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# Table of Contents

## 2016 AIUM Award Winners

- William J. Fry Memorial Lecture Award ................................................................. iii
- Joseph H. Holmes Basic Science Pioneer Award ...................................................... iv
- Joseph H. Holmes Clinical Pioneer Award ............................................................. v
- Peter H. Arger Excellence in Medical Student Education Award ....................... vi
- Distinguished Sonographer Award ..................................................................... vii
- Honorary Fellow Awards ................................................................................... viii
- Memorial Recognition ....................................................................................... x
- Endowment for Education and Research Donors ........................................... xii

## 2016 Scientific Sessions

### Saturday, March 19, 2016

**Scientific Sessions, 11:00 AM–12:30 PM**
- Basic Science: Bioeffects and Instrumentation .................................................. S3
- Obstetric Ultrasound: Fetal Anomalies ................................................................. S4
- Point-of-Care Ultrasound .............................................................................. S7
- Elastography .................................................................................................... S11

**Scientific Sessions, 4:00 PM–5:30 PM**
- Musculoskeletal Ultrasound ............................................................................ S15
- Obstetric Ultrasound: Uterus, Placenta, and Cervix ........................................ S18
- Therapeutic Ultrasound .................................................................................. S21

### Sunday, March 20, 2016

**Scientific Sessions, 11:00 AM–12:30 PM**
- Basic Science: Tissue Characterization ......................................................... S25
- Breast Ultrasound ......................................................................................... S26
- Contrast-Enhanced Ultrasound .................................................................... S28
- General, Abdominal, and Interventional-Intraoperative Ultrasound .......... S31
- Obstetric Ultrasound: New Techniques ....................................................... S34
- Point-of-Care Ultrasound ............................................................................ S38
- Ultrasound in Medical Education ............................................................... S41

**Scientific Sessions, 4:00 PM–5:30 PM**
- Gynecologic Ultrasound ............................................................................... S45
- High-Frequency and Contrast-Enhanced Ultrasound .................................. S48
- Pediatric Ultrasound and Neurosonology .................................................... S51

### Monday, March 21, 2016

**Scientific Sessions, 11:00 AM–12:30 PM**
- Contrast-Enhanced Ultrasound .................................................................... S56
- Fetal Echocardiography ............................................................................... S61
- Obstetric Ultrasound: Fetal Growth ............................................................. S64
William J. Fry Memorial Lecture Award

The William J. Fry Memorial Lecture Award was established by Joseph H. Holmes, MD, in 1969 and presented for the first time at the AIUM Annual Convention in Winnipeg that year. William J. Fry was a physicist with a strong interest in ultrasound in medicine, whose innovative research efforts advanced the field of medical ultrasound. One of Prof Fry's most notable contributions was the successful design of an ultrasonic system used to pinpoint lesions in the brain without damaging adjacent tissues. This ultrasonic system was later used to treat various brain pathologies and, in particular, Parkinson disease. His impassioned interest in ultrasound led him to become president of the AIUM from 1966 until his death in 1968. The following year, the William J. Fry Memorial Lecture Award was established in his honor. It recognizes a current or retired AIUM member who has significantly contributed in his or her particular field to the scientific progress of medical ultrasound.

Dirk Timmerman, MD, PhD, FRCOG

The AIUM's most prestigious award—the William J. Fry Memorial Lecture Award—is rightly presented this year to a most prestigious physician. Dirk Timmerman, MD, PhD, FRCOG, a native of Belgium, is a full professor in obstetrics and gynecology at the University of Leuven (known commonly as KU Leuven) and clinical head of benign gynecology and gynecological ultrasound at the University Hospitals Leuven. He graduated from medical school (summa cum laude) in 1989 and subsequently served as registrar in obstetrics and gynecology at Watford General Hospital in the United Kingdom and University Hospitals Leuven until he became a specialist and consultant in obstetrics and gynecology at the University Hospitals Leuven.

Not content with just a medical degree, Dr Timmerman defended his doctoral thesis in 1997, titled “Ultrasonography in the Assessment of Ovarian and Tamoxifen-Associated Endometrial Pathology.” Thus, he continued his impressive career in gynecologic ultrasound, early pregnancy and miscarriage, and the detection and staging of gynecologic cancers—and women across the globe are significantly better for his commitment.

Dr Timmerman is founder and coordinator of the International Ovarian Tumor Analysis Group, whose aims include the development of new algorithms to detect ovarian cancer, as well as optimal care of patients with adnexal tumors. There are currently 40+ centers throughout the world that are part of this collaborative effort, which has the potential to have such a positive impact on so many women from all strata and from all geographic locations.

His service as past editor of Ultrasound in Obstetrics and Gynecology and reviewer for 20 international journals are just small indications of his interest in imparting the latest and best information to all clinicians. In 2012, his nomination was approved to the International Advisory Board of The Obstetrician & Gynaecologist (TOG), which is the journal for continuing professional development of the Royal College of Obstetricians and Gynaecologists (RCOG), and in 2013, he became an associate editor of TOG. In addition, Dr Timmerman has coauthored more than 300 journal articles and been a presenter 400+ times at international meetings.

A board member of the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) for multiple terms, Dr Timmerman has also been a member of ISUOG’s Scientific Committee since 2013. He is a member of the Medical Council of UZ Leuven, former chair of the Clinical Research Fund of the University Hospitals Leuven, president of the Flanders Ultrasound Society, and senior clinical investigator of the Scientific Research Fund Flanders, which partly releases him from clinical duties to perform more clinical research.

In 2014, Dr Timmerman was awarded the InBev Baillet-Latour Prize for Clinical Research by Her Majesty the Queen of the Belgians at the Royal Academy of Medicine for his multicenter study of computer models for diagnosis of ovarian tumors, work that has already changed international clinical guidelines. Also in 2014, RCOG bestowed on him the status of Fellow ad eundem, which is awarded to individuals who have demonstrated, through research or clinical commitment, major contributions to obstetrics, gynecology, or reproductive health, have contributed to the advancement of the science or practice of obstetrics and gynecology in a substantial way, and are of an extremely high scientific caliber. We think RCOG has described Dr Timmerman to a T.

Lecture Topic: Tips and Tricks of Successful Ultrasound Studies

This lecture will cover lessons learned from 20 years of clinical research in gynecologic ultrasound ranging from assessment of ovarian tumors and uterine pathology to complications in early pregnancy.
2016 AIUM Award Winners

Joseph H. Holmes Basic Science Pioneer Award

The Pioneer Award, which honors an individual who has significantly contributed to the growth and development of medical ultrasound, was established in 1977. This special award was renamed in 1982 to honor Joseph H. Holmes, MD, who died that year. Dr Holmes, the first person named as an AIUM pioneer, was an important figure to both the field of diagnostic ultrasound and the AIUM. His early efforts in ultrasound research, which included tissue characterization and ultrasound's diagnostic use in polycystic kidney disease and orthopedics, helped advance the field of ultrasound and encourage others to conduct new research. Serving the AIUM in many capacities, Dr Holmes was president from 1968 to 1970 and was editor of the AIUM’s official journal, which was then titled the Journal of Clinical Ultrasound, for nearly 10 years. Each year, the Joseph H. Holmes Pioneer Award honors 2 current or retired members: 1 in clinical science and the other in basic science.

Michael Kolios, PhD

In 1997, Michael Kolios, PhD, was an assistant professor in the Department of Mathematics, Physics, and Computer Science at Ryerson University in Toronto, Canada. From day 1, Ryerson University realized what an incredible asset Dr Kolios was and has never let him go. Today he is a tenured professor in the Department of Physics and associate dean of research and graduate studies, Faculty of Science, as well as an affiliate scientist at St Michael's Hospital in Toronto. Dr Kolios earned his bachelor’s degree in physics from the University of Waterloo, followed by master’s and doctoral degrees at the University of Toronto, Department of Medical Biophysics.

He has been winning awards since his undergraduate days, and as a faculty member receiving the Ontario Premiers’ Early Researcher Award and a Canada Research Chair in Biomedical Applications of Ultrasound. His most recent award is the Sarvan Sahota Distinguished Scholar Award, which is presented to faculty who have made an outstanding contribution to knowledge in their area of expertise, and there certainly could not have been a more deserving candidate. With 5 patents and another 3 provisional patents to his name, Dr Kolios—whose calendar age puts him the toddler category in comparison to other professional researchers—is taking the ultrasound science world by storm and setting an example that will be difficult for his juniors to achieve and for his seniors to match.

One of the many attributes that sets Dr Kolios apart is his commitment to education at all levels. He has supervised a total of 16 doctoral candidates, as well as 29 master-of-science students, which would keep most people busy enough, but Dr Kolios has also supervised a dozen undergraduate students and 25 research assistants and has been involved in promoting science among high school students through programs such as the Sanofi-Aventis BioTalent Challenge, the Dragon Academy Scientists-in-Action program, and Ryerson’s Research Opportunity Program in Engineering. There is no doubt that due to his exceptional tutelage, the people whom he has taken under his wing will be making significant contributions to medical ultrasound in the future—a legacy that anyone would envy.

A reviewer for more than 15 scholarly journals, Dr Kolios is on the editorial boards of Ultrasonic Imaging and Photoacoustics and has served as an abstract reviewer for more than 10 professional conferences. He regularly reviews for the Canadian Institutes of Health Research and is a charter member of the National Institutes of Health Biomedical Imaging Technology Study Section. Recognized for his exceptional research skills, he has served as project leader, principal investigator, or coinvestigator on close to 80 projects with the potential for a significant impact on technology, cancer, bioengineering, and health care. Dr Kolios has 5 book chapters to his name, has published 80 articles in peer-reviewed journals, has 100+ papers in national and international conference proceedings, and has presented 150+ papers or abstracts at conferences throughout Canada, the United States, and Europe.

He has been an active member of the AIUM’s Bioeffects Committee and twice chair of the AIUM’s High-Frequency Clinical and Preclinical Imaging Community, as well as a long-term member of the Institute of Electrical and Electronics Engineers International Ultrasound Symposium Technical Program Committee, to name just a few of his leadership positions.

Dr Joseph Holmes was certainly innovative and a pioneer, but he probably never imagined in his wildest dreams how far someone like Dr Kolios would advance the science of ultrasound and how he would set the stage for future pioneers.
2016 AIUM Award Winners

Joseph H. Holmes Clinical Pioneer Award

The Pioneer Award, which honors an individual who has significantly contributed to the growth and development of medical ultrasound, was established in 1977. This special award was renamed in 1982 to honor Joseph H. Holmes, MD, who died that year. Dr Holmes, the first person named as an AIUM pioneer, was an important figure both in the field of diagnostic ultrasound and the AIUM. His early efforts in ultrasound research, which included tissue characterization and ultrasound's diagnostic use in polycystic kidney disease and orthopedics, helped advance the field of ultrasound and encourage others to conduct new research. Serving the AIUM in many capacities, Dr Holmes was president from 1968 to 1970 and was editor of the AIUM’s official journal, which was then titled the Journal of Clinical Ultrasound, for nearly 10 years. Each year, the Joseph H. Holmes Pioneer Award honors 2 current or retired members: 1 in clinical science and the other in basic science.

Alfred Abuhamad, MD, FAIUM

Physician, educator, inventor, and humanitarian—Alfred Abuhamad, MD, FAIUM, is not a man who can be described with just one word. A graduate of the American University of Beirut Medical School in Lebanon, he interned and completed his residency in obstetrics and gynecology at the University of Miami School of Medicine, followed by a fellowship at the same institution and another fellowship in ultrasound and prenatal diagnosis at Yale University. His exceptional expertise in ultrasound resulted in his appointment in 1992 as the director of ultrasonography at the Eastern Virginia Medical School, where he has remained ever since. Currently, he is the vice dean for clinical affairs, chair of the Department of Obstetrics and Gynecology, professor of radiology, and the Mason C. Andrews professor of obstetrics and gynecology. Dr Abuhamad’s innovation and creativity have resulted in 3 patents (system, method, and medium for acquiring and generating standardized operator-independent ultrasound images of fetal, neonatal, and adult organs; a cerclage suture removal device; and a compression balloon belt for postpartum hemorrhage). This same vision for improving diagnosis and treatment of pregnant women has resulted in 160+ abstracts, which is just a small reflection of his tireless research efforts and his commitment to educating his fellow clinicians and ensuring superb-quality health care.

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Currently associate editor in obstetrics for the Journal of Ultrasound in Medicine, Dr Abuhamad has served on the editorial boards of 3 other journals and is a reviewer for 11 other prestigious medical journals from the New England Journal of Medicine to Lancet. A prolific author, he has 5 books to his name (including Ultrasound in Obstetrics and Gynecology: A Practical Approach, an e-book with free open access), 31 book chapters, and more than 156 articles in peer-reviewed journals. Dr Abuhamad is also the recipient of a National Institutes of Health (NIH) R01 grant award for the application of novel ultrasound techniques in the study of the human placenta in early gestations—part of the NIH Human Placenta Project.

Because of his desire to promote the proper use of ultrasound not only within his specialty but among all clinicians, Dr Abuhamad was instrumental in the establishment of 2013 as the Year of Ultrasound. It was under his leadership as AIUM president that the Ultrasound First initiative began, which included an Ultrasound First Forum that addressed the expanding role of ultrasound imaging as a “first” imaging examination, as well as the creation of an ongoing series of Sound Judgment clinical vignettes in the Journal of Ultrasound in Medicine. Active in many professional societies, Dr Abuhamad has also served as president of the Maternal-Fetal Medicine Foundation and the Society of Ultrasound in Medical Education.

It is not surprising that a physician of the caliber of Dr Abuhamad has earned numerous awards, ranging from a National Faculty Award for Excellence in Resident Teaching to a Presidential Recognition Award to a Dean’s Outstanding Faculty Award. But, he has also been recognized 8 separate times as one of the Best Doctors in America; Hampton Roads Magazine has named him a Top Doctor every year since 2003; and he has twice received the Healthcare Hero’s Award. A hero to many of his patients, Dr Abuhamad is selfless in his concern for others. Through the International Society of Ultrasound in Obstetrics and Gynecology, for which he chairs the Outreach Committee, Dr Abuhamad has engaged in 7 outreach humanitarian trips to Haiti, Ghana, and Somaliland.

Yes, Dr Abuhamad is a skilled physician, a consummate educator, an ingenious inventor, a humble humanitarian—and, indeed, a true clinical pioneer.
2016 AIUM Award Winners

Peter H. Arger Excellence in Medical Student Education Award

The Peter H. Arger, MD, Excellence in Medical Student Education Award was established in 2013, with its first presentation occurring at the 2014 AIUM Annual Convention in Las Vegas, Nevada. Dr Arger has contributed much to the AIUM and to the growth of diagnostic ultrasound, but his true passion has been ultrasound education. This annual presentation honors an individual whose outstanding contributions to the development of medical ultrasound education warrant special merit.

John Christian Fox, MD, RDMS, FACEP, FAAEM, FAIUM

John Christian Fox, MD, RDMS, FACEP, FAAEM, FAIUM, has done a lot of traveling in his educational journey. Born on the East Coast, he earned his bachelor’s degree on the West Coast at the University of California (UC), Irvine, and then traveled back across the continent to obtain his medical degree at Tufts University. He returned to the West Coast to complete his residency in emergency medicine but then tarried in the Midwest for his fellowship at the University of Illinois, Chicago, before completing his journey back on the West Coast at the UC Irvine Medical Center, where he is professor of clinical emergency medicine, vice chair of academic affairs, emergency ultrasound fellowship director, and assistant dean of student affairs. Not one to let moss grow under his feet, Dr Fox is also an adjunct professor at the University of New England, Armidale, Australia, as well as at the University of Santo Tomas, Manila, Philippines.

Dr Fox’s passion for ultrasound education has had, and will continue to have for the foreseeable future, a profound impact on medical students, practicing clinicians (especially emergency medicine specialists), and, ultimately, patients, who are receiving better, more comprehensive, and less expensive care. During the past 15 years, Dr Fox has received $1.6 million in grants for ultrasound instruction with an emphasis on medical students, international ultrasound teaching, a curriculum for bedside ultrasound training, and faculty development—all of which will have many long-term benefits.

With his commitment to medical education, it is not surprising that Dr Fox has written 66 peer-reviewed articles, close to 3 dozen books chapters, and 3 exceptional textbooks, but he has also created 10 multimedia (DVD) publications, been invited to give 40+ presentations at educational institutions, been a guest speaker 200 times in 37 different states, and lectured another 200 times at professional meetings, not to mention the abstracts he has presented or the lectures he has given to medical students at the UC Irvine School of Medicine.

But it is not the number of papers or professional appearances that is important, it is the subject matter, the quality of the presentations, and the superior hands-on instruction from physics and knobology to cost-effective imaging and critical decision making that resonates. His teaching skill is reflected in the 2 dozen honors and awards he has received for Medical Student Faculty Teaching, Emergency Ultrasound Teaching, Academic Excellence, Outstanding Faculty Service, Excellence in Teaching, and Emergency Ultrasound Educator of the Year, just to name a few. And let us not forget his exceptional TEDxUCIrvine presentation “Point of Care Revolution: Ultrasound” in 2015.

One would not think that Dr Fox would have time for much else, but like many emergency physicians, he thrives under pressure and handles multitasking with ease. For the AIUM alone, he has served on the Finance Committee, Web Development Committee (vice chair), Clinical Standards Committee, Membership Committee, Clinical Content Task Force, Annual Convention Committee, and Emergency Section (cochair), but he is also an active member of 9 societies, having served in various roles from cochair of the Ultrasound Multimedia Task Force of the Society of Critical Care Medicine to panelist for the Early First-Trimester Sonography Guideline Consensus Panel of the Society of Radiologists in Ultrasound. In addition to his membership on numerous committees for UC Irvine, Dr Fox served for 10 years as faculty advisor for the Flying Samaritans UCI, supervising undergraduate students, medical students, and postgraduate residents at a free medical clinic in El Teterazo, Baja California; since 1989, Dr Fox has made 115 trips!

Dr Peter H. Arger is known for his intense concern for patients, his powerful commitment to medical teaching, and his strong belief in outstanding ultrasound education, and Dr Fox mirrors those values and traits, which makes him the ideal recipient of this award.
If individuals thinking about careers in sonography wondered what heights they could achieve, they would need look no further than the curriculum vitae of Daniel A. Merton, BS, RDMS, FSDMS, FAIUM. Currently a senior project officer for the Health Devices Group at ECRI Institute in Pennsylvania, Mr. Merton learned that ultrasound was used for diagnostic medical applications during his service in the US Navy when he served as a sonar technician. After receiving an associate degree in biology/zoology (with honors) at the State University of New York, he transferred to Thomas Jefferson University where he earned his bachelor of science degree in diagnostic imaging (cum laude) in 1988, and that was the start of his meteoric rise.

After graduating, he became a staff sonographer at Thomas Jefferson University Hospital, and 3 years later, became a research sonographer. In 1993, Mr. Merton was hired as the technical coordinator of research for the Jefferson Ultrasound Research and Education Institute (JUREI). His attention to detail, in-depth knowledge of ultrasound, excellent writing skills, and commitment to research made him the ideal professional for this position. Many sonographers are asked to be part of a research grant or two, but few have been involved in more than 30 grant-funded activities as has Mr. Merton, including support from the National Institutes of Health, the US Agency for International Development, and numerous pharmaceutical and medical device companies.

Coauthor of the book An Atlas of Ultrasound Color Flow Imaging with Barry Goldberg, MD, Mr. Merton has also penned 20 book chapters. In addition, he has authored or co-authored more than 100 articles in peer-reviewed journals—a claim to fame that not many clinicians or ultrasound researchers have achieved—as well as another 80 articles online and in trade magazines. It is, therefore, not surprising that he has received the Kenneth R. Gottesfeld Award from the Society of Diagnostic Medical Sonography (SDMS) 3 times; this award recognizes sonographer authors for the publication of outstanding research. Throughout his career, Mr. Merton has regularly been recognized for his achievements ranging from an Alumni Special Achievement Award from the Jefferson College of Health Professions, to a Presidential Recognition Award from the AIUM, to a Telly Award for “Ultrasound: New Advancements,” and recognition from CIVCO, DuPont Pharmaceuticals, and Medison—just to name a few of his honors.

Both sonographers and sonologists have benefited from his high-level of expertise and superb teaching skills, as Mr. Merton has been invited to lecture at nearly 200 local, national, and international imaging society meetings. Mr. Merton has provided many lectures as a clinical instructor for JUREI and has presented more than 200 scientific abstracts. Moreover, he has been a coauthor on 55 scientific posters and exhibits, many of which have received first-, second-, and third-place honors, certificates of merit, and honorable mentions.

He’s a writer, a researcher, an educator, and a sonographer (oh, and a husband and father of 2 boys), so it’s hard to imagine that Dan would have time for anything else. However, he cares deeply about promoting exceptional ultrasound practice and ensuring that all sonographers have the requisite skills to ensure superb patient care through education and credentialing. Thus, he has been an active member of the SDMS, the American Registry for Diagnostic Medical Sonography (ARDMS), and the AIUM, serving on countless committees and task forces, as well as the editorial board of both the AIUM’s and the SDMS’s journals, and the board of governors for both the AIUM and the ARDMS. He is the current treasurer of Inteleos—the parent organization of the ARDMS. “Distinguished Sonographer” is an understatement when it comes to Mr. Merton.
Aris T. Papageorghiou, MD, FRCOG

Aris T. Papageorghiou, MD, FRCOG, is professor in fetal medicine and obstetrics at St George’s Healthcare NHS Trust in London and associate professor of fetal medicine at the Nuffield Department of Obstetrics and Gynaecology, University of Oxford. He earned his medical degree at the University of Sheffield and completed his doctoral thesis at the University of London—while he was a research fellow at the Harris Birthright Research Centre for Fetal Medicine—on the prediction of preeclampsia using uterine artery Doppler ultrasound (the largest study on this topic to date).

Dr Papageorghiou subsequently completed specialist training in obstetrics and gynecology and subspecialist training in maternal-fetal medicine while serving as a lecturer at St George’s, University of London. An internationally recognized expert in fetal diagnosis and therapy, Dr Papageorghiou has also developed a keen interest in medical statistics, which has served him well in his work on large population-based studies (eg, the characterization of normal and abnormal fetal and neonatal growth in relation to maternal and fetal nutritional status) and international multicenter research endeavors (eg, INTERGROWTH-21st and INTERBIO-21st). He is engaged in active research collaborations with Liverpool University, Cambridge University, University of London, University of Oxford, and the Shoklo Malaria Research Unit in Thailand and is beginning work on a proposed project on the introduction of fetal growth standards and tools for phenotypic characterization.

Committed to education and having a love of teaching, he has trained sonologists across the globe, served as an advisor to 6 postgraduate students, teaches in the MBBS program at St George’s, and been a trainer and examiner for the MRCOG (membership examination of the Royal College of Obstetricians and Gynaecologists). In addition to authoring several book chapters and serving as coeditor of a major textbook on obstetrics and gynecology and coauthor of Obstetric Ultrasound: A Problem-Based Approach, Dr Papageorghiou has penned close to 200 journal articles.

Fluent in English, Greek, and German, with good knowledge of Spanish, it is not surprising that Dr Papageorghiou has a passion for providing ultrasound to underserved communities worldwide. As part of his fetal growth studies, he has shown that it is possible to train local workers with little health training to obtain accurate fetal measurements using ultrasound, which has the potential to reduce maternal and perinatal mortality and morbidity.

An avid reader and amateur photographer with interests in contemporary art, modernist architecture, and scuba diving, Dr Papageorghiou—with his dedication to research, teaching, and global ultrasound—has set the bar high for other physicians. The AIUM is delighted to welcome him to the organization as an honorary fellow.
2016 AIUM Award Winners

Honorary Fellow Award

The Honorary Fellow Award bestows an honorary membership to individuals who have contributed significantly to the field of ultrasound.

Paul Sidhu, BSc, MBBS, MRCP, FRCR

Paul Sidhu, BSc, MBBS, MRCP, FRCR, is the fifth individual from King’s College London to be designated as an AIUM honorary fellow. This says volumes about the ultrasound expertise associated with King’s, as well as being a reflection of the exemplary skills and proficiency that Dr Sidhu brings to the world of medical ultrasound. Currently professor of imaging sciences and consultant radiologist at King’s College London, Dr Sidhu has excelled in both academia and athletics since his undergraduate days—not necessarily a common combination among physicians. His list of postgraduate awards and prizes consumes 4 single-spaced pages printed in a font size that would be an optician’s dream. They include a magnum cum laude and a cum laude scientific exhibition award from the European Association of Radiologists, as well as a cum laude award and 4 certificates of merit for his poster presentations for the Radiological Society of North America.

Dr Sidhu is the author of more than 200 peer-reviewed papers, 52 book chapters, and 5 books. Authors that prolific rarely have time to do little else, but Dr Sidhu has served as past president of the British Medical Ultrasound Society and of the Section of Radiology of the Royal Society of Medicine and is currently the president-elect of the European Federation of Societies for Ultrasound in Medicine and Biology. In addition, he is an active member of 13 professional radiology associations, serving for many in the capacity of committee chair or member, as well as officer—just a small indication of his commitment to staying current in all aspects of his field with the goal of providing superlative patient care.

Currently editor of the European Journal of Ultrasound (Ultraschall in der Medizin), Dr Sidhu is a past deputy editor of the British Journal of Radiology, has been a member of the editorial boards of 10 medical journals, and has served as guest editor for 2 imaging journals. It should come as no surprise that he received an Editor’s Recognition Award 5 years in a row from Radiology for his high-quality, prompt, detailed, and scholarly reviews.

Recognized as a world authority on the application of contrast-enhanced ultrasound in clinical practice, Dr Sidhu is an expert in male health, liver transplantation, and vascular interventional radiology. Through all his work—publishing, lecturing, and clinical practice—he has continually demonstrated his dedication to the highest quality medical standards. His patients, his colleagues, his readers, and his attendees receive only the best. Dr Sidhu is the quintessential ultrasound professional. The AIUM is proud to have him as an honorary fellow.
2016 AIUM Award Winners

Memorial Recognition

Established in 2002, Memorial Recognition serves as a posthumous tribute to a creative and devoted physician, research scientist, or other member who has contributed to the field of ultrasound in medicine. The honoree is recognized at the Opening Session during the AIUM Annual Convention.

Anna S. Lev-Toaff, MD, FAIUM, FACR, FSRU

It was with great sadness that the AIUM learned of the too-early death of Anna S. Lev-Toaff, MD, FAIUM, FACR, on April 3, 2015, at only 60 years of age due to complications secondary to multiple myeloma. This distinguished clinician and respected researcher received her bachelor's degree in biology and her medical degree from New York University. She subsequently trained in surgery at Pennsylvania Hospital in Philadelphia and Tel Aviv University in Israel before completing her radiology residency at the Thomas Jefferson University Hospital in Philadelphia, followed by an abdominal imaging fellowship at the Hospital of the University of Pennsylvania.

From 1985–1986, Dr Lev-Toaff was a radiology instructor at the Perelman School of Medicine at the University of Pennsylvania, an institution she would return to in 2008 as a professor of radiology and a member of the Clinical Practices of the University of Pennsylvania and where she would teach and practice until 2014. In between her stints at the University of Pennsylvania, she served on the faculty at Temple University from 1986–1990 and for 18 years at Thomas Jefferson University.

Coeditor of the textbook Clinical Pelvic Imaging: CT, Ultrasound and MRI, Dr Lev-Toaff’s research interests centered around ultrasound contrast agents, 3-dimensional ultrasound, and virtual colonoscopy. This accomplished radiologist and academic focused her considerable clinical expertise on interventional ultrasound (ultrasound-guided biopsy), sonohysterography, virtual colonoscopy, abdominal/pelvic computed tomography and diagnostic ultrasound, 3-dimensional ultrasound, and gastrointestinal radiology. Her death is a loss to so many patients—people whom she cared about deeply.

A prolific author, Dr Lev-Toaff published 75 journal papers and more than 100 abstracts. Because of the respect for her knowledge and expertise, she was invited to present 200 lectures; her sharp wit and brilliant verbal skills made her the consummate educator. Generous to a fault, Dr Lev-Toaff was known by radiologists worldwide for her concern for those in need and her commitment to her profession and to her patients. Due to her many accomplishments in research, education, and clinical and volunteer work, she was elected to fellow status by the AIUM, the American College of Radiology, and the Society of Radiologists in Ultrasound and was actively involved in all 3 organizations. A reflection of Dr Lev-Toaff’s dedication to education and research, she served on the Editorial Board of the Journal of Ultrasound in Medicine and had been a member of the AIUM’s Annual Convention Committee and its Endowment for Education and Research Committee.

We grieve with Dr Lev-Toaff’s 4 children (her proudest accomplishment), her extended family, her colleagues worldwide, and her past and would-have-been patients; the world of radiology has lost one of its best.
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Carol Mittelstaedt, MD, FAIUM

On March 12, 2015, Carol Mittelstaedt, MD, FAIUM, died at an age (69 years) when she was just beginning to enjoy her well-deserved retirement. A native of Arkansas, she earned a bachelor of science degree from the University of Arkansas in Fayetteville and her medical degree at the University of Arkansas Medical School. She subsequently completed a radiology residency at the same institution, followed by a fellowship in diagnostic ultrasound at the University of California San Diego under George R. Leopold, MD, FAIUM, editor emeritus of the Journal of Ultrasound in Medicine.

Affectionately known as Dr Mitt, she was an ultrasound pioneer who founded the Clinical Ultrasound Service at the University of North Carolina (UNC) and was one of the first women appointed to the faculty of the Department of Radiology, where she served as director of ultrasound until 2004. Recognizing that the usefulness of medical ultrasound is dependent on the skill and knowledge of the person scanning, she founded a school of sonography at UNC.

A member of the AIUM for more than 3 decades, Dr Mittelstaedt was awarded fellowship status in 1990. As she did with everything, she gave the organization her all. She was a member of the AIUM’s Board of Governors (1995–1998), chaired the Program Committee as well as what was previously known as the Abdominal Section, and served on the Annual Convention Committee, the Education and Research Scientific Advisory Committee, and the Americas Conference on Ultrasound Committee. She was also active in the Society of Radiologists in Ultrasound (SRU), serving as program chair and chair of the SRU’s Constitution Committee. In addition, she examined in ultrasound for the American Board of Radiology in the late 1980s.

An exceptional teacher, she was an invited lecturer at national and local radiology conventions and at foreign medical convocations in Chile, Egypt, Hong Kong, and Thailand. An ideal mentor, she nurtured the careers of many who would go on to become leaders in medical ultrasound. Indeed, it was due to her efforts in introducing young faculty to ultrasound that inspired many to choose ultrasound as their main specialty of interest. She was ahead of her time in recognizing the importance and value of diagnostic ultrasound.
The AIUM’s Endowment for Education and Research (EER) was created to provide much-needed funding for ultrasound research and educational initiatives. What makes this possible is the generous support of AIUM members, vendors, and individuals who provide gifts in honor or in memory of ultrasound professionals.

It is with great appreciation that the AIUM thanks the individuals listed below who contributed to the EER during the 2015 campaign. These individuals have a ribbon on their name badge acknowledging their generosity; please thank them for their support. If you would like to make an EER donation, you can do so at the Registration Desk.

Contributions of $1000 and Above
Alfred Abuhamad, MD, FAIUM
Peter Arger, MD, FAIUM, FCR
David Bahner, MD, RDMS, FAIUM, FAEEM, FACEP
Beryl Benacerraf, MD, FAIUM
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*Presenter of scientific paper with more than 1 author.
**2385072 Hermite Function Pulses for Scatterer Identification**
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**Objectives:** Different classes of scatterers have characteristic frequency dependences, from nearly flat (in the case of ideal specular reflections from surfaces) to Rayleigh scattering from subresolvable scatterers. The Gaussian-weighted hermite polynomials have a power law relation in the frequency domain and may be useful for assessment of the type of reflected signal in pulse-echo imaging.

**Methods:** The nth successive differentiation of the Gaussian pulse \( G = \exp(-t^2) \) generates the nth order Hermite polynomial (Poularikas, 2010). The function \( H_n(t)G \) resembles a typical broadband pulse. Assuming a pulse-echo system has a round-trip impulse response of \( A_HH_n(t)G \), then we expect that a reflection from a step function of acoustic impedance will produce a corresponding received echo proportional to \( G(t)H_n(t) \). However, a thin layer of higher impedance would have a discrete doublet (derivative) in impedance and an echo proportional to \( G(t)H_n(t) \) by the derivative nature of the Hermite polynomials. Finally, a small scatterer or incoherent cloud of small scatterers would exhibit a second derivative behavior and return an echo proportional to \( G(t)H_n(t) \). In this framework, the identification task is simply to classify echoes by similarity to either \( G(t)H_n(t) \), or \( G(t)H_n(t) \), or \( G(t)H_n(t) \).

**Results:** To demonstrate the potential of this approach to identify properties that are otherwise hidden in the conventional B-scan, simulations of different classes of scatterers are examined. Conventional imaging parameters are used or a \( G(t)H_n(t) \) round-trip impulse response scaled to a peak frequency of 5 MHz. Scatter types include a single impulse, a discrete doublet (axially), and the left discrete triplet. Thus, the scatterers approximately produce reflections that correspond to the pulse, the derivative of the pulse, and the second derivative of the pulse with respect to time. The resulting B-scan image is examined, and echoes can be correctly classified according to their class. Tissue scans also demonstrate groups of echoes separated by Hermite order \( H_n \).

**Conclusions:** A theoretical framework is introduced where reflections are characterized by their similarity to nth order Hermite polynomials.
239402 Differentiation of Breast Lesions Using Statistics of Backscattered Echoes Combined With the Breast Imaging Reporting and Data System
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Objectives: The aim of the study was finding the relationship between Breast Imaging Reporting and Data System (BI-RADS) classification combined with K. K-homodyne, and Nakagami statistics of echoes backscattered in the breast tissue and histologic data.

Methods: A total of 220 breast lesions were examined: 66 malignant and 154 benign. Both the radiodensity (RF) echo signal and B-mode images from the lesions and surrounding tissue were recorded. The analysis method was based on combining data from BI-RADS classification and statistical parameters. Two types of data, a traditional B-mode image and a set of RF echo lines, were acquired for the breast regions where the tumors were localized and from the healthy regions of the breast tissues. One image consists of up to 500 RF echo lines. Influence of the attenuation on RF echoes was compensated prior to the statistical properties of the breast backscatter. For every sub-region of interest (ROI) region, the mean value of echo envelopes was calculated. Next, the values of the envelopes inside each square subregion were divided by the mean value of the envelope, which was determined for this area. In the next step, each lesion was divided into N sub-ROIs covering the lesion. The quantitative parameters were calculated for sub-ROIs inside the lesion and for surrounding tissues. Based on the distribution parameters, the set of 21 parameters was defined.

Results: When only B-mode imaging was used with the cutoff at BI-RADS 3/4a, all malignant lesions were diagnosed correctly; however, 46 benign lesions were sent for biopsy unnecessarily. The best result, obtained for K distribution showed a sum of specificity and sensitivity equal to 164.79%. Combined BI-RADS classification and statistics showed 96.88% sensitivity with specificity equal to 65.33%, which means the number of lesions that were biopsied decreased from 46 to 35.

Conclusions: Combining quantitative ultrasound with BI-RADS classification seems to be encouraging. Analysis of 220 breast lesions showed that the use of quantitative parameters together with BI-RADS classification categories improved distinguishing benign from malignant lesions and allowed us to reduce the number of biopsies by almost 25%, compared to procedures based on B-mode images only.

239438 Shear Rate Normalized Flow-Mediated Vasodilation of the Radial Artery
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Objectives: Preceding atherosclerosis is endothelial dysfunction. There is therefore interest in the application of noninvasive clinical tools to assess endothelial function. There are commercially available ultrasound scanners to measure flow-mediated vasodilatation (FMD) of the brachial artery using 10–12-MHz linear array probe; however, the precision in estimating artery dilation does not exceed 0.2 mm, far beyond the required one. To improve the axial resolution, we have used a Sonix Touch Research ultrasound scanner (Analogic) with a 20-MHz linear array to measure the dilation of the radial artery. FMD results were next normalized to the accumulated shear rate (SR_{max}) recorded using 20-MHz pulses Doppler attached to the linear array transducer.

Methods: Eighteen healthy volunteers and 3 volunteers with a minor cardiac accident were examined. The radial artery reactive response (RAR) was provoked by 5-minute artery ischemia through the inflated pressure cuff on the forearm. A B-scan of the radial artery was recorded for 2 minutes after cuff release. During this time, the maximum flow velocity (V_{max}) along the central stream was also acquired. The normalization of FMD to shear is done by dividing peak FMD by the accumulated value of shear rate area under the curve SR_{max}, calculated for the time span between releasing the cuff and peak dilation. The SR_{max}, was calculated as SR_{max} = \frac{6V_{max}t}{D}, assuming a slightly flattened flow profile.

Results: The measured initial internal radial artery diameter was in the range of 1.59–2.35 mm; the maximum diameter of 2.01–2.60 mm was observed 35–55 seconds after releasing the cuff. In a limited number (18) of examined young healthy patients, the FMD_{max} was in the range from 7.8–9.9 in arbitrary units. In older patients with a minor cardiac history, the normalized FMD_{max} was clearly lower: 6.8–7.6.

Conclusions: The radial FMD using 20-MHz imaging/Doppler equipment has over 2 times better resolution than the resolution obtained using 7–10-MHz brachial scanning. The normalized FMD of radial artery RARR in our group was 13%–28% and can be an alternative to the brachial FMD where the precision of measurements is lower and the diameter dilation does not exceed 7%–10%.

Cardiovascular Ultrasound
Moderator: M. Robert De Jong, RDMS, RDCS, RVT

236109 Will the Next Generation of Hospitalists Use Ultrasound in Practice? Observations Regarding Use of a Pocket-Sized Ultrasound Device by Residents During a Hospitalist Rotation
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Objectives: Although a pocket-sized ultrasound device (PSD) can augment cardiac physical examination, actual use on patients requires a perception of diagnostic need, a belief in one’s skills, and convenience. We sought to observe the pattern of autonomous use and perceived clinical utility of a PSD when carried by on-call internal medicine residents (MDs).

Methods: We interviewed 14 consecutive MDs, formally trained in a cardiac limited ultrasound exam (CLUE), who carried a PSD for use at their own discretion during a busy night hospitalist call rotation. After a shift, MDs reported their use of the PSD with regard to indications, detering factors, and difficulties in imaging. A separate detailed analysis was performed with a single MD instructed to utilize the PSD on every admission to compare the proportion of abnormal CLUEs and clinical utility in patients with and without perceived indications. Clinical utility was considered when changes in management or significant reassurance were attributable to PSD use. Proportions were compared using 95% confidence intervals and a test of proportions.

Results: MDs admitted 243 patients (mean age, 54 years; range, 18–91 years) during 48 shifts. CLUE was felt to be indicated during 107/243 (44%) admitting physicals. MDs elected not to scan 136 patients due to lack of perceived indications (89 patients; 65.4%), time constraints (22 patients; 16.2%), or cooperative patients (25 patients; 18.4%) and considered 17% of CLUE views technically difficult. In the detailed analysis (n = 71), the MD felt CLUE would have been indicated vs not indicated in 32 (45%) vs 39 (55%), with abnormality rates of 50% (32.7%, 66%) vs 20.5% (7.8%, 33.2%) (P < 0.05) and clinical utility of 28.1% (12.5%, 43.7%) vs 15.4% (4.1%, 26.7%) (P = not significant), respectively.

Conclusions: On a hospitalist rotation, residents frequently used ultrasound in initial assessment, and, in a detailed analysis, a considerable rate of abnormalities and management changes exist in patients with and without perceived indications. Augmenting patient evaluation with ultrasound may be a desired technique of hospitalists in the future.

American Institute of Ultrasound in Medicine Proceedings
Coronary Calcium Volume Measurement in a Diabetic Cohort Using Intravascular Ultrasound Videos: A Comparative Study

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Objectives: The planning of percutaneous coronary intervention procedures requires a quantitative assessment of the calcified volume in atherosclerotic plaques. The objective of this study is to automatically measure the calcium volume from intravascular ultrasound (IVUS) videos in a diabetic cohort with Japanese ethnicity.

Methods: Fifteen patients (14 M/1 F; age of 67 ± 11 years), Institutional Review Board approved, Toho University, written informed consent, consisting of 30,600 coronary IVUS frames were collected using a 40-MHz IVUS catheter (Atlantis SR Pro, Boston Scientific, pullback speed of 0.5 mm/s). The mean hemoglobin, total Cholesterol, low-density lipoprotein, high-density lipoprotein, and percentage smokers were 5.89 ± 1.05 g/dL, 165 ± 20 mg/dL, 95 ± 23 mg/dL, 49 ± 13 mg/dL, and 46.6%, respectively. Lesion locations: 7 patients had a proximal lesion location, 4 at a middle and 4 at a distal location. The following locations were observed on calcification: 8 patients on left anterior descending, 4 on right ascending, 2 on left circumflex, and 1 on left main. Three automated soft computing fuzzy pixel classification techniques, namely, fuzzy C-means (FCM), K-means, and hidden Markov random field (HMRF), were designed for automated extraction of calcified regions in above the frames including the outliers, a moderate to high CC was observed and between (a) LD and PS, at 0.38 ± 0.24 mm (sensitivity, 100%; specificity, 100%). The intraobserver CCs between the 4 segments from the internal carotid artery and common carotid artery. The correlation coefficients (CCs) between (a) LD and PS and (b) IAD and PS were calculated and compared.

Results: The CC observed between (a) LD and PS was 0.19 (P < .007), and between (b) IAD and PS, it was 0.25 (P < .0006). On excluding the outliers, a moderate to high CC was observed between LD and PS, at 0.38 (P < .0001), and between IAD and PS, it was 0.25 (P < .0001). We validated our automated LD/IAD measurements against 2 manual expert tracings. The corresponding errors for LD were 0.27 ± 0.26 and 0.25 ± 0.24 mm, while for IAD, the errors were 0.23 ± 0.23 and 0.24 ± 0.24 mm (sensitivity, 100%; specificity, 100%). The intraobserver CCs between the 2 manual tracings for LD and between the 2 manual tracings for IAD were 0.95 (P < .0001) and 0.98 (P < .0001), respectively.

Conclusions: We demonstrated 3 automated techniques for coronary calcium volume measurement using IVUS videos on a Japanese diabetic cohort. K-means showed the best performance. We validated our system against the expert’s reading and performed the 3 statistical tests. The prototype design can be adapted in clinical settings.
2375021 Initial Attempt Combining Transthoracic Echocardiography and Ultrasonography to Diagnose Intravascular and Intracardiac Metastatic Tumors
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Objectives: Ultrasonography (US) and transthoracic echocardiography (TTE) are seldom applied in the comprehensive evaluation of cardiovascular metastatic tumor thrombus in routine clinical practice. We attempt to combine US with TTE in the diagnosis of metastatic tumor thrombus in the heart and vessels.

Methods: Vascular, abdominal, pelvic, and small-parts US was applied in 18 patients and transthoracic echocardiography was conducted in 14 patients to evaluate metastatic tumor thrombus.

Results: The tumor thrombus invaded the inferior vena cava (IVC) system in 12 patients, superior vena cava (SVC) system in 5 patients, and aorta in 1 patient. The tumor thrombus extended to the right cardiac chamber in 11 patients; 6 patients had pathological diagnoses. The primary neoplasm was identified by conventional imaging in 8 patients, and 1 patient had no more information. The morphology and echogenicity of the tumor thrombus were diverse and depended on their original tumor; most had imaging characteristics of solid masses except for 2 leiomyomatosis cases with tube-like masses; the tumor thrombus were either continuous or distinct from the original tumors. The neoplastic vascularity in the thrombus was the primary characteristic distinguishing the lesion from a clot.

Conclusions: Combining US and TTE is a feasible way to identify the location and extension of metastatic tumor thrombus in most patients. The right ventricular inflow tract/right heart 2-chamber view is an important and useful view to differentiate cardiac tumor thrombus from the SVC with those from the IVC. Misdiagnosis can be avoided using this view in clinical practice.

2381935 Ultrasound Characterization of Carotid Plaque Vulnerability in Patients Prior to Endarterectomy
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Objectives: To investigate 2 new ultrasound (US) image-processing techniques (MicroPure and SMI; Toshiba Medical Systems, Tokyo, Japan) for evaluating carotid plaque calcification and neovascularization as predictors of carotid plaque vulnerability.

Methods: Twelve subjects, with preoperative CT angiography (CTA) and scheduled for carotid endarterectomy, were enrolled in an ongoing Institutional Review Board–approved pilot study. Bilateral grayscale and power Doppler of the carotids were performed followed by MicroPure and SMI using an Apio 500 US system (Toshiba). MultiPure combines nonlinear imaging and speckle suppression to mark suspected calcifications as white spots in a blue overlay, while SMI utilizes advanced clutter suppression to extract microvascular flow signals and depicts those as a color overlay or a monochrome flow map. Two independent reviewers scored calcifications as present or absent, while intraplaque neovascularization was scored on a 4-point scale (0-3; no flow to marked vaso vasmor flow). MicroPure and SMI assessments were compared to conventional US and CTA for the evaluation of intraplaque calcifications and neovascularization using Wilcoxon signed rank tests, with pathology as the reference standard. Inter-reader agreement was established by the k statistic.

Results: One subject was eliminated from the study due to technical difficulties (ie, 22 carotids were studied). To date, 6 of the 12 subjects have undergone endarterectomy (producing 7 specimens due to 1 case of bilateral endarterectomies). Intraplaque neovascularization was detected by SMI in 6 of 7 specimens and overall in 17 of 22 vessels examined. There was excellent inter-reader agreement (k = 0.74) and no statistical differences between both readers and pathology (P > .08). Intraplaque neovascularization was not detected by CTA. Intraplaque microcalcifications were detected in 6 of the 7 specimens by MicroPure but did not provide information not already evident with conventional US.

Conclusions: SMI may have potential for predicting key histopathologic features of vulnerable carotid plaques that are not well evaluated by conventional imaging modalities. MicroPure is designed for breast imaging and appears less useful in carotid applications.

2385100 Initial Assessment of Carotid Doppler Velocity Measurement Reproducibility in Normal Volunteers
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Objectives: Knowledge of the standard deviation (SD) of clinical peak systolic velocity (PSV) measurements would greatly facilitate PSV comparisons between new and prior exams and with standard velocity threshold values. Reproducibility may vary between vascular ultrasound (US) practices due to differences in US imaging systems, clinical protocols, and levels of sonographer training and experience. Our aim was to measure PSV measurement SD in the carotid vessels in normal volunteers in our practice.

Methods: The right and left distal common carotid artery (CCA), bulb, and internal carotid artery (ICA) in 5 normal volunteers (2 male, 3 female) were scanned by 4 sonographers in separate scan sessions on 2 different days, using our standard clinical approach. Sonographer experience ranged from 3-15 years. Two nonsequential repeat measurements of each vessel segment were made by each sonographer in each scan session. PSV SDs and 95% confidence intervals were calculated using the method reported by Barnhart and Barboriak (Transc Oculd 2009; 2:231–235).

Results: SDs for the distal CCA, bulb, and ICA were 7.0, 7.1, and 9.6 cm/s, respectively. Overall SD was 8.0 cm/s (11.9% of the mean) for all vessel segments combined. SD ranged from 4.6–5.7 cm/s, across the 4 sonographers. These differences were not significant, but some evidence of bias was seen (tendency toward higher or lower measurements). SDs from measurements made earlier and later in each scan session were 7.3 and 6.1 cm/s, respectively, but this difference was not significant. Some correlation between measurement time in the scan session and sonographer was present due to lack of true randomization of sonographer scan order. No significant Doppler angle effect on SD was noted, but only a relatively narrow range of angles was used in this study. Overall SD was significantly reduced from 8.0 to 5.3 cm/s by averaging 2 measurements from different sonographers, while SD from same-sonographer averages was not significantly reduced.

Conclusions: The overall PSV SD was 8.0 cm/s in these normal subjects. Intersonographer performance was consistent despite differences in experience. Averaging pairs of different sonographer measurements reduced PSV SD by ~33%.
2385287 Noninvasive Intracardiac Pressure Measurements Using Subharmonic Aided Pressure Estimation: Proof of Concept in Humans

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Objectives: To evaluate the feasibility of noninvasive intracardiac pressure estimation using subharmonic signals from ultrasound (US) contrast agents in patients undergoing cardiac catheterization.

Methods: This Institutional Review Board–approved pilot study included 15 patients (age, 49–80 years; 13 male and 2 female) who were scheduled for left and right heart catheterization. All subjects provided written informed consent. Gray-scale US imaging was performed for each patient before catheterization to mark optimum acoustic windows for cardiac imaging in a supine position. During the catheterization procedure, 2 vials of Definity (Lantheus Medical Imaging, North Billerica, MA) mixed in 50 mL of saline were infused intravenously at 4–10 mL/min to provide intracardiac contrast visibility. US scanning was performed with a Sonix RP (Analogic Corporation, Peabody, MA) scanner operating in pulse inversion mode with acoustic power values of 0, –2, and –4 dB at a transmit frequency of 2.5 MHz. Radiofrequency (RF) data were acquired for 10 seconds (n = 3 per power level) using a pulsed Doppler gate placed in the left and right ventricles (LV and RV) and the aorta (to provide a calibration factor) synchronously with pressure catheter measurements. Central pressures were also obtained using a Sphygmocor (ACIcor Medical, Itasca, IL) device. Subharmonic signals were extracted from the RF data offline and filtered using MATLAB (Mathworks Inc, Natick, MA). Linear regression analysis was used to compare subharmonic aided pressure estimation (SHAPE) and pressure catheter data.

Results: SHAPE data were acquired from all 15 patients. The duration of contrast infusion ranged from 8–13 minutes. SHAPE data from 3 patients showed a relatively low subharmonic signal-to-noise ratio due to extrinsic factors and were eliminated from the study. Correlation between the SHAPE data and the pressure catheter data reached 0.4 and 0.7 for the LV and the RV, respectively. For data acquired with optimum acoustic power, error values as low as 2.6 mm Hg were obtained.

Conclusions: The SHAPE technique has potential to provide intracardiac pressures noninvasively, enabling more frequent pressure measurements for diagnosis or monitoring treatment outcome.

Obstetric Ultrasound: Fetal Anomalies
Moderator: Nazrin Benion, MD

2377086 Association Between Soft Markers and Abnormal Newborn Phenotype in Women 35 Years or Older With Negative Cell-Free DNA Testing

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Objectives: Women 35 years or older at the time of delivery are at highest risk of having a child with Down syndrome, and in recent years, the cell-free DNA analysis was recommended as a screening option in that population. In this study, our aim was to evaluate the association between the presence of soft markers on second-trimester ultrasound and an abnormal newborn phenotype in women 35 years or older who had risk-reducing cell-free DNA.

Methods: This was a cohort study of 667 women 35 years or older who elected to undergo cell-free DNA screening for the indication of advanced maternal age and received negative results. All women underwent a routine anatomic survey between 18 and 22 weeks. Women with multifetal gestations or delivery at an outside hospital were excluded. Bivariable analyses were performed comparing women with and without the presence of soft markers (choroid plexus cyst, echogenic cardiac focus, pyelectasis, renal anomalies, bowel) on the anatomic survey. Multivariable logistic regression was performed to assess the independent association of soft markers with an abnormal newborn phenotype.

Results: Of 667 anatomic surveys, 58 demonstrated the presence of soft markers. In bivariable analysis, women with the presence of soft markers had a higher frequency of fetal structural anomalies detected on the anatomic survey (6.5% vs 1.6%; P = .02). The rest of the characteristics, including maternal age, body mass index, race/ethnicity, prior pregnancy loss, and presence of maternal diabetes, were similar between the 2 groups. The frequency of an abnormal newborn phenotype was higher among women with the presence of soft markers (5.0% vs 1.1%; P = .04). In multivariable analysis, after adjusting for the presence of structural anomalies, soft markers were not associated with an abnormal newborn phenotype (odds ratio, 0.72; 95% confidence interval, 0.04–11.74).

Conclusions: Among women who are 35 years or older with risk-reducing cell-free DNA, no association was found between the presence of soft markers on the anatomic survey and an abnormal newborn phenotype.
2377581 Congenital Lung Overinflation: A Rare, Enigmatic Lung Lesion on Detailed Fetal Sonography
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Objectives: To report the variable sonographic features in prenatal cases of suspected congenital cystic adenomatoid malformation (CCAM) or nonspecified lung lesions with a final surgical pathology or postnatal computed tomographic (CT) diagnosis of congenital lung over-inflation (CLO).

Methods: An Institutional Review Board–approved database search of medical records was performed at the Center for Fetal Diagnosis and Treatment at Children’s Hospital of Philadelphia for prenatally diagnosed lung lesions with a final diagnosis of CLO. All patients had detailed ultrasound (US) with gray scale and color Doppler and ultrafast magnetic resonance (MR) scans for comparison. Lesion location, size, echo texture, and vascularity were assessed on US.

Results: The study population consisted of 10 patients with a mean maternal age of 29.0 years and mean gestational age of 24 weeks 1 day. Lesion locations were 2 cases in the left upper lobe, 2 in the left lower lobe, 1 in the right upper lobe, 3 in the right lower lobe, and 2 in more than 1 lobe. Mean volume on US was 32.8 mL. Texture was homogeneously echogenic relative to normal lung in 100% with no visualized macrocysts, and color Doppler demonstrated only a pulmonary arterial supply and venous drainage in 90%, with a small feeding vessel questioned in 1 case. Hypervascularity was observed in 3 cases. Nonimmune hydrodrops was not seen in any case. Ascites, however, was observed in 2 cases, which was trace and large volume. CLO was the most likely diagnosis on US in 2 and included in the differential in 2, CCAM in 5, and CCAM, hybrid, or bronchopulmonary sequestration in 1. CLO was the most likely diagnosis on MR in 2, CCAM most likely in 7, and no specification other than “lung lesion” in 1. Five cases had pathology-proven CLO, and 5 had postnatal CT diagnosis of a hyperinflated lung confirming CLO.

Conclusions: CLO should be considered in the differential of in utero echogenic lung masses without macrocysts. Prevalence has been reported for the left upper lobe; however, our results indicate any lobe can be involved, and lesions may even be multifocal. Size is also quite variable; however, flow is consistently pulmonary in origin and may be hypervascular. Smaller lesions may be managed expectantly without surgery.

2378007 The Utility of Repeat Midtrimester Anatomy Ultrasound for Anomaly Detection
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Objectives: To assess the utility of repeat anomaly ultrasound (US) for anomaly detection following prior suboptimal US visualization (SUV).

Methods: Retrospective cohort of all singleton with a fetal anatomic US attempt before 20 weeks, delivered at a single institution from 2006–2014. US completion was based on criteria defined by the AFIUM, SMFM, ACR, SRLU, and ACOG. The presence or absence of major structural anomalies (causing death, significant disability, or requiring medical/surgical treatment) was confirmed for all prenatally detected anomalies, neonatal intensive care unit admissions, and neonatal deaths. Patients with an incomplete US underwent repeat US until completion. Groups were compared using a t test and χ2 test as appropriate. The number of US examinations needed to detect 1 anomaly was assessed for each US performed.

Results: A total of 13,855 US examinations were performed, including 2326 detailed and 11529 standard US examinations. Overall, 341 anomalies were detected (2.5%). A total of 12,811 (92%) US examinations were completed on the first attempt at a mean gestational age (GA) of 18.5 ± weeks (first); 991 (7%) patients required 1 repeat US, completed at a mean GA of 20.2 ± weeks (second); 53 patients required ≥2 repeat US examinations (third). Groups significantly differed by maternal age, race, payor, body mass index, diabetes, and hypertension. The numbers of US examinations needed to detect 1 anomaly were 48, 216, and 1155 for first, second, and third, respectively. The majority (77.7% [265]) of anomalies were detected in first, 18.8% (64) in second, and 3.5% (12) in third. Most anomalies detected on repeat US were detected in anatomic areas with SUV on prior US (Table 1).

Conclusions: Most major anomalies are detected on initial US, even if incomplete. The residual risk of an anomaly following SUV is low, suggesting repeat US may be an inappropriate utilization of resources. Anomalies detected following incomplete US were mostly congruent with the SUV system, which may add to patient counseling following incomplete US.

Table 1

<table>
<thead>
<tr>
<th>Anomaly Type</th>
<th>Congruent SUV System</th>
<th>Incongruent SUV System</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/face/spine</td>
<td>17</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chest/heart</td>
<td>9</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Abdomen/genitourinary/gastrointestinal</td>
<td>15</td>
<td>24</td>
<td>.002</td>
</tr>
<tr>
<td>Extremities</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>All anomaly types</td>
<td>41</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

χ2

2380242 Cardiac Axis in Fetuses With Tetralogy of Fallot: Associations With Prenatal Findings, Genetic Anomalies, and Postnatal Outcome
Yili Zhao1, *Scott Edington2, Elena Sinkovskaya1, Jonathan Fleenor2, Alfred Abuhamad1
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Objectives: To compare the prenatal findings, associated genetic anomalies, and postnatal outcome of fetal tetralogy of Fallot (TOF) with or without an abnormal cardiac axis (CAX).

Methods: Of all pregnancies scanned by obstetric ultrasound in our clinic between 2005 and 2014, 85 cases were diagnosed with TOF. Follow-up ultrasound and postnatal outcome was available on 67 cases. Of those, 60 cases were confirmed with TOF postnatally and contributed to the study population. The remaining 7 cases had other cardiac abnormalities and were not included in this study. The study population (60 cases) was divided into 2 groups with normal CAX (33/60) and abnormal CAX (27/60). Prenatal sonographic findings, associated genetic anomalies, and postnatal outcome were compared between the 2 groups.

Results: Compared to TOF fetuses with normal CAX, those with abnormal CAXs were more likely to be complicated with pulmonary atresia (16/27 vs 5/33; P = .026), as well as a right-sided aortic arch (13/27 vs 7/33; P = .028). Postnatal death happened in 30.4% (7/23) of patients with abnormal CAX but only in 6.5% (2/31) of patients with normal CAX (P = .028). The incidence of genetic anomalies was similar between fetuses with and without abnormal CAX.
Conclusions: In fetuses with TOF, abnormal CAx is associated with pulmonary atresia, a right aortic arch, and a higher chance of postnatal death.

2385879 Lung-to-Head Ratio, Ultrasound Liver-to-Thoracic Ratio, and Stomach Position in Fetuses With Isolated Left-Sided Congenital Diaphragmatic Hernia: Proposal of Multiple-Parameter Sonographic Evaluation

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1Obstetrics and Gynecology; 2Pediatric Surgery, Baylor College of Medicine, Houston, TX USA

Objectives: To evaluate the accuracy in predicting postnatal outcome in fetuses with isolated left-sided congenital diaphragmatic hernia (CDH) using multiple sonographic parameters.

Methods: Using the same ultrasound image (cross-sectional view of the fetal chest at the level of the 4-chamber view of the heart), the following ultrasound parameters were evaluated in 77 fetuses with left-sided CDH: fetal lung size by measuring the lung-to-head ratio (LHR) and liver herniation by assessing the ultrasound liver herniation-to-thoracic area ratio (US-LiTR) and the stomach position (SP). The predictive value of ultrasound parameters for mortality and the need for extracorporeal membrane oxygenation was evaluated by univariate, multivariate, and factor analysis and by receiver operating characteristic curves.

Results: The LHR, US-LiTR, and SP (according to Cordier classifications) were significantly associated with both mortality (area under the curve [AUC] 0.86; 95% confidence interval [CI] 0.74–0.98; AUC 0.77; 95% CI, 0.63–0.90; and AUC 0.74; 95% CI, 0.62–0.87). Significant correlations were observed between all these ultrasound parameters. The combination of LHR with the US-LiTR and with SP statistically improved the prediction of mortality (AUC, 0.86; 95% CI, 0.74–0.98; and AUC, 0.83; 95% CI, 0.74–0.92, respectively).

Conclusions: It is possible to evaluate the LHR, US-LiTR, and the SP by conventional sonography. The combinations of those ultrasound measurements seem to improve the accuracy of predicting mortality in those fetuses.

2386805 What Is the Role of 11- to 14-Week Ultrasound in Women With Negative Noninvasive Prenatal Screening? A Negative NIPS and 11- to 14-week ultrasound were available in 1739 patients. An unexpected finding was identified in 60/1739 (3.5%) patients. Previously unrecognized twins occurred in 13 patients (0.7% of scans), and an unsuspected fetal demise was identified in 10 patients (0.6%). Thirty-seven (2.1%) patients with a living fetus were identified as having abnormal sonographic findings; 33 fetuses had an NT ≥3.0 mm, including 4 with “isolated” cystic hygroma and 3 with concurrent structural abnormalities. Four fetuses had a major structural abnormality without a thickened NT. Karyotype confirmed euploidy in 98.7% of available cases. In 1 patient with an abnormal nuchal translucency and multiple structural anomalies, karyotype revealed trisomy 18, representing a false-negative cell-free DNA screen. Pregnancy termination was chosen by 63.6% of those with cystic hygroma or a structural anomaly at the 11- to 14-week scan.

Conclusions: Unexpected findings at the 11- to 14-week scan occur in 3.5% of patients with negative NIPS. Recognition provides options for comprehensive testing, consultation, and management.

2386862 Patient Choice and Clinical Outcomes Following Positive Noninvasive Prenatal Screening

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Objectives: Evaluate the role of the 11- to 14-week scan in patients with positive noninvasive prenatal testing (NIPS) and the impact on patient choice and clinical outcome.

Methods: Retrospective cohort study of women with positive NIPS receiving obstetric care from providers affiliated with 2 academic centers between March 2012 and December 2014. Patients were screened based on ACOG indications. The timing of NIPS was at the discretion of the primary provider. Patients undergoing an 11- to 14-week scan for aneuploidy evaluation had a crown-rump length and nuchal translucency measurement. Early anatomic imaging met the AIUM recommendations of “embryonic/fetal anatomy appropriate for the first trimester” and included at minimum evaluation of body contour, cranium, umbilical cord insertion site, and extremities. Sonographic assessment of the fetus at ≥15 weeks was performed based on referral by the obstetric provider and included a fetal anatomic evaluation that was as complete as possible. Medical records were reviewed for genetic counseling, sonographic findings, diagnostic testing, karyotype, and pregnancy outcome.

Results: NIPS was positive in 114 women: 105 singletons and 9 twin pairs. NIPS was positive for autosomal trisomy (21, 18, and 13) in 96 (84.2%) and sex chromosome aneuploidy in 18 (15.8%). Certified genetic counselors provided posttest counseling in 95% of patients. Karyotype was available in 91/105 (86.7%) singletons and confirmed aneuploidy in 75/91 (82.4%). Discordance was identified in 16/91 (17.6%). An abnormal sonographic finding was present in 58/75 (77.3%) with concordance vs 4/16 (25%) with discordance. The positive predictive value (PPV) of NIPS with any sonographic finding was 93.6% vs 58.6% without a finding. Pregnancy termination was chosen in 53/79 (67%) with an abnormal or unknown karyotype for autosomal trisomy. Nine patients (16.7%) terminated without prenatal confirmation of karyotype. In those choosing to terminate, 55% were able to do so at ≤14 weeks.

Conclusions: NIPS discordance with karyotype reinforces the need for further karyotype confirmation. Sonographic findings modify the PPV of NIPS. Termination rates are not higher than historical controls; however, 16.7% of patients terminated without prenatal confirmation of karyotype despite counseling.
2392543 Are Nuchal Septations Clinically Significant for Early Prenatal Genetic Screening?
Lauren Mack1,*, Wesley Lee1, Arame Thiam1, Joan Mastrobattista1, Michael Belfort1, Alireza Shamshirsaz1, Rodrigo Ruano1, David Rendon1, Jimmy Espinoza1
1Obstetric and Gynecologic Ultrasound, Baylor College of Medicine, Houston, TX USA; 2Baylor College of Medicine, Houston, TX USA

Objectives: Prior reports of transvaginal ultrasonography during early pregnancy have suggested that visualization of septated cystic hygromas are associated with a higher incidence of abnormal karyotype and a poorer fetal prognosis. This study investigates whether the presence of septations in the nuchal translucency (NT) during transabdominal scanning is an independent predictor of abnormal karyotype.

Methods: A retrospective cohort of all first-trimester screens was evaluated at a single tertiary center from 2011 to 2014. Women who did not have follow-up at our institution were excluded. An assessment was performed by 1 expert reviewer of all cases with an increased NT to confirm whether or not nuchal septations were visualized from ultrasonography screening. Logistic regression models were used to estimate the odds ratio (OR) of an abnormal karyotype associated with the presence of nuchal septations, adjusting for potential confounders, including NT measurement, advanced maternal age (≥35 years), race/ethnicity, parity, and multiple gestation.

Results: This cohort included 2779 consecutive patients, of whom 0.5% had a confirmed chromosomal abnormality. Nuchal septations were visualized in 0.5% (15) and an increased NT in 1.7% (46) of the population sample. Both the presence of septations and an increased NT were independently associated with an abnormal karyotype (OR, 7.1; 95% confidence interval [CI], 1.2–45.0; and OR, 3.7; 95% CI, 2.5–5.7, respectively). Abnormal karyotypes included trisomy 21, 18, 13 and Noonan’s.

Conclusions: Visualization of nuchal septations during the first-trimester screen is an independent risk factor for an abnormal karyotype. The presence of nuchal septations in addition to NT measurement should be documented and incorporated into prenatal counseling for aneuploidy.

2392630 Are Ultrasonographic Renal Parameters Associated With Urinary Biochemistry in Fetuses With Lower Urinary Tract Obstruction?
Ahmed Nassr1,*, Chester Koh2, Patricio Gargollo1, Alireza Shamshirsaz1, Jimmy Espinoza1, Hadeh Sangi-Haghighfar3, Stehen Welsy2, David Roth4, Michael Belfort1, Michael Braun1, Rodrigo Ruano1
1Obstetrics and Gynecology, Baylor College of Medicine, Houston, TX USA; 2Baylor College of Medicine, Houston, TX USA; 3Baylor College of Medicine, Houston, TX USA

Objectives: To evaluate the association between ultrasonographic renal parameters and urine biochemistry in fetuses with lower urinary tract obstruction (LUTO).

Methods: Data were collected prospectively from 31 consecutive fetuses with LUTO that underwent vesicocectomy for fetal urinary biochemistry between April 2013 and September 2015. The following ultrasonographic findings related to fetal kidneys were evaluated immediately before the vesicocectomy: renal echogenicity, presence of cortical cysts, presence of images suggestive of “renal dysplasia” (hyperechoic cystic kidneys with no cortical-medullar differentiation), and severe oligohydramnios (amniotic fluid <5th percentile). These ultrasonographic parameters were compared to the fetal urinary concentration of sodium, chloride, calcium, osmolality, and β₂-microglobulin. Logistic regression was performed to evaluate the association between ultrasonographic renal parameters and fetal urinary biochemistry markers. A statistical difference was considered when P < .05.

Results: There was no statistical association between any ultrasonographic fetal renal parameters and fetal urinary biochemistry (Table 1).

Conclusions: Our data suggest that fetal renal parameters and urinary biochemistry are not statistically associated in cases with LUTO. Further studies are necessary to confirm our findings and to investigate the use of those factors to predict postnatal renal function in combination.

Table 1. Association Between Ultrasound Renal Parameters and Fetal Urinary Biochemistry

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fetal Urinary Biochemistry</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperechoic kidneys</td>
<td>Sodium</td>
<td>1.03 (0.99–1.07)</td>
<td>.14</td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>1.04 (0.99–1.10)</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>1.35 (0.92–1.77)</td>
<td>.16</td>
</tr>
<tr>
<td></td>
<td>Osmolarity</td>
<td>1.0 (0.98–1.02)</td>
<td>.92</td>
</tr>
<tr>
<td></td>
<td>β₂-Microglobulin</td>
<td>1.0 (1.0–1.001)</td>
<td>.23</td>
</tr>
<tr>
<td>Renal cysts</td>
<td>Sodium</td>
<td>1.05 (0.99–1.13)</td>
<td>.15</td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>1.09 (1.0–1.24)</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>1.06 (0.57–1.57)</td>
<td>.75</td>
</tr>
<tr>
<td></td>
<td>Osmolarity</td>
<td>1.02 (0.99–1.06)</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>β₂-Microglobulin</td>
<td>1.0 (1.0–1.001)</td>
<td>.13</td>
</tr>
<tr>
<td>Renal dysplasia</td>
<td>Sodium</td>
<td>1.06 (0.99–1.17)</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>1.16 (1.0–1.50)</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>0.98 (0.59–1.59)</td>
<td>.93</td>
</tr>
<tr>
<td></td>
<td>Osmolarity</td>
<td>1.03 (0.99–1.09)</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>β₂-Microglobulin</td>
<td>1.0 (1.0–1.001)</td>
<td>.47</td>
</tr>
<tr>
<td>Bilateral hydrenephrosis</td>
<td>Sodium</td>
<td>0.99 (0.96–1.03)</td>
<td>.74</td>
</tr>
<tr>
<td></td>
<td>Chloride</td>
<td>0.99 (0.94–1.04)</td>
<td>.60</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>0.74 (0.45–1.01)</td>
<td>.18</td>
</tr>
<tr>
<td></td>
<td>Osmolarity</td>
<td>0.99 (0.97–1.02)</td>
<td>.67</td>
</tr>
<tr>
<td></td>
<td>β₂-Microglobulin</td>
<td>1.0 (0.99–1.00)</td>
<td>.23</td>
</tr>
<tr>
<td>Oligohydraminos</td>
<td>Sodium</td>
<td>1.01 (0.96–1.06)</td>
<td>.74</td>
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<tr>
<td></td>
<td>Chloride</td>
<td>1.05 (0.98–1.14)</td>
<td>.15</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>1.32 (0.85–2.31)</td>
<td>.26</td>
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<tr>
<td></td>
<td>Osmolarity</td>
<td>1.01 (0.98–1.04)</td>
<td>.54</td>
</tr>
<tr>
<td></td>
<td>β₂-Microglobulin</td>
<td>1.00 (1.00–1.001)</td>
<td>.41</td>
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</table>

CI indicates confidence interval; and OR, odds ratio.

2393058 Progression of Functional Motor Level in Neonates With Myelomeningocele Can Be Scored by Prenatal Sonography
Joan Mastrobattista1,*, Elena Carreras2, Lauren Mack3, Anna Maroto4, William Whitehead5, Tamara Illescas6, Karin Fox7, Carlota Rodo3, Michael Belfort8, Silvia Arevalo9, Rodrigo Ruano10, Rajshi Gandhi2, Wesley Lee1, Ampar Cuxart11
1Obstetric and Gynecologic Ultrasound, Baylor College of Medicine, Houston, TX USA; 2Pediatric Neurosurgery, Baylor College of Medicine, Houston, TX USA; 3Maternal-Fetal Medicine, Physical Medicine and Rehabilitation, Hospital Universitari Vall d’Hebron, Barcelona, Spain

Objectives: Currently there are no reliable prenatal sonographic predictors of preintervention and postintervention neurologic function in fetuses affected by myelomeningocele (MMC). To remedy this gap, we developed a sonographic prediction tool and tested it in a prospective cohort. The primary study outcome was performance of a sonographic evaluative tool (SET) in accurately and precisely predicting the site and functional level of neurologic deficits in infants with MMC. The secondary outcome was to determine the rate and extent of deterioration over the course of gestation using the same sonographic measures: specifically, testing if SET predicted the level of fetal neurologic function throughout pregnancy.

Methods: A prospective cohort study of fetuses with MMC between July 2010 and July 2015 was conducted. Patients underwent in utero MMC repair or continued pregnancy without a repair based on clin-
Results: Twenty-six women were enrolled; 19 had in utero repair (17 fetoscopic, 2 open), and 7 continued without repair. Initial sono-
graphic evaluations at mean gestational ages of 24 and 29 weeks, respectively. Nine women in the repair and 3 women in the unrepaired group delivered <37 weeks. The prenatally assigned functional motor level in the repair group was on average 2–3 levels better than expected from the anatomic level. In the repair group, 2/19 cases showed a better functional level, and 2 exhibited a decreased functional level compared to the anatomic level. In the unrepair group, 1/7 cases showed a better functional level, and 2 worsened throughout pregnancy, confirmed postnatally.

Conclusions: Sonographic evaluation appears to be a reliable method of monitoring neurologic function in fetuses with MMC, and in utero repair may prevent the progression of neurologic injury.

2393074 Prenatal Ultrasonography Reliably Predicts Postnatal Neurologic Function in Fetuses With Myelomeningocele

Objectives: There are currently no reliable prenatal predictors of neurologic function in fetuses affected by myelomeningocele (MMC). The study goals were to utilize a prospective, single-arm interventional cohort of MMC-affected fetuses to test a novel sonographic prediction tool in identifying subsequent neurologic function. We sought to deter-
mine if the prenatal functional level is different between the right and left lower extremities (LEs) in MMC. The primary objective was to determine if sonographic assessment of the functional level correlates with the post-
natal motor level. A secondary objective was to investigate if differences in right and left LE function can be detected.

Methods: Prospective cohort study of fetuses with MMC. Patients underwent in utero MMC repair (fetoscopic/open) or continued pregnancy without a repair based on clinical eligibility (MOMs trial) and patient preference. All patients with fetal MMC identified between January 2013 and July 2015 were eligible. Motor function of the LEs was studied using a novel technique as first described by Carreras et al: (1) prenatally, standardized sonographic evaluation using in-
utrauterine fetal limb movements to predict the functional level based on the known nerve distribution, performed every 3–6 weeks from enrollment to delivery; and (2) postnatally, clinical motor evaluation (physical exam by a single examiner, blinded to sonographic results). Postnatal examina-
tion was used to confirm the side, site, and functional level.

Results: Twenty-three women were enrolled; 19 had in utero repair (17 fetoscopic, 2 open repair), and 4 were unrepaired. All pa-
tients delivered in our centers. Of these, 2 neonates in the in utero repair group and 1 neonate in the unrepair group displayed functional differ-
ences between their right and left LEs as confirmed by postnatal evalua-
tion. The state of symmetry or asymmetry between the right and the left LEs was correctly predicted by prenatal sonography in 18/23 (78%) cases.

Conclusions: Functional symmetry in the right and left LEs in fetuses with MMC can be predicted with a high degree of reliability by prenatal sonography.
Methods: We surveyed physician sonographers at 5 conferences held at 3 academic medical centers in the New York City area. They were allotted 20 seconds per slide to determine whether each of 15 video clips of patients in cardiac arrest were standstill or not. Data were collected anonymously using Turning Technologies’ Turning Point polling software and exported to R for analysis.

Results: There were 98 total participants, including faculty, fellows, and resident physicians specializing in emergency medicine, critical care, and cardiology. There was only moderate inter-rater agreement among all participants (Krippendorff’s α coefficient = 0.47). This lack of agreement persisted across specialties, training levels, and self-reported ultrasound expertise (Table 1).

Conclusions: There is substantial variability in determination of cardiac standstill among physician sonographers of varied specialties and levels of training. A clear definition of cardiac standstill is necessary to improve the quality of cardiac arrest ultrasound research and to standardize the use of this technology at the bedside.

Table 1. Cardiac Standstill Inter-Rater Agreement

| Specialty: Emergency Medicine | 0.30 | Moderate |
| Specialty: Critical Care | 0.40 | Fair |
| Specialty: Cardiology | 0.47 | Moderate |
| Training Level: Attending | 0.46 | Moderate |
| Training Level: Fellow | 0.55 | Moderate |
| Training Level: Resident | 0.43 | Moderate |
| Ultrasound Experience: Basic | 0.43 | Moderate |
| Ultrasound Experience: Intermediate | 0.33 | Moderate |
| Ultrasound Experience: Expert | 0.41 | Moderate |

*Krippendorff’s α coefficient: <.20, poor; 0.21–0.40, fair; 0.41–0.60, moderate; 0.61–0.80, good; 0.81–1.00, very good.

2379957 Emergency Physician Focused Cardiac Ultrasound Exam Improves Diagnosis of Ascending Aortic Dissection

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Emergency Medicine, Yale University, New Haven, CT USA; Frank H. Netter, MD, School of Medicine, North Haven, CT USA; Radiology, Yale New Haven Hospital, New Haven, CT USA

Objectives: Ascending aortic dissection (AAD) is an uncommon, time-sensitive, and deadly diagnosis with a nonspecific presentation. AAD is associated with aortic dilation, which can be determined by emergency physician focused cardiac ultrasound (EP FOCUS). The study objective was to determine if patients who receive EP FOCUS have at least a 1-hour reduced time to diagnosis for AAD in comparison to patients who do not receive EP FOCUS. Secondary outcomes were to determine if EP FOCUS reduced misdiagnosis, time to disposition, and mortality.

Methods: We performed a retrospective cohort analysis of patients treated at 1 of 3 affiliated emergency departments (EDs) from March 1, 2013, to May 1, 2015, with AAD. All autopsies were reviewed for missed cases. Patients were divided into 2 cohorts, EP FOCUS and non-EP FOCUS, to assess primary and secondary outcome measures. Study outcome measures, patient demographics, medical histories, presenting clinical findings, chest radiographic findings, and electrocardiographic findings were abstracted and compared between cohort groups. Student t tests, Fisher exact tests, and Wilcoxon rank sum tests were performed as appropriate for comparison between cohort groups.

Results: Of 386,547 ED visits, targeted review of 123 charts and 194 autopsy reports identified 32 patients for inclusion. Sixteen patients received EP FOCUS, and 16 did not. Median time to diagnosis in the EP FOCUS group was 80 (interquartile range [IQR], 46–157) minutes vs 226 (IQR, 109–1449) minutes in the non-EP FOCUS group (P = .023). Misdiagnosis was 0% (0/16) in the EP FOCUS group vs 43.8% (7/16) for non-EP FOCUS (P = .028). Mortality, adjusted for do not resuscitate, for EP FOCUS vs non-EP FOCUS was 15.4% vs 37.5% (P = .24). The median EP FOCUS rooming time to disposition was 134 (IQR, 101–195) minutes vs non-EP FOCUS of 205 (IQR, 114–342) minutes (P = .27). There was otherwise no statistical difference between abstracted information between cohort groups with the exception of heart rate of 71 ± 15 beats per minute for EP FOCUS vs 86 ± 20 beats per minute for non-EP FOCUS (P = .03).

Conclusions: Patients who receive EP FOCUS are diagnosed faster and misdiagnosed less than patients who do not receive EP FOCUS. We recommend that assessment of the thoracic aorta be performed routinely during cardiac ultrasound in the ED.

2385154 Does Carotid Intima-Media Thickening Predict a Negative Stress Test in Low-Risk Chest Pain?

Matthew Tabbi

Emergency Department, MetroHealth Medical Center, Cleveland, OH USA; Case Western Reserve University School of Medicine, Cleveland, OH USA

Objectives: Chest pain is a common presentation to the emergency department (ED). Patients frequently undergo stress testing following negative diagnostic markers. Carotid intima-media thickness (CIMT) is a useful tool to noninvasively identify patients with a higher atherosclerotic burden. CIMT has been shown to be associated with myocardial infarction, stroke, coronary artery disease (CAD), as well as angiographic evidence of CAD. There are no known studies evaluating the use of CIMT on low-risk chest pain patients in the ED observation (OU) setting. The goal of this study is to evaluate CIMT in the ED OU to determine if it can be used as a tool to help predict patients who will have a negative stress test in attempt to risk stratify patients complaining of chest pain.

Methods: This is an ongoing prospective convenience sample of patients admitted to our ED OU with chest pain, dyspnea, or symptoms determined to be a coronary equivalent by the treating physician in the ED. Patients were included if they were to receive a stress test during their observation stay or had received one within 2 months prior to the ED OU visit. Patients were scanned with a high-frequency linear transducer in the long axis to the carotid artery. Three measurements of the IMT were taken on each side proximal to the carotid bulb within 1 cm of the bulb. The results were averaged on each side. The results were compared to a known standard for age and ethnicity at the 75th percentile. IMT above the 75th percentile for age and ethnicity on either side was considered a positive result.

Results: To date, 59 patients were evaluated; 5 had a positive stress test (8.8%; 0.95 confidence interval [CI], 1.4%–16.2%). Of the 57 patients, 37 patients (64.9%; 0.95 CI, 52.5%–77.3%) had a negative IMT study, and 20 (35.1%; 0.95 CI, 22.7%–47.5%) had a positive IMT study. There were 4 patients among the positive stress group who had a positive IMT (80%; 0.95 CI, 44.9%–100%) and 1 patient with a negative IMT (20%; 0.95 CI, 0%–55.1%).

Conclusions: In this cohort of patients with low-risk chest pain was a trend toward negative stress correlating with negative IMT. However, data are insufficient to confidently risk stratify patients based on IMT alone.
2383172 Determining the Number of Ultrasound Scans Required for Medical Students to Achieve Competency in Clinical Settings Stephanie Gondra-Sanabria,* Richard Chyan,† Daniel Udrea,‡ Logan Villarreal,‡ Deanna Lo,§ Andrew Summicht,‖ Vi Am Dinh¶

School of Medicine, Loma Linda University, Loma Linda, CA USA; 1Emergency Medicine, 2Medicine, Division of Pulmonary and Critical Care, Loma Linda University Medical Center; Loma Linda, CA USA

Objectives: Despite its advantages in many medical settings, ultrasound (US) technology appears to be evolving at a quicker pace than US education. This may be attributed to the limited research demonstrating how many scans are needed for students to gain US proficiency. The purpose of this study is to evaluate the relationship between the number of US scans performed by medical students and (1) the quality of the US images acquired, (2) the ability to interpret pathology, and (3) student’s comfort level.

Methods: Over an 8-week period, 5 medical students performed point-of-care US in the emergency department (ED). Prior to beginning, 16 SonoSim training modules were completed to provide students with a basic understanding of US pathology, followed by quizzes from the American College of Emergency Physicians (ACEP) to assess improvements in knowledge. Students scanned a variety of organ systems and reported their comfort levels during the exam. The overseeing physician then rated the image quality and interpretation. Confirmatory studies were reviewed to see if they agreed with the student’s interpretation.

Results: Students completed 629 scans (mean, 125.8). They reported a significant increase in comfort levels by the 6th week for the following scans: cardiac (25 scans), inferior vena cava (11.8 scans), extended focused assessment with sonography for trauma (eFAST; 11.2 scans), renal (15.6 scans), pulmonary (7.2 scans), and soft tissue (5.4 scans). Image quality showed a significant increase in biliary (10 scans), eFAST (11.2 scans), renal (15.6 scans), and obstetric (4 scans) scans by week 6, and cardiac scans by week 8 (32.8 scans). Physicians agreed 95.1% of the time with the student’s interpretation, and confirmatory studies agreed 82.3% of the time. ACEP test scores increased over time, with an average score of 51.4% prior to the students’ completing the SonoSim modules to 85.6% 2 weeks after completing their ED rotation.

Conclusions: During an 8-week period, medical students improved their image acquisition and interpretation skills, and comfort levels while performing point-of-care US across most organ systems. In addition, the SonoSim modules proved to be an adequate tool in improving students’ understanding of US pathology prior to beginning their ED rotations.

2384122 Soft Tissue Ultrasound and Failure of Therapy for Suspected Skin Abscesses Romolo Gaspari,*, Alexander Sanseverino

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Objectives: Bedside ultrasound for soft tissue infection is used to differentiate an abscess from cellulitis and to determine appropriate therapy. Our hypothesis was that failure of therapy following incision and drainage (I&D) was less than failure of therapy following expectant management without I&D.

Methods: We performed a retrospective multicenter review of patients presenting with a suspected abscess to the emergency department at 4 hospitals. Patients were eligible if they presented with signs and symptoms of an abscess and underwent soft tissue ultrasound. Patients’ data were obtained from the electronic medical record. Patients were determined to fail therapy if they underwent I&D after being discharged from the emergency department. Patients discharged with a planned future I&D were not categorized as failure. Ultrasound images were blindly reviewed for accuracy. Comparison between groups was performed using a Fisher exact test.

Results: Over a 12-month period 718 soft tissue ultrasound exams were performed for a suspected abscess. Overall 399 (55.6%) ultrasound exams demonstrated an abscess, with the majority of those (310 or 77.8%) undergoing I&D. Failure rates for patients with a suspected abscess were similar regardless of intervention (I&D vs expectant management). Twenty-one of 328 (6.4%) patients who underwent I&D required a repeat I&D; 27 of 337 (8.0%) patients who underwent expectant management eventually required I&D; 85.3% of patients with a visible abscess cavity who did not undergo I&D were successfully treated with expectant management. Overall, 5.8% of patients with symptoms of an abscess but no sonographically visible abscess cavity eventually required I&D. Failure rates following expectant management were similar to failure rates following I&D (6.11% vs 5.56%; P = 1.0).

Conclusions: With the use of ultrasound, failure rates of suspected abscesses following expectant management are low. Patients with no visible abscess cavity treated with expectant management fail therapy at a similar rate as visible abscess cavities treated with I&D. Some patients without sonographically visible abscess cavities can benefit from I&D. Conversely, not all sonographically visible abscess cavities need I&D.

2384354 Emergency Physician Utilization of Ultrasound in Arizona Richard Amini,*, Michael Wymar, Nicholas Hernandez, Srikanth Adhikari

1Emergency Medicine, 2College of Medicine, University of Arizona, Tucson, AZ USA

Objectives: Point-of-care ultrasound (POCUS) has been defined as an integral component to the practice of emergency medicine (EM). New guidelines require residents to demonstrate proficiency in POCUS, and nearly all academic EM programs provide dedicated ultrasound training. Previous studies have indicated that there remains variability in the use of ultrasound at nonacademic emergent care settings. The purpose of this study is to better understand the current use of POCUS in community nonacademic emergency departments (EDs) throughout the state of Arizona.

Methods: This was a cross-sectional study. An online questionnaire on the use of POCUS in the ED was electronically sent to all of the medical directors or ultrasound directors of each nonacademic ED in Arizona. The survey consisted of questions regarding demographics, current practice patterns, policies, interdepartmental agreements, and perceptions regarding the use of POCUS.

Results: A total of 70 community nonacademic EDs were identified for inclusion in our study. To date, 28 EDs have completed the survey, representing a 40% response rate. All (28/28) EDs have a dedicated ultrasound machine; 75% (95% confidence interval [CI], 56%–94%) of EDs perform or interpret POCUS for patient care. The 3 most common applications of POCUS in responders were focused assessment with sonography for trauma, cardiac ultrasound (for code arrest), and line placement. Only 40% (95% CI, 19%–61%) indicated that ultrasound experience is important in hiring decisions for ED physicians. Although 55% (95% CI, 33%–77%) of EDs have an ultrasound director or similar position filled, 80% (95% CI, 62%–98%) reported that they do not assess ED physicians in POCUS competency; 50% (95% CI, 28%–72%) of EDs indicated that they do not provide POCUS training; 65% (95% CI, 44%–86%) of EDs perform less than 20 ultrasound exams per week; and only 30% bill for POCUS.

Conclusions: In the state of Arizona, a majority of nonacademic EDs have access to ultrasound machines and have ultrasound privileges. However, only a small minority bill for ultrasound or provide regular assessment of this skill.
Objectives: Ultrasound-guided procedures have become the standard of care for many procedures performed in the emergency department (ED). To date, there are limited data on whether ultrasound-assisted lumbar puncture (USA-LP) reduces the rate of LP failures among upper-level residents in the ED setting.

Methods: This pilot study took place in an urban academic ED serving more than 100,000 patients per year. The study randomized 27 patients to either USA-LP or a landmark technique over a 6-month period. In patients who were randomized to the USA-LP group, a curvilinear transducer (2–5 MHz) was placed on the patient’s back in a transverse orientation. Lumbar spinous processes were identified and marked with a vertical line. The transducer was then placed in the sagittal orientation, and the L4–L5 interspace was found and marked with a horizontal line. The intersection of these marks was used as the site for LP needle insertion. The landmark group used palpation to identify the L4–L5 interspace in the standard fashion. Pain scores, time to cerebrospinal fluid (CSF) collection, number of cannulation attempts, body mass index, and CSF analysis were recorded on each patient.

