Sonography of the Normal Female Pelvis

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Disclosures

Rochelle F. Andreotti M.D.

Relevant Financial Relationships: Speaker for Philips Healthcare user course

Learning Objectives

After completing this presentation, the learner will :

Objective 1: recognize the normal sonographic appearance of the non-gravid female genital tract.

Objective 2: recognize the sonographic appearance of the female pelvis with respect to the menstrual cycle.

Objective 3: become aware of newer sonographic techniques and other modalities for imaging the female pelvis.

Introduction

Pelvic sonography is the imaging modality of choice for evaluating the female pelvis.

The following is a review of pelvic sonographic anatomy which forms the framework to be used to evaluate the abnormal pelvis.

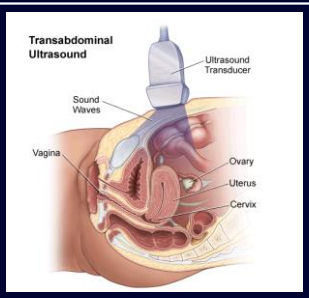
Lecture Outline

- Sonographic technique
- Normal pelvic anatomy
- Pelvic hormonal changes during the menstrual cycle and with menopause
- Other sonographic techniques and modalities used to image the female pelvis

Technique
A Complementary Approach

- The standard pelvic examination
  - composed of the traditional transabdominal approach (TAS)
  - combined with transvaginal sonography (TVS)
  - frequently using color or power Doppler sonography to enhance diagnostic capabilities

Transabdominal Sonography



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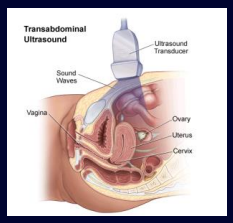
Classic Technique Transabdominal Sonography

- Uses a distended bladder as window to pelvic structures for a global view
- Visualization limited by attenuation from the body wall and the distance from the area of interest of the transducer
- Unable to use higher frequency transducers and benefit from their inherent higher axial and lateral resolution



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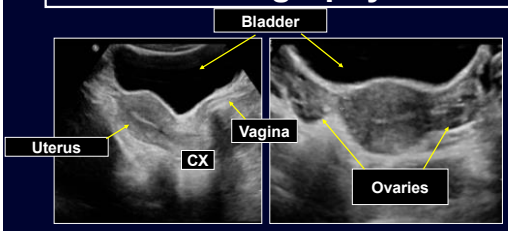
Transabdominal Sonography



- Sagittal and transverse views of the pelvis

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Limited Technique Transabdominal

- Used to complement TVS
- Initial evaluation without dedicated bladder filling
- For global view of pelvis

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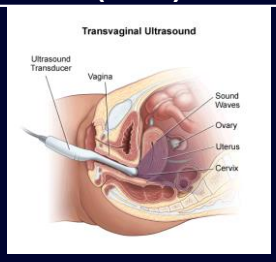
Transvaginal Sonography (TVS)



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Technique Transvaginal sonography

- Gives a more detailed evaluation of pelvic architecture using higher frequency transducers (>5 MHZ) at closer proximity to pelvic structures
- Field of view is limited

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Technique Contraindications

- Premenarchal patients
- The majority of virginal patients
- Any patient who does not willingly consent to vaginal examination

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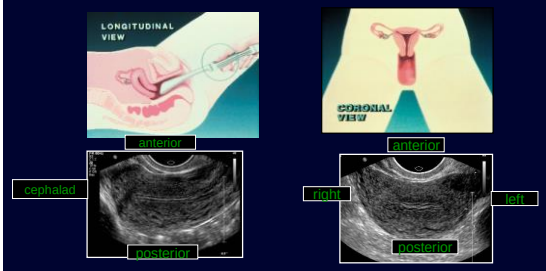
Transvaginal Sonography