Results: Twenty-seven patients were enrolled in the study: 12 in the landmark group and 15 in the USA-LP group. After randomization, 1 patient from the landmark group was excluded secondary to an intern performing the LP. In the USA-LP group 73.3% achieved successful LP, compared to 72.7% in the landmark group ($P > .999$). The median times from consent to obtaining CSF were 55 minutes in the USA-LP group and 32 minutes in the landmark group ($P = .591$). Using a Likert 11-point pain scale to assess pain during the procedure, the USA-LP group’s mean pain score was 6.93/11, and the landmark group’s mean pain score was 4.0/11 ($P = .722$). The average numbers of attempts prior to successful LP were 2.0 in the USA-LP group and 3.08 in the landmark group ($P = .0458$).

Conclusions: Ultrasound guidance did not affect the rate of LP failure by trainees; however, there appear to be fewer attempts needed to obtain CSF. Our hope is that further enrollment and completion of this study will ascertain the true utility of ultrasound guidance for LP in the academic setting.
Elastography

**Saturday, March 19, 2016, 4:00 PM–5:30 PM**

**Elastography**

Moderator: Richard Barr, MD, PhD

2381698 Ultrasound Elastography: Variation of Fibrosis Assessment as a Function of Depth, Force, and Distance From the Central Axis of the Transducer With a Comparison of Different Systems

Changtian Li1,* Luzeng Chen1, Zhikui Chen1, David Congrove1, Atul Bhan1, Duhlene Fusco1, Manish Dhyan1, Anthony Samir1

1Abdominal and Interventional Radiology, Massachusetts General Hospital, Boston, MA USA; 2Hammersmith Hospital, London, England; 3Massachusetts General Hospital, Boston, MA USA

**Objectives:** To evaluate the accuracy of ultrasound elastography in the assessment of fibrosis using different systems and to assess variation at different depths, forces, and distance from the central axis of the transducer.

**Methods:** In this Institutional Review Board–approved single-institution prospective study, 20 patients underwent elastographic assessment on 3 systems (FibroScan, Siemens, and SuperSonic). All subjects had undergone nonlocal liver biopsy within the past 6 months as part of their clinical care, and biopsy was evaluated by the META VIR system (F0–F4). Acoustic radiation force impulse and shear wave elastographic measurements were obtained at different depths (3, 5, and 7 cm), 3 different forces (4, 7, and 10 N), and 2 and 4 cm off axis. FibroScan was also performed on the same day. Spearman correlations of shear wave speed with fibrosis stage were calculated and the area under the receiver operating characteristic curves (AUROC) to differentiate ≥F2 fibrosis from lesser grades (F0 and F1) was charted.

**Results:** A total of 20 subjects (male:female = 12:8) with a mean age of 54 years and varying fibrosis stages (F0 = 4, F1 = 9, F2 = 3, F3 = 2, and F4 = 2) participated in the study. FibroScan values showed high correlation with the fibrosis stage (r = 0.579; P = .009) and an AUROC of 0.88. For the Siemens system, there was a statistically significant difference (P = .003) between values obtained at 3 different depths, with the highest correlation (r = 0.667; P = .001) and AUROC at a depth of 7 cm. Similarly, for the SuperSonic system, the correlation (r = 0.620; P = .004) and AUROC were highest at a depth of 7 cm, but the difference across depths was not statistically significant. Variation in preload force at a 5-cm measurement depth made no statistically significant difference. Measurements along the central axis had the highest AUROC for both the Siemens (0.846; 95% confidence interval [CI], 0.669–1.023) and SuperSonic (0.764; 95% CI, 0.547–0.981) systems.

**Conclusions:** (1) In this small study, the SuperSonic and Siemens systems performed best for differentiation between advanced fibrosis (F≥2) and lesser or no fibrosis (F0 and F1) at a depth of 7 cm along the central axis. (2) Preload force variations between 4–10 N do not appear to affect measurements made via an intercostal approach.

2383952 Ultrasound Strain Elastography in Assessment of Resting Biceps Brachii Muscle Stiffness in Patients With Parkinson’s Disease: A Primary Observation

Jing Gao1,* Li-Juan Du2, Wen He2, Shuo Li2, George Shih1, Keith Hentel2, Jonathan Rubin3

1Radiology, Weill Cornell Medical College, New York, NY USA; 2Ultrasound, Beijing Tiantan Hospital–Capital Medical University, Beijing, China; 3Radiology, University of Michigan, Ann Arbor, MI USA

**Objectives:** The aim of this study was to evaluate the feasibility of ultrasound strain elastography (SE) for the assessment of resting biceps brachii muscle (BBM) stiffness in patients with Parkinson’s diseases (PD).

**Methods:** From May 2014 to December 2014, we prospectively performed SE of BBM in 14 patients with PD and 10 healthy controls. Based on the Unified Parkinson’s Disease Rating Scale for scoring muscle rigidity (UPDRS, part III), patients were divided into a high-rigidity (UPDRS III–IV, n = 3) and a low-rigidity (UPDRS I–II, n = 11) group. Ultrasound strain was represented by the deformation of the BBM and subcutaneous soft tissues that was produced by external compression with a sand bag (1.5 kg) tied onto an ultrasound transducer. Deformation was estimated with 2D speckle tracking. The difference in strain ratio (SR, mean BBM strain/mean subcutaneous soft tissue strain) among high-rigidity patients, low-rigidity patients, and healthy controls was tested by analysis of variance, and the difference in each paired group was then examined by the Bonferroni test. The correlation between SR and muscle rigidity score was analyzed by the Pearson correlation coefficient. The reliability of SR in assessment of BBM stiffness was tested using the intraclass correlation coefficient (ICC).

**Results:** The SR in high-rigidity patients, low-rigidity patients, and healthy controls measured 1.91 ± 0.31, 2.95 ± 0.36, and 3.30 ± 0.27, respectively. A significant difference in SR was noted among the 3 groups (P = .000), as well as between paired groups (all P < .05). A negative correlation was found between SR and UPDRS rigidity score (r = –0.78). The ICC for SR in assessment of BBM stiffness was 0.88.

**Conclusions:** Our study suggests that the SR of BBM to reference tissue can be used as a quantitative biomarker in assessing resting muscle stiffness associated with muscle rigidity in PD.

2384881 Summative Elastography Score Is Superior to Single-Plane Elastography Score in Dupuytren’s Cord Treatment

Andrew DeMarco1,2,++ Megan Bishop4, Teresa BassGoldman4, Paul DeMarco1,2,++

1Arthritis and Rheumatism Associates, PC, Wheaton, MD USA; 2Rheumatology/Internal Medicine, Georgetown University School of Medicine, Washington, DC USA; 3Dupaeque University, Pittsburgh, PA USA; 4Clinical Trials Department, Center for Rheumatology and Bone Research, Wheaton, MD USA

**Objectives:** To determine if a calculated index from orthogonal planes, when compared to single-plane scoring, would be statistically significantly more likely to detect elastographic changes during treatment of Dupuytren’s cords with collagenase clostridium histolyticum (CCH).

**Methods:** An Institutional Review Board–approved pilot protocol established elastography of 5 normal hands, 5 untreated Dupuytren’s cords, and 10 Dupuytren’s cords treated with CCH. Serial elastography during CCH treatment was performed using a GE LOGIQ S8 with compatible elastographic software. Standardized imaging (Table 1) of either the normal palmar aponeurosis or a Dupuytren’s cord (with or without exposure to CCH) was collected at designated times. Images were graded with a scale of 1–4. Statistical analysis was performed on the individual planes and on a summative score, the weighted elastographic score (wES), accounting for orthogonal planes. Statistical analysis was assessed with the Shapiro-Wilk, Student t, or Pearson χ² test.
Results: Elastography of individual regions of normals showed an average score of 1, while untreated Dupuytren’s cords showed an average of 3. The elastography of individual regions of the treated Dupuytren’s cord on days 1 and 30 (see Table 1) was not statistically significant. The wES of normals was 7.65, while that of untreated Dupuytren’s contracture was 11.4; the treated Dupuytren’s contracture score reached statistical significance (Table 1).

Conclusions: The pilot established the ability for elastography to act as an outcome measure after application of a therapeutic. The wES performed better than individual scores. This suggests that evaluation of organ response in orthogonal planes may be superior to a single-view measurement and has significant implications for data collection and sample sizes. Further study of this effect in other organ systems is warranted.

Table 1

<table>
<thead>
<tr>
<th>Region for Measurement</th>
<th>Day 1</th>
<th>Day 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastographic Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midline sagittal</td>
<td>3.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Distal transverse</td>
<td>2.7</td>
<td>2.5</td>
</tr>
<tr>
<td>Middle transverse</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Proximal transverse</td>
<td>2.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Weighted elastographic score</td>
<td>11.6</td>
<td>8.8</td>
</tr>
</tbody>
</table>

NS indicates not significant.

2384911 Three-Dimensional Reconstruction in Ultrasound Elastography Using a Markov Random Field Model

Atul Ingle,* Tomy Varghese
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Objectives: This work aims to develop a computationally tractable algorithm capable of reconstructing a complete volume on a fine grid in 3D from a scattered cloud of shear wave velocity (SWV) measurements obtained using electrode vibration shear wave elastography.

Methods: An electrode vibration SWV experiment was performed on a tissue-mimicking phantom consisting of a stiff ellipsoidal inclusion surrounded by softer background material. A needle, which was firmly bonded to the inclusion, was vibrated using an actuator operated in synchronization with a high-frame rate radiofrequency ultrasound data acquisition routine on a research ultrasound scanner. A 128-element linear array transducer with a center frequency of 5 MHz was used, and axial displacements were tracked using a 2-mm window with 50% overlap. The laterally traveling shear wave pulse vibration was tracked as a function of distance away from the needle in the image plane, and SWV was estimated using time of arrival processing. This experiment was repeated in a sheep geometry over different imaging planes by rotating the ultrasound transducer around the needle, and SWV maps were generated on each plane. A Markov random field (MRF) model was used to generate a visualization on a fine grid of points in 3D. An iterative reconstruction algorithm was used to estimate the mode of the joint distribution of the values on all the grid nodes. Quantitative estimates of SWV were obtained by averaging over 2 cuboidal regions of interest in the stiff and soft regions of the phantom. A standard nearest neighbor (NN) interpolation algorithm was used for comparison.

Results: Visual comparison suggests that NN reconstruction appears more blocky than MRF reconstruction. Quantitative estimates suggest that the values obtained from the MRF algorithm agree with those obtained from standard NN interpolation, but the MRF method provides up to a 2-dB better signal-to-noise ratio.

Conclusions: This work presented an iterative reconstruction algorithm for 3D visualization of SWV obtained from electrode vibration elastography. This model-based method is quite general and can be applied to other quantitative measurements as well.

2384985 Assessment of Liver and Spleen Stiffness in Patients With Myelofibrosis Using FibroScan and Shear Wave Elastography

Muriel Webb
Gastroenterology, Ichilov Hospital, Tel Aviv, Israel

Objectives: To date, the liver and spleen stiffness in patients with myelofibrosis was assessed by manual palpation, thus influenced by interobserver variability. In this work, for the first time, the liver and spleen stiffness of patients with myelofibrosis was evaluated using FibroScan and shear wave elastography (SWE).

Methods: The study included 9 patients with myelofibrosis, and 11 patients with liver cirrhosis and 8 healthy volunteers served as 2 control groups.

Results: In myelofibrotic patients, the mean stiffness of the spleen was 41.3 and 32.9 kPa by FibroScan and SWE, respectively, and was not related to spleen size. The stiffness of the liver was 7.8 kPa for FibroScan and 10.4 kPa for SWE. The stiffness of the spleen in cirrhotic patients was even higher, reaching a mean of 58.5 kPa in FibroScan and 37.5 kPa in SWE, but the correlation among cirrhotic patients was inferior in comparison to patients with myelofibrosis, with $r = 0.35$ and $r = 0.78$, respectively.

Conclusions: FibroScan and SWE may serve as tools for evaluation of response to treatment in patients with myelofibrosis.

2387759 Sonoeastography, B-Mode Sonography, and Color Doppler Sonographic Findings of Pleomorphic Adenoma and Warthin Tumors of the Parotid Gland

Hasan Yeli
Baskent University, Izmir, Turkey

Objectives: To research the sonoelastographic (SE), B-mode sonographic, and color Doppler sonographic findings of pleomorphic adenoma and Warthin tumors of the parotid gland and to determine the contribution of the SE method to the differentiation of the pleomorphic adenoma and Warthin tumors after B-mode and color Doppler sonographic examinations.

Methods: Forty-eight parotid masses in 72 patients (23 pleomorphic adenomas and 25 Warthins) were retrospectively evaluated. For each lesion, B-mode sonographic, color Doppler sonoimages, and SE images were evaluated. Vascularity of the tumors during the color Doppler sonographic examinations was determined with a 4-scoring method, and qualitative categorization was also applied if there was any vascularity in the tumor. Elasticity scores of the tumors during the SE examinations were determined with the 4-scoring method. Differences among the pleomorphic adenomas and Warthin tumors were assessed using the Student t test.

Results: The presence of a lobulated contour and cystic area was more common in the pleomorphic adenomas and Warthin tumors, respectively, during the B-mode sonographic examinations. Peripheral vascularity was seen in more than half of pleomorphic adenoma cases. Central or mixed vascularity was seen in a large group of Warthin tumor cases. The mean scores on color Doppler sonography were 1.13 ± 0.81 for pleomorphic adenomas and 1.96 ± 0.97 for Warthin tumors. The mean scores on SE were 2.69 ± 0.70 for pleomorphic adenomas and 1.83 ± 0.63 for Warthin tumors ($P < .05$). Score 1 on SE was determined in 3 cases of 5 Warthin tumors showing peripheral vascularity on color Doppler sonography.

Conclusions: B-mode, color Doppler, and elastography examinations by sonography provide some helpful findings in the differentiation of pleomorphic adenoma and Warthin tumors.
**Muscloskeletal Ultrasound**

Moderator: Humberto Rosas, MD

2377365 Multifidi Activity Helps Explain Clinical Measures in Older Adults With Low Back Pain

J. Megan Sioms1, Peter Coyte1, Teonette Velasco1, Gregory Hicks1

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**Objectives:** To determine if lumbar multifidi activity, as obtained with ultrasound imaging, helps explain disability, balance confidence, and physical performance among older adults with low back pain (LBP).

**Methods:** A total of 221 older adults, ages 60–85 years, with LBP, participated in a clinical examination that included the Oswestry Disability Index (ODI), the Activity-Specific Balance Confidence Scale (ABC), physical performance testing, ie, 6-Minute Walk Test (6MWT), and assessment of self-selected gait speed using a computerized walkway. Following the examination, a blinded examiner performed ultrasound imaging of the bilateral L3-4 multifidi, using a MyLab 25 portable ultrasound unit (Biosound Esaote, Inc, Indianapolis, IN). Ultrasound images were taken at rest and during an isometric contraction facilitated with a straight leg raise. Percent thickness change was calculated to determine multifidi activity. Regression modeling was used to determine the variance explained by average multifidi activity, above and beyond covariates. Age, sex, and body mass index were entered in the first block, followed by current LBP in the second block and multifidi activity in the third block.

**Results:** For the ODI, the model explained 17.2% of the variance with pain explaining 6.6% of the variance (P = .000) and multifidi activity explaining 4.2% of the variance (P = .001). For the ABC, the model explained 17.8% of the variance, with pain explaining 7.2% of the variance (P = .000) and multifidi activity explaining 4.7% of the variance (P = .000). For 6MWT, the model explained 27.6% of the variance, with pain explaining 16.5% of the variance (P = .036) and multifidi activity explaining 9.4% of the variance (P = .000). For self-selected gait speed, the model explained 13.3% of the variance, with pain explaining 0% of the variance (P = .813) and multifidi activity explaining 4.0% of the variance (P = .002).

**Conclusions:** Findings suggest that multifidi activity may be an independent factor that helps explain LBP-related disability and balance confidence among older adults, but to a lesser degree than LBP intensity. However, multifidi activity may be a more important factor than LBP intensity with respect to walking performance.

2327733 Musculoskeletal Ultrasound in American Occupational Medicine Residency Programs: A Survey of Program Directors

Yusef Sayeed1, Anna Allen1, Joseph Minardi1, Hussam Kardi1, Charles Werntz1

1 Occupational Medicine, 2 Emergency Medicine, West Virginia University, Morgantown, WV USA

**Objectives:** The objectives of this study were 2-fold: describe the current state of musculoskeletal (MSK) ultrasound (US) training in occupational medicine (OM) residency programs and to gauge interest in MSK US among program directors (PDs).

**Methods:** A Web-based survey was sent to all 22 United States OM residency programs.

**Results:** Fifty-nine percent (13 of 22) of program directors completed the survey, with 2 assistant program directors completing the survey, for a total of 15 responses. Ninety-three percent of programs have an OM clinic, yet no programs offer access to MSK US in the clinic. Twenty-three percent of the respondents reported including any MSK US training (formal and informal courses), with 1 respondent reporting 6–10 hours of exposure being the maximum amount of time; 23% of respondents report providing resident’s access to US machines for training purposes outside the OM clinic; 77% of respondents indicated that they were interested in attending MSK US training and bringing this skill set back to their institution.

**Conclusions:** There is a disparity between OM program directors’ desire to use and be trained in MSK US and the presence of US machines in clinic. The interest in learning MSK US clearly exceeds the portion of residency programs including this in their curricula. This level of interest suggests this modality will become increasingly useful for diagnosis and interventions as clinical practices evolve.

2369886 Preloaded Machine Protocols: Are They Better Ways to Ensure a Complete Shoulder Ultrasound Exam?

Akash Garg1, Patricia Delzell, Jennifer Bullen, Naveen Subhas

Cleveland Clinic Foundation, Cleveland, OH USA

**Objectives:** The AIUM protocol for a complete shoulder ultrasound (US) exam requires documentation of a number of structures in orthogonal planes. We observed that, despite training US technologists to follow the protocol, we routinely had incomplete exams. Therefore, we preloaded the US machine with the labels of all the required images in the order of scanning such that after an image is captured, the label for the next required image would automatically appear on the screen. This study evaluated if machine labeling of images resulted in a higher rate of complete exams compared to manually labeling images.

**Methods:** Shoulder US exams of 22 consecutive patients from 1/2010–8/2010 before machine labeling of exams were retrospectively reviewed. A 24-month window after implementation of machine labeling was selected to ensure familiarity with the new system. All exams were performed by the same 8 technologists with at least 2 years of experience using the AIUM protocol. Exams scanned by other technologists were excluded. All exams were reviewed by a single reviewer for the presence of 32 specific images/cine clips required by the protocol. The frequency of obtaining each required image for each group was then calculated.

**Results:** All of the machine-labeled exams resulted in a complete exam compared to none of the manually labeled exams. Specifically, power Doppler images of the subacromial-subdeltoid bursa and cine clips for dynamic evaluation of shoulder impingement, both of which are common causes of shoulder pain, were evaluated in only 9% (2/22) and 0% of the manually labeled exams, respectively. Images of the supraspinatus and infraspinatus muscles, posterior joint, and spinoglenoid notch, which are not common causes of shoulder pain but part of the required protocol, were not captured in any of the manually labeled exams.

**Conclusions:** Shoulder US exams performed using machine labeling of images always resulted in a complete exam compared to manual labeling of images, where required images of important structures were routinely not captured. Using preloaded protocols for technologists performing shoulder US exams can help ensure a complete examination.
2384646 Ultrasound-Guided Platelet-Rich Plasma Injection: Clinical Outcomes in Patients With Patellar Tendinopathy Following Anterior Cruciate Ligament Reconstruction Using a Patellar Tendon Autograft
Garrett Wodabury, John Wilson, Kari Taggart, Geoffrey Bauer, Tim McGuine, Ken Lee
1Radiology, 2Orthopedics, University of Wisconsin, Madison, WI USA

Objectives: Anterior cruciate ligament (ACL) reconstruction utilizing a patellar tendon autograft can cause patellar tendinopathy (PT), leading to decreased function, activity level, and postoperative satisfaction. When conservative measures have not provided pain relief, platelet-rich plasma (PRP) injection has been proposed as an additional treatment option to augment patellar tendon healing, alleviate pain, and improve function. The purpose of this study is to evaluate the efficacy of PRP in improving knee function and pain in patients suffering from PT after ACL reconstruction and to describe our ultrasound (US)-guided technique in targeting diseased tendon tissue.

Methods: A retrospective analysis was performed to evaluate the efficacy of PRP injection in alleviating pain related to PT. The study group included 11 patients (9 females, 2 males; average age, 19 ± 2.19 years) with PT recalcitrant to a myriad of conservative treatments following an ACL reconstruction utilizing a patellar tendon autograft. Each patient was diagnosed with PT and received a US-guided intratendinous PRP injection of the proximal patellar tendon. Injections were performed 34.8 ± 17.1 weeks after ACL reconstruction. Each patient completed the 2000 International Knee Documentation Committee (IKDC) scores before injection and at 29.5 ± 17.7 weeks after PRP injection.

Results: IKDC preinjection values were 48.3 (44.3, 60.3), while postinjection values were 74.7 (52.9, 82.8). Postinjection scores were significantly higher (13.8 [1.1, 33.0]; P = .02). Seven (64%) patients showed clinically significant improvement in their IKDC scores, while 4 (36%) showed no clinically significant change. The primary outcome variable was the paired differences of IKDC scores (preinjection to postinjection) for each patient assessed with the Wilcoxon signed rank test (P = .05) and reported as the median (interquartile ranges: 25th and 75th). A change of 12 points in the IKDC values for patients was considered clinically significant.

Conclusions: US-guided PRP injection may be a viable treatment option for patients with PT following ACL reconstruction with a patellar tendon autograft.

2385559 Ethnicity Does Not Affect Cross-Sectional Areas of Major Upper Extremity Nerves on Ultrasound
Nathan Anderson, Leland Finlay, Bryce Betteridge, Weston Pratt, Jongyeol Kim
1Neurology, Texas Tech University Health Sciences Center, Lubbock, TX USA; 2Texas Tech University Health Sciences Center School of Medicine, Lubbock, TX USA

Objectives: Age, gender, and body mass index (BMI) are known to affect cross-sectional area (CSA) of peripheral nerves on ultrasound. However, the effect of race on the CSA of nerves is not well defined. Normal CSAs of median and ulnar nerves of healthy volunteers from 3 different ethnicity groups were compared to investigate the effect of race on nerve size.

Methods: A total of 120 healthy subjects of 3 different races (Caucasian, 20 M, 20 F; African American, 20 M, 20 F; Mexican American, 20 M, 20 F), aged between 18 and 30 years, were recruited. Measurements were made at 5 standard points along each nerve in the upper limb. Anthropometric data (age, height, weight, fat mass, muscle mass, total body water, bone mass, basal metabolic rate, metabolic age, visceral fat rating, BMI, and degree of obesity [%]) were recorded.

Results: There was no statistically significant difference in normal values of CSA of median and ulnar nerves at 5 spots between races after adjusting for other confounders. Females showed smaller CSA at each point (P < .05), but the difference between genders was insignificant when controlled for fat-free mass index (FFMI). Contrary to previous studies, BMI did not show any significant correlation with sex.

Conclusions: For ultrasound of major upper extremity nerves, race-specific reference values will not be needed, but normative data of CSAs should be obtained according to anthropometric parameters, including FFMI and gender. FFMI has the potential to be a powerful indicator for explaining differences in nerve CSA.

2377749 The arcTOA Technique for Out-of-Plane Ultrasound-Guided Injections: Technique Description and Comparison Study
Sathish Rajasekaran, Jonathan Finnoff
1Orthopedics and Rehabilitation, University of Iowa Sports Medicine, Iowa City, IA USA; 2Physical Medicine and Rehabilitation, Mayo Clinic School of Medicine, Rochester, MN USA; 3Physical Medicine and Rehabilitation, University of California Davis School of Medicine, Sacramento, CA USA

Objectives: To describe the trigonometric function angle equals arc tan of the opposite side divided by adjacent side for out-of-plane ultrasound-guided injections (arcTOA technique) and determine if this technique resulted in fewer needle passes and less time for physical medicine and rehabilitation (PM&R) residents to accurately place a needle tip into targets at various depths in an ultrasound phantom than the modified walk-down technique.

Methods: The arcTOA technique was described. Then participants performed ultrasound-guided injections in gelatin models into 5 targets located between 1 and 5 cm in depth using the arcTOA and modified walkdown techniques. The target depth and technique order were randomized. The number of needle passes required to reach the target was the primary outcome measure. The secondary outcome measure was the time taken to reach the target.

Results: The mean number of needle passes and duration of time required to successfully complete the procedure by all participants using the arcTOA technique were significantly less than those for the modified walkdown technique (P < .001).

Conclusions: Our findings suggest that when using the arcTOA technique, PM&R residents are able to accurately place a needle into a target at various depths in a phantom using less needle passes and less time when compared to the walkdown technique. Thus, educators may wish to consider using this technique when teaching residents how to perform OOP injections. Future studies need to assess whether these results are reproducible in the clinical setting and when used by experienced interventional sonographers.

Obstetric Ultrasound: Uterus, Placenta, and Cervix
Moderator: Anna Monteagudo, MD

2378589 Utility of Volumetric Assessment of Cervical Funneling to Predict Cerclage Failure
Jessica Sheng, Frank Schubert, Avinash Patil
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Objectives: Cervical funneling has been found to be predictive of poor obstetric outcomes; however, the value of volumetric assessment is not clear. We seek to assess the utility of volumetric measurement cervical funneling as a predictor of cerclage failure.

Methods: We performed a retrospective cohort study of pregnant women with a McDonald cerclage and sonographic evidence of cervical funneling between 1/2008 and 2/2014 at an academic medical center. Funnel volume (FV) was calculated from cervical measurements and used
as a correction factor for individual subject cervical length (CL) or cervical height (CH) parameters. Receiver operating characteristic (ROC) curves were used to determine the predictive value of CL, CL:FV, CH, and CH:FV for cervical failure at <28 or <36 weeks. CL:FV obtained at the initial ultrasound after cerclage placement was further stratified to the <5th, <10th, and >10th percentiles and analyzed by a t-test to determine if these thresholds were predictive of preterm delivery at <28 or <36 weeks.

Results: Of 57 patients with a cerclage and sonographic evidence of cervical funneling, 30 patients had a cerclage failure. The mean gestational age at birth was 29.8 ± 5.3 weeks in the failure group compared to 38.1 ± 1.4 weeks in those that did not fail (P < .001). ROC curves demonstrated that CL, CL:FV, and CH:FV were predictive for cerclage failure <28 weeks' gestation (P = .003; P = .001; P = .03, respectively). CL:FV demonstrated the largest area under the curve (CL:FV AUC, 0.80; vs CL AUC, 0.77) for prediction of delivery <28 weeks. CL alone had the largest AUC (0.76) for prediction of delivery <36 weeks. The mean gestational age at delivery was significantly lower in subjects with CL:FV <5th percentile compared to >10th percentile (25.1 ± 34 weeks; P = .01) and 5th–10th (25.1 vs 33.3 weeks; P = .08).

Conclusions: Volumetric assessment of the cervical funnel may improve the ability of existing cervical morphologic parameters to predict cerclage failure in a high-risk population in the midtrimester.

2377958 More Data Supporting That Intra-Amniotic “Sludge” Does Not Affect Pregnancy Outcome in Patients Undergoing Cerclage for a Sonographically Short Cervix

Fereshteh Boojarjomehri, a Margaret Dziadosz, b Morgan Pellei, b Fatima Boojarjomehri, Anthony Vintzileos, a Ilan Timor-Tritsch, a Frederick Natholi a
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Objectives: Previously we showed that the finding of intra-amniotic “sludge” (IAS) and amniotic fluid hyperechoic material in the amniotic fluid (AF) close to the cervical internal os, did not change the pregnancy outcome in asymptomatic patients (pts) undergoing cerclage for a sonographically short cervix (Cx). We aim to find if addition of 22 pts to our previously reported 46 would change the results.

Methods: Case records of 68 consecutive pts, who underwent McDonald cerclage at 16–24 6/7 weeks’ gestation for a sonographically short cervix (Cx). Images were reviewed for cervical length, funneling, and presence of IAS. Baseline morphologic characteristics and pregnancy outcomes were compared between those with and without IAS.

Results: Of the 68 pts, 36 (53%) had IAS present, and 32 (47%) did not. Comparison of the 2 groups is shown in Table 1. Pts with IAS had significantly shorter cervical lengths at the time of cerclage, 9.9 ± 7 vs 13.7 ± 6.7 mm (P = .025) and more frequently had cervical funneling (P = .02). Other baseline characteristics were largely similar. One patient without IAS was lost to follow-up.

Conclusions: Despite associated differences in Cx funneling and shorter Cx, the presence of IAS did not affect pregnancy outcome in terms of gestational age at birth or neonatal birth weight. These results suggest that the presence of IAS does not contraindicate the use of cerclage in asymptomatic pts who are candidates for cerclage.

Table 1

<table>
<thead>
<tr>
<th>Pregnancy Outcome</th>
<th>Sludge (n = 36)</th>
<th>No Sludge (n = 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational age at delivery, wk</td>
<td>36.4 ± 7.4</td>
<td>36.2 ± 6.3</td>
</tr>
<tr>
<td>Delivery at &lt;28 wk</td>
<td>1/36 (2.8)</td>
<td>6/32 (19)</td>
</tr>
<tr>
<td>Delivery at &lt;25 wk</td>
<td>2/36 (5.6)</td>
<td>8/32 (25.0)</td>
</tr>
<tr>
<td>Delivery at &lt;20 wk</td>
<td>4/36 (11.1)</td>
<td>14/32 (43.8)</td>
</tr>
<tr>
<td>Delivery at &lt;15 wk</td>
<td>9/36 (25)</td>
<td>22/32 (68.8)</td>
</tr>
<tr>
<td>Delivery at &lt;10 wk</td>
<td>16/36 (44)</td>
<td>29/32 (90.6)</td>
</tr>
<tr>
<td>Baby weight, g</td>
<td>2745 (808)</td>
<td>2938 (827)</td>
</tr>
</tbody>
</table>

1 Median (minimum, maximum); 2 proportion (%); 3 mean (SD).
* Wilcoxon test; t Fisher test; t’t test.

2380128 Prospective Evaluation of Postpartum Uterine Sonographic Measures Following Vaginal and Cesarean Deliveries

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Objectives: We aimed to prospectively describe uterine sonographic features following vaginal and cesarean deliveries.

Methods: Transabdominal ultrasound examination was performed within 3 days following vaginal deliveries (VD; n = 103) and lower-segment cesarean section (LSCS; n = 34). The uterine length, width, and height as well as endometrial thickness at the fundus, midlength of the corpus uteri, and proximal cervical canal were measured.

Results: (1) No significant differences were found with respect to mean uterine length (127.7 ± 25.5 vs 126.0 ± 22.9 cm), width (123.0 ± 16.8 vs 117.8 ± 14.5 cm), and height (91.2 ± 16.3 vs 86.0 ± 13.6 cm) between women with VD compared to LSCS. The mean endometrial thickness at the fundus (9.0 ± 5.3 vs 8.2 ± 4.2 mm), at midlength of the corpus uteri (8.3 ± 4.0 vs 8.5 ± 3.4 mm), and at the proximal cervical canal (14.6 ± 8.6 vs 12.6 ± 5.1 mm) was comparable between women with VD and LSCS. Uterine and endometrial measurements were comparable for women who underwent early postpartum hemorrhage (PPH) or uterine revision (n = 28) to those who did not (n = 75). (2) Overall, 80 women underwent 2 consecutive measurements at <36 and 36–72 hours. No significant change was observed regarding endometrial thickness at the fundus or proximal cervical canal. The endometrial thickness at midlength of uteri increased in the 2nd measurement (9.5 ± 5.3 vs 8.3 ± 3.7 mm; P = .01). Endometrial irregularity was significantly demonstrated in the 2nd measurement. Among women following VD, endometrial thickness at the fundus site (6.7 ± 2.5 vs 9.7 ± 4.8 mm; P < .001) and at midlength of uteri (6.7 ± 2.5 vs 8.7 ± 3.9 mm; P = .01) as well as uterus width (117.4 ± 17.5 vs 125.9 ± 15.9 mm; P = .03) were significantly lower in nulliparous compared to multiparous women. (3) Overall, the time interval from delivery had no clinical effect on various outcome measurements.

Conclusions: There were no significant differences between uterine and endometrial measurements during the first 3 days postpartum. Sonographic parameters were significantly affected by parity but not by PPH, uterine revision, or mode of delivery.
2382045 Relationship of Cervical Length With Need for Adjuvant Progesterone and Pregnancy Outcomes in Women With Cerclage
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Objectives: The benefit of progesterone (P) therapy as an adjuvant to cerclage (C) is unclear. Our objective is to investigate the relationship of cervical length (CL) with need for adjuvant P and pregnancy outcomes among women with C.

Methods: A retrospective cohort review was performed by identifying women undergoing vaginal C placement from 10/2011–6/2015 within the surgery database. Patients were included if they had a singleton gestation and subsequently used P (either intramuscular P [17P] or vaginal P [VagP]). Patients were excluded if they had a multiple gestation, simultaneously used 17P and VagP, had no previous cerclage, or were lost to follow-up. Controls included women with C and singleton pregnancies who did not use P and were not lost to follow-up. The Student t test and χ² tests were used as appropriate. Logistic regression was used to create receiver operating characteristic curves, and the area under the curve (AUC) was primary interest.

Results: Sixty-two patients met inclusion criteria. Twenty-five (40%) patients with C subsequently started P; 37 (60%) had C alone. Mean gestational age (GA) at C placement was earlier for women who subsequently used P: 16.9 ± 3.0 vs 18.6 ± 3.2 weeks (P = .03). CL among women who subsequently used P was 26.52 ± 13.5 mm as compared to the C-only group: 20.4 ± 14.5 mm (P = .10). Among women who used P, it was initiated at mean GA of 18.5 ± 3.7 weeks. GA at delivery was similar between groups: 34.3 ± 5.8 weeks in the adjuvant P group vs 36.2 ± 4.1 weeks in the C-only group (P = .13). Demographic factors including age, race, and parity were similar among groups. More women in the P group had previous preterm deliveries (P = .001). Birth weight, 1- and 5-minute Apgar scores, rates of neonatal intensive care unit admission, and hospital length of stay were similar between groups. The AUC for a model for predicting delivery < 35 weeks was 0.62.

Conclusions: Paradoxically, a short cervix was not associated with adjunctive P therapy in women with C. The additional use of P did not prolong gestation or improve neonatal outcomes. Neither C use nor the addition of P prevented preterm birth < 35 weeks.

2382463 Revision of a Failed Cerclage Is Associated With Higher Risk of Premature Birth Compared to Primary Cerclage
Freesteh Booyarjomehri1, Margaret Dziadosz2, Morgan Pelletier1, Fatima Booyarjomehri3, Anthony Vintzileos1, Ian Timor-Tritsch1, Frederick Nafziger2
1Obstetrics and Gynecology, Winthrop University Hospital, Garden City, NY USA; 2New York University School of Medicine, New York, NY USA; 3Swarthmore College, Swarthmore, PA USA

Objectives: Little is known about pregnancy outcome of revising a failed cerclage previously placed for a sonographically short midtrimester cervix (Cx). Our previous data reported a higher risk of premature birth in patients (pts) with a revision compared with single cerclage. We aim to find if addition of 23 pts to previously reported 54 pts changes the results.

Methods: This is a cohort of 77 pts with Cx of < 25 mm, at 16–24 6/7 weeks who underwent a McDonald cerclage in 2007–2015. Nine pts required revision to correct a failed cerclage. Failed cerclage was defined as presence of a prolapsed membrane beyond the cerclage or Cx distal to cerclage of < 1 cm. All cerclages were performed or supervised by 1 operator (F.B.). The gestational age at birth and other obstetric outcomes, were compared between the 2 groups.

Results: There were 4 pregnancy losses (2 in the 1st attempt, 2 in revision). One pt was lost to follow-up (Table 1).

2385068 Placental Mesenchymal Dysplasia Imitating a Partial Molar Pregnancy
David McKinney,* Carri Warshak
Obstetrics and Gynecology, University of Cincinnati College of Medicine, Cincinnati, OH USA

Objectives: Case reports of placental mesenchymal dysplasia (PMD) have been published, but PMD remains incompletely understood and under-recognized by providers. We report a case of PMD detected during a routine anatomic survey.

Methods: A case with an omphalocele, cystic placentomegaly, fetal growth restriction (FGR), and large bilateral maternal theca lutein cysts was identified on a midtrimester ultrasound. Patient history, ultrasound findings, prenatal course, karyotype results, and pathologic findings are reported.

Results: A 19-year-old woman primigravida, who presented for routine ultrasound at 18 weeks’ gestation. Her ultrasound revealed an omphalocele, cystic placentomegaly, FGR, and large bilateral maternal theca lutein cysts. The primary concern was for a partial molar pregnancy. Evaluation with amniocentesis for fluorescence in situ hybridization (FISH) results and karyotype and blood work for serum human chorionic gonadotropin (hCG) and thyroid studies were performed. The patient’s thyrotropin and FISH results were normal, but her hCG was significantly elevated (444,892 mU/mL). This further raised suspicion for a partial molar pregnancy until the karyotype returned as normal male (46,XY).

Conclusions: Pts who need cerclage revision have higher premature birth compared to those who have successful primary cerclages. Revised cerclages were associated with a high take-home baby (7/9 or 78%) but also with a high preterm birth rate (8/9 or 89%), which should be considered when counseling pts who have failed cerclage and are candidates for revision cerclage.
with Beckwith-Wiedemann syndrome, and placental pathology was consistent with PMD. Therefore, the patient is not at risk for subsequent invasive disease, as would have been the case had the patient had a molar pregnancy.

Conclusions: PMD must be included in the differential diagnosis in patients with findings concerning for a partial molar pregnancy. The treatment, outcome, and complications are significantly different for these 2 conditions.

2385849 Large Vascular Placental Lake on First-Trimester Ultrasound
David McKinney,* Carri Warshak
Obstetrics and Gynecology, University of Cincinnati College of Medicine, Cincinnati, OH USA

Objectives: Placental sonolucencies can be the initial presentation of a wide spectrum of conditions from benign placental lakes and chorioangiomas to malignant gestational trophoblastic neoplasia (GTN). We report a case of a large vascular placental lake seen on first-trimester ultrasound that resulted in early-onset fetal growth restriction (FGR) and delivery at 34 weeks gestation.

Methods: A case with a large retroplacental mass and extensive vascularity was identified on first-trimester ultrasound. Patient history, ultrasound findings, antepartum course, and placental pathology are reported.

Results: A 23-year-old woman multigravida, who presented for first-trimester ultrasound at 12 weeks' gestation and was found to have a large anechoic retroplacental mass that measured 4.9 × 5.6 × 3.5 cm. The mass was initially thought to be a subchorionic hemorrhage, but color Doppler imaging revealed extensive vascularity with venous-type flow throughout the fluid collection. The differential diagnosis included a placental lake, abruption, chorioangioma, or a developing GTN such as a choriocarcinoma. Serum human chorionic gonadotropin (hCG) was drawn throughout the fluid collection. The differential diagnosis included a placental lake, abruption, chorioangioma, or a developing GTN such as a choriocarcinoma. Serum human chorionic gonadotropin (hCG) was drawn to evaluate for GTN. Initial hCG was elevated at 391,000 mIU/mL, and a repeat the following day was 465,560mIU/mL. This further raised concern for GTN. Workups for metastatic disease with chest computed tomography and head magnetic resonance imaging (MRI) were both negative. Pelvic MRI showed prominent vascularity but was not consistent with choriangioma or GTN. By 14 weeks' gestation, the patient’s hCG was 239,390mIU/mL. This decrease in hCG and stable size of the placental lesion provided evidence against a malignant placental condition. At 24 weeks' gestation, the mass was noted to have rapidly expanded to 7.4 × 9.4 × 7.5 cm, and the fetus was noted to have new-onset FGR that prompted an admission for administration of corticosteroids, but ultimately, induction of labor was not performed until 34 weeks secondary to worsening FGR. The patient had an uncomplicated vaginal delivery, and placental pathology revealed a partially disrupted placental disc compatible with a venous lake and no evidence of neoplasia.

Conclusions: Vascular placental sonolucencies can represent a variety of conditions from benign to malignant, and both conditions may have a significant impact on a pregnancy such as the FGR that developed in this case.

Therapeutic Ultrasound
Moderator: Peter Lewin, MSc, PhD

2364234 Treatment of Lower Limb Deep Vein Thrombosis by Combining Microbubble-Enhanced Ultrasound and Urokinase: A Clinical Study
Qiong Zhu1,2, Gang Dong1, Mengjiao Guo1, Shunji Gao1, Zheng Liu1, Peng Xie1
1Ultrasound, Xinqiao Hospital, Third Military Medical University, Chongqing, China; 2Ultrasound, First Affiliated Hospital of Zhengzhou University, Zhengzhou, China

Objectives: The study explored catheter-directed thrombolysis (CDT) of acute lower limb deep vein thrombosis (DVT) by combining microbubble-enhanced ultrasound (MEUS) and urokinase.

Methods: Fourteen patients with acute DVT (<14 days) undergoing CDT consented to accept coordinated MEUS treatment as the experimental group. During the CDT process, percutaneous therapeutic ultrasound (TUS) and transcatheter injection of SonoVue microbubbles were simultaneously performed for about 40-60 minutes once a day depending on the length of the thrombus. A TUS device (SL-10 Sonolyser, Welld Medical Electronics Co, Ltd, China) equipped with a single-element, nonfocused transducer was used for ultrasound thrombolysis. The transducer was operated at a frequency of 1.0 MHz with a duty factor of 0.01 and a peak negative pressure from 750 kPa to 1.0 MPa. One vial (5 mL) of SonoVue microbubbles diluted into 10 mL of saline was infused constantly into the catheter during the treatment. The other 60 acute DVT patients treated with the same CDT procedure without combining MEUS were retrospectively reviewed for the treatment days and overall urokinase dosage as the control. The criterion for terminating thrombolysis and extubation was vessel recanalization confirmed by contrast-enhanced ultrasound. Major complications such as hemorrhage were monitored. The average treatment days and overall urokinase doses of the 2 groups were compared by 1-way analysis of variance.

Results: The average treatment days of the experiment group (5.2 ± 1.5 days) were significantly less than those of the control (11.9 ± 4.4 days; P < .01). Also, the overall dosage of urokinase used in the experiment group (391.4 ± 165.6 IU) dropped significantly (about 28.2%) when compared to the control group (545.5 ± 247.4 IU; P < .01). No intracranial and local hemorrhage events happened in both groups.

Conclusions: By combining MEUS in CDT treatment of acute DVT, the treatment days and overall urokinase dosage were remarkably reduced. This method may help shorten the hospital stay and reduce the risk of hemorrhage.

2366593 Clinical Studies of Far-Field Continuous Therapeutic Ultrasound for Enhancing Drug Delivery
Mingde Li
Ultrasonic Technique, Vancouver, BC, Canada

Objectives: Some infectious diseases, for example, chronic prostatitis, arthritis, nephritis, and pulpitis, are difficult to cure because of poor drug penetration. Studies indicate that ultrasonic cavitations can open poor drug penetration. Studies indicate that ultrasonic cavitations can open poor drug penetration. Studies indicate that ultrasonic cavitations can open
solved. The effectiveness of a device for far-field continuous therapeutic ultrasound designed for this mechanism is evaluated by clinical studies.

Methods: After each intravenous injection of antibiotics, exposure at an intensity of 1.8 W/cm² and transducer frequency of 1.7 MHz on a target region was applied immediately for 0.5 hour.

Results: Imipenem therapy cured a chronic prostatitis patient of Gram-positive cocci whose sexual function recovered after the treatment and failed for a patient with a similar infection treated with a fake device. Imipenem therapy improved a male ankylosing spondylitis patient who lived for more than 2 years without pain killers and failed for his brother treated with a fake device. Levofloxacin and azithromycin therapy improved reactive arthritis and cured recurrent nephritis in a female patient treated with a fake device. Imipenem therapy improved a male ankylosing spondylitis patient whose urinary protein dropped from 0.15 to 0 g/L. Levofloxacin therapy improved a male with recurrent nephritis.

Conclusions: Far-field continuous therapeutic ultrasound is effective for antibiotic therapies of chronic prostatitis, arthritis, nephritis, and recurrent nephritis in a female patient.

2378893 Ultrasound-Enhanced Neoadjuvant Chemotherapy of Cervical Carcinoma Combined With Microbubbles and Hydrogen Peroxide

Xueyan Qiao,1* Yan Zhu,1 Xi Xiong,2 Ping Yan,1 Zheng Liu3
1Ultrasound, 2Obstetrics and Gynecology, Xinqiao Hospital, Third Military Medical University, Chongqing, China

Objectives: The study is aimed to enhance neoadjuvant chemotherapy of cervical carcinoma by combining diagnostic ultrasound (US), microbubbles (MBs), and hydrogen peroxide (H2O2).

Methods: Seven patients with cervical carcinoma (aged 33–72 years, International Federation of Gynecology and Obstetrics stage Ia–IIb) who were eligible to receive neoadjuvant chemotherapy (nadalplatin and paclitaxel) after hysterectomy consented to the combination therapy. Another 29 patients with neoadjuvant chemotherapy alone served as the control. For the combination therapy, the cervical lesions were exposed to transvaginal US (Philips iU22) at the peak plasma concentration of chemotherapy for 15–20 minutes. Two US settings were selected for exposure. Flash mode was applied to 5 cases with a mechanical index (MI) of 0.77 and B-mode for another 2 cases with an MI of 0.4. During US exposure, 5 mL of SonoVue MBs was infused, and the vagina was persistently rinsed with 100 mL of 3% hydrogen peroxide.

Results: Most of the cervical lesions showed a decrease in blood perfusion in the central area and slight perfusion enhancement at the margin after being treated by flash mode. However, the lesion perfusion was overall significantly enhanced in the other 2 cases treated by B-mode. As shown in Table 1, the cancer-free rate in the patients treated with the combination therapy had an increasing trend when compared with the control (P = .06).

Conclusions: Diagnostic US combined with MBs and hydrogen peroxide can change the blood perfusion of cervical carcinoma, which was understood as vascular effects of cavitation. These effects tended to improve the cancer-free rate in the chemotherapy.

Table 1. Semiquantitative Scores of Pathologic Results

<table>
<thead>
<tr>
<th>Scoring</th>
<th>0, n (%)</th>
<th>1, n (%)</th>
<th>2, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combination</td>
<td>3 (42.8)</td>
<td>1 (14)</td>
<td>3 (42.8)</td>
</tr>
<tr>
<td>Chemotherapy alone</td>
<td>3 (10.3)</td>
<td>9 (31)</td>
<td>17 (58)</td>
</tr>
</tbody>
</table>

2381296 Restoration of the Blood-Brain Barrier Following Ultrasound-Induced Opening Appears to Be Independent of Opening Volume

Meaghan O’Reilly1,2, * Olivia Hough1, Kallervo Hynynen1,2,3
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Objectives: Preclinical studies have shown promising results for the use of focused ultrasound (FUS) opening of the blood-brain barrier (BBB) in the treatment of brain diseases, including tumors and Alzheimer’s disease. Some studies have reported significantly longer times (>24 hours) to BBB closure following FUS when higher pressures, and consequently larger volumes, are opened and have related closure time to the size of the opening. Clinical implementation of this method, particularly for some conditions, may require large treatment volumes. Thus, the relationship between opening volume and closure time merits further investigation. The purpose of this study was to test the hypothesis that controlled BBB opening with overlapping focal spots will result in a closure time that is independent of the disrupted volume.

Methods: Sprague Dawley rats (n = 5; <300 g) were used in this study. Sonication (551 kHz; 10-millisecond burst; 1-Hz pulse repetition frequency; 2-minute duration; Tx FN = 0.8; diameter = 75 mm) were performed using magnetic resonance imaging (MRI) targeting (7 T), beginning simultaneously with the start of an intravenous injection of Definity microbubbles (MBs; 0.02 mL/kg). MB emissions were detected by a wideband receiver and used to actively control the sonication pressures during the treatments (O’Reilly and Hynynen, Radiology 2012). Each animal was treated in 1 hemisphere with a single point and a 4-point overlapping grid in the contralateral hemisphere. Contrast-enhanced T1-weighted MRI was used to assess the integrity of the BBB at t = 0, 6, and 24 hours.

Results: There was no significant difference immediately following FUS (t = 0) in the mean enhancement between the 2 hemispheres (30% ± 18% vs 30% ± 24%; paired t test: P = .9975). The mean opening cross-sectional area of the 4-point sonication was 3.5 times larger than the 1-point sonication (14.2 ± 4.7 vs 4.1 ± 3.3 mm²). Only 1 hemisphere remained open at 6 hours and was fully closed by 24 hours. T2-weighted fast spin and gradient echo images at 6 and 24 hours showed no signs of edema or hemorrhage.

Conclusions: The time for the BBB to be restored appears to be independent of opening volume on the time scale investigated. With other studies examining the safety of FUS BBB opening, this study supports the conclusion that FUS BBB opening would be safe at a clinical scale.

2383984 Effects of In Vivo Ultrasonic Exposure to the Rat Heart: Reproducibility of Heart Rate and Cardiac Output Depression

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Objectives: An important aspect of therapeutic ultrasound is its ability to produce a controlled biological effect noninvasively. The aim of this study was to investigate the reproducibility of an in vivo cardiac effect using a sequence of ultrasonic pulses and decreasing pulse repetition frequencies (PRFs).

Methods: Two independently conducted studies were evaluated, each using 3-month-old 200- to 250-g Sprague Dawley rats. Study 1: Experimental (US1) and sham control (CTR1) groups used 10 and 5 rats, respectively. Study 2: Experimental (US2) and sham control (CTR2) groups each used 5 rats. Each study used a different 1-MHz, 25-mm-
diameter transducer. The protocol was the same for both studies: 1-MHz
pulses, 1% duty factor with 3 sequences of 2.0, 2.5, and 3.0 MPa peak
rarefractional pressure amplitude (PRPA) pulses and with variable PRFs
every 10 seconds (ie, 6, 5, and 4 Hz for a total duration of 30 seconds) in
each sequence. The total ultrasound exposure duration was 90 seconds.
Cardiac conditions were evaluated before (at baseline) and at 3 and 15
minutes after ultrasonic exposure ceased.

Results: Heart rate (HR) and cardiac output (CO) groups are shown in
Table 1. Post–3- and 15-minute decreases for HR and CO show the
same trends and about the same values when US1-US2 are compared
and CRT1-CRT2 are compared. For example, CO after 3 and 15 minutes
for US1 and US2 decreases are, respectively, 15%–18% and 16%–19%.

Conclusions: These results raise the possibility of circulatory
depression resulting from therapeutic ultrasonic stress and stress the
need of additional studies to elucidate not only the physiologic mechan-
isms involved in the production of these effects but also the potential
risks of the clinical use of ultrasound application to the thorax. (Supported
by National Institutes of Health grant R37EB002641.)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>US1 (n = 10)</th>
<th>US2 (n = 5)</th>
<th>CRT2 (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR at baseline, beats/min</td>
<td>345 ± 8</td>
<td>353 ± 8</td>
<td>323 ± 13</td>
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<tr>
<td>HR post 3 min, %</td>
<td>−19.7 ± 6.0</td>
<td>−0.98 ± 1.59</td>
<td>−7.29 ± 2.28</td>
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<td>HR post 15 min, %</td>
<td>−24.8 ± 7.0</td>
<td>−5.14 ± 3.15</td>
<td>−12.5 ± 0.33</td>
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<tr>
<td>CO at baseline, mL/min</td>
<td>49.6 ± 2.0</td>
<td>56.7 ± 3.2</td>
<td>59.4 ± 4.4</td>
</tr>
<tr>
<td>CO post 3 min, %</td>
<td>−14.9 ± 11.5</td>
<td>−3.18 ± 0.90</td>
<td>−16.1 ± 5.63</td>
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<tr>
<td>CO post 15 min, %</td>
<td>−18.7 ± 5.5</td>
<td>−6.48 ± 6.75</td>
<td>−19.0 ± 3.36</td>
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</tbody>
</table>

2384123 A Novel Tikhonov Regularization Scheme to Focus Ultrasound Phased Arrays
Alec Hughes,* Kullervo Hynynen
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Objectives: Conventional focusing of phased array ultrason-
ics involves the use of phase delays to obtain a pressure maximum at the
desired focus location; that is, the desired focus is considered an infini-
tesimal point in space. This allows for beam steering, as well as tight fo-
cusing through even highly heterogeneous media. In reality, the focus manifests as an elongated distribution of pressure, which can be studied
using contours of pressure, or in the case of focused ultrasound for hy-
perthermia, temperature, and thermal dose. Here, a novel method of fo-
cusing a phased array using a modified Tikhonov regularization scheme is
introduced, so that the spatial orientation of the focus is controlled.

Methods: Tikhonov regularization is used to solve ill-posed in-
verse problems. Here, a modified Tikhonov regularization is used to per-
form spatial isometries on a focus. By sampling points away from the
target focus location, it is possible to solve the inverse problem for the
phased array controls to freely control the spatial manifestation of the
focus. Numerical simulations demonstrate the implementation of these
novel controls to a planar phased array.

Results: It is shown that given a sufficient number of elements in the
array, it is possible to freely rotate and steer a focus through space
using this focusing method. It is found that the modified Tikhonov regu-
larization parameter, which will be called $\alpha$, allows for the balance be-
tween the peak intensity of the focus, the spatial orientation of the focus,
and the even distribution of power among the elements in the array. Future applications and limitations of this method are then discussed.

Conclusions: Conventional focusing of ultrasound phased
arrays considers the target location as an infinitesimal point in space. We
argue that there are benefits to considering the spatial shape of the focus
and its orientation. A novel technique for focusing ultrasound phased ar-
rays is introduced.

2385368 First-in-Human Clinical Trial Using Ultrasonic Propulsion to Reposition Renal Calculi in Humans
Jeff Thiel1,2,* Jonathan Harper3, Franklin Lee4, Bryan Canic5, Barbara Dunmore6, Michael Bailey7, Manjiri Dighe8, Mathew Sorensen9
1Radiology, 2Applied Physics Lab, 3Urology, University of Washington, Seattle, WA USA; 4Urology, Department of Veterans Affairs, Seattle, WA USA

Objectives: Ultrasonic propulsion is a new technology de-
veloped to facilitate the natural passage of stones tractually.

Methods: Fifteen subjects were treated with the investigational
device, either awake or under anesthesia. Nine subjects had de novo stones (2–10 mm), and 6 subjects were postlithotripsy (~2-mm fragments). The
research device consisted of a software-based ultrasound system and C5-
imaging probe. The same probe was used for imaging and for propuls-
ion. Stone movement was monitored in real time using B-mode imaging. Effectiveness was evaluated by the number of stones moved and stone
passage. Safety was evaluated by completion of a pain questionnaire be-
fore and after the investigational treatment and verbal follow-up for 3
weeks following treatment.

Results: Stone movement was achieved in 14 of 15 subjects, in-
cluding 43 targets. Four of the 6 lithotripsy subjects reported passing in
total more than 30 stone fragments within a few days following treatment.
One subject passed 2 fragments before leaving the clinic. All awake sub-
jects reported minor warming of the skin from probe surface heating as-
soiated with the longer-duration ultrasonic propulsion pulse. Two subjects
reported a minor sensation deep within the kidney, on a couple occasions;
neither indicated wanting to stop the treatment. No treatment-associated
adverse events were reported by the subjects outside the normal experience
of having kidney stones. In 4 subjects, calculi identified on ultrasound as
being 1 large stone were shown to be multiple small fragments.

Conclusions: Ultrasonic propulsion has been shown to safely
and effectively reposion renal calculi in humans and facilitate stone pas-
sage. In addition to the therapeutic benefit, ultrasonic propulsion proved
to be diagnostic in cases where multiple fragments appeared as 1 large
stone. This could be extended to aid confidence in the detection of kidney
stones with ultrasound. Research is continuing to improve efficiency in
clearing large groups of fragments and also relieving acute pain caused by
obstructing stones. (Support provided by the National Space and Biomedical
Research Institute through NASA NCC 9-58 and National Institutes of Health
National Institute of Diabetes and Digestive and Kidney Diseases grants
DK043881 and DK092197.)

2393124 Therapeutic Ultrasound for Stimulation of Insulin Release as a Potential Treatment for Type 2 Diabetes
Ivan Suarez1, Aleksandar Jeremic2, Vesna Zderic3*
1Biomedical, 2Biological Sciences, George Washington University, Washington, DC USA

Objectives: Type 2 diabetes mellitus is a complex metabolic
disease that has reached epidemic proportions. The objective of this study
is to explore a novel, nonpharmacologic approach that utilizes the applica-
tion of ultrasound energy to augment insulin release from pancreatic $\beta$ cells.

Methods: Our experiments focus on determination of the effec-
tiveness and safety of ultrasound application in stimulation of insulin
release from pancreatic β cells. An insulin release enzyme-linked immunosorbent assay (ELISA) was used to determine and quantify the effects of ultrasound on insulin release in cultured INS-1 β cells. Effects of ultrasound on cell viability were assessed by the trypan blue exclusion method. Planar ultrasound transducers with center frequencies of 400 kHz, 600 kHz, 800 kHz, and 1 MHz were used to expose cells for a duration of 5 minutes at an intensity of 1 W/cm².

**Results:** Our results indicated that cell viability was not significantly affected during and for up to 30 minutes after treatment when cells were exposed to ultrasound frequencies of 800 kHz and 1 MHz. However, cell viability was highly reduced (by ~80%–90%) when the cells were exposed to ultrasound frequencies of 400 and 600 kHz ($P < .001$). ELISA results showed that significant amounts of insulin were released from β cells exposed to 400- and 600-kHz ultrasound at the cost of cell viability ($P < .05$). Cell exposure to ultrasound at a frequency of 800 kHz resulted in an approximately 4-fold increase in insulin release ($P < .005$). Cell exposure to ultrasound at a frequency of 1 MHz also showed increased insulin release (~50%), although no statistical significance was achieved when compared to sham treatment.

**Conclusions:** If shown to be successful, our approach may eventually lead to new methods in the treatment of diabetes and other secretory diseases. Our future studies will focus on application of ultrasound to human pancreatic islets to determine whether it would be possible to stimulate β cells without stimulating other endocrine and exocrine cells of the pancreas.

**2393141 Amperometric Detection of Ultrasound-Induced Secretory Events From Pancreatic β Cells**

*Bogdan Balteanu¹, Tania Singh¹, Ivan Suarez¹, Aleksandar Jeremic², Vesna Zderic*¹

1Biomedical, 2Biological Sciences, George Washington University, Washington, DC USA

**Objectives:** The objective of this study was to explore a potential new treatment method that utilizes a noninvasive application of ultrasound energy to induce exocytosis of insulin from pancreatic β cells. Our amperometric measurements can not only provide confirmation of secretion but also data that could lead to optimization in controlling the release via ultrasound application.

**Methods:** Our experiments focused on detecting exocytotic secretions from pancreatic β cells in response to ultrasound stimulation using carbon fiber amperometry. Exocytosis of insulin is measured via amperometric readings of the oxidation of dopamine. Dopamine that is loaded into cells is released via vesicles along with insulin. Results were obtained with commercially available electrodes as well as electrodes fabricated in-house. A sham group was included in which cells were loaded with dopamine but not stimulated for secretion.

**Results:** To confirm the functionality of the in-house–made electrodes, a triangular waveform was run through the electrode, and using an oscilloscope, the original signal was compared to the one from the electrode. The test was run repeatedly with different parameters to ensure accurate measurements from the electrode. The ultrasound pulse was applied 3 times ($t = 30, 90, and 150$ seconds). Amperometric spikes were seen starting at $t = 250$ seconds, although the highest peak was observed at $t = 325$ seconds. The delay between the point of stimulation and the amperometric spikes can be attributed to the diffusion time of dopamine from the stimulated cell to the tip of the microelectrode. Meanwhile, the cells belonging to the sham group did not exhibit any amperometric response.

**Conclusions:** Our proposed technology could directly target one of the underlying causes of insulin deficiency in type 2 diabetes and could result in the development of new therapeutic approaches in the treatment of this disease.
Basic Science: Tissue Characterization
Moderator: Katherine Nightingale, MD

2378080 Limitations of the Kramers-Kronig Approximations for Ultrasound Propagation in Soft and Hard Tissue
James Miller,* Jonathan Katz; Physics, Washington University, St Louis, MO USA

Objectives: This study examines, in the context of future applications of ultrasonic tissue characterization, the validity of specific approximations to the causality-imposed Kramers-Kronig (KK) relations. Methods: Attenuation was determined using log spectral subtraction. Phase velocity was obtained using phase spectroscopy.

Results: Data from wide ranges of samples of heart, cancellous bone, and tissue-mimicking materials exhibited an approximately linear increase of the attenuation coefficient with frequency. A “nearly local” KK approximation then predicted dispersions that increased logarithmically with frequency, in good agreement with experimental data for most substances but with significant deviations for others.

Conclusions: For a given type of material, lower sound speeds are generally accompanied by higher attenuations, although no quantitative “completely local” link between the speed of sound at a given frequency and the attenuation coefficient at that frequency is known. Although the exact KK relations involve properties from zero to infinite frequency, experimental data are usually processed with some type of “finite bandwidth” approximation. An extreme case is the “nearly local” KK relations, in which the attenuation coefficient at a specific frequency is related to the frequency derivative of the phase velocity at that single frequency. Surprisingly, the “nearly local” KK relations are remarkably accurate in most cases of interest. However, data from this study and from other laboratories contain instances in which not only the magnitude but even the sign of the predicted dispersion differs from that measured. Effects arising from the tails of strong responses outside of the experimental frequency range (analogous to optical dispersion at visible wavelengths produced by UV absorptivity), phase aberration, and the presence of multiple modes (eg, fast and slow compressional modes) can yield significant deviations. (Contributions by many previous members of our laboratory will be acknowledged in the presentation.)

2373262 Coronary Artery Disease Risk Stratification Using Feature Strength in a Machine-Learning Paradigm: A Link Between Coronary and Carotid Ultrasound Plaque Burdens
Tadashi Araki1, Nobutaka Ikeda2, Devarshi Shukla3, Narendra Londhe4, Vimal Shrivastava5, Sumit Banchhor5, Luca Saba6, Andrew Nicolaides7, John Laird8, Jasjit Suri1
1Electrical Engineering, University of Idaho (Affiliate), Pocatello, ID USA; 2Electrical Engineering, AdheroPoint, LLC, Roseville, CA USA; 3Division of Cardiovascular Medicine, Toho University Ohashi Medical Center, Tokyo, Japan; 4Cardiovascular Medicine, National Center for Global Health and Medicine, Tokyo, Japan; 5Electrical Engineering, NIT Raipur, Raipur, Chhattisgarh, India; 6Azienda Ospedaliero Universitaria di Cagliari–Polo di Monserrato, Università di Cagliari, Monserrato, Italy; 7Vascular Screening and Diagnostic Center, London, England; 8Biological Sciences University of Cyprus, Nicosia, Cyprus; 9CorVasc Vascular Laboratory, Indianapolis, IN USA; 10UC Davis Vascular Center, University of California, Davis, CA USA

Objectives: During the screening procedure prior to stenting and intravascular ultrasound (IVUS)-based percutaneous coronary interven-

2382475 Does Soft Tissue Vascularity Influence Elasticity?
Kevin Parker
Electrical and Computer Engineering, University of Rochester, Rochester, NY USA

Objectives: To assess the effects of changes in vascularity on the biomechanics response of soft tissues, using experimental and theoretical approaches.

Methods: Experimental tests of the microchannel flow model (MFM) were made on liver samples where changes in salinity (and therefore cellular swelling, which restricts small channels) were found to change the stress-relaxation curves. Cylindrical cores (approximately 25 mm in diameter and 60 mm in length) were acquired from fresh bovine livers using a custom-made coring tool and stored at 4°C for 24 hours in either hypertonic (0.65%) saline, normal (0.9%) saline, or hypertonic (1.15%) saline. The osmotic pressure difference can cause swelling or shrinking.

Results: The result shows that the 4-parameter MFM provides us with a closer curve fit for the beef liver tissues compared to the Kelvin-Voigt Fractional Derivative model. In the 4-parameter model parameters, the amplitude A has a distinct trend as its value is decreasing from 0.65% saline (highest, 4.1 kPa) to 1.15% saline (lowest, 1.4 kPa). The power law parameter was in the range of 0.11–0.14 for all samples. Similar results were obtained in other soft tissues.

Conclusions: The MFM predicts a number of ways in which a sample of normal soft tissue such as liver can be modified so as to be perceived as less compliant, or hardened. First, an increase in E may, for example, be achieved by soaking the specimens in formalin, which is known to harden and preserve samples. A second way to harden a sample is by increasing the viscosity of the fluids in the microchannels (Parker, 2015). Finally, and even less obvious, is the hardening caused by constriction of the smallest microchannels. This has a double effect in modifying the re-
laxation spectrum and shifting it to the right (longer time constants) according to the theory of the MFM (Parker, 2015). The net result is a modification that makes the specimen feel more resistant, or harder, over long time intervals. This was experimentally approximated with swelling from hypotonic saline; however, in vivo, this could be the net effect of inflammatory responses or edema. This could explain, for example, why inflamed regions of skin feel harder than the surrounding normal tissue.

2385301 Acquiring Maps of Attenuation Slope During Thermal Ablation of Ex Vivo Bovine Liver
Kayvan Samimi,* Tomy Varghese
Medical Physics, University of Wisconsin, Madison, WI USA

Objectives: Evaluate feasibility of monitoring thermal ablation of liver using real-time maps of the slope of the attenuation parameter overlaid on B-mode images of the ablation site.

Methods: We performed 10 microwave ablation procedures (Certus 140; NeuWave Medical) on ex vivo bovine liver. Ablations were monitored using an ultrasound research scanner (SonixTouch; Analogic) equipped with a linear array transducer (L14-5), with radiofrequency (RF) data acquired in real time. Fiber-optic temperature sensors (Neoptix Canada) were inserted into the ablation zone to record tissue temperature changes. A well-characterized uniform tissue-mimicking phantom was also scanned using the same scanner settings. RF data were downloaded and processed offline using the spectral difference reference phantom method (RPM) and the spectral shift hybrid method. Attenuation slope maps were formed at 1-second intervals and overlaid on their corresponding B-mode frames to create a series of augmented images, monitoring the procedure before, during, and after completion of microwave ablation.

Results: The ablation zone presents with an increase in the slope of attenuation. A good correlation between the shape and size of the ablation zone in the attenuation maps and in the pathologic images of the ablated liver was observed. Known issues with spectral difference methods, such as presence of negative attenuation estimates near backscatter change boundaries, are also noted in the results. Reduction in these artifacts is shown using an improved hybrid algorithm.

Conclusions: Attenuation slope is a quantitative ultrasound parameter that can monitor the progression of ablation during minimally invasive therapeutic procedures. Conventional methods of attenuation estimation using clinical scanners, including the spectral difference RPM, are not sufficiently accurate for clinical use. Improving attenuation estimation techniques is an important area of research and one of the focus areas of our group. (Supported in part by National Institutes of Health R01 CA111292, and T32 CA09206-36 A1.)

2385314 In Vivo Acoustic Radiation Force Impulse Characterization of Human Carotid Atherosclerotic Plaque Composition and Structure
Tomasz Czermsiewicz1, Jonathon Homeister 3, 2, 3, Melissa Caughey3, Mark Farber3, Joseph Fulson3, Peter Ford3, William Marston3, Raghveer Vallabhaneni3, Timothy Nichols4, Caterina Gallippi2, 3
1Joint Department of Biomedical Engineering, University of North Carolina and North Carolina State University, Chapel Hill, NC USA; 2McAllister Heart Institute, 3Pathology and Laboratory Medicine, 4Medicine, 5Surgery, 6Biomedical Research Imaging Center, University of North Carolina, Chapel Hill, NC USA

Objectives: It has been shown that carotid plaques composed of large, mechanically soft necrotic cores covered by thin fibrous caps have a propensity to rupture and induce cerebrovascular accidents. To improve plaque characterization with ultrasound, our group has been investigating acoustic radiation force impulse (ARFI) imaging, which has shown promise in early animal and human studies. We herein report results for in vivo carotid ARFI imaging with matched histology and trained reader assessments in patients undergoing endarterectomy.

Methods: Patients were consented and recruited from University of North Carolina Hospitals and imaged with ARFI on a Siemens Acuson Antares. Imaging was performed preoperatively by focusing on the surgical plaque. After surgery, the extracted specimen was imaged with micro computed tomography, decalcified, and sectioned according to noted arterial geometry for spatial registration to the ultrasound imaging plane. The sections were stained with hematoxylin-eosin, combined Mason’s elastin (CME), and Von Kossa. ARFI peak displacement images were assessed by 6 trained readers, who identified the lipid/necrotic core, intraplaque hemorrhage, fibrous cap, calcium deposit, and collagen deposition within the ARFI plaque images. Reader assessments were compared to the matched histology.

Results: From 25 patients, 20 intact plaque samples were collected with matched ARFI images. In a 45-year-old symptomatic female, the ARFI image shows a focal stenosis with plaque in the proximal wall. The plaque appears to displace far (10.8 ± 11.7 µm) and is covered by a low-displacing region (2.8 ± 0.9 µm, 0.93 ± 0.4 mm thick), suggesting a necrotic core and fibrous cap that was confirmed by histology (with cap thickness of 0.91 ± 0.1 mm). Readers properly identified the high-displacing ARFI region as corresponding to the location and size of the necrotic core and the low-displacing region as corresponding to the location and thickness of the fibrous cap. Out of the 20 plaque samples, 13 were ruptured with significant hemorrhage, and 9 were correctly identified by the best-performing reader.

Conclusions: These results suggest that ARFI is relevant to characterizing plaque composition and structure via mechanical stiffness, which may improve plaque risk stratification.

Breast Ultrasound
Moderator: Gary Whitman, MD

2385255 New York State Breast Density Mandate: Follow-up Data of Screening Ultrasound and Breast Cancer Detection
Stamatia Destounis
Elizabeth Wende Breast Care, LLC, Rochester, NY USA

Objectives: To determine the impact of screening breast ultrasound (US) in women with mammographically dense breasts on breast cancer detection.

Methods: This study utilized a retrospective chart review. Data collected included: total number of screening mammograms; total number of dense breast screening US exams performed; total number of procedures performed; biopsy results; and demographic data on those with cancer diagnosis. Data were obtained from the time period of 6/1/2014 through 8/31/2015.

Results: In this time period, there were a total of 93,817 screening mammograms performed at our facility. Of these, 36,341 patients were informed that their breast tissue was heterogeneously dense or extremely dense (39%), with 4900 screening US exams performed in 4785 patients. We reviewed the outcomes of the screening US exams performed in this population. There were 51 biopsies/procedures (1.0%) performed based on the screening US exam, with 12 cancers and 1 atypical lesion diagnosed. Cancers detected were all invasive. Average lesion size at excision was 1.4 cm, and all were node negative. One patient did not have surgery due to extensive metastatic disease. This study found a positive predictive value (PPV) of 24% (12/51) and 99% specificity (4849/4900), with cancer detection of 2.5 cancers per 1000.

Conclusions: The results review the second year of our screening program with screening US and identify that screening breast US in women with dense breast tissue can detect otherwise occult malignancy with a low recall rate and a reasonable PPV for biopsy.
2385774 Characterizing Breast Microcalcifications Using A New Ultrasound Image-Processing Technique
Priscilla Machado,* Maria Stanczak, John Eisenbrey, Barbara Cavanaugh, Lisa Zorn, Flemming Forsberg
Radiology, Thomas Jefferson University, Philadelphia, PA USA

Objectives: To evaluate a new commercial image-processing technique (MicroPure; Toshiba America Medical Systems, Tustin, CA) for the characterization of breast microcalcifications in patients undergoing stereotactic or ultrasound (US)-guided biopsies.

Methods: One hundred women scheduled for stereotactic or US-guided biopsy of an area with breast calcifications (almost always without an associated mass) provided informed consent to participate in the study. Patients underwent real-time dual imaging of grayscale US and MicroPure using an Aplio XG scanner (Toshiba). MicroPure combines nonlinear imaging and speckle suppression to mark suspected calcifications as white spots in a blue overlay image. Four independent and blinded readers (2 radiologists and 2 physicists) analyzed 208 digital clips to determine the number of calcifications seen with MicroPure and also to provide a subjective view on the level of suspicion (LOS) on a 5-point scale (benign to malignant). Mammograms of the subjects were analyzed by a reader and on average with the mammographic numbers. The LOS was compared to pathology number of microcalcifications was compared by reader and on average with the mammographic numbers. The LOS was compared to pathology using receiver operating characteristic (ROC) analysis.

Results: The mean number of microcalcifications seen on MicroPure was 5.9 ± 4.2 (range, 0–22). These values were significantly lower than the number of microcalcifications identified on mammography (42.6 ± 51.5; P < 0.01), which is similar to our prior study (Machado et al., J Ultrasound Med 2012). ROC analysis of readers’ LOS scores produced areas under the curve of 0.54–0.59. However, the number of microcalcifications seen with MicroPure was significantly higher in malignant than benign cases (6.8 ± 5.1 vs 5.3 ± 3.7; P = 0.021) with the radiologists showing a better agreement with the pathology findings than the physicists. No such difference was found for mammography (P > 0.15).

Conclusions: MicroPure was able to identify breast microcalcifications and correctly characterize a target area based on the number of calcifications seen. The accuracy of the ROC curves was quite low, indicating that the visual appearance of microcalcifications is not as important.

2385746 Breast Ultrasound Tomography: A Clinical Study
Lianjie Huang,* Junseob Shin, Youzuo Lin, Ting Chen, Kai Guo, Kenneth Hanson
Los Alamos National Laboratory, Los Alamos, NM USA

Objectives: Breast ultrasound tomography is a new imaging modality for breast cancer detection and characterization. It could become a safe (nonionizing), comfortable (no compression), cost-effective, and operator-independent imaging modality if its clinical capability is proved. The objective of this study is to study the clinical feasibility of breast ultrasound tomography for breast cancer imaging and characterization.

Methods: We have designed and manufactured a cutting-edge breast ultrasound tomography prototype with 2 parallel transducer arrays and a ring transducer array for the clinical study. The distance of these 2 arrays is adjustable for scanning different sizes of the breast. The transducer arrays are translated vertically to scan the entire breast from the chest wall to the nipple region. The scanning process is controlled by a computer and thus is operator independent. It takes approximately 2–4 minutes to scan the entire breast. We have used the system to acquire in vivo patient data at the University of New Mexico Hospital and reconstructed breast images using our recently developed high-resolution ultrasound tomography algorithms.

Results: We have compared our ultrasound tomography images with mammograms and clinical ultrasound images. Our breast ultrasound tomography images show lesions seen on mammograms. For 2 of the 28 patients scanned, our ultrasound tomography images reveal lesions that are not seen on mammograms.

Conclusions: We have designed and manufactured a novel breast ultrasound tomography prototype capable of scanning the whole breast in 2–4 minutes. We have used the prototype to acquire in vivo patient data, and our clinical images not only show lesions seen on mammograms but also reveal lesions that are not detectable using mammography. This preliminary study demonstrates the great potential of ultrasound tomography for breast cancer detection and characterization.

2384877 Fusion of Computed Tomographic (CT) and Sonographic Images for Breast Cancer Evaluation Using Real-time Virtual Sonography With CT Navigation
Tsun-Hou Chang,* Hsian-He Hsu
Radiology, Tri-Service General Hospital, Taipei, Taiwan

Objectives: We recently developed a real-time virtual sonography (RVS) system that enables simultaneous display of both sonographic and computed tomographic (CT) cutaway images of the same site in real time. The aim of this study was to evaluate the role of RVS in the management of suspicious lesions visualized with CT.

Methods: Between December 2014 and April 2015, 5 patients underwent CT for staging of known breast cancer going to neoadjuvant chemotherapy, postmastectomy regular follow-up, or incidental abnormal findings on CT under some clinical purposes at our hospital. All patients were examined using ultrasonosonography (US), CT, and RVS before biopsy for tissue proof if indicated. Results were correlated with histopathologic findings. CT was obtained on a multidetector CT imager (64/256), with the patient in the supine position. Diagnostic accuracy was compared with or without RVS.

Results: Suspicious lesions on CT or US can be identified under the RVS system. Diagnostic accuracy depends on good landmarks of chest anatomy for multistep registration. It is necessary to perform RVS over the breast or axillary region with soft maneuvers. More practice could increase diagnostic accuracy.

Conclusions: Our results suggest that the RVS system can help those whose lesions are not clearly seen on US but suspicious looking on CT, to localize it on the US. If indicated for tissue proof, it is also convenient to do sonographically guided core biopsy under RVS with navigation.

2381756 Subharmonic Pressure Estimation in Breast Tumors: Calibration and Treatment
Valgerdur Halldorsdottiri,1,* Jaydev Dave1, Andrew Marshall1,2, Anya Forsberg1, Priscilla Machado1, Traci Fox1, Ji-Bin Liu1, John Eisenbrey1, Flemming Forsberg1
1Radiology, Thomas Jefferson University, Philadelphia, PA USA; 2School of Biomedical Engineering, Sciences, and Health Systems, Drexel University, Philadelphia, PA USA; 3Plymouth Whitemarsh High School, Plymouth Meeting, PA USA; 4Trinity College, Hartford, CT USA

Objectives: To noninvasively estimate in vivo tumor interstitial fluid pressure (IFP) in female nude athymic rats implanted with breast cancer xenografts using subharmonic aided pressure estimation (SHAPE) and compare results to an invasive intracompartmental pressure monitor (the reference standard). Also to monitor changes due to chemotherapy treatment.

Methods: Eighty-nine female nude athymic rats were injected in the mammary fat pad with 5 × 106 breast cancer cells (MDA-MB-231). Animals were randomly assigned to a calibration group (n = 25) or a treatment group (n = 64), with the treatment group receiving a single injection of 5 mg/kg paclitaxel (Mayne Pharma, Paramus, NJ). Radiofrequency signals were acquired with a Sonix RP ultrasound scanner (Analogic Ultrasound, Richmond, BC, Canada) using a linear array (L9-4, trans-
mit/receive: 8/4 MHz). The contrast agent Definity (Lantheus Medical Imaging, North Billerica, MA) was injected into a tail vein (dose: 180 µL/kg), and acoustic power was varied from 0 to –20 dB to identify the optimal choice for SHAPE. Measurements from the tumors and surrounding tissue were obtained (in triplicate) after contrast administration at the optimal acoustic power. SHAPE IPF estimates were compared to an invasive pressure monitor (Stryker, Berkshire, UK) using linear regression analysis.

**Results:** Fifty rats developed tumors (56%) and 39 were successfully imaged (13 and 26 for calibration and treatment, respectively). Tumor flow was clearly visualized in the tumor periphery, while slow capillary-type flow was more difficult to depict. An inverse linear relationship was established between tumor IFP and SHAPE ($v = -1.06x + 28.27; r = -0.69; P = .01$) based on the calibration group. Using this relationship in the treatment group resulted in an r value of 0.74 ($P < .05$) between measured and estimated IPF values with an average error of 6.24 mm Hg. No significant differences in tumor IFP were seen before and after paclitaxel treatment with either SHAPE or the Stryker technique ($P ≥ .15$).

**Conclusions:** A calibration equation for in vivo studies of breast tumor IFP using SHAPE has been derived and verified in an independent population. SHAPE IFP estimates may be useful in future clinical breast studies.

**2385253 Four-Dimensional Subharmonic Contrast Imaging for Monitoring Neoadjuvant Chemotherapy of Breast Cancer**

**Flemming Forsberg,** *Maria Staniszak, Elizabeth Hsu, Anush Sridharan, Adam Berger, Tiffany Avery, John Eisenbrey*

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**Objectives:** To determine if breast tumor vascularity or interstitial fluid pressure (IFP) measured by 4D subharmonic imaging (SHI) can be used as a predictor of neoadjuvant chemotherapy response.

**Methods:** Seventeen patients scheduled for neoadjuvant treatment (approximately 16 therapy cycles over 3–6 months) of a primary breast cancer provided informed consent to undergo ultrasound exams immediately prior to starting therapy, at 10% and 60% through the course of therapy, as well as at the conclusion of therapy. Scanning was performed using a modified LOGIQ 9 scanner with a 4D10L probe (GE Healthcare, Milwaukee, WI). Experimental software enabled 4D pulse inversion SHI (transmitting 4 cycle pulses at 5.8 MHz and receiving at 2.9 MHz) and collection of radiofrequency data for the estimation of IFP using subharmonic-aided pressure estimation (SHAPE). Subjects first underwent 3D B-mode and Doppler imaging of the mass. Then patients received a continuous infusion of Definity (Lantheus Medical Imaging, North Billerica, MA) at acoustic pressures optimized for either SHI or SHAPE. The relative changes in blood flow and IFP were scored (from –3 to 3, where 0 indicates baseline conditions). Results were grouped by complete (>99% reduction in tumor volume) or partial treatment response and compared with Mann-Whitney tests.

**Results:** To date, 8 subjects have completed all 4 exams, while 1 subject has received 3 of 4 scans and another 3 have completed 2 of 4 exams. Overall, 42 SHI studies have been performed. Volume acquisition rates ranged from 0.6–3.2 volumes/second. Five patients saw complete resolution of the primary mass, while 3 subjects achieved a partial response only. Complete responders demonstrated greater vascularity at baseline and a greater overall change in flow and IFP relative to partial responders, albeit not statistically significant ($P > .19$). Additionally, fully responding masses showed a trend toward significance for decreased tumor vascularity at 60% and completion compared to partial responders ($P = .07–.08$).

**Conclusions:** Preliminary results indicate that changes in breast cancer vascularity and in IFP observed on 4D SHI and SHAPE may predict neoadjuvant chemotherapy treatment response.
2D, the arterial phase, and the delayed phase of CEUS from 1 image section. The 3 measurements were compared by paired $t$ test.

**Results:** The mean longitudinal diameter of HCC appeared to be maximal in the arterial phase (4.73 ± 2.04 cm) of CEUS and minimal in the delayed phase (3.98 ± 1.99 cm) of CEUS. The 2D diameter (4.26 ± 2.07 cm) was in the middle between the 2 CEUS measurements. There were significant differences between any 2 measurements.

**Conclusions:** There are size differences between the 3 kinds of HCC measurement. The tumor size appeared to be maximal in the arterial phase of CEUS and minimal in the delayed phase, whereas the 2D diameter was in the middle.

2381690 Characterization of Pancreatic Masses With Subharmonic and Endoscopic Contrast Ultrasound

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**Objectives:** To demonstrate the feasibility of using subharmonic imaging (SHI) to depict and characterize pancreatic masses in humans and to compare results to contrast-enhanced endoscopic ultrasound (EUS) as well as to pathology.

**Methods:** Sixteen patients scheduled for an EUS-guided biopsy of a pancreatic mass were enrolled in an Institutional Review Board–approved study. Pulse inversion SHI (transmitting/receiving at 2.5/1.25 MHz) was implemented on a LOGIQ 9 ultrasound scanner (GE Healthcare, Milwaukee, WI) with a radial endoscope (GF-UTC180; Olympus, Tokyo, Japan) connected to a ProSound SSD s10 scanner (Hitachi-Aloka, Tokyo, Japan). Two injections of the contrast agent Definity (Lantheus Medical Imaging, North Billerica, MA) were administrated (dosages of 0.3–0.4 and 0.6–0.8 mL for EUS and SHI, respectively). Contrast-to-tissue ratios (CTRs) in the mass and an adjacent vessel were calculated offline for both modes and compared using paired $t$ tests. Four blinded physicians independently scored the contrast images on a 5-point scale (benign to malignant).

Receiver operating characteristic (ROC) curves (4 in all) for diagnostic accuracy and $k$ values for inter-reader agreement were calculated.

**Results:** One subject dropped out before imaging, leaving 11 adenocarcinoma, 1 gastrointestinal stromal tumor with pancreatic infiltration, and 3 benign cases. Marked subharmonic signals and reasonable tissue suppression were obtained in all subjects with intratumoral blood flow clearly visualized using transabdominal SHI. Significantly greater CTRs were obtained in the masses with SHI than with EUS ($1.71 ± 1.63$ vs $0.63 ± 0.89$, $P < .016$). In the larger surrounding vessels, SHI and contrast EUS CTRs were similar ($P = .72$). There were no differences in CTR when grouped by pathology ($P > .60$). The areas under the ROC curves were 0.09 and 0.52 for contrast EUS, while for SHI they were 0.45 and 0.32 with greater $k$ values for the latter ($0.34$ vs $0.13$ for EUS).

**Conclusions:** The diagnostic accuracy of contrast EUS and transabdominal SHI for assessment of pancreatic masses was quite low in this pilot study. However, SHI demonstrated better agreement between readers and improved tumoral CTRs relative to contrast EUS.

2382015 Preliminary Clinical Application of Contrast-Enhanced Ultrasound Using a High-Frequency Linear Probe in the Detection of Small Colorectal Liver Metastases

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**Objectives:** To compare the performance of contrast-enhanced ultrasound (CEUS) using a high-frequency linear probe and routine convex probe in the detection of small colorectal liver metastases (CRLMs).

**Methods:** Sixty-six CRLMs in 38 patients were evaluated with both ultrasound (US) and CEUS by using a convex probe and linear probe respectively. The size of lesions ≤5 mm was 7.3 ± 2.1 mm (range, 3.0–10.0 mm, measured by CECT/magnetic resonance imaging). US and CEUS were performed with a LOGIQ E9 (GE Healthcare, Milwaukee, WI) equipped with a convex probe (C1-5, frequency range from 3.0–5.0 MHz) and a linear probe (9L, frequency range from 6.0–9.0 MHz). The contrast agents used in CEUS was SonoVue (Bracco, Milan, Italy). Imaging findings and detection rates of both US and CEUS were reviewed and compared.

**Results:** On baseline US, for the 53 lesions within 60 mm, high-frequency US detected more than routine US (79% vs 58%; $P < .05$). The boundary and halo sign were depicted more clearly by using the high-frequency linear probe compared with the convex probe ($P < .05$). On CEUS, 48 lesions (73%) were detected by using the convex probe, and 54 lesions (82%) were detected by using the linear probe, with no statistical difference ($P > .05$). However, for the lesions within 60 mm, high-frequency CEUS detected more than routine CEUS (89% vs 66%; $P < .05$). Combining the convex probe and linear probe, CEUS detected 97% (64/66) of all the lesions, which was significantly higher than baseline US (97% vs 85%; $P < .05$). For enhancement levels and patterns, there was a statistical difference between routine CEUS and high-frequency CEUS in the arterial phase ($P < .05$).

**Conclusions:** High-frequency CEUS may help improve not only the detection of tiny CRLMs but also depiction of the tumor vascularization. For patients with a high risk of CRLMs, we recommend the combination of a convex probe and high-frequency linear probe for CEUS to detect and characterize CRLMs in clinical practice.

2383496 Double Contrast-Enhanced Ultrasound for Diagnosis of Gastric Subepithelial Tumors

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**Objectives:** To explore the application value of double contrast-enhanced ultrasound (DCEUS) in the diagnosis of gastric subepithelial tumors.

**Methods:** A total of 172 cases of gastric subepithelial lesions were covered (from January 2013 to May 2015), and the various patterns of DCEUS in different subepithelial lesions were summarized to compare with pathology results in every patient.

**Results:** Of the 172 lesions, 37 were gastric cancers (Borrmann I; 21.5%), 47 were gastrointestinal stromal tumors (27.3%), 12 were lymphomas (7.0%), 7 were inflammatory masses (4.1%), 35 were polyoid adenomas (20.3%), 11 were gastric cysts (6.4%), 7 were ectopic pancreas (4.1%), 5 were lipomas (2.9%), 4 were glomus tumors (2.3%), 5 were leiomyomas (2.9%), and 2 were schwannomas (1.2%). Perfusion patterns vary in different lesions, and they are connected to histopathology and malignant degree.