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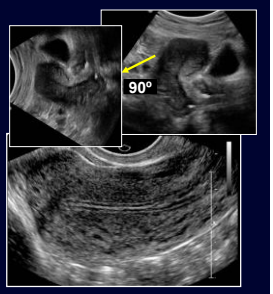
Sagittal view

- Uterine axis rotated 90 degrees counterclockwise from the TAS image on the sagittal view



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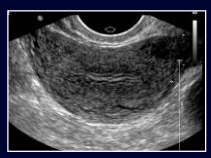
Transverse Uterine View (coronal view of pelvis)

- Uterine orientation on transverse view (coronal view of the pelvis) is usually the same as TAS image



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The Normal Sonographic Appearance of the Non-Gravid Genital Tract

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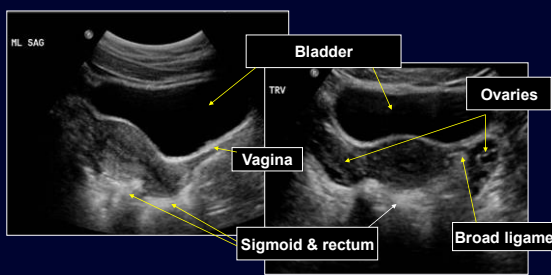
Pelvis



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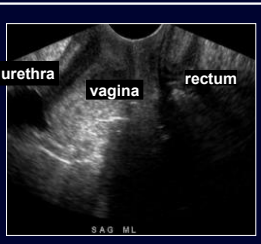
Pelvic Floor
Sagittal midline



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Pelvic Floor
Transperineal coronal view

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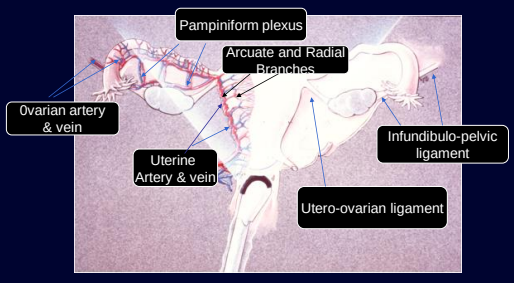
Pelvic Vasculature



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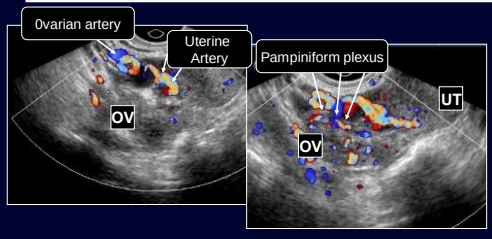
Pelvic Vasculature



- Uterine and ovarian artery

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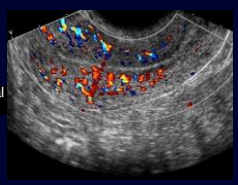
Pelvic Vasculature



- Uterine artery branches

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Uterus

- Consists of:
  - Cervix- the lower cylindrical portion which projects into the vagina
  - Body or corpus
  - Isthmus- narrow area connecting the body and cervix

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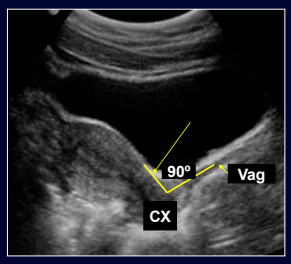
Cervix



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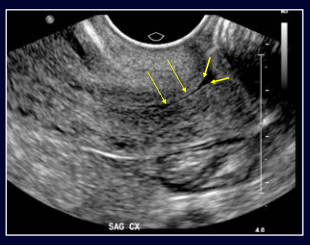
Cervix



Cervical mucus

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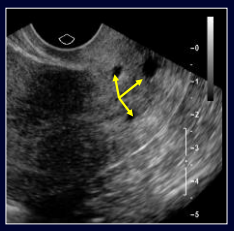
Cervix