**Conclusions:** The presentation of different DCEUS perfusion pattern in 172 gastric subepithelial lesions could be treated as a novel and reliable diagnostic tool to identify the different kinds of subepithelial tumors, and DCEUS surveillance can be an appropriate strategy for lesions.
2384518 Dynamic Contrast-Enhanced Ultrasound and Elastography for Assessing Deltoid Muscle Integrity After Reverse Shoulder Arthroplasty
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Objectives: Reverse shoulder arthroplasty (RSA) is the treatment of choice for cuff tear arthropathies. The condition of the deltoid muscle plays a key role in the outcome of RSA, which we assessed with contrast-enhanced ultrasound (DCE-US), elastography, and electromyography.

Methods: Sixty-four patients (mean age, 72.9 years) who were treated with RSA between 2004 and 2013 were recruited. Clinical, functional, electromyography, and ultrasound examinations were performed to assess the long-term outcome. DCE-US perfusion parameters such as wash-in rate (WRi) and wash-in perfusion index (WiPI) were recorded and referenced to the posterior humeral circumflex artery. The results of the healthy and operated shoulders were compared in order to rate the vitality of the deltoid muscle based on the microperfusion of the muscle tissue.

Results: There were significant functional differences between both shoulders (eg, Constant score = −14 ± 24; P < .0001) as well as in DCE-US (WRi = −15.7% ± 29.9%; P = .0002; WiPI = −12.0% ± 22.0%; P = .0001). Elastography showed a higher stiffness of the deltoid muscle on the operated side (difference = 0.2 ± 0.9 m/s; P = .0002; WiP = –15.7% ± 29.9%; P = .0545). The postoperative interval did not have any impact on these differences. Electromyography did not show any signs of neurologic injury in the study patients.

Conclusions: The DCE-US analysis showed diminished microperfusion kinetics of the operated deltoid muscle with slower blood flow and lower blood volume. These results correlated with the functional impairment after RSA and can be interpreted as signs of degenerative changes in the muscle. DCE-US serves as a surrogate parameter for the integrity of the deltoid muscle.

2384901 Contrast-Enhanced Ultrasound in Small Indeterminate Renal Lesions
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Objectives: To determine the value of contrast-enhanced ultrasound (CEUS) in small renal lesions indeterminate on prior imaging.

Methods: This Institutional Review Board–approved, retrospective study evaluated all patients who underwent CEUS from 2006–2015 at our tertiary care hospital. Renal lesions initially deemed indeterminate by computed tomography (CT), ultrasound (US), or magnetic resonance imaging (MRI) were evaluated by CEUS. Cystic lesions were categorized by the Bosniak classification system, and solid enhancing masses were labeled as solid. We compared the number of lesions definitively characterized by CEUS with the indeterminate lesions by prior imaging. The accuracy of CEUS was analyzed and compared with the final diagnosis by histology.

Results: Of 134 renal lesions evaluated by CEUS, 108 were indeterminate by prior imaging. Mean ± SD lesion size was 2.9 ± 1.8 cm. Sixty-nine renal lesions were indeterminate on prior CT due to equivocal enhancement of 10–20 Hounsfield units (n = 21), noncontrast scan only (n = 39), or venous phase only (n = 8). Six lesions were indeterminate by MRI due to lack of contrast, and 36 lesions were indeterminate by conventional US. Of 108 renal lesions indeterminate by prior imaging, 79.6% were definitively diagnosed by CEUS (95% confidence limits (CL), 0.71, 0.88; P < .0001). Specifically, CEUS was definitive for 83.6% of lesions deemed indeterminate by CT (95% CL, 0.73, 0.92; P < .0001); 100% of lesions were indeterminate by MRI (95% CL, 0.54, 1.0; P = .0143); and 73.7% of lesions were indeterminate by prior US (95% CL, 0.57, 0.87; P = .0035). Of those that were indeterminate on prior CT, 41.1% were classified as Bosniak 1 or 2, 16.1% as Bosniak 2f, 21.4% as Bosniak 3 or 4, and 21% as solid enhancing masses. CEUS was definitive for characterization of renal lesions in 85.0% of patients with end-stage renal disease (95% CL, 0.62, 0.97; P = .0017) and in 85.4% of patients with a glomerular filtration rate <60 (95% CL, 0.76, 0.92; P < .0001). Of the 24 lesions classified as Bosniak 3, Bosniak 4, or solid enhancing mass, 22 went on to pathologic diagnosis. Sensitivity was 100% (P < .0001), positive predictive value was 0.91 (P < .0001), and accuracy was 90.1%.

Conclusions: CEUS is frequently useful for definitive characterization of small renal masses that were indeterminate by prior imaging, especially in patients with previous indeterminate MRI or CT.

2385019 Preoperative Tumor Studies Using Contrast-Enhanced Ultrasonography in Patients With Clinically Suspected Insulinoma
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Objectives: Insulinomas are relatively rare pancreatic endocrine tumors. These insulinomas with a diameter less than 1 cm are very difficult to be identified. The aim of this study was to localize and diagnose insulinomas preoperatively using contrast-enhanced ultrasonography (CEUS) in correlation with postoperative pathologic results.

Methods: A total of 38 consecutive patients with clinically suspected insulinoma were surgically treated in our hospital between November 2004 and March 2015. CEUS was performed before the operation. The echogenicity, shape, diameter, localization, and number of tumors were described. SonoVue was applied intravenously through the cubital vein as a 2.5 mL bolus injection within 5 seconds, followed by a 10-mL saline flush. Then we observed the dynamic enhancement of pancreas to confirm whether there were abnormal nodules and to analyze the enhancement patterns. The characteristics of lesions from the preoperative and intraoperative ultrasonography reports and operation reports were analyzed retrospectively and compared with postoperative pathologic findings.

Results: A total of 34 cases were located accurately. In the arterial phase, 37 lesions were enhanced. Moreover, the lesions were still enhanced in the venous phase. The enhancement pattern of insulinoma on CEUS was fast wash-in and slow wash-out. In the arterial phase, 1 lesion enhanced inhomogeneously with a filling defect in the center, and it faded away earlier than the rest of the pancreas during the venous phase. Tumor sizes ranged from 6 × 6 to 31 × 37 mm. Emulsification was carried out in 20 patients, Whipple in 6, segmental resection in 5, distal pancreatectomy in 5, and intraoperative radiofrequency in 2. The operations were successful, and the mortality rate was 0%. Pathologic findings were insulinoma in 37 cases. One patient had neuroendocrine tumors.

Conclusions: We conclude that the preoperative localization of insulinoma in clinically suspected patients can be made by CEUS. There are characteristics for insulinoma on CEUS. Preoperative localization of insulinoma is very important for choosing the appropriate surgical procedure.
2385711 Value of Contrast-Enhanced Ultrasonography in Confident Diagnosis of Ovarian Torsion: Initial Experience
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Objectives: B-mode ultrasonography (US) along with color duplex imaging is known to help in diagnosis of suspected ovarian torsion. In the appropriate clinical setting, identification of a twisted pedicle (sign and whirlpool sign) with or without absence of intravascular color flow is a highly useful sign, with unilateral ovarian enlargement and trapped follicles being the commonest features. In young patients it is always difficult to prepare a patient or parents for emergency surgery such as oopherectomy. Adding contrast-enhanced ultrasonography (CEUS) as an adjunct just prior to sending the patient for surgery has shown additional diagnostic value in our series.

Methods: We could use CEUS in 4 cases in the last 7 months in our small community hospital. The patient age group was 4–33 years, all presenting with acute lower abdominal pain but without any preexisting ovarian lesion such as a cyst or solid tumor. On initial B-mode US using various signs, clinical history, and acute onset of presentation, a tentative diagnosis of ovarian torsion was established. This was communicated to the surgeon, and with prior consent CEUS using 2 mL of intravenous sulfur hexafluoride microbubbles (SonoVue; Bracco; which is approved in our country for human use), review US was done on high-end ultrasound units with suitable abdominal probes.

Results: CEUS did not reveal any microbubble uptake on the suspected side compared to the normal ovary; hence, a confident diagnosis was given. Emergency laparoscopic ovarian detorsion was achieved. This was communicated to the surgeon, and with prior consent CEUS using 2 mL of intravenous sulfur hexafluoride microbubbles (SonoVue; Bracco; which is approved in our country for human use), review US was done on high-end ultrasound units with suitable abdominal probes.

Conclusions: In a suspected case of ovarian torsion, quick add-on CEUS helps in establishing the diagnosis. This is important for avoiding interin delay, especially in younger patients prior to emergency surgery. CEUS is safer and faster than further contrast-enhanced computed tomography with added radiation exposure, as seen in our institute, where US is still the initial and at times the only available diagnostic tool in emergency conditions such as gonadal torsion.

2385754 Value of Ultrasound Contrast Agents in the Diagnosis of Endoleaks in Patients With Abdominal Aortic Aneurysms Treated With Stent Graft Implantations
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Objectives: To assess the value of ultrasound contrast agents in the diagnosis of endoleaks in patients with abdominal aortic aneurysms (AAAs) treated by stent graft implantation.

Methods: A total of 198 patients with AAAs were referred to our department for stent graft implantation. In every patient, control examinations were done 6 months after treatment. First ultrasound examinations before and after contrast administrations were done, and next angio-computed tomography (CT) was performed. In every ultrasound examination, color, power, and B-flow options were used before and after contrast injections, and additionally, contrast-enhanced ultrasound (CEUS) was performed after contrast administration.

Results: In control ultrasound examinations performed 6 months after stent graft implantations before contrast injections, in all options (color, power, and B-flow), 16 endoleaks were diagnosed: 6 type IA, 4 type IB, 2 type IIA, and 4 type IIB. In control ultrasound examinations after contrast injections using color, power, and B-flow options, 16 known endoleaks were confirmed, and additionally, 6 endoleaks were diagnosed: 1 type IB, 2 type IIA, and 3 type IIB. In CEUS examinations after contrast administration, 22 diagnosed endoleaks were confirmed, and additionally, 4 endoleaks were diagnosed: 2 type IIA and 2 type IB. In angio-CT examinations, 22 endoleaks were diagnosed: 6 type IA, 5 type IB, 4 type IIA, and 7 type IIB.

Conclusions: Ultrasound contrast agents significantly increased the sensitivity of ultrasound examinations in the diagnosis of endoleaks, particularly type II. CEUS studies show the greatest sensitivity in detecting the endoleaks because they disclose endoleaks unrecognized by other techniques, including angio-CT. Ultrasound examinations after contrast injection can replace angio-CT in monitoring patients after stent graft implantations.

General, Abdominal, and Interventional-Intraoperative Ultrasound
Moderator: Nirvikar Dahiya, MD

2351545 Ultrasound of Human Papillomavirus Cancers in the Base of the Tongue and Tonsils
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Objectives: To demonstrate how ultrasound can show masses in the base of the tongue and tonsils using normal scanning techniques through the neck. To discuss the pitfalls of magnetic resonance imaging (MRI) and computed tomography (CT) and learn how ultrasound is a viable alternative to imaging these patients.

Methods: Using Siemens S3000 and Philips Epiq units with a variety of transducer types and frequencies, we were able to visualize the normal and abnormal tonsils and base of tongue, as well as any associated lymph nodes. We scanned patients with known human papillomavirus cancer of the oropharynx. Patients also had to have a recent CT or MRI scan for comparison and validation of pathology.

Results: In our initial group of 15 patients, we visualized both normal and abnormal tonsils, including 1 patient with an enlarged tonsil that was suspicious for a cancer on physical examination. We demonstrated extension of the tumor from the tonsil into the tongue in 2 patients. We were able to visualize the extent of tumors in patients who had dental artifacts on CT and MRI.

Conclusions: Using standard scanning techniques and equipment, ultrasound can be used to visualize cancers of the tonsils and base of the tongue, overcoming some of the obstacles of CT and MRI, such as contrast, radiation, and dental artifacts, thus helping surgeons in their planning of treatment for patients.

2376078 Sonographic Appearance of Topical Hemostatic Agents With Computed Tomographic and Magnetic Resonance Imaging Correlation and Long-term Follow-up
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Objectives: To describe the sonographic appearances of topical hemostatic agents, correlate with other imaging, and distinguish imaging features from pathology.

Methods: Patients were identified by key word search of an ultrasound (US) report database. Operative notes were reviewed, and patients were excluded if placement of a hemostatic agent was not documented. US, computed tomography (CT), and magnetic resonance imaging (MRI) studies were also reviewed.

Results: Twelve patients were treated with the following agents: Floseal (3), Gelfoam (3), Surgicel (2), and a combination of agents
(4). Imaging performed included US only (5), US and CT (5), and US, CT, and MRI (2). Procedures included ovarian cystectomy (3), cesarean section (5), exploratory laparotomy (1), cholecystectomy (1), partial nephrectomy (1), and cervical cone biopsy (1). Imaging characteristics were as follows. Floseal appeared echogenic early, became hypechoic, and then resolved. Gelfoam was initially hypechoic or not visible and then echogenic. Long-term follow-up of Gelfoam showed dense echogenic shadowing at US, calcification at CT, and a hypointense T2 signal at MRI. Surgicel had an echogenic shadowing appearance early; no long-term studies were available. Combinations of agents resulted in a variety of appearances. Four patients had subsequent intervention in the area of the agent due to abnormal CT imaging: 3 to exclude abscesses and 1 to exclude a recurrent tumor. Only 2 of these were positive for pathology.

Conclusions: Topical hemostatic agents have a characteristic US and cross-sectional imaging appearance that changes over time. Recognition of the appearance of commonly used agents is crucial to avoid misdiagnosis.

2378969 Detection of Transplant Renal Artery Stenosis: Determining Normal Velocities at the Renal Artery Anastomosis
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Objectives: Spectral Doppler evaluation of peak systolic velocity (PSV) at the renal artery anastomosis (RAA) exceeding 250 cm/s has been historically used to suspect significant transplant renal artery stenosis (TRAS). However, the mean and range of RAA PSV in transplants without TRAS have not been well established. Defining this range is the aim of this investigation.

Methods: A retrospective analysis of renal transplantations at a single institution over 5 years was performed to identify patients without out graft dysfunction, failure, or refractory hypertension. The RAA PSVs obtained in the immediate postoperative period and on interval sonograms closest to 1, 4, and 12 months after transplant were recorded.

Results: Of 1141 patients, 127 with graft dysfunction/failure/death, 157 with more than 1 renal artery anastomosis, and 13 with clinically suspected or confirmed RAS were excluded; 844 patients met inclusion criteria (age range 18–83 years; 489 males). Mean RAA PSV for 377 patients evaluated within 2 days of transplant (mean, 1 day) measured 195 ± 103 cm/s; 97 patients (26%) had RAA PSV >250 cm/s, with 18 patients (5%) having RAA PSV >401 cm/s (mean = 2 SD). Mean RAA PSV for 820 patients evaluated between 3 and 60 days after transplant (mean, 34 days) measured 206 ± 91 cm/s; 224 patients (27%) had RAA PSV >250 cm/s, with 29 (4%) exhibiting RAA PSV >388 cm/s (mean + 2 SD). Mean RAA PSV for 785 patients evaluated between 60 and 273 days after transplant (mean, 131 days) measured 203 ± 86 cm/s; 201 patients (26%) had RAA PSV >250 cm/s, with 32 patients (4%) exhibiting RAA PSV >375 cm/s (mean + 2 SD). Mean RAA PSV for 766 patients evaluated 330–766 days after transplant (mean, 394 days) measured 189 ± 76 cm/s; 141 patients (18%) had RAA PSV >250 cm/s, with 26 (3%) exhibiting RAA PSV >341 cm/s (mean + 2SD).

Conclusions: Approximately 26% of patients without TRAS will have RAA PSV exceeding 250 cm/s in the first 9 months, dropping to 18% at 1 year. Using a 250 cm/s threshold for suspicion of TRAS would result in many false-positive assessments. A more appropriate threshold may be 2 SD above the mean, which translates to 340–400 cm/s.

2380816 Gallstone Prevalence in the Ngobe Population
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Objectives: The objective of this study is to quantify the prevalence of gallstones in the Ngobe population of rural Panama and investigate potentially significant risk factors. By focusing on the indigenous Ngobe communities off the northwest coast of Panama, the aim is to characterize the prevalence of gallstones in a specific demographic using modern ultrasound technology. Similar studies focusing on particular population groups have found prevalence rates of gallstones between 5% in Ghana (Gyedu et al, 2015) and 15% in Sweden (Muhrbreck et al, 1995). Assessing the dietary and lifestyle factors unique to the Ngobe communities can elucidate potentially significant risk factors.

Methods: The ultrasound and survey data used for this study were obtained by 10 University of California Irvine medical students over 8 weeks in rural Panama through a partnership with Floating Doctors, a nonprofit organization that provides health care to indigenous Ngobe communities. The primary outcome of interest is the prevalence of gallstones within the Ngobe population. The secondary concern is potential risk factors associated with gallstone development. Each patient answered a set of questions determining their age, weight, height, body mass index (BMI), sex, diet, family history, pregnancy status, ongoing symptoms (nausea/vomiting), and physical exam findings (including Murphy’s sign).

Results: There were a total of 80 participants; 70% were females. Mean age was 39 ± 14 years. Of the 74 participants who had BMI data, the mean BMI was 30.8 ± 5.5. Prevalence of cholecystitis was 11.25%. Females had a higher prevalence compared to males (14.28 vs 4.16). Further analysis of risk factor data is pending.

Conclusions: The prevalence of gallstones in the Ngobe population screened at Floating Doctors clinics was 11.25%, a higher rate than has been reported in previous studies. There was a higher prevalence in females compared to males. Other conclusions regarding the particular risk factors important in this population’s development of gallstones are pending full analysis of the data. We expect to comment on each of the criteria recorded in the surveys and discuss whether each general gallstone risk factor was indeed a statistically significant risk factor for these patients.

2381102 What’s All the Noise About? Detecting Post-Transplant Hepatic Vein Stenosis With Doppler Ultrasound Versus Venography
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Objectives: Hepatic venography with pressure measurements is often considered the “gold standard” for the diagnosis of hepatic vein stenosis in the post–liver transplant patient. We compare transjugular hepatic venography with Doppler ultrasound to detect hepatic venous outflow stenosis after liver transplantation.

Methods: A retrospective review of 87 consecutive patients (mean age, 52 ± 15 years; 60% male) with liver transplantation who underwent transjugular liver biopsy between July 2011 and August 2014 was performed. Pressure measurements in the right atrium and hepatic veins were performed. Venography images were reviewed to identify hepatic venous outflow stenosis. Concurrent Doppler ultrasound images of the hepatic veins were also reviewed, with waveform tracings graded as “normal” (triphasic or biphasic) versus “abnormal” (monophasic). Pathology reports were evaluated for sinusoidal congestion suggestive of venous out-
flow obstruction, and transthoracic echocardiogram reports were reviewed to exclude right heart failure.

Results: Of the 87 total patients, venous outflow obstruction was confirmed in 27 (31%) based on sinusoidal congestion on pathology without presence of right heart failure. Of these 27 patients, 5 had detectable stenosis at venography (sensitivity, 19%; specificity, 100%) and demonstrated an increased pressure gradient between the right atrium and free hepatic vein compared to patients without visible stenosis (7.00 ± 8.04 and 1.54 ± 4.17 mm Hg; P = .021). In contrast, 13 of the 27 patients with sinusoidal congestion had a monophasic Doppler waveform (sensitivity, 48%; specificity, 88%) and also tended toward a larger pressure gradient compared to patients with a normal waveform (7.94 ± 5.14 and 5.57 ± 4.71 mm Hg; P = .093).

Conclusions: While hepatic venography has superb specificity for the diagnosis of hepatic vein stenosis, many cases of stenosis suspected on pathology do not manifest venographically. One hypothesis is that stenosis is a dynamic finding, and presence of a sheath or stiff wire may straighten the anatomy. Therefore, concurrent Doppler ultrasound may serve as a noninvasive test that may screen patients with hepatic venous outflow stenosis.

2384546 Evaluation of Gastric Accommodation: Comparison of 3-Dimensional Ultrasound and Magnetic Resonance Imaging of Gastric Volumes

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Objectives: Gastric accommodation plays an important role in many clinical conditions. To investigate gastric accommodation, accurate measurements of gastric volumes are necessary. One of the techniques to measure gastric volumes is dynamic magnetic resonance imaging (MRI). Unfortunately, dynamic MRI is relatively expensive and not always available. A new 3D ultrasound (3D-US) method using a matrix transducer was developed to measure gastric volumes. In this study, we aim to compare the accuracy of our novel 3D-US method to dynamic MRI in gastric volume measurements.

Methods: A prospective study with 14 healthy adult volunteers, 6 men and 8 women with a median age of 27.2 years, was performed. All volunteers consecutively underwent dynamic MRI and a 3D-US of the stomach. An X6-1 Purewave xMatrix probe (Phillips) with a wide field of view and automated acquisition was used for 3D images. After an overnight fast, a 500-mL liquid test drink was distributed to the healthy volunteers, and 3 postprandial volume scans were performed. Gastric volumes were calculated with intragastric liquid content and total gastric volume (intragastric liquid content plus intragastric air). Accuracy of the 3D-US versus the dynamic MRI was evaluated according to Bland-Altman analysis.

Results: Mean postprandial liquid gastric content was 397 mL. Mean volume difference between the dynamic MRI and 3D-US was 1.0 mL, with limits of agreement (LoA) of –8.9 to 10.9 mL and a high intraclass correlation coefficient (ICC; 0.977). When gastric air was taken into view and automated acquisition was used for 3D images. After an overnight fast, a 500-mL liquid test drink was distributed to the healthy volunteers, and 3 postprandial volume scans were performed. Gastric volumes were calculated with intragastric liquid content and total gastric volume (intragastric liquid content plus intragastric air). Accuracy of the 3D-US versus the dynamic MRI was evaluated according to Bland-Altman analysis.

Conclusions: Matrix 3D-US showed excellent agreement with dynamic MRI in measuring gastric volumes, despite the negative influence of gastric air. Therefore, matrix 3D-US is a reliable alternative to measure gastric volumes, making assessment of gastric accommodation more accessible, fast, and less expensive.
Results: The mean maximum diameter of anterior mediastinum lesions was 43.5 ± 6.1 mm (mean ± SD). All lesions were proved by pathology as benign lesions (n = 6), primary malignancies (n = 62), or metastasis (n = 2). In the CEUS group, 94.3% (33/35) lesions showed necrotic areas after SonoVue administration, which was higher than conventional ultrasound (54.3% [19/35]; P < .05). Internal mammary arteries were displayed in 57.1% (20/35) in the CEUS group, which were not obvious before CEUS. The sampling success rate and pathologic diagnosis rate of CEUS-guided biopsy (100% and 97.1%) were higher than the conventional ultrasonic-guided group (90.4% and 81.7%; P < .05).

Conclusions: CEUS before biopsy provided useful diagnostic information about anterior mediastinum lesions. By depicting interior necrotic areas and internal mammary arteries, it is a promising technique for guaranteeing the accuracy, success, and safety of coarse-needle biopsy.

2379078 Ex Vivo Ultrasound Margin Assessment in Basal Cell Carcinoma: Initial Experience in 30 Cases

Fernando Alfageme, Eugenio Cerezo, Lola Suárez, Irene Salguero, Rita Cabeza, Gaston Roustan

Objective: With this pilot study, we intended to explore the possibility of assessing basal cell carcinoma (BCC) specimens sonographically, comparing it with gold standard histologic margin evaluation.

Methods: Thirty consecutively excised BCC specimens were sonographically explored immediately after excision with an 18–22-MHz linear probe (Esaote, Geneva, Switzerland) attached to Mylab class C equipment. Exploration was performed, fixing the specimen to a bed of gauze with two 25-gauge needles and immersing in conventional ultrasound gel, leaving a 1-cm layer of gel over the specimen. The probe was protected with a sterile plastic cover to avoid contact of the probe with the fresh specimen. Scans of the whole specimens including the totality of lateral and deep margins were done, and both representative images and clips were acquired. Conventional histologic examination was performed for diagnostic confirmation, subtype classification, and lateral and deep specimen margin involvement. Sensitivity, specificity, positive predictive value, and negative predictive value of the sonographic evaluation of margin involvement in comparison with conventional histologic examination were calculated.

Results: Ex vivo ultrasound margin assessment (EVUSMA) was performed in 30 consecutive BCC specimens of 28 patients (9 female, 19 male). Mean age of the patients was 75.4 ± 5.3 years, and locations of the BCC were 21 in facial, head, and neck areas and 9 in the rest of the body surface. Mean maximum diameter of the lesions was 10 ± 2.3 mm. With respect to BCC histologic subtype 7 were infiltrative, and 21 were expansive. EVUSMA was coincident with histologic free-margin diagnosis in both lateral and deep margins in 97.77% of the cases (29/30). False positives (5/30) were more frequent in lateral than in deep margin assessment (13.33% vs 3.33%). EVUSMA sensitivity and specificity for free margins were 97.77% and 86.66% for free lateral margins and 97.77% and 97.77% for deep margins.

Conclusions: EVUSMA in BCC is highly sensitive and specific for diagnosis of lateral and deep margin involvement. Further studies are needed to refine diagnostic features of the technique in other skin tumors.

2380144 Revisiting Cardiac Chamber Discrepancy in the Prenatal Diagnosis of Coarctation of the Aorta

Suguna Ganesan, Darren Hutchinson, Bryn Jones, Nicole Woodrow

Objective: Prenatal diagnosis of aortic coarctation remains one of the most challenging, with far-reaching consequences if not promptly recognized and managed. The purpose of this study was to assess the utility of fetal cardiac chamber size discrepancy as a reproducible finding when potentially considering fetal aortic coarctation in an otherwise normal midtrimester fetal cardiac study.

Methods: In this combined retrospective and prospective study, during the period of January 2013–December 2014, we identified 48 referrals requesting tertiary evaluation for isolated fetal cardiac chamber discrepancy between 18–26 weeks’ gestation. Measurements of the mitral and tricuspid, aortic, and pulmonary valvular annuli, as well as across the aortic isthmus, were performed in all cases, and Z scores were calculated. Fetuses with chamber discrepancy due to right-sided hypoplasia, established hypoplastic left heart syndromes, and suspected aortic coarctation in conjunction with other major anomalies were excluded. Nineteen cases fitted the potential prenatal diagnosis of an isolated fetal coarctation of the aorta. Postnatal correlation with neonatal echocardiography as well as follow-up data were obtained.

Results: Our postnatal cohort confirmed aortic coarctation in 16/19 (84.1%). There were 3 (15.9%) false positives following postnatal assessment. No cases were missed prenatally. An associated bicuspid aortic valve was noted in a high proportion of patients (7/16 [43%]). A mean percentage difference of 26% (95% confidence interval [CI], 21.39–30.69) was noted between absolute dimensions of the mitral and tricuspid valves in confirmed cases of aortic coarctation. Although aortic isthmus Z scores ±2.4 appeared more consistent with need for surgical intervention, they did not show statistical significance.
Conclusions: Standard cardiac screening views do not always include direct examination of the aortic arch to identify hypoplasia. Quantitative assessment of ventricular discrepancy (left < right) of greater than 25% (95% CI, 21.39–30.69) at the midtrimester scan appears to be a reproducible marker when attempting to identify an evolving isolated narrowing of the fetal aortic isthmus. The possibility of a bicuspid aortic valve also needs to be strongly considered in this patient group.

2385462 High-Frequency Photoacoustic Characterization of Ex Vivo Lymph Nodes of Colorectal Patients

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Objectives: Quantitative photoacoustics (QPA) is an emerging modality that characterizes tissue based on tissue property estimates derived from spectrum analysis of photoacoustic (PA) radiofrequency (RF) signals and estimates derived from statistical analysis of the RF signal envelope. Our study seeks to employ QPA to distinguish cancerous from noncancerous regions of dissected lymph nodes (LNs) and hence to detect small, but clinically significant, cancerous foci that would be missed by current methods.

Methods: Dissected LNs were submerged in 0.9% saline, pinned through the perinodal fat layer to a sound-absorbing material, and scanned with our high-frequency PA data acquisition apparatus. A tunable laser was used to excite PA signals in the LN. A 26.2-MHz f2 transducer was scanned in the X-Y direction to acquire a complete 3D PA data set, which also was used to generate B-mode images. A calibrated power spectrum was computed from the PA signals, and linear regression was used to fit the resulting data to a straight line. The slope (dB/MHz) and absorber size (microns) were computed. A maximum-likelihood estimator was used to fit a Nakagami probability-density function (PDF) to the empirical PDF to produce a dimensionless parameter µN, which defines the number of microstructures per unit resolution cell.

Results: QPA analysis resulted in effective absorber sizes on the order of 28.1773 ± 4.2838 microns, with a slope of 0.1748 ± 0.1619 dB/MHz and a µN of 0.9084 ± 0.1596 at 680 nm. The absorber size distribution was consistent with the PA contrast found in the B-mode image. The corresponding mean scatter size, slope, and µN for the processed region from ultrasound measurements were found to be 26.0577 ± 5.4970 microns, 0.2612 ± 0.1681 dB/MHz, and 0.7201 ± 0.0921, respectively.

Conclusions: The feasibility of using QPA for tissue characterization was demonstrated using dissected LNs. QPA tissue property estimates show promise for characterizing tissue and have the potential to provide molecular information for tissue constituents. Future studies will include blood volume and oxygen saturation maps that can greatly improve the estimates obtained from this preliminary QPA study.

2388520 A Novel Semiautomated Fractional Limb Volume Tool for Rapid and Reproducible Fetal Soft Tissue Assessment

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Objectives: To document the reproducibility and efficiency of a semiautomated image analysis tool that rapidly provides fetal fractional limb (FLV) measurements.

Methods: Fifty pregnant women underwent 3DUS scans at a mean menstrual age of 31.3 weeks for fractional arm (Avol) and thigh (Tv01) volumes. Manual or semiautomated FLV measurements were calculated using novel software (5D Limb Vol; Samsung Medison, Seoul, Korea). The software applies an image transformation method based on major axis length, minor axis length, and limb center coordinates. A transformed image is used to perform a global optimization technique for determination of an optimal limb soft tissue boundary. Bland-Altman analysis defined bias with 95% limits of agreement (LOA) between methods, and timing differences between manual versus automated methods were compared using a paired t test.

Results: Bland-Altman analyses indicate acceptable bias with 95% LOA between manual and semiautomated methods: Avol, 1.7% ± 4.6% (95% LOA, –7.3% to 10.7%); Tv01, 0.0% ± 3.8% (95% LOA, –7.5 to 7.5%). Computer-assisted software completed measurements about 5 times faster when compared to manual tracings.

Conclusions: Semiautomated FLV measurements are significantly faster to calculate when compared to a manual procedure. These results are reproducible and are likely to reduce operator dependency. Addition of computer-assisted FLV to standard biometry may improve the precision of estimated fetal weight by adding a soft tissue component to the weight estimation process.
2379335  Uterocervical Angle: A Novel Ultrasound Marker to Predict Spontaneous Preterm Birth
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Objectives: It has been proposed that pessary reduces risk of spontaneous preterm birth (sPTB) in high-risk women by mechanically altering the uterocervical angle (UCA). Performance of the UCA as measured by ultrasound for predicting sPTB is poorly understood. We examined whether a novel ultrasound marker, UCA, correlates with risk of sPTB.

Methods: This was a retrospective cohort study of singleton deliveries at a single center from May 2014-May 2015. Demographic data and pregnancy outcomes were collected. Transvaginal ultrasound was performed during routine 2nd-trimester ultrasound (16-24 weeks). Cervical lengths (CLs) were recorded, and images of the lower uterine segment were obtained and remeasured for UCA between the lower uterine segment and the cervical canal. Receiver operating characteristic curves were used to determine an optimal cutoff of UCA for prediction of sPTB <34 weeks with sensitivity of 81% (95% CI, 0.702–0.811; specificity, 53%; positive predictive value [PPV], 92%; negative predictive value [NPV], 99%). UCA of >95° predicted sPTB <37 weeks (n = 43). UCA of >105° predicted sPTB <34 weeks (n = 30; P < .001, 95% CI, 0.702–0.811; specificity, 53%; positive predictive value [PPV], 92%; negative predictive value [NPV], 99%). UCA of >95° predicted sPTB <37 weeks with sensitivity of 81% (P < .001; RR, 7.2; CI, 0.719–6.453; specificity, 65%; PPV, 10%; NPV, 99%). Cervical length <2.5 cm was significantly associated with prior sPTB, dilation and curettage, cone, and obesity at conception with sPTB and UCA. Data were evaluated using a chi-square test with P < .05 as significant.

Results: A total of 972 women met inclusion criteria. Rates of sPTB in this cohort were 9.6% for delivery <37 weeks (n = 84) and 4% for <34 weeks (n = 43). UCA of >95° is associated with sPTB <37 weeks with sensitivity of 80% (P < .001; relative risk [RR], 4.3; confidence interval [CI], 0.702–0.811; specificity, 53%; positive predictive value [PPV], 14%; negative predictive value [NPV], 95%). UCA of >105° predicted sPTB <34 weeks with sensitivity of 81% (P < .001; RR, 7.2; CI, 0.719–0.853; specificity, 65%; PPV, 10%; NPV, 99%). Cervical length <2.5 cm predicted sPTB with sensitivity of 15% (specificity, 98%; PPV, 46%; NPV, 92%; P < .001). Regression analysis revealed that there was a significant association of prior sPTB, dilation and curettage, cone, and obesity at conception with sPTB and UCA >95° in this cohort. There was no correlation between race, abnormal pap smear results, smoking, and obesity at delivery on sPTB and UCA.

Conclusions: An obtuse UCA >95° and >105° detected during the 2nd trimester is associated with an increased risk for sPTB <37 and <34 weeks, respectively. UCA performed better than CL in identifying patients at increased risk of sPTB in this population. Our data suggest that UCA may be a useful, novel ultrasound marker predictive of sPTB.

2377746  Uterocervical Angle Measurement Improves Prediction of Cervical Failure
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Objectives: The anterior uterocervical angle has been used to measure the efficacy of cervical pessary placement for the prevention of preterm birth. Our objective is to evaluate the uterocervical angle as a predictor of preterm delivery in patients with a transvaginal cerclage.

Methods: A retrospective cohort of 59 women with transvaginal cerclage and evidence of cervical funneling were evaluated at a tertiary academic center from 2010-2015. Cervical morphologic characteristics (length, funnel volume, and uterocervical angle) were measured from endovaginal imaging of the cervix prior to cerclage placement (Angle 1), the first image after cerclage placement (Angle 2), and the last image prior to delivery (angle 3). Cervical failure was defined as preterm delivery prior to 28 weeks. Pearson correlation, linear regression, and receiver operating characteristic (ROC) curves were used for statistical analysis using SPSS software. Statistical significance was defined as P < .05.

Results: Among the 59 women with transvaginal cerclage and evidence of funneling, the mean gestational age at birth was 29.8 ± 3.8 weeks in the failure group (n = 29) compared to 38.1 ± 1.4 weeks in those that did not fail (n = 30; P < .001). Measurements (mean ± SD) of angle 1, angle 2, and angle 3 were 113.5° ± 11.02°, 99.7° ± 8.59°, and 109.4° ± 10.97°, respectively. The gestational age at birth correlated to angle 3 (R = 0.47; P < .001), cervical length (R = 0.47; P < .001), cervical funnel volume (R = 0.302; P < .023), and the interval change between angle 2 and angle 3 (R = 0.50; P < .001). A linear regression model consisting of cervical length and angle 3 was the most predictive of gestational age at birth (R² = 0.55). ROC curves demonstrated improved prediction of delivery prior to 34 weeks with angle 3 (90% sensitivity, 71% specificity) vs cervical length (90% sensitivity, 51% specificity), and similarly prior to 28 weeks with angle 3 (93% sensitivity, 68% specificity) vs cervical length (93% sensitivity, 46% specificity).

Conclusions: Patients in transvaginal cerclage, a larger uterocervical angle increases the likelihood of cerclage failure. Uterocervical angle measurement may be an adjunct technique to identify patients at risk for cerclage failure and subsequent preterm delivery.

2382415  Comb-Push Shear Elastography on a Clinical Ultrasound Machine: First Report on Differentiation of Breast Masses
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Objectives: To determine the performance of comb-push shear elastography (CUSE) on a clinical ultrasound machine (GE LOGIQ E9) in differentiation of breast masses when compared to pathologic results as the reference standard.

Methods: This study was done under an approved protocol by the Mayo Clinic Institutional Review Board. Female volunteers with suspicious breast masses on their clinical evaluation were selected for this study. A written signed informed consent was obtained from enrolled patients. Conventional ultrasound (US) and CUSE using GE’s LOGIQ E9 machine with a 9L linear array probe were performed in 108 patients (mean age, 57.66 years; age range, 23–82 years) with 109 breast lesions (54 benign, 55 malignant; mean mass size, 16.40 mm); pathologic results served as the reference standard.

Results: All 109 breast masses were identified by an expert sonographer, and 3 sequences of elastography were acquired as shear wave speed maps. Three 3-mm regions of interest (ROIs) were selected from sono images. Three 3-mm regions of interest (ROIs) were selected from sono images. Three 3-mm regions of interest (ROIs) were selected from sono images. Three 3-mm regions of interest (ROIs) were selected from sono images.

Conclusions: CUSE provides quantitative elasticity measurement with high sensitivity and specificity in differentiating between malignant and benign breast masses, thus adding the complementary information that potentially could help in breast lesion characterization using US.
Effect of Fabrication Methods on the Acoustic Properties of Encapsulated Oxygen Microbubbles

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Objectives: The delivery of oxygen to hypoxic tumors through microbubbles is expected to aid in radiotherapy sensitization. This study compares how different shell materials and primary fabrication gasses influence encapsulation and acoustic properties of oxygen microbubbles.

Methods: Different freeze-dried microbubbles were tested: the first (A), originally containing sulfur hexafluoride (SF6), had a phosphatidylserine shell; the second (B) was composed of galactose microparticles and palmitic acid (PA) from an air core; the third (C), from a perfluorocarbon (PFC) bubble, had a mixed phospholipid/PA shell with a polyethylene glycol stabilizer; and the fourth (D) consisted of a surfactant combined with a water-soluble vitamin E shell originally containing PFC. After removal of the primary filling gas, oxygen was introduced into the microbubble vials under vacuum. The formulation with the highest acoustic enhancement was further tested by comparing PFC and SF6, as primary fabrication gasses. In vitro acoustic testing was completed in a tank setup with a single-element 5-MHz transducer (0.45 MPa peak negative pressure with a pulse repetition frequency of 100 Hz). The temperature within the tank was 37°C, and the sample was continuously stirred. Enhancement as a function of dosage was compared between the microbubbles. The half-life of the SF6 and PFC microbubbles was also compared.

Results: The average peak enhancement values for microbubbles A, B, C, and D were 2.8 ± 2.5, 5.0 ± 1.5, 5.0 ± 1.1, and 17.0 ± 1.0 dB, respectively (P < .0001). When comparing fabrication gasses, the peak enhancement values of the PFC- and SF6-charged microbubbles were 15.1 ± 1.4 and 8.6 ± 1.9 dB (P < .0001), while the half-life values were 6.1 ± 1.6 and 0.76 ± 0.2 minutes (P < .0001).

Conclusions: Microbubbles composed of a surfactant/vitamin E shell appear to be superior at encapsulating oxygen compared to microbubbles with lipid or galactose shells. In addition, using PFC as the primary fabrication gas in microbubbles appears to be superior at encapsulating oxygen compared to microbubbles with lipid or galactose shells. In contrast, using SF6 as the primary fabrication gas in microbubbles appears to be superior at encapsulating oxygen compared to microbubbles with lipid or galactose shells.

Comparison of 3-Dimensional Strain Volume Reconstructions Using Sheaf of Ultrasound Planes Reconstruction and Wobbler-Based Acquisitions

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Objectives: To compare 3D reconstruction of ultrasound strain imaging using a conventional Wobbler transducer and our previously developed sheaf of ultrasound planes reconstruction (SOUPR).

Methods: Three-dimensional strain volume reconstructions were performed on a single-inclusion tissue-mimicking phantom. The Wobbler transducer provides quasiplanar imaging planes with a 2-mm separation. At each imaging plane, a 2% quasistatic compression with respect to the phantom height was applied to obtain 2D strain images with a 2D cross-correlation-based deformation-tracking algorithm. Eight different cross-correlation kernels with axial dimensions ranging from 3.4–7.5 wavelengths and 3–7 A-lines were evaluated. These 2D strain images were reconstructed using a bicubic interpolation into a 3D volume. The same processing parameters were applied for SOUPR except that the imaging planes acquired were rotated over a 30° interval, with the reconstruction algorithm formulated as an optimization problem with constraints on data consistency and smoothness. Reconstructed inclusion volumes, shapes, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) were compared between SOUPR and Wobbler acquisitions for 10 independent experimental realizations for each kernel size. Validation of SOUPR and Wobbler reconstruction was also performed using a thermally ablated region created in ex vivo bovine liver tissue.

Results: Inclusion volume estimates were in a similar range for both acquisition approaches. The SNR and CNR obtained with SOUPR, however, were significantly higher: on the order of 250% and 160%, respectively. The mean square error of the reconstructed inclusion dimensions using a Wobbler was significantly higher: on the order of 1300% and 386% along the x- and z-axes, respectively.

Conclusions: Improved 3D strain volume reconstructions were obtained with SOUPR when compared to a conventional Wobbler transducer-based method for an ellipsoidal inclusion, which is common for tumor and ablated region geometries. (Funded by National Institutes of Health grant 2R01 CA112192.)
Effect of Percutaneous Ultrasound-Guided Subacromial Bursography With Microbubbles for Assessment of Rotator Cuff Tears
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Objectives: The purpose of this study was to determine the feasibility and the value of percutaneous ultrasound-guided subacromial bursography (PUSB) with contrast-enhanced ultrasound (US) for assessment of rotator cuff tears.

Methods: Between January 2012 and September 2014, 2D US and PUSB were prospectively performed in 135 patients with suspected rotator cuff tears from among 2169 patients with clinically diagnosed subacromial impingement syndrome. Sixty-three patients who had undergone arthroscopy were included. The PUSB findings were compared with those from 2D US using the McNemar test, with arthroscopy as a standard.

Results: Of a total of 19 full-thickness tears (FTTs), 2D US correctly diagnosed 12 and PUSB correctly diagnosed 18 (P = .031). With regard to partial-thickness tears, 2D US correctly diagnosed 31 and PUSB correctly diagnosed 35 of a total of 41 tears (P = .375). Accuracy in diagnosing FTTs was 81.0% for 2D US and 98.4% for PUSB. 2D US and PUSB yielded sensitivity of 63.2% and 94.7%, respectively, for full-thickness tears, with specificity of 88.6% and 100.0%, respectively.

Conclusions: PUSB is a safe and feasible procedure, with greater sensitivity and specificity than 2D US in diagnosing FTTs. As such, PUSB improves the value of ultrasound for assessing rotator cuff pathology.

Recipient Umbilical Artery Elongation in Twin-Twin Transfusion Syndrome
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Objectives: Chronic hypertension causes arterial elongation in systemic arteries through arterial stretching. Recipient fetus's changes in twin-twin transfusion syndrome (TTTS) include hypertension and hypervolemia, but the effect of increased intravascular pressure and volume on umbilical vessels is unknown. We tested the hypothesis that the recipient umbilical artery (UA) increases in length relative to its vein compared to controls.

Methods: Prospective study comparing two groups: TTTS patients undergoing laser surgery and gestational age–matched controls. A preoperative 3D color Doppler volume image of a 5-cm segment of the umbilical cord was obtained. Quantitative assessment of the angle of inclination between the UA and umbilical vein (UV) was performed by a 2-line angle method. The ratio of the UA to UV length (AVI) was obtained by tracing the vessels within the same cord segment. Correlation of AVI to the stage of disease and UA Doppler indices was performed.

Results: A UA-to-UV angle of ≥26° (above 95th percentile for control) was seen in 54% of recipient cords. The UA-to-UV angle and AVI significantly correlated (R² = 0.74; P < .0001). Stages II and III had significantly higher AVI (P = .04) and angle (P < .001) compared to controls. Among TTTS cases, the AVI for stage IIIIR (1.8 ± 0.57) was significantly higher than the remaining recipients (1.4 ± 0.43; P = .04). Linear regression showed that an increasing UA pulsatility index (PI) was associated with increased AVI (P = .027), while the systolic/diastolic ratio and resistance index were not significant. Inter-rater and intra-rater agreements for AVI and UA-to-UV angle were 0.95 (k statistics, P = .04).

Conclusions: The umbilical arterial length is increased in 54% of recipients and associated with increased UA PI. This may reflect chronicity and the severity of hypertension in the recipient. Further research is needed to explore the mechanisms of elongation and its implications for cardiovascular health during adult life.

Table 1. Recipient Versus Healthy Controls

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<thead>
<tr>
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<th>Recipient (n = 28)</th>
<th>Control (n = 20)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational age at ultrasound, wk</td>
<td>20.2 ± 2.5</td>
<td>21.1 ± 1.7</td>
<td>.16</td>
</tr>
<tr>
<td>Estimated fetal weight, g</td>
<td>386.5 ± 199</td>
<td>434.3 ± 140.8</td>
<td>.36</td>
</tr>
<tr>
<td>UA-to-UV angle</td>
<td>34.6° ± 30°</td>
<td>8.8° ± 7.7°</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>AVI</td>
<td>1.5 ± 0.48</td>
<td>1.1 ± 0.1</td>
<td>&lt;.001</td>
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Obstetric Ultrasound: New Techniques
Moderator: Jude Crino, MD

HDlive Silhouette Mode in Antenatal Diagnosis of Intestinal Abnormalities
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Objectives: We present our experience with normal fetal gastrointestinal tract (GIT) and congenital intestinal abnormalities reconstructed using the HDlive silhouette mode.

Methods: Three normal fetuses and 5 fetuses with GIT abnormalities (1 case each of meconium peritonitis [MP], a diaphragmatic hernia, and an enteric duplication cyst, and 2 of jejunal atresia/stenosis) at 17–36 weeks’ gestation were included.

Results: In normal fetuses, clear visualization of the stomach with its position on the left side below the heart was achieved at 17 weeks. Spatial relationships among the stomach and surrounding structures such as the heart, diaphragm, descending aorta, and spine can be achieved at 23 weeks 6 days. At the same age, detailed demonstration of stomach parts (fundus, body, and pylorus) was made. A panoramic ventral view of the fetal GIT was depicted at 36 weeks 4 days, where the stomach, ascending colon, hepatic flexure, transverse colon, splenic flexure, and descending colon were displayed in the same scanning plane, identical to normal anatomy. In MP, the inner wall of the dilated intestinal loops with different caliber changes was demonstrated. In the diaphragmatic hernia, the stomach and heart were both seen at the same level above the clearly visualized diaphragm. In the enteric duplication cyst, its wall appeared to be thick with opacities representing the debris inside at 33 weeks. In jejunal atresia, the dilated stomach was seen located behind the dilated duodenum. The atrial proximal part of the jejunum was demonstrated. Spatial relationships among the stomach, duodenum, and jejunum and the delineation of their outer contour enabled localization of the lesion. The propagation of the peristaltic wave in different parts of the GIT was easily judged by changes in its caliber at 28 weeks. Moreover, the spine as an anatomic landmark for the back and umbilical vein for the front in jejunal stenosis were evident at 28 weeks 4 days.

Conclusions: Accurate evaluation of the fetal GIT from the inside as well as its outer contour, the peristaltic wave, and the relationship with surrounding structures represent the main prospective use of the HDlive silhouette mode. This technique provides more a comprehensive, detailed view of different parts of the fetal GIT, which might be beneficial in diagnosing and differentiating fetal GIT abnormalities.
2362569  Fetal Adrenal Gland Size and Ability to Predict Spontaneous Term Labor

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Objectives: Fetal adrenal size has been shown to be predictive of spontaneous preterm birth. The objective of this study was to evaluate whether ultrasound-measured fetal adrenal gland size predicts spontaneous labor.

Methods: Prospective cohort study using 2-dimensional ultrasound to measure fetal adrenal gland total length, total width, fetal zone length, and fetal zone width in women presenting for a biophysical profile at 36–42 weeks gestational age. The ratio of total fetal gland width (W) and fetal zone width (w) was used to control for fetal weight. The ability of w/W and other fetal adrenal measurements was evaluated for prediction of spontaneous labor. Exclusion criteria were: known scheduled cesarean delivery, receiving 17α-hydroxyprogesterone, cerclage, fetal anomalies, planned preterm delivery, known uterine anomaly, multiple pregnancy, fetal growth restriction, and polyhydramnios.

Results: Forty-three patients were recruited: 11 (27.5%) presented in spontaneous labor. Secondary outcomes were vaginal delivery (n = 31 [77.5%]), length of labor, and maternal and neonatal morbidities. Three patients were excluded for adrenal gland unable to be measured (n = 1), primary cesarean without labor on presentation for induction (n = 1), and breech presentation and subsequent primary cesarean delivery (n = 1). Patient demographics were similar except for cervical exam at the time of admission and oxytocin use. A receiver operating characteristic curve was created to assess differing fetal adrenal gland measurements as a test for predicting spontaneous labor. w/W was the best predictor of spontaneous labor among variables measured, with an area under the curve of 0.674 (P = .93). w/W ≥0.41 had a sensitivity of 91.0%, specificity of 44.8%, positive predictive value of 38.5%, and negative predictive value of 92.3% for predicting spontaneous labor. Maternal and neonatal morbidities were not different between groups.

Conclusions: Ultrasound-measured fetal w/W was moderately predictive of spontaneous labor in this small prospective cohort.

2380504  Elastography of the Postpartum Perfused Human Placenta

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Objectives: Elastography is well established in a number of organs. However, the biomechanical properties of the normal placenta have not been studied extensively. Recently, Cimsit (2015) demonstrated a potential use of placental elastography to predict preeclampsia. Many unresolved issues remain for elastography in the human placenta, including the range of normal values, possible dependence on physiologic variables such as fetal blood pressure and flow, and the results of specific pathologies. This study aims at providing initial estimates of placenta stiffness under a range of experimental conditions.

Methods: Eight human term placentas were obtained postpartum. The umbilical arteries and vein were catheterized using 5F umbilical catheters as previously described (Miller, 1985, 1993). Hemodynamic control consisted of instantaneous pressure readings with recordings every 5 seconds and maintenance of fetal arterial flow at 3 mL/min. Placental elastographic images were generated using a Siemens Antares scanner and VF10-5 probe at 5 MHz with our custom single-track-location shear wave elasticity imaging (STL-SWEI) pulse sequences and graphics-processing unit-accelerated processing (McAuley, 2009). Placenta were placed on an acoustically absorbing pad, immersed in a buffered saline bath at 35°C and scanned during perfusion, during a pause in perfusion, and following the injection and setting of a barium/agar solution. Color and Doppler spectral signals were obtained after injection of Optison (GE Medical Imaging).

Results: Placental elastographic measurements can be acquired in near real time using a Siemens scanner and advanced STL-SWEI. Shear wave speeds for normal parenchyma on the fetal side are on the order of those measured in soft liver (<2 m/s). Shear wave speeds in the placenta are measurably increased by abnormalities, including infarcts and artificial “clots” introduced by perfusing viscous gelatin solutions into the vasculature. Fetal flow and pressure can modify tissue stiffness.

Conclusions: Elastography of human placentas will provide a useful clinical tool for discriminating normal vs abnormal regions. Future work includes a determination of the range of normal placental shear wave speed vs gestational age.

2380956  Uterocervical Angle: A Novel Ultrasound Marker to Assess Risk for Spontaneous Preterm Birth in Twins

Margaret Dzidzows*, Terri-Ann Bennett, Cara Dolin, Annie Honart, Sarah Lee, Sarah Pivo, Ashley Roman
New York University Langone Medical Center, New York, NY USA

Objectives: Spontaneous preterm birth (sPTB) has multiple etiologies and poorly defined pathophysiology. It is significantly more common in multiple gestations. Alterations to the uterocervical angle (UCA) have been proposed as a method to reduce sPTB through mechanical support via pessary. We examined whether a novel ultrasound marker, UCA, correlates with sPTB in twins.

Methods: This was a retrospective cohort study of deliveries at a single center from May 2014–May 2015. Demographic data and pregnancy outcomes were collected. Transvaginal ultrasound was performed during routine 2nd-trimester ultrasound (16–24 weeks). Cervical lengths (CLs) were recorded, and images of the lower uterine segment were obtained and remeasured for UCA between the lower uterine segment and the cervical canal. Receiver operating characteristic curves were developed to determine an optimal cutoff of UCA for prediction of sPTB <37 weeks for twin gestations. The primary outcome was prediction of sPTB by UCA. Data were evaluated using a χ² or Fisher exact test with P < .05 as significant.

Results: A total of 1109 women met inclusion criteria. Forty-one twin gestations were identified, and 28 met inclusion criteria for sPTB. The rate of sPTB in this cohort was 42% for delivery <37 weeks (n = 12). UCA of >95° is significantly associated with sPTB <37 weeks, with sensitivity of 82% (P < .001; specificity, 46%; positive predictive value [PPV], 73%; negative predictive value [NPV], 92%). No UCA was identified to predict sPTB at earlier gestational ages. Cervical length <2.5 cm did not predict sPTB (sensitivity, 8%; specificity, 93%; PPV, 50%; NPV, 57%). Regression analysis revealed that there was no correlation between race, history of PTB, abnormal pap smear results, cervical surgery, mode of delivery, smoking, and obesity at delivery on sPTB and UCA.

Conclusions: An obtuse UCA >95° detected during the 2nd trimester is associated with an increased risk for sPTB <37 weeks in twin gestations. UCA performed better than CL in identifying at-risk patients in this cohort. Our data suggest that UCA may be a useful, novel ultrasound marker predictive of sPTB in twin gestations.
2381556 Effect of Preeclampsia on Umbilical Vein Blood Volume Flow in a Limited Cohort

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1Radiology, Obstetrics and Gynecology, University of Michigan, Ann Arbor, MI USA

Objectives: Measurement of umbilical vein blood volume flow in normal and preeclamptic maternal subjects using a 3D/4D sonographic method that is independent of traditional pulsed wave Doppler flow limitations and assumptions: e.g. beam-to-flow angle, vessel diameter, and vessel flow profile.

Methods: A GE LOGIQ E9 ultrasound system and RAB6-D transducer (2.0–8.0 MHz) were used to acquire multivolume 3D/4D color and power Doppler data. Volumetric flow was computed offline via a user-specified focal c-surface (lateral-elevational) with surface integration of Doppler-measured velocity vectors. Power Doppler data were used to eliminate partial volume effects. Under Institutional Review Board approval, a cohort of 8 normal subjects (singleton; gestation 25.9–34.7 weeks) and 5 preeclamptic subjects (singleton; gestation 29.7–34.3 weeks) were recruited from the University of Michigan Medical Center High-Risk Obstetrics Clinic. Subjects were followed full term, and outcomes were verified. For each subject, average umbilical vein flow was determined from 3 different positions along the cord. Flow measurements were computed using an average of 28 ± 2 (mean ± SD) volumes, and estimates were depth corrected. Weight-normalized flow was computed using the 90th percentile weight (Hadlock et al, Radiology 1991; 181:129–133). Cohorts were compared based on absolute flow (mL/min/kg) and normalized flow (mL/min/kg) using an unpaired t test.

Results: Absolute flow was 177.5 ± 21.5 and 155.5 ± 7.5 mL/min (mean ± SE) in the normal and preeclamptic cohorts, respectively, with a statistically significant difference (P = .032).

Conclusions: Results indicate that weight-normalized umbilical vein blood flow is reduced in preeclamptic subjects and encourage further studies in a larger clinical population. Volume flow measurement with 3D/4D sonography may provide a complementary diagnostic metric to manage at-risk pregnancies. (This work was supported by the AIUM Endowment for Education and Research (Samsung Medison America). Volume flow is under development by the Quantitative Imaging Biomarkers Alliance.)

2384611 The Role of the First-Trimester Maxillary Gap in a Series of 4 Cases in Lebanon

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Objectives: The maxillary gap (MxG) has recently been described as a first-trimester marker for cleft lip and palate (CLP). As such, we sought to assess its role in our population.

Methods: This was a retrospective study carried out by 2 experienced sonologists (R.A.R. and N.H.) on 20 first-trimester fetuses: 4 confirmed cases of CLP each matched with 4 normal controls. There were stored volume data sets on all cases. Outcome was available on all fetuses. R.A.R. retrieved the midsagittal plane for all 20 cases, assessed the images for the MxG, measured it when present, and then deidentified, cropped, and mixed all images. Images were sent for offline analysis to N.H., who was completely blinded to the outcome and the number of affected cases. N.H. was asked to identify the cases with an MxG. The data were analyzed using a Student t test. P < .05 was considered significant.

Results: The mean crown-rump length was 67.85 mm in the controls and 68.53 mm in the affected fetus (P = .87). The mean nuchal translucency was 1.78 mm in the controls and 1.7 mm in the affected fetus (P = .65). Of the 4 cases of CLP, 1 was isolated unilateral, 1 was isolated bilateral, 1 was unilateral with multiple anomalies, and 1 was bilateral with multiple anomalies. The MxG was clearly identified by both sonologists in all 4 cases. The MxG measured >1.5 mm in all 4 cases with CLP. There were no false-positive cases noted by either reviewer.

Conclusions: Even in this small cohort of patients, our study attests to the feasibility of visualizing the MxG and its clinical utility as a new first-trimester marker in the early screening for CLP. Incorporating the MxG into first-trimester screening may enhance the sensitivity for early detection of CLP. However, larger prospective studies are needed to assert its role prior to routine incorporation into the first-trimester anatomy scan.

2384672 The Role of Adjunct Ultrasound Parameters During Antepartum Testing: The Doppler Cerebroplacental Ratio Versus the Amniotic Fluid Deepest Vertical Pocket

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Objectives: Evaluate the role of ultrasound measurement of the deepest vertical pocket (DVP) vs the cerebroplacental ratio (CPR) in fetuses undergoing antepartum testing.

Methods: The antepartum testing records of 534 women who underwent antepartum testing were retrospectively reviewed between 2009 and 2013. All patients underwent a nonstress test, measurement of the DVP, and Doppler evaluation of the resistance index (RI) of the middle cerebral artery (MCA) and umbilical artery (UA). The CPR was computed as follows: RI of the MCA/RI of the UA, with a value <1 considered abnormal. A DVP <2 cm was considered abnormal. The patients were divided into 2 groups at the time of their last antepartum test based on the recommendation of the maternal-fetal medicine specialist: continuation of the pregnancy or recommendation for delivery. The gestational ages of the fetuses evaluated were between 36 and 41 weeks.

Results: Of the 534 pregnancies, recommendations were made for delivery in 23.6%. There were no significant differences in the DVP between those who continued the pregnancy and those in whom delivery was recommended (Table 1). There were no significant differences in the CPR between those who continued the pregnancy and those in whom delivery was recommended for gestational ages between 36 and 38 weeks 6 days. However, in pregnancies at 39 weeks and greater, there was a significant difference (P < .05) between those with an abnormal CPR in whom delivery was recommended (13%) vs those in whom continuation of the pregnancy was recommended (2.5%).

Conclusions: The CPR has recently been shown to be a predictor of adverse perinatal and neonatal outcomes. This retrospective study demonstrates that the CPR identified fetuses in whom recommendations were made for delivery at 39 weeks of gestation and greater. Therefore, while the clinician may utilize the DVP as part of antepartum assessment, the CPR may be a useful measurement from 39 weeks onward in evaluating the high-risk fetus.

Table 1

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>DVP (no delivery vs delivery)</td>
<td>0% vs 0%</td>
<td>0.95% vs 0.8%</td>
<td>1.2% vs 1.3%</td>
<td></td>
</tr>
<tr>
<td>CPR (no delivery vs delivery)</td>
<td>6.35% vs 11%</td>
<td>5.1% vs 0%</td>
<td>6.2% vs 12%</td>
<td>2.55% vs 13% (P &lt; .05)</td>
</tr>
</tbody>
</table>
2384939 The Value of Second-Trimester Crown-Rump Length Measurement in the Diagnosis of Skeletal Dysplasia
Karla Leavitt1,2,* Alberto de la Vega1, Komal Bajaj2
1Obstetrics and Gynecology, University of Puerto Rico School of Medicine, San Juan, PR USA; 2Obstetrics and Gynecology, Division of Reproductive Genetics, Montefiore Medical Center; Bronx, NY USA

Objectives: The first aim of this study was to establish a normogram of second-trimester crown-rump length (CRL). This normogram was then applied to aid in the detection of spondylocostal dysostosis.

Methods: This was a prospective cross-sectional continuous selection done at a tertiary center, with subjects between 13 and 25 weeks of gestation to develop the normograms for CRL. Patients with uncertain gestational age, abnormal ultrasound findings, multifetal pregnancy, or maternal conditions that may affect fetal growth, such as diabetes, hypertension, autoimmune disease, or teratogenic exposure, were excluded. Data obtained were used to create fetal growth curves and the establish the 5th, 50th, and 95th percentiles. The fetuses suspected of having spondylocostal dysostosis and later confirmed postnatally had CRL measurements during the second trimester.

Results: A total of 1157 normal fetuses from 13–25 weeks were included in this study. The CRL of all 14 cases of spondylocostal dysostosis were found to be significantly below the 5th percentile for the normal population and to also maintain a linear growth pattern.

Conclusions: All 14 fetuses with postnatal confirmation of spondylocostal dysostosis had a CRL well below the 5th percentile irrespective of the gestational age at which they were identified. This may serve as a diagnostic aid for this type of skeletal dysplasia that has normal long bones and a short trunk. By establishing a normogram for second-trimester CRL, the diagnosis of other conditions in which a shorter-than-expected fetal trunk is present may benefit from the application of this normogram. Application of these data to this and other early fetal growth disorders may also prove to be useful, respectively.

2385788 A Novel Technique to Assess the Uterine Cervix: 3-Dimensional Sphere Application
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Obstetrics and Gynecology, Brigham and Women’s Hospital, Boston, MA USA

Objectives: Three-dimensional assessment of cervical volume (CV) has shown early promise in risk stratification for preterm birth. However, little is known as to whether cervical volume changes over gestation or differs between multiparas and nulliparas. Additionally, no standardized technique exists for volume measurement. We developed a novel technique for CV measurement and aimed to describe CV in normal pregnancies across gestation.

Methods: CVs were collected prospectively on 276 women undergoing transvaginal TV ultrasound (US). CVs were measured using the virtual organ computer-aided analysis sphere application with the initial sphere volume set to 100 cm³ (±2 cm³). The cervix and lower uterine segment were outlined in 6 (30°) planes. Volume was assessed at three gestational age (GA) ranges, 16+0–19+6 weeks, 20+0–23+6 weeks, and 24+0–27+6 weeks. Women with the US indication of cervical incompetence or preterm birth (PTB) were excluded. Twenty-five women in each group, all with singleton pregnancies resulting in term deliveries, were included. We examined differences in CV by GA at US both in the population overall and between nulliparas and multiparas and tested the differences by the Wilcoxon rank sum test. Spearman correlations were calculated between CV, cervical length (CL), and GA at US, stratified by parity status.

Results: CV and CL were moderately well correlated over gestation (r = 0.5). Mean (SD) CVs in the 3 GA ranges were 59.0 (21.9), 64.4 (19.4), and 57.9 (13.8) cm³. CV differed by maternal parity (54.9 vs 63.6 cm³; P < .0001). While CL was significantly correlated with gestational age (P = .004), CV was not (P = .43).

Conclusions: CV appears to remain stable over gestation, as opposed to CL, which is correlated with GA. CV may therefore be a useful adjunct to CL in assessing risk of PTB.

Point-of-Care Ultrasound
Moderator: Arun Nagdev, MD

2384610 Computerized Detection of Abdominal Free Fluid in Focused Assessment With Sonography for Trauma Exams: A Pilot Study
Anna Spiegel1,*, Megan Leo1, Joseph Gwin3
1Emergency Department, Boston Medical Center, Boston, MA USA; 2Emergency Department, Boston University School of Medicine, Boston, MA USA; 3BioSensics LLC, Cambridge, MA USA

Objectives: The focused assessment with sonography for trauma (FAST) exam is an ultrasound exam used within emergency and critical care to detect free fluid in the setting of trauma. Interpretation of the FAST exam can be limited by operator experience. There may be a role for automated, computerized interpretation to assist those operators with minimal training. This pilot study tests the feasibility of automating the detection of free fluid in a FAST exam using image segmentation, feature selection, and machine learning.

Methods: Using an emergency ultrasound database, 10 positive and 10 negative right upper quadrant FAST exam videos from adult patients were randomly selected. Image segmentation identified hypoechoic regions of interest (ROI). Emergency physicians trained in ultrasound manually classified all hypoechoic ROIs as free fluid or not. Six geometric properties and eight grayscale color properties of the shapes and their surroundings were computed. These features were normalized and used as inputs to a radial basis function support vector machine (SVM) classifier. A 10-fold cross-validation assessed the sensitivity and specificity as compared to manual classification.

Results: On a shape-by-shape basis, the sensitivity and specificity of the SVM were 66.1% and 99.5%, respectively. On a frame-by-frame basis, the sensitivity and specificity were 74.9% and 98.6%, respectively. On a video-by-video basis, the sensitivity and specificity were 100% and 90%, respectively.

Conclusions: This pilot study demonstrates the feasibility of developing a computer program that would automate the detection of free fluid in the FAST exam. This technology could be expanded to all quadrants of the FAST exam. Much like the automated electrocardiogram read, this technology could assist providers in FAST interpretations and have a profound impact on patient care.

Table 1. SVM Classification Results

<table>
<thead>
<tr>
<th>Predicted</th>
<th>By Shape</th>
<th>By Frame†</th>
<th>By Video‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Actual</td>
<td>434</td>
<td>223</td>
<td>286</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>1874</td>
<td>6</td>
</tr>
<tr>
<td>Actual</td>
<td>10</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>9</td>
<td>3</td>
</tr>
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</table>

†Frame is predicted positive if at least 1 shape in the frame is positive.
‡Video is predicted positive if it has at least 1 sequence of ≥2 sequential positive frames.
Objectives: Recent studies suggest that carotid corrected flow time (FTc) measured by bedside sonography can be used in assessing volume status and volume responsiveness. We aim to determine whether sonographic measurement of the carotid FTc in subjects with prolonged fasting is a reliable method to detect fluid status.

Methods: A prospective cohort of fasting people who presented at a community health fair at the Islamic Education Center during the month of Ramadan was recruited. All adult subjects who were fasting and had no preexisting cardiac diseases were eligible to participate. Sonographic carotid FTc measurements were obtained in the long-axis view while participants were fasting and repeated approximately 3 hours after breaking their fast. We measured FTc in both semi-Fowler’s and passive leg-raising (PLR) positions. The primary outcome was to quantify changes in FTc from the fasting to the nonfasting states. Secondary outcomes included the correlation between changes in FTc associated with PLR in the fasting state and consuming fluids. FTc values were measured in real time and retrospectively by using a digital ruler, and the inter-rater reliability was calculated.

Results: In total, 123 participants with mean age of 47 ± 14 years and 55% male were enrolled. Participants had fasted for an average of 16.9 hours and consumed an average of 933 mL between the 2 sonographic measurements. Significant increases in mean FTc were observed from the fasting to the nonfasting state (312 ± 22 vs 345 ± 25 milliseconds; P < .001). Relative changes in FTc from fasting to nonfasting states of >10% and >5% were observed in 68 (55.3%) and 92 (74.8%) participants, respectively. Multivariable mixed linear regression analyses, controlling for participant characteristics, demonstrated that the fasting state independently reduces FTc values (coefficient [95% confidence interval], −19.10 [−23.31 to −4.88]) and increases change in FTc from the PLR maneuver (6.08 [4.93 to 7.24]) relative to the nonfasting state.

Conclusions: The carotid FTc measured by bedside sonography was significantly related to state of hydration among subjects with prolonged fasting. The FTc measurement can be used to accurately predict patients’ fluid status.

Objectives: A dilemma of 2-point limited compression ultrasound is the potential to miss atypical deep vein thrombi (aDVTs) isolated to either the femoral or deep femoral veins. It is possible that aDVTs are associated with specific demographics or symptoms, but this has not been studied. The current study set out to identify clinical variables associated with the presence of aDVTs.

Methods: This was a retrospective study of 2 emergency departments with an annual census of 100,000. Patients who had radiology ultrasound and a diagnosis of DVT between 2011 and 2014 were included. Patients were excluded if the DVT was not an acute proximal DVT of the lower extremity. Chart review was performed by 2 trained research associates, and demographic and clinical variables were extracted using a standardized data collection tool. Standard descriptive statistics were performed.

Results: A total of 748 patients were identified, with 464 patients having acute proximal DVTs for analysis. The mean age was 61 years (SD, 18) and 52% (239/464) were male. There were 23 cases (5.0%; 95 confidence interval, 3.2%–7.4%) of aDVTs (20 isolated femoral vein and 3 isolated deep femoral). The only variable found to be significantly associated with aDVT was pain localized to the thigh (Table 1).

Conclusions: Our study corroborates the findings of previous studies for a non-negligible (5%) incidence of aDVTs. Of patients with acute proximal DVTs, thigh pain is more commonly associated with aDVTs; however, whether this finding can be used to guide imaging strategies requires prospective evaluation.

Table 1. Clinical Variables Associated With Isolated Femoral or Deep Femoral DVTs

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Patients (n = 464)</th>
<th>Isolated Femoral or Deep Femoral DVTs (n = 23)</th>
<th>All Other Proximal DVTs (n = 441)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elderly (age &gt;65 y)</td>
<td>43% (197)</td>
<td>57% (13)</td>
<td>42% (184)</td>
<td>.16</td>
</tr>
<tr>
<td>Male gender</td>
<td>52% (239)</td>
<td>38% (8)</td>
<td>49% (217)</td>
<td>.18</td>
</tr>
<tr>
<td>Obesity</td>
<td>37% (173)</td>
<td>31% (7)</td>
<td>38% (166)</td>
<td>.49</td>
</tr>
<tr>
<td>History of DVT</td>
<td>36% (165)</td>
<td>48% (11)</td>
<td>35% (154)</td>
<td>.21</td>
</tr>
<tr>
<td>History of cancer</td>
<td>22% (103)</td>
<td>35% (8)</td>
<td>22% (95)</td>
<td>.14</td>
</tr>
<tr>
<td>Immobility</td>
<td>10% (44)</td>
<td>9% (2)</td>
<td>10% (42)</td>
<td>.90</td>
</tr>
<tr>
<td>Inguinal pain</td>
<td>4% (20)</td>
<td>9% (2)</td>
<td>4% (18)</td>
<td>.28</td>
</tr>
<tr>
<td>Thigh pain</td>
<td>10% (44)</td>
<td>22% (5)</td>
<td>9% (39)</td>
<td>.04</td>
</tr>
<tr>
<td>Knee pain</td>
<td>9% (41)</td>
<td>13% (3)</td>
<td>9% (38)</td>
<td>.47</td>
</tr>
<tr>
<td>Calf pain</td>
<td>14% (67)</td>
<td>9% (2)</td>
<td>15% (65)</td>
<td>.42</td>
</tr>
</tbody>
</table>

How Does Clinical Ultrasound Affect the Patient-Physician Relationship?

Jason Fields1, Julie Gianakon1, Carl Alsup1,* Kunal Desai2, Arthur Au1

1Emergency Medicine, Thomas Jefferson University, Philadelphia, PA USA; 2Rowan University, Stratford, NJ USA

Objectives: Clinical ultrasound (cUS) has the potential to improve the patient-physician relationship through increased contact time and communication. The current study set out to determine if patients who receive cUS have a stronger connection with their providers.

Methods: This was a prospective matched case-control study performed in an urban academic emergency department (ED). Adult patients who had cUS were enrolled. Age- and gender-matched control patients who were seen by the same provider but who did not receive cUS were also enrolled. All patients were administered a survey of questions assessing the provider-patient relationship. Comparison between the 2 groups was performed using Student t and χ² tests.

Results: Seventy-two patients were enrolled (36 cases and 36 controls). The mean age was 50.4 years (SD, 18.3); 47% were male; and 53% were female. No significant difference was found between the 2 groups for any of the patient-provider relationship questions (Table 1). The cUS group had higher overall satisfaction, with 100% indicating they were “satisfied” or “very satisfied” with their ED visit, compared with 81% of the controls (P < .01).

Conclusions: cUS did not appear to increase the provider-physician relationship using our adapted survey. cUS was associated with higher patient satisfaction.
Noninvasive measure to detect changes in intravascular volume status. FTc may be an early reliability with 0.3 mg of nitroglycerin. FTc was able to detect a significant difference in heart rate increased 5 beats/min with administration of nitroglycerin (P < .001). Mean FTc decreased from 339 milliseconds (95% confidence interval [CI], 332–346) to 325 milliseconds (95% CI, 318–331) with administration of 0.3 mg of sublingual nitroglycerin (P < .001). Mean FTc decreased from 339 milliseconds (95% CI, 332–346) to 325 milliseconds (95% CI, 318–331) with administration of 0.3 mg of sublingual nitroglycerin (P < .001). Mean FTc decreased from 339 milliseconds (95% CI, 332–346) to 325 milliseconds (95% CI, 318–331) with administration of 0.3 mg of sublingual nitroglycerin (P < .001).

Table 1. Patient-Provider Relationship Scores Between cUS and No-cUS Groups

<table>
<thead>
<tr>
<th>Question</th>
<th>eUS Group</th>
<th>No-cUS Group</th>
</tr>
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<tbody>
<tr>
<td>I find my ED team easily accessible</td>
<td>4.20</td>
<td>4.25</td>
</tr>
<tr>
<td>I feel content with my ED team’s treatment</td>
<td>4.22</td>
<td>4.25</td>
</tr>
<tr>
<td>I feel comfortable talking to my ED team</td>
<td>4.53</td>
<td>4.44</td>
</tr>
<tr>
<td>My ED team and I agree on the nature of my symptoms</td>
<td>4.22</td>
<td>4.17</td>
</tr>
<tr>
<td>My ED team is dedicated to helping me</td>
<td>4.42</td>
<td>4.42</td>
</tr>
<tr>
<td>My ED team understands me</td>
<td>4.17</td>
<td>4.19</td>
</tr>
<tr>
<td>I trust my ED team</td>
<td>4.36</td>
<td>4.36</td>
</tr>
<tr>
<td>My EDR team has enough time for me</td>
<td>4.31</td>
<td>4.17</td>
</tr>
<tr>
<td>My ED team helps me</td>
<td>4.36</td>
<td>4.39</td>
</tr>
</tbody>
</table>

For each question, patients selected between “strongly agree,” “agree,” “neutral,” disagree,” and “strongly disagree.” Survey adapted from the validated Patient-Doctor Relationship Questionnaire 9.

2385477 Three-Window Point-of-Care Ultrasound Confirmation of Correct Endotracheal Tube Placement

Shadi Lahham¹, Elizabeth Turner¹, Sean Wilson¹, Marc Rose², Arthur Youssefian¹, Mohammed Sabeh¹, Craig Anderson¹, J. Christian Fox¹
¹Emergency Medicine, University of California, Irvine, Orange, CA USA; ²Intensive Care Unit, University of California, Irvine, Irvine, CA USA

Objectives: Establishing a definite airway is often an initial step in the management of the critically ill patient. In the emergency setting, this can be particularly challenging, as previous studies have demonstrated that up to a quarter of emergency intubations result in the esophagus and another quarter that are initially placed in the trachea end in a main stem bronchus. We therefore sought to evaluate the accuracy of a comprehensive 3-window point-of-care ultrasound (POCUS) assessment to confirm correct endotracheal tube (ETT) placement.

Methods: This study was a prospective observational study using a convenience sample of patients who underwent emergency intubation between July 2011 and August 2013 in the emergency department or medical intensive care unit at a 422-bed level 1 trauma center with an annual emergency department census of 50,000 visits. After presuming successful ETT intubation, 3 sonographic windows were obtained, which included the trachea, bilateral lung sliding, and diaphragm movement. A 2-sample t test was used to compare the average time between ultrasound and plain-film radiography.

Results: A total of 140 patients were enrolled. There were no esophageal intubations. The 3-window POCUS method correctly identified 132 of 137 ETTs placed in the trachea with sensitivity and specificity of 96.4% (95% confidence interval [CI], 91.7%–98.8%) and 33.3% (95% CI, 0.8%–90.6%), respectively. Ultrasound assessment was completed on average 25 minutes quicker than usual confirmatory plain-film radiography (95% CI, 6.2–43.9 minutes; P = .005).

Conclusions: The 3-window POCUS appears to be a quick and reliable method for the early confirmation of correct ETT placement in the trachea and not one of the main stem bronchi. With future advances in technology training, there may be a role to reduce the need for postintubation plain-film radiography. Additional large-scale studies are required to validate this conclusion.

2385428 Emergency Medicine Physician–Performed Transesophageal Echocardiography in Simulated Cardiac Arrest

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Objectives: Transesophageal echocardiography (TEE) is an established method of evaluating cardiac pathology. It has many advantages over transthoracic echocardiography (TTE), including the ability to image the heart during active cardiopulmonary resuscitation. This is a prospective simulation study that aims to evaluate the ability of emergency medicine (EM) physicians to learn and apply TEE image acquisition techniques and demonstrate those techniques to identify common pathologic causes of cardiac arrest.

Methods: This was a prospective educational cohort study with 40 EM physicians from 2 participating academic medical centers who underwent an educational module and a testing protocol. All participants were tested across 6 cases, including 2 normals, pericardial tamponade, acute myocardial infarction (MI), ventricular fibrillation (V-FIB), and 1 asystole presented in random order. Primary end points were correct identification of the cardiac pathology, if any, and time to sonographic diagnosis. Calculated end points included sensitivity, specificity, positive predictive value, and negative predictive value for EM-performed TEE. A x statistic was calculated to determine the degree of inter-rater reliability.

Results: Forty EM physicians completed both the educational module and testing protocol. This resulted in a total of 104 normal TEE studies and 208 pathologic TEE studies. Our calculations for the ability to diagnose life-threatening cardiac pathology by EM physicians in a high-fidelity TEE simulation resulted in sensitivity of 98.5%, specificity of 99%, a positive predictive value of 99.5%, and a negative predictive value of 97.1%. The average time to diagnose each objective structural clinical examination case was a follows: normal A in 35 seconds, normal B in 31 seconds, asystole in 13 seconds, tamponade in 14 seconds, acute MI in 22 seconds, and V-FIB in 12 seconds. Inter-rater reliability between EM physicians was extremely high, resulting in a x coefficient across all cases of 0.95, where >0.9 is considered to be “almost perfect.”

Conclusions: EM physicians can rapidly perform TEE studies in a simulated cardiac arrest environment with high degrees of precision and accuracy. Performance of TEE studies on human patients in cardiac arrest is the next logical step to determine if our simulation data hold true in clinical practice.
2385846 Medical Student–Performed Point-of-Care Ultrasound: The Effect on Patient Satisfaction in the Emergency Department

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Objectives: Although medical school ultrasound curriculum guidelines have not yet been standardized, some early-adopter programs have used student-performed point-of-care ultrasound (SP-POCUS) for educational purposes in the emergency department (ED) and elective rotations. This study set out to measure the effects that SP-POCUS might have on patient satisfaction in the ED.

Methods: Patient satisfaction surveys were collected from patients in an urban level 1 trauma ED at an academic institution. Patients were divided into 2 populations: a physician-indicated population in which SP-POCUS was potentially helpful to diagnosis and an educational population in which SP-POCUS was mainly for student learning. Indicated patients were randomized into control (completed survey prior to SP-POCUS) and experimental (completed survey after SP-POCUS) groups. Educational patients were matched to controls based on the length of stay and chief complaint. All patients completed a 5-question satisfaction survey based on a 5-point Likert scale. Experimental groups received an additional 5-question survey specific to SP-POCUS.

Results: A total of 481 patients with 200 indicated and 281 educational patients were enrolled. Average patient satisfaction for indicated SP-POCUS was 4.54 for the experimental group and 4.47 for the control group (P = .48). Average patient satisfaction was 4.50 for patients receiving educational SP-POCUS and 4.43 for matched controls (P = .43). Patients reported feeling comfortable during indicated SP-POCUS (4.51; confidence interval [CI], 4.36–4.67) and educational SP-POCUS (4.61; CI, 4.50–4.72) and would recommend ultrasound for a patient with a similar chief complaint (indicated: 4.38; CI, 4.21–4.56; educational: 4.52; CI, 4.39–4.64).

Conclusions: There were no significant positive or negative effects of SP-POCUS on patient satisfaction. Patients remained comfortable during the exam and recommended that SP-POCUS be performed on a patient with a similar chief complaint. These results suggest that SP-POCUS may be used as a tool for clinical ultrasound education while maintaining quality patient-centered care.

2382868 Lung Ultrasound for Evaluating Acute Chest Syndrome in Pediatric Patients With Sickle Cell Disease: So Easy Even a Medical Student Can Do It!

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Objectives: We evaluated the feasibility of medical student–performed ultrasound (US) compared to chest x-ray (CXR) to identify patients with sickle cell disease (SCD) who have acute chest syndrome (ACS).

Methods: This is a prospective observational study that took place in 2 urban pediatric emergency departments. Children with SCD are repeatedly exposed to diagnostic radiation for the evaluation of ACS. Focused chest US can visualize lung consolidation and can be used to identify patients with ACS, thereby limiting radiation exposure in this pop-

ulation. Children with SCD were enrolled if they were receiving a CXR for evaluation of ACS. Medical students without experience in lung US underwent a focused training session conducted by a pediatric emergency physician with training in point-of-care ultrasound. The session consisted of a 1-hour didactic lecture followed by a 1-hour hands-on session. Focused lung US was performed by medical students and was interpreted as either positive or negative for lung consolidation. A blinded expert in point-of-care US reviewed studies for quality assurance and agreement. Sensitivity, specificity, and likelihood ratios (LRs) were calculated for test performance characteristics of ultrasound using CXR as a reference standard. Interobserver agreement (κ) between enrolling sonologists and the reviewer was also calculated.

Results: Three medical students completed the training and enrolled 85 patients, for a total of 98 cases. Median age was 7 years (interquartile range, 2–13 years), and 53% of patients were male. The prevalence of ACS by CXR was 14%. Lung US was able to detect consolidation with sensitivity of 86% (95% confidence interval [CI], 56%–97%), specificity of 95% (95% CI, 87%–98%), a positive LR of 18 (95% CI, 7–48), and a negative LR 0.2 (95% CI, 0.04–0.5). The agreement between enrolling sonologists’ interpretation and the blinded reviewer’s interpretation was very good, with a Cohen k of 0.86 (95% CI, 0.7–1).

Conclusions: With limited training, novice medical student sonologists were able to identify ACS with high specificity. There was very good agreement between novice and expert sonologist interpretation.

2385154 Does Carotid Intima-Media Thickening Predict a Negative Stress Test in Low-Risk Chest Pain?

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Objectives: Chest pain is a common presentation to the emergency department (ED). Patients frequently undergo stress testing following negative diagnostic markers. Carotid intima-media thickness (CIMT) is a useful tool to noninvasively identify patients with a higher atherosclerotic burden. CIMT has been shown to be associated with myocardial infarction, stroke, coronary artery disease (CAD), as well as angiographic evidence of CAD. There are no known studies evaluating the use of CIMT on low-risk chest pain patients in an ED observation (OU) setting. The goal of this study is to evaluate CIMT in the ED OU to determine if it can be used as a tool to help predict patients who will have a negative stress test in attempt to risk stratify patients complaining of chest pain.

Methods: This is an ongoing prospective convenience sample of patients admitted to our ED OU with chest pain, dyspnea, or symptoms determined to be a coronary equivalent by the treating physician in the ED. Patients were included if they were to receive a stress test during their observation stay or had received one within 2 months prior to the ED OU visit. Patients were scanned with a high-frequency linear transducer in the long axis to the carotid artery. Three measurements of the IMT were taken on each side proximal to the carotid bulb within 1 cm of the bulb. The results were averaged on each side. The results were compared to a known standard for age and ethnicity at the 75th percentile. IMT above the 75th percentile for age and ethnicity on either side was considered a positive result.

Results: To date, 59 patients were evaluated. Five had a positive stress test (8.8%; 95% confidence interval [CI], 1.4%–16.2%). Of the 57 patients, 37 patients (64.9%; 95 CI, 52.5%–77.3%) had a negative IMT study, and 20 (35.1%; 95 CI, 22.7%–47.5%) had a positive IMT study. There were 4 patients among the positive stress group who had a positive IMT (80%; 95 CI, 44.9%–100%) and 1 patient with a negative IMT (20%; 95 CI, 0%–55.1%).

Conclusions: In this cohort of patients with low-risk chest pain was a trend toward negative stress correlating with negative IMT. However, data are insufficient to confidently risk stratify patients based on IMT alone.
Ultrasound in Medical Education

**Objectives:** This study aims to evaluate the efficacy of a novel near-peer teaching program as a model for medical students to learn ultrasound.

**Methods:** Third-year (M3) medical school students begin by training a small group of interested M2 students in a set of specialty-specific scans. Each M3 student will then use the trained M2 students to serve as proctors and models during a didactic and clinical training session for novice ultrasound learners (mostly M1s). All novice participants completed preinstruction and postinstruction knowledge tests, self-ratings of ultrasound skills, and a satisfaction survey. Peer-instructors completed a preinstruction and postinstruction practical examination as well as a pre-instruction and postinstruction self-assessment of their own ultrasound skill and teaching ability. M3 students were assessed using comprehensive knowledge exams and surveys.

**Results:** Those who participated as proctors showed an increase in basic ultrasound knowledge and skills and also self-reported an increase in comfort with various ultrasound-related tasks as well as in comfort with teaching skills. Those who participated as novice learners also showed a statistically significant improvement in ultrasound knowledge while self-reporting an increase in comfort with various ultrasound-related tasks. Novice learners also rated the multidisciplinary ultrasound leadership training initiative (MULTI) sessions highly on a follow-up program evaluation. Data from M3 leaders is under analysis currently.

**Conclusions:** Initial results of the MULTI program demonstrate the efficacy of using a near-peer teaching model for expanding ultrasound education in medical school. The MULTI program helped both learners and peer-instructors to see the practical application of ultrasound across a spectrum of specialties, particularly ones in which participants were interested. The MULTI program not only taught new ultrasound skills but also helped reinforce foundational skills and knowledge. Peer-instructors and leaders developed teaching skills in ultrasound acquisition and interpretation.

**2384041 Medical Student Perceived Value of Ultrasound Education During the First Year of Medical School**

**Objectives:** To assess student perception of the value of ultrasound education during the first year of medical school.

**Methods:** An electronic survey was administered to learners on the completion of their first year of undergraduate medical ultrasound curriculum. Year 1 students in 2 academic years were surveyed.

**Results:** Two hundred thirty-six students (95%) felt that the overall educational experience in ultrasound enhanced their undergraduate medical education (n = 247). Two hundred forty-eight (93%) reported that they would like to see more ultrasound included in the undergraduate medical curriculum (n = 266).

**Conclusions:** A large majority of first-year medical students believed that the integration of ultrasound into their curricula enhanced their undergraduate medical education. Most students desire more ultrasound within the curricula.

**2384071 Pair Scanning: Integrating the Student Sonographer Without Impacting Patient Care**

**Objectives:** During an ultrasound placement, the student sonographer is often provided time to examine patients before or after they have been examined by a registered sonographer. This practice, which increases patient examination times for student training, is limiting access to clinical training placements not only because it reduces patient volumes but also negatively affects revenue. Moreover, this practice requires patients to undergo 2 ultrasound examinations. A research project was launched to challenge this practice by developing a pair-scanning protocol that can integrate the student sonographer into the workplace without impacting patient care and tested whether the protocol prepares the student sonographer for entry-level practice faster than traditional practice.

**Methods:** This research project was conducted in 2 phases. The first phase used action research to design and develop a pair-scanning protocol. The second phase examined the transferability of the protocol using mixed methods.

**Results:** Phase 1 produced a pair-scanning protocol that effectively integrated the student sonographer into a busy clinic without impacting patient care and prepared her for entry-level practice faster than traditional practice. The student logged more total examinations and logged statistically significantly more independent exams than her cohort (H = 36.297; P < .01). The phase 2 results demonstrated that students can be integrated into a variety of sites without a reduction in patient volumes. The pair-scanning group (n = 5) and the control group (n = 9) performed equally.

**Conclusions:** Student sonographers can be integrated into the workflow without impacting patient care. The pair-scanning protocol provides a framework for this integration and may be most effective for weak to average students.
Midwifery Students’ Perceptions of the Importance of Ultrasound in Medical Education in Lebanon
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Objectives: Evaluate 4th-year midwifery students’ perceptions of the importance of ultrasound (US) before and after the first integrated US course in the midwifery curriculum in Lebanon.

Methods: Responses to precourse and postcourse surveys from 14 enrolled students were collected. Using a 5-level Likert scale, students responded to questions in 5 categories: exposure to US and need of training; role of US in enhancing comprehension of obstetrics (OB) and gynecology (Gyn); importance of US integration into medical education; role of US in their future; and postcourse impressions. Data were analyzed using the Mann-Whitney nonparametric test. P < .05 was considered significant.

Results: All students completed precourse and postcourse surveys with an individual response rate >95% to each question. Even though 78% of students agreed/strongly agreed (A/SA) to sufficient exposure to US after the course in comparison to 42.9% before the course (P = .05), >85%, both before and after the course, indicated their persisting need for more structured instruction in US. Persisting before and after the course, >95% of students A/SA on the role of US in enhancing their Ob knowledge. On the other hand, their perception toward the role in Gyn declined significantly from ~75% to 40% (P = .021). Students’ perceptions were as strong before and after the course on the role of US in medical education and their future clinical practice: >85% of students A/SA to the importance of US integration into their own education and globally, >95% of students A/SA to the role of US in their future clinical practice. After the course, all students SA to the course benefits and their willingness to serve as future instructors.

Conclusions: Our study demonstrates that US integration into medical education is a positive experience for midwifery students, enhancing their knowledge. Our data indicate the insufficiency of our course in addressing their Gyn needs and the need for earlier and longer structured training in OB sonography. The student’s strong belief in US’s clinical applicability in their future, the need for its universal implementation, together with their willingness to serve as future instructors, provide further evidence in support of the importance of global implementation of US in medical education.

Comparison of Third-Year Medical Students Using Vscan Handheld Ultrasound With Obstetric Sonographers for Determination of Biparietal Diameter and Fetal Lie in Obstetric Patients
Felicia Toreno, Barry Knapp, Craig Goodmurphy, Donald Byars, Khaled Sakhel*
Eastern Virginia Medical School, Norfolk, VA USA

Objectives: The purpose of this study was to evaluate the accuracy of third-year medical students (M3) in measuring fetal biparietal diameter (BPD) and determination of fetal lie (FL) using handheld ultrasound as compared to experienced sonographers using hospital-based ultrasound systems.

Methods: This was a prospective observational study evaluating M3 students’ accuracy in measuring BPD and determining FL during the second and third trimesters of pregnancy. M3 students utilized a GE Vscan handheld ultrasound machine during their obstetrics and gynecology clerkship at Eastern Virginia Medical School. During the clerkship, students were required to measure BPD and determine FL on patients determined to need a formal ultrasound exam. Students were asked to perform the ultrasound first unaided, followed by a second-trimester scan by sonographers. Student Vscan assessments were compared with those of 14 experienced American Registry for Diagnostic Medical Sonography–certified obstetric sonographers using traditional ultrasound systems. The 2-tailed Student t test was used to assess statistical significance between the 2 groups via P values and to determine 95% confidence intervals (CIs). For the determination of fetal lie, a k coefficient statistic was used to determine the level of agreement between sonographers. An a priori estimation of sample size for statistical power was performed utilizing Cohen’s delta.

Results: BPD measurements were recorded by 128 students, while 130 students obtained FL (M3 total class size = 155). No statistical difference was noted between the BPD measurements obtained by students versus experienced sonographers (P = .58 with difference between the means of ~0.11 with a 95% CI from ~0.54 to 0.30). The k coefficient for inter-rater reliability for assessment of fetal lie was 1.0, resulting in a strong level of agreement between the M3 and obstetric sonographers. The a priori sample size calculation of 128 was met for both measured end points.

Conclusions: Results indicate that M3 students can accurately determine BPD and fetal lie using the Vscan handheld ultrasound machine as compared to experienced sonographers using traditional ultrasound machines.

Collaboration Between Eastern Virginia Medical School (EVMS) and the Diagnostic Medical Sonography Program at Tidewater Community College in the Implementation of Ultrasound Into the Medical School Curriculum at EVMS
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1Eastern Virginia Medical School, Norfolk, VA USA; 2Diagnostic Medical Sonography, Tidewater Community College, Virginia Beach, VA USA

Objectives: As Eastern Virginia Medical School (EVMS) made the decision to implement an ultrasound component into the existing medical education curriculum, it looked for support and input from a local source of sonography education: Tidewater Community College (TCC). With a well-established and accredited diagnostic medical sonography (DMS) program, TCC was able to offer supporting equipment as well as manpower. This collaboration has proven to be successful for both partners and has highlighted the strengths of both partners. We hope to encourage other such collaborations to be developed.

Methods: EVMS and TCC have collaborated to utilize resources provided by sonographers in scanning labs built into the medical student ultrasound learning labs. The community college provides faculty, students, and equipment to help run scanning labs for first- and second-year medical school students. DMS faculty earn community respect; DMS students gain self-confidence and EVMS gains additional qualified faculty and mentoring staff. In addition, the medical students learn to respect the skills and capabilities of sonographers.

Results: EVMS and TCC have established what we feel is a benchmark collaboration between a community college and a medical school. All parties recognize the strengths of the other and gain something from the collaborative effort, including the most important of all: the medical students themselves.

Conclusions: When medical schools make curriculum changes, resources are often limited. One very effective resource available to medical schools may already be available within the community: the local college-based sonography program. In the model of collaboration between EVMS and TCC, both partners benefit from the current collaborative process, and both partners would be negatively impacted without this partnership. As educators embrace the concepts of learning across curricula and interdepartmental learning, this medical-based skill set provides a good means to do just that at both educational levels. Further studies are underway at EVMS to see if the interactions with sonographers change general perceptions of medical students regarding sonographers as health care workers.
2385233 Does the Addition of an Integrated Cardiac Ultrasound Curriculum to the M1 and M2 Years of Medical Education Enhance Comprehension of Cardiac Physiology and Pharmacology?
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Eastern Virginia Medical School, Norfolk, VA USA

Objectives: Cardiac physiology is an educational challenge to entering medical students. Deficiencies in learning manifest in lower cardiac physiology test grades and lower student course evaluation scores. These deficits may carry over into the second-year (M2) medical school student’s performance in cardiovascular pharmacology and may impact clinical years. Our hypothesis is that by using ultrasound (US) to visualize the cardiac cycle, medical students can better comprehend and retain elements of cardiac mechanics and function.

Methods: The average grade point average (GPA) and Medical College Admission Test (MCAT) scores of entering classes at Eastern Virginia Medical School (EVMS) were used to estimate performance of first-year medical students who were taught cardiac physiology by EVMS faculty. Standardized test questions were used to create 2 examinations on cardiac physiology. Student course evaluation results were collected using a Likert scale. The most recent student groups also received US training. US training included didactic and “hands-on” laboratory sessions scanning standardized patients.

Results: The average GPAs and MCAT scores of years 2003–2011 medical students were not significantly different from years 2012 and 2013. In 2003–2011, the averaged scores for both cardiac physiology exams were 81.5 + 2.8. In 2012 and 2013, the averaged scores were 88.35 and 86.5, respectively, significantly higher than the 2003-2011 average, while other physiology tests scores were not significantly different. Physiology course evaluations averaged 3.92 ± 0.89, higher than 3.21 ± 0.63 in the previous years. Student surveys showed that ≈99% affirmed that learning US improved their overall medical school experience. The class data demonstrated positive trends linking cardiovascular pharmacology/physiology scores with US scanning.

Conclusions: Our data show upward trends in cardiovascular physiology and pharmacology test scores, student course evaluations, and overall medical school experience when US is integrated into the medical school curriculum. We will continue to follow the performance of medical student classes to determine if there will also be a trend for improvement in clinical tasks involving elements of cardiac physiology in the third and fourth years of medical school.
Elastography
Moderator: Shigao Chen, PhD

2385532 Shear Wave Elastography for Liver Fibrosis Staging: Validating Cutoff Values for ≥F2 Fibrosis
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Objectives: To determine the validity of previously established estimated liver Young’s modulus (eYM) cutoff values for ≥F2 fibrosis in a cohort of patients with chronic liver diseases.

Methods: In this Institutional Review Board–approved Health Insurance Portability and Accountability Act–compliant prospective study, a total of 338 patients undergoing liver biopsy from January 2014 to January 2015 underwent shear wave elastography (SWE) using an Aixplorer ultrasound machine (SuperSonic Imagine, France). Sets of 10 elastograms were obtained in the right upper lobe utilizing an intercostal approach at the end of normal expiration. Median SWE values were calculated. Sixty-one patients were excluded (all organs = 29, low-quality SWE = 25). A single blinded subspecialty-trained pathologist performed METAVIR fibrosis staging on all biopsy samples. Receiver operating characteristic (ROC) curves were computed for distinguishing higher grades (≥F2) of liver fibrosis from F0 and F1 fibrosis.

Results: A total of 277 subjects (male:female = 125:152) with a mean age of 48 years were analyzed. The reason for biopsy was liver disease workup in 55.6% of patients (n = 154) and follow-up of known liver disease in 44.4% (n = 123). On pathologic examination, a total of 212 subjects had either no fibrosis (F0; n = 108 [39.0%]) or F1 fibrosis (n = 104 [37.5%]), while 28 had F2 fibrosis (10.1%), 27 had F3 fibrosis (9.7%), and 16 had F4 fibrosis (5.8%). Spearman’s correlation showed moderate correlation of fibrosis with eYM (r = 0.456; P < .001). A cutoff value of 7.29 kPa yielded sensitivity and specificity of 95% and 51%, respectively, test performance results similar to those defined in our prior work.

Conclusions: A cutoff value of 7.29 kPa has been validated to have sensitivity of >95% and specificity of >50% for the diagnosis of METAVIR stage ≥F2 fibrosis.

Table 1

<table>
<thead>
<tr>
<th>Initial Cohort (Samar, Radiology 2015)</th>
<th>Validation Cohort</th>
</tr>
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<tbody>
<tr>
<td>n</td>
<td>136</td>
</tr>
<tr>
<td>Mean age (range)</td>
<td>49 y (18–74 y)</td>
</tr>
<tr>
<td>Cutoff value for METAVIR ≥F2 fibrosis</td>
<td>7.29 kPa</td>
</tr>
<tr>
<td>Area under the ROC curve</td>
<td>0.77 (0.68–0.86)</td>
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<td>Sensitivity (95% CI)</td>
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<td>Specitivity (95% CI)</td>
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<tr>
<td>Positive predictive value</td>
<td>40.0% (95% CI)</td>
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<tr>
<td>Negative predictive value</td>
<td>94.0% (95% CI)</td>
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CI indicates confidence interval.

2376985 Performance of 2-Dimensional Ultrasound Shear Wave Elastography in Liver Fibrosis Detection Using Magnetic Resonance Elastography as the Reference Standard: A Pilot Study
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Objectives: To investigate the correlation between 2D ultrasound shear wave elastography (SWE) and magnetic resonance elastography (MRE) in liver stiffness measurement and the diagnostic performance of 2D SWE for liver fibrosis detection when imaging from different intercostal spaces and using MRE as the reference standard.

Methods: Two-dimensional SWE was performed on 47 patients (22 females, 25 males, age 19–77 years) using the GE LOGIQ E9 (LE9) scanner. LE9 uses the comb-push ultrasound shear elastographic technique to simultaneously produce multiple shear waves inside the tissue to improve shear wave imaging quality. Each of the 47 patients had same-day MRE obtained for clinical purposes. Two-dimensional SWE measurements were acquired from the 9th, 8th, and 7th intercostal spaces. Correlation with MRE was calculated at each intercostal space and multiple intercostal spaces combined. The performance of 2D SWE in diagnosing liver fibrosis was evaluated with receiver operating characteristic (ROC) curve analysis using MRE as the standard.

Results: The overall success rate of SWE measurements was 93% using LE9 2D SWE. The highest correlation between 2D SWE and MRE was from the 8th and 7th intercostal spaces (r = 0.68–0.76). The ranges of the areas under the ROC curve for separating normal or inflamed livers from fibrotic livers using MRE as the clinical reference were 0.84–0.92 when using the 8th and 7th intercostal spaces individually and 0.89–0.99 when combined, with 0.76–0.89 sensitivity and 0.83–0.96 specificity. High inter- and intra-rater correlation coefficients were obtained for the LE9 2D SWE: 0.995 and 0.987, respectively.

Conclusions: The results suggest that 2D SWE and MRE are well correlated when SWE is performed at the 8th and 7th intercostal spaces. The 9th intercostal space is less reliable for diagnosing fibrosis using 2D SWE. Combining measurements from multiple intercostal spaces does not significantly improve 2D SWE performance for fibrosis detection. This study suggests that repeated liver stiffness measurements from a single intercostal space that provides the best acoustic window may be sufficient for diagnosing liver fibrosis using 2D SWE.

2379753 Pediatric Cardiac Shear Wave Elastography: A Pilot Study on Healthy Controls
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Objectives: The long-term goal of this study is to assess chemo-induced cardiotoxicity for pediatric cancer patients using cardiac ultrasound shear wave elastography (cSWE). This pilot study aimed to systematically investigate the feasibility of using cSWE in children and provide myocardial stiffness control data for the cancer patients.

Methods: Twenty healthy volunteers (ages 5–18 years) were recruited and scanned 3 times on 3 different days. A novel cSWE sequence with pulse inversion harmonic imaging and time-aligned sequential track-
ing was developed for this study. cSWE was implemented using an adult and a pediatric cardiac transducer (P4-2 and P7-4; Philips Healthcare), driven by a Verasonics ultrasound system. The Verasonics was electrocardiographically gated to produce and detect a transient shear wave propagating in the myocardium in late-diastole. Two-dimensional shear wave speed (SWS) maps of the myocardium were reconstructed for data analysis.

**Results:** The parasternal long-axis (L-A) and short-axis (S-A) views of the interventricular septum (IVS) were found to be feasible for reliable shear wave measurement. The inter- and intra-rater correlation coefficients for SWS measurements were 0.86 and 0.77, respectively. The L-A and S-A views of the basal and mid IVS provided better success rates than those of the apical IVS. Success rate decreased with increased body mass index but did not differ with age or gender. SWS measurements were 1.26, 1.22, 1.71, and 1.67 m/s for L-A base, L-A mid, S-A base, and S-A mid IVS, respectively. All S-A SWS values were significantly higher (P < .01) than L-A values due to myocardial anisotropy, corroborating a prior animal study and MRI tractography results. No SWS difference was observed for different ages and genders. Among successful SWS measurements, 90% were found to be repeatable across different days.

**Conclusions:** This pilot study demonstrated, for the first time, the feasibility of using cSWE to measure quantitative myocardial stiffness in children and established control SWS values for using cSWE to assess chemo-induced cardiotoxicity for pediatric cancer patients. The results showed that the myocardial anisotropy needs to be accounted for when comparing SWS from different scan views. No SWS difference was observed for age or gender.

**2369615 Correlation of Cognitive Function With Strain Indices for Accessing Carotid Plaque Instability**

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**Objectives:** Carotid plaque rupture can occur through dissection, which may cause substantial cognitive impairment. Vulnerable plaques may be identified with ultrasound-based carotid strain imaging. Localized regions of interest (ROIs) with maximum strain tensor values (strain indices) are identified by assessing the strain distribution spatially and temporally across a cardiac cycle. We examined the relationship between maximum strain indices and cognition before carotid endarterectomy.

**Methods:** Presurgical strain imaging and cognitive evaluations were obtained from 51 patients (31 symptomatic for stroke/transient ischemic attack; 20 asymptomatic). ROIs surrounding the maximum value of accumulated strain were identified around the center of the ROI. Maximum strain in each frame was obtained by averaging the strain values in each ROI and temporal progression of the mean strain within this ROI was studied. Cognition was tested using the 60-minute test battery of National Institute of Neurological Disorders and Stroke–Canadian Stroke Network Vascular Cognitive Impairment Harmonization Standards and assessed language, memory, visuospatial, motor, and executive function.

**Results:** In patients symptomatic for stroke, strain values were positively correlated with time taken to reproduce a complex figure (r = 0.616; P < .001) and inversely correlated with memory for that figure (r = -0.441; P < .012), while asymptomatic patients demonstrated an inverse correlation between maximum strain and executive function (r = -0.590; P = .006). Both groups showed a relation between strain and a coding (symbol substitution) task (r = -0.522, -0.752; P = .002, .001).

**Conclusions:** Maximum strain indices in carotid plaque can serve as vascular biomarkers associated with specific cognitive deficits depending in part on symptomatic status. Although the etiology of these impairments is still uncertain, our results suggest that the decline of motor function, speeded motor function, executive function, visual attention, and visuospatial learning may be associated with embolization related to high-strain indices in carotid plaque. (Funded in part by National Institutes of Health grants R21 EB010098, R01 NS064034, and R201 CA112192.)

**2381340 Strain-Based Vascular Biomarkers for Classification of Patients With Cognitive Impairment**

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**Objectives:** Cognitive impairment has different etiologies, with microemboli from carotid plaque being one of the causative factors. We have previously reported on maximum strain indices in the carotid wall and plaque as vascular biomarkers demonstrating strong correlations with cognitive function. Here we evaluate the ability of these biomarkers to differentiate between low- and high-cognition patient groups.

**Methods:** Ultrasound-based carotid strain imaging and cognition assessment were performed on 75 patients. Ultrasound radiofrequency data for strain imaging were acquired, along with clinical B-mode and color flow Doppler images, on patients using either a Siemens Antares or S2000 ultrasound system (Siemens Ultrasound, Mountain View, CA) equipped with a VFX 13-5 or 18L 6 linear array transducer. A standardized cognitive test battery, using either the Repeatable Battery for the Assessment of Neuropsychological Status or the National Institute of Neurological Disorder and Stroke–Canadian Stroke Network Vascular Cognitive Impairment Harmonization Standard, was administered. Cognition scores were standardized within each of these tests to combine and compare to strain indices as z scores.

**Results:** A negative association between cognitive z scores and maximum strain indices was observed. Patients with higher strain indices performed poorly on cognitive assessment tests and vice versa. Strain indices utilized to differentiate between the lower- and higher-cognition groups provided area under the curve (AUC) values between 0.75 and 0.8 for all patients, improving to between 0.78 and 0.85 for symptomatic patients. Lateral strain indices exhibited the best performance, with an AUC of 0.79 for all patients and 0.85 for asymptomatic patients.

**Conclusions:** All correlations were significant at P < .05, and our vascular strain indices demonstrate good classification performance for cognitive impairment. This study supports our hypothesis that microemboli resulting from the rupture of vulnerable plaque, manifesting as local regions with increased strain or deformation, may lead to cognitive impairment. (This work was supported in part by National Institutes of Health grants R21 EB010098, R01 NS064034, and R201 CA112192.)

**2383351 Effect of Various Technical and Patient-Related Factors on the Success Rate of Acoustic Radiation Force Impulse Elastography in Patients With Morbid Obesity**

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**Objectives:** Liver stiffness with transient elastography can have a failure rate of up to 59% in obese patients, which is an important segment of the American population. The objective of this study was to evaluate the effect of technical and patient-related factors on the success rate of acoustic radiation force impulse (ARFI) shear wave speed (SWS) in morbidly obese patients undergoing bariatric surgery.

Conclusions: Liver stiffness with transient elastography can have a failure rate of up to 59% in obese patients, which is an important segment of the American population. The objective of this study was to evaluate the effect of technical and patient-related factors on the success rate of acoustic radiation force impulse (ARFI) shear wave speed (SWS) in morbidly obese patients undergoing bariatric surgery.
Limitations and Artifacts in the Use of Shear Wave Elastography in the Liver

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Objectives: Liver biopsy is the standard of reference to assess and follow chronic liver disease. However, liver biopsy is an invasive procedure associated with drawbacks such as bleeding, pain, sampling error, and intraobserver/interobserver variability. The use of shear wave–based elastographic techniques has grown in use for the noninvasive assessment of fibrosis. However, shear wave elastographic (SWE) techniques also have limitations and artifacts. SWE imaging enables 2-dimensional quantitative visualization of tissue stiffness. Other approaches such as transient elastography (Echosens, Paris, France) or point-based shear wave approaches, available on several ultrasound systems, provide a single numerical stiffness estimate of a region. SWE imaging was used to characterize and contrast different artifacts and limitations between these techniques in estimating liver stiffness.

Methods: SWE imaging was used to assess liver stiffness in 204 patients (mostly hepatitis C and B) receiving biopsy and having varying levels of fibrosis and body habitus. Some of these patients also had one of the point-based shear wave techniques performed for comparison. SWE imaging and point-based approaches were acquired in different areas, including the area of the biopsy. The elastographic acquisitions were acquired prior to biopsy and compared with the resulting pathologic results using the META VIR score.

Results: Artifacts observed with SWE techniques were composed of reverberation underneath the liver capsule, pulsations around larger vasculature, and artifacts associated with respiratory and cardiac motion. Cardiac motion and reverberation artifacts were encountered consistently in left lobe liver tissue stiffness measurements. Measurement bias was difficult to appreciate underneath the liver capsule with the point-based techniques. Ultrasound-associated limitations consisted of a compromised SWE signal due to poor acoustic windows and limits in penetration.

Conclusions: SWE-based techniques are proving to be useful alternatives to liver biopsy in assessing and following fibrosis. However, care is needed in the placement and acceptance of successful liver stiffness measurements to reduce measurement variability and biases, which could lead to misleading fibrosis assessments.

Identifying Clinically Significant Prostate Cancers Using 3-Dimensional In Vivo Acoustic Radiation Force Impulse Imaging With Whole-Mount Histologic Validation

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Objectives: Overly-aggressive prostate cancer (PCA) treatment adversely affects patients and places an unnecessary burden on our health care system. The inability to identify and grade clinically significant PCA lesions is a contributing factor to excessively aggressive PCA treatment, such as radical prostatectomy, instead of more focal, prostate-sparing procedures such as cryotherapy and high-dose radiation therapy. In this study we assess the accuracy of acoustic radiation force impulse (ARFI) imaging for identifying clinically significant prostate cancer.

Methods: We have performed 3D in vivo B-mode and ARFI imaging using a mechanically rotated, side-fire endorectal imaging array to identify regions suspicious for PCA in 29 patients being treated with radical prostatectomies for biopsy-confirmed PCAs. Whole-mount histopatho-
logic analyses were performed to identify regions of clinically significant/insignificant PCa lesions, atrophy, and benign prostatic hyperplasia. Regions of suspicion for PCa were reader identified in ARFI images based on boundary delineation, contrast, texture, and location. These regions of suspicion were compared to histopathology-identified lesions using a near-est-neighbor regional localization approach.

Results: A total of 71.4% of all clinically significant lesions identified on histopathology were also identified using ARFI imaging, including 79.3% of posterior and 33.3% of anterior lesions. A total of 79.3% of ARFI-identified lesions corresponded to clinically significant PCa lesions, with these lesions having higher indices of suspicion than clinically insignificant PCa.

Conclusions: This study has demonstrated that ARFI imaging has clinical value in identifying and differentiating clinically significant PCa lesions in the posterior region of the prostate, and advances in transducer technology and modified ARFI imaging sequences should allow the anterior region of the prostate to be more reliably interrogated in future studies.

2385755 Comparison of the Accuracy of Prostate Biopsy Guided by Grayscale Ultrasound and Real-time Elastography in Patients Selected by Different Methods of Assessing Prostate-Specific Antigen in the Diagnosis of Prostate Cancer

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Objectives: To compare the accuracy of prostate biopsies guided by grayscale ultrasound (GSU) and real-time elastography (RTE) in predicting prostate cancer (PC) in men with increased levels of prostate-specific antigen (PSA) evaluated by different methods.

Methods: A total of 103 consecutive patients suspicious for prostate cancer underwent RTE-guided systematic biopsies from December 2012 to December 2013. Patients were selected in 3 groups: PSA levels between 2.5 and 10.0 ng/mL (group a), PSA density (PSAD) >0.15 ng/mL/cm3 (group b), and PSA density in the transition zone (PSADTZ) >0.35 ng/mL/cm3 (group c). Each patient enrolled in the study underwent a 12-core prostate biopsy. Six lateral prostate sectors (base, mid, and apex) were scanned for cancer suspicious areas, defined as stiffer blue using RTE and hypoechoic using GSU. Suspicious areas were sampled by a single targeted biopsy and considered representative of a defined prostate sector. If RTE or GSU did not visualize a suspicious area in a sector, the biopsy core was taken systematically. Imaging findings were correlated with histopathology. The results were compared in terms of cancer detection.

Results: Seventy-two patients were selected for group a, 45 for group b, and 46 for group c. Of the 103 patients, 41(39.8%) had PC on histopathologic examination. In the groups, we detected 21 patients in group a (20.8%), 37 in group b (35.9%), and 38 in group c (36.8%) with positive biopsy results. Overall sensitivity was 100% for each group for RTE and 71.4%, 75.8%, and 78.5% for GSU. The specificity was 41.1%, 50.0%, and 44.4% for RTE and 70.5%, 56.2%, and 66.6% for GSU. The detection rate was significantly higher in patients selected by PSAD and PSADTZ (P < 0.001). The highest positive predictive value was found in patients selected by PSAD and with biopsy guided by RTE (78.3%).

Conclusions: Sensitivity to visualize and detect PC improved using RTE in addition to GSU for guiding prostate biopsies in all groups, but with lower specificity. The detection rate was higher in patients selected by PSAD and PSADTZ, but there was no difference between these 2 groups. We concluded that targeted biopsy alone is not sufficient to replace the traditional systematic biopsy technique in patients selected by these 3 different methods of assessing PSA.

2385768 The Value of Shear Wave Elastography to Differentiate Benign From Malignant Thyroid Nodules

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Objectives: The aim of the study was to evaluate the diagnostic performance of shear wave (SW) and strain elastography (SE) and their combined use in differentiating thyroid nodules. This prospective study included 384 thyroid nodules in 183 patients, and 129 nodules had pathologic diagnoses (77 benign and 52 malignant). The purpose of this study was to evaluate the value of SE and the SW to differentiate benign from malignant thyroid nodules according to 2 criteria: (1) nodule stiffness and (2) differences in size between B-mode sonography (US) and elastography (E).

Methods: One hundred twenty-nine nodules were prospectively evaluated from September 2010 to August 2015 with high-resolution US using SW and SE with the AS-2000 (Siemens), and the diagnosis was correlated with histopathology. The nodules were grouped according to the stiffness in 5 patterns: (1) ≥60% soft; (2) ≥60% hard; (3) ≥60% intermediate; (4) same stiffness of thyroid parenchyma; (5) other combinations of stiffness. Patterns 1 and 4 were considered benign, 2 malignant, and 3 and 5 inconclusive. We also considered the finding benign if the nodule was bigger in B-mode US than E, malignant if bigger in E than B-mode US, and inconclusive if it had the same size in both.

Results: The sensitivity, specificity, positive predictive value, and negative predictive value were 84.2% (32/38), 93.6% (59/63), 88.8% (32/36), and 90.7% (59/65) using the stiffness criterion and 80.5% (29/36), 85.0% (17/20), 90.6% (59/52), and 70.8% (17/24) using the size criterion. We had 6 false negatives; all of them were papillary cancer with cystic soft content; and 4 false positives due to calcified or fibrotic benign nodules. Of 129, 28 (21.7%) nodules were classified as inconclusive by the stiffness criterion, half of them malignant, and 73 (56%) by the size criterion, 16 (22%) of them malignant.

Conclusions: SW and SE of suspicious thyroid nodules using the stiffness criterion are precise and helpful to differentiate between benign and malignant thyroid nodules, and we recommend that they be incorporated in clinical practice. The size criterion is less helpful due to many inconclusive cases despite good specificity and negative predictive value.

Gynecologic Ultrasound
Moderator: Arthur Fleischer, MD

2346589 Real-time Transvaginal Ultrasound Observation of Fallopian Tube Peristalsis in Patients With Acute Pelvic Inflammatory Disease

Ronald Wachsbreg
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Objectives: In patients with pelvic inflammatory disease (PID), a thickened fallopian tube may be the only abnormality noted on transvaginal ultrasound (TVUS). The literature states that, if an indeterminate tubular structure is noted in the adnexa, the presence of peristalsis indicates that the structure is bowel, because fallopian tube peristalsis is not discernible on TVUS. The objective of this paper is to report the real-time TVUS observation of fallopian tube peristalsis in patients with acute PID.

Methods: A 1-year retrospective review was conducted of symptomatic women in whom TVUS findings were consistent with acute PID. Patients in whom peristalsis of a thickened (>5 mm diameter) fallopian tube was observed during real-time TVUS were identified, and their imaging studies were reviewed.

Results: Peristalsis was noted in 11 thickened fallopian tubes in 10 women with acute PID. Mean thickness of the affected tube was 10.7 mm (SD, 1.8 mm). The abnormal tube was on the right side in 6 patients, on the left side in 3 patients, and bilateral in 1 patient.
Conclusions: Fallopian tube peristalsis can be observed on real-time TVUS in acute PID. Therefore, if an otherwise indeterminate tubular adnexal structure is seen on TVUS, visible peristalsis does not indicate that the structure is not a fallopian tube.

2374066 Correlation Between Transperineal Ultrasound and Urodynamic Findings in Patients With Lower Urinary Tract Symptoms After Midurethral Sling Placement
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Objectives: To evaluate dynamic 2D transperineal pelvic ultrasound (TPU) findings with urodynamic studies (UDS) in women with lower urinary tract symptoms (LUTS) after midurethral sling placement.

Methods: TPU and UDS were reviewed from women presenting to our center with a midurethral sling and LUTS from 12/2013 to 12/2014. TPU was carried out with the ultrasound probe positioned at the vaginal introitus. The midurethral sling was identified as the hyperechoic structure under the urethra. The shape and sonographic dynamic change of the sling from the rest position to maximum Valsalva and from maximum Valsalva back to rest were recorded. Patients were categorized into 3 groups: group 1 (G1), at rest the sling lies parallel to the urethral lumen, and during Valsalva this shape is maintained. For analytical purposes, G1 was compared to G2 and G3. Multiple logistic regressions were used to evaluate the association between TPU and UDS.

Results: Seventy-seven women were enrolled. There were no significant demographic differences between the groups. The detrusor pressure at the maximum flow rate (PdetMax) was significantly higher in G1 compared to G1+2 (36 ± 16 vs 19 ± 11 mm H2O; P < .001). A significant association was noted between G1 and high detrusor pressure (PdetMax > 20 mm H2O) compared to patients in G1+2. The odds of high PdetMax among those in G1 were approximately 12 times the odds of among those in G1+2. After adjusting for other variables using multiple logistic regression analysis, a statistically significant association between G1 and high PdetMax (odds ratio, 29.7; 95% confidence interval, 2.95–299.6; P < .001) persisted. Sensitivity, specificity, and positive and negative predictive values of high PdetMax in G1 were 57%, 89%, 84%, and 68%, respectively.

Conclusions: This is the first report of a correlation between 2D dynamic TPU and UDS. Transperineal dynamic 2D ultrasound can help predict women with high-pressure voiding after a midurethral sling and thus aid in the diagnosis of bladder outlet obstruction.

2374870 Emergency Department Utilization of Pelvic Ultrasound and Computed Tomographic Studies in Women Presenting With Lower Abdominal or Pelvic Pain
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Objectives: To determine which characteristics are associated with the selection of either a radiology- or emergency physician-performed ultrasound (U/S) or a computed tomographic (CT) imaging study in non-pregnant women presenting to the emergency department (ED) with lower abdominal or pelvic pain.

Methods: This was a retrospective study performed at a regional level 2 Trauma center ED from January 2013 to April 2015. Female patients with a chief complaint of diagnosis of either lower abdominal or pelvic pain who had either a radiology-performed CT scan or U/S or an archived emergency physician-performed transvaginal U/S scan were included. Patients were excluded if they had trauma or orthopedic injury, positive pregnancy, upper gastrointestinal etiologies, sepsis, known neoplastic disease, and renal etiologies. All CT and radiology-performed U/S images were interpreted by board-certified radiologists. All ED-performed U/S scans were interpreted at bedside by credentialed emergency physicians. This study received a full review and approval by the Institutional Review Board.

Results: Of the patients imaged, 49 met all eligibility requirements and were included in the study. The mean age of study participants was 32 years (range, 19–60 years). In the study population, a total of 15 CT scans, 10 radiology-performed U/S scans, and 31 emergency physician-performed U/S scans were performed. There were no discrepancies between the ED- and radiology-performed U/S reported results. Eight (53.3%) of the 15 CT scans and 27 (65.9%) of the 41 U/S scans performed were positive studies. U/S was not significantly more likely to be performed between the hours of 0800 and 2000 compared to 2000 and 0800 (30/37 [81.1%] vs 12/19 [63.2%; P = .19]). However, a history or diagnosis of vaginal bleeding was significantly associated with the performance of a U/S scan as compared to imaging by CT scan (14/15 [93.3%] vs 1/15 [6.7%], respectively; P < .05).

Conclusions: U/S imaging, especially ED physician-performed U/S, was highly utilized in our study population who presented with either lower abdominal or pelvic pain. A history of vaginal bleeding was significantly associated with the type of imaging modality selected, but time of day was not.

2383686 HDliveFlow With HDlive Silhouette Mode for Diagnosis of Uterine Disorders
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Objectives: To present our experiences with uterine disorders reconstructed using HDliveFlow with the HDlive silhouette mode.

Methods: Six cases (1 case each of uterine artery pseudoaneurysm [UAP], complete mole, and hydropic degeneration in missed abortion, and 3 cases of uterine fibroids) were studied using HDliveFlow with the HDlive silhouette mode.

Results: In cases of uterine fibroids, 3 patterns of blood flow were demonstrated. In 1 case, abundant blood flow inside the fibroid was noted. In another case, a moderate blood flow pattern was observed inside the tumor. In the third case, vascularity inside the tumor was poor, with identification of circular blood vessels around the fibroid resembling the classic belief about fibroid vascularity. A spatial view of the distribution of these vessels within the fibroid as well as their relation to clearly seen uterine vasculature was achieved. In the case of hydropic degeneration on missed abortion, several small vesicles surrounded by the abundant uterine blood flow were clearly seen, while the numerous vesicles without blood flow in the uterine cavity formed the characteristic shape of a complete mole. In the case of UAP, a spatial “yin-yang sign” or “shell-like appearance” with identification of the feeder artery was visualized.

Conclusions: HDliveFlow with the HDlive silhouette mode should provide new insight into the patterns of vascularity in different uterine disorders. This would be beneficial in diagnosing and differentiating these lesions and therefore providing proper management.
2384737 Surgical Correction of Uterine Subseptations Reestablishes Standard Uterine Cavity Measurements
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Objectives: Existing ultrasound guidelines identify the uterus as normal if its length is 8 cm, height is 4 cm, and width is 5.0 cm; however, there is no clear definition of the normal uterine cavity dimensions. Our group previously defined the uterine and uterine cavity dimensions of subseptate uteri and their postoperative uterine remodeling. With this study we sought to define the uterine cavity dimensions of normal uteri with 3D ultrasound and compare them to those obtained in subseptate uteri before and after hysteroscopic surgical resection.

Methods: This was a prospective cohort study. Measurements of the cavity width, length, and area were obtained with 3D ultrasound on a frozen coronal view of the uterus in normal and in subseptate uteri before and after surgical resection by hysteroscopy. Paired and unpaired t tests were used for comparisons (SPSS version 22).

Results: One hundred eighty patients were included in the study: 90 in the normal and 90 in the subseptate uterus groups. Preoperative uterine length and height were similar in the preoperative and postoperative subseptate uterus and in the normal uteri, while uterine width was significantly greater in the preoperative (5.1 ± 0.8 cm) than postoperative (4.7 ± 0.9 cm) groups and normal uteri (4.6 ± 0.7 cm; P < .001). The preoperative uterine cavity length (3.4 ± 0.5 cm), width (3.2 ± 0.7 cm), and area (4.6 ± 1.4 cm²), were significantly greater than the postoperative ones (length, 2.9 ± 0.6 cm; width, 2.6 ± 0.7 cm; area, 3.8 ± 1.1 cm; overall P < .015), which became similar to the normal uteri (length, 3.1 ± 0.6 cm; width, 2.6 ± 0.6 cm; area, 4.0 ± 1.4 cm²; P = not significant).

Conclusions: To our knowledge, this is the first study to define the 3D ultrasound dimensions of the uterine cavity in normal and subseptate uteri and their change after surgical correction. Uterine cavity length, width, and area show very little variation in adult normal uteri, but they are increased in subseptate uteri. Once surgical correction occurs, the cavity remodels to regain a shape and size similar to normal uteri.

2388879 A Tale of Two Hospitals
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Objectives: Maternal birth trauma has become an increasing concern in recent years. Our aim was to determine the association between variations in obstetric practice between two tertiary hospitals and such trauma. Primary outcome measures were sonographic levator ani muscle (LAM) avulsion and external anal sphincter (EAS) trauma.

Methods: This was a secondary analysis of a prospective study on 660 women with an uncomplicated singleton pregnancy. Offline analysis of ultrasound (US) volume data was performed blinded against all other data. Avulsion was defined as a gap of ≥30° in its circumference, in at least 4 of 6 central tomographic (TUI) slices. A “significant EAS defect” is defined as a gap of ≥30° in its circumference, in at least 3 central tomographic (TUI) slices. A “significant EAS/IAS defect” on using the published tomographic method seems very low. EAS/IAS defects can be assessed with good repeatability by translabial 3D/4D ultrasound. The likelihood of a false-positive diagnosis of a “significant defect of EAS/IAS” on using the published tomographic method seems very low.

Results: Of 660 women recruited, 504 (76%) returned for postpartum review at a mean interval of 5.1 (range, 2.3–22.4) months. Two were excluded, due to missing postpartum US volumes in 1 and an intercurrent birth in another, leaving 502. Assessment of avulsion was possible in all women. Assessment of EAS integrity was possible in 488. Of the 502 women, 116 (23%) were delivered by cesarean section; 386 (77%) delivered vaginally, by normal vaginal delivery in 280 (56%), vacuum in 70 (14%), and forceps in 36 (7%). We evaluated the incidence of maternal trauma in those delivered vaginally. There was a significant difference in the incidence of LAM avulsion (Table 1). On multivariate binary logistic regression modeling, the association between delivery centers and incidence of LAM avulsion became nonsignificant. Body mass index (BMI), length of the second stage, and forceps delivery were predictors of the difference in the incidence of LAM avulsion between the hospitals, with forceps delivery being the strongest (adjusted odds ratio [OR], 5.2; 95% confidence interval [CI], 2.3–12.1; P = .001).

Conclusions: We found a significant difference in the incidence of LAM avulsion between two tertiary centers, explained by the differences in maternal BMI, length of the second stage, and rate of forceps, the latter being the strongest predictor of LAM avulsion.

Table 1. Incidence of Maternal Birth Trauma in Two Tertiary Obstetric Units

<table>
<thead>
<tr>
<th></th>
<th>Hospital A (n = 165)</th>
<th>Hospital B (n = 221)</th>
<th>OR (95% CI)</th>
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<tr>
<td>Levator avulsion</td>
<td>19/165 (11.5%)</td>
<td>47/221 (21.3%)</td>
<td>2.1 (1.2–3.7) .01</td>
</tr>
<tr>
<td>EAS defect</td>
<td>32/159 (20.1%)</td>
<td>53/217 (24.4%)</td>
<td>1.3 (0.8–2.1) .33</td>
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2388892 Normal Values of Anal Sphincter Biometry by 4-Dimensional Pelvic Floor Ultrasound
Julie Magpoc, Ixora Atan, Hans Dietz,*
University of Sydney, Penrith, New South Wales, Australia

Objectives: Translabil ultrasound (TLUS) can provide a noninvasive alternative to endoanal ultrasound in the investigation of obstetric anal sphincter trauma. We aimed to define limits of normality for dimensions of external and internal anal sphincters (EAS and IAS).

Methods: This study involved primigravid women seen prospectively for 4D TLUS at a mean gestation of 36 (range, 32.9–37.3) weeks. TLUS was performed supine at rest and on pelvic floor muscle contraction (PFMC). Offline analysis of volume data was done blinded against all other data. Sphincter assessment was performed on tomographic ultrasound imaging (TUI). EAS length (ventral and dorsal) was measured in the mid sagittal plane. EAS thickness was measured at the 12- and 6-o’clock positions in the axial plane. EAS rotational asymmetry was defined as the distance between ventral and dorsal EAS cranial terminations, measured in the midsagittal plane at maximal PFMC.

Results: A test-retest series (n = 20) showed good repeatability of all measures (intraclass correlation coefficient, 0.62–0.85). One hundred twelve women were seen. One was excluded due to missing volume data, leaving 111. The majority were Caucasian (n = 77 [69%]) with a mean age of 30.9 (range, 18.8–40.5) years. On TUI, EAS defects were noted in 12% (n = 13), affecting a maximum of 3/6 slices. IAS defects were noted in 7% (n = 8) in a maximum of 3 slices. None of the 111 women fulfilled published minimal criteria for the diagnosis of significant IAS/EAS defects. Mean measured EAS length was 17.5 (range, 8.4–34.8) mm. The EAS was shorter dorsally at a mean length of 16.4 (range, 7–32.7) mm compared to ventral EAS length of 18.7 (range, 7.5–36.9) mm (P < .001). The mean difference in EAS length was 2.3 (range, –6.4–9.7) mm. The ventral EAS was observed to reach further cranially than the dorsal EAS, resulting in a positive mean rotational cranial asymmetry of 0.8 (range, –4.8–5.1) mm. Mean EAS thickness was 3.4 (range, 2.0–5.8) mm, being thicker dorsally (P < .001). IAS thickness did not vary much.

Conclusions: Sonographic measures of sphincter biometry can be assessed with good repeatability by translabil 3D/4D ultrasound. The likelihood of a false-positive diagnosis of a “significant defect of EAS/IAS” on using the published tomographic method seems very low.
Mean body mass index was 29 (range, 18–29; SD, 6.13) kg/m². Fifty-nine
patients and examiners.

Results: Mean age was 58 (range, 17–89; SD, 13.48) years. Mean body mass index was 29 (range, 18–29; SD, 6.13) kg/m². Fifty-nine percent (n = 103) presented with symptoms of prolapse. Clinically, 83% (n = 146) had significant prolapse of ICS stage 2 and above in any compartment. Offline measurements of cystocele, uterine descent, descent of the rectal ampulla, and hiatal area on Valsalva were undertaken at a later date, blinded against all other data. Measurements were performed on volume data sets obtained on maximal Valsalva in the supine and standing positions.

Conclusions: Measurements of organ descent on Valsalva and hiatal dimensions in the standing position are generally higher than supine. The association between symptoms and organ descent is significantly stronger in the standing position, but we feel that the difference is not sufficient to warrant the additional effort that is required for patients and examiners.

| Table 1. Pelvic Organ Descent and Hiatal Area on Valsalva in Supine and Standing Positions |
|---------------------------------------------|-------------|-----------------|-----------------|
| Supine, Mean (SD) | Standing, Mean (SD) | Difference, t (95% CI) | P |
| Cystocele, mm     | –3.4 (17.30) | –8.72 (16.69) | 5.33 (3.54 to 7.11) | <.001 |
| Uterine descent, mm | 7.74 (19.35) | 3.38 (19.86) | 4.36 (1.23 to 7.49) | .007 |
| Descent of rectal ampulla, mm     | –9.1 (12.78) | –11.21 (11.66) | 2.11 (0.27 to 3.95) | .03 |
| Hiatal area on Valsalva, cm²       | 28.11 (8.69) | 33.68 (9.84) | –5.57 (–6.39 to <.001) | <.001 |

CI indicates confidence interval.

Objectives: Transabdominal ultrasound (TUS) is an accurate and noninvasive method to assess the pelvic floor but not commonly used in current obstetric practice. This study evaluates sonographic signs of pelvic floor injury using TUS in women who used a novel semiautomated pelvic floor dilator during the active phase of labor.

Conclusions: Four-dimensional TUS can be used to identify and characterize delivery-related pelvic floor injuries in pregnant and postpartum women.

2385262 Heterotopic Pregnancy: Case Series and Review of the Literature

Usha Verma, Juliana Martins*

Obstetrics and Gynecology, University of Miami, Miami, FL USA

Objectives: To report early diagnosis, management, and outcomes of 13 cases of heterotopic pregnancies from 2004–2015 at Jackson Memorial Hospital, Miami.

Results: Of all cases, 50% were in vitro fertilization pregnancies, and the rest were spontaneous conception. Of 13 heterotopic pregnancies, 8 were cervical, 2 were tubal, 2 were in the cesarean section scar, and 1 was interstitial in association with an intrauterine pregnancy. Four patients were lost to follow-up, 2 continued pregnancy until later gestation, 3 had pregnancy loss in the second trimester, 3 terminated both pregnancies, and 1 is still pregnant. Patients whose fetuses had cardiac activity in the ectopic pregnancy were successfully treated with potassium chloride, 3 patients received methotrexate as they wanted to terminate both pregnancies, 1 patient had no treatment with spontaneous resolution, and 2 had surgical treatment for ectopic pregnancy.
at 45 mm. Human-subject scans revealed images of the full globe, at 4 frames per second and 55-dB dynamic range, including features in the vitreous that would not normally be resolved.

Conclusions: An ophthalmic system using an annular array packaged in a handheld probe was demonstrated for clinical use on human subjects. Higher frame rates and signal-to-noise ratios are feasible, but the selected handheld probe was a limiting factor. The ability to image the full globe, including the vitreous, will open up new methods of diagnosis.

Conclusions:

Objectives: To characterize sentinel lymph nodes (SLNs) in a melanoma swine model using molecular imaging with dual-targeted contrast-enhanced ultrasound (CEUS).

Methods: Six Sinclair swine with naturally occurring melanoma (3–7 kg; Sinclair Bio-Resources, Columbia, MO) were studied.

Studies were performed on human subjects. Higher frame rates and signal-to-noise ratios are feasible, but the selected handheld probe was a limiting factor. The ability to image the full globe, including the vitreous, will open up new methods of diagnosis.

Conclusions: An ophthalmic system using an annular array packaged in a handheld probe was demonstrated for clinical use on human subjects. Higher frame rates and signal-to-noise ratios are feasible, but the selected handheld probe was a limiting factor. The ability to image the full globe, including the vitreous, will open up new methods of diagnosis.

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Conclusions: Successful management of heterotopic pregnancy remains a challenge given the lack of current guidelines. The principle remains the safe and effective removal of the ectopic pregnancy while protecting the intrauterine pregnancy and preserving fertility. A sonographer may be falsely reassured by visualization of an intrauterine gestation, and an adnexal mass can be interpreted incorrectly as a corpus luteum cyst. This diagnosis should be considered in any patient with risk factors, and a careful ultrasound examination of the uterus and adnexa should be performed to allow early detection and management. The treatment approach should be tailored such as not to jeopardize the intrauterine pregnancy.

High-Frequency and Contrast-Enhanced Ultrasound
Moderator: Jonathan Mamou, PhD

2380525 Acoustic Impedance of Bowman’s Layer as a Possible Indication of Keratoconus
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1Ophthalmology, Columbia University Medical Center, New York, NY USA; 2London Vision Clinic, London, United Kingdom; 3Riverside Research, New York, NY USA

Objectives: Keratoconus (KC) is a disease characterized by progressive corneal thinning and reduced corneal rigidity, leading to loss of visual acuity and possibly eventual corneal transplant to salvage the eye. At present, most techniques for identification of KC are based on anatomy, eg, surface topography or pachymetry. Bowman’s layer, a 12-15-µm thick basement membrane at the interface of the epithelium and stroma, is known to thin and have altered collagen fibers in early KC, changes that may be causative. In this study, we investigated Bowman’s layer acoustic impedance, a property related to biomechanics rather than anatomic structure.

Methods: Both eyes of 12 normal and 12 KC subjects were scanned with the Artemis arc-scan system at 55 MHz. Artemis acquires a radial set of scans while maintaining normality and range to the corneal surface. We treated the anterior surface of the cornea (the epithelium) as a specular reflector and deconvolved the radiofrequency data against this signal along each vector. Impedance was determined as Bowman’s reflectivity relative to that of the epithelial surface.

Results: Results showed that in normal corneas, Bowman’s relative impedance (Zbr) was quite uniform in distribution, even where epithelial thickness was nonuniform. Interestingly, we found that, in normal corneas, while Zbr varied from subject to subject, it was always the same in both eyes of a given subject. Zbr, however, was nonuniform in KC corneas, showing significantly elevated values paracentrally.

Conclusions: Acoustic impedance of Bowman’s layer is nonuniform in KC. Further investigation is required to determine the utility of this parameter as a means for identification of early KC.

2385414 Handheld Real-time 20-MHz Ophthalmic Imaging With an Annular Array
Jeffrey Ketterling1,*, Daniel Gross1, Jonathan Mamou1, Kathleen Smith2,3, Quan Hoang2, Ronald Silverman1,2
1Lizzi Center for Biomedical Engineering, Riverside Research, New York, NY USA; 2Ophthalmology, Harkness Eye Institute, Columbia University Medical Center, New York, NY USA; 3Örebro University, Örebro, Sweden

Objectives: Single-element ultrasound systems are the standard for clinical ophthalmic imaging. Annular arrays permit image quality of a linear array without the system complexity and cost. Here, improvements were made to a previous immersion scan prototype. The new system employs a handheld probe with a 20-MHz annular array that permits contact scanning.

Methods: A commercial handheld probe was modified so that a custom 5-element annular array could be mounted inside the probe. The array was based on a 25-µm P(VDF-TrFE) membrane with a focal length of 25.8 mm and an aperture of 9 mm. The array was excited with a 5-channel pulser/receiver, and a 4-channel PCIe digitizer card recorded the echo signals for real-time image formation. The elements had a 22-MHz center frequency and ~37% ~6-dB fractional bandwidth. Acoustic pressures of each array element were characterized to ensure safe operating limits, and the acoustic beam was evaluated using a 25-µm-diameter wire target. The cabling to the array elements was routed through a water-tight channel that was part of an attachment that slid over the end of the handheld probe. The attachment could be sealed with a membrane to create a water-tight chamber inside which the array translated. The membrane was then placed in contact with the eye for an ultrasound exam.

Results: Peak acoustic pressures were within 510k safety limits (mechanical index <0.14 and spatial-peak pulse-average intensity <5.5 W/cm²). The array was used in a synthetic-focusing mode with single-transmit to multiple-receive combinations. Due to limitations with the probe, frame rate and time intervals between scan lines, only 3 elements (1, 3, and 5) were used on transmit and 4 on receive (1–4). Beam widths measured with the wire target ranged from 0.16 mm at 16 mm to 0.42 mm at 15 mm.

plane wave imaging methods for imaging the eye that would address the above limitations of mechanically scanned single-element probes and conventional linear arrays.

Methods: We measured ultrasound intensity as a function of range and excitation voltage for a Verasonics L22-14v high-frequency probe using a needle hydrophone calibrated to 60 MHz. Measurements were made in the scanned, focused mode (focal ratio) and in the plane wave mode. Using parameters compatible with Food and Drug Administration (FDA) ultrasound exposure limits for the eye, coherent plane wave scans were performed on human subjects through both closed and open lids using the L22 probe with the Verasonics Vantage-128 system. Plane wave Doppler was used to capture blood flow.

Results: With 15-V excitation, derated spatial-peak pulse-average intensities (I感人) recorded at the elevation focus (~7 mm) were 318 and 27.4 W/cm² for focused and plane wave modes, respectively. Corresponding mechanical index values were 0.87 and 0.22 for focused and plane wave modes. Plane wave values at this voltage were just within the FDA limits for the eye. Scans performed with compound coherent plane wave (~5 angles over ±18° at 500 Hz/image) readily demonstrated blood flow in the major orbital vessels, the choroid, and retinal vessels. (Derated spatial-peak temporal-average intensity [I感人]) was within FDA guidelines at this frame rate.)

Conclusions: Compound coherent plane wave imaging allows depiction of anatomy and perfusion at acoustic intensity values compliant with stringent FDA requirements for ophthalmic imaging, which was not the case for the conventionally focused array at the same voltage. This modality will have immediate research and clinical applications in conditions such as glaucoma and macular degeneration.

2384224 Twenty-Megahertz Coherent Compound Plane Wave Imaging of the Eye
Ronald Silverman1,2,*, Raksha Urs1, Daniel Gross2, Jeffrey Ketterling2
1Ophthalmology, Columbia University Medical Center, New York, NY USA; 2Riverside Research, New York, NY USA

Objectives: Ophthalmic ultrasonography is almost exclusively performed using mechanically scanned, single-element transducers. This limits image rates to <20 Hz and precludes Doppler or color flow imaging. High frame rates are useful for capturing saccade-induced vitreous motion and blood flow. While conventional linear arrays can address these needs, acoustic intensity is often too high to meet the ophthalmic 510k standard, the most stringent for any organ. Our objective was to develop
Results: Four variables were included in the logistic regression models: age, shape, blood flow distribution, and enhancement pattern. The area under the receiver operating characteristic curve was 0.919. With 0.113 selected as the cutoff value, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 90.5%, 82.1%, 89.1%, 84.2%, and 87.3%, respectively. Independent risk factors for TMC determined with the combination of CEUS and conventional US were age, shape, blood flow distribution, and enhancement pattern. Age was negatively correlated with malignancy, whereas shape, blood flow distribution, and enhancement pattern were positively correlated.

Conclusions: The logistic regression model involving CEUS and conventional US was found to be effective in the diagnosis of subcentimeter thyroid nodules.

Pediatric Ultrasound and Neurosonology
Moderator: Rob Goodman, MD, BCHir

2367190 Validation of a Low-Cost Optic Nerve Sheath Phantom: An Educational Tool
David Murphy1,*, Stephanie Oberfoell2, Andrew French2, Stacy Trent2, David Richards2
1University of Colorado, School of Medicine, Aurora, CO USA; 2Emergency Medicine, Denver Health Medical Center, Denver, CO USA

Objectives: We developed an easily replicable, low-cost optic nerve sheath (ONS) phantom that simulates in vivo posterior ocular anatomy to facilitate ocular ultrasound training. The objective of this study was to validate an ocular phantom as a realistic educational tool utilizing in vivo and phantom ONS images obtained by ultrasound.

Methods: This prospective study enrolled 51 residents from the Denver Health residency in emergency medicine (EM) and 10 ultrasound fellowship-trained EM attendings. Subjects performed ONS diameter (ONSD) measurements in 5 in vivo and 5 phantom ocular ultrasound images and rated the reality of each image on a 5-point Likert scale. In vivo and phantom measurement precision was compared by estimating intraclass correlation coefficients (ICCs). $\chi^2$ analysis was performed to evaluate the subjective “realness” of in vivo and phantom images.

Results: Sixty-one participants performed ONSD measurements. Mean Likert scale values were 3.43 (95% confidence interval [CI], 3.31–3.55) for in vivo images and 3.41 (95% CI, 3.28–3.54) for phantom images. There was no difference in subjective “realness” between in vivo and phantom ONSD ultrasound images among EM residents. Ultrasound fellowship-trained EM attendings aptly differentiated between in vivo (P < .01) and phantom (P < .01) images, as compared to EM residents (Table 1). Composite ICCs for in vivo and phantom images were 0.75 (95% CI, 0.59–0.91) and 0.85 (95% CI, 0.66–0.98), respectively, among all EM physicians.

Conclusions: Ultrasound operators exhibit similar inter-rater reliability among in vivo and phantom ONSD measurements. Our ocular phantom simulates in vivo posterior ocular anatomy. EM residents found the phantom indistinguishable from in vivo images. Our ONS phantom model provides an inexpensive and realistic educational tool to teach bedside ONSD sonography.

Table 1. Intraclass Correlation Coefficient of ONSD by Type of Eye

<table>
<thead>
<tr>
<th>ICC (95% CI)</th>
<th>In Vivo ONSD</th>
<th>Phantom ONSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>All physicians</td>
<td>0.70 (0.59–0.98)</td>
<td>0.85 (0.66–0.98)</td>
</tr>
<tr>
<td>Ultrasound fellowship trained</td>
<td>0.79 (0.53–0.97)</td>
<td>0.83 (0.59–0.98)</td>
</tr>
<tr>
<td>EM residents (postgraduate years 1–4)</td>
<td>0.61 (0.35–0.93)</td>
<td>0.85 (0.66–0.98)</td>
</tr>
</tbody>
</table>

2384790 Fetal Intracranial Magnetic Resonance Imaging in Complicated Monochorionic Multiple Gestations Undergoing In Utero Therapy
Sherelle Laifer-Narin1,*, Russell Miller2, Lynn Simpson2
1Radiology, Columbia University Medical Center, New York, NY USA; 2Obstetrics and Gynecology, Columbia University, New York, NY USA

Objectives: Monochorionic multiple gestations are at risk for specific complications as a result of uneven distribution of a common placenta or shared placental circulation, with examples including unequal placental sharing (UPS), twin-twin transfusion syndrome (TTTS), and single twin demise. Fetoscopic laser therapy and radiofrequency ablation (RFA) are procedures that are utilized for severe UPS and TTTS presentations, respectively. Fetal magnetic resonance imaging (MRI) has been utilized to assess for intracranial hemorrhage and/or ischemia in viable twins following these procedures.

Methods: This descriptive series is a retrospective study from April 2008 to August 2015 evaluating the utility of fetal MRI to detect intracranial hemorrhage and/or ischemia following laser or RFA therapy for complicated monochorionic gestations.

Results: A total of 70 cases were identified, including 37 post-laser and 33 post-RFA pregnancies. There was 1 set of monochorionic/di-amniotic triplets in each group. The time interval range between the interventional procedure and fetal MRI was 3 days to 3 weeks. Gestational age at MRI ranged from 20 to 23 5/7 weeks. A single case of unilateral germinal matrix hemorrhage (1/33) was identified in the cohort of cases that underwent RFA. No abnormalities were seen in the remainder of RFA survivors. Thirty-seven monochorionic gestations were assessed in the post-laser MRI group, with 13 fetuses (12 twins/1 triplet) excluded due to in utero demise. Within the subgroup of single fetal demise, there was a single case of unilateral germinal matrix hemorrhage (1/13). In 12/13 cases with single fetal demise (11 twins, 2 triplets) there were no abnormal MRI findings. In 24 post-laser pregnancies without in utero demise, intracranial MRI was normal for 48 twins.

Conclusions: Fetal MRI demonstrated a low rate of neuroanatomic abnormalities in this cohort of fetuses who underwent in utero intervention for complications due to monochorionic status.

2373783 Sonographic Detection of Accessory Adrenal Tissue in Neonates
Daniel Mordechay1,*, Avisa Ben-Shlush1, Lisa Raviv-Zilka1,2, Jeffrey Jacobson2, Michelle Soudack1,2
1Diagnostic Imaging, Chaim Sheba Medical Center at Tel Hashomer, Ramat Gan, Israel; 2Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

Objectives: Accessory adrenal glands are developmental anomalies that occur when a small fragment breaks off from the parent adrenal gland during intratuteren life. Depending on what embryonic stage the fragmentation occurred, the fragment may be found at the gland’s origin in the region of the celiac axis, embedded in the liver or kidney, in the suprarenal area, or it can migrate with the gonads as they descend into the pelvis or scrotum. The majority of accessory tissues are discovered incidentally during autopsy or surgery. There are numerous reports describing them in anatomic and surgical publications, in conjunction with adrenal tumors or cortical hyperplasia, or mimicking tumors in other organs. Our search of the English literature did not find any reports of accessory adrenal tissue detected sonographically near the parental gland. The objective of this presentation is to describe the incidence and appearance of accessory adrenal tissue in neonates, as diagnosed by high-resolution ultrasound, and increase the awareness of this entity.

Methods: We examined the adrenal glands in 153 neonates referred for renal and urinary tract ultrasound at our institution between January 2014 and January 2015. All kidneys and adrenal glands, except for
ectopic kidneys, were scanned with the infant prone and a linear array transducer with a frequency of 12 or 14 MHz.

**Results:** In 9 (5.8%) neonates, ultrasound identified a unilateral, small, well-defined round or slightly oval structure in the suprarenal area, measuring 2.9–4.5 mm and separate from the parent gland in all scan planes. In 1 neonate, the structure was slightly embedded into the upper pole of the right kidney. All structures had a hyperechoic center surrounded by a hypoechoic periphery, resembling the echogenicity of the normal neonatal adrenal, and were diagnosed as accessory adrenal tissue. On follow-up studies, available for 7 infants, these structures were not evident, and the suprarenal area was normal.

**Conclusions:** Accessory adrenal tissue can be identified in the suprarenal area in neonates with high-resolution ultrasound. Radiologists and sonographers caring for infants should be aware of this finding and not confuse it with pathology.

2380220 The Hair Follicle Sign: An Ultrasound Finding to Help Make the Diagnosis of Proliferatricomas in Children
Anand Majmudar, Louis Parvey, Harris L. Cohen
Radiology, Lebonheur Children’s Hospital, Memphis, TN USA

**Objectives:** To describe an additional sign that can help diagnose a pilomatricoma among the other subcutaneous masses.

**Methods:** Two cases diagnosed by ultrasound (US) and proven to be pilomatricomas using a high-frequency linear array transducer.

**Results:** A 7-year-old female with a right temple mass and a 6-year-old boy with a left eyebrow mass underwent US diagnosis. In both cases, a linear echogenic hair follicle was noted to extend into the mass, which contained scattered calcification and had an echogenic border. This finding helped point to the suggested and proven diagnosis of pilomatricoma.

**Conclusions:** The hair follicle sign helps cement the diagnosis by US of pilomatricoma.

2384900 Accuracy of Point-of-Care Lung Ultrasonography for Diagnosis of Acute Chest Syndrome in Pediatric Patients With Sickle Cell Disease and Fever
Dina Daswanhi, Vaishali Shah, Jeffrey Avner, Deepa Manwani, Jessica Kurian, Joni Rahiner
1Pediatrics, Division of Pediatric Emergency Medicine, 2Pediatrics, Division of Pediatric Hematology and Oncology, 3Radiology, Division of Pediatric Radiology, Children’s Hospital at Montefiore, Albert Einstein College of Medicine, Bronx, NY USA; 4Pediatric Emergency Medicine, Children’s Hospital of New Jersey, Newark Beth Israel Medical Center, Newark, NJ USA

**Objectives:** To determine the test performance characteristics for point-of-care lung ultrasonography (LUS) performed by pediatric emergency medicine (PEM) physicians compared with radiographic diagnosis of acute chest syndrome (ACS) in patients with sickle cell disease (SCD) and fever.

**Methods:** This was a prospective study of patients up to 21 years with SCD and fever requiring chest x-ray (CXR) evaluation of ACS. Before obtaining CXR, a blinded PEM physician performed LUS using a standardized scanning protocol. Positive LUS for ACS was defined as lung consolidation. All patients received CXR and follow-up. The gold standard for ACS was consolidation on CXR as determined by a blinded radiologist. LUS clips were reviewed by a blinded expert PEM sonologist.

**Results:** One hundred sixteen febrile events from 91 patients with a mean age of 6.6 years were enrolled by 15 PEM sonologists. CXR was positive for ACS in 15 (13%) patients, and LUS was positive for ACS in 19 (16%) patients. Positive LUS had sensitivity of 87% (95% confidence interval [CI], 62%–96%), specificity of 94% (95% CI, 88%–97%), a positive likelihood ratio of 14.6 (95% CI, 6.5–32.5), and a negative likelihood ratio of 0.14 (95% CI, 0.04–0.52) for ACS. The interobserver agreement (k) was 0.77. Use of LUS would reduce radiography in 84% of patients but would miss 2 cases of ACS.

**Conclusions:** LUS is highly sensitive and specific for diagnosis of ACS in pediatric patients with SCD and fever. LUS may reduce the need for routine CXR and associated ionizing radiation exposure in this population.

2385835 Likelihood of Thyroid Cancer in Children
Hope Peters, Danielle Richman, Stephen Huang, Peter Doubilet, Carol Benson, Mary Frates
1Radiology, Brigham and Women’s Hospital, Boston, MA USA; 2Endocrinology, Boston Children’s Hospital, Boston, MA USA

**Objectives:** To determine the likelihood that a thyroid nodule in the pediatric population is malignant based on demographic and sonographic characteristics.

**Methods:** We identified all thyroid nodules with a maximum diameter of at least 10 mm in patients under 22 years of age undergoing ultrasound-guided fine-needle aspiration between January 2004 and October 2013. We recorded age and gender for each patient. For each nodule, we recorded size in 3 dimensions, location, composition (degree cystic vs solid), whether or not it was solitary (defined as no other nodule >5 mm in diameter), and pathologic diagnosis.

**Results:** We identified 180 nodules in 128 patients. Patient ages ranged from 2–21 years; 102 (79.7%) were female, and 26 (20.3%) were male. Multiple nodules were present in 48 (37.5%) patients, while a solitary nodule was identified in 80 (62.5%). Nodule location was closely divided between the right lobe (49.7%) and the left lobe (44.6%), with 5.6% located in the isthmus. Of 152 nodules with known pathology, 24 (15.8%) were malignant, and the majority of cancers were papillary (22 of 24 [91.7%]), including 3 diffuse sclerosing variant. Malignancy rates between sexes were similar (7/28 [25%] in boys and 17/110 [15.5%] in girls; P = .26, Fisher exact test). All malignant nodules were found in patients age 13 years or older (P = .07). Nodules less than 50% cystic were more likely to be cancerous when compared to nodules greater than 50% cystic (22/101 [21.8%] vs 2/35 [5.7%], P = .02, Fisher exact test).

**Conclusions:** In the pediatric population with thyroid nodules at least 1 cm in maximum diameter, predominantly solid nodules are more likely to be malignant than predominantly cystic ones.

558
American Institute of Ultrasound in Medicine Proceedings

**SCIENTIFIC SESSIONS**
**MONDAY, MARCH 21, 2016, 11:00 AM–12:30 PM**

**Contrast-Enhanced Ultrasound**
**Moderator: Andrej Lyschik, MD, PhD**

2385516 Quantitative Assessment of Tumor Perfusion During Sonoporation: Predicting Drug Uptake in Tumors
Shashank Sirsi
Bioengineering, University of Texas, Dallas, TX USA

**Objectives:** Over the last decade, microbubble contrast agents have frequently been cited as promising vehicles for targeted drug delivery applications. Microbubbles are gas-filled spheres between 1–10 µm in diameter that circulate in the bloodstream when injected systemically. When insonified under specific ultrasound (US) conditions, microbubbles can alter vascular permeability by a technique called “sonoporation.” In this study, we develop a novel technique to simultaneously monitor tumor perfusion in 3D and apply sonoporation to enhance tumor drug delivery. We expect that this technique will be useful for predicting drug delivery efficacy in tumors using quantitative perfusion imaging techniques.

**Methods:** Matrigel plugs (BD Biosciences, Franklin Lakes, NJ) were used as mock tumors that promote neovascular growth when injected subcutaneously in CD-1 mice. The vasculature was allowed to grow for 10–14 days, and tumor perfusion was assessed using a Verasonics Vintage imaging scanner with a custom 3D probe. After perfusion imaging, Matrigel plugs were sonoporated using at 0–3 W/cm² (1 MHz, 10% duty cycle) for 10 minutes with a high dose of microbubbles (1 × 10⁹ microbubbles) mixed with 5 mg of fluorescein isothiocyanate (FITC)-dextran (Sigma Aldrich, 3–5 kDa). Matrigel plugs were imaged again using US to monitor changes in perfusion and then excised to evaluate drug uptake by dissolving the plugs (Dispase; BD Biosciences) and quantifying FITC-dextran uptake.

**Results:** Matrigel sonoporation demonstrated significantly higher levels of FITC-dextran uptake with increasing US intensity. No significant differences in contrast volumes were detected at any US intensity; however, contrast agent reflow rates were inversely correlated with FITC-dextran uptake.

**Conclusions:** Currently we are able to demonstrate significantly improved drug uptake in mock tumors using US-mediated sonoporation. In this study, we expect that quantitative 3D perfusion imaging could be used to predict levels of drug uptake in tumors, which would have a significant clinical impact for designing tailored drug treatment regimens for patients.

2376902 A Novel Contrast-Enhanced Ultrasound Classification System for Solid and Cystic Renal Masses
Jessica Zarzour1,* Janelle West1, Eric Turner1, Bradford Jackson1, Mark Lockhart1, Michelle Robbin1
1Radiology, University of Alabama, Birmingham, AL USA; 2University of Alabama, Birmingham, AL USA

**Objectives:** To evaluate a new classification system in solid and cystic renal masses using contrast-enhanced ultrasound (CEUS).

**Methods:** This Institutional Review Board–approved retrospective study evaluated all patients who underwent CEUS from 2006–2015. Cystic renal lesions were classified according to the Bosniak computed tomographic (CT) classification and CEUS equivalent. Renal lesions were also classified utilizing a newly created system: class A, simple cysts; class B, cysts with nonenhancing or minimally enhancing thin septations; class C, solid enhancing neoplasms. The x coefficient was calculated to determine inter-rater agreement between Bosniak CT and CEUS classifications. Accuracy of CEUS was analyzed and compared with the histologic or follow-up final diagnosis.

**Results:** A total of 134 renal lesions were reviewed, with 108 lesions indeterminate by prior imaging. The mean lesion size was 2.9 cm (SD, 1.8). When comparing the Bosniak CT classification with the CEUS equivalent of the Bosniak classification system, the x coefficient was 0.68 (P < .0001). When comparing the Bosniak CT classification system with the new CEUS classification, the x coefficient was 0.86 (P < .0001), suggesting very high agreement. Of the 108 renal lesions indeterminate by prior imaging, 79.6% were given definitive diagnoses via CEUS evaluation (95% confidence limits, 0.71, 0.88; P < .0001). Of the 24 lesions classified by CEUS as class B or C, 22 went on to pathologic diagnosis. Sensitivity was 100% (P < .0001), positive predictive value was 0.91 (P < .0001), and accuracy was 90.1% of the lesions with histology. Based on follow-up (mean, 339 days) and pathology, sensitivity was 100% (P < .0001), specificity was 65% (P = .2), positive predictive value was 0.74 (P = .01), and accuracy was 82.6%.

**Conclusions:** This novel CEUS classification system and Bosniak classification system show good agreement. The CEUS classification system is highly sensitive for characterization of small renal masses.

2360546 Two- and Three-Dimensional Contrast-Enhanced Ultrasound Monitoring of Renal Cell Carcinoma Recurrence After Cryoablation
John Eisenbrey1,*, Maria Stanczak1, Andrej Lyschik1, Colette Shaw2, Ji-Bin Liu2, Costas Lallas2, Eduard Trabulsi2, Flemming Forsberg3
1Radiology, Urology, Thomas Jefferson University, Philadelphia, PA USA

**Objectives:** Following cryoablation of renal cell carcinoma (RCC), active surveillance using contrast-enhanced magnetic resonance imaging (MRI) or computed tomography (CT) may be limited by contrast media contraindications. This study investigated the use of 2D and 3D contrast-enhanced ultrasound (CEUS) to monitor RCC recurrence after cryoablation.

**Methods:** Patients scheduled for MRI or CT follow-up of a previously cryoablated RCC mass within the last 8 months to 3 years provided informed consent to undergo a CEUS exam. Imaging was performed using a GE LOGIQ E9 scanner with C1-5 and RAB2-5 probes (GE Healthcare, Milwaukee, WI). Following baseline imaging, patients received a 1-mL bolus injection of the ultrasound contrast agent Optison (GE Healthcare, Princeton, NJ) followed by a 10-mL saline flush during 2D imaging using the scanner’s coded harmonic imaging package. After 10 minutes, the injection was repeated during continuous 3D imaging in coded harmonics mode. Enhancement patterns and kinetics from CEUS and the patient’s clinically scheduled contrast-enhanced MRI or CT were then compared.

**Results:** Eight patients have enrolled in this ongoing study. Using MRI or CT as the patient’s reference standard, no cases of RCC recurrence have been observed yet. Fat necrosis and areas of surrounding renal tissue scarring were observed in 2 and 3 patients, respectively. Renal ablation cavity sizes studied to date have ranged from 1.2 to 4.6 cm and volume acquisition rates from 0.8 to 2.0 volumes/second at depths up to 6 cm. On CEUS, a lack of enhancement within the treated mass was observed during the arterial and cortical enhancement phases for all cases. Late enhancement during the medullary phase was observed in masses later found as having fat necrosis or scarring on MRI or CT. While full volumetric data enabled complete visualization of the ablation cavity, it was found that differentiating vascular phases and the lesion border was more difficult due to motion artifacts and a lack of anatomic landmarks.

**Conclusions:** CEUS may be a useful alternative to monitoring RCC recurrence after cryoablation. Observed enhancement in the medullary phase appears consistent with fat necrosis and scar tissue findings on MRI and CT.
Impact of Race on Contrast-Enhanced Transrectal Ultrasound for Prostate Cancer Detection

Ethan Halpern1,* Flemming Forsberg1, Leonard Gomella2, Edouard Trabulsi2
1Radiology; 2Urology, Thomas Jefferson University, Philadelphia, PA USA

Objectives: Recent studies have demonstrated improved detection of larger-volume and higher-grade “clinically significant” prostate cancer (PCa) with contrast-enhanced ultrasound (CEUS)-guided targeted biopsy. As PCa tends to be a more aggressive disease among African American patients, this study evaluated the impact of a patient’s race on PCa detection rate with CEUS.

Methods: We reviewed demographic, ultrasound imaging, and pathologic results from 272 consecutive participants in a National Institutes of Health–funded clinical trial who underwent conventional 12-core systematic biopsy of the prostate as well as CEUS-guided targeted biopsy with up to 6 additional targeted biopsy cores. The microbubble agent Definity (Lantheus Medical Imaging) was used.

Results: The study population consisted of 210 Caucasian, 54 African American, 2 Asian, and 4 Hispanic males. PCa was detected in 87 (41%) of Caucasian and 29 (54%) of African American males. Among patients with a positive biopsy, PCa was present in multiple systematic cores in 41/87 (47%) Caucasian and 17/29 (59%) African American males, and high-grade PCa (Gleason score ≥7) was present in 30/87 (34%) Caucasian and 11/29 (38%) African American males. PCa was detected by systematic biopsy alone more frequently in African American (15/54 [29%]) as compared with Caucasian (30/210 [14%]) males. The frequency of high-grade PCa detected by systematic biopsy was similar in both populations (7/54 vs 27/210 [both 13%]). However, the frequency of high-grade PCa detected by targeted biopsy with CEUS was greater among our African American patients (9/54 [17%]) as compared with our Caucasian patients (21/210 [10%]).

Conclusions: The frequency of PCa, the number of positive biopsy cores among patients with PCa and the frequency of high-grade PCa were greater among our African American patients as compared with Caucasian patients. Although PCa was detected more frequently among our African American patients with conventional systematic biopsy, high-grade PCa in this population was detected more frequently with a limited targeted biopsy based on CEUS.

Optimal Combination of Contrast-Enhanced Targeted and Systematic Biopsy of the Prostate for Detection of High-Grade Prostate Cancer

Ethan Halpern1,* Flemming Forsberg1, Leonard Gomella2, Edouard Trabulsi2
1Radiology; 2Urology, Thomas Jefferson University, Philadelphia, PA USA

Objectives: The per-core detection rate for high-grade prostate cancer (PCa) is improved with contrast-enhanced transrectal ultrasound (CE-TRUS). Nonetheless, a limited targeted biopsy based on CE-TRUS may miss PCa that would be detected on a standard systematic biopsy. The purpose of the current study was to define an optimal biopsy strategy, combining systematic and targeted biopsy approaches to maximize heterogeneous detection of high-grade prostate cancer.

Methods: A total of 272 consecutive patients underwent CE-TRUS-targeted biopsy with up to 6 cores (mean: 4.5 cores/patient) during infusion of Definity (Lantheus Medical Imaging), followed by a 12-core systematic biopsy. The per-patient diagnosis of all PCa and high-grade PCa (Gleason score ≥7) was tabulated for 12-core systematic biopsy, for CE-TRUS-targeted biopsy, and for the combination of a laterally or medially directed sextant biopsy (6 cores) with CE-TRUS-targeted biopsy.

Results: PCa was identified in 276/3264 (8.5%) systematic cores and 203/1237 (16.4%) CE-TRUS-targeted cores (P < .001). PCa was detected more frequently per patient by systematic biopsy (n = 105) as compared to CE-TRUS-targeted biopsy (n = 71; P < .001). Among 41 patients with high-grade PCa, high-grade PCa was detected slightly more frequently by systematic biopsy (n = 34) relative to CE-TRUS-targeted biopsy (n = 30; P = .48). The combination of a medially or laterally directed sextant biopsy with CE-TRUS-targeted biopsy resulted in reduced overall per-patient detection of PCa (n = 90 or 91) as compared with a systematic 12-core biopsy (n = 105; P < .04). However, the combination of a medially directed sextant biopsy with CE-TRUS-targeted biopsy (mean: 10.5 cores/patient) resulted in greater detection of high-grade PCa (n = 39) as compared with a systematic 12-core biopsy (n = 34; P = .18).

Conclusions: Although a laterally directed sextant biopsy is most efficient for detection of PCa (Stamey TA. Urology 1995; 45:2–12), the optimal combination of systematic and CE-TRUS biopsy cores includes a medially directed sextant. This result is related to the superior efficacy of CE-TRUS for detection of laterally located PCa, which is not adjacent to the hypervascular transition zone.

Contrast-Enhanced Ultrasound for Differentiation of Small (≤2 cm) Liver Metastases and Hepatocellular Carcinomas: Qualitative and Quantitative Evaluations

Wen-Ping Wang, Yi Dong,* Feng Mao, Xiao-Long Zhang
Ultrasound, Zhongshan Hospital, Fudan University, Shanghai, China

Objectives: To differentiate small (≤2 cm) liver metastases and hepatocellular carcinoma (HCC) by evaluating qualitative and quantitative perfusion changes in contrast-enhanced ultrasound (CEUS).

Methods: In this retrospective study, qualitative and quantitative CEUS analyses were retrospectively performed in 120 cases of small liver metastases and 150 cases of small HCCs. CEUS was performed, and enhancement patterns of tumors were compared. Time-intensity curves were conducted with SonoLiver (TomTec Imaging Systems, Germany). Quantitative perfusion indices, such as rise time, time to peak (TTP), and tumor-to-cortex enhancement ratio were obtained and compared. Statistical analyses were performed using R version 3.0.2 (R Core Team, Vienna, Austria).

Conclusions: Qualitative CEUS showed rapid rim enhancement in the arterial phase (65.8% in liver metastases vs 33.3% in HCCs; P < .01), a hypoechogenic appearance in the late arterial or early portal venous phase (95.8% in liver metastases vs 70.0% in HCCs; P < .05), which were valuable characteristics for differentiating small (≤2 cm) liver metastasis from HCCs. With quantitative analysis, TTP of small liver metastases (19.0 ± 4.1) was significantly shorter than small HCCs (23.0 ± 5.6; P < .05).

Conclusions: Qualitative and quantitative CEUS analyses are helpful in the differential diagnosis of small liver metastases from small HCCs.
tic (ROC) analysis. Cutoff values were determined by ROC analysis, and sensitivity, specificity, accuracy, and Youden indices were calculated.

Results: There were 39 patients with active and 16 with inactive CD according to hs-CRP. According to Limberg classification using PDI, 35 of the patients were classified into active disease and showed sensitivity of 0.74, specificity of 0.75, accuracy of 0.75, and Youden index of 0.49. By using the enhancement patterns on CEUS, 44 of the patients were evaluated as inflammatory activity and showed a sensitivity of 0.87, specificity of 0.38, accuracy of 0.73, and Youden index of 0.25. Quantitative analysis showed a higher PI (>19 dB), a shorter RT (≤6.2 seconds), and a shorter TTP (≤8.7 seconds) in patients with active inflammation than those from inactive CD patients (P < .05). Youden indices were 0.56, 0.39, and 0.45. PI showed higher efficiency in assessing inflammatory activity of CD according to the comparison of the area under the ROC curve with enhancement patterns of CEUS (P < .05). No significant differences were found between quantitative parameters (PI/RT/TTP) and PDI Limberg classification.

Conclusions: Quantitative analysis of CEUS provided better performance than CEUS enhancement patterns in assessment of the activity of CD. Although it is equal to the performance of PDI, it was more objective and should be recommended in clinical practice.

Table 1. Quantitative CEUS Enhancement Patterns

<table>
<thead>
<tr>
<th>Enhancement Pattern</th>
<th>PI &lt; .05</th>
<th>RT &lt; .05</th>
<th>TTP &lt; .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Minimal enhancement</td>
<td>0.56</td>
<td>0.39</td>
<td>0.45</td>
</tr>
<tr>
<td>II Submucosal enhancement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III Transparietal outward enhancement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV Transparietal inward enhancement</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

2362606 Fetal Myocardial Performance Index Can Predict Fetal Hypoxemia During Labor
Alexis Gimovsky,* Dennis Wood, Stuart Weiner
Obstetrics and Gynecology, Division of Maternal-Fetal Medicine, Sidney Kimmel Medical College at Thomas Jefferson University Hospital, Philadelphia, PA USA

Objectives: The myocardial performance index (MPI) is a Doppler-derived myocardial function tool. The MPI is a noninvasive, easily attainable measure of cardiac function that can be obtained during labor and does not change with labor. The objective of the study was to investigate whether the left MPI can predict fetal hypoxemia in singleton pregnancies during labor.

Methods: Prospective cohort study of women with term singleton pregnancies in labor who were recruited at Thomas Jefferson University Hospital. Exclusion criteria were fetuses with known cardiac anomalies, multiple gestations, intrauterine growth restriction, and non-cephalic presentation. The primary outcome was sensitivity and specificity of left MPI for cord pH < 7.2. The secondary outcome was expedited delivery due to category 2 or category 3 fetal heart tracing. All participants underwent an ultrasound examination, during which the fetal left and right-sided isovolumic contraction time (ICT), isovolumic relaxation time (IRT), and ejection time (ET) were recorded during labor. The left sided MPI was then calculated using the formula MPI = (ICT + IRT)/ET. A Student t test and χ² test were used as appropriate. P < .05 was considered statistically significant. A receiver operating characteristic (ROC) curve was created to evaluate left MPI as a screening test.

Results: Twenty-four laboring patients were evaluated. Demographics and delivery outcomes were similar between groups. The ROC curve had an area under the curve of 0.72, with P = .258. For an MPI of ≥0.51, there was sensitivity of 50.0% and specificity of 85.0% to predict cord pH < 7.2.

Conclusions: The MPI has a moderate ability to predict fetal hypoxemia during labor.

Table 1. Delivery Outcomes

<table>
<thead>
<tr>
<th>Delivery type</th>
<th>Total (n = 6)</th>
<th>MPI ≤ 0.51 (n = 6)</th>
<th>MPI &gt; 0.51 (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous vaginal delivery</td>
<td>21 (87.5)</td>
<td>16 (88.9)</td>
<td>5 (87.5)</td>
</tr>
<tr>
<td>Operative delivery</td>
<td>1 (4.2)</td>
<td>1 (5.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>2 (8.3)</td>
<td>1 (5.6)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>Delivery for non-reassuring fetal heart tracing</td>
<td>1 (4.2)</td>
<td>0 (0)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>Birth weight, g</td>
<td>3204 (366)</td>
<td>3345 (574)</td>
<td>3150 (260)</td>
</tr>
</tbody>
</table>

2372011 HDLiveFlow With HDLive Silhouette Mode/Glass Body Rendering Mode in the Assessment of the Fetal Heart
Mohamed AbälEllaï1,*, Kent Kenamoto1, Suraphan Sajapala1, Chiaki Tenkumo1, Megumi Ito1, Nobuhiro Mori1, Uiko Hanaoka1, Toshiyuki Hata1
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Objectives: We present our experience with normal fetal cardiac structures and congenital heart disease (CHD) reconstructed using HDLiveFlow with the HDLive silhouette mode/glass body rendering mode.

Methods: Ten normal fetuses and 8 fetuses with CHD (1 case each of tricuspid regurgitation [TR], ventricular septal defect [VSD], hypoplastic left heart syndrome [HLHS], Ebstein’s anomaly, truncus arteriosus [TA], and right aortic arch [RAA]) and 2 of double-outlet right ventricle (DORV) at 11–35 weeks’ gestation were included.

Results: In normal fetuses, origins of the pulmonary artery (PA) from the right ventricle (RV) and aorta (Ao) from the left ventricle (LV) were evident. Their courses and crisscross arrangements were clearly shown. The spatial 3-vessel view demonstrated their relation to the superior vena cava, and size comparison between them was easily achieved. The ascending Ao, aortic arch with its 3 main branches, and descending Ao were clearly visualized. The hepatic vein joining the inferior vena cava was also noted. Spatial impression of these great vessels and their relation to the spine was obvious using this technique. Mild TR was noted. In VSD, significant shunt flow through the VSD between left and right ventricles was evident. In HLHS at 16 weeks 4 days, a diminutive LV and significant TR with shunt flow across a large VSD were seen. A huge right atrium and small RV were seen in the case of Ebstein’s anomaly. In TA, a single arterial trunk, straddling both ventricles and giving rise to the PA and Ao, was identified at 12 weeks 6 days. In RAA, a vascular ring around the trachea with clear visualization of the diverticulum of Kommerell and aberrant left subclavian artery was achieved at 34 weeks. In DORV, a large Ao and small PA leaving the RV in parallel were clearly shown.

Conclusions: This technique may assist in the evaluation of the fetal cardiovascualr system in the normal heart and CHD, adjacent to fetal echocardiography. HDLiveFlow should become an important technology in future research on fetal cardiology.
2374880 Prenatal Diagnosis of Absent Pulmonary Valve Syndrome: Case Series of Five Cases; Most Common and Most Rare Presentations
Alpana Joshi
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Objectives: Absent pulmonary valve syndrome (APVS) is a rare congenital cardiac anomaly. Two variants of this anomaly are known. We report 5 patients who were referred to us for fetal echocardiography after abnormal findings on a detailed ultrasound scan. We discuss the fetal echocardiographic features of this rare cardiac anomaly.

Methods: We analyzed the fetal echocardiographic findings of APVS in 5 patients. The study was performed with Philips HD 11 XE and Philips iU22 ultrasound machines using a convex C5-2 transducer and fetal echo presets. The axis, size, and situs of the heart were evaluated. Color and spectral Doppler evaluation of both inflow and outflow tracts was done.

Results: The gestational age at diagnosis was 19–26 weeks. Of 5 cases, 4 cases showed typical features of APVS with a dilated pulmonary artery and its branches with a subaortic ventriculo-septal defect, overriding of the aorta, and ductal agenesis. There was typical to-and-fro flow noted on color and spectral Doppler examination. One fetus showed rare findings of APVS with an intact ventricular septum and patent ductus arteriosus associated with functional tricuspid atresia. We performed partial necropsy of the heart and lungs in this fetus with atypical features of APVS and confirmed these findings.

Conclusions: Antenatal diagnosis of the common (associated with tetralogy of Fallot) of APVS is easy due to its typical features of dilated main pulmonary and branch arteries and color Doppler detection of severe stenosis and insufficiency of the functionally absent pulmonary valve. However, the second variant of APVS can have varied findings, which can make a specific diagnosis difficult.

2381505 Impact of Congenital Heart Disease on In Utero Fetal Growth
Mert Bahtiyar,* Joshua Copel
Obstetrics and Gynecology, Yale University School of Medicine, New Haven, CT USA

Objectives: The aim of this study was to compare fetal biometric measurements, estimated fetal weight, and frequency of intrauterine growth restriction (IUGR) between fetuses with congenital heart disease (CHD) and normal singleton fetuses.