Nabothian cysts

- Result of occlusion of endocervical glands
- Have no clinical significance



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Uterus

- Uterine size and consistency
- Position
- Endometrium

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Uterine size

- Measurement may be performed by TAS or TVS in sagittal, transverse and anterior-posterior dimensions
- Uterine length is often measured more accurately by TAS since the cervix may not be completely included on the transvaginal image

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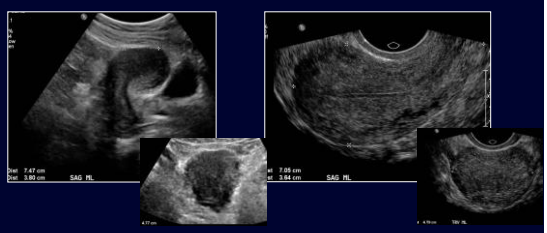
Uterine Size



- Uterine length measured more accurately by TAS when the cervix is not completely included on the transvaginal image

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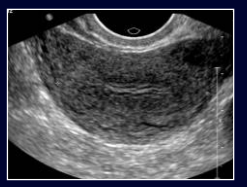
Uterine consistency



Myometrium best evaluated by TVS for improved resolution of architecture

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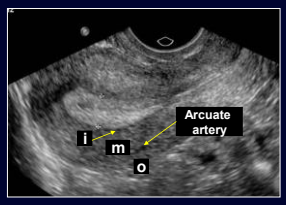
Uterine Consistency



- The myometrium is divided into an echogenic outer layer (o) and intermediate layer (m), and hypoechoic inner layer (i)

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Uterine Consistency Coronal view

- The inner layer appears as a thin hypoechoic halo surrounding the endometrium
- Best seen on coronal view

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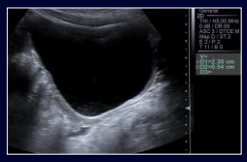
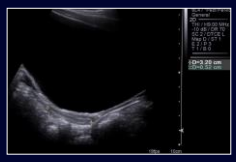
Uterine Measurements Premenstrual patients





- Ave volume approximately 1 cc up to age 9
- Larger cervix compared to corpus

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Uterine Measurements

- Normal measurements in menstrating females –vary with parity
  - 6-10.5 cm Length
  - 3-6 cm Transverse diameter
  - 2-5 cm A-P diameter

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Uterine Measurements

- Normal measurements in postmenopausal females
  - 3.5-7.5 cm Length
  - 2-4 cm Transverse diameter
  - 1.7-3.3 AP diameter

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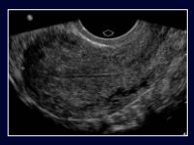
Uterine Measurements
Premenopausal Postmenopausal



7.1 cm L x 4.3 cm AP x 3.5 cm TRV

4.8 cm L x 2.4 cm AP x 2.5 cm TRV

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Uterine Position

Variable changing with degree of bladder and rectal distention

- Flexion- axis of uterine body relative to cervix
- Version- axis of cervix relative to the vagina

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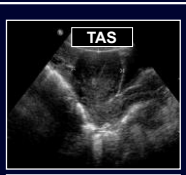
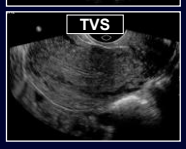
Uterine Position





- Anteversion/anteflexion- most common position

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Uterine Position

TAS

TVS

- Retroversion/retroflexion

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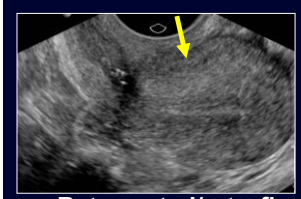
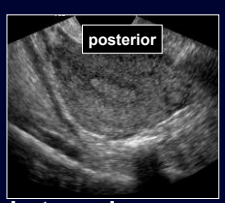
Uterine Position





- Retroverted/retroflexed uterus image orientation

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Uterine Position

- Neutral position
- Demonstrates coronal rather than transverse view of uterus

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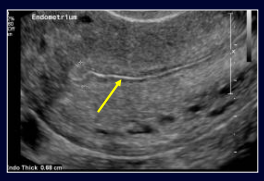
Endometrium

- Endometrial cavity seen as a thin echogenic line, a specular reflection of opposing endometrial interfaces
- Composed of superficial functional layer that sheds with menses and deep basal layer



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Endometrium
Endometrial echo

- The measurement of the endometrial thickness should include the "double layer" thickness anterior and posterior to the endometrial canal

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Premenopausal Endometrial Thickness

- Should not exceed 14-16 mm

Mendelson EB. AJR 150:139, 1988.