Methods: This was a retrospective case-control study of patients who were referred for a fetal echocardiogram between January 1985 and December 2013 at a single academic center. During the study period, 11,083 fetal echocardiograms were performed on 9,463 fetal echocardiograms that were included in this study. The control group was constituted of randomly selected 25,000 singleton gestations without any known or suspected fetal anomaly seen on ultrasound examination during the same study period. Fetal growth restriction was defined as estimated fetal weight below the 10th percentile for the gestational age.

Results: During the study period, 875 fetuses were prenatally diagnosed with CHD of varying severity. Overall, the prevalence of any CHD was 8.4%. The prevalence of IUGR was significantly higher in fetuses with CHD compared to fetuses without any anomalies: 20.0% and 9.1%, respectively (P < .05). On multivariate analysis, there was no statistically significant difference in fetal growth between study and control groups at 16–28 weeks of gestation. However, after 28 weeks of gestation, fetal growth was significantly lagging in fetuses with CHD (P < .05). Similarly, abdominal circumference measurements were significantly lagging after 28 weeks of gestation (P < .05). There was no difference in biparietal diameter throughout the pregnancy.

Conclusions: Consistent with previously published literature, we confirmed that fetuses with CHD are likely to have growth restriction, which is more pronounced in the third trimester. Fetuses with CHD should be followed closely for fetal growth restriction.

2383980 The Role of the 3-Vessel and Trachea View in Antenatal Detection of Tetralogy of Fallot
Anna Palatnik,* William Groberman, Lebeer Cohen, Jeffrey Dungan, Nina Gotteiner
1Obstetrics and Gynecology, Northwestern University, Feinberg School of Medicine, Chicago, IL USA; 2Pediatrics, Northwestern University, Chicago, IL USA

Objectives: Prenatal diagnosis of tetralogy of Fallot (TOF) remains less frequent compared to other major congenital heart defects. The aim of this study was to examine how often the 3-vessel and trachea view was abnormal in a large series of prenatally diagnosed TOF and to compare its sensitivity to that of the traditional outflow tract views.

Methods: This was a case series with retrospective analysis of all antenatally diagnosed TOF fetuses with postnatal confirmation at a single tertiary care institution between April 2007 and May 2015. Only cases of TOF diagnosed between 18 and 24 weeks were considered with regard to determination of the frequency of prenatal detection. Measurements of the aortic annulus (AA) and main pulmonary artery annulus (MPA) were obtained at the outflow tract views, and measurements of the aortic arch isthmus (AAi) and ductus arteriosus (DA) were obtained at the 3-vessel and trachea view. Z scores were calculated for all 4 dimensions according to Schneider’s nomograms. In order to determine which measures were most sensitive in the detection of TOF, the frequencies of Z scores ≥ 2.0 were compared for all 4 measurements using McNemar’s test.

Results: During the study time period, 40 fetuses were diagnosed with TOF. There were 2 additional cases of newborns delivered at our institution with postnatal diagnosis of TOF who had received a routine sonographic survey that did not detect TOF, thus accruing to a 95% (40/42) prenatal detection rate (95% confidence interval, 88%–99%). In all cases, the AA/MPA and AAi/DA ratios were > 1 in the outflow tract and 3-vessel and trachea views, respectively. As a single measurement, when using the Z score value of 2, the AAi measurement obtained at the 3-vessel and trachea view was found to be more frequently abnormal than the AA or MPA measurement obtained at the outflow tract view (86.5% vs 42.5%; P = .002 for AA; and 86.5% vs 65.0%; P = .003 for MPA).

Conclusions: Both the outflow tract and the 3-vessel and trachea views were abnormal in all fetuses with TOF, demonstrating reversed AA/MPA and AAi/DA ratios, respectively. However, as a single measured marker, the enlarged AAi on the 3-vessel and trachea view appears to be the most sensitive for TOF.

2384593 Retrospective Versus Prospective Normograms for the Cardiac Axis at 11 to 14 Weeks in a Lebanese Population: Is There a Difference?
Reem Abu-Rustum, M. Fouad Ziaed, Sameer Abu-Rustum
1Center for Advanced Fetal Care, Tripoli, Lebanon; 2Faculty of Public Health, Lebanese University, Tripoli, Lebanon; 3Obstetrics and Gynecology, Nini Hospital, Tripoli, Lebanon

Objectives: To evaluate the feasibility of measuring the cardiac axis (CAX) at 11–14 weeks and to compare our normograms to that established by Sinkovskaya et al.

Methods: The study was initially carried out retrospectively. On data analysis, it was repeated prospectively. In both instances, 100 normal fetuses had a full anatomic survey at the time of nuchal translucency (NT) assessment by a single sonologist certified by the Fetal Medicine Foundation. Maternal body mass index (BMI), crown-rump length (CRL),
and NT were obtained. The CAx was measured at the level of the 4-chamber view. In the retrospective group, the optimal stored image, with or without color Doppler, was utilized. In the prospective group, the CAx was measured utilizing high-definition flow (HDF) with optimal filling of the chambers. Neonatal outcome was available on the retrospective fetuses. The Kolmogorov-Smirnov test was used to assess normality. Data were analyzed using means (SD) and ranges. The effect of CRL on the CAx was evaluated using regression analysis. A t test was used to compare our means to the established means. P < .05 was considered significant.

Results: The CAx was measured on all fetuses in both cohorts. The patient characteristics were similar in both retrospective and prospective cohorts, with a mean maternal BMI of 25.06 vs 25.42, CRL of 69.39 vs 68.43 mm, and NT of 1.75 vs 1.82 mm, respectively. CAx was found to be normally distributed in both with no significant effect of CRL on CAx (P = .675 and .656, respectively). However, comparing the mean CAx, it was 46.7° retrospectively and was statistically different from Sinkovskaya et al, with P = .034. Prospectively, the mean CAx was 45.98°, and it was not statistically different from what has been established, with P = .302. Of note is that in the retrospective group, the range was 27.30°–83.93° vs 26.88°–60.95° in the prospective group.

Conclusions: It is feasible to obtain the CAx at 11–14 weeks. There is a significant difference between our retrospective and prospective data particularly in the upper limits of normal. This may be attributed to utilizing HDF. As such, it may be a consideration to employ HDF to enhance accuracy when introducing this powerful new marker into routine first-trimester screening.

Are There Head Volume Alterations at 11 to 14 Weeks in Fetuses With Congenital Heart Defects? Reem Abu-Rustum1,* M. Fouad Ziade2, Sameer Abu-Rustum1, Linda DAoud3
1Center for Advanced Fetal Care, Tripoli, Lebanon; 2Faculty of Public Health, Lebanese University, Tripoli, Lebanon; 3Obstetrics and Gynecology, Nini Hospital, Tripoli, Lebanon; 4Pediatric Cardiology, St Joseph University, Beirut, Lebanon

Objectives: To assess the presence of head volume (HV) alterations at 11–14 weeks in fetuses with congenital heart defects (CHDs).

Methods: Retrospective case-control study on 100 controls and 26 fetuses with CHDs. All fetuses had a first-trimester scan with nuchal translucency, crown-rump length (CRL), and cardiac axis measured, and volume data sets were stored. All scans and volume analyses were carried out by a single sonologist certified by the Fetal Medicine Foundation. From the 3D volumes, the plane of the biparietal diameter was reconstructed using rotation along the 3 axes. Virtual organ computer-aided analysis was activated using a manual trace at a rotational angle of 30° to calculate the HV. Fetuses with suboptimal volumes due to motion artifacts and shadowing were excluded from the analysis. All controls had a second-trimester scan and a normal neonatal exam. The presence of extracardiac anomalies and aneuploidy in fetuses with CHDs was recorded. Live-born fetuses with CHDs were evaluated by a pediatric cardiologist.

The HV as a function of CRL in fetuses with CHDs (grouped as hypoplastic left heart [HLH] and other) was plotted against the norms. The Nonparametric Kruskal-Wallis H test was used for comparing the measurements. P < .05 was considered significant.

Results: Included in the analysis were 102 fetuses: 83 normals and 19 with CHDs. Of the CHD fetuses, there were 7/19 (36.8%) with HLH, 6/19 (31.2%) with a ventricular septal defect/atresia/ventricular canal, 3/19 (15.8%) with hypoplastic right heart, 2/19 (10.5%) with isomerism, and 1/19 (5.3%) with tetralogy of Fallot. Karyotype was available on 4/19 (21%), 2 were trisomy 21. Extracardiac abnormalities (excluding hydrops) were present in 9/19 (47.4%). Of the 19 fetuses, 2 were live born (10.5%). Termination of pregnancy was carried out on 13/19 (68.4%). There was spontaneous in utero demise in 2/19 (10.5%). In addition, 2/19 (10.5%) were lost to follow-up. The HV as a function of the CRL revealed a significant difference between fetuses with CHDs and normals, with a statistically smaller HV in fetuses with CHDs. This was particularly applicable to fetuses with HLH (P = .043).

Conclusions: Despite the small sample size, our data suggest that the brain-sparing effect, as evidenced by alterations in HV, may be apparent as early as the first trimester in fetuses with CHDs and, in particular, those with HLH. Larger prospective studies are needed to validate our findings.

Two-Dimensional Speckle Tracking of the Longitudinal Systolic Displacement of the Right and Left Ventricular Chambers: Does It Alter the Interpretation of Fetal M-Mode Echocardiography? Gregory DeVore1,2,3,* Bardo Polanco1, Gary Satou1, Mark Sklansky1
1Fetal Diagnostic Center, Pasadena, CA USA; 2Obstetrics and Gynecology, 3Pediatric Cardiology, David Geffen School of Medicine at UCLA, Los Angeles, CA USA

Objectives: From the 2D 4-chamber view (4CV) the longitudinal systolic displacement (LSD) was measured with 2D speckle tracking obtained from the endocardium of the right ventricular (RV) and left ventricular (LV) lateral and septal walls. LSD was correlated with simultaneously recorded M-mode tracings obtained perpendicular to the interventricular septum at the basal (B), mid (M), and apical (A) levels from the 4CV.

Methods: The 4CV was recorded from 200 fetuses between 19 and 40 weeks of gestation in which the LSD from the endocardial B, M, and A of the lateral and septal walls of the RV and LV was measured. The displacements of the B, M, and A segments for each ventricle were summed, and the percentage of displacement computed for each segment was analyzed using repeated analysis of variance. In a subgroup of fetuses, the 4CV and a simultaneous M-mode were recorded at the B, M, and A regions of the RV and LV.

Results: The percent of LSD was not correlated with gestational age. There was a significant decrease in the percent of LSD from the base to the apex of the RV and LV (Table 1). When the simultaneous M-mode was analyzed, the end-systolic M-mode represented a different portion of the ventricular and septal endocardium than the diastolic M-mode because of LSD of the B, M, and A segments.

Conclusions: When the M-mode is used to measure diastolic and systolic dimensions of the ventricular chambers, the cursor should be placed in the midportion of the ventricular chamber to minimize measurement errors resulting from LSD.

Table 1. Percent of LSD for the B, M, and A Sections for the LV and RV Lateral Walls (LVLW and RVLW) and LV and RV Septal Walls (RVSW and LVSW)

<table>
<thead>
<tr>
<th>Section</th>
<th>LVLW</th>
<th>LVSW</th>
<th>RLW</th>
<th>LSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>43.1%</td>
<td>48.4%</td>
<td>43.8%</td>
<td>46.6%</td>
</tr>
<tr>
<td>M</td>
<td>34.4%</td>
<td>32.8%</td>
<td>34.2%</td>
<td>32.6%</td>
</tr>
<tr>
<td>A</td>
<td>22.5%</td>
<td>18.7%</td>
<td>22.1%</td>
<td>20.7%</td>
</tr>
<tr>
<td>B vs M</td>
<td>P &lt; .001</td>
<td>P &lt; .001</td>
<td>P &lt; .001</td>
<td>P &lt; .001</td>
</tr>
<tr>
<td>M vs A</td>
<td>P &lt; .001</td>
<td>P &lt; .001</td>
<td>P &lt; .001</td>
<td>P &lt; .001</td>
</tr>
<tr>
<td>B vs A</td>
<td>P &lt; .001</td>
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</table>
American Institute of Ultrasound in Medicine Proceedings

2384999

Semiautomated Evaluation of the Fetal Heart Using a 5DHeart Approach: Recent Data on Validity and Reproducibility in First- and Second-Trimester Fetuses

Jan Weichert,*, Michael Gembiicki, David Hartje
Obstetrics and Gynecology, Prenatal Medicine, University Hospital of Schleswig-Holstein, Campus Luebeck, Luebeck, Germany

Objectives: To scrutinize the performance and reliability of 5DHeart technology for standardized assessment of the fetal heart in first- and second-trimester pregnancies.

Methods: In this prospective study, we enrolled 114 uncomplicated singleton pregnancies undergoing targeted first- and second-trimester ultrasound examination including spatiotemporal image correlation (STIC) volumes of the fetal heart. All volume data sets were obtained with the fetus in an appropriate position (spine located between 5 and 7 o’clock), absent or minimal fetal breathing/movement, and satisfying image quality. All data sets were stored and reevaluated using FINE (Fetal Intelligent Navigation Echocardiography) software in order to rule out the visualization rates of 9 reconstructed cardiac planes.

Results: A total of 103 patients were eligible for final analysis.

Conclusions: 5DHeart technology facilitates reliable assessment of fetal cardiac anatomy even when used as early as the first trimester. With ongoing pregnancy, the visualization rate of all diagnostic planes needed during fetal echocardiography improves rapidly.

Table 1. Summary of the Results

<table>
<thead>
<tr>
<th></th>
<th>RV Septum vs RV Lateral Wall</th>
<th>LV Septum vs LV Lateral Wall</th>
<th>RV Septum vs RV Lateral Wall</th>
<th>LV Septum vs LV Lateral Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>B segment</td>
<td>43% vs 86%*</td>
<td>22% vs 78%*</td>
<td>41% vs 59%*</td>
<td>53% vs 47%*</td>
</tr>
<tr>
<td>M segment</td>
<td>12% vs 88%*</td>
<td>38% vs 62%*</td>
<td>18% vs 82%*</td>
<td>49% vs 51%*</td>
</tr>
<tr>
<td>A segment</td>
<td>13% vs 87%*</td>
<td>51% vs 48%*</td>
<td>9% vs 91%*</td>
<td>41% vs 59%*</td>
</tr>
</tbody>
</table>

*P < .01.

Obstetric Ultrasound: Fetal Growth

Moderator: Wesley Lee, MD

2381852

The Femur Length/Abdominal Circumference Ratio for Prediction of Shoulder Dystocia and Neonatal Brachial Plexus Palsy in Women With Gestational Diabetes

Elaine Duryea1,*, Donald McIntire1, Brian Casey1, Diane Twickler2
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Objectives: To determine whether the femur length-to-abdominal circumference ratio (FL/AC) may be useful in the identification of women with gestational diabetes mellitus (GDM) at increased risk of shoulder dystocia and neonatal brachial plexus palsy (NBPP).

Methods: This was a retrospective cohort study of women with GDM who delivered singleton live-born infants at our institution from 1997 to 2015. Diagnosis and treatment of GDM was uniform during the study period, including routine sonography after 32 weeks’ gestation. Various measurements and calculations such as biparietal diameter, FL, AC, and FL/AC, as well as estimated fetal weight and AC percentiles were evaluated for correlation with shoulder dystocia and NBPP in comparison to birth weight (BW).

Results: During the study period, 6952 women with GDM underwented a sonogram at 34.8 ± 1.8 weeks’ gestation; 2768 (40%) underwent cesarean delivery, with 4 cases of NBPP (1.5/1000); 4183 women underwent vaginal delivery, with 66 cases of shoulder dystocia (16/1000) and 13 NBPP (6/1000). FL/AC was most closely associated with shoulder dystocia (P < .001) with an area under the curve of 0.70 (confidence interval, 0.64–0.77), which was not improved with the addition of other ultrasound parameters to the prediction model. A FL/AC of <0.2 yielded a sensitivity of 29% for shoulder dystocia and 15% for NBPP, similar to the retrospective use of BW >4500 g. When examining the FL/AC in 281 women with multiple sonograms after 32 weeks’ gestation, the ratio was stable with advancing gestational age (P = .96).

Conclusions: In women with GDM, the FL/AC in the third trimester is a simple, stable measurement that may assist in identification of women with GDM at increased risk for shoulder dystocia and NBPP.
The Influence of Cardiac Defects, Anomalies, and Soft Markers on the Growth Pattern of Fetuses With Trisomy 21

Objectives: Fetuses with trisomy 21 are noted to have varying growth patterns from normal to significant growth restriction. The purpose of this study is to determine if a congenital heart defect (CHD), any congenital anomaly (A), a trisomy 21 soft marker (SM), or any combination (all finding) was not associated significant for the prediction of the fetal size compared to the gestational age.

Methods: This is a retrospective study of 425 ultrasound exams in 235 patients with trisomy 21, identified by antenatal or neonatal karyotype, comparing the fetal growth pattern with the presence of a CHD, A, or SM (echogenic intracardiac focus, echogenic bowel, thickened nuchal fold, pyelectasis, or shortened femur or humerus; Table 1). Using hierarchical linear modeling, fetal growth was defined using the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and femoral diaphysis (FDL) for patients with poor dating who present for care in the late third trimester.

Results: The BPD, HC, AC, and FDL were all statistically significant for the prediction of the fetal size compared to the gestational age (all P < 0.001, except HC, which ranged from 0.008 to 0.21). The presence of a CHD, A, SM, or any combination (any finding) was not associated with a statistically significant difference in the linear regression–defined fetal growth equation.

Conclusions: The fetal growth pattern in trisomy 21 is not statistically influenced by the presence of a CHD, A, or SM.

Table 1. Subject Distribution in Test Groups

<table>
<thead>
<tr>
<th>CHD</th>
<th>A</th>
<th>SM</th>
<th>Any finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>39 (16.6)</td>
<td>54 (23.0)</td>
<td>51 (21.7)</td>
<td>93 (39.6)</td>
</tr>
</tbody>
</table>

*aSubjects may be represented in multiple groups.

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Pathologic Fetile Growth: How Does Intergrowth 21 Compare With Established Growth Curves?

Objectives: Fetal growth restriction is a strong risk factor for stillbirth. We compared the performance of the newly published Intergrowth 21 (IG21) fetal growth norms against established ultrasound (US)- and birth weight (BW)-based curves in identifying abnormally grown fetuses.

Methods: We previously performed a case-control study of singleton stillbirths (2000–2010) at 1 center. Four live-born controls were randomly identified for each stillbirth. Fetal growth measurements taken within 1 month of delivery were used to calculate growth percentiles for each fetus. Abdominal circumference (AC) alone has been shown to predict both small for gestational age (SGA) and large for gestational age (LGA). IG21 describes percentiles for individual measurements rather than average values.
than estimated fetal weight; thus, in this secondary analysis, IG21 and Hadlock curves (Had AC) were applied to AC measurements for cases and controls. These findings were compared to fetal weight percentile by 2 fetal weight growth norms: the Hadlock US-based curve and a BW-based curve. Odds of being defined as <3rd, 3rd–10th, and >90th percentiles were calculated. The likelihood of being defined as SGA (<10th) or LGA (>90th) was examined with McNemar’s test.

**Results:** There were 49 stillbirths and 197 live births. Odds of stillbirth among fetuses identified as SGA <3rd percentile when IG21 was applied were 15.5 (3.0, 78.7), as compared to 1.65 (0.68, 4.01) under Had AC. Applying a BW or US curve, the odds ratio was 10.4 (1.94, 55.7) or 6.0 (2.0, 17.9). The likelihood of SGA or LGA was significantly different in both stillborns and live-borns, depending on the growth curve used. Growth was significantly more likely to be called abnormal (<10th or >90th percentile) with IG21 as opposed to US or BW curves (<0.001), largely due to significantly more LGA (31%; P < .0001). Significantly fewer fetuses in either group were SGA by IG21 than by Hadlock or Had AC (P < .0001; P = .002).

**Conclusions:** The IG21 fetal growth curve performed differently than either US- or BW-based norms. Similar to the BW curve, IG21 identified fewer fetuses as SGA than did US-based curves. Odds of stillbirth were highest when IG21 identified growth as <3rd percentile. IG21 also identified the greatest proportion of stillborn and live-born fetuses as LGA.

**2382783 Sonographic Detection of Birth Weight at or Below the Third Percentile in Women With Treated Chronic Hypertension Jamie Morgan,* Chet Wells, Donald McIntire, David Nelson Obstetrics and Gynecology, University of Texas Southwestern Medical Center, Dallas, TX USA

**Objectives:** To assess the utility of antenatal sonography to identify severe infant growth restriction, defined as birth weight at or below the 3rd percentile, in a cohort of high-risk women with treated chronic hypertension (CHTN) during pregnancy.

**Methods:** This was a retrospective cohort study of singleton pregnancies delivered at our hospital. All women were diagnosed with chronic hypertension and required antihypertensive therapy during pregnancy and routinely received sonograms to assess fetal growth at 2 epochs: (1) 26–28 weeks and (2) 34–36 weeks. The infant birth weight percentile was determined using a gestational age–specific nomogram derived from births at our institution. For this study, sonographic assessment of estimated fetal weight (EFW) at or below the 10th percentile using the Hadlock nomogram and biometric indices was compared with subsequent birth weights at or below the 3rd percentile to evaluate the utility of sonography to detect or exclude severe infant growth restriction at separate gestational age epochs as well as in paired observations for those with serial sonograms.

**Results:** Between January 2002 and December 2014, a total of 640 women with treated CHTN underwent serial sonograms, with 256 (40%) giving birth to infants weighing below the 25th and 75th percentiles and 65 (10%) delivering an infant weight below the 3rd percentile. Using random-effects modeling to generate a gestational age–specific HC/AC curve, the infants with birth weights below the 3rd percentile had HC/AC ratios above the 95th percentile for all gestational ages when compared with 25th–75th percentiles (P < .001), suggesting ubiquitous asymmetric fetal growth restriction. Sonographic identification of these discordant biometric parameters is significantly increased beginning at 25 weeks’ gestation and is most easily identified at 28 weeks’ gestation.

**Conclusions:** Women with CHTN requiring treatment are at increased risk for severe fetal growth restriction, and discordant biometric parameters, viz increased HC/AC, identify a significant proportion of asymmetric fetal growth in this high-risk cohort.

2384913 The Doppler Transitional Phase in Severely Premature Intrauterine Growth-Restricted Fetuses Ana Tobiasz,* Luis Gomez, Giancarlo Mari University of Tennessee Health Science Center, Memphis, TN USA

**Objectives:** We previously showed in a small cohort that premature fetuses with growth restriction (FGR) experience a transitional phase in the main vessels before persistent Doppler worsening. We sought to investigate if this phase is different when FGR is diagnosed <28 vs >28 weeks.

**Methods:** Prospective cohort. Serial Doppler studies were performed in FGR (estimated fetal weight <10th percentile) from diagnosis (group 1, <28 weeks; group 2, >28 weeks) until delivery or demise in the umbilical artery and vein (UA and UV), middle cerebral artery (MCA), and aortic isthmus (AI). At least 3 studies were performed in each fetus, consisting of 3 different sets of waveforms per vessel. A transitional phase was defined when normal and abnormal flow patterns were identified during the same exam.

**Results:** A total of 301 Doppler studies were performed (range, 3–16 per fetus) in 95 FGR (group 1 = 65; group 2 = 23). Median latency from diagnosis to delivery or demise was 6.3 (range, 1–54) days in group 1 and 1 (range, 1–23) days in group 2 (P < .01). There were more fetal and neonatal deaths (27% and 47%, respectively) in group 1 than in group 2.
Doppler transitional phases were noted in the UA (33 fetuses), MCA (25), UV (17), and AI (2); in 16 fetuses, transitional phases were seen simultaneously in >1 vessel. The latency period from transitional phases to persistent worsening Doppler was longer for all vessels among fetuses in group 1 (Table 1; \( P < .01 \)).

**Conclusions:** Doppler transitional phases are common findings in severe premature FGR. In our cohort, the latency period from a transitional phase to persistent Doppler worsening was longer in those diagnosed <28 weeks. This information should be considered when managing severe premature FGR.

### Table 1. Days of Doppler Findings Before Delivery or Demise

<table>
<thead>
<tr>
<th></th>
<th>UA</th>
<th>MCA PI</th>
<th>MCA PSV</th>
<th>UV</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NL</td>
<td>NL-AF</td>
<td>AF</td>
<td>AF-RF</td>
<td>RF</td>
</tr>
<tr>
<td>&lt;28 wk</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Median</td>
<td>22</td>
<td>6</td>
<td>19</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Mean Range</td>
<td>1–43</td>
<td>1–12</td>
<td>1–38</td>
<td>1–7</td>
<td>1–20</td>
</tr>
<tr>
<td>≥28 wk</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Median</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mean Range</td>
<td>1–10</td>
<td>1–9</td>
<td>1–6</td>
<td>1</td>
<td>1–10</td>
</tr>
</tbody>
</table>

\( P < .01 \) for all vessels.
E-Posters

Basic Science and Instrumentation

2363123 A Comparison of Different Hydrophones in High-Intensity Ultrasound Pressure Measurements
Yunbo Liu,* Keith Wear
US Food and Drug Administration, Silver Spring, MD USA

Objectives: A reliable characterization of the acoustic field distribution is important for both patient safety and treatment efficacy during clinical high-intensity ultrasound applications. Even though acoustic hydrophones are used extensively in ultrasound exposimetry for pressure measurements, technical challenges still exist due to the highly intense, focused, and nonlinear acoustic field. Measurement inconsistencies using different hydrophones were reported to be on the order of 50% (Haller et al. J Acoust Soc Am 2012; 131:1121–1130).

Methods: In this work, 4 different acoustic hydrophones were compared for pressure measurement: a piezoceramic needle hydrophone designed for high-intensity focused ultrasound (HIFU), a polyvinylidene difluoride capsule hydrophone with a small sensing element, and 2 fiber-optic acoustic hydrophones. The focal pressure waveform and field characteristics of a 3.3-MHz single element HIFU transducer were measured at several acoustic power levels from 0.25 up to 20 W. Complex deconvolution between the hydrophone output signal and the hydrophone frequency-dependent complex sensitivity was performed to obtain the focal pressure waveform.

Results: With increasing acoustic power output, the deconvolved focal waveform, compressional pressure (up to 20 MPa), rarefractional pressure (up to 8 MPa), and lateral focal beam profile are compared, and possible reasons for differences are evaluated. Rarefractional pressure P– varied the same as compressional pressure P+. In particular, the effect of hydrophone spatial averaging (12% for the needle hydrophone) and local nonlinear propagation parameters (up to 2.0) were compared and discussed between the different hydrophone sensors.

Conclusions: This study aimed to compare measurement accuracy using different acoustic hydrophones and assess the measurement variation due to sensor selection and analysis method during high-intensity pressure field characterization.

2380280 Quantitative Assessment of Damage During Myocardial Cavitation Enabled Therapy: A Parametric Study in a Rodent Model
Yiying Zhu1,2,* Douglas Miller1, Chunyan Dou1, Xiaofang Liu, Oliver Kripps1
1Radiology, 2Biomedical Engineering, University of Michigan, Ann Arbor, MI USA

Objectives: Myocardial cavitation enabled therapy (MCET) has been proposed as a means to achieve minimally invasive myocardial reduction using ultrasound to produce scattered microlesions by cavitation contrast agent microbubbles. The purpose of this study was to validate our novel computer-aided microlesion analysis method (Zhu et al. IEEE Trans Biomed Eng 2015; 62:717–727) by comparison with manual counting for a wide range of treatment parameters.

Methods: Rats were treated in a heated water bath using burst mode focused ultrasound at a 1.5-MHz center frequency. The treatment impact was varied over a range of therapeutic conditions, including contrast agent dose and infusion rate as well as exposure amplitude and exposure pulse modulation. For the latter, square versus Gaussian pulse train modulations of the acoustic pressure were investigated. Gaussian modulation was to simulate exposures using a sweeping therapeutic beam. Evans blue staining indicated lethal cardiomyocyte injury by fluorescence microscopy of frozen sections. Our above-cited quantitative scheme was compared to manual scoring.

Results: Macrolesions are generated as an accumulation of probability-driven microlesions. Macrolesions populate radially from the beam axis with radii from 0.1 to 1.6 mm, for peak negative exposure amplitudes of 2 and 4 MPa, respectively. The Gaussian modulations were found to maintain an acceptable macrolesion volume. The contrast agent dose scaled with the treatment effect, and changes in infusion rates did not significantly influence microlesion production. For low microlesion densities, manual and computer evaluations were in good agreement, while for higher densities, manual scores became problematic, and the computer method may have produced a more realistic evaluation of the total microlesion yield.

Conclusions: For lesion generation planning in treatment of hypertrophic cardiomyopathy, control of MCET is crucial. This study validated the computer-aided assessment of treatment volumes for moderate to high microlesion densities. Furthermore, the results demonstrated that the swept beam would not negatively affect the cavitation nucleation, thus allowing rapid lesion production over clinically relevant volumes of tissue.

2382998 Lessons Learned During a Clinical Implementation of DICOM Structured Reporting Across a Radiology Ultrasound Practice
Scott Stekel,* Samir Budimlic, Joel Wofery, Nicole Strissel, Jose Villarmara, Shyamala Bhat, Janice Pascoe, Donald Tradup, Nicholas Charboneau, Jason Tjelta, Nicholas Hangiandreou
Radiology, Mayo Clinic, Rochester, MN USA

Objectives: Digital Imaging and Communications in Medicine (DICOM) structured report (SR) transfer of ultrasound measurements to scanners, picture archiving and communication systems (PACS), and other systems may improve efficiency and report quality. Implementations are complex, involving tagging and mapping of measurements across multiple systems, and the DICOM ultrasound (US) SR standard is lacking. We have completed an implementation supporting all vascular, gynecologic, abdominal, small parts, and pediatric imaging in our US practice. We share lessons learned interfacing SR data between scanner and PACS.

Methods: A multispecialty clinical project team worked closely with our scanner and PACS vendors to complete this project, which went live in May 2015. We noted significant challenges during the implementation and developed strategies for overcoming them.

Results: Challenges encountered included the following: Many factors can cause SR data output variability, including scanner models and vendors, scanner software (SW) versions, factory vs user-defined measurements, and measurement acquisition details such as measurement group (eg, abdominal vs gynecologic) or use of an exam protocol function. Due to limited clinical SR use, scanner vendors cannot always predict how their systems will respond in practice; SW release notes may be incomplete. User-defined measurement ("calc package") design is often initially driven by the aesthetic appearance of the resulting measurement report on the scanner and may not be ideal for driving data-centric SR output; some reimplementation of measurements may be needed. Multiple copies of test exams modeled on clinical practice are essential for verification. Variations between like exams may reveal SR encoding novelties. Visual comparison of the scanner report pages with the PACS-presented measurements is tedious but essential. Loading stored sets of test exams and resending via SR can help test different scanner SW versions, but version-specific acquisitions are still required. Software (eg, the “Offis DICMTK DICOM Toolkit”) to evaluate SR data independent of the PACS is essential.

Conclusions: Comprehensive implementation of SR in practice is beneficial but challenging. Knowledge of potential pitfalls should assist in implementation.
238469 Superficial Breast Lesions: Does Ultrasound Need Some Better Adjustment to Be Able to Characterize?
Abdelmohsen Hussien
Radiology, University of Rochester, Rochester, NY USA

Objectives: In most centers, the breast is scanned utilizing a 12-MHz transducer. This may be defective in evaluation of superficial breast lesions and may make a solid lesion look like a cyst. This presentation will focus on the role of ultrasound in a variety of superficial breast lesions that are close to the skin and will also focus on changing ultrasound parameters for better evaluation of these lesions. It will also discuss differentiating solid from cystic superficial lesions. This includes choosing the high-frequency transducer, changing the focus depth, and the use of Doppler ultrasound. This presentation will be supported with various examples and will illustrate the difference in ultrasound appearance by changing to higher-frequency transducers.

Methods: This presentation will discuss evaluation of breast lesions by using ultrasound and Doppler evaluation of different types of superficial breast lesions, including cystic, benign solid, and malignant solid biopsy-proven lesions. iE22 and EPIQ 7 ultrasound systems were used with the use of 12-, 17-, and 18-MHz transducers.

Results: Superficial breast lesions are better characterized by the use of a high-frequency transducer along with Doppler.

Conclusions: Radiologists should be aware that some malignant superficial lesions can be overlooked or misinterpreted as benign cysts with the use of the everyday 12-MHz transducer. Characterization and differentiation between various types of breast superficial lesions are better achieved by the use of the high-frequency transducer: for example, 17 or 18 MHz.

2385119 Super-Resolution and Lateral Beam Patterns
Shujie Chen, Kevin Parker*
Electrical and Computer Engineering, University of Rochester, Rochester, NY USA

Objectives: Conventional B-mode ultrasound images suffer from their broad lateral beam patterns. To increase the image resolution, specific imaging strategies and postprocessing procedures are designed so that the lateral cuts are sampled to have their Z-transform zeros away from the unit circle, enabling the use of stable inverse filters. As a result, super-resolution is achieved.

Methods: Unfortunately, the point spread functions (PSF) from typical ultrasound imaging systems lead to inverse filters that are unstable. It is found that when properly shaped and sampled, a lateral cut can have a stable inverse filter. Hence, a 1D parameterized lateral inverse filter is designed from the down-sampled PSF using an integrated Gaussian model. To deconvolve an image, specific transverse down-sampling is applied to the radiofrequency signal to produce sub-images. Each sub-image is convolved separately using the designed inverse filter bank to form a partial deconvolution image. All the partial images are interleaved to generate the final result. Regarding the noise amplification, median filtering and conditioning of the inverse filters are applied accordingly.

Results: Both simulations in Field II (Jensen 1996) and experiments using the Verasonics scanner were performed. In Field II, models for the ATL L12-3 38-mm transducer, a 7.5-MHz transducer with 128 active elements, were simulated for a phantom around 60 mm deep. An ATL L7-4 transducer operating at 5 MHz focusing 50 mm with the Verasonics scanner was used to image wires in the water, the ATS 535 QA phantom, and tissues. By applying the proposed methods, stable inverse filters were found; the lateral opening of a nominally 4-mm-diameter cyst in the phantom was increased from 1.5 to 3.0 mm; and images with improved lateral resolution were achieved.

Conclusions: In the context of the Z-transform and the deconvolution model, an inverse filter approach has been designed. Examples are shown by applying the proposed method using both Field II and the Verasonics scanner. Super-resolution improvement is achieved by specific design of beam pattern and sampling.

2385593 Different Methods of Ultrasound Training for Medical Students at Cerrahpasa School of Medicine
Vira Fomenko,* Ramin Rajabi, Nicholas Taylor, Helene Nepomuceno, Soe Thein, Eric Dang, Joseph Zakaria, Michael Niechayev, Brittany Mitchell, J. Christian Fox
University of California, Irvine School of Medicine, San Jose, CA USA

Objectives: University of California Irvine medical students traveled to Cerrahpasa School of Medicine in Istanbul, Turkey, to teach medical students bedside ultrasound (BUS). Turkey suffers from economic challenges, making ultrasound an indispensable, cost-effective, and minimally invasive medical tool. Teaching medical students BUS indicates that it can be efficiently taught worldwide to maximize health care productivity. We aimed to compare different methods of teaching BUS in a 1-week course.

Methods: Three teaching methods were compared: lecture with hands-on training, podcast with hands-on training, and hands-on training alone. We predict that lecture with hands-on training would be most effective. BUS was taught in four 1-week sessions, of which each student could only attend one. One hundred thirty students participated in the BUS course. Hands-on training sessions accommodated 3 or 4 students per hour per group. Topics covered were (1) knobology, (2) cardiac, (3) abdominal, (4) pulmonary, and (5) focused assessment with sonography for trauma (FAST). Students were randomly assigned to 3 groups. Before the hands-on training, group A attended the lecture, group B watched the podcast, and group C had neither. All students took a pre- and post-training written exam. At the end, students were given a practical where they completed a FAST scan.

Results: Preliminary data indicate that students’ pre- to post-training scores increased by 47% in group A, by 44% in group B, and by 40% in group C. Pre-test written scores showed no significant difference using analysis of variance (ANOVA; \( F = 0.986; P = .377 \)); however, there was a significant increase between the groups on the post-test using ANOVA (\( F = 3.241; P = .044 \)). The practical exam average was significantly different: 90% for group A, 81% for group B, and 70% for group C (\( F = 3.295; P = .042 \)).

Conclusions: These preliminary results suggest that there is a difference in the didactic efficacy of different methods used to teach medical students basic ultrasound concepts as well as practical ultrasound skills. Specifically, watching a podcast in combination with attending a hands-on session improves the development of practical ultrasound skills.

2385633 An Overview of Ultrasound Scanner Display Performance and Management Features
Donald Tradup,* Scott Stekel, Zaiyang Long, Nicholas Hanganandreou
Radiology, Mayo Clinic, Rochester, MN USA

Objectives: Unlike other volumetric and projection imaging modalities, images in an ultrasound (US) exam do not sample all tissues in the patient region of interest, for presentation to the radiologist in the reading room. If pathology is not seen on the scanner, it is unlikely to end up in the reading room. Therefore US scanner displays require increased diagnostic (dx)-level performance compared with other modality displays. Our aim is to benchmark US scanner display performance and availability of features for effectively managing display quality.

Methods: We employed standard procedures for US scanner display setup and quality control (QC) to manage 138 systems (26 models from 8 vendors) in our clinical practice for both dx imaging and procedures. Setup involves specifying luminance operating points (especially maximum [L(nnax)]. QC includes assurance that Lmax meets setup specs, an artifact inspection, and an overall visual image quality assessment. Ideal displays would provide a high Lmax value, Digital Imaging and Communications in Medicine (DICOM) grayscale calibration and validation tools, test patterns needed for setup and QC, and luminance controls with...
visible settings that are locked out from users. We reviewed QC records and summarized compliance with these desired characteristics.

Results: Eighty-four percent of scanners had $\text{Lmax} \geq 120 \text{ cd/m}^2$; 11% had $\text{Lmax} \geq 150 \text{ cd/m}^2$, with a maximum of 207 cd/m², all well below the 350-cd/m² level recommended by the American College of Radiology for general dx interpretation. Table 1 summarizes availability of display-related features. Ninety-two percent of the systems had flat panel displays, the rest being cathode ray tubes.

Conclusions: US scanner displays are critical for optimizing patient benefit, but current systems are generally lacking in needed performance and features. Increased physician and sonographer focus on scanner display performance may drive improved capabilities in future commercial imaging systems.

### Cardiovascular Ultrasound

#### 2379959

**Managing Low-Risk Clots in High-Risk Patients: A Case Report Showing Propagation of Unstable Peroneal Deep Vein Thrombosis to Saddle Pulmonary Embolism During Serial Ultrasound Scanning**

Marcia Bockbrader¹, *Jayesh Vallabh¹, Kevin Donlon¹, Matthew Fanous⁴, David Bahner²

¹Physical Medicine and Rehabilitation, ²Emergency Medicine, Ohio State University, Columbus, OH USA

**Objectives:** To illustrate the propagation of low-risk deep vein thrombosis (DVT) to pulmonary embolism (PE) during serial venous duplex scanning (VDS) in a high-risk patient.

**Methods:** Case report of a 53-year-old hemiparetic male admitted to inpatient rehabilitation after an ischemic stroke with hemorrhagic conversion and craniectomy. He was monitored with serial VDS, received mechanical DVT prophylaxis, and began prophylactic heparin on post-stroke day (PSD) 22. On PSD 24, he developed right calf swelling with peroneal DVT diagnosed by VDS. He continued on prophylactic-dose anticoagulation until his next serial VDS on PSD 31, which visualized his right peroneal DVT and found a new partially occlusive thrombus in his right proximal femoral vein. The femoral DVT disappeared during scanning; he developed tachycardia, tachypnea, and oxygen desaturations and was found to have a large acute saddle PE on a pulmonary computed tomographic angiogram. He was then treated with therapeutic anticoagulation and inferior vena cava (IVC) filter placement.

**Results:** One of 6 calf DVTs propagate to become proximal DVTs or PEs. Current recommendations (Henry, 2014) stratify treatment by patient risk, with 1 month of therapeutic anticoagulation recommended for high-risk patients and serial scanning for both low- and high-risk patients with contraindications to anticoagulation. Implicit is the assumption that serial VDS carries minimal risk for clot propagation. However, in the early stages of DVT formation, unstable clots that are sessile with tenacious adhesion to vessel walls may be susceptible to being dislodged with pressure.

**Conclusions:** This case shows that conservative management of DVTs with serial VDS may not be benign in the acute stage of thrombus formation, when clots are most likely to be unstable. Rehabilitation patients often fall into the high-risk category for DVTs due to immobility but may also have conditions that are contraindications for anticoagulation.

In such high-risk patients who have low-risk clots, IVC filter placement may be preferred to serial VDS to prevent the morbidity and mortality associated with PE.

#### 2381853

**Carotid Body Abnormalities: Analysis of a Series of Cases Found Incidentally During Carotid Ultrasound**

Nathalie Garbani

Clinical, Life Line Screening, Independence, OH USA

**Objectives:** To illustrate the propagation of low-risk deep vein thrombosis (DVT) to pulmonary embolism (PE) during serial venous duplex scanning (VDS) in a high-risk patient.

**Methods:** Case report of a 53-year-old hemiparetic male admitted to inpatient rehabilitation after an ischemic stroke with hemorrhagic conversion and craniectomy. He was monitored with serial VDS, received mechanical DVT prophylaxis, and began prophylactic heparin on post-stroke day (PSD) 22. On PSD 24, he developed right calf swelling with peroneal DVT diagnosed by VDS. He continued on prophylactic-dose anticoagulation until his next serial VDS on PSD 31, which visualized his right peroneal DVT and found a new partially occlusive thrombus in his right proximal femoral vein. The femoral DVT disappeared during scanning; he developed tachycardia, tachypnea, and oxygen desaturations and was found to have a large acute saddle PE on a pulmonary computed tomographic angiogram. He was then treated with therapeutic anticoagulation and inferior vena cava (IVC) filter placement.

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In such high-risk patients who have low-risk clots, IVC filter placement may be preferred to serial VDS to prevent the morbidity and mortality associated with PE.

**2381928**

**Handheld Ultrasound Versus Chest Radiography in the Coronary Care Unit**

Colin Phillips,* Warren Manning

Cardiology, Beth Israel Deaconess Medical Center, Boston, MA USA

**Objectives:** Goal-directed handheld ultrasonography (HHU) has the potential to revolutionize the diagnosis and care of critically ill patients, although few data exist comparing it to existing imaging technology. We sought to examine the performance of HHU compared to daily portable chest radiography (CXR) to detect common diagnoses in the coronary care unit.

**Methods:** An experienced (4 years) HHU user performed an HHU examination for the presence of interstitial edema ($\geq 3$ comet tail artifacts) pneumonia (lung parenchyma consolidation), pericardial and pleural effusions, central line seen in the right ventricle, left atrial enlargement (left atrium diameter $> aorta$), and cardiomegaly (left ventricle larger than the scanning screen at 14 cm depth). Data were compared to the radiologist read of the CXR obtained within 30 minutes. HHU and CXR interpretations were performed blinded to the results of the other imaging modality.

**Results:** A total of 47 CXR and HHU exams were performed in 37 patients, with adequate quality in all studies. The most common CXR findings were central line position (66%) and pulmonary edema (45%). Overall performance of HHU to detect abnormalities was good, with sensitivity varying between 40% (pneumonia) and 100% for left atrial enlargement and specificity of 54% for left atrial enlargement and 100% for central line location (Table 1).

**Conclusions:** HHU is reasonably accurate in diagnosing common conditions in the coronary care unit with the added benefit of instantaneous bedside diagnosis and lack of ionizing radiation. Larger multicenter studies are needed to determine if the use of HHU could displace routine daily CXR in the coronary care unit.
with a linear or curvilinear array during bolus injections of 0.3 mL of Definity (Lantheus Medical Imaging, North Billerica, MA). Three Helix scanner (Siemens Medical Solutions, Mountain View, CA) petitions with 50% of the measured maximum knee extensor strength repeated knee extensions until the participant was unable to complete a repetition.

The quadriceps, 1 in a rest state and the other in a fatigue state. Muscle function was assessed using an ISPTA value of 0.03–0.24 W/cm² and pulse durations of 2 and 5 milliseconds, with burst periods (pulse repetition periods) of 100, 250, and 300 milliseconds. Multiple trials were conducted at each setting with 30 total trials, consisting of 30 seconds of continuous ultrasound exposure with a subsequent off interval of 1 minute.

Results: The rates of depolarization were assessed by the R-R interval durations (IDs) that were measured throughout the recording period. Prior to ultrasound delivery, the IDs were highly regular: ID range, 0.3–3.6 seconds. As ultrasound was delivered in an asynchronous manner, using ISPTA values of 0.03–0.24 W/cm² and pulse durations of 2 and 5 milliseconds, there was suppression/inhibition of cellular depolarization for 5–10 seconds during the first 15 seconds of the exposure period. Subsequent to this suppression/inhibition effect, the depolarization rate increased and demonstrated less R-R interval variability with IDs of 0.8–1.0 seconds (P < .05) after ultrasound exposure. This decreased interval variability persisted after ultrasound exposure. The ID changes occurred in a predictable fashion in greater than 90% of recordings using these ultrasound exposure parameters.

Conclusions: Ultrasound can inhibit and modify the frequency of spontaneous electrical depolarizations of neonatal ventricular cardiomyocytes in a cell-based model. Our results demonstrate that pulsed ultrasound can influence the mechanotransduction pathways of cardiomyocytes in the mecanoelectric feedback circuit in a dose- and time-dependent manner.

Contrast-Enhanced Ultrasound

2374736 Utility of Superb Microvascular Imaging for Visualizing Lesions in the Portal Vein

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Objectives: Portal vein thrombosis is sometimes observed in hepatic cirrhosis and hepatic cancer. Superb Microvascular Imaging (SMI), developed by Toshiba Medical Systems, is a new imaging technology that enables visualization of low-velocity blood flow without use of a contrast agent. This study compared visualizing lesions in the portal vein among SMI in monochrome mode (mSMI) with conventional Doppler technology (Advanced Dynamic Flow [ADF]) and with contrast-enhanced ultrasound (CEUS).

Methods: The Aplio500 diagnostic ultrasound system and a 3.5-MHz convex probe were used. CEUS was performed for 6 patients after rapid intravenous injection of 0.01 mL/kg Sonazoid. The following items were evaluated: (1) capability visualizing lesions in the portal vein; (2) capability of detecting blood flow signals within lesions in the portal vein; (3) levels of blood flow signals (1, dotted; 2, unclear line; 3, clear thread and streak sign); and (4) diagnostic US findings (blood clot or tumor...
thrombosis in the portal vein). Images were analyzed by 2 examiners and the agreement rate (κ coefficient) between them was calculated. Contrast-enhanced computed tomography was used as a gold standard.

**Results:** Among 11 subjects (7 men, 4 women), hepatic cirrhosis was found in 8, chronic hepatitis in 3, and concurrent liver cancer in 8. The definitive diagnosis was a blood clot thrombus in 6 cases and a tumor thrombus in 5 cases. The diagnostic accuracy was 64% for ADF, 91% for mSMI, and 91% for CEUS. Examination results agreed well between the examiners, with κ coefficients ≥0.5 for most evaluation items. However, in the item for evaluating the level of blood flow signals, only mSMI had a κ coefficient of 0.5.

**Conclusions:** The accuracy of mSMI was higher than that of ADF and comparable to that of CEUS in detecting lesions in the portal vein. Also, 2 examiners agreed that only mSMI clearly depicted blood flow signals within lesions. Taken together, these results indicate that mSMI is a useful and less-invasive technique for reproducible diagnosis of lesions in the portal vein.

**2377135 Contrast-Enhanced Ultrasound: A Problem-Solving Tool in the Multimodality Evaluation of Hepatocellular Carcinoma

**Eugenia Khorochkov1,* Joel Mercer1, Stefanie Lee12**

1Western University, London, Ontario, Canada; 2McMaster University, Hamilton, Ontario, Canada

**Objectives:** To review the indications and technique for contrast-enhanced ultrasound (CEUS) in the evaluation of liver lesions in patients at risk for hepatocellular carcinoma (HCC). To demonstrate the application of CEUS as a problem-solving modality in the imaging diagnosis of HCC. To provide the correlation between the hemodynamic parameters of conventional US, computed tomography (CT), magnetic resonance imaging (MRI), and CEUS in cases of HCC.

**Methods:** This educational e-poster will cover: indications for CEUS; performing CEUS and image optimization; CEUS findings in the liver and HCC; and case examples of CEUS as a problem-solving tool.

**Results:** HCC enhancement patterns on CEUS classically mirror those of more traditional imaging modalities, where there is early arterial hyperenhancement with “washout” in the portal venous phase. In cases such as these, a biopsy is often not necessary to confirm the diagnosis of HCC. However, not all HCCs demonstrate this classic pattern on static imaging modalities such as CT and MRI, which is where dynamic CEUS can function as an effective problem-solving tool, allowing for assessment of lesion characteristics in real time. This is especially useful in cases of infiltrative HCC, where enhancement may vary in pattern and timing. We have also found it to be an effective tool for distinguishing bland versus tumor thrombus by monitoring the enhancement pattern on CEUS where CT and MRI have been equivocal. This differentiation can be essential for patient staging and surgical planning. An additional benefit to CEUS is that it can be used in patients for whom iodinated contrast or gadolinium are contraindicated (ie, allergy, renal failure).

**Conclusions:** CEUS is a safe alternative in patients with impaired renal function or allergy to other forms of intravenous contrast, providing superior temporal resolution with real-time assessment of blood flow, which offers advantages over conventional US or CT/MRI. It can be an effective problem-solving tool in equivocal or challenging cases of HCC diagnosis (eg, confirming tumor thrombus, infiltrative HCC, late arterial enhancement, and/or delayed washout). The technical limitations are similar to those of conventional US.

**237733 Combination of Conventional Ultrasound and Contrast-Enhanced Ultrasound in Transjugular Intrahepatic Portosystemic Shunt Follow-up: An Effective Method

**Jean Ayoub**

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**Objectives:** Obstruction is a frequent transjugular intrahepatic portosystemic shunt (TIPS) complication, and its monitoring by ultrasound is ambiguous in the literature. The objective of this study was to demonstrate the efficacy of the color and pulsed Doppler velocity profile (CPDV) combined with contrast-enhanced ultrasound (CEUS) in assessment of TIPS dysfunction during 1 year for each patient.

**Methods:** Thirty-seven patients followed from 2007 to 2014 had baseline CPVD examinations 1 day before and 5 days after TIPS and follow-up at 1, 3, 6, 9, and 12 months, by the same operator. The results were correlated with those of the angiography. CEUS was used only in cases of doubt of shunt stenosis.

**Results:** After the procedure, portal vein and hepatic artery mean velocities increased by 270% and 162% (P < 0.0001). The portal and hepatic artery flow volumes increased by 311% and 178% (P < 0.0001). The portal vein pressure decreased by 71% (P < 0.0001) immediately after TIPS placement. There was a moderate intradividual correlation between portal vein pressure and portal mean velocity (R < 0.05). Most of these hemodynamic parameters decreased with time. TIPS dilatation was decided in cases of reversed flow in portal branches or pronounced spectral curve dispersal on pulsed Doppler. CEUS was also used to confirm TIPS obstruction. CPDV and CEUS diagnoses were confirmed by angiography and portal vein pressure during dilatation.

**Conclusions:** Color Doppler ultrasoundography combined with CEUS allowed quantitative and qualitative confirmation of the diagnosis of obstruction of TIPS. It is an effective and noninvasive method of evaluating shunt function. The success of this method requires adequate training of operators.

**2378960 Contrast-Enhanced Ultrasound Liver Imaging Reporting and Data System for Diagnosis of Hepatocellular Carcinoma: Initial Proposal

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**Objectives:** Hepatocellular carcinoma (HCC) is the second leading cause of cancer-related death worldwide and is the fastest growing cause of cancer death in the United States. The American College of Radiology endorsed the Liver Imaging Reporting and Data System (LI-RADS) to standardize the reporting and data collection of computed tomography (CT) and magnetic resonance (MR) imaging for HCC. It is expanded here to also include contrast-enhanced ultrasound (CEUS) for the same indication.

**Methods:** A CEUS LI-RADS working group has developed an initial proposal of CEUS LI-RADS categories, an algorithm, and management recommendations. The working template is based on the already established LI-RADS for CT and MR imaging and its stated objectives to:
apply consistent terminology; reduce imaging interpretation variability and errors; enhance communication with referring clinicians; facilitate quality assurance and research; facilitate integration and correlation between imaging modalities; and enhance communication with and understanding by patients. The working template encompasses the range of possible observations from obviously benign through definitely malignant, including HCC. The algorithm begins with the baseline appearance of the observation as well as its enhancement characteristics in the arterial, portal venous, and late phases, following contrast injection.

Results: The CEUS LI-RADS algorithm is shown in pictorial display of LR-5, definitely HCC; LR-M, malignant but not specific for HCC; LR-4, probably HCC; and other less-concerning appearances down to LR-1, a definitely benign lesion. Unique aspects of CEUS considered in the algorithm include the real-time acquisition of images as compared with the more “snapshot” acquisition with CT and MR, the necessity of precise timing in seconds, and the importance of washout characteristics (timing and its intensity). Further, the CEUS algorithm recognizes the importance of a nodule-based approach for CEUS as compared to CT and MR.

Conclusions: This initial proposal for CEUS LI-RADS will extend the benefits of consistent reporting and terminology to US from its already recognized benefit for CT and MR scans. This should improve its already recognized benefit for CT and MR.

Efficacy of Contrast-Enhanced Ultrasonography Compared with Color Doppler Imaging in Metastatic Cervical Lymph Nodes of Head and Neck Cancer Patients

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Objectives: It is well known that angiogenic processes in growing tumors promote increased vessel density and structural abnormalities. The purpose of this study is to evaluate the vascular density and morphology in metastatic lymph nodes by contrast-enhanced ultrasonography (CEUS) compared with other diagnostic modalities.

Methods: Nineteen patients with head and neck carcinoma from July 2014 to July 2015 were enrolled in this study. Written informed consent was obtained from each patient. Primary tumors were 8 in the hypopharynx, 4 in the oropharynx, 3 in the oral cavity, 1 in the larynx, 1 in the maxillary sinus, and 1 in the parotid gland. Clinical N classifications were 2 N1, 1 N2a, 12 N2b, and 4 N2c diseases diagnosed by a combination of physical examination, computed tomography, magnetic resonance imaging, and fluorodeoxyglucose-positron emission tomography. We used a HI VISION Preirus (Hitachi Medical Corporation) or LOGIQ E9 (GE Healthcare). The ultrasound contrast agent Sonazoid was injected intravenously into the cubital vein of the patients. Under contrast mode, movies of the image of metastatic lymph nodes of the patients were recorded, and obtained images were subjected to analysis by image-analyzing software.

Results: When we scanned the metastatic lymph nodes of the patients, 5 of 18 patients showed no signs of color Doppler images in their lymph nodes. However, CEUS revealed a microvascular network in these lymph nodes to some extent. Although 13 patients showed active color Doppler images in their lymph nodes, their vascular patterns were different from the images constructed by CEUS. Only 4 patients showed a similar pattern of vascular images. Vascular densities calculated by our software of the patients who showed no signs of Doppler images in their lymph nodes were smaller than those of the patients who showed active color Doppler images.

Conclusions: CEUS is thought to be quite useful to detect vascular networks in metastatic lymph nodes of head and neck cancer patients more accurately than color Doppler imaging.

Elastography


Grzegorz Malek,1,* Grzegorz Aderek, Witold Tomkowski, Monika Majdanska, Pawel Kucza, Artur Maliborski, Krzysztof Duda1
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Objectives: A properly assessed blood clot (acute or chronic) is the key source of information for staging of deep venous thrombosis (DVT) and for appropriate treatment. Over time, the blood clot becomes hardened. Strain imaging allows staging of clots and may help in assessing the effectiveness of treatment. VirtualTouch IQ is an implementation of acoustic radiation force impulse (ARFI) imaging allowing one to evaluate displacement and velocity of shear waves in many points in an appropriate region of interest. The purpose of this study was to assess the ability of sonostric strain imaging using ARFI technology to distinguish acute from chronic DVT.
Methods: Twenty-five patients with acute DVT and 25 with chronic DVT (>8 months) were studied. Compression ultrasound and ARFI imaging were performed with a 4-9-MHz linear array. VirtualTouch IQ imaging was used to assess clot properties. We compared shear wave velocity and displacement in 5 or 6 points in each clot. Relative thrombus echogenicity was assessed by comparing to the adjacent arterial lumen. Statistical analysis was performed with the Mann-Whitney U test and receiver operating characteristic analysis.

Results: The velocity of shear waves in patients with chronic DVT was significantly higher than in the group with acute DVT. Measured displacement was significantly lower in chronic DVT than in acute DVT.

Conclusions: Strain imaging is more accurate and specific than thrombus echogenicity evaluation. Assessment of thrombus aging using ARFI imaging (VirtualTouch IQ) is helpful in evaluation of acute DVT and post-thrombotic syndrome. Further investigations must be done.

2383331 Virtual Analysis of the Pancreas in Type 2 Diabetes by Ultrasound Acoustic Radiation Force Impulse Quantification Chunxiang Jin,* Yu He, Juanjuan Zheng, Hui Wang Third Hospital of Jilin University, Changchun, China

Objectives: To study the elastic properties of the pancreas in patients with type 2 diabetes.

Methods: Fifty patients with type 2 diabetes mellitus (DM group) and 25 healthy persons (control group) were included and underwent conventional sonography and virtual touch tissue quantification (VTQ). For every person, the thickness and the shear wave velocities (SWVs) of the pancreatic head, body, and tail were measured, respectively. Because of the interference of gas, the total numbers of pancreatic heads, bodies, and tails examined were 41, 50, and 35, respectively.

Results: The thickness of the pancreatic body in the DM group was significantly lower than that in the control group (P < .05). The local shear wave velocity of the pancreatic head, body, and tail in the DM group was significantly higher than that in control group (P < .05).

Conclusions: Acoustic radiation force impulse imaging with VTQ demonstrated a difference in pancreas stiffness between patients with type 2 diabetes and healthy persons.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DM</th>
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<tr>
<td></td>
<td>Thickness, cm</td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>1.75 ± 0.30</td>
<td>1.73 ± 0.22</td>
</tr>
<tr>
<td>Body</td>
<td>1.43 ± 0.18</td>
<td>1.25 ± 0.20 a</td>
</tr>
<tr>
<td>Tail</td>
<td>1.50 ± 0.20</td>
<td>1.40 ± 0.23</td>
</tr>
<tr>
<td>SWV, m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>1.04 ± 0.06</td>
<td>1.09 ± 0.10 a</td>
</tr>
<tr>
<td>Body</td>
<td>1.08 ± 0.07</td>
<td>1.29 ± 0.12 a</td>
</tr>
<tr>
<td>Tail</td>
<td>1.04 ± 0.07</td>
<td>1.10 ± 0.08 a</td>
</tr>
</tbody>
</table>

*P < .05 compared with control group.

2339640 Mobile Echogenic Material on Ocular Ultrasound Is Not Always Pathologic: A Cross-sectional Survey in an Asymptomatic Emergency Department Population Gavin Budhram1,*, Jennifer Cronsell2, Michele Schroeder3 Emergency Medicine, Baystate Medical Center, Springfield, MA USA; 2Emergency Medicine, Bridgeport Hospital, Bridgeport, CT USA; 3Emergency Medicine, Baystate Medical Center, South Hadley, MA USA

Objectives: Bedside ultrasound is an adjunct to standard examination techniques in emergency department patients with ocular trauma or acute vision loss. Several pathologic conditions have similar appearances on ultrasound and may even overlap with normal age-related changes. One approach that clinicians often use is to assume that unilateral findings visible at normal gain are acute, while bilateral findings requiring high gain are chronic, especially in the elderly population. To date, no ultrasound studies have systematically evaluated this assumption. Our objective is to determine the prevalence of monocular and binocular mobile echogenic material (MEM) in the posterior ocular chamber at normal and high gain levels and to evaluate if it increases in prevalence with age in an asymptomatic population.

Methods: We conducted a cross-sectional survey of 105 asymptomatic subjects aged 20–89 years and evaluated each subject’s eyes for the presence of MEM at both normal and high gain levels.

Results: Ultrasound scans were obtained on a total of 105 subjects (210 eyes). At normal gain levels, MEM was present in 1 subject unilaterally (0.95%; 95% confidence interval, 0.0%–5.0%). At high gain levels, MEM was present in 28.6% (30/105) of subjects. Of the subjects with MEM at high gain, 60% (18/30) had unilateral MEM. MEM at high gain was found more frequently with advancing age, being present in 23 subjects older than 59 years, compared with 7 subjects 59 years and younger (51.1% vs 11.7%; P < .001).

Conclusions: Our findings suggest that MEM in the posterior chamber visualized at high gain levels is relatively common and may not be pathologic, even if unilateral and occurring at a relatively young age.
American Institute of Ultrasound in Medicine Proceedings


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2366290 A Proposed Milestone for Pediatric Emergency Medicine Point-of-Care Ultrasound Competency

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**Objectives:** The Accreditation Council for Graduate Medical Education (ACGME) developed milestones for physician assessment in many subspecialties. Point-of-care ultrasound (POCUS) is one of 23 designated milestones in emergency medicine (EM); however, there are no specific milestones for pediatric emergency medicine (PEM) POCUS competency. Our objective was to assess PEM provider self-evaluation of POCUS skills using a modified assessment tool (MAT) based on the EM milestones.

**Methods:** This was a electronic survey of PEM faculty and fellows at 4 Midwestern pediatric academic centers. The survey included demographics, POCUS experience, and the MAT. Participants rated their competency level using the MAT with 2 established PEM ACGME milestones included for comparison. All milestones were scored from levels 1–5; 5 indicates highest competency. The Fisher exact test evaluated the association between training level and previous ultrasound experience with respect to the MAT.

**Results:** The response rate was 89% (123/138); 70.7% were PEM attending physicians and 29.3% PEM fellows. Eleven percent reported no EM POCUS training, and 17.4% reported no PEM POCUS training. On the MAT, 69.9% selected competency level 1 or 2 for POCUS in pediatric patients. In contrast, 54.5% and 73.2% respondents, respectively, selected competency level 4 or 5 for general procedures and medical stabilization of pediatric patients not using POCUS. There was a statistically significant association between self-reported POCUS milestone competency and provider type (P = .04), as well as previous POCUS training (P < .001). All respondents without POCUS training selected level 3 or less (83.2%).

**Conclusions:** This regional multicenter study supports the feasibility of using a milestone-derived tool to self-assess PEM POCUS competency. Respondents reported significantly lower POCUS competency as compared to established PEM ACGME milestones. The majority rate themselves as having lower competency in PEM POCUS despite training. With the increased use of POCUS in PEM, a measure of ultrasound competency for physicians is needed. Further studies could validate the use of this milestone at the national level.

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2366942 Ultrasound of Hepatic Infections: A Sonographic Pictorial Review

Vijayanadhi Ojill1,* Neeraj Kaur1, Arpit Nagari2

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**Objectives:** To describe the sonographic findings of hepatic infections and correlate these with computed tomographic (CT) findings where available.

**Methods:** A brief review of hepatic infections (including viral hepatitis, liver abscess, hydatid cyst, gas-containing hepatic abscess, mucormycosis, tuberculosis, schistosomiasis, etc) will be presented. The sonographic findings will be described and correlated with CT findings where available. Pertinent management issues including the role of ultrasound-guided interventions will be briefly discussed.

**Results:** Not applicable as this is a pictorial review.

**Conclusions:** The clinical manifestations of hepatic infections are varied and may range from being totally asymptomatic to potentially life-threatening presentations that may require aggressive medical, imaged-guided, or surgical management. Therefore, it is important for the radiologist to accurately diagnose these conditions in a timely fashion. Ultrasound may be the initial imaging test performed in the diagnostic workup of these patients and will provide a diagnosis in most cases. Ultrasound-guided interventions play an important role in the management of these patients.

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2371810 Operating Characteristics of Point-of-Care Ultrasound in Identifying Skin and Soft Tissue Abscesses in the Emergency Department

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1Emergency Medicine, State University of New York Downstate Medical Center/Kings County Hospital Center, Brooklyn, NY USA

**Objectives:** Emergency physicians evaluating skin and soft tissue infections (SSTI) must differentiate abscess from cellulitis, as the former benefits from incision and drainage. Our objective was to determine operating characteristics of point-of-care ultrasound (POCUS) compared to clinical exam in identifying abscesses in emergency department (ED) patients with SSTI features.

**Methods:** We systematically searched the MEDLINE, Web of Science, EMBASE, Cumulative Index to Nursing and Allied Health Literature, and Cochrane Library databases. Trials comparing POCUS with clinical exam to identify skin and soft tissue abscesses were included. Trials that included intraoral abscesses or abscess drainage in the operating room were excluded. Abscess presence was determined by pus drainage. No pus on incision or resolution without pus drainage at follow up proved no abscess. Quality of trials was assessed using Grades of Recommendation, Assessment, Development, and Evaluation criteria. Operating characteristics are reported as sensitivity, specificity, positive likelihood ratio (LR+), and negative likelihood ratio (LR−). Summary measures were calculated by generating a hierarchical summary receiver operating characteristic model (HSROC).

**Results:** Of 3203 references identified, 5 observational studies with 615 patients were included. We rated the quality of 3 trials as low and 2 as very low. The operating characteristics of POCUS and clinical exam are presented Table 1. The POCUS HSROC revealed a sensitivity of 96% (95% confidence interval [CI], 89%–98%), specificity of 79% (95% CI, 71%–86%), LR+ of 4.6 (95% CI, 3.2–6.8), and LR− of 0.06 (95% CI, 0.02–0.2).

**Conclusions:** Existing evidence indicates that POCUS is useful in identifying abscesses in ED patients with SSTI.
Table 1

<table>
<thead>
<tr>
<th>Study and Intervention</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>LR+</th>
<th>LR−</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marin et al, 2013</td>
<td></td>
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<tr>
<td>Clinical exam</td>
<td>87 (81–91)</td>
<td>71 (62–79)</td>
<td>3.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Clinical exam + POCUS</td>
<td>88 (82–92)</td>
<td>72 (63–79)</td>
<td>3.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Ivenson et al, 2012</td>
<td></td>
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<tr>
<td>Clinical exam</td>
<td>90 (75–97)</td>
<td>72 (50–87)</td>
<td>3.2</td>
<td>0.1</td>
</tr>
<tr>
<td>POCUS</td>
<td>98 (85–100)</td>
<td>68 (46–84)</td>
<td>3.0</td>
<td>0.04</td>
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<tr>
<td>Berger et al, 2012</td>
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<tr>
<td>Clinical exam</td>
<td>76 (58–89)</td>
<td>83 (36–99)</td>
<td>4.6</td>
<td>0.3</td>
</tr>
<tr>
<td>POCUS</td>
<td>97 (83–100)</td>
<td>67 (24–94)</td>
<td>4.0</td>
<td>0.04</td>
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<td>Sivitz et al, 2010</td>
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<tr>
<td>Clinical exam</td>
<td>78 (52–93)</td>
<td>81 (63–92)</td>
<td>4.1</td>
<td>0.3</td>
</tr>
<tr>
<td>POCUS</td>
<td>94 (68–100)</td>
<td>85 (68–94)</td>
<td>6.4</td>
<td>0.07</td>
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<tr>
<td>Squire et al, 2005</td>
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<tr>
<td>Clinical exam</td>
<td>86 (74–93)</td>
<td>70 (54–82)</td>
<td>2.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Clinical exam + POCUS</td>
<td>98 (90–100)</td>
<td>88 (74–96)</td>
<td>8.5</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Values in parentheses are 95% CIs.

Conclusions: This scale is not meant to replace credentialing or accreditation services but rather serve as a tool to represent the breadth of academic ultrasound within a program. The PULSE scale can be used by program or departmental leadership to determine the strengths and weaknesses of a program to continually make it better. Residents, fellows, and attending physicians applying to training institutions may use the scale to objectively evaluate the ultrasound footprint of a program and match individual goals with program resources. Further studies will have to determine whether the PULSE can be used for tracking specialty integration with academic ultrasound.

2373982 Suspected Small-Bowel Obstruction in the Emergency Department: Accuracy of Point-of-Care Ultrasound

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Objectives: Emergency department (ED) patients with suspected small-bowel obstruction (SBO) are often screened with relatively insensitive abdominal x-rays (AXR). Negative or inconclusive results generally necessitate subsequent evaluation with computed tomography (CT). Use of point-of-care ultrasound (POC US) as an initial screening test for SBO might reduce the need for CT imaging, decrease exposure to radiation, and expedite patient care. The primary objective of this study was to evaluate the accuracy of POC US in the diagnosis of SBO.

Methods: We conducted a prospective observational study of adult ED patients with suspected SBO. POC US for SBO was performed by an attending, fellow, or resident physician prior to the completion of AXR or CT. The presence or absence of SBO on POC US and AXR, as well as specific sonographic findings, were compared to the criterion standard of CT as well as discharge diagnosis. Sensitivity, specificity, and likelihood ratios (LRs) were calculated for both POC US and AXR.

Results: A total of 63 patients have been enrolled to date, of which 39 had POC US performed by a resident or fellow. POC US demonstrated an overall sensitivity of 93.5% (95% confidence interval, 77.9%–99.2%), specificity of 51.5% (33.5%–69.2%), +LR of 1.93 (1.34–2.77), and −LR of 0.13 (0.03–0.51) for the diagnosis of SBO. "To-and-fro" peristalsis (90.0% [73.5%–97.9%]) and small-bowel diameter >25 mm (90.0% [73.5%–97.9%]) were the most sensitive findings. The most specific finding was the presence of a transition point (93.9% [79.8%–99.3%]), although this was seen or suspected in only 11 cases. In comparison, AXR was performed in 31 of 63 patients and demonstrated a sensitivity of 71.4% (47.8%–88.7%), specificity of 90.0% (55.5%–99.8%), +LR of 7.14 (1.09–46.76), and −LR of 0.32 (0.16–0.64).

Conclusions: On the basis of interim data analysis, POC US is more sensitive than AXR in the diagnosis of SBO, although less specific. POC US is unlikely in the absence of "to-and-fro" peristalsis or small-bowel diameter >25 mm and likely in the presence of an identifiable transition point.

2374957 Peripheral Venous Cannulation Skill Acquisition Using Commercial and Homemade Ultrasound Phantoms

Dustin Morrow,∗ Julia Cuppi, Patrick Hunt, Richard Hoppmann
1Emergency Medicine, 2School of Medicine, University of South Carolina, Columbia, SC USA; 3Internal Medicine, Duke University, Durham, NC USA

Objectives: Ultrasound-guided peripheral vascular access decreases use of central lines, increases patient satisfaction, and expedites medical interventions. Providers are trained in this technique using ultrasound phantoms, but effective training strategies are limited, in part, by the high cost of commercial phantoms. This has led to the proliferation of alternative sonographic models for simulation, including food and animal models, which have limitations including penetrability and infection control concerns; these early methods were optimized using a commercially

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available ballistic-grade gelatin to create a phantom that is low cost, clean, and reusable. The published descriptions of these models have only given qualitative reports of course participant perceptions of their training utility. We now describe a formal study to objectively test the utility of both commercial and homemade models for training novices in the technique of ultrasound-guided peripheral vascular access.

Methods: Thirty-six medical students naïve to the technique will be randomized into 3 groups with the following educational interventions: didactics alone (control group); didactics + simulation with commercial phantoms; and didactics + simulation with homemade phantoms. They will be tested by a blinded proctor before and after their educational intervention with 5 timed attempts at intravenous cannulation of a Blue Phantom model. The primary outcome is the change in the number of successful attempts from before to after the educational intervention. Secondary outcomes will include participant perception surveys and time to cannulation. This study has been approved as Institutional Review Board exempt.

Results: The study event is scheduled to take place November 13, 2015. Results will be available well in advance of April 2, 2016.

Conclusions: We plan to report side-by-side comparisons of the effects of 3 teaching methods—commercial phantoms, homemade phantoms, and didactics alone—on objective skill testing as well as learners’ perception of preparedness. This would provide evidence to defend current simulation practices, as well as provide a foundation for future studies and educational initiatives.

2377342 The Hidden Territory of Transvaginal Ultrasound: A Window to Nongynecologic Pathology

Key words: Buchanan,* Artur Velcani
Diagnostic Radiology, Yale–New Haven Hospital, New Haven, CT USA

Objectives: While the most common causes of pelvic pain in females are secondary to uterine and ovarian pathology, other structures are in close physical proximity and can precipitate symptoms within the pelvis. These structures include small and large bowel, appendix, urinary bladder, mesenteric fat, lymph nodes, and blood vessels. Although transvaginal ultrasound is essential for evaluation of the uterus and the ovaries, often nongynecologic organs are well visualized and can demonstrate important incidental findings, which in the majority of the cases are acute in nature. The objective of this exhibit is to display illustrative cases of these incidental findings and describe methods to better visualize and analyze these entities so as to improve sensitivity in the acute setting.

Methods: In this review, we display cases of the most commonly detected nongynecologic findings on transvaginal ultrasound and outline the sonographic features of each entity, including acute appendicitis, distal ureteral or ureterovesical junction calculi, acute diverticulitis, urinary bladder masses, cystitis, pelvic vein thrombosis, as well as nongynecologic pelvic masses, specifically carcinoid tumors.

Results: Sonographic illustrations are presented along with descriptions of techniques to better visualize these entities. This exhibit also discusses the clinical significance of detecting these pathologies and provides management options for guiding referring clinicians.

Conclusions: Enhanced awareness of the ability to discover nongynecologic findings on transvaginal ultrasound will heighten observer sensitivity for detection, consequently resulting in more appropriate diagnoses and ultimately more efficient patient care.

237788 Bedside Ultrasound Evaluation of Diaphragm Thickening

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Objectives: To characterize and quantify diaphragm behavior, specifically diaphragm thickness (Tdi) with respect to tidal volume (Vt), under various conditions of ventilation and neurologic states.

Methods: Using a high-frequency linear array transducer, the right hemidiaphragm is visualized in B-mode at the zone of apposition at a right midaxillary scan plane. Images are acquired at both end-expiration and maximal inspiration. Tdi is measured on still frames. The thickening fraction (TF) is calculated as (Tmax – Tmin)/Tmax for each delivered Vt. Subjects enrolled thus far include those who are mechanically ventilated (n = 4), on pressure support (n = 2), and healthy volunteers (n = 5).

Results: Among healthy volunteers, the average Tdi values achieved with maximal inspiration and expiration were 0.46 and 0.17 mm, respectively, correlating with a TF of 1.79. This contrasts in a subject who was evaluated on pressure support following >48 hours of mechanical ventilation (MV), with Tdi inspiration and expiration of 0.13 and 0.09 mm, respectively, correlating with a TF of 0.44. Another subject, with a history of amyotrophic lateral sclerosis, had markedly lower values, with Tdi inspiration and expiration of 0.08 and 0.07 mm, respectively, and a TF of 0.14. Among subjects undergoing positive-pressure ventilation under sedation, there was a trend toward increased TF with respect to increased Vt. The average TF values observed at 400, 600, and 800 mL were 0.34, 0.52, and 0.65, respectively.

Conclusions: The diaphragm, a primary muscle of respiration, rapidly atrophies under the influence of MV, and its ability to contract is consequently impaired, as evidenced by a markedly reduced TF. Nevertheless, we observed a positive correlation between Vt and TF, indicating a more robust muscular contraction with larger volumes of delivered air. Notably, these changes may be observed and quantified with the use of bedside ultrasound. Looking forward, we aim to further characterize the effects of MV on the diaphragm in various patient populations. Deeper insight into the physiologic and structural changes that occur in the setting of positive-pressure MV can alter the way we think about respiratory failure, how we teach it, and ultimately how we treat it.

2378430 Creating a Happy Home: Impact of Point-of-Care Ultrasound Services on Physician in-House Satisfaction

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Objectives: To determine whether having an in-house point-of-care ultrasound (POCUS) service staffed by ultrasound fellowship-trained physicians improves emergency medicine physician satisfaction.

Methods: A 12-question survey regarding satisfaction of POCUS services was distributed among 39 non-ultrasound fellowship-trained physicians at a university hospital with a residency program. Participation was voluntary, and all responses were anonymous.

Results: Thirty-five of 39 physicians (90%) replied. Overall, respondents felt that in-house POCUS provided by their fellowship-trained colleagues was performed in a timely fashion; was of high quality; did not need confirmation by a radiology department study, assisted with length of stay, quality of care, and disposition in a timely fashion, and thus improved their workplace satisfaction (Table 1). 

Conclusions: This study demonstrates a high level of satisfaction with an emergency physician–staffed POCUS team. It also suggests a high level of trust with the sonographic diagnoses made and a decreased need to obtain ultrasound imaging outside the emergency department (ED).
2378535 Expectations and Outcomes for the Development of an Ultrasound Curriculum in a Resource-Limited Environment
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Objectives: Point-of-care ultrasound (US) can be an invaluable tool in resource-limited settings. With increasing recognition of the benefits of global health training, physicians from developed countries are traveling to resource-limited areas for US courses or to establish US programs. The objective of this study was to determine if instructors could design appropriate didactics for Mozambican medical students based on limited knowledge of students’ backgrounds and needs, and if surveying novice learners before training would be informative for curriculum development.

Methods: Members of the US and global health divisions traveled to Beira, Mozambique, to teach a 3-day course in US for 20 fifth-year medical students. The curriculum included lectures on 12 topics based on experience conducting similar courses and research on regional disease patterns. Instructors and students were surveyed 1 day before the course and 1 day after. The survey collected information about perceptions of local morbidity/mortality and the utility of US modalities, as well as anticipated barriers to adoption and suggested curriculum changes.

Results: Overall, instructors accurately identified the diseases perceived by students as most prevalent and responsible for the most mortality; however, they overestimated the rate of obstetric (OB) complications. They also overestimated the extent of trauma and infectious diseases other than human immunodeficiency virus, tuberculosis, and malaria. Regarding the utility of each US modality, instructors rated focused assessment with sonography for trauma (FAST), late OB, and intravenous (IV) access highest and then thoracic and procedural guidance highest after the course. Students rated cardiac and late OB highest, and cardiac and thoracic lowest. After the course, 40%–50% of students rated cardiac, thoracic, FAST, early OB, and late OB in their top 3.

Conclusions: Based on limited research of the local epidemiology and medical system, instructors designed a course for medical students that was well-received; however, when instructors’ and students’ answers were compared, it was evident that the curriculum could have been improved by several changes: namely, less focus on OB, IV access, and skin/soft tissue evaluation and more emphasis on thoracic and procedural guidance.

Table 1. Physician Responses to the POCUS Satisfaction Survey
<table>
<thead>
<tr>
<th>Question</th>
<th>Mode</th>
<th>Mean</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ultrasound team performs studies timely</td>
<td>4</td>
<td>3.83</td>
<td>3.59–3.91</td>
</tr>
<tr>
<td>2. Trust diagnoses made by ED sonographer</td>
<td>4</td>
<td>3.91</td>
<td>3.78–4.00</td>
</tr>
<tr>
<td>3. Studies are more accessible due to POCUS service</td>
<td>4</td>
<td>3.71</td>
<td>3.31–3.83</td>
</tr>
<tr>
<td>4. POCUS assists with timely patient disposition</td>
<td>4</td>
<td>3.69</td>
<td>3.49–3.88</td>
</tr>
<tr>
<td>5. Overall satisfied with POCUS service</td>
<td>4</td>
<td>3.74</td>
<td>3.40–3.80</td>
</tr>
<tr>
<td>6. During residency received training in POCUS</td>
<td>4</td>
<td>3.14</td>
<td>2.83–3.59</td>
</tr>
<tr>
<td>7. POCUS service increases job satisfaction</td>
<td>3</td>
<td>3.17</td>
<td>2.83–3.59</td>
</tr>
<tr>
<td>8. POCUS assists in providing better clinical care</td>
<td>3</td>
<td>3.34</td>
<td>3.12–3.60</td>
</tr>
<tr>
<td>9. POCUS service not available when needed</td>
<td>2</td>
<td>2.00</td>
<td>1.67–2.19</td>
</tr>
<tr>
<td>10. POCUS does not assist in providing better care</td>
<td>1</td>
<td>1.37</td>
<td>1.24–1.76</td>
</tr>
<tr>
<td>11. POCUS did not decrease length of stay in ED</td>
<td>1</td>
<td>1.49</td>
<td>1.29–1.71</td>
</tr>
<tr>
<td>12. POCUS does not decrease length of stay in ED</td>
<td>1</td>
<td>1.77</td>
<td>1.48–2.02</td>
</tr>
</tbody>
</table>

CI indicates confidence interval: 1, strongly disagree; 2, disagree; 3, agree; and 4, strongly agree.

2378883 Comparison of Subxiphoid Versus Parasternal Long-Axis Views in Focused Assessment With Sonography for Trauma Examinations
Tanya Bajaj,* Christopher Raine, Maya Lin, Mathew Nelson, Adam Ash
1Emergency Medicine, North Shore University Hospital, Manhasset, NY USA; 2Emergency Medicine, Good Samaritan Hospital, West Islip, NY USA; 3Emergency Medicine, New York Methodist Hospital, Brooklyn, NY USA; 4Emergency Medicine, St Joseph Hospital, Bethpage, NY USA

Objectives: To compare the subxiphoid (Sx) and parasternal long-axis (PSL) views during a focused assessment with sonography for trauma (FAST) exam for the following aspects: the image quality of the view, the length of time to obtain the view, the sonographer preference, and the perceived difficulty in obtaining the view. A secondary objective is to determine whether a correlation exists between the quality of the view and the body mass index (BMI) of a patient undergoing a FAST exam.

Methods: This is a prospective study in the emergency department at an academic level 1 trauma center. The study included any adult patient undergoing a clinically indicated FAST exam. Pregnant and pediatric patients were excluded. Sonographers were timed in obtaining video clips of the 2 views as part of the FAST exam. They then completed a survey addressing these topics: the sonographer preference of view, relative difficulty in obtaining each view, and quality of images of each view. Two cardiologists, each blinded to the study’s objectives, reviewed each video clip and graded the images based on a modified Brightness Mode Quality Ultrasound Imaging Examination Technique (mBQ) scale.

Results: Data collection on 35 scans has been completed. The average mBQ score from rater 1 for the Sx view was 9.21 (SD, 6.02), and from rater 2 it was 9.18 (SD, 4.67). The average time was 32 seconds (SD, 17.8 seconds) to obtain the Sx image. For the PSL view, the average mBQ score from rater 1 was 10.48 (SD, 4.88), and from rater 2, it was 9.97 (SD, 4.26). The average time to obtain the view was 27.5 seconds (SD, 15.8 seconds). Linear regression analysis shows a slight trend toward an inverse relationship between mBQ scores and BMI for both the Sx and PSL views, with the trend being more pronounced for the Sx view (r = –0.47 and –0.35 for raters 1 and 2, respectively, for the Sx view and r = –0.28 and –0.17 for raters 1 and 2, respectively, for the PSL view).

Conclusions: The preliminary data show that there is no statistical difference between the image quality of both views overall. Experienced sonographers obtain better images using the PSL view. The PSL view may be superior to the subxiphoid view as patient BMI increases.

2380777 Implementation of a 4-Year Ultrasound Curriculum in a Medical School
Jason Mefford,* Sean Wilson, Shadi Lahham, Mohammed Subeh, J. Christian Fox
Emergency Medicine, University of California, Irvine, Orange, CA USA

Objectives: The ability of point-of-care ultrasound (POCUS) to improve patient care, save time, and reduce cost has been well established. Furthermore, the use of POCUS has continued to grow in the practice of medicine globally. As such, the need to integrate ultrasound into medical education is becoming of increasing importance. After implementing a 4-year ultrasound curriculum in a medical school, we sought to assess whether graduating students were able to demonstrate a basic understanding of ultrasound physics, machine operation, and image interpretation.

Methods: A 4-year ultrasound curriculum was integrated into the medical school educational curriculum, which consisted of teaching basic knowledge of ultrasound physics and machine use (referred to as “knobology”) and interpretation of ultrasound images. The curriculum was implemented using both didactics and hands-on experience with live models. On completing the program, fourth-year medical students were...
administered an exit exam consisting of 48 questions, divided into 19 knobby questions and 29 interpretation questions. The image interpretation questions were further subdivided by anatomic system with 9 cardiac, 2 thoracic, 3 abdominal, 9 vascular, 1 genitourinary, and 5 musculoskeletal questions. Average scores and system-specific scores with corresponding standard deviations were calculated. It was assumed that medical students would have little to no prior ultrasound experience prior to matriculating to medical school.

**Results:** Ninety-five percent (n = 84) of fourth-year medical students completed the exam. The overall mean score was 79.5% (SD, 10.2%), with mean scores on the knobby and anatomy portions being 77.1% (SD, 11.0%) and 85.9% (SD, 21.0%), respectively. In the anatomy subdivision, mean scores by system were: cardiac, 95.2% (SD, 18.7%); thoracic, 89.7% (SD, 17.1%); abdominal, 80.0% (SD, 17.6%); vascular, 96.4% (SD, 18.9%); genitourinary, 74.5% (SD, 25.6%); and musculoskeletal, 77.9% (SD, 18.3%).

**Conclusions:** After implementation of a 4-year ultrasound curriculum, medical trainees were able to demonstrate a basic understanding of ultrasound physics, machine use, and image interpretation.

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**2380792 Effect of Prior Concussion on Sonographic Optic Nerve Sheath Diameter Measurement After Undergoing Transient Intracranial Pressure Change**

**Ivan Morales1,* Kyle Friez1, Richard Gordon1,2, Matthew Lyon1,3**

1Medical College of Georgia, Augusta, GA USA; 2Emergency Medicine, Georgia Regents University, Augusta, GA USA

**Objectives:** The measurement of the optic nerve sheath diameter (ONSD) by ultrasound is widely recognized as a correlate of intracranial pressure (ICP). Measurement of the ONSD by ultrasound is a quick, noninvasive, and readily available point-of-care tool that can indicate the need for further evaluation of elevated ICP when ONSD dilation is noted. With the increased clinical prevalence of utilizing sonographic ONSD measurements, it is important to recognize additional causes of ONSD dilation. The purpose of this study was to determine the effect of prior concussion on sonographic ONSD measurements after undergoing a transient ICP change via the Valsalva maneuver.

**Methods:** The ONSDs of 10 participants without prior traumatic brain injury (TBI) and 10 participants with a history of mild TBI (concussion) that occurred 1–14 years earlier were measured via ultrasound. The ONSD of each participant was then measured immediately after performing the Valsalva maneuver for 30–45 seconds. The pre- and post-Valsalva ONSD measurements of each group were then compared using a 2-tailed paired t-test.

**Results:** The group without prior TBI showed no significant ONSD dilation with an average increase of 0.03 mm (95% confidence interval [CI], –0.03–0.09 mm; \( P = 0.3446 \)). The group with prior concussion showed significant ONSD dilation with an average increase of 1.31 mm (95% CI, 0.89–1.74 mm; \( P = 0.0001 \)).

**Conclusions:** These results indicate that transient increases of ICP can interfere with ONSD measurements when individuals have experienced prior concussions. The ability of the ONSD to remain dilated after physiologic processes such as Valsalva suggests that dilation may not be representative of increases in ICP secondary to acute injury in individuals with a prior history of concussion. Additionally, detection of abnormal ONSD dilation after the Valsalva maneuver may serve as a screen for or evidence of prior concussion.

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**Table 1. Results**

<table>
<thead>
<tr>
<th></th>
<th>No History of TBI (n = 10)</th>
<th>History of Mild TBI (n = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, y</td>
<td>22.8</td>
<td>25.0</td>
</tr>
<tr>
<td>Mean baseline ONSD, mm</td>
<td>4.28 ± 0.13</td>
<td>4.29 ± 0.14</td>
</tr>
<tr>
<td>Mean post-Valsalva ONSD, mm</td>
<td>4.31 ± 0.12</td>
<td>5.60 ± 0.17</td>
</tr>
<tr>
<td>Mean ONSD dilation, mm</td>
<td>0.03</td>
<td>1.31</td>
</tr>
</tbody>
</table>

\( P = 0.3446 \) for official radiology CXR interpretation.