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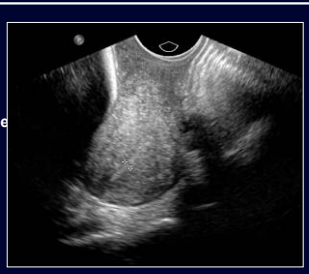
Premenopausal Endometrium
Menstrual

Menstrual

Consists of an echogenic line



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Premenopausal Endometrium

Secretory

Proliferative

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Postmenopausal Endometrium

- Commonly atrophic with thickness measuring less than 4-5 mm(3.4 mm mean)
- Vaginal bleeding is often secondary to atrophy
- PMB and < or = 4 mm thickness- 1/917 chance of endometrial cancer

Goldstein SR. Am J Obstet Gynecol. 201(1):5-11, 2009
Granberg S et.al. Am J Obstet Gynecol . 164:47-52, 1991

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The Asymptomatic Thickened Postmenopausal Endometrium

- Significance of thickening debatable
- No prospective studies performed to determine significant thickness
- Texture most important-polyp? fibroid?
- Routine biopsy not recommended

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Postmenopausal Endometrium

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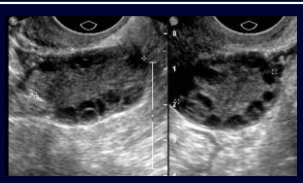
Ovary



- The ovaries are ellipsoid and can be identified in menstruating females by the presence of follicles

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Ovary Location

- The location of ovaries is variable
- Often seen in the ovarian fossa (Waldeyer's Fossa), especially in nulliparous females
- Waldeyer's Fossa bounded by the obliterated umbilical artery anteriorly, the ureter and internal iliac artery posteriorly and the external iliac vein superiorly

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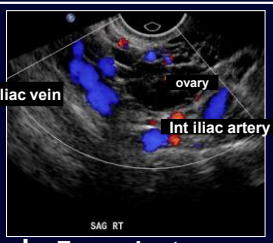
Ovary Location



- Waldeyer's Fossa by transvaginal color Doppler sonography

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Ovary

Ovarian Volumes

"Bigger than we think"

Cohen H. Radiology 177: 189, 1990.

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Ovarian volumes

- Menstruating females:
  mean volume 9.8 cc, range 2.5- 21.9 cc
- Premenarchal:
  mean volume 3.0 cc, range .2- 9.1 cc
- Postmenopausal:
  mean volume 5.8 cc, range 1.2 -14.9 cc

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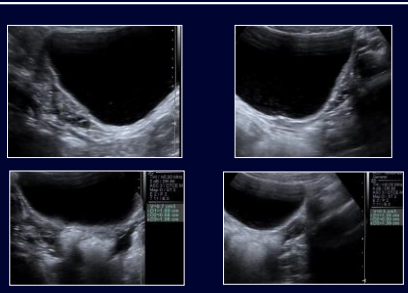
Ovarian volumes 9 year old premenarchal



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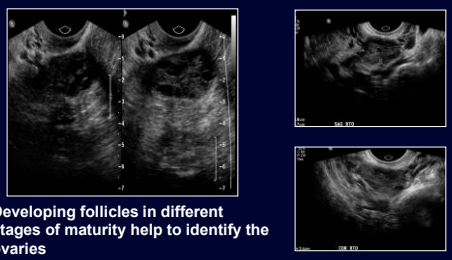
Ovarian volumes Menstruating females