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**2380891 Does Confirmation by Plain-Film Radiography Delay the Use of a Central Venous Catheter When Compared to Ultrasound?**

**Samer Assaf1,* Sean Wilson1, Chiem Alan2, Shadi Lahham1, Mohammed Subeh1, Samantha Shwe2, J. Christian Fox1**

1Emergency Medicine, University of California, Irvine, Orange, CA USA; 2Emergency Medicine, University of California, Los Angeles, Sylmar, CA USA

**Objectives:** The current standard practice is to confirm correct placement of central venous catheters of the internal jugular and subclavian veins with plain-film chest radiography (CXR) prior to their use. Previous studies have demonstrated that point-of-care ultrasound (POCUS) may have a potential application to confirm correct placement of these invasive lines. We hypothesized that POCUS would reduce time to confirm correct catheter placement. We therefore sought to compare time to placement confirmation by POCUS to CXR.

**Methods:** This study was a convenience sample of patients in the emergency department and intensive care unit who required central venous catheter placement in the internal jugular or subclavian vein from January 2012 through May 2015. An emergency medicine or internal medicine resident trainee performed the POCUS evaluation after line placement. Correct placement was determined if turbulent flow was visualized in the right atrium on a subxiphoid, parasternal, or apical cardiac view after injecting 5 cc of nonagitated normal saline through the central line. Research assistants recorded time to POCUS, CXR completion, and official radiology CXR interpretation. A 2-sample t test was used to compare groups.

**Results:** Seventy-eight patients were enrolled; 52% were female, and average body mass index was 29. POCUS had a sensitivity of 84.2% (95% confidence interval [CI], 74.0%–91.6%) and specificity of 100% (95% CI, 15.8%–100.0%) for identifying correct central venous catheter placement. Average times from the start of the procedure to POCUS confirmation, radiography completion, and official radiology read of plain-film radiography were 28, 38, and 449 minutes, respectively. There was a delay of 10 minutes (95% CI, 0.1–20.2 minutes; \( P = 0.06 \)) for CXR completion and 449 minutes (95% CI, 316.7–525.3 minutes; \( P < 0.05 \)) for official radiology CXR interpretation.

**Conclusions:** POCUS may be an effective tool for the early confirmation of central venous catheter placement, especially in instances where there is a delay in obtaining a confirmatory CXR.
2381023 A Survey Evaluation of Barriers to Provider Compliance With Point-of-Care Ultrasound Documentation

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1Emergency Medicine, Mount Sinai St Luke’s Roosevelt, New York, NY USA; 2Kaiser Oakland, Oakland, CA USA

Objectives: Inadequate point of care ultrasound (POC US) documentation may be detrimental to patient care and lead to substantial lost revenue. The objective of this study was to survey emergency attending physicians on their use of POC US, barriers to documentation, work flow improvements, and incentives. This information may guide improved practices at our institution and may be applicable to other institutions.

Methods: A survey was e-mailed to 42 salaried attending physicians at a large academic medical center with an emergency US fellowship and an annual census of 180,000 visits. Fellows, per diem staff, and US faculty were excluded. Responses were anonymous, and data were analyzed with descriptive statistics.

Results: Thirty physicians responded to the survey (71.4%). Average experience was 7.86 years; 83.3% of respondents were credentialed in at least 2 POC US applications. Respondents reported that they performed an average of 1.70 POC US exams per shift and documented an average of 56.4% of these exams. The most commonly performed exams were pelvic, focused assessment with sonography for trauma, hepatobiliary, and vascular access. Factors most frequently cited as negatively impacting POC US documentation were “too many other demands on my time,” “requires logging into a separate program,” and “problems with the ultrasound machine.” Suggestions for improvement of the workflow were integration into the existing electronic medical record (EMR), improvements to the US machines, and simplification. When asked which incentives would most increase their compliance with documentation, respondents most frequently chose “financial reward,” “productivity-based bonus structure incorporating relative value units,” and “positive recognition.” All negative reinforcement choices were selected by less than 25% of respondents.

Conclusions: The most significant barriers to POC US documentation were time constraints, the existence of a separate computer program for POC US documentation, and problems with the US machines. When establishing a system for POC US documentation, US directors should consider a rapid workflow integrated into the EMR. Positive incentives such as financial rewards are likely to be more effective than penalties for noncompliance.

2381269 Ultrasound Confirmation of Gastric Tube Placement: A Novel Method

Vlad Radulescu1, *Sahar Ahmad2
1Internal Medicine, Pulmonary and Critical Care, Stony Brook University Hospital, Stony Brook, NY USA

Objectives: The nasogastric tube (NGT) and orogastric tube (OGT) are essential inpatient tools. We have developed a simple ultrasound (US) protocol for the bedside confirmation of feeding tube placement, which is rapid, is cost-effective, decreases exposure to radiation, requires little experience, and is easy to replicate without adding any substances.

Methods: US involved 2 criteria. First, the anterolateral neck was scanned at a high frequency to visualize the gastric tube’s characteristic echogenic surface with a posterior anechoic shadow in the esophagus. Then, the right diaphragm location was identified by low-frequency imaging. A distance was measured from the diaphragm to the temporomandibular joint (TMJ) then the TMJ to the nose or mouth (for NGT or OGT, respectively). To be well positioned, their sum would be less than 10 cm.

Results: Thirty-two subjects were studied. The gastric tubes were confirmed to be in the esophagus and below the diaphragm in 28 cases. In 2 cases, the US scan falsely predicted the tubes to be incorrectly positioned, while in 2 cases, the tubes were not correctly inserted, and the US yielded a true-negative result. The sensitivity of US was 93% (79.5–98.8%), specificity was 100% (22.4–100%), positive predictive value was 100% (9.8–90.2%), and negative predictive value was 50% (89.1–100%). The length of the gastric tube protruding below the diaphragm estimated by US was within 2.7 cm (SD, 2.34 cm) of the CXR measurement.

Conclusions: We have demonstrated a novel and reliable approach for confirming placement of NGT/OGT using US in the hands of a physician with limited training and without prematurely pushing fluid. Our method maintained a strong positive predictive value and accurately estimated the projected length below the diaphragm and should be considered an adjunct or alternative to CXR for NGT/OGT placement.

2381993 Ultrasound to Improve Lumbar Puncture Success: A Randomized Controlled Study

Lori Ludeman1, Priel Schmalbach1, *Shadi Lahham1, Mohammed Sabeh1, Sean Wilson1, Sophia Spann1, Jocelyn Chao1, Diane Shin1, Nadeem Albadawi1, J. Christian Fox2
1Emergency Medicine, University of California, Irvine, Orange, CA USA; 2School of Medicine, University of California, Irvine, Irvine, CA USA

Objectives: The objective of the study is to compare the success of ultrasound- versus palpation-guided lumbar puncture (LP). LP is a routine procedure performed in the emergency department (ED). It is essential in the diagnoses of meningitis, encephalitis, and subarachnoid hemorrhage, all conditions with a high morbidity and mortality that cannot be missed in the ED. Despite its diagnostic implications, a LP is an invasive process that can be uncomfortable. It was hypothesized that the utility of ultrasound in finding landmarks for LP would decrease the procedural time and number of needle redirections and reinsertions.

Methods: This study was conducted at the ED and intensive care unit of a tertiary academic medical center in Orange County, CA. Patients were 18 years or older, scheduled to receive an LP (n = 158), and were randomized into an ultrasound landmark (UL) or a palpation landmark (PL) group. Outcome variables included time from needle insertion to cerebral spinal fluid (CSF) collection and number of needle redirections and reinsertions.

Results: The likelihood of a successful procedure was not statistically significant between the UL and PL groups (Fisher exact statistic = 0.112). There was a nonsignificant 28-second reduction in the average procedural time between PL and UL groups (PL = 7.05 [SD = 13.52] vs UL = 6.38 [SD = 7.42] minutes; P = .27). The number of needle redirections and reinsertions differed by less than 1 between the two groups (P > .10).

Conclusions: Although ultrasound is a promising modality for the improvement of LP, the present study found no effect of ultrasound on the success of the LP, time to CSF, needle redirections, and needle reinsertions. Future studies may examine whether ultrasound improves LP success in subpopulations with difficult landmarks such as the obese and individuals with spinal malformations.

2382969 Can Emergency Medicine Resident Sonographers Performing Bedside Tracheal Ultrasound Accurately Confirm Endotracheal Tube Placement During an Intubation?

Shadi Lahham, J. Christian Fox, Wynne Breed*
Emergency, University of California, Irvine, Orange, CA USA

Objectives: Primary: Can minimally trained resident physicians detect passage of an endotracheal (ET) tube into the trachea or esophagus in real time? Secondary: Real-time resident read vs remote read by the ultrasound (US) director and comparison of postgraduate year 1...
Lung transplantation is limited by donor lung availability. Management of donors currently includes serial chest x-ray (CXR), arterial blood gases, fluid management, alveolar recruitment, steroids, naloxone, albuterol, chest physiotherapy, and repositioning. Time delays limit the intervention opportunities and decrease the potential transplantability of organs. Bedside thoracic ultrasound (US) identifies pathology in critically ill patients and is equivalent to superior to CXR or computed tomographic scans. We evaluated thoracic US techniques in identifying abnormal lung pathology in neurologically deceased organ donors and correlated these findings with the current standard approach.

Methods: Six neurologically deceased donors were evaluated using bedside lung US. Donors were enrolled sequentially based on availability and were available immediately. We show that lung US techniques compared to the standard donor data. Individual interpretations of US scans were recorded following positive findings. US images and video clips were later reviewed by blinded US directors at each site for ET intubation vs esophageal vs unsure.

Results: In order to obtain a 95% confidence interval, we hope to obtain a target goal of 100 patients. Maximum enrollment will be 160, as some patients will need to be excluded if insufficient airway views do not allow an assessment of ET tube placement. An estimated total of 300 patients will be enrolled between both sites. To date, 41 patients have been enrolled with a sensitivity of 96% and a specificity of 100%.

Conclusions: With our results thus far, point-of-care US in the hands of minimally trained EM residents has shown great promise in accurately identifying correct placement of ET tube during ED intubations.

3383343 A Readily Available, Inexpensive, and Reusable Simulation Model for Teaching Ultrasound-Guided Abscess Identification and Drainage
Julie Augenstein,* Hiromi Yoshida
Pediatrics, University of Washington, Seattle, WA USA; Emergency Medicine, Seattle Children’s Hospital, Seattle, WA USA

Objectives: To create an inexpensive, readily available, and reusable homemade ultrasound phantom that simulates a superficial soft tissue abscess and can be constructed.

Methods: We experimented with precooked polenta to create a model that would appear similar to human soft tissue under ultrasound examination. Paintballs were embedded in the polenta and evaluated at different depths until a sonographically satisfactory phantom abscess model was obtained. Various paintball brands and sizes were evaluated to determine the ease of reproducibility.

Results: The use of a precooked commercial polenta phantom and commercial paintballs required minimal preparation and closely replicated a superficial soft tissue abscess on ultrasonographic examination. The polenta can be reshaped easily, and the model may be punctured and/or incised multiple times.

Conclusions: A homemade high-fidelity simulation phantom that simulates an abscess in superficial soft tissue can be made inexpensively in less than 5 minutes and reused for numerous trainees. This model allows for just-in-time training for procedures such as ultrasound-guided abscess drainage.
in our ACS model. The abolishment of S3 indicates a loss of normal, low-velocity, low-pressure, late-systolic, anterograde blood flow seen during peripheral artery recoil. We believe this finding is secondary to the increased pressure gradient created by ACS.

**Conclusions:** This study suggests that SD could be used as a noninvasive screening tool to detect early ACS.

**2384129 A Prospective Feasibility Trial of AccuCath 2.25” Blood Control Intravascular Catheter System With a Retractable Coiled Tip Guide Wire Placed in Difficult-Access Patients in the Emergency Department**

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**Objectives:** The primary study objective is to evaluate insertion success rates. Secondary objectives include user preference, patient satisfaction, complication, completion of therapy, and dwell time of the novel AccuCath 2.25” BC catheter system (Food and Drug Administration approved) placed in difficult-access patients.

**Methods:** This is a single-arm feasibility trial evaluating the novel AccuCath 2.25” BC catheter system in a convenience sample of difficult-intravenous access patients defined as at least 2 failed initial attempts or a history of difficult access plus the inability to directly visualize or palpate a target vein. The retractable coiled tip guide wire device is placed under dynamic ultrasound guidance after identification in the emergency department (ED) using a modified Seldinger technique. Patients are followed daily until catheter removal. The following information is recorded for each subject enrolled: catheter device gauge; date, time, and location of each intravenous placement attempt; total number of venipuncture attempts; date and time of successful catheter placement; patient satisfaction at initial placement and on removal using a 5-point Likert scale; and clinician satisfaction at completion of the study using a 5-point Likert scale.

**Results:** Over a 1-month time period 18 patients (>18 years old) have been enrolled and completed the study, with a goal of 120 participants. These patients had an average of 3.5 (95% confidence interval, 3.0–4.0) and median of 3 prior attempts at vascular access prior to AccuCath placement by the ED registered nursing team. Successful access was gained in 100% of the patients, 77% on the 1st attempt and all within 3 attempts. Seventy-seven percent of patients completed therapy, with no moderate or major complications in the other subjects. The average patient satisfaction score on a 5-point Likert scale was highly positive at 4.33.

**Conclusions:** Preliminary results show that the AccuCath2.25” BC catheter system has excellent success rates in gaining vascular access in an extremely difficult patient population. The device thus far has not led to any significant complications. Patients are also very satisfied with the procedure.

**2384574 A Retrospective Analysis of Ultrasound Usage Rates at Cardiac Arrest Resuscitation Events at a New York Academic Hospital**

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**Objectives:** At our institution, ultrasound (US) has recently come into practice for management of cardiac arrest. We aimed to describe the frequency with which leaders of cardiac arrest resuscitation events have chosen to utilize US examinations during their resuscitation efforts. We also aimed to compare these usage rates among different medical service teams with a goal of investigating a correlation between the US usage rate and a likelihood that spontaneous circulation (ROSC) was achieved.

**Methods:** Retrospective patient data were reviewed for date of arrest, medical record number, unit, ROSC achievement, and US usage for each resuscitation event in the internal medicine services from 07/01/14–06/25/15. The exclusion criteria for this initial analysis were any resuscitation events where it was not recorded whether or not US was used in the management (n = 2 events).

**Results:** The usage rate for events lead by internal medicine residents from 07/01/14–06/25/15 overall was 24.8%. Due to a limited data collection period and currently low rates of usage, preliminary data did not have the statistical power to analyze a controlled association between US usage, patient ROSC, and mortality. Our initial unmatched analysis of pooled events shows a positive correlation ($r^2 = 0.97$) between US usage rates and the rates of ROSC in the units reviewed.

**Conclusions:** Our retrospective data review demonstrates a usage rate of 24.8% of US during cardiac arrest resuscitation events. With limited data, our initial analysis of events shows a positive correlation between US usage and rates of ROSC. We intend to disseminate this new information and continue data collection prospectively to further our analysis. We also aim to use these data to encourage more US usage and to fuel interest in an upcoming US-guided resuscitation training program for all internal medicine residents at our institution (Stony Brook University Hospital).

**2384720 Is There a Difference in Radial Artery Localization by Medical Students Using Bedside Ultrasound When Compared to Pulse Palpation?**

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**Objectives:** Radial artery puncture or cannulation is performed for blood gas analysis, to obtain blood samples in cases of difficult venipuncture, and to monitor intra-arterial blood pressure. Arterial puncture can be challenging, especially in certain patient populations, including the elderly, obese, and those with vascular disease. The procedure has traditionally been performed by simple palpation of the radial pulse, with reported first-attempt success rates ranging from 13.8%–68.6%. While ultrasound is being used with increasing frequency to perform venous access, there are fewer studies on ultrasound for arterial puncture. The objective of this study is to determine whether there is a difference in radial artery localization by medical students using bedside ultrasound when compared to pulse palpation.

**Methods:** Prospective observational study of a convenience sample of medical students and patients. Patients will include those with risk factors for difficult arterial access (age >65 years, wrist circumference >19 cm for men or 16.5 cm for women and/or history of vascular disease). All students will participate in a 1-hour didactic session on ultrasound-guided vascular access. Students will attempt to locate the radial artery by both palpation and ultrasound visualization and mark these sites with an invisible ink pen (only seen with black light). Based on the distance from the ultrasound location, palpation locations will be considered “in” if they fall within 90% of the radius of the radial artery or “out” if they do not.

**Results:** At this time, 11 patients have been enrolled in the study. The projected sample size is 120, including 60 patients with risk factors for difficult radial artery access and 60 control patients. This sample size is powered to achieve confidence intervals of ±8.9% with a 95% confidence level for the average distance between the two locations.

**Conclusions:** There may be a difference in radial artery localization by medical students using bedside ultrasound when compared to pulse palpation. Ultrasound may assist in radial artery localization in a population with risk factors for difficult arterial access.
2384781 A Survey of the Importance of Emergency Ultrasound in Prospective Practice Settings Among Emergency Medicine Residents

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Objectives: The goal of this study was to survey emergency medicine (EM) residents about their experience with point-of-care ultrasound (POCUS) and the importance of the accessibility of ultrasound in their future practice settings. This information is important to help set a foundation for the need for ultrasound infrastructure in the community setting. We also aim to highlight the need for POCUS in emergency departments to large EM contract groups and community hospital administrators.

Methods: FREIDA, an online residency resource, was referenced to obtain contact information for all current Accreditation Council for Graduate Medical Education–accredited EM residency programs. Each program was asked to distribute a 14-question survey to all residents currently in training. The survey was accessed through surveymonkey.com. All communication was done via e-mail in order to increase compliance. Participation in the survey implied consent.

Results: There were 380 responses from various residency programs around the United States. Of the respondents, 36% were postgraduate year 1 (PGY-1), 33% PGY-2, 21% PGY-3, and 5% PGY-4. When asked how often they were using ultrasound, 80% said they were performing at least 1 scan per shift, and of those 80%, 21% said they were performing at least 3 scans per shift. Sixty-five percent of the respondents came from programs that have EM ultrasound fellowships. The residents were asked to score on a scale of 1–5, with 1 being “absolutely will not” and 5 being “very likely”: How likely are you to take a job that does not have POCUS available? How likely are you to take a job that has a machine solely for procedural guidance? The weighted averages of responses were 1.84 and 2.18, respectively. When asked if they felt they would be able to perform quality EM without POCUS, 65% said no, 14% were unsure, and 22% said yes.

Conclusions: Residents felt that procedural guidance, echocardiography, early obstetric US, focused assessment with sonography for trauma, and abdominal aortic aneurysms were considered to have the most utility in their future practice. The majority of residents felt that they were very unlikely to take a job at a site that did not have POCUS available. It is clear that current EM residents believe that in order to perform quality EM, POCUS needs to be readily available.

2384882 Evaluation of Self-Guided Versus Traditional Ultrasound Education for Third-Year Medical Students

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Objectives: Point-of-care ultrasound is increasingly incorporated into undergraduate medical education (UME). Students feel that it is a valuable skill they will use in residency and beyond. Ultrasound education can serve to reinforce anatomy and physiology and enhance problem-solving skills. Limitations exist to implementing ultrasound education in UME. Ultrasound is traditionally taught with a lecture and a hands-on scanning session, requiring machines, instructors, and standardized patients. Monetary constraints for universities as well as time constraints from faculty may be potential limitations. New ultrasound simulators are designed to complement ultrasound education with individual, hands-on training. We aim to compare traditional ultrasound teaching to self-guided learning in the 3rd year of medical school, focusing on free-fluid detection, aorta, cardiac, and thoracic exams. Traditional ultrasound teaching consisted of a lecture with hands-on instruction.

Methods: We performed a retrospective review of 3rd-year medical students at the Charlotte Branch of the University of North Carolina School of Medicine. Students previously selected to participate in a longitudinal curriculum received traditional ultrasound education, and students in a block curriculum were invited to participate in self-guided ultrasound education through YouTube videos and SonoSim. Students were assessed by pre- and post-curriculum written tests and hands-on skills assessment.

Results: Students with traditional ultrasound education scored 55% and 82% on the pre and post tests. Students with self-guided learning scored 54% and 74%, respectively. On the skills assessment, students with traditional ultrasound education scored an average of 4.5, and those with self-guided learning scored an average of 2.5. However, the traditional education cohort had a total of 24 hours of education, and the self-guided cohort averaged 2.6 hours. In the self-guided group, those who spent more time with the simulator had better scores.

Conclusions: Students with traditional ultrasound education had better scores but dedicated time for ultrasound education. We do see a role for ultrasound simulators as an adjunct in ultrasound education.

2384888 Retrospective Review of Ectopic Pregnancies Diagnosed by Emergency Department Point-of-Care Ultrasound

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Objectives: To demonstrate that point-of-care ultrasound (POCUS) reduces time to emergency department (ED) disposition, time to the operating room (OR), and hospital length of stay (LOS) in women with ectopic pregnancies.

Methods: A retrospective chart review was performed on patients presenting to the ED from January 1, 2011, to August 1, 2015, who were diagnosed with ectopic pregnancy. Patient charts that utilized comprehensive US were compared to patient charts that used POCUS. The time to disposition, time to the OR, and hospital LOS were reviewed for each patient.

Results: From 2011–2015, 66 patients with ectopic pregnancies were reviewed. POCUS was used to make the diagnosis of ectopic pregnancy 41% of the time compared to comprehensive US (65%). Of those patients, 8% received both POCUS and comprehensive US. The majority of ectopic pregnancies were admitted (92%), and less than half of all patients went to the OR (47%). Of the 31 patients who went to the OR, 16 had ectopic pregnancies diagnosed by POCUS, and 2 (13%) had both POCUS and comprehensive US. The ED LOS for patients who went to the OR was 41.43 minutes shorter if ectopic pregnancy was diagnosed by POCUS versus comprehensive US (234.44 vs 275.87 minutes, respectively; $P = .488$). The time to the OR was also shorter in patients who received POCUS (350.44 vs 385.37 minutes for comprehensive US, $P = .661$). The hospital LOS was 1.19 days in patients with ectopic diagnosed by POCUS versus 1.00 day for comprehensive US; however, the POCUS group included 1 patient with a 4-day hospital admission after respiratory failure in the OR.

Conclusions: POCUS is often utilized for diagnosing ectopic pregnancies. Although at our institution POCUS is obtained 18% less than comprehensive US, the decision to admit and go to the OR occurs earlier in patients who receive POCUS. Additionally, patients who receive POCUS have shorter ED LOS but have similar hospital LOS compared to those patients who receive comprehensive US. It is reasonable to conclude that POCUS allows for faster decision making and earlier implementation of treatment in patients diagnosed with ectopic pregnancies.
2385058 Ultrasound Simulation for Small-Bone Fractures: The Chicken Drumstick Model
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Objectives: In vitro animal models have been used as a teaching aid in ultrasound (US) education, but identifying practical, inexpensive models for the expanding list of bedside applications is a challenge. The purpose of this study was to evaluate the feasibility of a novel US model consisting of raw chicken drumsticks as an aid in demonstrating the sonographic appearance of fractures in bones approximating the size of adult phalanges and metacarpals.

Methods: Twenty emergency medicine residents with no formal training in musculoskeletal US were given a 5-minute presentation on how to use a high-frequency linear probe to examine chicken drumsticks for evidence of fracture. Afterward, each resident scanned 20 drumsticks and recorded their impression of “fracture” or “no fracture.” They then rated the utility of the model on a 5-point Likert scale with 1 indicating “not useful” and 5 indicating “very useful.” A second question utilized a 100-mm visual analog scale (VAS) to assess how much more likely they were to use US to evaluate for small bone fractures in the emergency department after the drumstick experience. \( \chi^2 \) analysis was used to compare the Likert scores of simulation usefulness between junior (postgraduate year 1 [PGY1]) and senior (PGY2–3) residents; an unpaired \( t \) test was used for all other comparisons.

Results: The cost of all materials was $37, including $24 for 30 chicken drumsticks. Twenty residents scanned 20 drumsticks each, with a mean total scanning time of 12.25 minutes per resident. Accuracy varied widely in this previously unexposed group (mean sensitivity, 75% ± 20%; mean specificity, 79% ± 18%), but the model was well received, earning a mean Likert score of 3.85, which was consistent (\( P = .77 \)) between junior and senior residents. There was no correlation between scanning accuracy and enthusiasm for the model (\( R = 0.05 \)). Residents reported that the experience made them more likely to consider high-frequency bone US for clinical use, with a mean VAS of 53 on the 100-mm scale, which did not differ across the PGYs (\( P = .51 \)).

Conclusions: The chicken drumstick model described is highly efficient in terms of time and resources for use as an aid in simulated scanning for human small-bone fractures. It appears to be well accepted by those inexperienced in musculoskeletal scanning.

2385059 Contrast Extravasation in Emergency Department Patients With Ultrasound-Guided Peripheral Intravenous Catheters
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Objectives: Ultrasound-guided peripheral intravenous catheters (USGIVs) are commonly placed in emergency department (ED) patients when traditional attempts have failed. The purpose of this study was to evaluate the prevalence of contrast extravasation and related complications in patients with a USGIV compared to those with traditionally placed peripheral intravenous lines (PIVs).

Methods: This was a cross-sectional study of patients ≥18 years old in an academic urban ED who had intravenous contrast administered for a computed tomographic (CT) scan from 1/2009–4/2014. This study population was generated using administrative billing data of each contrasted CT scan performed in the department. The exposure variable was the type of intravenous (IV) catheter used for contrast administration: USGIV placed by an ED physician versus traditional IV placed without ultrasound. The study outcome was extravascular extravasation of contrast, which was reported throughout the study period as part of a hospital-wide quality assurance program. Two independent reviewers evaluated each contrast extravasation event to confirm the IV type (traditional PIV vs USGIV) and identify complications that occurred as a result of the extravasation. Extravasation events were classified as having a complication if any of the following occurred: surgical specialty consultation, an otherwise unnecessary admission, or surgical management. The proportion of extravasation events between USGIVs and traditional IVs were compared using the \( \chi^2 \) test.

Results: There were a total of 49,365 IV contrast boluses for CT scans, including 445 (0.90%) through a USGIV. A total of 120 contrast extravasation events occurred. The prevalence of extravasation was greater with a USGIV (16/445 [3.60%]) compared with a traditionally placed IV (104/48,920 [0.21%]; \( P = .002 \)). Thirty-two (26.9%) of the extravasation events resulted in a plastic surgery evaluation, with 1 hospitalization and no cases of operative management.

Conclusions: USGIVs have a low infiltration rate for contrasted CT scans. Although the complication rates are similar, the incidence of contrast extravasation events with USGIVs is significantly greater than with traditionally placed peripheral IVs.

2385080 Algorithm-Based Automated Inferior Vena Cava Diameter Tracking Correlates With Physician-Performed Measurements
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Objectives: Assessment of the inferior vena cava (IVC) with ultrasound is a validated technique in the assessment of hypovolemic patients and can be repeated serially to guide intravenous fluid therapy. However, this technique can be time-consuming and is subject to considerable inter-rater variation. An automated method for tracking IVC variation would be useful and could be consistently applied to serial evaluations of the IVC. Here we describe a novel Kanade-Lucas-Tomasi–based speckle-tracking algorithm and compare its performance to manual image analysis.

Methods: A cohort of spontaneously breathing subjects was examined. The IVC was visualized with ultrasound using a subxiphoid approach, in the longitudinal view. Two ultrasound-trained physicians then performed a frame-by-frame analysis of the images and measured the maximum and minimum diameters of the IVC approximately 2 cm caudal to the insertion of the hepatic vein. Continuous automated tracking of the same points in the IVC was also performed using a speckle-tracking algorithm, and IVC diameters were measured throughout the ultrasound clip. The caval index (IVC max diameter – IVC min diameter divided by the IVC max diameter) for each clip was calculated for both the manual and automated techniques and then compared.

Results: Ultrasound image clips from 47 patients were analyzed. A wide range of IVC diameter variation was seen with both manual and automated measurements. Mean physician- and algorithm-measured caval indices were 36.4% and 33.5%, respectively, with standard deviations of 29.2% and 26.0%. Intraclass correlation coefficients for the maximum and minimum IVC diameters as well as the caval index were calculated and were 0.897, 0.967, and 0.975, respectively. Additionally, a Bland-Altman analysis indicated that >95% of the manual and automated measurements agreed to within 10%.

Conclusions: Automated algorithm-based IVC diameter tracking is highly accurate and correlates well with manual physician-performed image analysis. Continuous real-time tracking of IVC diameter can rapidly calculate a caval index and aid in the assessment of potentially hypovolemic patients.
2385093 Acute Breast Complaint at Night: What the Emergency Radiologist Needs to Know
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Objectives: In the emergency setting, acute breast inflammatory lesions are sometimes a challenge for emergency radiologists; some tend to avoid making a final report and prefer to have the study evaluated the next day by a breast radiologist, concerned about the possibility of inflammatory carcinoma and lacking mammography or other additional imaging. In this presentation, we will emphasize the various types of acute breast lesions seen in the emergency department (ED) setting. We will also focus on an algorithm of management from the radiologist’s point of view supported by some clinical facts.

Methods: In this presentation, we will discuss a variety of examples of breast lesions seen in the acute setting by ultrasound, including acute mastitis, idiopathic granulomatous mastitis, abscess, and inflammatory carcinoma.

Results: Increased ED radiologist awareness of the various types of breast lesions in the ED setting would minimize next-day double reads and would also lead to improved patient management in an emergency setting.

Conclusions: Availability of a convenient clear imaging and management algorithm for breast lesions in the acute setting would help optimal decision making by the ED physician and minimize delays in the ED.

2385096 Is it Time for Ultrasound Badges of Competency?
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Objectives: The use of bedside ultrasound is expanding rapidly, and thus many different providers can use this tool. One specialty where this is especially evident is emergency medicine. In fact, the Accreditation Council for Graduate Medical Education (ACGME) states that “Residents must use ultrasound for the bedside diagnostic evaluation of emergency medical conditions and diagnoses, resuscitation of the acutely ill or injured patient, and procedural guidance.” Recently, the ACGME included point-of-care ultrasound into the 23 milestones that serve as a framework for competencies to obtain during residency training. Even with these guidelines, there is still significant variation in training and competency among residents and residencies. The authors describe a “badge system” to clarify specific ultrasound competencies for residents within a department.

Methods: Currently, residents spend a minimum of 6 weeks on ultrasound training. As part of this time they complete quizzes, objective structured clinical examinations (OSCEs), and log scans. Using data from the rotation, minimum guidelines for competency equated to achievement levels. This included a log of 25 scans in the desired area, successful completion of an OSCE, an application-specific test, and quality review with no major infractions in the area. On successful completion of all elements, the resident was awarded a badge for this ultrasound competency.

Results: There are 55 faculty and over 60 residents. There are 11 indications for emergency medicine. That means there are over 1100 badges that are possible in such a system. This process is still in its inception but has been received positively by residents and faculty.

Conclusions: By implementing a badge system to delineate resident competency, residents are able to seek one another out for peer supervision and are able to easily identify which residents are able to assist them with a specific scan. In addition, with over 60 residents and over 40 faculty, this allows the faculty to quickly see which scans the resident is competent in and which others may need more supervision. As more varied operators begin to use this tool, a visible badge system may be useful in a trauma or critical care setting where operators from varied specialties gather.

2385124 Intermediate Ultrasound: Going Beyond the Basics of Ultrasound in Medical Student Education
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Objectives: Since the trained standardized ultrasound patient (TSUP) program inception in 2006 and an article in 2013, there have been significant modifications, as an entirely new medical school curriculum was implemented in 2012. Adapting ultrasound (US) experiences into the framework of this new 3-part curriculum was necessary to rebrand the experience as part of a competency pathway. The US curriculum progressed from beginner to intermediate to an advanced competency in undergraduate US. The transition to the intermediate US experience (I-US) enhances the student model’s role as a learner. The key changes of this revised TSUP program consist in its inclusivity to all 4 years and inclusion in a longitudinal US education competency program.

Methods: The I-US program has 2 coordinators. The coordinators e-mail medical students advertising I-US and work with faculty to organize the events of I-US. Interested students (1) attend lectures where various clinical US scans are taught using the I-AIM (indication, acquisition, interpretation, and decision making) method, (2) attend open scanning sessions and save 10 complete scans, (3) take a practical and written ultrasound exam, and (4) fulfill 15 TSUP service hours. Fulfilling these requirements constitutes completing the I-US program. Thus, this is an example of how TSUP is easily incorporated into an extracurricular US education program.

Results: Since February 1, 2015, over 100 I-US participants have collectively participated in over 500 hours of didactics or scanning sessions as part of the I-US program. These same students have collectively provided almost 900 hours of TSUP modeling service, allowing physicians and students in various departments in the College of Medicine and University Medical Center to become familiar with normal sonographic signatures and practice US technique.

Conclusions: Since US is not yet required during medical school, coordinating US experiences in medical education can be challenging. This project describes an adapted US service program previously described into an intermediate part of the path toward an advanced competency. As these changes to the program increase available participation and expand the pathways for students to get involved, the variety of advanced competencies may increase.

2385135 Enhancing Quality Assurance Through Examination of Point-of-Care Ultrasound Scans
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Objectives: With multiple machines, users, and patients, hospitals have adopted quality assurance programs to assess bedside ultrasound exams, as there exists great variability among operators and images saved. Many operators save images without documenting findings, while others document findings without images, necessitating quality assurance. Yet other operators perform ultrasound exams with neither saved images nor documentation. A formal nomenclature system on such scans will educate physicians on best practice measures necessary for increasing physician compliance in using bedside ultrasound. We propose a model for...
naming bedside ultrasound exams to identify deficiencies in documentation to enhance patient safety, user compliance, and hospital billing.

**Methods:** We applied this model to the quality assurance of all emergency department–performed bedside ultrasounds at the Ohio State University Wexner Medical Center during the month of August 2015.

**Results:** Of 497 ultrasound exams performed, 393 exams were “true scans,” with both images and a note attached to the medical record, accounting for 79.1% of all scans. An additional 90 scans (18.1%) were “illiterate scans,” where images were saved, but there was no documentation of corresponding findings. Eight scans (1.6%) were “phantom scans,” where no ultrasound images and no documentation were found, but only patient title “dummy” screens. Six scans (1.2%) were blind scans, where no images were saved, but there was documentation of a scan performed with corresponding “dummy” screens. Limitations include accounting for phantom and blind scans in which there was no “dummy” screen found. We are likely missing a large number of these exams, as we included only those scans with “dummy” screens with no respective ultrasound images. Another limitation includes accounting for educational, or nonbillable, exams, in which the ultrasound was performed for learning purposes or after a comprehensive exam was performed; there is no corresponding documentation to avoid duplicate billing.

**Conclusions:** A nomenclature system as a best practice guideline for bedside ultrasound quality assurance can enhance compliance with documentation, patient safety, compliance, and billing.

**2385146 Ultrasound-Guided Vascular Access Education: Effectiveness of Live Versus Recorded Instruction**

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**Objectives:** This study examined the effectiveness of recorded lectures versus live lectures in teaching ultrasound-guided vascular access (UGVA).

**Methods:** Participants were divided into a live lecture group and a recorded lecture group. Each group had 60 minutes of instruction on the fundamentals of ultrasound and instruction on both short-axis (SA) and long-axis (LA) approaches for vascular access. Participants then performed SA and LA vascular access on a phantom device without further instruction. Technique was evaluated on time to access (TTA), number of punctures, and errors observed. Techniques that could result in direct patient harm were considered major errors; techniques that could result in reduction in image quality were considered minor errors; and errors in technique that may lead to failure to achieve access in a patient were classified as procedural errors. Participants had to complete the technique in the allotted time, or their results were excluded.

**Results:** There were 66 participants: 35 live lecture participants, and 31 recorded lecture participants. In the live lecture group, the average TTA was 74 seconds in SA (n = 34; σ = 56) with an average of 1.80 punctures, and 41 seconds in LA (n = 35; σ = 50) with an average of 1.17 punctures. One participant’s SA results were excluded. In the recorded lecture group the average TTA was 56 seconds in SA (n = 30; σ = 52) with an average of 1.45 punctures, and 51 seconds in LA (n = 30; σ = 70) with an average of 1.26 punctures. One participant’s LA, and another participant’s SA were excluded. The error rates for the live lecture group were 3% major errors, 43% minor errors, and 29% procedural errors. The error rates for the recorded lecture group were 13% major errors, 55% minor errors, and 23% procedural errors. Two-tailed Student’s t-tests showed no statistical significance (P > .05) for the differences in averages for any comparison between the live and recorded lecture groups.

**Conclusions:** This study demonstrates that recorded lectures are as effective as live lectures in didactic teaching for UGVA. This suggests that recorded lectures could be as effective as live lectures in teaching other ultrasound skills, which could help overcome the current limitations of traditional instruction.
predictive value (NPV) of 68%. For radiology scans only, FRS had sensitivity of 50%, specificity of 82%, PPV of 73%, and NPV of 62%. For ED scans only, FRS had sensitivity of 88%, specificity of 88%, PPV of 88%, and NPV of 88%. Both ovaries were visualized in 43 of 46 scans. The presence of an ovarian mass or cyst had sensitivity of 84%, specificity of 79%, PPV of 80%, and NPV of 83%. An ovarian mass alone had sensitivity of 28%, specificity of 100%, PPV of 100%, and NPV of 77%. Doppler flow was done in 44 of 46 scans. Nineteen of 44 (43%) had normal arterial and venous Doppler flow; 25/44 (57%) had abnormal or absent arterial flow; 15/44 (34%) had abnormal or absent venous flow; and 15/44 (34%) had abnormal or absent arterial and venous flow.

Conclusions: The FRS does not appear to be highly sensitive or specific for the diagnosis of ovarian torsion. The sensitivity and specificity of the ED-focused scan are higher compared to the radiology scans. The presence of an ovarian mass was found to be 100% specific for the diagnosis of ovarian torsion. Forty-three percent of the patients with ovarian torsion had normal arterial and venous blood flow.

2385363 Does Point-of-Care Ultrasound Reduce the Emergency Department Length of Stay in the Pregnant Patient Who Requires Pelvic Sonographic Evaluation? Kiah Connolly,* Sean Wilson, Shadi Lahham, Mohammed Subeh, Craig Anderson, J. Christian Fox
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Objectives: In the emergency department (ED), it is often necessary to perform either a point-of-care ultrasound (POCUS) or radiology department ultrasound (RDUS) as part of the evaluation of a pregnant female patient with a pelvic complaint. The addition of any imaging modality has potential to increase the overall length of stay (LOS). We hypothesized that in patients who required sonographic evaluation, initial evaluation by POCUS would result in a shorter LOS.

Methods: This was a subgroup analysis of a prospective randomized control trial of a convenience sample of female patients presenting to the ED between October 2012 and February 2014 for whom the treating clinician deemed sonographic evaluation of the pelvis was indicated. The study was performed at a level 1 trauma center ED with an annual census of 50,000 visits per year and RDUS services readily available 24 hours per day. After informed consent, patients were randomized to POCUS on even days or RDUS on odd days. Time to test completion and overall LOS were obtained. Patients who were <2 weeks pregnant were further analyzed. A 2-sample t test and Pearson χ² test were used to compare groups. A linear model with an identity link was found to have best fit for mean LOS.

Results: A total of 198 patients were enrolled in the initial study, of which 98 were pregnant. Average age was 29 years old. Forty-one (41.8%) patients were randomized to the POCUS arm, of which 13 (31.7%) subsequently underwent RDUS during the same visit. Patients randomized to RDUS were on average 2.5 years older ($P = .19$). Patients randomized to RDUS were on average 2.5 years older ($P = .06$) and no more likely to be admitted ($P = .14$) or undergo gynecologic consultation ($P = .06$). Time to completion of RDUS was 65 minutes longer than POCUS (95% confidence interval [CI], 51–73 minutes; $P < .01$). Patients randomized to the RDUS arm experienced a 43-minute longer LOS (95% CI, 21–108 minutes; $P = .19$).

Conclusions: While POCUS did not reduce overall LOS, it may have allowed for earlier diagnosis or specialty consultation. POCUS reduced the need for RDUS in up to two-thirds of patients, which may have significant implications in practice environments without 24-hour radiology ultrasound services. Further larger-scale study is needed to confirm these findings.

2385382 Performance of an Ultrasound-Guided Fascia Iliaca Block Using a Novel Porcine Neurovascular Bundle Model Compared With a Commercially Available Ultrasound Phantom
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Objectives: A fascia iliaka block (FIB) is a minimally invasive procedure for analgesia in hip fracture patients. The use of simulation training helps reduce procedure-associated morbidity. Unfortunately, the cost of commercially available models can be a significant barrier to simulation. We prospectively evaluated emergency medicine (EM) provider’s performance, degree of satisfaction, and degree of realism when performing ultrasound (US)-guided FIB utilizing a novel porcine model ($≈$20) versus the commercially available Blue Phantom model ($≈$4,000).

Methods: This was a prospective observational cohort study. All EM providers who participated in the study completed an FIB procedure education session consisting of physician-taught skill stations for both models and were required to perform an FIB in both models. The primary objective measurements recorded were proper transducer manipulation, needle tip visualization, use of hydrodissection, number of passes of the needle, overall success rate, number of vessel/nerve punctures, and operator’s assessment of both degree of satisfaction and degree of realism of both models.

Results: Twenty-three EM providers participated in the study. There was no statistically significant difference in success rates, number of needle passes, or vessel/nerve penetrations between the porcine and Blue Phantom models. Operator-assessed degree of satisfaction as rated on a 10-point Likert scale, with 10 being most satisfied, was 8.17 for the porcine model and 6.52 for the Blue Phantom model ($P = .0019$). Operator-assessed degree of realism as rated on a 10-point Likert scale, with 10 being most realistic, was 8.13 for the porcine model and 6.00 for the Blue Phantom model ($P = .0005$).

Conclusions: There was no statistical difference in EM physician performance of FIB using the porcine model as compared to the commercially available phantom. The inexpensive porcine model was rated superior to the commercially available model in operator-assessed degree of realism and satisfaction. Inexpensive simulation models like the porcine FIB have the potential to make invasive procedure training more accessible to the provider.

2385386 Comparison of the eZono Ultrasound System Compared With a Traditional Technique for Ultrasound-Guided Central Venous Line Placement in a Simulation Model
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Objectives: Central venous line (CVL) placement is a common procedure for critically ill and injured patients in the emergency department. Ultrasound guidance has significantly improved the safety of this invasive procedure. There is still, however, significant morbidity associated with CVLs. The use of a needle guidance system such as the eZono may further reduce the patient morbidity associated with this invasive procedure. We prospectively evaluated the performance of emergency medicine (EM) providers in the task of CVL placement utilizing traditional technique (TT) ultrasound versus the eZono system.

Methods: This was a prospective observational cohort study. All EM providers who participated in the study completed an eZono education session and a TT CVL review. The education consisted of physician-taught skill stations for both the eZono and TT. Participants were tasked to place a CVL with both the TT and eZono techniques on a phantom. The primary objective measurements recorded were success...
rate, time to CVL insertion, number of passes of the needle, number of back wall penetrations, and operator’s assessment of ease of use via a Likert scale.

Results: Twenty-seven EM providers participated in the study. The success rate for TT was 96% and for eZono was 100% (P = .32). The mean number of needle passes required to establish the CVL with TT compared to eZono was 1.52 versus 1.00, respectively (P = .0024). The number of back wall penetrations recorded was 13 for TT versus 0 for eZono (P < .0001). The time for CVL placement for TT compared to eZono was 68.8 versus 32.7 seconds, respectively (P < .0001). Operator-assessed ease of use of TT compared to eZono, from 1 (easy) to 10 (hard), was 3.7 versus 2.5, respectively (P = .0007).

Conclusions: Though CVL placement success rates were not statistically significant for either technique, the eZono device was superior to TT in all other primary objective measurements. Dynamic needle guidance systems, including the eZono device, have the potential to make CVL placement safer for the patient and easier for the provider.

2385415 Comparison of the EUCLID Tier 1 Mini-Access System With a Traditional Technique for Ultrasound-Guided Central Venous Line Placement in a Simulation Model

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Objectives: Placement of a central venous line (CVL) is a mainstay for critically ill and injured patients. The use of ultrasound has significantly improved the safety of this invasive procedure. There is still, however, significant morbidity associated with CVLs such as inadvertent arterial puncture and pneumothorax. The use of a needle guidance system such as the EUCLID, which is capable of providing precise and accurate needle tip position, may further reduce the patient morbidity associated with this invasive procedure. We prospectively evaluated the performance of emergency medicine (EM) providers in the task of CVL placement utilizing traditional technique (TT) ultrasound versus placement with the EUCLID system.

Methods: This was a prospective observational crossover cohort study. All EM providers who participated in the study completed EUCLID education and a TT CVL review. The education consisted of physician-taught skill stations for both the EUCLID and TT. Participants were tasked to place a CVL with both the TT and EUCLID techniques in a phantom. The primary objective measurements recorded were success rate, time to CVL insertion, number of passes of the needle, number of back wall penetrations, and operator’s assessment of ease of use.

Results: Twenty-seven EM providers participated in the study. The success rate for TT was 96% and for EUCLID was 100% (P = .32). The mean number of needle passes required to establish the CVL with TT compared to EUCLID was 1.52 versus 1.00, respectively (P = .0007). The number of back wall penetrations recorded was 13 for TT versus none for EUCLID (P < .0001). Time for CVL placement for TT compared to EUCLID was 68.8 versus 32.1 seconds, respectively (P < .0001). Operator-assessed ease of use of TT compared to EUCLID, from 1 (easy) to 10 (hard), was 3.65 versus 2.50, respectively (P = .0008).

Conclusions: Though CVL placement success rates were not statistically significant for either technique, the EUCLID device was superior to TT in all other primary objective measurements. Needle guidance systems, including the EUCLID device, have the potential to make CVL placement safer for the patient and easier for the provider.

2385434 An Ultrasound Supplement to Medical Student Education on the Renal System

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Objectives: To integrate ultrasound education into a traditional organ systems–based curriculum to enhance understanding of organ anatomy, physiology, and pathophysiology.

Methods: Second-year medical students were offered a hands-on ultrasound session to supplement their learning of renal anatomy and pathophysiology. These sessions were preceded by an electronic learning module and a pretest. Participants experienced a 15-minute lecture by a senior medical student, which was followed by small-group proctored scanning time. Proctors were senior students, emergency medicine residents, and faculty. A posttest and satisfaction survey were sent to participants at the end of the session. Pretests and posttests assessed knowledge of renal anatomy and basic renal pathophysiology presented as clinical cases. A paired t test was used to evaluate test score gains.

Results: Seventy-eight of 385 students from 2 medical school classes participated in the program (20.3%): 34 in year 1 and 44 in year 2. Fourteen students from year 1 and 20 from year 2 completed both pretests and posttests (34/78 [43.6%]). Students gained an average of 26 percentage points between pretests and posttests (mean pre = 53.8% [SD = 14.8%]; mean post = 80% [SD = 8.4%]; t = 11.06; df = 33; P < .0001). Almost all students said the session was an effective learning experience, believed that they better understood renal system anatomy after the session, and would recommend it for future students.

Conclusions: Medical students showed a significant gain in tests covering renal system anatomy and pathophysiology after their participation in the supplemental ultrasound session. Students rated the session as beneficial as a supplement to the traditional curriculum. This study demonstrated that introducing ultrasound as a supplement to the traditional organ-based curriculum benefitted student learning of organ anatomy and pathophysiology and may have untasted additional benefits.

2385831 Ultrasound Ground School: A Novel Curriculum for Undergraduate Medical Education

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Objectives: With the growth of point-of-care ultrasound (US), there is an increased onus on medical schools to provide US education. While US in the preclinical curriculum has been described, there is often a lack of US education during clinical clerkships. The authors aim to describe a novel US curriculum for third-year medical students that has been implemented for students at the Ohio State University College of Medicine (OSUCOM) designed to facilitate understanding of the clinical applications of US.

Methods: At OSUCOM, clinical rotations for third-year students are arranged into groups of 2 or 3 rotations, including surgery and obstetrics/gynecology, family medicine and pediatrics, and internal medicine and neurology. Before commencement of the clerkship, students undergo “ground school,” where they learn essential clinical skills relevant to each specialty, including US. Before their session, students complete asynchronous didactics. During the ground school experience, students are instructed on physics and troubleshooting and participate in a case-based review of pathology. Students have hands-on practice performing US exams critical to the practice of the specialties in which they will be rotating: obstetrics/gynecology and surgery—pelvic and first-trimester pregnancy US and focused assessment with sonography for trauma; intramuscular and neurology—cardiac, lung, and nerve US; family medicine and pediatrics—aorta and soft tissue US. All students gained further
practice in US-guided procedures and were assessed on their ability to successfully cannulate a vessel using US on a vascular access phantom.

**Results:** To date, over 375 students have participated in the ground school US experience. By utilizing a ground school approach, we have the opportunity to ensure all medical students receive appropriate and standardized training in the use and acquisition of US irrespective of individual clinical assignments.

**Conclusions:** The opportunity for structured US teaching for junior medical students is rare. This curriculum for third-year medical students provides a feasible model for meeting training guidelines without increasing the educational burden on residency programs.

### 2385845 Tiered Longitudinal Ultrasound Curriculum for Undergraduate Medical Education

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**Objectives:** The Ultrasound Interest Group (USIG) at the Ohio State University College of Medicine (OSUCOM) has consistently been involved in creating opportunities for medical students to acquire ultrasound (US) skills throughout their 4 years in medical school. The USIG decided to survey medical students at OSUCOM to evaluate perceptions of the current US opportunities. Based on the students' responses, the USIG Board reorganized the training experiences and developed a tiered curriculum.

**Methods:** A survey was sent to the student body asking for feedback on the current state of the US program at OSUCOM. Students were asked about their level of involvement and participation. Additionally, free-text response boxes were provided for any additional comments. Based on the results of the survey and verbal suggestions from classmates, the USIG Executive Committee held a series of meetings where the US programs were compiled into a cohesive curriculum.

**Results:** A tiered curriculum was created and is separated into Beginner US, Intermediate US, Advanced US, and Honors, each a year in duration. Each program is designed to build sequentially on the previous program. Students have the opportunity to demonstrate their image acquisition skills at an assessment opportunity. A 2-way analysis of covariance with preexisting ability as a covariate was performed, and it was not significant. Almost all of the participants agreed or strongly agreed that the course was an effective supplement to the traditional curriculum.

**Conclusions:** Proposed benefits of this new communication strategy includes ease of information access, less confusion, a more streamlined interface for students, and decreased e-mail fatigue.

### 2385904 Enhancing Medical Student Comprehension of Cardiac Anatomy Through Ultrasound

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**Objectives:** To evaluate whether a 2-hour voluntary cardiac ultrasound course improves medical student knowledge about cardiac anatomy.

**Methods:** First-year medical students volunteered for a 2-hour immersive course on cardiac anatomy and physiology. The course was preceded by an asynchronous online learning module and a pretest. To determine if course success was related to pre-existing ability, students also took a test of spatial-perceptual ability (the Revised Vandenberg & Kuse Mental Rotations Test). The course consisted of a 45-minute lecture and an hour of guided hands-on practice. Students were also provided an opportunity to demonstrate their image acquisition skills at an assessment station. At the conclusion of the session, students completed a written posttest and a brief satisfaction survey. Pretests and posttests assessed knowledge of cardiac anatomy and basic image recognition. A 2-way analysis of covariance with 1 repeated measure was used to evaluate test score gains while controlling for preexisting differences in spatial perceptual ability.

**Results:** Two-thirds of the first-year class participated in the immersive US course (129/195). All but 9 of the participants completed both the pretest and posttest (n = 120). Course participants gained an average of 35 percentage points from pretest to posttest (mean pre = 46.0% [SD = 24.5%]; mean post = 81.8% [SD = 16.3%]; F = 40.1; df = 1,117; P < .001). The spatial-perceptual ability test score was not a significant covariate (i.e., the interaction between the mental-rotations test and pretest-posttest gain was not significant). Almost all of the participants agreed or strongly agreed that the course was an effective supplement to the traditional cur-
curriculum (100%), that they better understood cardiac anatomy (97.5%), and that they would recommend the course for future students (100%).

Conclusions: First-year medical students rated the immersive cardiac ultrasound experience highly and felt that it was an effective supplement to the traditional curriculum. Participants showed statistically significant gains on a test covering cardiac anatomy and ultrasound images of the heart. Gains were not seemingly related to preexisting spatial-perceptual ability.

2385906 Beginner Ultrasound: An Innovative 1-Year Introductory Course for Medical Students
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Objectives: Numerous ultrasound activities geared toward different years (medical school years 1–4) were created at various times at the Ohio State University College of Medicine. These programs were initially standalone training sessions with a specific end goal and generally were not designed to go with or complement other programs. Beginner Ultrasound will be composed of both required and optional activities designed for students new to ultrasound to get them interested and build the foundations for the subsequent Intermediate Ultrasound course in the next year. Medical students from all 4 years are welcome to participate in Beginner Ultrasound.

Methods: Beginner Ultrasound will consist of required lectures on ultrasound physics, which will be followed by a written examination. Students will be taught 3 hands-on sessions built around the Trinity protocol: aorta, cardiac, and focused assessment with sonography for trauma ultrasound scans. Each hands-on session will have both an introductory lecture on the anatomy and an emphasis on hands-on-probe time to build scanning fundamentals. The skills built in these sessions will be tested at the end of the year with both a written and practical test. Additionally, each student will be required to complete 10 hours of trained simulated ultrasound program modeling, where students serve as models for peers and physicians to practice scans. There will be additional optional scans offered by third-year medical students tailored to specific career pathways that students can complete if interested.

Results: There was an overwhelming response to the new program, with over 150 students signing up to take part. After the completion of the program, the number of students progressing to Intermediate can be tallied, and the test results from the written and practical tests can be compared to the test results from a precursor program.

Conclusions: There was an overwhelming response to the new program, with over 150 students signing up to take part. After the completion of the program, the number of students progressing to Intermediate can be tallied, and the test results from the written and practical tests can be compared to the test results from a precursor program.

2385909 Integrated, Tiered, Self-Guided Ultrasound Scanning
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Objectives: Many medical schools have the infrastructure in place for medical students to gain exposure to ultrasound and practice in a dedicated educational space. However, opportunities for independent hands-on learning in ultrasound education are limited. This project was designed as a structured longitudinal model for independent ultrasound learning that could be integrated into an existing medical student ultrasound curriculum. The Ohio State University College of Medicine’s new curriculum, Lead. Serve. Inspire. (LSI), is divided into 3 parts. Part I spreads gross anatomy course work over the 2 preclinical years and integrates physiology and pathology, organized by organ system. Part II represents core clinical clerkships, while Part III focuses on developing advanced competencies. This project was designed to supplement the existing ultrasound learning opportunities in LSI parts I–III.

Methods: Preclinical medical students attend 7 optional hands-on ultrasound sessions as part of LSI part I. Additionally, students receive access to 8 system-based self-study ultrasound modules designed to teach image acquisition and sonographic signatures of normal tissue by exploring anatomy. Tasks are tiered according to difficulty. Students save images as part of their digital portfolios, while successful completion will be credited toward completion of an Advanced Competency in Ultrasound in LSI part III.

Results: This project has built on the existing ultrasound infrastructure to develop 8 self-guided, flexible modules covering the following systems: musculoskeletal, head and neck, cardiac, aortic, hepatobiliary, renal, endocrine, and reproductive anatomy. Furthermore, the flexible modular design of this project makes it possible to use in various combinations throughout LSI parts I–III.

Conclusions: Ultrasound education and competency require a combination of mentorship and opportunity. Structured, self-guided ultrasound scanning represents a unique opportunity to supplement synchronous, directly supervised ultrasound learning. This project provides a possible educational model to increase medical student opportunities for independent, structured, self-directed ultrasound learning that can be integrated with existing educational programs.

2386348 Determination of Right Ventricular Function by Emergency Physician Measurement and Visual Estimation of Tricuspid Annular Plane Systolic Excursion in the Setting of Suspected Pulmonary Embolism
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Objectives: First, to determine whether emergency physicians (EPs) are capable of measuring tricuspid annular plane systolic excursion (TAPSE) with a high degree of agreement between observers in the setting of suspected pulmonary embolism (PE). Second, to determine the capability of the EP to accurately visually estimate TAPSE and classify it in a binary fashion as either normal or abnormal, based on a pre-established definition of abnormal being <1.70 cm.

Methods: This was a prospective observational study at an urban teaching emergency department (ED) with >100,000 visits per year. Investigators performed a standardized 4-view echocardiogram and measurement of TAPSE using M-mode on a convenience sample of 36 patients in the ED. Subjects were included if they underwent computed tomography of the chest for suspicion of PE. Exclusion criteria were non–English-speaking patients, prisoners, and wards of the state. TAPSE was measured by 2 blinded investigators in 21 subjects to determine interobserver variability. In 19 subjects, a single investigator visually estimated TAPSE and categorized it as normal or abnormal, prior to measuring TAPSE using M-mode. All investigators were blinded to the subject’s diagnosis.

Results: The interobserver variability of TAPSE was small. The intraclass correlation coefficient of TAPSE between 2 observers was 0.95 (95% confidence interval, 0.90–0.98; P < .001). When TAPSE, as measured by 2 observers, was categorized in a binary fashion as normal or abnormal, the kappa statistic for agreement between independent observers was 1. Regarding a single investigator’s ability to visually estimate TAPSE, the phi coefficient as derived by Pearson, which is a measure of association between 2 binary variables, was 1. In all 19 subjects, the EP’s binary estimation of TAPSE agreed with its subsequent measurement.

Conclusions: EPs are capable of measuring TAPSE with a high degree of agreement between observers and are capable of the accurate visual estimation of TAPSE as normal or abnormal in patients with suspected PE.
Fetal Echocardiography

2374773 Fetal Echocardiographic Findings in Pulmonary Atrioventricular Septal
With an Intact Ventricular Septum
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Objectives: Pulmonary atresia with intact ventricular septum (PAIVS) is a severe cardiac malformation characterized by variable right ventricular (RV) development, an imperforate pulmonary valve, and abnormal connections between the RV and the coronary arteries, known as “ventriculocoronary connections” (VCCs). VCCs are typically found when the RV and tricuspid vein are severely hypoplastic, with hypoplasia of the RV walls. In contrast, VCCs are rare in PAIVS, with a relatively large ventricle capable of supporting more significant tricuspid regurgitation (TR). We describe fetal echocardiographic features of PAIVS in 4 patients.

Methods: The study was performed on Philips HD 11 XE and iU22 ultrasound machines using a convex C 2-5 transducer. The size, wall thickness of the RV, tricuspid regurgitation (TR), morphology of the pulmonary valve, presence of a VCC, and presence of retrograde flow in the pulmonary artery were assessed.

Results: The gestational age varied from 19 weeks in 3 patients to 26 weeks in 1 patient. Of 4 patients, 2 patients showed typical features of a hypoplastic RV cavity, no TR, a VCC, and reversal of flow through the ductus filling the PA seen in the 3-vessel and trachea view. Two patients showed uncommon features of a massive right atrium, RV enlargement, TR, no VCC, and reversal of flow through the ductus filling the PA. Three patients terminated pregnancy after knowing poor postnatal outcomes. One patient continued until term; the neonate expired a few hours after birth.

Conclusions: Fetal echocardiography exposes forms of congenital heart disease not commonly seen postnatally because of the high incidence of perinatal/immediate neonatal period loss. PAIVS is one such condition; especially when there is TR, high mortality in utero is noted. In the absence of TR, the disease is well tolerated in utero. The presence of a VCC is a poor prognostic indicator; hence, its antenatal diagnosis helps in counseling the patients.

2384586 The Role of the Left Brachiocephalic Vein in the Prenatal Diagnosis of Total Anomalous Venous Return: A Case Report
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Objectives: We present the case of a 31-year-old female, gravida 4, para 1021, with antiphospholipid syndrome, referred at 26 weeks 3 days for a right-sided stomach and abnormal outflow tracts.

Methods: Not applicable.

Results: On evaluation, there were several findings, including a right-sided stomach, an unbalanced atrioventricular canal, a small left ventricle, a single nonobfuscaturing large vessel exiting the right ventricle, and total anomalous pulmonary venous return (TAPVR) exemplified by a visible supracardiac collecting vessel. In addition, the left brachiocephalic vein measured 4.5 mm in width (~95th percentile for gestational age), confirming the diagnosis of TAPVR. The diagnosis of heterotaxy with right atrial isomerism and a complex cardiac defect was discussed with the family and confirmed antenatally by pediatric cardiology. The family opted for expectant management and delivered a live-born male at 36 weeks 4 days weighing 2560 g. Postnatally, the findings were confirmed. The family declined surgical intervention due to religious beliefs and unacceptability of any blood transfusions. The neonate is still alive with central cyanosis.

Conclusions: Our case attests to the role of the left brachiocephalic vein in ascertaining the diagnosis of TAPVR. Measuring the width of the left brachiocephalic vein is feasible. Comparing it to the established normogram of Sinkovskaya et al proves helpful in these challenging cases.

General and Abdominal Ultrasound: Breast

2381822 The Diagnostic Performance of Automated Versus Manual Segmentations of Breast Lesions on Ultrasound Images
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Objectives: The shape of a breast lesion provides clues as to whether it is malignant or benign; therefore, a highly accurate delineation of lesion margins on ultrasound images plays an important role in the diagnosis of breast masses. Usually, a user with medical expertise draws the tissue-mass border, defining lesion margins manually. The process, however, is labor intensive and prone to significant variation due to differences in selection criteria. The aim of this study is to compare the diagnostic performance of leak-plugging (LP) automated segmentation to that of manual segmentation of breast masses on ultrasound.

Methods: Fifty-two biopsy-proven breast lesion images were analyzed by LP automated and manual segmentation. Three observers manually outlined the boundaries on each lesion. The lesions were also segmented using an automated LP algorithm on the same set of images by the same observers. From each LP segmentation and manually drawn margin, grayscale and morphologic features were extracted and classified as malignant or benign by logistic regression analysis. The performance of LP and manual segmentations was compared by the area under the receiver operating characteristic curves ($A_z$), size of the lesion, and overlap area ($O_a$) between the margins.

Results: The $A_z$ for LP was consistently higher (0.910 ± 0.003 with a 0.29% coefficient of variation) than the $A_z$ for the manual tracings (0.888 ± 0.012 with a 1.3% coefficient of variation). The lesion size from LP segmentation correlated closely with that from manual tracing ($R^2$ = 0.91). The $O_a$ was higher for LP: 0.92 ± 0.01 and 0.86 ± 0.02 for benign and malignant masses, respectively, compared to 0.80 ± 0.01 and 0.73 ± 0.01 for manual tracings.

Conclusions: The diagnostic performance, size measurements, and observer variability for automated LP segmentations were either comparable to or better than those of manual tracings. LP segmentation of breast lesions is a viable alternative to manual tracings for computer-aided analysis of ultrasound images.

2385269 A Novel Ultrasound Image-Processing Technique for Detecting Microcalcifications in Surgical Breast Specimens
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Objectives: To evaluate a new commercial image-processing technique (MicroPure; Toshiba America Medical Systems, Tustin, CA) for the identification of breast microcalcifications in surgical specimens compared to fundamental grayscale ultrasound imaging (US), using x-ray imaging of the specimen as the reference standard.

Methods: Twenty women, scheduled for surgical excision of 1 or 2 areas with breast calcifications (identified on a prior mammogram), were enrolled in the study. The 22 retrieved surgical specimens underwent a standard US and MicroPure exam using an Aploio XG scanner (Toshiba
General and Abdominal Ultrasound: General

2362995 Beyond the Basics: Pitfalls in Hepatic Transplant Doppler Sonography
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Objectives: Sonography is the principal modality for assessment of vascular complications following hepatic transplant. Our purpose is to discuss the pitfalls in Doppler sonography of hepatic transplantation and provide strategies for their recognition to avoid misinterpretation.

Methods: Educational exhibit based on a retrospective review of the pitfalls in Doppler sonograms of hepatic transplants performed at a single institution over the last 7 years.

Results: The following pitfalls will be reviewed: (1) increased velocity of arterial flow due to vascular spasm, tortuosity, perivascular edema, and fluid collections mimicking stenosis; (2) presence of collateral vessels in the setting of chronic hepatic artery thrombosis simulating hepatic artery stenosis; (3) increase in maximum portal vein flow in the early post-transplant period due to reperfusion hemodynamics; (4) temporary dampening of the hepatic venous waveforms in the early post-transplant period commonly due to peritransplant fluid collections or graft edema; (5) The double inferior vena cava (IVC) pattern seen in the piggyback technique of IVC anastomosis most commonly used for partial hepatic transplants.

Conclusions: Confident identification of the normal and abnormal Doppler sonographic findings after hepatic transplants and their imaging pitfalls is critical to guide timely management of serious complications, which can lead to graft loss and high mortality.

2366186 Liver Imaging Reporting and Data System: Ultrasound Recommendations for Sonographic Screening and Surveillance of Hepatocellular Carcinoma—Initial Proposal
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Objectives: Hepatocellular carcinoma (HCC) is a worldwide health care problem and the second most common cause of cancer-related death in the world. The most significant risk factors are cirrhosis from any etiology and hepatitis B virus infection. The goal of HCC screening/surveillance is to detect preclinical HCC at an early stage so that the lesion(s) can be treated with local therapy or so that the patient may still be within guidelines for liver transplantation. Surveillance guidelines have been published by 4 societies, all of which advocate semiannual ultrasound (US), but none of these societies have provided guidance for how US should be performed, interpreted, or reported. Moreover, few studies have addressed the effectiveness of US-based HCC screening/surveillance. There is a need for standardization of sonographic screening and surveillance of HCC, and the intent of this exhibit is to address that need.

Methods: The American College of Radiology has convened a working group of experts to develop a US Liver Imaging Reporting and Data System (LI-RADS) for screening/surveillance in patients at risk for developing HCC.

Results: Four US LI-RADS categories with corresponding management recommendations have been established: US-0, inadequate; US-1, negative; US-2, subthreshold; and US-3, positive. We illustrate an algorithm that begins with the US examination, poses questions about the quality of the examination and the findings, and places the examination into 1 of the 4 US LI-RADS categories. To complement the US LI-RADS categories, illustrated examples of each category have been collected, and a lexicon of proposed terminology as well as guidelines outlining proper sonographic technique have been developed.

Conclusions: This exhibit will present the basis of a US screening/surveillance system in patients at risk for developing HCC. Readers will become familiar with the US LI-RADS categories, algorithm, and management recommendations, with the long-term goal of standardization in US screening/surveillance of HCC.

2365108 Common and Uncommon Hepatobiliary and Splenic Infections on Ultrasonography
Jeffrey Roberts, Marjorie Stein,* Robert Berkenblit, Melanie Moses, Susan Frank, Mordecai Koenigsberg, Fernanda Mazzariol
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Objectives: We aim to review the spectrum of sonographic findings of common and uncommon bacterial, fungal and parasitic infections involving the liver, biliary tree, gallbladder, and spleen. We will highlight technical and interpretative pitfalls that should be recognized for accurate diagnosis.

Methods: Educational exhibit of the sonographic findings in hepatobiliary and splenic infections.

Results: The following are examples of teaching points and strategies that will be discussed and illustrated: (1) tips to recognize bright echoes from clips, sutures, and Surgicel from gas-forming infection and calcifications; (2) the use of color Doppler to help differentiate an abscess from hemorrhage; (3) tips to differentiate bright echoes from gas from calcifica-
tions on B-mode and color Doppler; (4) pearls to differentiate between hepatic and splenic pyogenic infection and fungal (such as candidiasis) and parasitic infections (echinococcus, amebiasis, and schistosomiasis); (5) discussion of sonographic pitfalls and helpful techniques to distinguish granulomatous cholecystitis from a gallbladder neoplasm; (6) Discussion of sonographic pitfalls and helpful techniques to distinguish fungal infections from malignancy in the immunocompromised oncology patient.

Conclusions: Knowledge of the ultrasound findings and imaging pitfalls in upper abdominal infections will aid accurate diagnosis to help promptly guide management.

2380576 Regional Vascularity Differences of Thyroid Nodules on Color Doppler Ultrasound
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Objectives: Angiogenesis and proliferation of abnormal vessels are often linked with neoplastic cellular proliferation; thus, increased vascularity within thyroid nodules has been associated with malignancy. Although the use of Doppler ultrasound in thyroid imaging has increased, its role in nodule characterization remains limited. The aim in this study is to assess the use of quantitative Doppler vascularity for differentiating thyroid nodules.

Methods: Color Doppler images of 100 thyroid nodules were analyzed quantitatively to assess vascularity in 3 concentric regions corresponding to the nodule center, nodule rim, and surrounding parenchyma. Color Doppler pixels displayed in each region were analyzed for vascularity measures, mean flow velocity index, and mean flow volume index. The diagnostic performance of regional differences was evaluated by randomly dividing the thyroid nodules into training and testing groups. From the training group, the threshold that gave the least percentage error in diagnosis was determined. The threshold was used in the testing group to determine sensitivity and specificity of diagnosis.

Results: The vascular fraction area (2.8 ± 5.52) and mean flow volume index (0.34 ± 0.12) of malignant nodules were significantly higher in the center region compared to benign (vascular fraction area, 14.6 ± 4.1; P = .016; mean flow volume index, 0.24 ± 0.08; P = .045). The rim regions were highly vascular, but the measurements were not statistically significant (P = .386). The mean flow velocity index, on the other hand, was the same for both regions. Of the 3 vascularity metrics studied, the vascular fraction area of the central region was most effective in predicting malignancy, with a sensitivity of 0.90 ± 0.05, specificity of 0.88 ± 0.13, positive predictive value of 0.92 ± 0.03, and accuracy of 0.89 ± 0.08.

Conclusions: Of the various quantitative vascularity features studied, the vascular fraction area of the center region was most effective in discriminating benign and malignant thyroid nodules. Future studies using independent data sets will be helpful in validating the proposed methodology, as well as in establishing the potential value of Doppler imaging for clinical applications.

2380938 Hepatic Steatosis and the Potential Use of Hepatic Artery Peak Velocity in Predicting Superimposed Steatohepatitis
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Objectives: The purpose of this study was to evaluate patients with sonographic evidence of hepatic steatosis and whether there is a correlation between hepatic arterial and portal venous measurements on Doppler ultrasound with potential superimposed steatohepatitis as evidenced by an elevated liver function test (LFT).

Methods: A total of 146 patients with sonographically evident hepatic steatosis on grayscale ultrasound were evaluated in this Institutional Review Board–approved retrospective study. Serum bilirubin, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, and albumin were recorded at the time of the ultrasound. On grayscale ultrasound, the presence of fatty liver was determined based on ultrasound criteria. In all patients, the angle-corrected hepatic arterial velocity (HAV), hepatic arterial resistive index (HARI), and angle-corrected portal vein velocity (PVV) were recorded. Correlation of hepatic arterial and portal venous Doppler values with fatty liver with or without LFT abnormality was tested using binary logistic regression analysis. The diagnostic performance of 100 cm/s for HAV was studied compared to normal LFT.

Results: HAV showed a statistically significant correlation with the presence of LFT abnormality (P = .0018), while HARI (P = .6508) and PVV (P = .7624) did not correlate with these factors. An HAV threshold of 100 cm/s had a sensitivity, specificity, positive predictive value, and negative predictive value for LFT abnormality of 23.8%, 100%, 100%, and 33.9%, respectively.

Conclusions: Elevated HAV statistically significantly correlates with LFT abnormalities in patients with hepatic steatosis and may be a useful imaging biomarker for predicting superimposed steatohepatitis, which has important clinical ramifications.

2384660 Potential Use of Hepatic Artery Peak Velocity in Predicting Liver Function Test Abnormality in Patients With Normal-Appearing Livers
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Objectives: We sought to evaluate whether hepatic arterial and portal venous measurements in sonographically normal-appearing livers correlated with abnormal liver function tests (LFT).

Methods: A total of 544 consecutive patients who underwent abdominal ultrasound with liver Doppler evaluation with concurrently measured LFT values were included in this Institutional Review Board–approved retrospective study. Serum bilirubin, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, and albumin were recorded at the time of the ultrasound. Patients were excluded from the study if they had evidence of cirrhosis, hepatic steatosis, ascites, biliary ductal dilatation, or hepatomegaly. On Doppler ultrasound, the hepatic arterial velocity (HAV) with angle correction, hepatic arterial resistive index (HARI), and portal vein velocity (PVV) were measured. Correlation of hepatic arterial and portal venous Doppler values was tested in patients with and without LFT abnormalities using binary logistic regression analysis. A threshold of 100 cm/s for HAV was studied for diagnostic performance.

Results: A total of 141 patients had sonographically normal livers on grayscale ultrasound. HAV showed a statistically significant correlation with the presence of LFT abnormality (P = .0101), while HARI (P = .2737) and PVV (P = .5056) did not show statistically significant correlation with these factors. An HAV threshold of 100 cm/s had a sensitivity, specificity, positive predictive value, and negative predictive value for LFT abnormality of 16.4%, 97.3%, 84.6%, and 56.3%, respectively.

Conclusions: In patients with normal-appearing livers, HAV showed statistically significant correlation with presence of LFT abnormality, while PVV did not show statistically significant correlation with these factors.

2384674 Abdominal and Pelvic Varicosities on Ultrasound
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Objectives: The purpose of this educational exhibit is to familiarize the participant with different types of varicosities encountered in the abdomen and pelvis and their pathophysiologic basis.

Methods: Table of Contents Outline: (1) Pathophysiologic basis of varicosities in the abdomen and pelvis, such as portal hypertension, por-
tal vein thrombosis, pancreatitis, and pelvic congestion syndrome. (2) Review of the normal and variant anatomy of major venous structures evaluated on abdominal and pelvic ultrasound and their appearance on grayscale and Doppler imaging. A short review of proper Doppler technique will be included. (3) Appearance of varicosities on grayscale and Doppler ultrasound, including waveforms and direction of flow. (4) Types of varicosities will include: parametrical varices, intrahepatic portosystemic shunts, portal vein varix or aneurysm, superior mesenteric vein varix, gallbladder varices, abdominal wall varices, splenic varices, splenorenal shunt, gastrosplenic shunt, retroperitoneal varices, and pelvic varices.

Results: On completion of this educational activity, the participants will be familiar with the pathophysiologic basis of varicosities in the abdomen and pelvis and their appearance on ultrasound, including waveforms and directionality of flow.

Conclusions: The spectrum of varicosities that can be detected on abdominal and pelvic ultrasound is broad. The key to their successful detection is knowledge of normal and variant venous anatomy and of the imaging appearance of varicosities on grayscale and Doppler ultrasound. Awareness of pathologic conditions resulting in formation of varicosities is key for their successful detection and subsequently for appropriate patient management.

2384706 The Usefulness and Safety of 4-Dimensional Ultrasonography With Radiofrequency Therapy for Hepatocellular Carcinoma Tomonitsu Matono,* Toshiaki Okamoto, Kenichi Miyoshi, Takaaki Sugihara, Keiko Hosho, Junichi Okano, Masahiko Koda, Hajime Isamoto Tottori University, Yonago, Japan

Objectives: Radiofrequency ablation (RFA) therapy under ultrasonography (US) guidance is common therapy for small hepatocellular carcinoma. However, its therapeutic effect and safety depend on accurate needle insertion. Conventional 2D US can only recognize the needle, the target tumor, and the surrounding vessels/organs in the 2D slice images but not in the multiple images, while the 4D US can evaluate them with a multiplanar reconstruction view (A, B, and C planes) using a continuous volume data. The aim of the present study is to compare 2D and 4D US images after needle insertion for RFA and to investigate if they can show the spatial configuration among the needle, the target tumor, and the surrounding vessels/organs.

Methods: Thirty-one nodules in 28 patients who underwent RFA underwent 2D and 4D US. An Aplo 500 (Toshiba Medical Systems) was used as the US system for 2D and the 4D probe. We used LeVeen needles for 20 nodules and cool-tip needles for 11 nodules. Before and after the needle insertion for RFA, we semiquantitatively evaluated the visible levels for the needle (1, invisible; 2, partial; 3, all), the target tumor (1, <40%; 2, 40%–80%; 3, >80%), and the surrounding vessels/organs (1, <40%; 2, 40%–80%; 3, >80%) by 2D or by 4D US after needle insertion.

Results: 2D and 4D US showed the inserted needles as visible as well as before the needle insertion. The target tumors became invisible in all nodules after the needle insertions in 2D US. The visible levels for the target tumor in 4D US after the needle insertion were better in 28 of 31 nodules than in 2D US and invisible in 3 nodules. The visible levels for the surrounding vessels/organs in 4D US after the needle insertion were better than those in 2D US (4D: 1, 6; 2, 5; 3, 20 nodules; 2D: 1, 11; 2, 20; 3, 0 nodules).

Conclusions: 4D US could maintain visualization of the tumor and surrounding vessels/organs after as well as before needle insertion. 4D US was a useful support tool for RFA to exhibit the spatial configuration among the needle, the tumor, and the surrounding vessels/organs.

2384931 Preliminary Evaluation of a Novel Ultrasonographic Protocol to Detect Schistosomiasis-Associated Intestinal Morbidities in Ukerewe Island, Tanzania Elisa Zhang, Kala Ghooray, Jacqueline Kulwein,† Samuel Kaplan, Maryte Gylys, Taylor Davis, Jamie Miller, Matthew Gunther, Morgan Kendall, Michael Bernaba, Janice Boughton, Christopher Fox University of California Irvine School of Medicine, Danville, CA USA

Objectives: The Niamey ultrasonographic protocol is a widely used, World Health Organization–recommended protocol to assess pathologic changes in the liver and urinary system in Schistosoma mansoni and hematobium infection. However, it currently does not include a quantitative scoring system to assess intestinal pathologies known to be associated with schistosomiasis. At the time of publication (1996), it stated that a research priority was to determine the predictive value of ultrasonographic intestinal lesions on schistosomiasis bowel pathology. Here, we create the first quantitative ultrasonographic scoring system for intestinal lesions in schistosomiasis and evaluate the predictive value of this score for recent schistosomiasis infection in Ukerewe Island, Tanzania, a population in which schistosomiasis is endemic.

Methods: We used 3 different self-reported measures as indicators of recent schistosomiasis infection: (1) recent or frequent loose and bloody stools, (2) recent schistosomiasis diagnosis, and (3) recent S. mansoni diagnosis. Using the graded compression technique, subjects’ bowels were scored 0 (absent) or 1 (present) on 3 different ultrasonographic bowel measures: free fluid between bowel loops, bowel wall thickness >3 mm, and >2 loops of fluid-filled bowel >2 cm. Scores were summed to give a composite bowel score (CBS; min = 0, max = 3).

Results: Forty-three inpatient and outpatient subjects from Ukerewe Hospital were included in our study (mean CBS = 0.4). Mean CBS was significantly higher (P = .0453, 67; n = 21; 2-tailed Student t test) in subjects with recent schistosomiasis diagnosis in the last 5 years compared to those without a diagnosis. Mean CBS was not significantly different between subjects with or without bloody loose stools (P = .1620; n = 6) or between subjects with or without recent S. mansoni diagnosis in the last 5 years (P = .1483; n = 9).

Conclusions: Our preliminary findings suggest that quantitative ultrasonographic scoring of bowel abnormalities may have a predictive value on recent schistosomiasis infection and should be further evaluated (ie, against fecal diagnoses of schistosomiasis) to determine its predictive value on schistosomiasis intestinal morbidity.

2384952 Doppler Ultrasound in Patients With Liver Cirrhosis: Correlation of Hepatic Artery and Portal Vein Measurements With a Model for End-Stage Liver Disease Score and Spleen Size Hooi Park*, R. Brooke Jeffrey*, Terry Dessier*, Aya Kamaya* Radiology, Konkuk University, Seoul, Korea; *Radiology, Stanford University, Stanford, CA USA

Objectives: The purpose of this study was to determine whether hepatic arterial and portal venous Doppler measurements in patients with liver cirrhosis correlate with markers of hepatic decompensation.

Methods: Between September 2014 and March 2015, 274 consecutive patients with hepatic cirrhosis who underwent abdominal ultrasound with dedicated hepatic Doppler measurements were studied in this Institutional Review Board–approved retrospective study. Model for End-Stage Liver Disease (MELD) scores were recorded at the time of the ultrasound. On grayscale ultrasound, spleen length was measured, and the presence of ascites was recorded. The angle-corrected hepatic arterial velocity (HAv), hepatic arterial resistive index (HARI), and portal vein velocity with angle correction (PVv) were measured on spectral
Doppler interrogation. Correlation of hepatic arterial and portal venous Doppler values with the MELD score, spleen size, and presence of ascites was tested using Pearson correlation or binary logistic regression analysis.

Results: HA v showed a statistically significant correlation with the MELD score ($P = .0001$), spleen size ($P = .027$), and presence of ascites ($P = .0001$), while HARI ($P = .421$, .85, and .577, respectively) and PVv ($P = .327$, .48, and .62, respectively) did not correlate with any of these factors.

Conclusions: Elevated HA v statistically significantly correlates with a high MELD score, decompensated liver cirrhosis, and splenomegaly in patients with liver cirrhosis and may be a useful imaging biomarker in evaluation of patients with cirrhosis.

General and Abdominal Ultrasound: Urinary Tract

2362794 Common and Uncommon Genitourinary Infections on Ultrasoundography
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Objectives: Ultrasound is often used for the initial workup of flank pain from presumed stone disease and urinary tract infection, and it is the primary modality for imaging of the scrotum. We aim to review the spectrum of sonographic findings of common and uncommon genitourinary (GU) bacterial, fungal, and parasitic infections involving the kidneys, bladder, and scrotum. We will highlight technical and interpretative pitfalls that should be recognized for accurate diagnosis.

Methods: Retrospective review of the sonographic findings in common and uncommon GU infections in our institution in the last 20 years.

Results: The following are examples of teaching points and strategies that will be discussed and illustrated: (1) proper adjustment of B-mode gain to demonstrate low-level echoes in inflammatory collections and to differentiate between infection and hemorrhage; (2) the use of color Doppler to help diagnose focal nephritis; (3) tips to recognize gas in tissues and to distinguish gas from small calcifications on B-mode and color Doppler; (4) pearls to differentiate between orchitis and torsion/detorsion; (5) the sonographic difficulty distinguishing an atypical abscess from a infiltrative tumor.

Conclusions: Knowledge of the ultrasound findings and imaging pitfalls in GU infections will aid accurate diagnosis to help promptly guide management.

2366167 Missing Diagnosis and Sonographic Characteristics of Horsehoe Kidney
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Objectives: To evaluate the missing diagnosis and the characteristics of the horseshoe kidney on sonography.

Methods: From January 2003 through October 2015, 54 consecutive patients with horseshoe kidney had been proven by computed tomographic (CT) scans. All cases received sonographic examinations before or after CT scans. Retrospective analyses of the sonographic findings and reports of all patients were performed by 2 experienced sonologists.

Results: Tracing reports of sonography, there were 9 cases (17%) that were missed by initial sonography just before or after CT scans. Reliably sonographic features of horseshoe kidney included an isthmus anterior to the aorta in 47 cases (87%), a tapering lower end in 28 cases (52%), and a bent contour and overlapping vertebra in 39 cases (72%), but malrotation and an altered axis of kidney were difficult to assess by sonography.

Conclusions: To prevent missing diagnosis of horseshoe kidney, searching the isthmus and especially the longitudinal view, tapering lower end, bent contour, and overlapping vertebra, are important features during ultrasound scanning.

2384923 Renal Arteriovenous Malformation as a Cause of Hematuria: An Uncommon Cause of a Common Problem
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Objectives: Our objective is to describe renal arteriovenous malformation (AVM) and how it can present with hematuria. The importance of recognizing this entity as a cause of hematuria beyond the more common causes of stones, urinary tract infections, and tumors will be highlighted.

Methods: Our methods included a MEDLINE and PubMed search on “renal arteriovenous malformation,” “uncommon causes of hematuria,” and “congenital renal AVM.” Relevant literature and recent guidelines on the management of renal AVM were reviewed.

Results: We present the case of a young male who presented with hematuria and anemia. As part of an initial workup, renal ultrasound revealed a cystic structure near the renal hilum that demonstrated a mosaic pattern and aliasing on Doppler, related to the turbulent flow. Tortuous vessels were also identified adjacent. As the patient had no history of prior renal intervention, a diagnosis of congenital renal AVM was made. In addition to detailed sonographic findings, further workup and management options will be discussed.

Conclusions: Gross hematuria and flank pain are among the most frequent complaints seen in urology outpatient clinics and emergency departments worldwide. Common causes of gross hematuria include urinary tract infections, urolithiasis, and neoplasms of the genitourinary tract. Renal AVM is among the rare causes of gross hematuria. The consideration of this diagnosis early during diagnostic workup can be paramount to management of this condition, especially with its potential for rapid clinical deterioration. Other more infrequent presentations may include symptoms or signs of congestive heart failure from high-output fistulas or hypotension from massive hematuria.

Gynecologic Ultrasound

2348973 Ultrasound Appearance of the Uterus After Endometrial Ablation
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Objectives: Endometrial ablation is a relatively new procedure. We aim to review the various sonographic findings in the uterus after endometrial ablation and provide correlation with computed tomography (CT) and magnetic resonance imaging (MRI), when available. The differential diagnosis of the appearance of the endometrium will also be highlighted.

Methods: Retrospective review of the sonographic appearance of the uterus and complications after endometrial ablation in a single institution over 4 years.

Results: The teaching points to be discussed and illustrated are as follows: (1) Explanation of the purpose and technique of endometrial ablation. (2) Discussion and demonstration of possible outcomes related to the procedure, such as air in the endometrial cavity, hematometra, and residual islands of endometrial tissue. (3) Discussion of the postablation endometrial thickness measurements in patients without hematometra. (4) Recognition of the irregularity of the endometrial echo in patients with an almost normal-appearing endometrium. (5) Establishing the unusual ultrasound appearance of hematometra in patients with endometrial ablation.
tion by comparing it to the appearance of hematometra secondary to other causes. (6) Determining guidelines for recognizing the appearance of endometrial ablation on CT and MRI as well as ultrasound.

**Conclusions:** Recognizing the potential appearances of the endometrial cavity after endometrial ablation and knowledge of possible complications aids in accurate diagnosis and proper patient management.

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**2362790 Essure Confirmation Test With Transvaginal Ultrasound**

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**Objectives:** Essure is indicated for women who desire permanent birth control via bilateral tubal occlusion. The efficacy of Essure when a new confirmation testing algorithm with transvaginal ultrasound (TVU), modified hysterosalpingogram (HSG), or both was used 3 months post-placement was assessed in a phase 4 study.

**Methods:** Women aged 21–44 years without contraindications and scheduled for Essure placement were eligible. Per the TVU/HSG confirmation testing algorithm, TVU was an option for confirmation testing 3 months post-placement if the placement procedure was not difficult and the postoperative course was uneventful, according to the defined protocol. Co-primary end points were the 1-year pregnancy rate and Essure reliance rate. Safety evaluation was based on adverse events (AEs).

**Results:** Essure placement was attempted in 597 women (intent-to-treat [ITT]; mean age, 34.4 years), with bilateral placement achieved in 582; 547 were told to rely on Essure. In these 547, the 1-year pregnancy rate was 0.67% (95% confidence interval [CI], 0.16%–1.53%). The ITT reliance rate was 91.6% (95% CI, 89.2%–93.6%). Four women became pregnant after being told to rely on Essure; all 4 were told to rely based on TVU confirmation testing alone, read as optimal insert location. Postpregnancy follow-up and root cause analysis revealed 2 perforations and 2 unsatisfactory insertion locations. Of the 547 told to rely, 85.9% had TVU confirmation testing alone (Table 1); test usage patterns for reliance were similar in and outside the US. TVUs were performed mostly by physicians in Spain/Canada and by physicians or sonographers in the US/Netherlands. The range of endovaginal probe center frequencies (arithmetic average) used was 5.8–6.5 MHz. Most AEs were mild and unrelated to Essure.