Developing follicles in different stages of maturity help to identify the ovaries

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Ovarian Volumes Postmenopausal Females

- Once late postmenopause is reached (greater than 5 years since final menstrual period), folliculogenesis ceases, the ovary atrophies and the follicles disappear, with the ovary decreasing in size
- May be difficult to visualize sonographically

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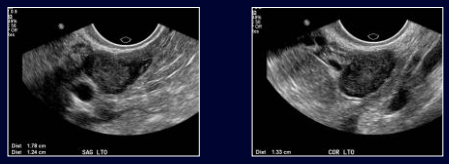
Ovarian volumes Postmenopausal Females



- Smaller and more homogeneous
- Follicles no longer demonstrated in late postmenopause

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Fallopian Tubes

- Musculomembranous structures measuring approximately 12 cm in length
- Not a routine part of a normal examination, but can often demonstrate at least a portion of each tube in the majority of patients

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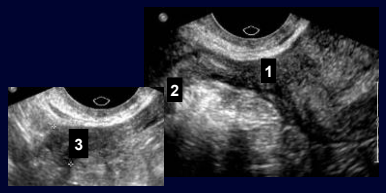
Fallopian Tubes



- intramural, (1) isthmic (2) and ampullary (3) portions

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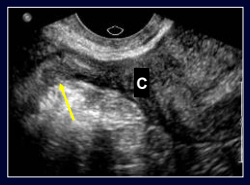
Fallopian Tubes



- Identified by its tubular structure (arrow) which can be followed to the uterine cornua (C)

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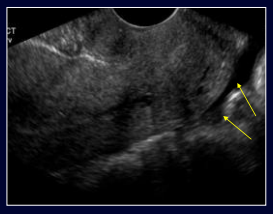
Cul-de-sac



- Physiologic fluid in cul-de-sac seen in menstruating females (<15 ml)

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Sonographic Changes in the Appearance of the Female Pelvis with Respect to the Menstrual Cycle and with Age

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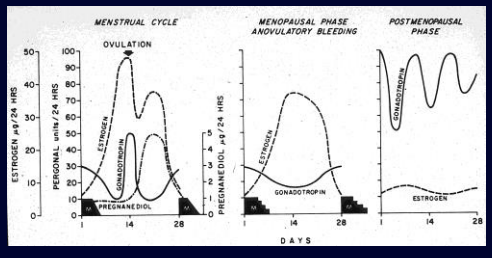
Cyclic Hormonal changes



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Cyclic Changes of the Ovaries

- Follicular phase- Enlargement of ovarian follicles with usually one dominant, preovulatory follicle (20 mm average diameter) prior to ovulation

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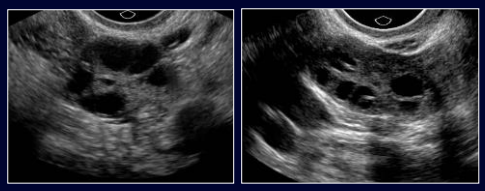
Cyclic Changes of the Ovaries



- Developing follicles in the early follicular phase

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Cyclic Changes of the Ovaries

- One or two dominant follicles usually seen after day 10

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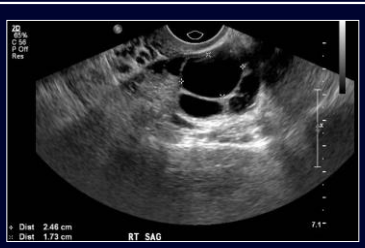
Cyclic Changes of the Ovaries



- Ovulatory follicle usually 18-25 mm average diameter (ave 20 mm)

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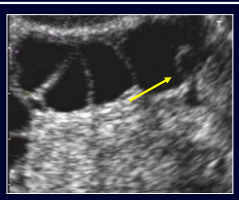
Cyclic Changes of the Ovaries



- Ovulatory follicle containing a cumulus oophorus
- Separation of the granulosal layer of the follicular wall from the thecal layer (containing ovum) 24 hours prior to ovulation

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Cyclic Changes of the Ovaries

Luteal phase- LH surge triggering ovulation with ruptured follicle becoming postovulatory corpus luteum

- Crenulated thick walled cystic structure
- Peripheral vascularity by color Doppler

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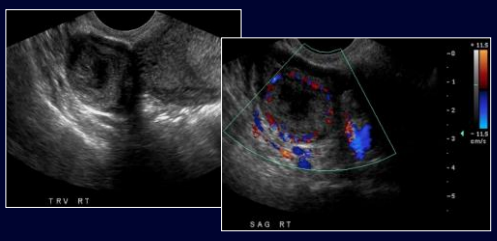
Cyclic Changes of the Ovaries



- Post-ovulatory corpus luteum

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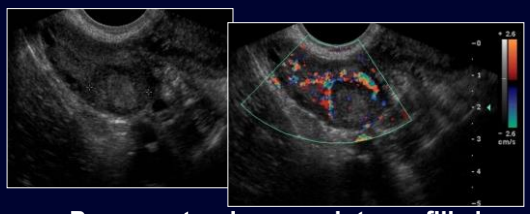
Cyclic Changes of the Ovaries



- Pre-menstrual corpus luteum-fills in with echoes no longer appearing cystic

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FOLLICLE EVALUATIONS

- Monitoring size and number of follicles for evaluation of ovulation in:
  - Normal cycles
  - Ovulation induction cycles
  - IVF cycles
- Mature follicle (18-25mm)

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Cyclic Changes of the Endometrium

- Menstrual phase
- Proliferative phase
- Secretory phase

*Variations in thickness and architecture**

*Lyons EA, Radiol Clin North Am 30:663, 1992.

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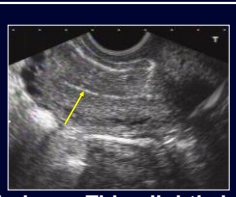
Cyclic Changes of the Endometrium



- Menstrual phase: Thin slightly irregular echogenic surface due to sloughing of the functional layer of the endometrium

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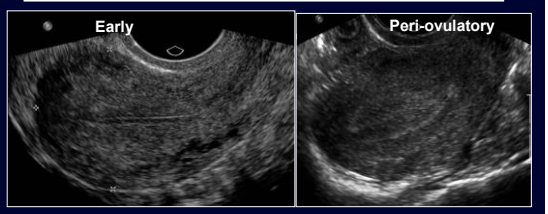
Cyclic Changes of the Endometrium



- Proliferative phase: Thickens with an echogenic border but hypoechoic inner layer reflecting increase in length of glands (4-10 mm)

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Cyclic Changes of the Endometrium

- Secretory phase: Increase in echogenicity reflecting tortuosity and distention of glands with mucin (7-14 mm)

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Perimenopause

- Unopposed estrogen stimulation: Increase in echogenicity with thickening that can be greater than 14 mm
- Cannot differentiate from hyperplasia

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Early Postmenopause

- Within 5 years of last menstrual period
- Occasional follicular development with subsequent ovulation
- Resulting in cyclic changes of the endometrium and menstruation

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Postmenopausal Simple Cysts

- Simple cysts (thin walled, anechoic)often seen in postmenopausal ovaries
- Follicles, paraovarian or paratubal, ovarian surface epithelial inclusion cysts, cystadenomas
- Simple cysts <1 cm considered almost certainly benign and clinically unimportant

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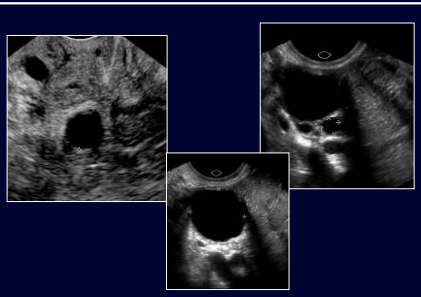
Postmenopausal Simple Cysts