**Conclusions:** Essure is an effective method of permanent sterilization when the TVU/HSG confirmation testing algorithm is used; 85.9% of women were able to rely on Essure based on TVU confirmation testing alone.

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**2374872 Cervical Ectopic Pregnancy: Case Series of 5 Cases**

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**Objectives:** A “cervical pregnancy” is an ectopic pregnancy that has implanted in the uterus endocervix. It typically aborts within the first trimester; however, if it is implanted closer to the uterine cavity, so-called cervico-isthmic pregnancy, it may continue longer. Placental removal in a cervical pregnancy may result in major hemorrhage. It can be confused with miscarriage as abortion in progress, with the sac passing through the cervix. Hence, it is important to diagnose it correctly. We discuss the diagnostic features on ultrasound, importance of color Doppler in correct diagnosis, and role of ultrasound in follow-up and treatment of these cases.

**Methods:** We analyzed the ultrasound findings of cervical ectopic pregnancy in 5 cases. The study was performed on a Philips HD 11 XE ultrasound machine using C 5-2 convex and C 8-4 V transvaginal transducers. The size of the gestational sac, trophoblastic reaction and vascularity, presence of an embryo, and its cardiac activity if present were documented.

**Results:** The gestational ages at diagnosis were 6–9 weeks. All 5 cases showed an empty endometrial cavity and a closed internal os; 2 cases showed the presence of only a gestational sac (without a fetal pole) with trophoblastic vascularity; and 3 showed the presence of an embryo within the sac: 2 with cardiac activity and 1 without cardiac activity. All cases underwent curettage. One live ectopic was treated with methotrexate first, and curettage was done later as the patient then complained of bleeding on and off.

**Conclusions:** A cervical ectopic pregnancy is a very rare form of extraterine pregnancy. Its correct diagnosis helps in timely intervention. Surgical evacuation of the pregnancy alone is not recommended because the cervix is unable to contract, and prolonged bleeding may follow. Hence, expectant management with methotrexate is recommended in nonemergency cases. Ultrasound as an imaging modality helps not only in diagnosis but also in follow-up if it is treated with methotrexate.
2374922 Cesarean Scar Endometriosis: Case Series—Ultrasound and Doppler Characteristics
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Objectives: Endometriosis is defined as the presence of ectopic functioning endometrial tissue outside the uterine cavity. Abdominal wall endometrioma presents as a painful swelling resembling surgical lesions. It mostly follows obstetric and gynecologic surgeries like cesarean delivery (commonest), hysterectomy, and tubal ligations. We describe 9 cases of scar endometriosis following cesarean delivery. The varied appearance of the lesion on sonography is discussed. The importance of using a high-frequency linear transducer to diagnose this condition is emphasized.

Methods: The study was performed on a Phillips HD 11 XE ultrasound machine using a high-frequency linear 3-12 transducer. The size, location, ultrasound morphology, and color Doppler flow were evaluated.

Results: Nine women (age range, 28–38 years) with 11 scar endometriomas (2 women had 2 different nodules at the scar site) were evaluated. Out of 11 nodules, 5 nodules were located between subcutaneous fat and the muscular sheath; in 3 cases, both the subcutaneous and muscular planes were infiltrated; 2 endometriomas were purely subcutaneous; and 1 nodule was entrapped in the muscular layer of the abdominal wall. Out of 11 nodules, 9 were solid hypoechoic with spiculated margins; 1 was predominantly cystic; and 1 was both solid and cystic. Five lesions showed vascularity within; 4 were avascular; and 2 showed minimal peripheral vascularity. Seven out of 9 were subsequently surgically removed and confirmed on histopathology. Two patients responded to medical line of treatment and refused surgical intervention.

Conclusions: A high index of suspicion of scar endometriosis in patients with a relevant clinical history always clinches the diagnosis. Use of a high-frequency linear transducer is strongly recommended to make the diagnosis. Judicious use of B-mode sonography and color Doppler to achieve this diagnosis obviates the need of any further imaging modality like magnetic resonance imaging.

2379044 Intrauterine Device Insertion Under Ultrasound Guidance: Clinical Indications
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Objectives: Identification of common clinical indications in our university practice for intrauterine device (IUD) insertion under ultrasound guidance.

Methods: All women referred to our gynecologic ultrasound unit for an ultrasound-guided IUD insertion over a 2-year period were evaluated. The IUD insertions were done in the gynecologic ultrasound unit by the same team physician and sonographer.

Results: Fifty-five women (ages 20–51 years) were having the IUD inserted for abnormal uterine bleeding (28 patients), contraception (23 patients), and both reasons (4 patients). Of this cohort, referred for ultrasonic-guided IUD insertion, 9 patients had a failed attempt in the office, and the remainder (46) were referred, based on the clinical judgment, due to fibroids (17), uterine positioning (10), history of expulsion of the IUD (10), and other (9). Of the 9 patients with failed traditional office attempts, 6 had documentation that the cervix was unable to be sounded or unable to pass more than a few centimeters; 2 were due to extreme retroflexion; and 1 was due to lateral uterine deviation. Of these 9 patients, 7 went on to have successful ultrasound-guided insertion. The success rate of ultrasonic-guided insertion was 85%. Of the 8 in whom ultrasound-guided insertion was unsuccessful, 5 experienced intolerable discomfort during the procedure, and 3 had a uterus that was unable to be sounded. Of the patients with a failed IUD attempt in the office, the success rate of ultrasonic-guided IUD insertion was 77%.

Conclusions: Based on our data, we believe there are certain clinical indications that warrant sending a patient for ultrasound-guided IUD insertion. These include: an extreme anteflexed, retroflexed, or de-viated uterus, a uterus that cannot be sounded, a previously expelled IUD, and a fibroid uterus with a distorted endometrial cavity. Ultrasound-guided insertion should be considered for training programs. Using ultrasound for guidance would increase patient safety by reducing the risk of perforation as well as allow the learner to understand proper technique and confirm correct placement of the device.

2379754 An Application of the Learning Curve—Cumulative Summation Test to Evaluate Training for Diagnosis of Müllerian Duct Anomalies With 3-Dimensional Ultrasonography
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Objectives: To evaluate the learning curve—cumulative summation test (LC-CUSUM) of 3D ultrasound (3DUS) for the diagnosis of müllerian duct anomalies (MDA) and the deviations of the level of trainees’ performance at the control-stage CUSUM.

Methods: A 1st-year resident (R1) and a 2nd-year resident (R2) in obstetrics and gynecology received a theoretical and practical course, developed at our center, in order to learn how to analyze the 3DUS volumes on an offline workstation and to classify MDAs according to the European Society of Human Reproduction and Embryology—European Society for Gynaecological Endoscopy consensus. Each trainee worked on 155 3DUS volumes of preselected patients. Their results were evaluated using the LC-CUSUM and standard CUSUM. Time for each volume analysis was calculated for the expert examiner and the 2 trainees. Trainees carried out the volume analysis separately and were blinded to each other’s results and to the true diagnosis.

Results: R1 and R2 reached competence at the 85th and 58th evaluations, respectively, with success rates of 80% (R1) and 81% (R2), and kept the process under control, with error levels of less than 4.5% until the end of the test. Both trainees significantly reduced the average time of evaluation per volume ($P < .001$).

Conclusions: The LC-CUSUM provided quantitative indicators of learning evolution of 3DUS for the diagnosis of MDA by residents in obstetrics and gynecology. The training received by the residents was adequate for diagnosis of uterine anomalies using 3DUS.

2383094 Diagnosis of Adenomyosis Using Sonographic Criteria: Expert Preoperative Assessment by Transvaginal Ultrasonography Compared to Definitive Histopathology of the Surgical Specimen
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Objectives: We evaluated the role of expert-guided transvaginal ultrasonography (TVUS) as a preoperative diagnostic tool for adenomyosis using specific diagnostic criteria.

Methods: A retrospective chart review of 308 patients who underwent hysterectomy for benign pathology over a 3-year period at a community teaching hospital was performed. A review of the surgical pathology reports for these patients was conducted. The charts of these patients were then reviewed for preoperative expert-guided TVUS. Comparisons were made between the results of the TVUS and postoperative pathology reports.

Results: Of the 308 patients who were included in the study, 129 (41.8%) were found to have adenomyosis. Of these 129 patients with
adenomyosis, 45 (34.8%) had a preoperative TVUS performed by an expert sonographer. Expert-guided TVUS had a 71.43% sensitivity for extensive adenomyosis as diagnosed on pathology using the following sono graphic criteria: enlarged uterus, globular shape of the uterine body, asymmetry between anterior and posterior myometrium walls, hetero geneity of the myometrium with anechoic and hyperchoic areas, micro cystic diverticular areas in the myometrium, and blurred transitional zone between the endometrium and myometrium. Routine guided TVUS had a 14.29% sensitivity for diagnosis of adenomyosis using no specific criteria for diagnosis.

Conclusions: Expert-guided TVUS has increased sensitivity when diagnosing adenomyosis compared to routine TVUS. Expert-guided TVUS sensitivity is increased further in specimens with extensive disease. A grading system might be evaluated to improve the overall diagnosis of adenomyosis by stratifying its degree of likelihood compared to the extent of the disease.

2384089 Does 3-Dimensional Ultrasonographic Evaluation of Women’s Ovarian Reserve Adequately Discriminate Between Young Women With Normal and Poor Ovarian Reserve? Sara Chohli,* Carmela Valdecabres, Carlos Pascual, Francisco Raga, Antonio Cano Obstetrics and Gynecology, Hospital Clinico Universitario de Valencia, Alginet, Valencia, Spain

Objectives: Currently the determination of anti-müllerian hormone (AMH) levels is considered the gold standard to evaluate the ovarian reserve. Our aim is to evaluate if 3D ultrasonography discriminates adequately between young women with normal and poor ovarian reserve.

Methods: Prospective, population-based, cross-sectional study conducted at our Department of Obstetrics, Gynecology, and Reproductive Medicine from January 2009 to September 2015. The study was approved by the Institutional Review Board, and all participants gave informed consent for the trial. A total of 926 healthy women (18–29 years) recruited from students at our university decided to participate in this study. The 3D ultrasonographic sono-automatic volume calculation, antral follicular count (AFC), and AMH level were determined on days 2–5 of the menstrual cycle to evaluate the ovarian reserve.

Results: The prevalence of young women with a poor ovarian reserve based on the determination of AMH (<1 ng/mL) was 4.24% (n = 41). Moreover, the prevalence of polycystic ovarian syndrome ascertainment by a high AMH level (>10 ng/mL) was 13.1% (n = 121). Therefore, 82.5% of our students presented average AMH levels (n = 764). On the other hand, the prevalence of young women with a poor ovarian reserve by 3D ultrasonography (AFC <10) was 4.85 (n = 45). The prevalence of women with polycystic ovaries was 14.25% (n = 132). Finally, women with an average AFC by 3D ultrasonography was 80.9% (n = 749). No statistically significant differences were observed between both techniques.

Conclusions: Exploring women’s ovarian reserve by 3D ultrasonographic sono-AVC and AFC seems to precisely correlate with the serum AMH levels. Consequently, estimating women’s ovarian reserve by this ultrasonographic mode is very reliable. Therefore, it allows the precise recognition of young women with a diminished ovarian reserve.

2384643 Localization of Essure Microinserts: Easy 3-Dimensional Algorithm Adrian Baltica, Susan Egan, Chi-Son Kim,* Phani Simhadri Obstetrics and Gynecology, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ USA

Objectives: 3D ultrasound with the Z technique is used to obtain the midcoronal plane of the uterus. This technique has been used to check the position of microinsert placement. We present a 4-step algorithm to visualize the microinsert’s relationship with the endometrial cavity.

Methods: We used a GE Voluson E8 ultrasound system with a transvaginal 5–9-MHz probe in the render mode as follows: (1) Acquire a fundal transverse 2D image at the largest transverse dimension of the endometrial cavity at the fundal region. Adjust the direction of the render box to align with the position of the uterus if needed. (2) In plane A, place the reference line at the middle of the endometrial cavity (transverse plane). (3) In plane B, use the Z rotation to align the long axis of the endometrial stripe parallel to the reference line (sagittal plane). (4) In the 3D coronal plane, adjust X and Y rotations to optimize visualization of bilateral microinserts in relation to the endometrial cavity.

Results: An easy-to-learn algorithm to visualize proximal ends of microinserts and their relationship to the endometrial cavity.

Conclusions: Clinical outcomes are dependent on the location of the microinserts. This algorithm provides an easy-to-learn method that provides visualization of a microinsert’s position by 3D transvaginal ultrasound.

2385022 Are the Ultrasonographic Criteria for Polycystic Ovaries Still Necessary for Their Diagnosis? Carmela Valdecabres,* Sara Chohli, Carlos Pascual, Francisco Raga, Antonio Cano Obstetrics and Gynecology, Hospital Clinico Universitario Valencia, Valencia, Spain

Objectives: Demonstrate if the use of ultrasound is almost necessary for the diagnosis of polycystic ovary syndrome (PCOS) or if there are other useful strategies.

Methods: Prospective, population-based, cross-sectional study conducted at our Department of Obstetrics, Gynecology, and Reproductive Medicine from January 2009 to September 2015 to evaluate the prevalence of PCOS with the different current classifications: Rotterdam, National Institutes of Health (NIH), and Excess Androgen Society (EAS) criteria. The study was approved by the Institutional Review Board, and all participants gave informed consent for the trial. Additionally, the prevalence of PCOS with 3D sono-automatic volume calculation, antral follicle count (>25), or anti-müllerian hormone (AMH) determination (>10 ng/mL) criteria was ascertained.

Results: A total of 926 healthy women (18–29 years) recruited from students at our university decided to participate in this study. The prevalence rates of PCOS under Rotterdam, NIH, and AES criteria were 14.7%, 6.1%, and 10.4%, respectively. Moreover, the prevalence rates of PCOS based on the exclusive 3D ultrasound evaluation or AMH determination were 26.2% and 19.6%, respectively.

Conclusions: Our study reveals significant differences when using diverse classification criteria. We believe that a future effort is needed to find the most appropriate definition for PCOS. However, excluding the sono graphic criteria in such ovaries seems a mistake, given the many clinical implications associated with an ovary with such a large ovarian reserve.


Objectives: To evaluate the efficacy of 3D ultrasound (3DUS) to diagnose uncommon congenital uterine anomalies, comparing with magnetic resonance imaging (MRI) as the gold standard, using the European Society of Human Reproduction and Embryology–European Society for Gynaecological Endoscopy (ESHRE–ESGE) consensus on the classification of congenital anomalies of the female genital tract.

Methods: Sixty-three women with 2DUS suspicion of congenital uterine anomalies were evaluated with 3DUS and MRI. These data were retrospectively analyzed in order to confirm the presence and type of uncommon uterine anomalies in accordance with the ESHRE–ESGE con-
sensus. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated with 95% confidence intervals. Agreement between the 2 methods was evaluated using the κ index.

Results: Uncommon congenital uterine anomalies were diagnosed by 3DUS in 14 (22.6%) women of the 63 included in the study group: 1 (1.6%) dysplastic uterus, 6 (9.5%) bicornal uteri, and 7 (11.1%) hemiuteri. MRI diagnosed uncommon congenital uterine anomalies in 15 (23.8%) patients. In 1 case where 3DUS diagnosed a septate uterus, MRI diagnosed a bicornal uteru. 3DUS demonstrated 85.7% sensitivity, 100% specificity, 100% PPV, 98.2% NPV, and 0.91 κ in the diagnosis of bicornal uteri. For dysmorphic uteri and hemiuteri, sensitivity, specificity, PPV, and NPV all were 100% with 1.00 κ.

Conclusions: Ultrasonographic diagnosis with 3DUS is very efficient in the diagnosis of the uncommon congenital uterine anomalies, with a good level of agreement with MRI using the ESHRE–ESGE consensus.

2385465 Intestinal Polyps in Asymptomatic Postmenopausal Women Identified During a Routine Gynecologic Transvaginal Ultrasound Evaluation Claudia Maksoud,* Yara Leitão Ultrasound, Centro de Pesquisa em Medicina Tropical de Rondônia, Rio de Janeiro, Brazil

Objectives: To show 2 cases of intestinal polyps suspected at transvaginal evaluation, confirmed by posterior colonoscopy and biopsy, in asymptomatic postmenopausal women who were scanned for routine gynecologic evaluation.

Methods: B-mode and color Doppler images were acquired with a Philips 2–5-MHz HD11 transvaginal probe, and no previous intestinal preparation was required. We scanned the patients in sagittal, transverse, and oblique views. Color Doppler was used to identify the vascular pattern and fluxometry to measure the resistance index.

Results: The lesions were hypoechoic, circumscribed, and solid, and the vascular pediculus and its insertion in the mucosal intestinal surface were observed using color Doppler and power Doppler. There was no visible sign of invasion of the intestinal walls that could be clearly defined by ultrasound aspects.

Conclusions: When performing gynecologic transvaginal studies, it is important to carefully look at the structures and adjacent organs because it is possible to identify intestinal lesions even in the asymptomatic phase, assisting in early detection and improving the prognosis.

2385918 Two- and Three-Dimensional Transvaginal Ultrasound With Power Doppler in Prediction of Endometrial Malignancy in Patients With Postmenopausal Bleeding Karol Dokus,* Jozef Visnovsky, Zuzana Laveckova, Erik Kudela, Jan Danko Gynecology and Obstetrics, Jessenius Faculty of Medicine, Comenius University, Martin, Slovakia

Objectives: The aim of the study was to correlate 3D power Doppler ultrasound (PD-US) scans of the endometrium with biopsy findings in women with postmenopausal uterine bleeding in order to create a clinical model for evaluation of the risk of endometrial malignancy.

Methods: A total of 324 patients underwent transvaginal 2D grayscale and 3D PD-US examination of the endometrium before getting endometrial biopsy. Inclusion criteria were one-off post-menopausal bleeding and an endometrial sagittal thickness >5 mm. The ultrasound image showing the most vascularized section of the endometrium on 3D PD-US was used to estimate endometrial thickness, and the vascularity index (VI) was calculated using virtual organ computer-aided analysis software. A thorough patient history was taken to collect clinical information.

Multivariate logistic regression analysis was used to create a model for prediction of endometrial malignancy.

Results: There were 22 (6.79%) endometrial carcinomas, 34 (10.49%) endometrial hyperplasias, and 268 (82.71%) benign endometrial findings. Women with an endometrial malignancy were older (median age, 64 vs 54 years; P = .026) and had a thicker endometrium (median thickness, 12.8 vs 6.8 mm; P = .015) and higher VI values compared to the histologically negative group, but compared with the hyperplasia group, the differences were insignificant (median age, 64 vs 62 years; P = .744; median thickness, 12.8 vs 10.7 mm; P = .338), and VI values were also comparable.

Conclusions: Postmenopausal bleeding is a frequent cause of consultation in gynecologic practice. It is also the main alarming clinical sign of endometrial carcinoma. The transvaginal ultrasound scan has become the “gold standard” in the initial examination. It is a powerful tool to identify the individual risk of malignancy in symptomatic postmenopausal women in order to optimize management. (This study was supported by grant AVV-14-0815.)

High-Frequency Clinical and Preclinical Imaging

2382440 Assessing Fasciocutaneous Flaps With High-Frequency Ultrasound and Photoacoustic Imaging Maria Stanczak1,* Edita Aksamietiene2, John Eisenbrey1, Lucas Bryant2, Fleming Forsberg2, Ji-Bin Liu1, Edmund Pribitkin1 1Radiology, 2Otolaryngology–Head and Neck Surgery, Thomas Jefferson University, Philadelphia, PA USA

Objectives: Fasciocutaneous flaps are transfers of skin and subcutaneous tissues to another location on the body. The intent is to cover large superficial defects in the skin relying on vessels within the fascial planes for vascular supply. Vascular compromise is the most common cause of flap failure, resulting in surgical removal and/or therapeutic intervention. This study investigated changes in flap perfusion and saturated oxygen levels with high-frequency ultrasound (US) and photoacoustic imaging (PA) as early predictors of failure.

Methods: Six Sprague Dawley rats (550–650 g) received 8 × 2.5-mm bilateral anterior abdominal wall fasciocutaneous flaps as part of an ongoing study. The left epigastric artery was injured, resulting in compromised left flaps, preserving right flaps as controls. High-frequency (21–70 MHz) bilateral grayscale US and PA was conducted preoperatively and 24 and 48 hours postoperatively with a Vevo LAZR scanner (Visualsonics, Toronto, Canada). PA was performed with fixed parameters (gain 31 dB, depth 16 mm, 100% PA power). Changes in vascular perfusion and saturated oxygen levels were averaged over 50–60 frames. Measurements were compared bilaterally in all fasciocutaneous flaps.

Results: In all rats, flaps were visualized as linear hyperechoic structures with a thickness of 1.7–2.3 mm. Preoperative abdominal wall imaging observed minimal vascular perfusion patterns with average saturated oxygen levels within the right and left sides of 79% and 75%, respectively. Increased vascular patterns developed 24 hours after surgery in the control flaps, with a decrease in vascular perfusion visualized in the compromised flaps. PA of the compromised flaps measured decreased oxygen levels 24 and 48 hours postoperatively (56% and 59%, respectively). Contralaterally, the control flaps yielded postsurgical oxygen levels of 86% and 80% at the same time points. Of the rats followed to completion, half the compromised flaps ended in failure.

Conclusions: Assessment of fasciocutaneous flaps in Sprague Dawley rats can be achieved with high-frequency US and PA. Changes in vascular perfusion and saturated oxygen levels can be observed 24 and 48 hours after surgery.
2383795 The Use of Blood Oxygen Level-Dependent Magnetic Resonance Imaging in Growth-Restricted Fetuses Carolina Bibbo1,*, Jie Luo2, Esra Turk2, Borjan Gagoski3, Mark Vangele1, Arvind Palanisamy2, Elfar Adalsteinsson2, Ellen Grant1, Julian Robinson2

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Objectives: To use blood oxygen level–dependent magnetic resonance imaging (BOLD-MRI) to investigate changes in placental and fetal tissue oxygenation associated with transient maternal oxygenation in pregnancies where uteroplacental insufficiency is suspected.

Methods: Singleton and twin pregnancies were recruited for BOLD-MRI if the ultrasound-estimated fetal weight was below the 10th percentile or if umbilical artery Doppler measurements were abnormal. Controls were also recruited. BOLD-MRI signaling was measured in the fetal brain, liver, thigh, and placenta. The total acquisition time was 30 minutes, and 3 different 10-minute phases of maternal oxygenation were investigated: (1) normoxic, (2) hyperoxic, and (3) normoxic. The oxygen supply was alternated from room air (21% oxygen) to oxygen (15 L/min) via a non-rebreathing facial mask and back to room air.

Results: Eight subjects were recruited: 2 singleton and 6 twin pregnancies. There were 6 cases (either abnormal umbilical artery Dopplers in uterus or small for gestational age at birth weight) and 8 controls. The gestational age of enrollment ranged from 26–34 weeks. In placental tissue, the rate of signal intensity increase with oxygen and the rate of signal intensity decrease after oxygen were both slower in the cases as opposed to the controls (0.085 vs 0.097 min–1; P < .01; and –0.068 vs –0.15 min–1; P < .01, respectively). After oxygen exposure, the signal intensity was higher for the cases (12.3% vs 7.1%; P < .01). In the brain, liver, and thigh, the signal intensity after oxygen exposure was lower for the cases in comparison with the controls (–3.1% vs –0.2%; P < .01; –3.8% vs 6.6%; P < .01; and –6.1% vs 2.1%; P < .05, respectively).

Conclusions: BOLD-MRI can be used to study changes in placental and fetal tissue oxygenation. Although preliminary, we postulate that these findings showing different oxygen dynamics in the insufficient placenta suggest less efficient oxygen transport, and the lower postoxy- genation plateau in the fetal tissue with insufficient placenta could suggest increased fetal oxygen extraction.

Interventional-Intraoperative Ultrasound

2380574 Sonographic Guidance for Pancreas Transplant Biopsies: Technique, Complications, and Outcomes Louise Truong,*, Todd Leung, Mader Ponder, Vickie Feldstein

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Objectives: Pancreas transplants are increasingly performed and evaluated using ultrasound (US). Transplant biopsy results assess for rejection and/or pancreatitis and inform clinical management. Real-time US is often used to guide these percutaneous procedures. The objective of this study was to review technique, efficacy, and safety of these biopsies.

Methods: All pancreas transplant biopsies performed at a single large tertiary transplant center from January 1, 2000, to August 1, 2015 were retrospectively reviewed. The medical records were searched to assess for number of core biopsy samples obtained and histologic results, including adequacy in each case. Clinical evidence of biopsy-related complications within 30 days was also reviewed. Minor complications were defined as arteriovenous fistula, pseudoaneurysm, or hemorrhage that did not need further intervention. Major complications were defined as complications requiring intervention such as transfusion of blood products or an invasive procedure (by surgery or interventional radiology).

Results: A total of 131 biopsies were performed in 97 patients. In 98 cases (75%), a single biopsy pass with an 18-gauge, 2-mm-penetration, spring-loaded core biopsy device (Bard Biopsy Systems, Inc) was performed. Technical success was achieved in 123/131 biopsies (94%). Eight biopsies were nondiagnostic (6%), with 2 requiring repeat US-guided biopsy. There were a total of 11 (8%) minor complications and 0 major complications. Minor postbiopsy complications included 6 small arteriovenous fistulae, 4 small peritransplant hematomas, and 1 small pseudoaneurysm with minimal postbiopsy bleeding. These complications were clinically insignificant, and subsequent imaging demonstrated resolution of these minor complications.

Conclusions: US-guided percutaneous pancreatic transplant core biopsy can be safely performed with high technical success and with a low rate of complications. The most common complication is a small arteriovenous fistula, typically clinically insignificant and managed expectantly.
2381037 Role of Sonography in the Treatment of Chronic Granulomatous Mastitis
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Objectives: (1) To discuss the methodology and role of ultrasound-guided aspiration of symptomatic fluid collections as a treatment option in chronic granulomatous mastitis of the breast, presenting our institutional experience with corresponding illustrative images. (2) To review the clinical presentation, radiologic and pathologic features, and diagnostic criteria of granulomatous mastitis. (3) To discuss existing treatment options for the disease and the morbidity associated with wide surgical excision and corticosteroid therapy, based on comprehensive review of the current literature.

Methods: In addition to reviewing clinical, radiologic, and pathologic features of granulomatous mastitis, we present our institutional experience including the details of our unique treatment technique and the natural course of the disease and patient outcomes.

Results: Thus far, ultrasound is typically only used for the diagnosis and follow-up of granulomatous mastitis of the breast. Standard treatment options include high-dose corticosteroid therapy and surgical excision of affected tissue. We have developed a minimally invasive, ultrasound-guided aspiration method for symptomatic fluid collections in treatment of the disease as an alternative. In the past 2 years, we have treated 5 patients with the diagnosis of chronic granulomatous mastitis in our institution using the aforementioned technique. All patients were able to avoid the adverse effects and morbidity associated with lumpectomy, mastectomy, and long-term corticosteroid use with eventual resolution of the inflammatory process and good cosmetic outcomes.

Conclusions: We recommend consideration of the minimally invasive repeat ultrasound-guided aspiration technique for symptomatic fluid collections in patients diagnosed with chronic granulomatous mastitis as an alternative to more invasive surgery or long-term corticosteroid therapy.

2385500 Sonographic Pictorial Review of Image-Guided Renal Interventions and Their Complications
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Objectives: (1) To highlight the utility of ultrasound in guiding renal interventional procedures. (2) To describe the sonographic findings of complications associated with renal interventional procedures and correlate these with computed tomographic (CT) angiographic findings where available.

Methods: A brief review of ultrasound-guided renal interventions will be presented. The sonographic findings of complications associated with renal interventions (hematomas, pseudoaneurysms, and arteriovenous fistulas) will be described and correlated with CT/angiographic findings where available. Pertinent management issues will be briefly discussed.

Results: Not applicable as this is a pictorial review.

Conclusions: Ultrasound plays a major role in guiding nonvascular renal interventional procedures. It also plays an important role in diagnosing complications associated with these procedures, of which some are potentially life threatening and require aggressive management.

2387663 Doppler Imaging of the Periorbital Vessels
Robert Bard
Biofoundation, New York, NY USA

Objectives: Map anatomy of periorbital arteries/veins to avoid puncture during facial procedures. Many cases of blindness are now attributed to vascular trauma.

Methods: Thirty-nine patients were mapped by 3D Doppler 17-MHz ultrasound in 6 periorbital regions. Maps were provided pre-treatment to surgical staff.

Results: Imaging showed 25% of aberrant facial arteries that were avoided during treatment. No arterial damage was incurred.

Conclusions: Presurgical vascular mapping may avoid iatrogenic trauma.

2387685 Ultrasound Guidance for Hyaluronidase Injections
Robert Bard
Biofoundation, New York, NY USA

Objectives: Hyaluronidase may reduce the volume effect if the aliquot is intact. Sonography will differentiate an intact aliquot from hemorrhage.

Methods: Four patients with 84 injection sites were scanned for volume.

Results: Twenty-five percent had full or moderate dispersion of the aliquot. Seventy-five percent had no dispersion of the aliquot.

Conclusions: Hyaluronidase may be used effectively when no dispersion of the aliquot is noted.

Musculoskeletal Ultrasound
2342432 Ultrasound-Guided Lateral Femoral Cutaneous Nerve Block for the Diagnosis and Treatment of Meralgia Paresthetica: Case Report
Carmen Wong
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Objectives: A patient presents with bilateral burning pain and numbness in the lateral aspect of proximal thighs for 18 months with occasional toe curling. Laboratory diagnostic workup was negative for nutritional deficiencies and endocrine pathologies. Nerve conduction studies were also within normal limits. There was concern for an L2 radiculopathy, in addition to meralgia paresthetica. Since the patient’s burning pain was interfering with function and quality of life, the patient received bilateral lateral femoral cutaneous nerve (LFCN) injections with lidocaine using ultrasound guidance for diagnosis and treatment of pain.

Methods: The anterior superior iliac spine was palpated, and the ultrasound transducer was placed mediially below the level of the inguinal ligament. The femoral artery and vein were visualized; the transducer was advanced laterally and caudally until the LFCN was visualized lateral to the sartorius muscle border. After aspiration, 2 mL of 1% lidocaine was injected into the area of the nerve.

Results: The patient’s pain decreased more than 50% percent on a visual analog scale bilaterally at the initial visit. On 2-week follow-up, the patient reported 90%–95% improvement of pain on the left thigh and 60% improvement on the right lateral thigh. The patient reported a 75% decrease in paresthesias when ambulating. There were no adverse effects, such as weakness, infection, or erythema at the injection site.

Conclusions: LFCN blocks have been used for harvesting skin grafts; however, they are rarely used in the diagnosis and treatment of meralgia paresthetica. Ultrasound imaging allows for real-time visualization of anatomy and needle positioning, allowing for successful placement of the injectate into the area of interest. Ultrasound-guided lidocaine injection
of the LFCN for meralgia paresthetica can be both a therapeutic and diagnostically sound approach with minimal adverse effects and is a minimally invasive procedure.

2367161 Sonographic Evaluation of Ligaments and Tendons of the Hands
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Objectives: Fine spatial resolution and dynamic assessment make sonography useful for the evaluation of ligaments and tendons in the hand. The objective of this exhibit is to review the normal sonographic appearance of tendons and ligaments in the hand, to illustrate dynamic imaging techniques for these structures, and to demonstrate common pathology of the tendons and ligaments as seen on sonography.

Methods: Normal anatomic sonographic appearances of the flexor and extensor tendons of the fingers and ulnar and radial collateral ligaments will be demonstrated from control patients. The picture archiving and communication system was searched for pathologic cases involving the hand, and clinical notes were reviewed to confirm sonographic diagnosis.

Results: Pathologic cases that will be demonstrated include sagittal band rupture, acute pulley tear with bowstringing, flexor and extensor tendon tear, trigger finger, ulnar collateral ligament tear, Stener lesion, giant cell tumor of the tendon sheath, Dupuytren contracture, tenosynovitis, and digital neurona mimicking tendon injury.

Conclusions: Linear high-frequency transducers and a dynamic technique make ultrasound extremely useful for evaluation of the ligaments and tendons of the hands. After reviewing this exhibit, the learner will be comfortable with normal and abnormal sonographic appearances of the hand.

2369681 Diagnostic Accuracy of Ultrasound Among Patients With Osteoarthritis in Detecting Knee Synovitis Using Magnetic Resonance Imaging as the Reference Standard: A Meta-analysis
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Objectives: To determine the accuracy of ultrasound in the detection of knee synovitis among patients with osteoarthritis using magnetic resonance imaging as the reference standard.

Methods: An extensive search of PubMed, Embase, and the Cochrane Central Register of Controlled Trials was performed by 2 reviewers (I.B. and R.P.). This was completed by hand search of references from relevant articles and review papers published from 1995 to 2014. A modified Quality Assessment of Diagnostic Accuracy Studies checklist was used to assess the quality of the included studies. The 2 reviewers independently selected eligible studies, with disagreement resolved by consensus. The same 2 reviewers independently extracted data from the full text of the selected 2 studies. Data analysis was used to generate the measures of diagnostic accuracy and summary receiver operating characteristic curves.

Results: Diagnostic performance of ultrasound in detecting joint effusion, pooled from 2 studies, demonstrated sensitivity of 86.2% and specificity of 73.1%. Sonographic feature of synovial thickening showed sensitivity of 98.6% and specificity of 77.1%. Popliteal cysts had sensitivity of 85.5% and specificity of 100%.

Conclusions: Sonographic findings of joint effusion and the presence of popliteal cysts have moderate sensitivity and high specificity. The sonographic feature of synovial thickening has moderate sensitivity and specificity. Thus, these findings may be used as diagnostic criteria in evaluating patients with knee osteoarthritis.

2371631 Utilizing Sonographic Imaging to Compare 2 Clinical Methods of Lower Trapezius Assessment
Dexter Witt,* Nancy Talbott
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Objectives: The clinical assessment of strength in the lower trapezius (LT) is traditionally performed in a prone position with the arm overhead. For individuals with shoulder pathologies, this position may be difficult to achieve. Sitting with the arm in neutral is often more comfortable, and most patients with shoulder pain are able to adduct and depress the scapula in this position without increasing pain. Ultrasound (US) imaging is a reliable method of determining LT thickness and can be used to assess LT activation. The purpose of this study was to utilize US imaging to compare LT thickness during a traditional prone manual muscle test (MMT) with thickness during sitting scapular adduction and depression (SADD).

Methods: Eighteen subjects consented to participate. With the subject sitting, the US transducer was used to clearly visualize the LT. An image of the LT was captured at rest and when the subject pulled the scapula down and back. This process was repeated 3 times bilaterally. Next, the subject was moved to a traditional prone MMT position in which US images were taken at rest and under 3 states of resistance. Images were stored and thickness measurements of the LT taken using ImageJ. Descriptive analyses were used to summarize mean LT thickness. An analysis of variance was used to analyze the association between LT thickness, position, and condition.

Results: In sitting, LT thickness significantly increased from 3.2 mm at rest to 7.7 mm during active SADD. In prone, LT thickness significantly increased from 3.3 mm at rest to 5.6 mm during an active hold, 6.0 mm during a hold with a 2-lb weight, and 6.2 mm during a hold against maximal resistance. While rest values during sitting and prone testing were not significantly different, the thickness of the LT was significantly greater during the active scapular movement in sitting than during the prone maximal MMT.

Conclusions: This study suggests that active SADD in sitting can produce LT thickening greater than the traditional prone MMT position. For patients with movement restrictions or significant pain with overhead movements, the sitting scapular activity may be more appropriate for examination than the traditional MMT position.

2375191 In Vivo Measurements Using Ultrasound Imaging to Investigate Intersession Reliability of 3 Grades of Posterior Glenohumeral Mobilization Used by Practitioners of Manual Therapy
Dexter Witt,* Nancy Talbott
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Objectives: Grades of posterior humeral mobilizations (PHM) are commonly used in manual therapy procedures performed by physical therapists, chiropractors, and osteopaths. These procedures are used to promote positive outcomes in patients with shoulder dysfunction. Evidence is limited to support the ability to reliably reproduce graded mobilization movements between sessions. The purpose of this study was to use ultrasound imaging to assess the amount of posterior humeral movement during grades of PHM on 2 separate days and to determine the intersession reliability during 3 grades of mobilization.

Methods: Eleven healthy subjects were tested. In supine, the shoulder was positioned in 55° of abduction and 30° of horizontal adduction. An ultrasound transducer was placed over the anterior glenohumeral joint and the position of the humerus recorded at rest and as a single examiner applied grade 1, grade 2, and grade 3 PHM. Each grade was repeated 3 times on both arms. Measurements were repeated 1 week later. Posterior movement of the humeral head during the mobilization was de-
terminated by measuring the position of the humeral head in reference to the coracoid process.

Results: Grade 1 mean movement was 2.3 mm during session 1, which was significantly different from the 2.9 mm of movement measured during session 2. Grade 2 mean movement was 8.1 mm during session 1 and 8.6 mm during session 2, while grade 3 mean movement was 11.3 mm during session 1 and 11.5 mm during session 2. Grade 2 and grade 3 differences between sessions were not significant. Intraclass correlation coefficients were 0.810 for grade 1, 0.647 for grade 2, and 0.549 for grade 3.

Conclusions: Differences between sessions were small for each grade of PHM, and reliability was lower at higher grades. Results emphasize the variability between sessions of a single examiner who is attempting to mobilize the same subject in a similar manner on 2 different days. Further study is needed to determine if this variability can be decreased within a single examiner.

2375204 A Sonographic Investigation Into the Manual Assessment of Inferior Glenohumeral Joint Stiffness

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Objectives: Manual assessment of joint stiffness is often incorporated into the examination of the shoulder and can assist clinicians in identifying the need for increasing flexibility or emphasizing stabilization. Testing, however, can be performed in multiple positions, including (1) a neutral position (NP) in which the arm is at the side; (2) an open packed position (OP) in which the arm is in 55° of abduction and 30° of horizontal adduction; and (3) an abducted position (AP) in which the arm is in 90° of abduction. The purpose of this study was to determine via ultrasound (US) imaging the intratester reliability of manual assessment of inferior glenohumeral stiffness in each of the 3 positions and to determine if the positions significantly altered stiffness values.

Methods: Fourteen healthy adults participated. In sitting, the arm was placed in the NP with the US transducer over the superior glenohumeral joint. US images were taken at rest and as a maximal inferior translational force was applied through a handheld dynamometer. This process was repeated 3 times in the NP and in the AP. The subject was then placed in a supine position and testing was performed 3 times in the OP. The humeral head position was measured in reference to the superior acromion and the amount of movement determined by the distance the humeral head moved from the rest position. Stiffness was calculated as force per millimeter (N/mm).

Results: Intrasesson intraclass correlation coefficient values were good for the NP (0.841) and for the AP (0.739) and poor for the OP (0.392). Mean stiffness values were highest in the AP (149.1 N/mm) and significantly lower in the in the OP (86.7 N/mm). Mean stiffness in the NP was 113.9 N/mm, which was not significantly different from the other positions.

Conclusions: High correlations suggest that testing for stiffness is clinically reliable in either the NP or the AP. Lower correlation values in the OP do not support the ability to repeatedly assess stiffness in the position. Because of the differences in the stiffness values in the 3 positions, results of this study also suggest that clinical assessments for stiffness should be repeated in a single test position.

2375215 Sonographic Assessment of the Lower Trapezius During Dynamic Overhead Movement

Dexter Witt,* Nancy Talbott
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Objectives: Static assessment of the lower trapezius (LT) has been found to be reliable using ultrasound imaging (USI) and offers the ability to compare LT thickness in individuals with and without suspected LT involvement when the arm is placed and held in one position. LT activity, however, is required to appropriately function during dynamic movements of the arm, suggesting that dynamic assessment of the LT is needed. The purpose of this study was to use USI to measure and describe thickness changes in the LT during dynamic overhead arm movement.

Methods: Thirty-five adults consented to participate. With the subject sitting, the US transducer was placed lateral to T7 and adjusted to clearly visualize the LT and the ipsilateral trapezius. A video of the LT was recorded as the subject performed the following flexion movements: 0–120, 0–90, and 0–180. Each test was repeated 3 times on the dominant arm. During the 0–120 movement, measurements of LT thickness were taken when the arm was at 0° and at 120°; during the 0–90 movement, measurements were taken at 0° and at 90°; and during the 0–180 movement, measurements were taken at end range. Intraclass correlation coefficients (ICCs) were calculated to determine the reliability of LT measurements between repetitions. Descriptive analyses and an analysis of variance were used to determine the association between thickness and joint position.

Results: The ICC for LT measurement was 0.964. Mean LT thickness at rest was 3.25 mm. Mean thickness significantly increased from rest to 4.1 mm at 90° and from rest to 3.8 mm at 120°. Mean thickness at end range was 6.1 mm. The thickness at 90° was not significantly different from the thickness at 120°, but the thickness at end range was significantly greater than the thickness at 90° and 120°.

Conclusions: LT muscle thickness as measured by USI increased from rest to midrange and from midrange to end range. Resting thickness of the LT nearly doubled as the arm reached end range. USI can be used to reliably measure LT thickness during dynamic movement, offering clinicians an objective methodology for LT assessment.

2375234 In Vivo Sonographic Assessment of Thickness Changes in the Serratus Anterior During Overhead Humeral Movement

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Objectives: Activation of the serratus anterior (SA) is essential to normal shoulder mechanics, with alterations in SA contraction associated with shoulder pathologies. Although past research has used electromyography to assess SA activity, ultrasound imaging (USI) offers a method to visualize the SA and to measure SA thickness changes during isometric testing. Considering the dynamic function of the SA, expanding USI methodology to include dynamic assessment may improve recognition of abnormal SA activation during arm motion. The purpose of this study was to measure and describe thickness changes in the SA during dynamic overhead arm movement.

Methods: Thirty-five adults consented to participate. With the subject sitting, the US transducer was placed on the ribcage at the level of T7 and the SA visualized. A video of the SA was recorded as the subject performed the following flexion movements: 0–120, 0–90, and 0–180. Each test was repeated 3 times on the dominant arm. During the 0–120 movement, measurements of SA thickness were taken at 0° and at 120°; during the 0–90 movement, measurements were taken at 0° and at 90°; and during the 0–180 movement, measurements were taken at end range. Intraclass correlation coefficients (ICCs) were calculated to determine the reliability of SA measurements between repetitions. Descriptive analyses and an analysis of variance were used to determine the association between thickness and joint position.

Results: The ICC for SA measurement was 0.917. Mean SA thickness at rest was 5.1 mm. Mean thickness significantly increased from rest to 8.5 mm at 90° and from rest to 8.9 mm at 120°. Mean thickness at end range was 10.4 mm. The thickness at 90° was not significantly different from the thickness at 120°, but the thickness at end range was significantly greater than the thickness at 90° and 120°.
Conclusions: SA muscle thickness as measured by USI increased as the arm was elevated, showing close to a 100% increase in thickness from rest to end range. While there may be greater SA thickening at end range than at midrange, a significant difference can be achieved at lower ranges for those individuals whose pain or stiffness limits overhead movement.

2377192 Can Physical Therapy Students Reliably Measure Humeral Head Position on Ultrasound Images?

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Objectives: Physical therapy curricula have expanded to increase emphasis on the importance of imaging. Ultrasound imaging (UI) is one such imaging technique that is being used with greater frequency in musculoskeletal differential diagnosis and intervention. One challenge with UI, however, is the consistency of measurements of images by novices. Once an acceptable image has been acquired, the image must be interpreted similarly between individuals to have equivalent input into a decision-making process. Instruction and the use of selected images may improve this consistency to facilitate the goal of the profession to improve the knowledge of physical therapy graduates in the area of UI. The purpose of this study was to examine the reliability of measurements of humeral head position made by 2 physical therapy students after exposure and instruction in UI.

Methods: Twelve healthy subjects consented to participate. Ultrasound images were taken on each subject during 3 grades of posterior mobilization. One therapist performed the mobilization; 1 therapist performed UI; 1 student recorded forces during the mobilizations; and 1 student stored captured images. Both arms were mobilized 3 times on day 1. Testing was repeated 1 week later. In addition, a second therapist completed 3 repetitions of the mobilizations on the nondominant arm. Following the completion of testing, students were instructed in the use of ImageJ to measure humeral head position. Instruction consisted of a 30-minute demonstration of the measurements by an individual who was registered in musculoskeletal ultrasound. Each student independently completed 288 measurements. Intraclass correlation coefficients (ICCs) were calculated to determine the reliability of the measurements.

Results: The ICC between measurers was 0.966. Measurements were not significantly different between measurers.

Conclusions: The results of this study suggest that ultrasound images of humeral head position can be reliably measured by physical therapy students after a brief period of instruction. As UI becomes more prevalent in education, research, and the clinic, reliability may not need to be an obstacle for its use.

2378339 In Vivo Measurements of Lower Trapezius Muscle Thickness: Intraexaminer and Interexaminer Reliability During Sitting Scapular Adduction and Depression

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Objectives: Manual muscle testing of the lower trapezius (LT) muscle is traditionally performed in prone position with the arm overhead. Many patients with shoulder pathology cannot tolerate this position due to pain or restriction. Most can achieve a sitting position and tolerate an active scapular adduction and depression movement, commonly referred to as a scapular squeeze (SS). Ultrasound imaging can be used to measure any changes in LT thickness that occur during the scapular squeeze and thereby provide an alternate assessment of LT muscle activity. The purpose of this study was to determine the intraexaminer and interexaminer reliability of LT thickness assessments during a sitting SS.

Methods: Eighteen healthy adults consented to participate. With the subject sitting, examiner 1 placed the ultrasound transducer lateral to T7 and adjusted the image to visualize the LT muscle and the ipsilateral transverse process. An image was recorded at rest. The subject was then instructed to perform an SS as examiner 2 provided tactile cues. The image was recorded by examiner 1. This process was repeated 3 times on both arms. After rest, examiner 2 recorded the images, and examiner 1 provided the cues. Thickness measurements from captured images were made using ImageJ. Descriptive statistics and intraclass correlation coefficients (ICCs) were calculated for intraexaminer and interexaminer reliability.

Results: For examiner 1, mean LT thickness measurements at rest and during an SS were 3.2 and 7.7 mm, respectively. These were not significantly different from the mean thickness values for examiner 2 (3.4 mm at rest and 7.7 mm during the SS). The intraexaminer ICCs for examiner 1 and examiner 2 were 0.970 and 0.950, respectively. The interexaminer ICC was 0.886.

Conclusions: This study supports the utility of ultrasound imaging to reliably measure LT thickness during an SS. Measurements made by one examiner had good agreement with measurements made by a second examiner. Siting may be an acceptable position to measure changes in LT thickness for clinicians seeking to assess LT activity or to promote LT contraction.

2378345 A Sonographic Investigation of Interexaminer Differences During 3 Grades of Posterior Glenohumeral Mobilization: An In Vivo Comparison of Movement and Force

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Objectives: Posterior glenohumeral (GH) mobilizations can be utilized to promote positive outcomes in patients with shoulder dysfunction. Limited in vivo evidence is available that supports the ability of different clinicians to repeatedly utilize similar mobilization movements. In fact, current evidence indicates that despite the wide use of mobilization as a treatment, significant variations between the amount of force and movement between clinicians may exist. The purpose of this study was to use ultrasound imaging to analyze movement and force differences between 2 therapists during the performance of 3 grades of posterior GH mobilization.

Methods: Twelve healthy subjects participated. With the subject in the commonly preferred mobilization position, an ultrasound transducer was placed over the anterior GH joint and the position of the humerus recorded at rest and as a single examiner applied 3 grades of posterior mobilizations through a handheld dynamometer. Each grade was repeated 3 times. This process was repeated by a second examiner. Posterior movement of the humeral head was determined by measuring the position of the humeral head in reference to the coracoid process.

Results: Grade 1 mean movement was 3.4 mm for therapist 1, which was not significantly different from the 3.6 mm recorded by therapist 2. Grade 2 mean movement was 9.0 mm for therapist 1, which was significantly different from the 5.8 mm produced by therapist 2. Grade 3 mean movement was 12.0 mm for therapist 1, which was also significantly different from the 7.5 mm produced by therapist 2. Force measurements for grade 1 mobilizations were not different between therapists, but forces used during grade 2 and 3 mobilizations were significantly greater for therapist one (22.2 and 42.6 lb, respectively) than for therapist 2 (10.7 and 14.4 lb, respectively).

Conclusions: The results of this study suggest that 2 therapists can consistently produce similar grade 1 mobilizations using similar forces, which result in similar joint movement. However, at higher grades, the amount of force and the amount of the resulting movement diverge significantly.
2380232 Verification of Isolated Lumbar Deep Muscle Contraction by Magnetic Nerve Root Stimulation Using Ultrasonography
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Objectives: To evaluate the changes of lumbar deep muscle thickness and cross-sectional area using ultrasonography with magnetic stimulation.

Methods: Twelve healthy volunteers (39.6 ± 10.0 years) without low back pain during 3 months were included. Magnetic stimulation was done on the L5 and S1 roots with a figure-8 coil. To confirm the proper motor root stimulation, the surface electrode was put on the tibialis anterior (L5) and abductor hallucis (S1) muscles, and the hot spots of magnetic stimulation were found with 50% of maximal magnetic stimulation and determined the stimulation threshold lowering the magnetic intensity by 5%. Ultrasonography was used to assess the changes of L5 and S1 lumbar multifidi (superficial and deep) cross-sectional area and thickness with maximal magnetic stimulation. The cross-sectional area (CSA) and thickness were measured with image acquisition program ImageJ software (National Institutes of Health, Bethesda, MD). The Wilcoxon signed rank test was used to compare outcomes between before and after stimulations.

Results: The mean minimal threshold was 29.6% ± 3.8% of maximal stimulation intensity. With minimal magnetic stimulation, thicknesses of the L5 and S1 deep multifidi (DM) were increased from 1.25 ± 0.20 and 1.42 ± 0.23 cm to 1.40 ± 0.27 and 1.56 ± 0.34 cm, respectively (P = .005; P = .003). CSAs of L5 and S1 DM were also increased from 2.26 ± 0.18 and 1.40 ± 0.26 cm² to 2.37 ± 0.18 and 1.56 ± 0.34 cm², respectively (P = .002; P = .002). However, thicknesses of the L5 and S1 superficial multifidi (SM) were not changed from 1.92 ± 0.21 and 2.04 ± 0.20 cm to 1.91 ± 0.33 and 1.96 ± 0.33 cm (P = .211; P = .199) and CSAs of L5 and S1 were also not changed from 4.29 ± 0.53 and 5.48 ± 0.32 cm² to 4.42 ± 0.42 and 5.64 ± 0.38 cm² (P = .003; P = .003). With maximal magnetic stimulation, thicknesses of the L5 and S1 DM and SM were increased (L5 DM, 1.29 ± 0.26 and 1.46 ± 0.27 cm; P = .028; L5 SM, 2.01 ± 0.42 and 2.24 ± 0.39 cm; P = .005; S1 DM, 1.29 ± 0.19 and 1.67 ± 0.29 cm; P = .002; S1 SM, 1.90 ± 0.36 and 2.30 ± 0.36 cm; P = .002). CSAs of L5 and S1 DM and SM were also increased (all P values were .002).

Conclusions: Deep lumbar muscles could be stimulated with lumbar motor root magnetic stimulation. With minimal stimulation, the thickness and CSA of the lumbar sacral DM measured using ultrasonography were increased.

2383189 The Detection of the Intra-articular Loose Bodies in the Joints by Point-of-Care Ultrasonography
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Objectives: To discuss the value of point-of-care ultrasonography (US) in the assessment of loose bodies compared to other imaging modalities.

Methods: We selected 3 cases with a final diagnosis of loose bodies proven by US from a sports medicine clinic. All 3 cases were examined by primary care sports medicine fellows under supervision of the sports medicine program director with extensive experience in musculoskeletal US: case 1, 29-year-old male with a history of patella dislocation with frequent locking, catching, and severe pain on left knee for 1 year with a negative magnetic resonance imaging (MRI) study; case 2, 58-year-old male with a 2-year history of limited range of motion of the left elbow and pain on the lateral side of the elbow joint since an injury from a fall onto an outstretched hand with a negative elbow x-ray; case 3, 47-year-old male with acute right 1st metatarsophalangeal joint pain with swelling and erythema with a remote history of turf toe.

Results: In all 3 cases, we were able to visualize loose bodies easily by a standard musculoskeletal US protocol for the affected joint, which were missed by other imaging modalities and/or the orthopedic specialist.

Conclusions: US is a valuable tool to detect intra-articular loose bodies, which can be easily missed by history, physical exam, plain x-ray, computed tomography, or MRI/MR angiography. High suspicion, a careful scanning technique, and knowledge of the radiographic studies are essential to make a reliable and correct diagnosis of loose bodies by US.

2383206 Comfort of Orthopedic Trainees With Ultrasound-Guided Hip Arthrocentesis Before and After Educational Intervention
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Objectives: Hip arthrocentesis for both the evaluation of joint effusions and injection of anesthetics can be a difficult task without the aid of adjunct guidance techniques. Fluoroscopy is a popular modality, though it carries a number of disadvantages, including infrequent availability, decreased portability, and also radiation to both patient and provider. Ultrasound has been shown to be a reliable and accurate guidance tool for hip arthrocentesis without many of the disadvantages of fluoroscopy. Though they are tasked with the care of patients with hip pathology, many orthopedic trainees are not comfortable with ultrasound-guided hip arthrocentesis (USGHA), which can at times delay definitive patient care and management. We sought to evaluate the baseline comfort of orthopedic trainees both before and after a brief educational presentation and cadaver-based workshop on USGHA.

Methods: Orthopedic trainees ranging from medical students to chief residents underwent a 15-minute didactic lecture and subsequent hands-on cadaver-based workshop. Participants were surveyed before and after intervention for their experience, comfort, and likelihood of performing USGHA on a 1–10 scale. Participants were surveyed before and after intervention survey, and 20 participants completed the postintervention survey. Six of 19 (31.5%) had previous experience with hip arthrocentesis utilizing either fluoroscopy or landmark-based guidance techniques. No participant had previous experience with USGHA. Prior to the intervention, on a 10-point analog scale, the average comfort with USGHA was 1.26, and the average likelihood of performing USGHA on a 1–10 analog scale.

Results: Nineteen participants completed the preintervention survey, and 20 participants completed the postintervention survey. Six of 19 (31.5%) had previous experience with hip arthrocentesis utilizing either fluoroscopy or landmark-based guidance techniques. No participant had previous experience with USGHA. Prior to the intervention, on a 10-point analog scale, the average comfort with USGHA was 1.26, and the average likelihood of performing USGHA on a 1–10 analog scale.

Conclusions: Our study shows that the confidence and familiarity of novice operators can be greatly increased with a brief educational intervention. Further studies need to be done to investigate the actual accuracy of these trained novice operators.

2383507 Development of a New Index of “Muscular Age” Evaluated by Ultrasonography: Quantitative Assessment of the Quadriceps Femoris Muscle and Comparison With Knee Extension Force
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Objectives: To discuss the value of point-of-care ultrasonography (US) in the assessment of loose bodies compared to other imaging modalities.

Methods: We selected 3 cases with a final diagnosis of loose bodies proven by US from a sports medicine clinic. All 3 cases were examined by primary care sports medicine fellows under supervision of the sports medicine program director with extensive experience in musculoskeletal US: case 1, 29-year-old male with a history of patella dislocation with frequent locking, catching, and severe pain on left knee for 1 year with a negative magnetic resonance imaging (MRI) study; case 2, 58-year-old male with a 2-year history of limited range of motion of the left elbow and pain on the lateral side of the elbow joint since an injury from a fall onto an outstretched hand with a negative elbow x-ray; case 3, 47-year-old male with acute right 1st metatarsophalangeal joint pain with swelling and erythema with a remote history of turf toe.

Results: In all 3 cases, we were able to visualize loose bodies easily by a standard musculoskeletal US protocol for the affected joint, which were missed by other imaging modalities and/or the orthopedic specialist.

Conclusions: US is a valuable tool to detect intra-articular loose bodies, which can be easily missed by history, physical exam, plain x-ray, computed tomography, or MRI/MR angiography. High suspicion, a careful scanning technique, and knowledge of the radiographic studies are essential to make a reliable and correct diagnosis of loose bodies by US.
Non–Weight-Bearing and Weight-Bearing Ultrasonography to tentatively assess muscular morphologic changes due to aging and could be the quadriceps femoris muscle and to develop a “muscular age” index. The relationship among aging, muscle strength, and the image features analysis of the quadriceps femoris muscle to develop a “muscular age” index. The aim of this study was to evaluate the detection of musculoskeletal disorders is important, no index is available to quantify muscular age at present. The developed equation for the estimation of “muscular age” was significantly decreased in the elderly group compared with the younger and middle groups. In contrast, MEAN and SUE significantly decreased in the elderly group and describing the change in muscle size when weight bearing.

Methods: One-hundred forty-five healthy volunteers were included in this study. The subjects were classified into 6 groups on the basis of sex and age as follows: under 44 years old (younger group; n = 68), 45–64 years old (middle-aged group; n = 31), and over 65 years old (elderly group; n = 46). We studied a total of 290 lower limbs of 145 participants who underwent both knee extension strength and ultrasound examinations. For the assessment of the muscle quality, the texture analysis was mathematically defined as the following parameters: MEAN, skewness (SKEW), kurtosis (KURT), inverse different moment (IDM), sum of entropy (SUE), and angular second moment (ASM). The knee extension force and the QM thickness (QMT) were also measured.

Results: QMT, SKEW, KURT, IDM, ASM, and muscle strength significantly decreased in the elderly group compared with the middle and elderly groups. The developed equation for the estimation of “muscular age” was the following formula: male, 5.453 × (–0.413 × ASM + 0.439 × SUE – 0.384 × IDM + 0.375 × MEAN + 0.378 × QMT – 0.201 × height) + 39.491 + [0.841 × (age – 39.491)]; female, 6.705 × (–0.400 × ASM + 0.406 × SUE – 0.384 × IDM + 0.375 × MEAN – 0.371 × SKEW – 0.351 × KURT – 0.272 × QMT – 0.221 × height) + 50.190 + [0.697 × (age – 50.190)].

Conclusions: The proposed index of muscular age can quantitatively assess muscular morphologic changes due to aging and could be a valuable tool for early detection of musculoskeletal disorders.

Non–Weight-Bearing and Weight-Bearing Ultrasonography of Select Foot Muscles in Young Asymptomatic Participants: A Descriptive and Reliability Study

Participants were recruited after Institutional Review Board approval. Two examiners collected long- and short-axis ultrasound images of the abductor hallucis (AH), flexor digitorum brevis (FDB), and quadratus plantae (QP) muscles in the non–weight-bearing and weight-bearing postures. A GE Logiq E9 (GE Healthcare, Wauwatosa, WI) ultrasound system was used for image acquisition. Weight-bearing images were collected with the participant standing on a custom-built platform, permitting transducer access to the plantar foot while maintaining hind and fore foot contact.

Results: There were 26 participants (17 female) with a mean age of 25.5 ± 3.8 years and a mean body mass index of 28.0 ± 7.8 kg/m². Interexaminer reliability was excellent when measuring the muscles in the short axis (intraclass correlation coefficient [ICC] = 0.75) and fair to good in the long axis (ICC > 0.4). Intraexaminer reliability was excellent in both planes for each rater when measuring the AH and FDB. Rater 1 demonstrated excellent reliability in measuring the QP in the short axis and fair-to-good reliability when measuring the QP in the long axis. Rater 2 demonstrated fair-to-good reliability when measuring the QP in both planes. Weight bearing did not reduce reliability. The AH cross-sectional area (CSA) increased from 2.47 ± 0.93 cm² when non–weight bearing to 2.60 ± 0.91 cm² when weight bearing. The FDB CSA increased from 2.03 ± 0.44 cm² when non–weight bearing to 2.20 ± 0.51 cm² when weight bearing. The QP CSA increased from 1.85 ± 0.47 cm² when non–weight bearing to 1.97 ± 0.50 cm² when weight bearing. All muscles demonstrated a significant increase in CSA when weight bearing.

Conclusions: The ability to reliably image these muscles with weight-bearing ultrasonography may permit a greater understanding of the pathophysiology in foot deformities and pain syndromes.

Sonography of a Morel-Lavallée Lesion of the Knee in a Child

Objective: Illustrate sonographic findings of a Morel-Lavalèe lesion in a 7-year-old boy.

Methods: A 7-year-old boy presented with suprapatellar fullness in the left knee and mild localized tenderness. High-frequency sonography was performed to show the focal abnormality. Correlation with knee magnetic resonance imaging helps confirm the sonographic diagnosis.

Results: Characteristic sonographic findings are noted and depicted.

Conclusions: Focused sonography using a high-frequency transducer can well demonstrate a Morel-Lavallée lesion in the knee.

Obstetric Ultrasound: Fetal Anomalies

Non–Weight-Bearing and Weight-Bearing Ultrasonography of Select Foot Muscles in Young Asymptomatic Participants: A Descriptive and Reliability Study

A 31-year-old female in her first pregnancy with a hitherto uncomplicated course underwent a scheduled anatomic survey at 21 weeks’ gestation. The sonogram identified multiple skeletal anomalies, including bowing and shortening of the distal extremities, S-shaped ribs, and a normal facial profile. Following counseling, the patient subsequently elected to undergo dilatation and evacuation. Karyotype and microarray did not identify any genetic anomaly. Targeting sequencing of specific genes associated with skeletal dysplasia showed a heterozygous base pair change in the fetus on the COL1A1 gene on chromosome 17q21.31-q22 with consequent nucleotide change C.319G. A causing amino acid change in the fetus on the COL1A1 gene.

Conclusions: This is a case report concerning a patient in her first pregnancy whose fetus was noted on a sonogram to have multiple skeletal anomalies. Subsequent genetic testing identified a previously undescribed mutation in the COL1A1 gene. This case serves to highlight the sonographic features of the skeletal survey encountered in conjunction with the genetic mutation.

Methods: The case is reviewed, including pertinent prenatal records, results of genetic testing, and prior sonographic findings. Using PubMed and Google Scholar, a review of the pertinent literature was performed.

Results: A 31-year-old female in her first pregnancy with a hitherto uncomplicated course underwent a scheduled anatomic survey at 21 weeks’ gestation. The sonogram identified multiple skeletal anomalies, including bowing and shortening of the distal extremities, S-shaped ribs, and a normal facial profile. Following counseling, the patient subsequently elected to undergo dilatation and evacuation. Karyotype and microarray did not identify any genetic anomaly. Targeting sequencing of specific genes associated with skeletal dysplasia showed a heterozygous base pair change in the fetus on the COL1A1 gene on chromosome 17q21.31-q22 with consequent nucleotide change C.319G. A causing amino acid change P1064D. Parental testing demonstrated that this is a de novo mutation. The mutation has not been described previously. COL1A1 codes for type 1 collagen, and previously described mutations have been associated with osteogenesis imperfecta type 1 and Ehlers-Danlos type 7. As neither parent carried the mutation, recurrence in subsequent pregnancies was determined to be unlikely. A subsequent pregnancy resulted in the live birth of an unaffected child.

Conclusions: We present the skeletal anomalies associated with a novel mutation of the COL1A1 gene.
2351310 Prenatal Diagnosis of Congenital Dacrocystocele
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Objectives: This is a case report concerning a patient in her fourth pregnancy whose fetus was noted on a sonogram to have a cystic structure medial to the right eye, approximately 8 mm in size. The location and appearance were in keeping with dacrocystocele. This report serves to highlight the sonographic features in addition to the pathophysiology of dacrocystocele.

Methods: The case is reviewed, including pertinent prenatal records, results of genetic testing, and prior sonographic findings. Using PubMed and Google Scholar, a review of the relevant literature was performed.

Results: A 43-year-old patient in her fourth pregnancy attended for a fetal sonogram at 32 weeks to measure fetal growth. Prior sonograms including an anatomic survey and nuchal translucency measurement were within normal limits. Medial to the right orbit and lateral to the nose was an 8-mm circumscribed structure. The patient attended for follow-up imaging, and on subsequent scans, no change in size was observed. The patient subsequently underwent vaginal delivery of a live female infant. The facial profile appeared within normal limits, and subsequent pediatric and ophthalmologic review following delivery determined that no action in the neonatal period was necessary. Congenital dacrocystoceles are rarely encountered in clinical practice, with an estimated incidence of 1 in 3,800. The majority are detected clinically following delivery; less commonly they are seen on prenatal sonograms. Subsequent treatment is usually indicated due to the risk of dacrocystitis and mucocele formation in the nasal passage with subsequent airway obstruction.

Conclusions: Congenital dacrocystocele is rarely encountered on prenatal imaging. We recommend sequential imaging to ensure expansion is not present and close follow-up after delivery due to the potential complications of dacrocystitis and airway obstruction.

2371388 Prenatal Microarray Analysis in Pregnancies Complicated by Advanced Maternal Age or Fetal Sonographic Anomalies in the Setting of a Normal Karyotype
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Objectives: To assess the added value of microarray analysis to the conventional karyotype testing among pregnancies complicated by advanced maternal age (AMA) or abnormal sonographic findings.

Methods: This was a case series of 33 pregnancies complicated by either abnormal sonographic findings (n = 22) or AMA (n = 11). All included cases underwent genetic testing and had a normal karyotype but an abnormal microarray. All pregnancies that continued past 20 weeks underwent a detailed sonographic survey and fetal echocardiogram. Pregnancy outcome was recorded when available for all cases included in the analysis.

Results: Among fetuses with abnormal sonographic findings, congenital heart defect (CHD) was the most common finding, 10/22 (45%), followed by central nervous system (CNS) anomalies, 8/22 (36%). Fifteen fetuses underwent echocardiograms that were abnormal in 10 cases. The most common CHDs were outflow tract abnormalities, followed by atrioventricular valve atresia. The 22q11 deletion was found in 3/10 (30%) of the fetuses with CHD. An additional 7/10 (70%) of the fetuses with CHD had microarray alterations in chromosomes 3, 4, 6, and 15. The most common CNS abnormalities were agenesis of the corpus callosum and ventriculomegaly. Microarray alterations in these cases involved chromosomes 1, 2, 3, 4, 6, 9, and 14. Two patients were lost to follow-up after the genetic testing. One pregnancy was complicated by intrauterine fetal death. Pregnancy termination occurred in 16/31 (51.6%): 11 among pregnancies with abnormal sonographic findings and 5 among women with AMA, prior to performance of a detailed anatomic survey. Only 3 women had an unaffected live-born.

Conclusions: Microarray analysis identified clinically significant genomic alterations in pregnancies complicated by AMA or abnormal sonographic findings. The most common fetal abnormality identified in the setting of an abnormal microarray was CHD, with aberrations in the 22q11 region accounting only for 30% of genetic alterations in fetuses with CHD. The microarray affected pregnancy outcomes even in the absence of sonographic abnormalities and enabled early reproductive decision making among women with AMA.

2373997 Can You Give Me a Hand? Diagnosing and Understanding the Clinical Significance of Fetal Hand Anomalies in Obstetric Ultrasound
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Objectives: (1) Recognize the most common hand anomalies identified in utero. (2) Understand the spectrum of malformations associated with hand anomalies.

Methods: We present a case series of fetal hand anomalies with emphasis on potential associations, prenatal workup, and postnatal follow-up.

Results: Fetal anatomy screening utilizes ultrasound to assess for in utero anomalies. While the fetal brain, heart, and body are most often the focus of the exam, prenatal assessment of the extremities is also recommended by a recent executive summary jointly published by the Eunice Kennedy Shriver National Institute of Child Health and Human Development in conjunction with a group of national multidisciplinary societies. The extremities can be difficult to visualize during the ultrasound due to fetal movement and position or maternal scanning characteristics. However, when detected, fetal extremity anomalies can provide critical clues to underlying fetal aneuploidies, syndromes, and dysmorphic conditions. Cases discussed include polydactyly, syndactyly, ectodactyly, trisomy 18, VACTERL, amniotic band syndrome, trisomy 21, and arthrogryposis. Other associated abnormalities and syndromes that can be seen with hand anomalies are reviewed.

Conclusions: Identifying and characterizing fetal hand anomalies can be challenging but important to attempt at the time of the routine anatomy scan. When found prenatally, careful evaluation for associated anatomic abnormalities or dysmorphic conditions should be performed, as a significant portion of fetuses with hand anomalies will have additional malformations.

Table 1. Fetal Hand Anomaly Associations

<table>
<thead>
<tr>
<th>Associated Syndrome</th>
<th>Polysyndactyly</th>
<th>Unilateral synechia</th>
<th>Bilateral synechia</th>
<th>Polydactyly</th>
<th>Isolated, familial, trisomy 13 and 18, Meckel-Gruber, diabetic embryopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial ray</td>
<td>VACTERL, trisomy 18, Holt-Oram, thrombocytopenia—absent radius, Fanconi anemia</td>
<td>Ectodactyly-ectodermal dysplasia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clenched hand</td>
<td>Trisomy 18, fetal akinesia deformation sequence</td>
<td>Ectodactyly-ectodermal dysplasia</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>VACTERL</td>
<td>Trisomy 18, distal arthrogryposis, amnioplasia, multiple pterygium syndrome</td>
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</tr>
<tr>
<td>Clodactyly</td>
<td>Amniotic band syndrome, triploidy, Apert syndrome, Poland syndrome</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Syndrome</td>
<td>Congenital heart defect (CHD) was the most common finding, 10/22 (45%), followed by central nervous system (CNS) anomalies, 8/22 (36%). Fifteen fetuses underwent echocardiograms that were abnormal in 10 cases. The most common CHDs were outflow tract abnormalities, followed by atrioventricular valve atresia. The 22q11 deletion was found in 3/10 (30%) of the fetuses with CHD. An additional 7/10 (70%) of the fetuses with CHD had microarray alterations in chromosomes 3, 4, 6, and 15. The most common CNS abnormalities were agenesis of the corpus callosum and ventriculomegaly. Microarray alterations in these cases involved chromosomes 1, 2, 3, 4, 6, 9, and 14. Two patients were lost to follow-up after the genetic testing. One pregnancy was complicated by intrauterine fetal death. Pregnancy termination occurred in 16/31 (51.6%): 11 among pregnancies with abnormal sonographic findings and 5 among women with AMA, prior to performance of a detailed anatomic survey. Only 3 women had an unaffected live-born.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Prenatal Diagnosis of Urinoma and a Dilated Azygous Vein

James Mahen,† Randall Kelly, Kathryn Hutton, Mamie Gao
Obstetrics and Gynecology, Texas Tech University Health Sciences Center, Odessa, TX USA

Objectives: We present a case or urinoma and a dilated azygous vein and postnatal follow-up.

Methods: A primigravid patient was followed with serial ultrasound from 11 until 33 weeks. The urinoma was followed, and the subsequent changes in the venous drainage and cardiac findings were documented.

Results: The patient had a normal 11-week scan. An anatomy scan at 22 weeks demonstrated a right-sided cystic mass of 3.7 cm in diameter, which deflected the right kidney medially. The umbilical vein drained normally into the portal system, and flow in the ductus venosus was normal. The fetal heart including the 3-vessel view was normal. Over the next month, the cyst grew to >7 cm, and the abdominal circumference was >97% for gestational age. The liver was displaced into the left abdomen by the cyst, and the azygous system was noted to dilate. The patient had a spontaneous vaginal delivery at 34 weeks, and postnatal evaluation at the time of surgery confirmed a urinoma from a ruptured renal pelvis.

Conclusions: Prenatal diagnosis of a dilated azygous vein is often a marker for disruption of the normal embryologic formation of the abdominal visceral venous drainage associated with heterotaxy. Compensatory dilation of the azygous vein will develop when there is an interruption of the inferior vena cava (IVC) as a result of the right subcardinal vein failing to anastomose with the hepatic sinusoids to form the hepatic segment of the IVC. This is a frequent finding with left atrial isomerism. In our case, the abdominal venous drainage and cardiac findings were normal in the early second trimester. A retroperitoneal cystic mass developed as a result of a urinoma, and the progressively enlarging mass gradually displaced the right-sided abdominal viscera including the liver to the left of the midline. By 26 weeks’ gestation, the mass had compressed the IVC drainage of the lower body, resulting in a dilation of the azygous vein behind the 4 chambers and a dilated azygous arch emptying into the superior vena cava. Following spontaneous delivery at 34 weeks, the infant had a laparoscopic nephrectomy and removal of the retroperitoneal cyst. With decompression of the abdominal cyst, the normal drainage on the IVC and normal echocardiographic findings were documented. We present an interesting case, which highlights how compression of the IVC by a retroperitoneal mass led to a compensatory dilation of the azygous system.

Prenatal Ultrasound Findings of a Large Spontaneous Subdural Hematoma

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1Obstetrics and Gynecology, New York Methodist Hospital, Brooklyn, NY USA; 2Pediatric Neurosurgery, Weill–Cornell Medical College, New York, NY USA

Objectives: This is the 10th reported case in the medical literature of a prenatally diagnosed spontaneous intrathoracic subdural hemorrhage, as well as the largest volume and the first treated by surgical evacuation without neurologic sequelae to date.

Methods: Ultrasonography (US) performed at 31 weeks for a patient measuring size greater than dates on exam revealed bilateral hydrocephalus and a midline shift by a hypoechoic extra-axial intracranial mass suspicious for a spontaneous subdural hematoma. Targeted US of the fetus revealed no other structural abnormalities. Subsequent fetal magnetic resonance imaging (MRI) confirmed these findings.

Results: A c-section was performed at 35 weeks. The newborn was managed on day 1 of life with transfontanellar aspiration and bilateral craniootomy for hematoma evacuation. She maintained steady improvement and was discharged with home services 21 days postoperatively.

Conclusions: US is likely to be the initial imaging modality on which subdural hematoma is diagnosed. Only a handful of specialized academic centers will have a fetal MRI machine as well as properly trained neuroradiologists, underscoring the importance of the skilled sonologist as the front line for prenatal pathologic diagnosis. This is the first reported case of surgical evacuation with no postnatal neurologic sequelae identified and the earliest diagnosed case resulting in a live birth. We believe our earlier diagnosis at 31 weeks contributed to the successful outcome in our patient and underscores the need for sonologists to familiarize themselves with both normal and abnormal neurosonography in order to continue to make this early prenatal diagnosis possible.

Table 1. Previously Reported Cases

<table>
<thead>
<tr>
<th>Authors</th>
<th>Gestational Age, wk</th>
<th>Hematoma Volume/Side</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>MacDonald (1977)</td>
<td>38</td>
<td>53 cc/bilateral convexity</td>
<td>Subdural tap</td>
<td>Hypotonia at 6 mo</td>
</tr>
<tr>
<td>Gunn (1985)</td>
<td>42</td>
<td>3 pts, 1 had 10 cc blood</td>
<td>Subdural tap in 1</td>
<td>Neonatal death (day 3 of life)</td>
</tr>
<tr>
<td>Mateos (1987)</td>
<td>35</td>
<td>220 cc/R with intraventricular and intra-parenchymal blood</td>
<td>Surgical</td>
<td>Neonatal death (day 14 of life)</td>
</tr>
<tr>
<td>Demir (1989)</td>
<td>33</td>
<td>NA</td>
<td>NA</td>
<td>Intraperitoneal fetal demise</td>
</tr>
<tr>
<td>Nougera (1992)</td>
<td>37</td>
<td>NA/R convexity</td>
<td>Burr hole evacuation</td>
<td>Developmental delay</td>
</tr>
<tr>
<td>Kawabata (1993)</td>
<td>35</td>
<td>100 g/R convexity</td>
<td>NA</td>
<td>Intraperitoneal fetal demise</td>
</tr>
<tr>
<td>Sohda (1996)</td>
<td>37</td>
<td>NA/posterior convexity</td>
<td>Subdural tap</td>
<td>Developmentally normal at 13 mo</td>
</tr>
<tr>
<td>Akman and Cracco (2000)</td>
<td>32</td>
<td>150 cc/R convexity</td>
<td>Burr hole evacuation</td>
<td>Seizures and speech delay</td>
</tr>
<tr>
<td>Pitalis (2002)</td>
<td>22</td>
<td>NA</td>
<td>NA</td>
<td>Termination of pregnancy</td>
</tr>
</tbody>
</table>

Evolution in Womb: Sonographic Pictorial Review of Common and Uncommon Congenital Fetal Anomalies

Vijayanadh Ojili†, Neeraj Kaur†, Arpit Nagrar†
1Radiology, University of Texas Health Science Center, San Antonio, TX USA; 2Radiology, Ohio State University Wexner Medical Center, Columbus, OH USA

Objectives: To describe the antenatal sonographic findings of a wide spectrum of congenital fetal anomalies and correlate these with magnetic resonance imaging (MRI) findings where available.

Methods: A brief review of congenital fetal anomalies (Arnold-Chiari malformation, Dandy-Walker malformation, holoprosencephaly, congenital diaphragmatic hernia, duodenal atresia, bladder outlet obstruction, etc) will be presented. The sonographic findings will be described and correlated with MRI findings if available. Pertinent management issues will be briefly discussed.

Results: Not applicable as this is a pictorial review.

Conclusions: The clinical outcome of various congenital fetal anomalies is briefly addressed.
anomalies may range from being totally asymptomatic to potentially life-threatening conditions, which may result in fetal demise. Therefore, it is important for radiologists and obstetricians to accurately diagnose these conditions in a timely fashion, which greatly impact the prognosis. Sonography is the initial antenatal imaging test performed and will provide diagnosis in most cases.

2384730 A Case of Prenatal Diagnosis of Split-Hand/Foot Malformation and Long-Bone Deficiency
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Objectives: Split-hand/foot malformation with long-bone deficiency (SHFLD) is a rare condition seen in 1:8500–20,000 newborns. It is characterized by the association of ectrodactyly, syndactyly, and malformations of the long bones, especially tibial defects, including tibial hemimelia, hypoplasia, aplasia, or dysplasia. The condition is inherited in an autosomal dominant manner with reduced penetrance and variable expressivity. Susceptibility loci have been identified, with most cases associated with microduplication at the 17p13.3 locus.

Methods: The patient, a 26-year-old G4P1 African American female, was referred at 23 weeks 3 days from an outside institution for evaluation of abnormal fetal upper and lower extremities seen on anatomy ultrasound. The patient’s past medical history was significant for asthma, obesity, sickle cell trait, depression, and sciatrica. The patient’s past obstetric history was significant for 1 full-term spontaneous vaginal birth of a normal female, 1 elective early termination of pregnancy, and 1 spontaneous abortion. The patient’s past medical history was noncontributory.

Results: On detailed ultrasound evaluation, the upper extremities are notable for V-shaped bilateral ectrodactyly with bony syndactyly of the lateral fingers. The right lower extremity was notable for a bowed femur, absent fibula, short tibia, and abnormal foot with few bones. The left lower extremity displayed a normal femur, absent fibula, short tibia, and abnormal foot with few bones and only 1 demonstrable toe. No other anomalies were noted. Following extensive counseling, the patient declined any invasive genetic testing as well as pregnancy termination. The patient had normal fetal echocardiography, and fetal growth remained adequate throughout the pregnancy. Microarray comparative genomic hybridization was sent on the newborn after delivery.

Conclusions: SHFLD with long-bone deficiency is a devastating skeletal anomaly that can be easily detected on a second-trimester anatomic scan. It is likely that detection of the anomaly would have been possible by an early anatomic scan and early genetic testing and would allow the patient a more reasonable time for decision making.

2385008 Prenatal Diagnosis of Sacrococcygeal Fetus in Fetu: A Case Highlighting the Utility of Serial Ultrasound
Jeffrey Denney,* Christy Stanley1, Lou Ann Armstrong1, Jayne Marshall, Bethany Settle1, Chad Haldeman-Englert2
1Obstetrics and Gynecology, Section on Maternal-Fetal Medicine, University of Tennessee, Memphis, TN USA; 2Pediatrics, Section on Medical Genetics, Wake Forest University School of Medicine, Winston-Salem, NC USA; 3Fullerton Genetics Center, Asheville, NC USA

Objectives: Fetus in fetu (FIF) is a rare congenital anomaly defined as an internal or external mass with fetiform structures demonstrating an axial skeleton and significant organogenesis. Prenatal diagnosis of FIF has been mostly limited to the intra-abdominal region. However, there are limited case reports of FIF in other anatomic locations. We present a sacrococcygeal FIF diagnosed on routine prenatal ultrasound that was clearly differentiable from a sacrococcygeal teratoma (SCT).

Methods: An anatomic survey was performed at 18 weeks gestation. Fetal magnetic resonance imaging (MRI) was performed to better delineate the lesion. To supplement fetal growth monitoring in context of the growing mass, additional ultrasounds were performed weekly to evaluate size, continually characterize the mass, monitor middle cerebral artery Doppler, and screen for prehydropic signs.

Results: Fetal ultrasound at 18 weeks’ gestation demonstrated a sacrococcygeal mass measuring 4.7 × 3.3 × 4.4 cm. The mass was heterogeneous in appearance and was noted to have a singular feeding vessel by color angiography. Fetal MRI findings were consistent with a sacrococcygeal teratoma. With the increasing size of the mass, subsequent ultrasounds allowed for visualization of fetal bone within the mass, including vertebral bodies, 2 femurs, tibia/fibula pairs, and feet. These findings were strongly suggestive of FIF, and the patient was counseled accordingly. The fetus was delivered by repeat cesarean section at 37 weeks due to growth restriction. On day of life 2, the 15 × 7 × 12-cm mass was excised. Pathologic evaluation confirmed the presence of a vertebral axis and axial skeleton, verifying the suspected diagnosis of FIF. Organogenesis within the mass included lung, pancreas, adrenal, and intestinal structures (gastric, small intestine, and large intestinal mucosa). No immature teratomatous elements or malignancy were identified.

Conclusions: We present a sacrococcygeal FIF with a prenatal workup that earmarks serial ultrasound as the primary tool used for differentiating FIF from the more commonplace SCT. Differentiation from SCT is key for both counseling and discussion of prognosis, given that 11%–35% of SCTs are malignant.

2385912 Fetal Magnetic Resonance Imaging: A Look Into Its Utility in the Prenatal Diagnosis of Congenital Anomalies
Danielle Tate, Hemanth Veluswamy,* Lindsay Meyers, Akosua Sintim-Damoo, Jeffery Copeland
University of Tennessee, Memphis, TN USA

Objectives: We sought to investigate the utility of fetal magnetic resonance imaging (MRI) in the diagnosis of fetal anomalies suspected on prenatal ultrasound.

Methods: We performed a retrospective review of 165 patients who underwent fetal MRI studies secondary to suspected fetal anomalies first detected via ultrasound. Fetal MRI reports were categorized as either confirming the suspected ultrasound diagnosis, reporting a new finding not previously seen on ultrasound, or definitively diagnosing a questionable anomaly seen on prior ultrasound. Neonatal assessments performed in the immediate postnatal period were then obtained in 111 patients. Neonatal assessments were categorized as those that confirmed the suspected fetal MRI diagnosis, reported a new finding not seen on fetal MRI, or reported findings inconsistent with fetal MRI.

Results: Of the cases reviewed, fetal MRI confirmed the suspected diagnosis in 65% of the cases. Fetal MRI was able to identify a previously undiagnosed fetal anomaly in 24% of the cases. In cases where ultrasound reported a questionable diagnosis, fetal MRI was able to give a definitive diagnosis in 15% of the cases. Of all suspected fetal anomalies that underwent fetal MRI, central nervous system anomalies accounted for the majority (53%). In the neonatal period, neonatal assessment confirmed diagnosis in 89% of cases, revealed a new finding in 10% of cases, and found inconsistent findings in 17% of cases of the patients that underwent fetal MRI. Of those neonates who underwent assessment, fetal MRI more accurately identified congenital anomalies in the antenatal period when compared to prenatal ultrasound: 78% vs 70% (P = .03).

Conclusions: Fetal MRI may serve as a useful tool to confidently identify suspected fetal anomalies. In combination with ultrasound, fetal MRI will allow for improved antenatal and neonatal care.
Cesarean Delivery for Omphalocele

2380773 Do Decreases in Estimate Fetal Weight Percentile on Ultrasound Between the Second and Third Trimesters Impact Neonatal Outcomes in Normally Grown Fetuses? Jennifer Amorosa, *Felipe Tudela, Luciana Vieira, Kelly Zajman, Eric Bergh, Katherine Connolly, Kathy Matthews, Meredith Miller, Angela Bianco Obstetrics and Gynecology, Icahn School of Medicine, Mt Sinai Medical Center, New York, NY USA

Objectives: Fetal growth restriction plays a major role in perinatal morbidity and mortality. Less is known about those fetuses whose estimated fetal weight percentile (EFW%) decreases over time while still remaining within a “normal” weight (EFW >10%, <90%). The purpose of this study was to see if a decrease in EFW of 20% between the 2nd and 3rd trimesters in a “normal”-weight fetus contributes to adverse neonatal outcomes.

Methods: We performed a retrospective cohort study of singleton pregnancies who had growth ultrasound during the 2nd (18–22 weeks) and 3rd (30–34 weeks) trimesters between June 2011 and March 2015. Fetuses with growth restriction (EFW <10%), macrosomia (EFW >90%) or anomalies were excluded. Demographics, delivery data, and composite neonatal outcomes (sepsis, respiratory distress, intubation, intraventricular hemorrhage, necrotizing enterocolitis, pneumonia, neonatal death, and 5-minute Apgars <5) were collected. Fetuses with an EFW% change of ≥20% between the 2 scans were compared to those fetuses that did not. Multivariable log-binomial regression models were used to estimate prevalence ratios and corresponding 95% confidence intervals. We controlled for age, parity, and body mass index (BMI).

Results: Of 5063 patients, 1866 (36.8%) showed a ≥20% decrease in EFW% between the 2nd and 3rd trimesters. This group had a statistically significant (P < .05) risk of birth weight <2500 g (10.66% vs 3.19%; P < .0001) and preterm delivery <37 weeks (8.74% vs 6.01%; P = .0003). There was no significant difference in adverse neonatal outcome (4.34% vs 5.53%; P = .1497). This remained true when the results were adjusted for maternal age, BMI, and parity.

Conclusions: Prospective parents are often concerned if their fetus has what they perceive as a significant drop in EFW% between the 2nd and 3rd trimesters. Prior studies have addressed percentiles changes between the 1st and 2nd trimesters and between 2 scans performed in the 3rd trimester. This is the first study to directly compare EFW% change between the 2nd and 3rd trimesters. While infants who exhibited decreases in EFW% between the 2nd and 3rd trimesters were at a slightly higher risk of preterm birth and low birth weight, there was no significant increase in risk of adverse composite neonatal outcomes.

Table 1. Comparison Between Those Attempting Labor and Those Undergoing Cesarean Delivery for Omphalocele

<table>
<thead>
<tr>
<th>Gestational age at delivery, wk</th>
<th>Attempted Cesarean Delivery for Omphalocele</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n = 17)</td>
<td>(n = 7)</td>
<td></td>
</tr>
<tr>
<td>Gestational age at last ultrasound prior to delivery, wk</td>
<td>36.66 (34.72–38.61)</td>
<td>.37</td>
</tr>
<tr>
<td>Omphalocele diameter, mm</td>
<td>47.70 (36.88–58.53)</td>
<td>.24</td>
</tr>
<tr>
<td>Omphalocele diameter/abdominal circumference</td>
<td>0.19 (0.15–0.22)</td>
<td>.61</td>
</tr>
<tr>
<td>Omphalocele diameter/femur length</td>
<td>0.83 (0.67–1.00)</td>
<td>.50</td>
</tr>
<tr>
<td>Omphalocele diameter/head circumference</td>
<td>0.16 (0.13–0.20)</td>
<td>.61</td>
</tr>
</tbody>
</table>

Data are presented as mean (95% confidence interval).