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Other Techniques for Imaging the Female Pelvis

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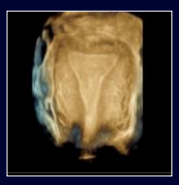
Uterine 3-D Reconstructions in the Coronal Plane

- 2D imaging limited by constraints of the vaginal probe
- Volume imaging allows routine visualization of the coronal plane



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Uterine 3-D Reconstructions in the Coronal Plane

- A 3D volume is obtained through the uterus using an automated or manual sweep in the sagittal plane
- Reconstructed in the coronal plane
- May include a surface rendered image-Thicker slice using shading and lighting effects

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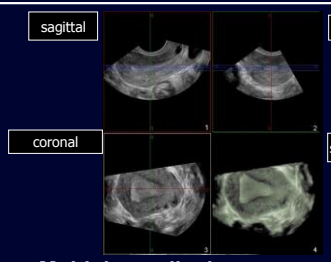
Uterine 3-D Reconstructions in the Coronal Plane



Multiplanar display

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Uterine 3-D Reconstructions in the Coronal Plane

- Reconstructed 3D volume in the coronal plane of a normal uterus and endometrium with surface rendering

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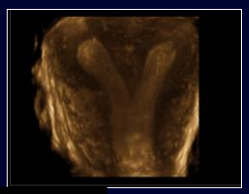
Uterine 3-D Reconstructions in the Coronal Plane

- Demonstration of findings not appreciated on traditional views
- Uterine anomalies



Septate uterus

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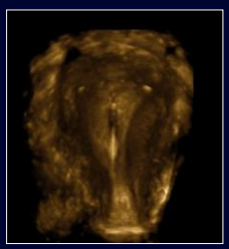
Uterine 3-D Reconstructions in the Coronal Plane

- Entire IUD most accurately demonstrated in the coronal plane



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Saline/Sonohysterography

- Instillation of saline within the endometrial cavity through a balloon catheter
- Allows for evaluation of associated endometrial and myometrial processes

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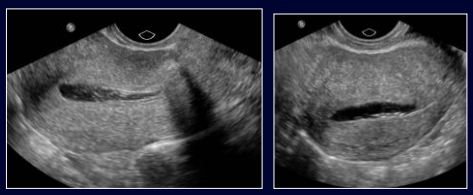
Saline/Sonohysterography



- Fluid distending the endometrial cavity

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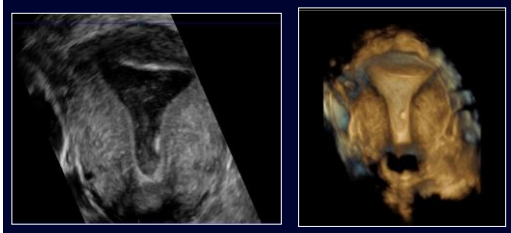
Saline/Sonohysterography



- 3D reconstructions of the distended cavity in the coronal plane

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Contrast Agents

- Microbubble contrast material can be used to enhance the microvascular circulation
- Although little support, a few studies suggest usefulness in differentiation of benign versus malignant ovarian masses*

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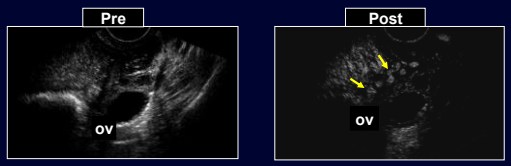
*Fleischer AC, et al., J Ultrasound Med 2008; 27:1011.