Obstetric Ultrasound: Fetal Growth

2384833 Fetal Penile Measurements in a Racially Mixed Population

Roger Newman, *Lori Cruz, Elizabeth Ural, James Kiger, Jeffery Korte Obstetrics and Gynecology; Pediatrics; Public Health Sciences, Medical University of South Carolina, Charleston, SC USA; Biology, Wofford College, Spartanburg, SC USA; Obstetrics and Gynecology, Southern Illinois University School of Medicine, Springfield, IL USA

Objectives: Perform fetal and newborn penile measurements and identify variables that affect penile size.

Methods: Women (n = 119; 59 white/60 black) with a singleton male fetus were recruited between 18-22 weeks' gestation. Exclusion criteria were uncertain gestational age (GA), fetal anomalies, progesterone use, or any endocrine disorder. AIUM-certified sonographers performed fetal penile measurements. Freeze-frame images and electronic calipers were used to measure fetal penile length (FPL) from the scrotal junction to the tip of the glans. Penile width (FPW) was measured at the midshaft.
Measurements were repeated 3 times and mean values calculated. Fetal penile volume [fPV: (fPW/2)² × fPL] was calculated. Neonatal genital measures were obtained prior to discharge using the same methods by research staff.

Results: IPL, IPW, and IPV all increased significantly between 18–22 weeks' gestation and were highly correlated with neonatal measures. IPL was significantly predicted by GA, maternal race, and gravity (all \( P < .001 \)) and were 41% of the variance. GA (\( P < .001 \)) was a significant predictor of IPW, and GA and gravidity were predictors of IPV. Maternal race (\( P < .003 \)) was the only significant predictor of neonatal PL and PV.

Conclusions: Racial differences have been reported in newborn and infant penile size, but this is the first report of fetal racial differences. During gestation, androgen hormonal concentrations vary by race and gravidity, and these affect fetal penile size. New reference standards are needed to better diagnose micropenis or ambiguous genitalia in a racially diverse population.

Table 1. Penile Measurements by GA (Mean ± SE)

<table>
<thead>
<tr>
<th>GA, wk</th>
<th>PL, mm</th>
<th>PW, mm</th>
<th>PV, mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>5.0 ± 0.6</td>
<td>4.2 ± 0.3</td>
<td>23.9 ± 6.0</td>
</tr>
<tr>
<td>19</td>
<td>6.2 ± 0.2</td>
<td>4.8 ± 0.2</td>
<td>36.9 ± 3.6</td>
</tr>
<tr>
<td>20</td>
<td>6.6 ± 0.2</td>
<td>5.2 ± 0.8</td>
<td>46.3 ± 2.0</td>
</tr>
<tr>
<td>21</td>
<td>7.3 ± 0.2</td>
<td>5.2 ± 0.8</td>
<td>55.7 ± 3.5</td>
</tr>
<tr>
<td>22</td>
<td>9.2 ± 0.5</td>
<td>5.9 ± 0.2</td>
<td>81.3 ± 6.7</td>
</tr>
<tr>
<td>Neonatal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>25.3 ± 1.4</td>
<td>10.4 ± 0.4</td>
<td>680 ± 53.5</td>
</tr>
<tr>
<td>38</td>
<td>27.1 ± 1.5</td>
<td>10.3 ± 0.3</td>
<td>739 ± 62.2</td>
</tr>
<tr>
<td>39</td>
<td>25.4 ± 0.9</td>
<td>10.6 ± 0.2</td>
<td>700 ± 39.9</td>
</tr>
<tr>
<td>40</td>
<td>27.0 ± 0.9</td>
<td>10.6 ± 0.2</td>
<td>775 ± 41.5</td>
</tr>
<tr>
<td>41</td>
<td>26.2 ± 1.9</td>
<td>10.0 ± 0.5</td>
<td>661 ± 65.5</td>
</tr>
</tbody>
</table>

Obstetric Ultrasound: General

2348862 Middle Cerebral Artery Doppler Ultrasound May Not Be Predictive of Fetal Anemia in Fetuses With Alpha Thalassemia
Shareece Davis-Nelson,* Yvonne Gollin Obstetrics and Gynecology, Loma Linda University Medical Center, Loma Linda, CA USA

Objectives: To determine a threshold for the middle cerebral artery (MCA) peak systolic velocity (PSV) multiples of the median (MoM) that should prompt intrauterine transfusion (IUT) in fetal alpha thalassemia.

Methods: When hydrops was diagnosed, IUT was performed, and the MCA PSV MoM was calculated immediately before and after each procedure using previously described techniques. Additionally, heamocue assessment, a complete blood count, and hemoglobin electrophoreses were performed.

Results: A couple of Southeast Asian descent that had a prior neonatal death from nonimmune hydrops presented for care. The mother was found to have \( cis \) (\( αααα \)) deletions for alpha thalassemia on sequencing. At the time of the anatomy ultrasound, fetal hydrops was noted. Subsequently, paternal alpha thalassemia molecular analysis also demonstrated \( cis \) deletions, and fetal analysis confirmed 4-gene deletion alpha thalassemia. At 19 weeks 6 days, hydrops was noted. The MCA PSV was 1.3 MoM. The case was discussed at a multidisciplinary conference between Radiology, Maternal-Fetal Medicine, Ethics, Pediatric Cardiology, Genetics, and Neonatology. The measurements were repeated, and Transplant Medicine counseled the couple. They opted for intervention for 4-gene deletion alpha thalassemia (which traditionally causes “hydrops fetalis”); based on the multidisciplinary conference proceedings, we performed the initial IUT at 20 weeks 4 days of gestation. The preprocedure MCA PSV MoM values were between 0.93–1.38. At the last IUT, there was an isolated MCA PSV MoM of 1.65; it is unclear if there was fetal movement that caused this occurrence.

Conclusions: Consideration should be given toward a modification of the MCA PSV MoM threshold for intrauterine transfusion in the setting of fetal 4-gene deletion alpha thalassemia.

Table 1. Preprocedure and Postprocedure MCA PSV MoM

<table>
<thead>
<tr>
<th>Transfusion # (wk Gestation)</th>
<th>Preprocedure MCA PSV MoM</th>
<th>Postprocedure MCA PSV MoM</th>
<th>Initial Hemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (20 4/7)</td>
<td>1.38</td>
<td>1.13</td>
<td>6.3</td>
</tr>
<tr>
<td>2 (21)</td>
<td>0.93</td>
<td>0.85</td>
<td>–</td>
</tr>
<tr>
<td>3 (23 6/7)</td>
<td>1.03</td>
<td>1.02</td>
<td>9.2</td>
</tr>
<tr>
<td>4 (27 3/7)</td>
<td>1.37</td>
<td>0.97</td>
<td>9.7</td>
</tr>
<tr>
<td>5 (30 3/7)</td>
<td>1.3</td>
<td>0.8</td>
<td>10.5</td>
</tr>
<tr>
<td>6 (35)</td>
<td>1.65</td>
<td>1.02</td>
<td>10.2</td>
</tr>
</tbody>
</table>

2351609 Polyhydramnios and Adverse Perinatal Outcomes: Comparing 2 Ultrasound Methods of Diagnosing Polyhydramnios and Their Association With Adverse Perinatal Outcomes
Tehila Avitan, Jennifer Hutcheon, Chantal Mayer
1Maternal-Fetal Medicine, BC Women's Hospital, Vancouver, British Columbia, Canada; 2Provincial Health Services Authority, Vancouver, British Columbia, Canada

Objectives: The aim of this study was to determine which measure of polyhydramnios, amniotic fluid index (AFI) or deepest vertical pocket (DVP) is more strongly correlated with adverse perinatal outcomes.

Methods: This retrospective cohort study was drawn from singleton pregnancies receiving a prenatal ultrasound scan ≥28+0 weeks' gestation at the BC Women’s Hospital from 2000–2014. Polyhydramnios was defined as an AFI ≥24 cm or DVP ≥8 cm. Ultrasound data were linked with the hospital’s quality-controlled obstetric and neonatal database, which contains abstracted medical chart data. An adverse perinatal outcome was defined as any of: stillbirth, in-hospital newborn death, or level 2 or 3 neonatal intensive care unit admission. Correlation was measured with Pearson \( r \), and differences in risk between groups were examined using logistic regression.

Results: Among 1029 pregnancies with polyhydramnios, the diagnosis was based on DVP alone for 607 patients (59%), AFI alone for 75 patients (7%), and both methods for 347 patients (34%). AFI and DVP were moderately correlated (\( r = 0.56 \)). There were 32 perinatal deaths (3.1%). Compared with pregnancies diagnosed by DVP alone, pregnancies diagnosed by AFI alone had a higher risk of adverse perinatal outcomes (15% vs 29%, respectively; odds ratio [OR], 2.3; 95% confidence interval [CI], 1.3–3.9). The highest risk was observed in pregnancies diagnosed with both methods (33%; OR, 2.49; 95% CI, 2.0–3.7). Every 1-cm increase in AFI was associated with an 11% increase in odds of an adverse outcome (95% CI, 1.08–1.15), while DVP did not provide additional information on adverse outcomes above and beyond that obtained from AFI (OR, 1.04 per 1-cm increase in DVP; 95% CI, 0.91–1.19).

Conclusions: Pregnancies diagnosed with polyhydramnios based on AFI alone had a significantly higher risk of adverse perinatal outcomes compared with those diagnosed using DVP alone. AFI appears to be a better determinant of adverse perinatal outcomes in the context of polyhydramnios, and this measurement should be used to guide clinical decisions.
Factors Impacting Completion of the Low-Risk Obstetric Ultrasound Anatomic Survey

Brady Coad1, Grace Pariseau2, Grace Stocker2, Lisa Finch1,4,5*

1Radiology, 2Neurosciences Institute, Swedish Medical Center, Seattle, WA USA; 3Gonzaga University, Spokane, WA USA; 4Obx Seattle Ultrasound, Seattle, WA USA; 5MEDAX, Sunrise, FL USA

Objectives: The purpose of this study is to identify variables that are associated with incomplete visualization of fetal anatomy during midtrimester obstetric ultrasound surveys to help predict which factors are more likely to result in inadequate imaging. We hope to generate recommendations to increase efficiency and optimize conditions in order to reduce the rate of incomplete surveys.

Methods: Subjects were 372 pregnant women, ages 18–35 years, with gestational ages of 18–22 weeks. All subjects had a fetal survey during March–May 2015. Twelve data points from each subject’s fetal survey were collected from patient charts: body mass index (BMI; kg/m²), gestational age (GA; weeks), maximum mechanical index (MI), maximum thermal index (TI), ultrasound machine used, location of exam, scanning sonographer, exam duration (minutes), whether all fetal anatomy parts (if any) were well visualized. BMI groups were defined as ≤22 kg/m², >22–25 kg/m², >25–34.9 kg/m², ≥35 kg/m².

Results: The strongest predictor of inadequate visualization was the patient’s BMI (r = .27 total; r = .27 for all). When covaried with BMI, physician, physician, location, MI, TI, GA, and exam time had no statistically significant relationship with incomplete surveys (P > .05 for all). When covaried with BMI, physician performance site, MI, TI, GA, and exam time had no statistically significant relationship with incomplete surveys (P > .05 for all). When covaried with BMI, physician had no statistically significant relationship with incomplete surveys.

Conclusions: After examining sonographer, physician, location, MI, TI, BMI, and GA, we can conclude that higher BMI was the only identified meaningful influence on inadequate ultrasound visualization of fetal anatomy. The likelihood of a fetal survey being adequate is higher in patients with a BMI in the group 1 and 2 range. This is one of many potential benefits of maintaining a healthy BMI.

Table 1. Complete Versus Incomplete Surveys in BMI Groups

<table>
<thead>
<tr>
<th>BMI</th>
<th>Complete, %</th>
<th>Incomplete, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;22</td>
<td>93.7</td>
<td>6.3</td>
</tr>
<tr>
<td>22.1–25</td>
<td>89.0</td>
<td>11.0</td>
</tr>
<tr>
<td>25.1–34.9</td>
<td>85.8</td>
<td>14.2</td>
</tr>
<tr>
<td>≥35</td>
<td>56.0*</td>
<td>44.0*</td>
</tr>
</tbody>
</table>

*p < .05.

Perimortem Demonstration and Treatment of Recipient-to-Donor Transfusion in Monochorionic Diamniotic Twin Gestation

Jessica Parrott,* Carl Weiner

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Objectives: Twin-twin transfusion (TTTS) is a complication of monochorionic diamniotic (mo/di) placenta. If one twin dies, the cotwin suffers mortality/morbidity rates of >30%, each believed secondary to hemorrhage of the cotwin into the dying/dead twin. We report the apparently first ultrasound (US)-documented case of perimortem hemorrhage and its treatment by emergent US-guided percutaneous cord occlusion followed by percutaneous fetal intravascular transfusion (IVT).

Methods: Case report.

Results: A 21 3/7-week G1P0 with mo/di twins was referred to the Kansas University Center for Advanced Fetal Care for TTTS. As the scan was initiated, terminal bradycardia (20 bpm) was seen in the presumed donor. Simultaneously, pulsatile blood flow was documented in the donor cord at the same rate as the recipient twin, whose middle cerebral artery (MCA) peak systolic velocity (PSV) was <1 multiple of the median (MoM). The woman was rapidly transferred to the operating room, where a repeat US showed donor asystole but continued pulsatile cord blood flow originating from the recipient. The recipient’s MCA PSV was still <1 MoM. The now dead donor’s cord was percutaneously occluded under US guidance (bipolar forceps). The time from the 1st scan with bradycardia to occlusion was <20 minutes. US in the recovery room demonstrated a steadily declining heart rate (HR) in the surviving twin from 125 to 90 bpm over 10 minutes. US-guided percutaneous fetal intracardiac epinephrine (0.04 mg) was administered at 85 bpm and a fatal hematocrit (HCT) obtained. The fetal HR rapidly responded to epinephrine, and the HCT was 19%. Over the next 3.5 hours, the MCA PSV rose progressively to 2.56 MoM. A cordocentesis sample revealed an 18% HCT, and an emergent IVT restored the HCT to 36%. Routine US of the next 2 weeks showed an active survivor with normal Doppler studies.

Conclusions: This case illustrates several important physiologic phenomena. One, the off-stated acute fetal-to-fetal hemorrhage does occur and may begin before death. Delivery upon discovery is unlikely to protect the living twin. Two, the increase in the fetal MCA PSV due to acute anemia is relatively slow to develop at least prior to 22 weeks. Three, intracardiac epinephrine can correct acute fetal bradycardia due presumably to fetal hypotension.

An Uncommon Presentation to a Common Problem: Aborting Tubal Ectopic Pregnancy Presenting as an Ovarian Ectopic Pregnancy

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Objectives: Our objective is to describe how a common pathology such as a tubal ectopic pregnancy may present in complex fashion, mimicking a more rare entity on both diagnostic imaging and surgical exploration.

Methods: Our methods included a MEDLINE search on “ovarian pregnancy/ovarian ectopic pregnancy,” “uncommon presentations of ectopic pregnancies,” and “imaging of ectopic pregnancies.” Relevant literature and recent guidelines on the management of ectopic pregnancies were reviewed.

Results: We present the case of a 32-year-old G1P0 female with no significant past medical history presenting with several days of vaginal spotting and mild abdominal cramping. On a pelvic sonogram, the patient was found to have a right ovarian ectopic pregnancy in the posterior cul-de-sac. The patient was subsequently sent to the operating room for laparoscopic surgical excision. On surgical exploration, a right ovarian ectopic pregnancy was identified, and the right adnexa was found tethered in the cul-de-sac. The ectopic pregnancy, right ovary, and right fallopian tube were removed. On pathologic examination, the gross appearance of the specimen was compatible with a right ovarian ectopic pregnancy. On microscopic examination, however, the tissue specimen revealed no implantation of the gestational sac within the ovarian parenchyma. Rather, the specimen was an aborting tubal ectopic pregnancy.

Conclusions: Ectopic pregnancies may occur in as high as 16% of women presenting to the emergency department with first-trimester bleeding. The vast majority of ectopic pregnancies (~98%) occur in the fallopian tube. Other less common sites include the cervix, heterotaxy, and abdominal wall. Ovarian pregnancies are rare, occurring in...
0.5% of ectopic pregnancies. This case demonstrates how a common pathology may present with similar findings and complications as a rarer entity. Although imaging and surgical findings were diagnostic for an ovarian ectopic pregnancy, the diagnosis of an aborting tubal ectopic pregnancy was only made following pathologic examination. Furthermore, rather than undergoing a routine salpingectomy or salpingostomy, our patient underwent an additional right oophorectomy.

2369449 Twin Reversed Arterial Perfusion Sequence Treated by Aortic Sclerosis of the Acardiac Twin
Mauricio Saito1, Juliana Martins1,2,*, Daniela Pinheiro1, Kamille Said1, Debora Silva1, Rogerio Guidoni1
1Conceptus, São Paulo, Brazil; 2Obstetrics and Gynecology, University of Miami, Miami, FL USA

Objectives: The objective of this paper is to report 2 cases of twin reversed arterial perfusion (TRAP) sequence treated by aortic sclerosis of the acardiac twin with hypertonic glucose (50%) in early pregnancy.

Methods: TRAP sequence is a rare malformation associated with monochorionic/mon羊双羊 twins where one twin (pump) develops normally and the other twin presents with severe anomalies, including an absent heart (acardiac), head, and body that will lead to its demise. The prognosis of the pump twin is also obscure, with a mortality rate ranging from 50% to 70%, mostly due to heart failure.

Results: From January 2011 to January 2013, 2 patients were referred to our department with an ultrasonographic diagnosis of TRAP sequence. Patients were primigravida in the early second trimester. Doppler identified the blood flow in the umbilical arteries toward the fetal abdomen of the acardiac twin (reverse of normal). In both cases, <10 mL of hypertonic glucose was infused into the fetal abdomen until cessation of aortic blood flow was identified by color Doppler. Steroids were administered at 36 weeks (2560 g) due to premature rupture of membranes. The mortality rate is approximately 50% to 70%. The mean gestational age at birth was 3536 ± 419 g. Mean gestational age at birth was 39.94 ± 1.12 weeks. There was significantly decreasing resistance to flow as measured by RI (0.62 vs 0.59; P < .01), PI (0.95 vs 0.88; P < .01), and S/D (2.69 vs 2.51; P < .01) from morning (AM) and evening (PM). Magnitudes of change were –5%, –7.5%, and –8.5%, respectively. There were no statistical differences in heart rate (HR) between AM and PM. Table 1 outlines the results.

Conclusions: In this study, we observed significant diurnal changes in UA Doppler flow parameters. The clinical implications of these findings are that when serial UA Doppler parameters are used to guide clinical management, consideration should be given to performing these measures at the same time of day to reduce the effect of diurnal variation.

Table 1. Comparison of UA Flow Characteristics: AM vs PM (n = 45)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AM</th>
<th>PM</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>Fetal HR</td>
<td>135.50</td>
<td>133.09</td>
<td>.014</td>
</tr>
<tr>
<td>UA RI</td>
<td>0.62</td>
<td>0.59</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>UA PI</td>
<td>0.95</td>
<td>0.88</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>UA S/D</td>
<td>2.69</td>
<td>2.51</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

2383165 Pregnant Women's Expectations and Perceptions of Ultrasound in Northern Tanzania
Michael Bernaba,*, Samuel Kaplan, Jacqueline Kublin, Kala Ghouray, Taylor Davis, Jamie Miller, Elisa Zhang, Maryte Gylys, Matthew Gunther, J. Christian Fox
University of California Irvine, Newport Beach, CA USA

Objectives: (1) Does knowing about ultrasound influence the chance of receiving ultrasound? (2) Does the ultrasound examination meet the needs and expectations of the population? (3) Does the ultrasound examination make patients feel more/less stressed about the pregnancy? (4) How do demographics influence maternal attitude towards ultrasound?

Methods: Pregnant patients at Buzuraga Maternal Health clinic in Mwanza, Tanzania, and Ukerewe Hospital in Ukerewe, Tanzania, were asked to fill out a 21-question survey before a routine ultrasound examination. The survey contained questions about demographics and previous ultrasound experience. A routine ultrasound examination of the fetus was then performed. The patients were then asked to fill out a 5-question post-ultrasound survey.

Results: Although 68% of survey responders had heard of ultrasound, only 19.7% of survey responders had received an ultrasound examination before. The χ² test of independence P = .060114. As expected, there was also a direct relationship with the number of births a woman has given to the chance of receiving ultrasound before (P = .12728). The most common expectations of the ultrasound were to see if the fetus was alive (45%), to see that everything is all right (53%), to confirm the date of birth (DoB; 52%), and to identify gender (59%). Additionally, 91% of surgery responders felt more/less stressed about the pregnancy? (4) How do demographics influence maternal attitude towards ultrasound?

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fessionals (78%), television (90%), newspapers (6%), and literature (6%).

**Conclusions:** The majority of women expected to receive specific information through the ultrasound examination, such as confirming DoB, identifying gender, or confirming twins, suggesting that the majority of women have well-defined expectations and are knowledgeable about the capabilities of ultrasounds. In the end, we see that there is a clear desire for Tanzanian women to obtain information about their pregnancy. Ultrasound is a relatively low-cost imaging technique that can help alleviate pregnancy anxieties.

2384955 The Effect of a Brief Ultrasound Training Session on the Proficiency of Medical Students in Obstetric Ultrasound Examination During a Core Clerkship

**Objectives:** Many recent studies have shown the benefit of incorporating ultrasound training into medical school. However, time in the medical school curricula remains a prominent barrier to implementation. In this study, we aimed to discover the effects of a short, 1-time training session on the proficiency in bedside obstetric ultrasound exams in third-year medical students.

**Methods:** During the 2014–2015 academic year, third-year medical students were randomly assigned into an experimental group, which received a 15-minute training session, and a control group, which did not. The training session took place at the beginning of the students’ obstetrics and gynecology clerkship and involved only 1 faculty member. These students were trained to identify the presenting part and measure the most vertical pocket and fetal heart rate. At the end of the clerkship, all students were tested and timed on their abilities to perform these exam maneuvers successfully. Survey data on ultrasound experience and exposure during the clerkship were also collected.

**Results:** A total of 86 third-year medical students (43 in each group) were included in the analysis. Across all tested variables, a higher percentage of the students who received the short training session were able to successfully identify ultrasound targets. Specifically, 90.7% of students in the trained group appropriately traced the fetal heart rate using “M-mode,” while only 60.5% of students in the untrained group were able to complete this task (P = .0012). Additionally, 74.4% of trained students versus 39.5% of untrained students were able to measure the fetal heart tracing from peak to peak or trough to trough (P = .0012). The trained students spent an average of 27.1, 76.2, and 90.2 seconds compared to the untrained group, which utilized 38.2, 87.1, and 97.0 seconds to identify the presenting part (P = .03), most vertical pocket (P = .17), and fetal heart rate (P = .38), respectively.

**Conclusions:** A brief, 1-time ultrasound training session can effectively enhance third-year medical students’ proficiencies in bedside obstetric ultrasound exams during their core clerkship rotation.

2385748 Does the Presence of Abnormal Umbilical Artery Doppler Findings at the Time of Detailed Ultrasound Predict Adverse Outcomes in the Advanced Maternal Age Population?

**Objectives:** Our goal was to determine if the finding of abnormal umbilical artery (UA) Dopplers in the advanced maternal age (AMA) population could be used to predict the occurrence of adverse outcomes in this population. Our secondary goal was to determine if AMA patients in our cohort had higher rates of adverse pregnancy outcomes after the exclusion of suspected aneuploid pregnancies.

**Methods:** A retrospective cohort study was conducted at a tertiary center from 7/2011 to 6/2014. Both AMA and non-AMA patients with abnormal UA Doppler flow at 18–22 weeks’ gestation were identified using our ultrasound database. Pregnancies complicated by multiple gestations, congenital fetal anomalies, and abnormal antenatal screening were excluded. Data regarding the pregnancy course were abstracted, including maternal age, demographic characteristics, medical complications, and perinatal complications. The Fisher exact test was used for analysis.

**Results:** One of 597 AMA cases was noted to have an abnormal UA Doppler (rate, 0.16%); 17/5592 non-AMA cases were identified as having elevated UA Doppler (rate, 0.30%), which was not statistically significant (P = .94). There was a statistically significant difference in the rate of uterine artery notch (AMA 2.84% vs non-AMA 0%; P < .01). AMA patients were noted to have a significantly increased risk of intrauterine growth restriction (AMA 3.69% vs non-AMA 0%; P < .01), preterm birth (AMA 8.38% vs non-AMA 0.02%; P < .01), neonatal intensive care unit admission (AMA 11.56% vs non-AMA 0.02%; P < .01), and preeclampsia (AMA 4.52% vs non-AMA 0%; P < .01). The rate of stillbirth in AMA (1.68%) vs non-AMA (0%) was not found to be statistically significant (P = .19).

**Conclusions:** There was no statistically significant difference in the rate of abnormal UA Dopplers between AMA and non-AMA, indicating that AMA by itself is not a risk factor for abnormal UA Dopplers. The AMA population is at higher risk of multiple complications. Given the lack of a significant difference between abnormal UA Dopplers in AMA vs non-AMA populations, this does not appear to be a useful marker to predict that subgroup of AMA patients at high risk for adverse outcomes. An alternative screening strategy is needed.

2385798 Is Second-Trimester Ultrasound Predictive of Extremes of Birth Weight?

**Objectives:** To evaluate the utility of estimated fetal weight (EFW) percentile at routine 2nd-trimester ultrasound in the prediction of extremes of birth weight (BW) at the time of delivery.

**Methods:** This is a retrospective cohort of women with singleton gestations who underwent 2nd-trimester (16–24 weeks) ultrasound at a single practice from May 2014 to May 2015. The EFW percentile for gestational age was calculated using Hadlock 91. Intrauterine growth restriction/SGA was defined as <10th percentile for gestational age using Hadlock 91 at time of ultrasound or delivery. Large for gestational age (LGA) was defined as >90th percentile for gestational age at time of ultrasound or delivery. The percentile at 2nd-trimester ultrasound was compared with BW percentile at the time of delivery. \( \chi^2 \) and Fisher exact tests were used where appropriate, with \( P < .05 \) denoted as significance.

**Results:** A total of 929 women met criteria for inclusion. In our population, 14% of women delivered an SGA infant, and 4.4% delivered an LGA infant. Second-trimester EFW <10th percentile was associated with BW <10th percentile with a sensitivity of 2.9%, specificity of 99.6%, positive predictive value (PPV) of 57%, and negative predictive value (NPV) of 85% (P = .01). In the assessment for LGA, a 2nd-trimester EFW >90th percentile had a sensitivity of 71%, specificity of 64%, PPV of 9%, and NPV of 98% (P < .001).

**Conclusions:** While there is an association between extremes of EFW percentile at routine 2nd-trimester ultrasound and BW percentile, the association is weak, indicating that most growth abnormalities arise later in pregnancy. Patients found to be carrying an LGA fetus in the 2nd trimester can be reassured that the chance of LGA at delivery is <10%.
Obstetric Ultrasound: New Techniques

2361889 Delayed Postpartum Decrease in Inferior Vena Caval Diameter in Women With Persistent Severe Preeclamptic Hypertension
Célio Hernandez,* Kathryn Reed, Wayne Cohen
University of Arizona, Tucson, AZ USA

Objectives: To assess changes in the postpartum inferior vena caval (IVC) diameter and collapsibility index (CI) during the early postpartum period in women with severe preeclampsia (PE).

Methods: We studied 3 groups of women within 12 hours prior to and 12 hours after delivery. One group consisted of 5 normal gravidas; a second included 4 patients with severe PE with hypertension (>160/110 mm Hg) that resolved promptly after delivery; the third consisted of 6 women with PE and severe hypertension that persisted postpartum. M-mode was used to measure the IVC diameter at end-inspiration and end-expiration. End-inspiration IVC diameter measurements were used for comparison. The CI was obtained by subtracting the difference between the end-expiratory and end-inspiratory values and dividing it over the end-expiratory IVC diameter.

Results: The groups did not differ in maternal age, body mass index, or parity. Gestational age was lowest in the PE group with persistent hypertension (26.4 ± 3.9 weeks) than the control group (31.2 ± 3.8 weeks) or those with resolved hypertension (33.3 ± 3.8 weeks; *P = .04). The predelivery IVC measurements were not different among the 3 groups. Comparison of these values with the postpartum measurements showed that the percentage change of the IVC diameter decreased significantly in the controls (−17.8% ± 7.8%, *P = .0002) and in the patients with resolving PE (−5.9% ± 7.2%, *P = .017) in comparison to the PE group with persistent hypertension, whose IVC diameter was increased over pre-delivery levels (11.2% ± 8.9%). There were no significant differences in the CI among the 3 groups.

Conclusions: Cardiovascular adaptations begin promptly after delivery, and previous studies have shown the expected reduction in blood volume is reflected in a decrease in the IVC diameter. We have confirmed this observation and shown that a similar change occurs in patients diagnosed with PE and hypertension that resolves promptly after delivery. However, in those women whose marked hypertension persisted after delivery, the fall in IVC diameter did not occur, probably a consequence of continued vasospasm. Whether the use of IVC measurements would have some prognostic value in assessing the course of PE should be studied.

2384612 Comparing Uptake of Noninvasive Prenatal Testing at 2 Centers in Lebanon
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1Center for Advanced Fetal Care, Tripoli, Lebanon; 2Centre de Diagnostic Prenatal, Zalka, Lebanon; 3Faculty of Public Health, Lebanese University, Tripoli, Lebanon

Objectives: Noninvasive prenatal testing (NIPT) using cell-free fetal DNA became available in Lebanon at the beginning of 2013. There are several cultural and religious beliefs that vary throughout the country affecting its uptake. As such, the aim of our study was to compare the uptake at 2 different areas of the country and to assess the patient demographics and testing indications.

Methods: Retrospective study on patients in our database at 2 centers in Lebanon (Centre de Diagnostic Prenatal [CDP] and Center for Advanced Fetal Care [CFAFC]) who underwent NIPT. All patients had undergone either first- or second-trimester ultrasound. The same counseling approach is adopted at both centers, where invasive testing/NIPT is offered to all patients over the age of 35 and to those with positive historical/sonographic/biochemical findings. In addition, it may be performed on patients who request it for reassurance following extensive counseling as to its advantages and limitations. All scans and counseling were carried out by 2 sonologists certified by the Fetal Medicine Foundation. Outcome was available on all fetuses. Data were analyzed utilizing a χ2 test. *P < .05 was considered significant.

Results: There were a total of 112 patients in the study. An NIPT result was available on 110/112 (98.2%) patients. There was 1 true-positive case (trisomy 21), 1 false-positive case (trisomy 18), and no false-negatives. Mean transport time was 3 days, and mean time from testing to a result was 9 days. There were 83/112 (74.4%) patients at CDP and 29/112 (25.6%) at CFAFC. The centers were similar in terms of patient age range; however, there was a statistically significant difference in the indications for testing primarily with respect to the presence of second-trimester soft markers (*P = .001), advanced maternal age (*P = .024), and an abnormal first-trimester scan (*P = .044). Based on the indications for testing, 51 patients would have been offered invasive testing.

Conclusions: Even in this small cohort of patients, our study at-tests to the acceptability of NIPT in our cultural setup in 2 areas of Lebanon. From our preliminary data, the primary indications for testing vary across the country. The national incorporation of NIPT into our patient population may avert a significant proportion of invasive tests on normal fetuses.

2385203 Comparison of the First-Trimester Transvaginal Anatomy Scan to the Second-Trimester Structural Survey in Obese and Nonobese Patient Populations: A Pilot Study
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1Maternal-Fetal Medicine, Medical College of Wisconsin, Lake Bluff, IL USA; 2Obstetrics and Gynecology, Rush University Medical Center, Chicago, IL USA

Objectives: To compare accuracy of fetal anatomic transvaginal ultrasound (TVUS) done at 12–14 weeks’ gestation to the traditional transabdominal ultrasound (TAU) for fetal anatomy at 18–22 weeks in normal-weight and obese patient populations.

Methods: In a prospective study, 26 women underwent TVUS for fetal anatomy evaluation between 12 and 14 weeks’ gestational age and TAU at 18–22 weeks. The results of both scans were compared. The percentage of patients in which each structure was optimally visualized was calculated. The relative risk of visualizing a structure in the second trimester compared with the first was calculated in the sample groups.

Results: Twenty-six patients received the first-trimester TVUS, and 24 patients completed the TAU. The average body mass index (BMI) in the obese group was 34, and the average BMI for nonobese patients was 23. In all patients, all structures were more likely to be visualized during the TAU when compared to the TVUS. The cardiac views and hands and feet were more difficult to visualize at both scans but more frequently visualized during the TAU and were seen in 70%/80% of patients. In the obese patients, the posterior fossa, profile, hands and feet, cardiac views, and spine views were less likely to be visualized in the first trimester, but importantly, the cardiac structures and spine views were also difficult to view in this population at the time of the TAU. For the second-trimester scan, the cardiac views, hands and feet, and spine were also less frequently visualized in the obese patients.

Conclusions: First-trimester TVUS detects some of the structures assessed during a complete anatomic survey; however, this study shows that for obese and normal-weight patients, second-trimester TAU allows for better visualization. This study points out the need for additional imaging in obese patients. More research is needed to show if TVUS can be utilized for focused anatomy in the first trimester in this population.
Obstetric Ultrasound: Uterus, Placenta, and Cervix

2378298 Fifth Recurrent Cesarean Scar Pregnancy
Terri-Ann Bennett,* Cara Dolin, Margaret Dziadosz, Ming Tsai, Judith Chervenak, Ana Monteagudo, Ilan Timor-Tritsch
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Objectives: The increase in the cesarean delivery (CD) rate, from 5% in 1970 to 32.2% in 2014, has been associated with an increase in cesarean scar pregnancies (CSPs). The incidence of CSP is approximately 1 in 2500 CDs performed. There is currently no consensus on the optimal management of CSP or recurrent CSP. Our goal is to describe a patient with a fifth recurrent CSP who desired to continue the pregnancy.

Methods: The patient is a 35-year-old G7P2042 with 2 prior CDs and 4 prior CSPs with a positive fetal heart rate, treated with intragestational injection of methotrexate. A GE Voluson E8 (Milwaukee, WI) transabdominal and transvaginal ultrasound system was used to perform serial 2D and 3D renderings. A live CSP was diagnosed on the initial scan at 8 4/7 weeks; the gestational sac was noted to be at the cesarean scar niche with a mostly posterior placenta previa that also wrapped around anteriorly to the level of the bladder. The placenta had multiple lacunae and hypervascularity by 11 4/7 weeks, and a morbidly adherent placenta (MAP) was suspected. A placenta percreta was assumed by 17 4/7 weeks. Magnetic resonance imaging was performed at 32 2/7 weeks, with an impression of placenta previa with increta.

Results: Maternal-fetal medicine specialists counseled and followed this patient throughout the pregnancy. An outpatient betamethasone dose was given 48 hours prior to scheduled cesarean hysterectomy with Gynecologic Oncology backup. Urology was consulted preoperatively and placed ureteral stents. At 34 0/7 weeks, the patient underwent a cesarean hysterectomy with bilateral salpingectomy. The pathology confirmed a MAP: placenta percreta. She did well postoperatively and was discharged home on postoperative day 3. The neonate was small for gestational age and was discharged home from the neonatal intensive care unit on day 9 of life.

Conclusions: CSP is a rare pregnancy complication of CD, and its frequency is mirroring the increasing CD rates. Recurrent CSPs are even more infrequent, and a fifth repeat as in our patient has not been previously described. This case adds more to the mounting data that CSP is a precursor to MAP. Additionally, it displays how the counseling of CSP has shifted over time, indicating that patients with CSP can be offered continuation of pregnancy with understanding of the maternal risks, including uterine rupture and cesarean hysterectomy for MAP.

Pediatric Ultrasound

2374890 Diagnosis of Appendicitis With Point-of-Care Ultrasoundography in Children: A Retrospective Review
Kay Odashima,* Etan Dickman, Francis See, Emin Elezi, Samuel Kluger, Sean McGann, Marla Levine, Lawrence Haines, Mark Tessaro
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Objectives: To determine the test characteristics of pediatric emergency medicine (PEM) physician-performed point-of-care ultrasonography (POCUS) for the diagnosis of appendicitis and to report differences in time to disposition between patients who received POCUS and those who did not.

Methods: We performed a single-center retrospective chart review of all pediatric emergency patients who were evaluated for possible appendicitis over a 4-year period. Patients were enrolled in the POCUS arm if: (1) POCUS by a PEM physician was performed; (2) the images were stored and available for review; and (3) the POCUS impression was documented in the chart. Test characteristics of POCUS for the diagnosis of appendicitis were the primary outcome measures. Secondary outcome measures included: (1) time elapsed between POCUS and the result of radiology department imaging; (2) time elapsed from emergency department arrival to the results of radiology department imaging, compared between patients who received POCUS and those who did not; and (3) time to disposition compared between patients who received POCUS and those who did not.

Results: A total of 7511 charts were reviewed, of which 91 met inclusion into the POCUS arm. Mean age was 10.7 years with a range of 21 months to 17 years. Thirty-six (40%) of patients were female. POCUS was 91% sensitive and 87% specific for the detection of appendicitis with a positive predictive value of 87% and a negative predictive value of 91%. The positive likelihood ratio was 7, and the negative likelihood ratio was 0.1. The average times elapsed between POCUS and radiology US and computed tomography (CT) preliminary reads were 126 and 353 minutes, respectively. It took an average of 55 and 38 minutes longer for the radiology US and CT preliminary reads, respectively, for patients who received POCUS compared to those who did not. However, the time from arrival to disposition was 62 minutes shorter in patients who received POCUS compared to those who did not.

Conclusions: POCUS performed by PEM physicians for the diagnosis of appendicitis has specificity and positive predictive value comparable to US performed by radiologists. Though the times to radiology studies were longer for patients receiving POCUS, the use of POCUS was associated with a faster time to disposition.

2377786 Effect of Ultrasound as an Initial Imaging Modality in Children With Suspected Appendicitis
Stephen Aelterman,* Ee Tay
Emergency Medicine, Icahn School of Medicine at Mount Sinai, New York, NY USA

Objectives: Computed tomography (CT) has traditionally been the initial diagnostic modality for detecting appendicitis. Recent studies point to the use of ultrasound (US) in children due to the lack of radiation. Using US first may decrease the overall length of stay in cases with diagnostic results. In cases with nondiagnostic US, however, CT is often performed afterward. This increases the length of stay and may contribute to disease progression. The objective of this study was to evaluate whether US as an initial imaging modality increases complication rates in children with appendicitis.

Methods: Retrospective review was performed for children ≤17 years old diagnosed with appendicitis in 2 urban pediatric emergency departments. Patients with known perforation, outside transfers, and nonoperative cases were excluded. Patients with US as their initial imaging modality were compared to those with CT only. Complication rates and time from triage to surgical incision were measured. Complications were defined as 1 or more of the following: perforated/gangrenous appendix on surgical/pathology reports; and pertinent medical visits, radiology studies, and/or procedures performed within 6 months after appendectomy. Time to appendectomy was expressed using medians and interquartile ranges (IQRs). Mann-Whitney tests were used where appropriate.

Results: Of 1411 charts reviewed, 661 patients (47%) were eligible for analysis. Those with US performed initially were not at increased odds of experiencing a complication (27.1%) compared to the CT-only group (27.7%; odds ratio [OR], 0.98; 95% confidence interval [CI], 0.70–1.38). Time (minutes) to appendectomy was not significantly different between the US group (553 [IQR, 385, 846]) and the CT-only group (594 [IQR, 437, 797]; P = .24). Of patients in the US group, 103 (28.8%) underwent a subsequent CT scan. This subgroup, compared to the CT-only group, had a greater time to appendectomy (867 [IQR 604.5, 1149.55]; P < .01) but was no more likely to experience a complication (28.2%; OR, 1.02; 95% CI, 0.62–1.68).

Conclusions: Performing US followed by CT does not increase the complication rate compared with performing US or CT alone. Thus, US should be offered as the initial imaging modality due to its safety features.
2385744 The Effect of Point-of-Care Ultrasound on Emergency Department Diagnosis and Management of Cellulitis Versus Local Allergic Reactions From Insect Bites
Jennifer Sanders,* Ee Tay
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Objectives: The sonographic findings of cellulitis have been well described, but to date, only a small case series can be found that describes the appearance of allergic reactions/angioedema from insect bites. Our objective was to evaluate the effect of soft tissue ultrasound (US) on management of soft tissue swelling in emergency department (ED) patients with insect bites.

Methods: This was a prospective study in a pediatric ED of patients ≤21 years old, with clinical soft tissue swelling from insect bites. Treating physician’s pretest opinions regarding the diagnosis and need for antibiotics (ABX) were determined. Trained ED physicians performed US of the affected area, and the effect on the management plan was recorded. We defined cellulitis on US as thickened skin and the presence of soft tissue lobules with surrounding fluid, known as “cobblestones.” Angioedema was defined as the presence of multiple, linear, horizontal, and striated hypoechoic bands within the tissue. Further imaging, medications, and disposition were at the discretion of the enrolling physician. Phone call follow-up was made within a week of the initial presentation.

Results: Among 143 enrolled patients, 16 had cellulitis (15.5%). Mean age was 7 years (±6 years); 50.5% were male. US changed the management of patients with soft tissue swelling secondary to insect bites in 27/103 (26%; 95% confidence interval [CI] 18% to 35%) patients. Of the patients who were believed to require ABX prior to the test, US changed management in 6/26 (23%; 95% CI, 6% to 40%) patients. In those patients who were not believed to require ABX prior to the test, US changed management in 12/77 (16%; 95% CI, 7% to 24%). On average, those patients who were not believed to require ABX prior to the test, US subsequently required ABX upon the follow-up visit.

Conclusions: Soft tissue US changes physician management in approximately 25% of patients in the ED with soft tissue swelling secondary to insect bites and may improve recognition of early cellulitis.

2386986 Beware! Inguinolabial Hernia Containing Reproductive Organs in Female Children Is Not as Rare as You Think—Anjum Bandarkar,* Egal Shalaby-Rana, Adehunni Adeyiga
Radiology, Children’s National Health System, Herndon, VA USA

Objectives: (1) Review differential diagnoses of groin swelling in girls <2 years of age. (2) Describe sonographic appearances and frequency of ovary, fallopian tube, and uterus-containing inguinal hernias.

Methods: Using a radiology search engine, we retrospectively reviewed 38 female children <2 years of age who underwent sonography for groin swelling. Their clinical presentation, sonographic imaging features, and intraoperative findings were recorded.

Results: Thirty-one of 38 patients (82%) had inguinal hernias. Of note, 10 patients in this group were premature infants. Seven patients (18%) had other etiologies, which included: (1) abscess (n = 3), (2) lymphadenopathy/cellulitis (n = 3), and (3) canal of Nuck hydrocele (n = 1). Thirty-one of the 38 patients (82%) had inguinal hernias; 26 patients (84%) had hernias containing female reproductive organs. Seventeen had ovary and/or fallopian tube in the hernia sac; 9 patients also had uterus in the hernia sac. Four patients (13%) had hernias with male gonads, either atrophic testes or ovotestes, later proven to have androgen insensitivity syndrome. One patient (3%) had a hernia containing bowel. A correct sonographic diagnosis was made prospectively in 36/38 patients. Missed findings were identified retrospectively in 2 patients, in whom the contents of the inguinal hernia were called bowel/omentum instead of ovary. Vascular compromise of the ovary was present in 1 patient, and it was prospectively identified. All of the inguinal hernia cases were successfully repaired with favorable outcomes.

Conclusions: Inguinal hernia is the most common cause of groin swelling in young female children, with premature infants comprising one-third of the group. Ovary and/or fallopian tube and sometimes uterus are the most common contents of the hernia sac. Infrequently, testis may be present in the hernia sac/labia, a clue to the diagnosis of androgen insensitivity syndrome. Bowel is rarely seen as contents of the hernia sac in female infants. Sonography easily and accurately depicts the contents of the hernia and may add valuable information such as vascular compromise. Sonography also helps exclude other causes of inguinal hernial swelling and hence should be included in the diagnostic and preoperative workup of patients with groin swelling.

2388097 Prediction of High-Grade Vesicoureteral Reflux in Children Younger Than 2 Years Using Renal Ultrasoundography: A Preliminary Study
Sun You, Kyung-Sook Shin
Radiology, Chungnam National University Hospital, Daejeon, Korea

Objectives: To investigate the predictive value of renal ultrasoundography (US) for vesicoureteral reflux (VUR) and the efficacy of renal US, technetium 99m-labeled dimercaptosuccinic acid (DMSA) scanning, and voiding cystourethrography for screening in children under 2 years of age with a first episode of febrile urinary tract infection (UTI).

Methods: Thirty-eight patients under 2 years of age with a first febrile UTI were included in our study, which was conducted from April through October 2014. Each kidney was considered as a separate renal unit (RU). A retrospective review of clinical information and images (renal US, DMSA scanning, and voiding cystourethrography) was performed.

Results: Of the 14 RUs (18.4%) with VUR, 4 (28.5%) had high-grade VUR. Among single findings, dilation of the renal collecting system (DRCS), wall thickening of the renal collecting system (WTRCS), and DMSA scans significantly predicted VUR (P = .038, .027, and .01, respectively). DRCS was the most common single finding (46 of 76 renal units). The sensitivities of DRCS, WTRCS, and DMSA scans were 85.7%, 64.2%, and 50.0%, respectively, and the negative predictive values were 93.3%, 89.7%, and 87.9%, respectively.

Conclusions: The negative predictive values indicate that normal renal US and DMSA scans can predict the absence of high-grade VUR. We propose that renal US findings of WTRCS, as well as DRCS, should be considered predictive of high-grade VUR.

Sonography: Education and Training
2348321 Peer-Assisted Learning: A New Model for Medical School Ultrasound Education
Ben Lasure,* Brian Dilcher, Joseph Minardi
Emergency Medicine, West Virginia University School of Medicine, Morgantown, WV USA

Objectives: To examine the utility of near-peer-assisted learning in medical school ultrasound education.

Methods: The coinvestigators created a review lecture based on the curriculum and practical rubric. Students were provided with objectives prior to the review session to assess its effectiveness in a voluntary and anonymous postsession survey. This demonstration consisted of 2 West Virginia University (WVU) peer-assisted learning strategy (PALS) tutors giving a 45-minute didactic review. Next, the floor was opened for
question-and-answer demonstrations lasting 15 minutes. At this point, the students were divided among 7 stations equipped with the same ultrasound machines that would be used for their practical examination. Within the groups, the first-year medical students took turns being models while their peers scanned, and the 2 PALS tutors rotated through the groups to provide direction. The small-group session lasted for 2 hours. The surveys were collected, and data and student comments were compiled to evaluate session efficacy. This session was run entirely by 2 WVU PALS second-year medical student tutors without instructor intervention.

**Results:** Over 60 first-year medical students attended the voluntary Saturday morning lecture 2 days before their anatomy exam and 4 days before their ultrasound practical. Fifty-four students signed in, and 34 took the postsession survey. The student response to the session was overwhelmingly positive, with one of the most frequently written comments being that WVU PALS should provide more similar sessions throughout the year. Other suggestions included that the session be broken into smaller groups with more tutors for a lower student:tutor ratio. Thirty-three of 34 responses reported that the session met the stated goals; 34/34 reported that the session was useful to improve ultrasound skills; 32/34 reported that the session helped them feel more comfortable with their scanning skills; and 33/34 reported that they would like to have more similar sessions in the future.

**Conclusions:** The review session was deemed successful, with good student turnout, positive evaluations, and interest in future sessions. Near-peer tutoring is a new and promising approach to medical school ultrasound education in the hands of skilled users.

**2366866 The Neck Is More Than the Thyroid Alone: 3-Dimensional Ultrasound**

**Objectives:** Ultrasound (US) imaging is helpful in evaluation of the neck in many clinical situations. The potential benefits of 3DUS when added to 2DUS will be explored in the following situations: cervical lymph node evaluation, including but not limited to post-thyroidectomy lymph node evaluation; parathyroid gland evaluation in patients with primary and secondary hyperparathyroidism; salivary gland evaluation for small masses and sialolithiasis; and evaluation of palpable/visible abnormalities.


**Results:** Additional information provided by 3DUS compared with 2DUS is illustrated in varied clinical applications, including the evaluation of cervical lymph nodes after thyroidectomy, the evaluation of the salivary glands in patients with pain or palpable abnormalities, the evaluation of the parathyroid glands in patients with primary hyperparathyroidism, and the evaluation of palpable or visible neck abnormalities.

**Conclusions:** 3DUS is not yet widely used for assessment of the neck aside from the thyroid gland, but initial experiences indicate that it may prove to be a powerful technique for a variety of clinical indications.
Clinical officer students in June 2015; an integrated basic pathology curriculum that is pertinent, time-efficient, retainable, and sustainable for Tanzanian health care students.

Objectives: The implementation of computed tomography (CT)-guided radiation treatment planning has resulted in greater precision in dose distribution, optimization, and patient positioning. However, limitations such as suboptimal tissue contrast and limited visualization of small tumor deposits/nodal disease persists and can sometimes preclude inclusion of locoregional metastasis for radiation. Real-time ultrasound scanning has good tissue contrast and can visualize small tumors and small lymph nodes while the patient is positioned in the same configuration used during radiation therapy. Ultrasound is also radiation free, does not require contrast, and is relatively quick to perform. To our knowledge, there is no published work on marking suspicious or proven malignant supravaccul-ular, infraclavicular, or lower neck nodes for inclusion in radiation therapy in breast cancer patients. This study highlights the use of ultrasound as an adjunctive tool during radiation therapy planning to detect small residual nodal disease for inclusion in the radiation field of breast cancer patients after breast surgery.

Methods: In this method of nodal localization, suspicious supravaccul-ular, infraclavicular, and lower neck adenopathy are identified by real-time ultrasound scanning. The site is marked on the skin using a BB or surgical marker, and the distance from the skin surface to the node/tumor implant is recorded. The patient is transported back to the radiation oncology suite for completion of CT-guided radiation planning.

Results: We show the successful use of ultrasound-guided nodal localization to identify and mark suspicious nodes in breast cancer patients for definitive inclusion in the radiation field.

Conclusions: Real-time ultrasound scanning is a safe and accurate method of detecting small-volume superficial disease, which can be marked, included, and targeted for radiation therapy in the hopes of improving patient outcomes and decreasing the residual disease burden. We highlight the use of ultrasound for directed supravacular, infraclavicular, or lower neck nodal localization for inclusion in the radiation field in breast cancer patients with residual nodal disease following breast surgery.

Objectives: Continue to develop and refine an introductory clinical ultrasound curriculum that is pertinent, time-efficient, retainable, and sustainable for Tanzanian health care students.

Methods: Revamped curriculum introduced by University of California Irvine School of Medicine's curriculum. The course pass rate was high. Lack of prior experience did not demonstrably impair students’ ability to score proficiently. Provided resources were rated highly.

Conclusions: Despite logistical, financial, linguistic, and intercultural challenges, measures put in place by UCISOM in developing a sustainable, efficient, and pertinent curriculum. The course pass rate was high. Lack of prior experience did not demonstrably impair students’ ability to score proficiently. Provided resources were rated highly.

Objectives: Formal ultrasound education has been incorporated into several medical schools across the country, but few are teaching students how to perform ultrasound-guided procedures. The purpose of this study was to assess the effectiveness of a 50-minute ultrasound-guided procedural training module for medical students utilizing a multimodal approach.

Methods: This was a self-controlled prospective observational cohort study. The ultrasound-guided procedural training module was taught at our institution’s 2015 Ultrafest ultrasound symposium. We assessed participants’ comfort level with ultrasound using a “normal” ultrasound. Future considerations: increased hands-on time, broader pathology coverage, curricular challenges, measures point to success by UCISOM in developing a sustainable, efficient, and pertinent curriculum.
2385030 Advanced Competency in Ultrasound for Undergraduate Medical Education
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Ohio State University College of Medicine, Columbus, OH USA; Physical Medicine and Rehabilitation, Emergency Medicine, Wexner Medical Center at Ohio State University, Columbus, OH USA

Objectives: To define a framework for advanced competency in ultrasound (US) in undergraduate medical education (UME).


Results: Advanced competency in US at the UME level is defined as the conceptual knowledge, psychomotor technical skills, and professional practice improvement skills and attitudes necessary for performing ultrasound in clinical settings. Table 1 describes criteria in each key competency area for attaining Advanced Competency, Advanced Competency With Distinction, and Advanced Competency With Honors.

Conceptual knowledge covers ultrasound physics, tissue characteristics, instrumentation, anatomy and physiology, indications, and protocols. Scanning skill is demonstrated through compilation of a scan portfolio, a portion of which must be clinical and must pass faculty quality review using B-QUIET. Practice improvement includes lifelong learning skills and evaluation of new ultrasound knowledge. Specific content may be tailored based on institutional resources and student interests. Feasibility of the framework has been established by honors US students at the Ohio State University College of Medicine who achieved these requirements during their UME training.

Conclusions: Advanced competency denotes focused knowledge, skills, and attitudes beyond the general UME curriculum intended to have immediate clinical significance on entering residency. This abstract describes a framework for advanced competency in US at the UME level that is flexible, achievable, provides clinically relevant skills for clerkships and residency, and is generalizable to other institutions.

Table 1. Advanced Competency Criteria

<table>
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<th>Requirements</th>
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<tr>
<td>Advanced Competency</td>
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<tr>
<td>Conceptual knowledge</td>
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<tr>
<td>&gt;150 h in supervised US curriculum topics</td>
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<tr>
<td>Scanning skill</td>
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<tr>
<td>Log of 50 scans (&gt;10 clinical, &gt;50% clinical scans pass B-QUIET faculty review)</td>
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<tr>
<td>Practice improvement</td>
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<tr>
<td>&gt;10 h of participation in physician-led journal club</td>
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<tr>
<td>Advanced Competency With Distinction</td>
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<tr>
<td>Conceptual knowledge</td>
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<tr>
<td>Above + advanced specialty-specific topics</td>
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<tr>
<td>Scanning skill</td>
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<tr>
<td>Log of 100 scans (&gt;20 clinical, &gt;50% clinical scans pass B-QUIET faculty review)</td>
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<tr>
<td>Practice improvement</td>
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<tr>
<td>Above + authorship on abstract presented at national conference</td>
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<tr>
<td>Advanced Competency With Honors</td>
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<tr>
<td>Conceptual knowledge</td>
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<tr>
<td>Above + teaches above</td>
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<tr>
<td>Scanning skill</td>
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<tr>
<td>Log of 150 scans (&gt;30 clinical, &gt;50% clinical scans pass B-QUIET faculty review)</td>
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<tr>
<td>Practice improvement</td>
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<td>Above + authorship on manuscript published in academic journal</td>
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2385291 Evaluation of Sophomore Medical Students’ Competencies in Image Recognition and Interpretation of Ultrasound Pathology: An Innovative Ultrasound Curriculum Developed at the Wayne State University School of Medicine
David Ampoumsah
Emergency Medicine, Henry Ford Hospital, Detroit, MI USA; Wayne State University School of Medicine, Detroit, MI USA

Objectives: Ultrasound education was first incorporated into the Wayne State University School of Medicine (WSUSOM) undergraduate curriculum in 2006. Sophomore students demonstrate skills in image capture, recognition, and interpretation of ultrasound pathology as part of their physical diagnosis final exam. The goals of this study are: (1) to provide a description of the sophomore ultrasound curriculum; (2) to determine how well students perform on the final exam after introduction to ultrasound pathology; and (3) to evaluate student performance since 2013 for improvement in scores with modification to instructional methods.

Methods: An average of 288 medical students during their sophomore year at WSUSOM receive instruction on image recognition and interpretation of ultrasound pathology using a case-based approach to teaching. Students also enhance their image acquisition skills using standardized patients with an instructor-to-student ratio of 1:4. Exams include an in-class image review of ultrasound pathology and a debriefing session focusing on presentation and discussion of clinical cases. The final exam includes an image capture portion and a computer-based 10-item multiple-choice exam with embedded video clips focusing on recognition and interpretation of ultrasound pathology.

Results: Average scores from 2011–2015 are as follows: academic year 2011–2012, 73.5%; academic year 2012–2013, 74.4%; academic year 2013–2014, 83.2%; academic year 2014–2015, 82.5%. Students also performed very well in their image capture portion (6-second video clips) of the final exam, with mean scores of 89.3% and 85.1% for the 2013–2014 and 2014–2015 academic years, respectively.

Conclusions: Developing innovative teaching methods since 2013 during the sophomore ultrasound course has resulted in improvement in student scores in their image acquisition skills and recognition and interpretation of ultrasound pathology. Fusion of ultrasound education into the sophomore medical school curricula provides students with unique learning opportunities in pathology.

2385882 Effects of Ultrasound Training During Year 2 of Medical School on Year 3 Medical Students
Reed Krause, *Cassandra Krause, Raymond Krause, Vi Am Dinh
School of Medicine, Loma Linda University, Loma Linda, CA USA

Objectives: Medical students face many barriers to practicing point-of-care ultrasound (POCUS) during their year 3 clerkships. We hypothesized that hands-on ultrasound training during year 2 of medical school is an important factor in the preparation for using POCUS during year 3.

Methods: At our institution ultrasound training is formally integrated into the year 1 medical school curriculum but not the year 2 curriculum. Optional hands-on POCUS training events are offered throughout year 2. During year 3 orientation week, year 3 volunteers took the 22-point Ultrasound-Objective Structured Clinical Examination (US-OSCE) that they previously took on completion of year 1. It tested image acquisition and interpretation of the following systems: ocular, neck, pulmonary, cardiovascular, and abdomen. Following the US-OSCE, participants completed a survey to assess participants’ comfort level with ultrasound.

Results: Of 68 participants, 78% (53/68) did not attend any POCUS training events during year 2, and 22% (15/68) did attend at least 1 training event. Comparing participants who did not attend versus participants who did, the mean US-OSCE score was 65.1% ± 20.0% versus

S120
93.0% ± 10.2% (P < .01). The mean completion time was 559 ± 81 vs 422 ± 118 seconds (P < .01). The survey showed 34.0% versus 93.3% (P < .01) of participants reported they were comfortable or very comfortable with the function of the US machine; 15.1% versus 73.3% (P < .01) of participants reported they were comfortable or very comfortable with US use on patients.

Conclusions: Attending POCUS training events during year 2 of medical school increases year 3 medical students’ overall comfort level with ultrasound and increases preparedness for using POCUS in year 3 clerkships.

2385893 Effectiveness of Animated Simulation for Teaching the Rapid Ultrasound for Shock and Hypotension Protocol to Medical Students Reed Kruse, Michael Douglas, Drew Sheldon, Vi Am Dinh School of Medicine, Loma Linda University, Loma Linda, CA USA

Objectives: Although the benefits of simulation training for resident physicians have been well established, its role in medical school ultrasound education is unclear. The goal of this study was to evaluate the effectiveness of teaching the rapid ultrasound for shock and hypotension (RUSH) protocol to medical students using combined didactics and animated simulation.

Methods: Enrolled subjects were medical students who voluntarily participated in the RUSH simulation module in an ultrasound symposium. This study is a self-controlled prospective observational cohort study, in which subjects’ confidence in utilizing ultrasound for diagnosing shock was assessed before and after the training (comparisons analyzed with the Mann-Whitney U test). Student satisfaction and perceived training effectiveness were also evaluated.

Results: Of the participants, 25 completed both preliminary and postcourse surveys. Responses represent students from 6 different institutions consisting of both MD and DO programs: 88% and 12% respectively. Overall, students were “very satisfied” (median 9/10), and 56% “strongly agree” that combining didactics and simulation was effective when compared to didactics alone. Further studies are required in order to quantify the value of supplementing didactics with simulation when compared to didactics alone.

Table 1. Results of Pre- and Post-Immersion Knowledge Evaluation Questionnaire

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<th>Pre-Immersion</th>
<th>Post-Immersion</th>
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<tr>
<td>Mean</td>
<td>2.87</td>
<td>3.82</td>
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<tr>
<td>SD</td>
<td>1.09</td>
<td>1.03</td>
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<tr>
<td>SEM</td>
<td>0.07</td>
<td>0.08</td>
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<tr>
<td>n</td>
<td>213</td>
<td>154</td>
</tr>
<tr>
<td>2-tailed P</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
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2387786 Posttraumatic Arteriovenous Malformation of the Neck: B-Mode Sonographic, Color Doppler Sonographic, and Magnetic Resonance Imaging Findings Hasan Yerli Baskent University, Izmir, Turkey

Objectives: Imaging findings that are related to posttraumatic arteriovenous malformation (AVM) of the neck are little known in the literature. We present the findings of B-mode sonography, color Doppler sonography, and magnetic resonance imaging (MRI) of posttraumatic AVM localized in the neck region.

Methods: A 31-year-old woman was admitted to the Department of Radiology for evaluation of a mass in her right neck. After the physical examination, B-mode sonography, color Doppler sonography, and MRI were performed. After surgical excision, the diagnosis was confirmed by histopathology.

Results: The physical examination revealed a nontender mass. In her history, there was an enlarging and shrinking mass in the right neck region. A heterogeneous solid soft tissue mass with regular contours located in the midjugular region having dimensions of 4.5 × 4.5 cm was determined on B-mode sonography. The mass had central vascularity on the color Doppler examination. On the MRI examination, the mass with a central hemorrhagic component was heterogeneous and intense with the muscle on T1-weighted images. Postcontrast images showed peripheral enhancement of the mass and its feeding artery and drainage vein. It had a multilobulated contour and was heterogeneously hypointense with the muscle on T2-weighted images. The histopathologic examination showed only and thin-wall arterial channels with adjacent venous channels.

Conclusions: Posttraumatic AVM that appears as a rare condition should be kept in mind in patients having a trauma history for the differential diagnosis of neck masses. The presence of central vascularity on color Doppler sonography and determination of a hemorrhagic component, the feeding artery, and a drainage vein on MRI may be important findings supporting the diagnosis of AVM of the neck.
Sonography: Practice Management

2385745 A Pictorial Display of Inflammatory Bowel Disease on Sonography: Its Diagnosis, Activity, and Complications
Christina Merrill,* Alexandra Medellin-Kowalewski, Stephanie Wilson 1
1Diagnostic Imaging, Foothills Medical Center, Calgary, Alberta, Canada; 2Radiology, Division of Gastroenterology, University of Calgary, Calgary, Alberta, Canada

Objectives: To demonstrate how sonographic evaluation of inflammatory bowel disease (IBD) can be an effective tool for the diagnosis, determination of disease activity, and identification of the most common complications of stricture, perforation, mechanical bowel obstruction, and fistula.

Methods: Sonographic evaluation of the bowel is performed according to a dedicated protocol with overlapping sequences of longitudinal and axial scans, to encompass the entire colon and small bowel. A survey is performed with a standard abdominal convex ultrasound probe. All abnormal bowel segments are interrogated with a higher-frequency convex or linear probe, 6–9 MHz, with a variable focus. Endovaginal and perianal scans are routine in the evaluation of deep pelvic and perianal disease, respectively. The location of the abnormal segments is recorded, as well as their length and thickness. Observations reflective of inflammation, including wall thickness, inflammatory fat, and signal on color Doppler, are graded from 0, suggesting normal or inactive disease; through 1, mild; 2, moderate; and 3, severe inflammatory activity. These provide an ultrasound global assessment. Complications are identified according to their familiar appearance on grayscale ultrasound with the benefit of real-time assessment with its high temporal resolution.

Results: Sonography provides high-resolution evaluation of any abnormal segment of bowel. The procedure has no ionizing radiation and is highly acceptable to patients. Disease presence at diagnosis or recurrence following surgery is shown on sonography with equivalence to computed tomography and magnetic resonance imaging. Sonography is valuable for establishing baseline activity prior to initiation of medical therapy and can be useful also in monitoring response. Dynamic real-time sonography shows a sensitive ability to detect and characterize common complications, including stricture and incomplete mechanical bowel obstruction.

Conclusions: Sonographic assessment of IBD is safe, cost-effective, and accurate. The method is highly acceptable to patients and should be considered for imaging evaluation of patients at the time of disease diagnosis, for monitoring surveillance, and at the time of acute exacerbation.

Therapeutic Ultrasound

2385067 Maturation of Lesions Induced by Myocardial Cavitation-Enabled Therapy
Xiaofang Lu,* Douglas Miller, Chunyan Dou, Yiyang Zhu, Mario Fabilli, Gabe Owens, Oliver Kripfgans
University of Michigan, Ann Arbor, MI USA

Objectives: Lethal cardiomyocyte injury induced by a cavitation response of microbubbles to ultrasound pulses indicated a potential application for tissue reduction therapy, as for hypertrophic cardiomyopathy (HCM). The aim of this study was to observe and characterize the maturation of the lesions and the extent of tissue loss 6 weeks after cavitation-enabled therapy under 2 different ultrasound exposure parameter settings.

Methods: Dahl/SS rats were anesthetized and treated by high-amplitude pulsed ultrasound guided by 10-MHz ultrasound images. Contrast microbubbles were infused via a tail vein during intermittent pulse-burst exposure at 4 MPa peak rarefractional pressure amplitude. A sham group, a low-impact group (group A; 5 cycle pulses with Gaussian modulation and a 1:4 trigger for 5 minutes), and a high-impact group (group B; 10 cycle pulses with 4-millisecond square modulation and a 1:8 trigger for 10 minutes) were tested.

Results: Higher exposure used in group B yielded more substantial injury than lower exposure in group A. Higher premature ventricular complex percentages during exposure and higher blood troponin I levels 4 hours after exposure occurred for group B. No injury was found in shams. Treated rats in both groups A and B had significant increases in wall thickness measured by echocardiography the next day, which returned to normal by the end of 6 weeks. Maturation of lesions involved fibrosis replacement, preserving structural tissue integrity. Six weeks after ultrasound exposure, heart tissue samples in group B showed more evident fibrosis in Masson’s trichrome–stained histology, with the microlesion fraction in the center of the damaged area ranging from 0.21 to 0.49.

Conclusions: This study showed that cavitation-induced myocardial injury progressed into permanent loss of myocardial tissue that was sufficient for possible HCM therapy. However, no actual reduction of heart wall thickness was measurable in the present study due to the fibrosis replacement. More research is needed to evaluate the functional impact of treatment, including possible pharmaceutical means to reduce the replacement scar volume, in order to define the treatment parameters required for symptomatic relief for HCM.
Continuing Medical Education (CME) Credit Information

2016 AIUM Annual Convention

Activity Description
The 2016 AIUM Annual Convention and Preconvention Program is the most comprehensive, cutting-edge meeting for the entire medical ultrasound community. Our unique multidisciplinary program provides a collaborative environment for all specialties and disciplines, from beginner to advanced.

Accreditation Statement
The American Institute of Ultrasound in Medicine (AIUM) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide CME activities for physicians.

Designation Statement for the 2016 Preconvention Program
The AIUM designates this live activity for a maximum of up to 7.5 AMA PRA Category 1 Credits™. Physicians should claim only the credits commensurate with the extent of their participation in the activity.

Designation Statement for the 2016 Convention
The AIUM designates this live activity for a maximum of up to 29.0 AMA PRA Category 1 Credits™. Physicians should claim only the credits commensurate with the extent of their participation in the activity.

Credits for Sonographers
Sonographers participating in AIUM educational activities may earn credits toward maintaining their professional certification from the following organizations:

- American Registry for Diagnostic Medical Sonography (ARDMS)
  The ARDMS accepts AMA PRA Category 1 Credits™.

- American Registry of Radiologic Technologists (ARRT)
  The AIUM is a Recognized Continuing Education Evaluation Mechanism (RCEEM) for the ARRT. These educational activities are approved by the AIUM for 7.5 ARRT Category A Credits for the 2016 AIUM Preconvention Program and 29.0 ARRT Category A credits for the 2016 Convention.

Target Audience
This activity is designed to meet the needs of ultrasound professionals from various medical disciplines and specialty areas who perform and interpret ultrasound examinations.

Course Objectives
On completion of this learning activity, participants should be able to:

- Demonstrate updated knowledge in basic science and instrumentation, cardiovascular ultrasound, contrast-enhanced ultrasound, dermatologic ultrasound, fetal echocardiography, general and abdominal ultrasound, gynecologic ultrasound, high-frequency clinical and preclinical imaging, interventional-intraoperative ultrasound, musculoskeletal ultrasound, neurosonology, obstetric ultrasound, pediatric ultrasound, point-of-care ultrasound, sonography, ultrasound in resource-limited areas, and therapeutic ultrasound.
- Discuss state-of-the-art ultrasound research.
- Practice updated ultrasound skills for more effective diagnosis.
- Apply updated knowledge and clinical skills in improving patient care.

Activity Designed to Change Competence and performance.

Accreditation Council for Graduate Medical Education (ACGME) Competencies
These courses are designed to meet 1 or more of the following ACGME competencies: interpersonal and communication skills, medical knowledge, patient care and procedural skills, practice-based learning and improvement, professionalism, and systems-based learning.

Disclosure Policy
As a provider accredited by the ACCME, the AIUM must ensure balance, independence, objectivity, and scientific rigor in its educational activities. Course directors, the planning committee, faculty, and all others who are in a position to control the content of this educational activity are required to disclose all relevant financial relationships with any commercial interest related to the subject matter of the educational activity. The AIUM may identify and resolve any conflicts of interest prior to the activity.

Disclosures for This Activity
The faculty, committee members, community officers, AIUM leadership, and AIUM staff involved in planning this CME activity have completed a Disclosure of Financial Relationship. Individuals with disclosures are listed in this issue of the Official Proceedings. Disclosures are available for review on request.

Documenting CME Credits
The AIUM provides CME certificates to those who have participated in an AIUM educational activity. The AIUM does not submit credits to regulating bodies or certifying organizations on behalf of the participant. It is the participant’s responsibility to submit proof of credits on his or her own behalf.

Disclaimer
The information presented in this activity represents the opinion of the faculty and is not necessarily the official position of the AIUM.
Disclosures From AIUM Officers, Board Members, Committee Members, and AIUM Staff

Committee members and AIUM staff involved in planning this CME activity have completed a Disclosure of Financial Relationship. All completed disclosure forms are on file and available for review at the AIUM office. Only individuals with disclosures are listed.

As of February 24, 2016.
Faculty Disclosures

Below are faculty members who disclosed that they have relevant relationship(s) with commercial interest(s) that may create a conflict of interest. Faculty members are instructed to advise the AIUM if new financial relationships with commercial interests arise since completing their disclosure forms. Described below each name are the commercial interest(s) and the nature of the financial relationship(s). Disclosures, if any, are listed under the speaker’s name. Only individuals with disclosures are listed. All completed disclosure forms are on file and available for review at the AIUM office.

As of February 24, 2016.
Disclosure of Commercial Support for the 2016 AIUM Annual Convention

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## Index

### A
- Abdel-Latif A 108
- Abe T 74
- AbouEllail M 38, 52, 61
- Abramowicz J 115
- Abu-Rustum R 40, 46, 62, 63, 91, 115
- Abu-Rustum S 62, 63
- Abuhamad A 8, 52, 96
- Adalsteinsson E 100
- Adams N 52
- Aderek G 73
- Adeyiga A 106, 117
- Adhikari S 13
- Adzeik NS 8
- Ahmad S 77, 80, 82
- Ajzen S 51
- Akhtar S 84
- Alazraki A 44
- Alhadawi N 80
- Alkacar JL 97
- Alerhand S 116
- Alexander M 37
- Allgrome F 34
- Alizad A 36
- Allen A 17
- Allen C 118
- Alsup C 42
- Amini R 13
- Aminololama-Shakeri S 101
- Amorosa J 110
- Amponsah D 120
- Anaia H 115
- Anderson C 43, 87
- Anderson N 18
- Andrus P 11
- Araki T 75, 25
- Archer T 56
- Arevalo S 10, 11
- Armstrong LA 109
- Ash A 77, 78, 82
- Ashwal E 19
- Assaf S 79
- Atan I 53, 54
- Au A 42
- Augenstein J 81
- Avery T 28
- Avitan T 111, 113
- Avner J 58
- Ayers C 97
- Ayoub J 72

### B
- Bachman K 120
- Baer G 18
- Bahr D 43, 70, 75, 76, 85, 88, 89, 90, 118, 120
- Bahtiyar M 62
- Bailey M 23
- Bajaj K 41
- Bajaj T 78, 82
- Baleschier A 5
- Balica A 97, 98
- Balk A 83, 86
- Ballou E 24
- Banchhor S 5, 25
- Bandarkar A 106, 117
- Bandong J 102
- Bangert K 96
- Banks A 71
- Bard R 101
- Bardin R 19
- Barker M 101
- Barr R 15
- BassGoldman T 15
- Battaglia P 106
- Bayat M 36
- Bebington M 38
- Becker B 76
- Belfort M 10, 11
- Belmont B 84
- Ben-Shlush A 57
- Benion N 7
- Bennett T-A 36, 39, 114, 116
- Benson C 58
- Berger A 28
- Bergh E 110
- Berkenblit R 92, 95
- Berkowitz R 78, 80, 82
- Bernana M 94, 113, 119
- Bernstein S 65
- Berry G 42
- Betteridge B 18
- Bhan A 15, 48
- Bhat S 68
- Bhooi R 34
- Bi X 48
- Bianco A 110
- Bibbo C 100
- Bigelow 3
- Bishop M 15
- Bober J 75
- Boockbrader M 70, 120
- Boozaizomehri F 19, 20
- Boughton J 94
- Bouger C 76, 85, 88, 89, 90
- Bouzaghar G 91
- Boyd J 84
- Brain L 113
- Braun M 10
- Braverman M 54
- Breed W 80
- Britto J 9
- Bromley B 9
- Brown A 50
- Brownham M 113
- Bruce M 50
- Bruckner T 30
- Bryant L 99
- Buchanan K 77
- Buck A 50
- Budhram G 74
- Budlamic S 68
- Busman W 33
- Bullen J 17
- Burnett-Roy S 45
- Butler M 32
- Byars D 43, 45, 46, 47, 87, 88

### C
- Cabeza R 34
- Callstrom M 48
- Canavan T 65
- Cano A 98
- Cantonwine D 41, 65
- Carmona S 81
- Carreras E 10, 11
- Cary T 91
- Casey B 64
- Cass D 9
- Caughhey M 26
- Cavanaugh B 27, 91
- Cerezo E 34
- Chan K 86
- Chandra S 42
- Chang C 89, 90
- Chang T-H 27
- Chao J 75, 80
- Charboneau N 68
- Chauhan A 33, 49
- Chen C 95
- Chen P 28
- Chen L 15
- Chen S 48, 69
- Chen T 27
- Chen Z 15
- Cheng R-F 96
- Cheng W 60
- Cheng X 38
- Cheng Y 6
- Chervenak J 116
- Chhaganlal K 78
- Ching B 105
- Chirico G 83, 86
- Cholvi S 98
- Christiansen M 53
- Chang R 48
- Chiyang R 13, 44
- Cipi A 87
- Clark E 114
- Coad B 112
- Cohen HL 58
- Cohen J 17
- Cohen L 62
- Cohen S 44
- Cohen W 115
- Colado O 22
- Colcord C 83
- Connolly K 87, 110
- Connor V 96
- Copel J 62
- Copeland J 109
- Coqutia S 31
- Corrado M 89, 90
- CoGrove D 15, 72
- Coyle P 17
- Cramer K 78
- Cristo J 38
- Cronull J 74
- Cross K 11
- Cruz L 110
- Cunji B 23
- Cunningham T 52
- Cupp J 76
- Cuxart A 10, 11
- Czapike C 32
- Czerwinski T 26

### D
- Dahiya N 31, 32, 92
- Daley J 90
- Darnell X 89
- Dang E 69
- Daniels J 105
- Danko J 99
- Dao L 63, 91
- Dar P 109
- Daswani D 58
- Dave J 7, 27, 55
- David L 112
- Davis J 94, 113, 119
- Davis-Nelson S 111
- De Jong MR 4, 31
- de la Vega A 41
- de Souza L 6
- Delaney M 82
- Detzel P 17
- DeMarco A 15
- DeMarco P 15
- Dempsey R 49
- Denis M 36
- Denney J 109
- Desai R 42
- Desser T 92, 93, 94
- Destounis S 26
- Detti L 53
- Devore G 40, 63, 64
- Dezelon L 81
- Dhyani M 15, 48, 50
- Dickman E 116
- Dietrich C 72
- Dietz H 53, 54
- Digeke M 23
- Dilcher B 117
- Dimuzio P 6
- Dinh VA 13, 44, 114, 119, 120, 121
<table>
<thead>
<tr>
<th>Authors</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subeh M 43, 78, 79, 80, 87</td>
<td></td>
</tr>
<tr>
<td>Subhas N 17</td>
<td></td>
</tr>
<tr>
<td>Subramaniam S 75</td>
<td></td>
</tr>
<tr>
<td>Sugahara T 71, 94</td>
<td></td>
</tr>
<tr>
<td>Sultan L 33, 91, 93</td>
<td></td>
</tr>
<tr>
<td>Stannich A 13, 44</td>
<td></td>
</tr>
<tr>
<td>Sun M 92</td>
<td></td>
</tr>
<tr>
<td>Sundervirth R 78</td>
<td></td>
</tr>
<tr>
<td>Suri J 5, 25</td>
<td></td>
</tr>
<tr>
<td>Surya M 54</td>
<td></td>
</tr>
<tr>
<td>Suskin B 109</td>
<td></td>
</tr>
<tr>
<td>Szczerbo-Trojanowska M 31</td>
<td></td>
</tr>
<tr>
<td>Szylery A 97</td>
<td></td>
</tr>
<tr>
<td>Tabbat M 12, 44, 81</td>
<td></td>
</tr>
<tr>
<td>Tabsh K 40</td>
<td></td>
</tr>
<tr>
<td>Taggart K 18</td>
<td></td>
</tr>
<tr>
<td>Takacs P 52, 96</td>
<td></td>
</tr>
<tr>
<td>Talamayan-Pascua R 32</td>
<td></td>
</tr>
<tr>
<td>Talbott N 102, 103, 104</td>
<td></td>
</tr>
<tr>
<td>Tanaka H 38</td>
<td></td>
</tr>
<tr>
<td>Tanaka T 52</td>
<td></td>
</tr>
<tr>
<td>Tang X 6</td>
<td></td>
</tr>
<tr>
<td>Tay E 116, 117</td>
<td></td>
</tr>
<tr>
<td>Tayal V 83</td>
<td></td>
</tr>
<tr>
<td>Taylor A 32</td>
<td></td>
</tr>
<tr>
<td>Taylor N 69</td>
<td></td>
</tr>
<tr>
<td>Taylor R 12</td>
<td></td>
</tr>
<tr>
<td>Teigen N 109</td>
<td></td>
</tr>
<tr>
<td>Teismann N 105</td>
<td></td>
</tr>
<tr>
<td>Templin M 11</td>
<td></td>
</tr>
<tr>
<td>Tenenbaum-Gavish K 19</td>
<td></td>
</tr>
<tr>
<td>Tenkomo C 61</td>
<td></td>
</tr>
<tr>
<td>Terabayashi N 105</td>
<td></td>
</tr>
<tr>
<td>Tessaro M 116</td>
<td></td>
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<tr>
<td>Thacker G 11</td>
<td></td>
</tr>
<tr>
<td>Thein S 69</td>
<td></td>
</tr>
<tr>
<td>Thieyvanni N 84</td>
<td></td>
</tr>
<tr>
<td>Thiam A 10</td>
<td></td>
</tr>
<tr>
<td>Thiel J 23</td>
<td></td>
</tr>
<tr>
<td>Thomas J 102</td>
<td></td>
</tr>
<tr>
<td>Thomas S 12</td>
<td></td>
</tr>
<tr>
<td>Tibah M 84</td>
<td></td>
</tr>
<tr>
<td>Timor-Trisch I 19, 20, 116</td>
<td></td>
</tr>
<tr>
<td>Tipton C 89, 90</td>
<td></td>
</tr>
<tr>
<td>Tjeita J 68</td>
<td></td>
</tr>
<tr>
<td>Tobias A 66</td>
<td></td>
</tr>
<tr>
<td>Tomkowi W 73</td>
<td></td>
</tr>
<tr>
<td>Toren F 45, 46, 47</td>
<td></td>
</tr>
<tr>
<td>Torrico D 51</td>
<td></td>
</tr>
<tr>
<td>Tozer J 14, 43</td>
<td></td>
</tr>
<tr>
<td>Trabulsi E 28, 29, 59, 60</td>
<td></td>
</tr>
<tr>
<td>Trace A 118</td>
<td></td>
</tr>
<tr>
<td>Tradap D 6, 68, 69</td>
<td></td>
</tr>
<tr>
<td>Trawinski Z 4</td>
<td></td>
</tr>
<tr>
<td>Trendwell M 40</td>
<td></td>
</tr>
<tr>
<td>Trent S 57</td>
<td></td>
</tr>
<tr>
<td>Trimsey L 71</td>
<td></td>
</tr>
<tr>
<td>Triong L 100</td>
<td></td>
</tr>
<tr>
<td>Issai B 4</td>
<td></td>
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<tr>
<td>Issai M 116</td>
<td></td>
</tr>
<tr>
<td>Tuchela F 110</td>
<td></td>
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<td>Turol F 54</td>
<td></td>
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<tr>
<td>Turer R 84</td>
<td></td>
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<tr>
<td>Turk E 100</td>
<td></td>
</tr>
<tr>
<td>Turner E 30, 43, 59</td>
<td></td>
</tr>
<tr>
<td>Twickler D 64</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Udrea D 13, 44</td>
<td></td>
</tr>
<tr>
<td>Ural E 110</td>
<td></td>
</tr>
<tr>
<td>Urban M 48</td>
<td></td>
</tr>
<tr>
<td>Urut R 56</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Valenzuela D 32</td>
<td></td>
</tr>
<tr>
<td>Valero B 98</td>
<td></td>
</tr>
<tr>
<td>Vallabhaneni R 26</td>
<td></td>
</tr>
<tr>
<td>Valldecabres C 98</td>
<td></td>
</tr>
<tr>
<td>Vangel M 100</td>
<td></td>
</tr>
<tr>
<td>VanWhey C 7</td>
<td></td>
</tr>
<tr>
<td>Varghes T 13, 16, 26, 37, 49</td>
<td></td>
</tr>
<tr>
<td>Velasco A 32</td>
<td></td>
</tr>
<tr>
<td>Velasco T 17</td>
<td></td>
</tr>
<tr>
<td>Velcanto A 77</td>
<td></td>
</tr>
<tr>
<td>Velssweyma H 109</td>
<td></td>
</tr>
<tr>
<td>Verma U 34</td>
<td></td>
</tr>
<tr>
<td>Victoria T 8</td>
<td></td>
</tr>
<tr>
<td>Vietra L 110</td>
<td></td>
</tr>
<tr>
<td>Villarana J 68</td>
<td></td>
</tr>
<tr>
<td>Villarreal L 13, 44</td>
<td></td>
</tr>
<tr>
<td>Vintzileos A 19, 20</td>
<td></td>
</tr>
<tr>
<td>Vlsnovsly J 99</td>
<td></td>
</tr>
<tr>
<td>Vitto M 14, 43</td>
<td></td>
</tr>
<tr>
<td>Vlengoris M 96</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Wachshberg R 51</td>
<td></td>
</tr>
<tr>
<td>Walinski P 7</td>
<td></td>
</tr>
<tr>
<td>Walker B 31</td>
<td></td>
</tr>
<tr>
<td>Wallace K 55</td>
<td></td>
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<td>Wang F 28</td>
<td></td>
</tr>
<tr>
<td>Wang H 74</td>
<td></td>
</tr>
<tr>
<td>Wang J 6</td>
<td></td>
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<tr>
<td>Wang P 55</td>
<td></td>
</tr>
<tr>
<td>Wang W-P 33, 60</td>
<td></td>
</tr>
<tr>
<td>Wang X 49, 55</td>
<td></td>
</tr>
<tr>
<td>Wang Y 6</td>
<td></td>
</tr>
<tr>
<td>Wapnir I 100</td>
<td></td>
</tr>
<tr>
<td>Ward J 91</td>
<td></td>
</tr>
<tr>
<td>Ward K 84</td>
<td></td>
</tr>
<tr>
<td>Warshak C 20, 21</td>
<td></td>
</tr>
<tr>
<td>Waznik A 92</td>
<td></td>
</tr>
<tr>
<td>Watanebe T 105</td>
<td></td>
</tr>
<tr>
<td>Way D 45, 88, 89</td>
<td></td>
</tr>
<tr>
<td>Wear K 3, 68</td>
<td></td>
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<tr>
<td>Webb M 16</td>
<td></td>
</tr>
<tr>
<td>Weber M-4 30</td>
<td></td>
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<tr>
<td>Weekes A 11</td>
<td></td>
</tr>
<tr>
<td>Weichert J 7, 64</td>
<td></td>
</tr>
<tr>
<td>Weiner C 112</td>
<td></td>
</tr>
<tr>
<td>Weiner S 61</td>
<td></td>
</tr>
<tr>
<td>Wells C 66</td>
<td></td>
</tr>
<tr>
<td>Wells S 37</td>
<td></td>
</tr>
<tr>
<td>Welty S 10</td>
<td></td>
</tr>
<tr>
<td>Wergin K 37</td>
<td></td>
</tr>
<tr>
<td>Werntz C 17</td>
<td></td>
</tr>
<tr>
<td>West J 30, 59</td>
<td></td>
</tr>
<tr>
<td>Wheatley M 37</td>
<td></td>
</tr>
<tr>
<td>Whitehead W 10, 11</td>
<td></td>
</tr>
<tr>
<td>Whitman G 26, 119</td>
<td></td>
</tr>
<tr>
<td>Wilbrand S 49</td>
<td></td>
</tr>
<tr>
<td>Wilkins-Haug L 9</td>
<td></td>
</tr>
<tr>
<td>Williams N 49</td>
<td></td>
</tr>
<tr>
<td>Willmann J 72</td>
<td></td>
</tr>
<tr>
<td>Wilson J 18</td>
<td></td>
</tr>
<tr>
<td>Wilson S 43, 72, 78, 79, 80, 87</td>
<td></td>
</tr>
<tr>
<td>Wilson T 88</td>
<td></td>
</tr>
<tr>
<td>Winchester B 106</td>
<td></td>
</tr>
<tr>
<td>Witt D 102, 103, 104</td>
<td></td>
</tr>
<tr>
<td>Wiznitzer A 19</td>
<td></td>
</tr>
<tr>
<td>Wohlmuth C 38</td>
<td></td>
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<tr>
<td>Wodery J 68</td>
<td></td>
</tr>
<tr>
<td>Wong C 101</td>
<td></td>
</tr>
<tr>
<td>Wood D 61</td>
<td></td>
</tr>
<tr>
<td>Wood R 39</td>
<td></td>
</tr>
<tr>
<td>Wood SL 8</td>
<td></td>
</tr>
<tr>
<td>Woodbury G 18</td>
<td></td>
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<tr>
<td>Woodhouse L 32</td>
<td></td>
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<tr>
<td>Woodrow N 34</td>
<td></td>
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<tr>
<td>Wymar M 13</td>
<td></td>
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<tr>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Xie F 21</td>
<td></td>
</tr>
<tr>
<td>Xiong H 91, 93</td>
<td></td>
</tr>
<tr>
<td>Xiong X 22</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Yabumoto T 105</td>
<td></td>
</tr>
<tr>
<td>Yamamoto K 38, 52, 61</td>
<td></td>
</tr>
<tr>
<td>Yan P 22</td>
<td></td>
</tr>
<tr>
<td>Yang W 37</td>
<td></td>
</tr>
<tr>
<td>Yang X 55</td>
<td></td>
</tr>
<tr>
<td>Yedi H 16, 121</td>
<td></td>
</tr>
<tr>
<td>YogeV Y 19</td>
<td></td>
</tr>
<tr>
<td>Yoshida H 81</td>
<td></td>
</tr>
<tr>
<td>You S 117</td>
<td></td>
</tr>
<tr>
<td>Young S 32</td>
<td></td>
</tr>
<tr>
<td>Youssefian A 43</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>Zafar H 93</td>
<td></td>
</tr>
<tr>
<td>Zafman K 110</td>
<td></td>
</tr>
<tr>
<td>Zagelzski J 37</td>
<td></td>
</tr>
<tr>
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S131