Contrast Agents



- Pre and post-contrast images of a normal ovary
- Enhancement of veins surrounding the ovary without significant enhancement within the ovary

Images courtesy of Andrej Lyschik, Dept. of Radiology, Vanderbilt University Medical Center

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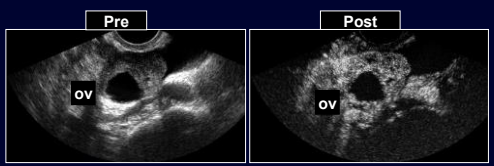
Contrast Agents



- Pre and post-contrast images of ovarian carcinoma
- Marked enhancement of ovarian neoplasia

Images courtesy of Andrej Lyschik, Dept. of Radiology, Vanderbilt University Medical Center

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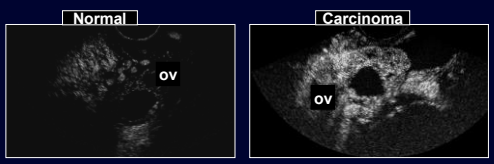
Contrast Agents



- Comparison of contrast enhancement of normal ovary and carcinoma

Images courtesy of Andrej Lyschik, Dept. of Radiology, Vanderbilt University Medical Center

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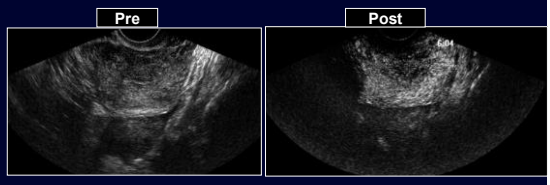
Contrast Agents



- Contrast enhancement of the normal myometrium

Images courtesy of Andrej Lyschik, Dept. of Radiology, Vanderbilt University Medical Center

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Other Imaging Modalities MRI and CT

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Computed Tomography (CT)

- Sonography is initial exam of choice for evaluation of the pelvis
- Computed tomography is used frequently in patients suspected of GI or GU abnormalities

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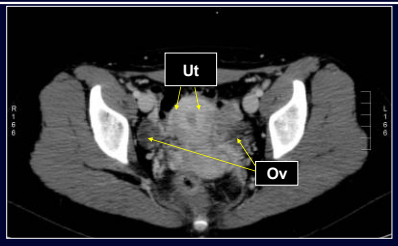
Computed Tomography (CT)



- Transverse image of pelvis with contrast

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Computed Tomography (CT)

- Reconstruction in the sagittal plane

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Pelvic MRI

- MRI can be a problem solving technique in the pelvis when US is not definitive
- Pelvic anatomy can be better defined with MRI than CT

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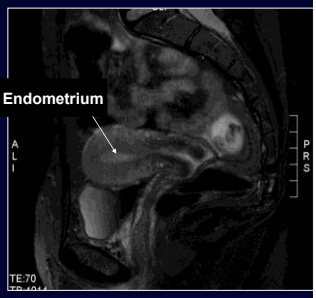
Pelvic MRI

- Sag T2 weighted image
- High intensity endometrium and myometrium



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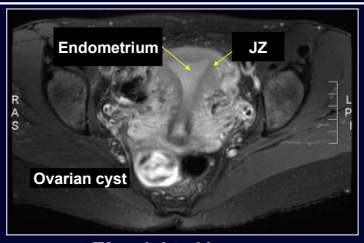
Pelvic MRI



- Transverse T2 weighted image
- Low intensity junctional zone(JZ) separating endometrium and myometrium

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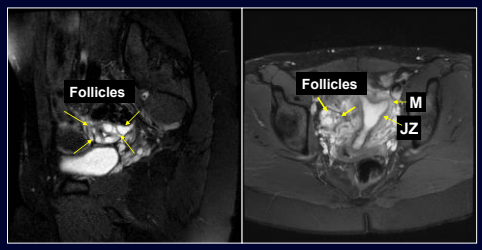
Pelvic MRI



- Sag and transverse T2 weighted images of the right ovary

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Conclusions

- Using transabdominal, transvaginal and color Doppler sonography, the architecture of female pelvic organs is well demonstrated.
- One should be familiar with the normal pelvic findings including the cyclic changes of the uterus and ovaries in order to differentiate these from true abnormalities.
- Newer sonographic techniques as well as other radiologic modalities also play a role in pelvic evaluation

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THANK YOU!

Key References

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