Learning Objectives
After completing this presentation, the learner will be able to:

• Diagnose a cesarean scar pregnancy (CSP), by the diagnostic criteria and differentiate it from an intrauterine pregnancy (IUP) and a cervical pregnancy (CxP).
• Recognize that there is a common histologic basis of CSP and morbidly adherent placenta (MAP) such as accreta, increta and percreta, and that CSP is its main precursor and a major risk for MAP.
• Construct an evidence based counseling and management plan for the CSP considering the patients' obstetrical goals.
• Recognizing the sonographic findings of MAP.

Lecture Outline
1. What is a cesarean scar pregnancy
2. Pathogenesis
3. Incidence
4. Diagnosis and differential diagnoses
5. Natural history if left untreated
6. Treatment
   a. Choices in the literature
   b. Management complications
   c. Best treatment: Is there any single one?
7. Conclusions

What is a CSP
• Clinically, CSP is a dangerous pregnancy presenting serious diagnostic, treatment and counseling challenges
• Synonyms in the literature: scar pregnancy, cesarean section scar ectopic, section scar ectopic
• Mistakenly considered an ectopic pregnancy (it IS low, but within the uterine cavity, left alone the sac “morphs “ into the uterine cavity)
• Unless REAL ectopic pregnancies, it can result in a live neonate

1. What is a Cesarean Scar Pregnancy?
• Cesarean Scar Pregnancy (CSP) is an iatrogenic entity
• A blastocyst implants in a microscopic or macroscopic tract on the uterine scar or in the “niche” left by the incision, in the anterior uterine wall developing into a chorionic sac
• The mechanism is similar to implantations after uterine surgery (myomectomy, curettage, endometrial ablation, manual removal of placenta etc)
What is a cesarean section scar/niche and how does it look?
On US, most of the time it appears like this:

EARLY sonographic appearance:
Placenta implanted "on the scar"

EARLY sonographic appearance:
Placenta implanted "in the niche"

2. Pathogenesis
Theories of pathogenesis.
Previous uterine surgery or uterine interventions: lead to thin or absent decidua basalis in scarred areas of the lower uterine segment.

Histological slide: courtesy: of Dr. Mittal, Dept Path NYU

Timor-Tritsch & Monteagudo
Theories of the pathogenesis.
Uterine interventions lead to the thinning or missing Nitabuch fibrinoid layer. The placenta will attach itself deeply into the uterine wall.


3. Incidence
- True incidence is not known
- ≈1 in 2000-2500 cesarean deliveries
- Rate closely related C/D rates
- 52% of CSPs had only one prior C/D
- The more previous C/D, the more CSP, the more placenta previa and accreta


4. How do we make the diagnosis and which are the differential diagnoses?

The sonographic diagnosis is made reliably and in the Ob/Gyn office by transvaginal sonography.

Diagnostic accuracy depends on the expertise and understanding its differential diagnostic issues.

Sonographic criteria of CSP
1. No fetal parts in the uterine cavity or cervix
2. Thin myometrial layer between the bladder and & gestational sac
3. Triangular® shaped gestational sac®
4. Gestational sac close to the bladder and anterior uterine wall

Should you order MRI to diagnose or to confirm a sono diagnosis of a CSP?

You could, but definitely not necessary! Why outsource, why delay diagnosis?
The first line imaging to diagnose or to confirm a CSP is transvaginal ultrasound!
5. Rarely: A-V malformation at the site of a CS

High peak systolic velocity

The differential diagnosis

1. Cervical Pregnancy – however – remember: Cx pregnancy is EXTREMELY rare & occur in intact uteri
2. IUP in the process of abortion – however – they very rarely have a beating heart!

Therefore:

If the chorionic sac is low, close to the cervix and the patient had a previous cesarean delivery: IT IS A CSP!!!!

The easiest and simplest way to the diagnosis

On a panoramic, longitudinal, sagittal scan determine the location of the gestational sac

Divide the uterus in half by an imaginary line

Sensitivity = 93.0%, Specificity = 98.9%, +LR = 88.4%, -LR = 0.07%

If the gestational sac is below it: it is mostly a normal implantation

If the gestational sac is low, close to the cervix: CSP

Warning:

At times (mostly after 7 weeks) the location of the sac of a CSP may be misleading.

Rely on the patient’s Hx, location of the placenta and its vascular supply!

After 7 -8 weeks don’t be “fooled” by the location of the sac!

In an anteverted uterus 7w2d

The sac may “move up”, but the placenta with its vessels stays at implantation site

Rely on color Doppler of the vessels at the scar implantation site. They stay anchored!

In a retroverted uterus 9w2d

Don’t promiss your patient that it may not re-occur

- Recurrent CSP in the literature: ≈2%
  - 9/751 cases in one review: 1.2%^*  
  - 8 women had recurrent scar pregnancy*
  - 1 molar pregnancy in t1 he scar**
  - 1 had 5 consecutive CSPs!***
  - 21/619 cases in another review: 3.4% ****

5. What is the natural history of CSP?

First let us answer this question:

a. Are CSP and MAP the same disease?

“Cesarean scar pregnancy and early placenta accreta (EPA) share a common histology”

- **Objective:** We evaluated the histology CSP & EPA in the second trimester
- **Our hypothesis was:** they are pathologically indistinguishable diseases; and represent an early clinical manifestation in the continuum of morbidly adherent placenta.

**Materials and Methods:**
- We reviewed 30 articles with 31 cases of CSP & 13 cases of EPA
- We added 3 CSP and 7 EPA cases
- Two pathologists examined all the material separately and blinded to each other providing pathological diagnosis based on their microscopic appearance.
- Inter-observer correlation between them determined

**Evaluation of the pathologic slides**

- All revealed placental villi invading the myometrium without an intervening decidua.
- It was impossible to determine the clinical diagnosis based upon the histologic picture.
- They were all consistent with adherent placentae of different degrees (placenta accreta, increta or percreta).

Copyright releases obtained for all pictures
Conclusions:

- This study supports our hypothesis, that Cesarean Scar Pregnancy and Early Placenta Accreta are one and the same histopathologic entity and CSP is an early manifestation of morbidly adherent placenta.


Placenta accreta and percreta can occur in the 1st trimester

- Fact based upon:
  - Reports of massive hemorrhage during D&C and histology of MAP in the involved uterus
  - Reports of proven 1st trimester US and subsequent histology of MAP in the near term placenta
  - In all 6 of the cases of Comstock** and 10 cases of Ballas*** previous C/D was the risk factor


The antenatal diagnosis of placenta accreta

- CH Comstock,** RA Bronsteen***

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In the first trimester…..


Additional literature support for the fact that CSP is one of the precursors of placenta accreta


5. What is the natural history of CSP?

Let us answer the second question:

b. Is CSP a precursor of MAP?
Is CSP a precursor of MAP?

- The cases in the literature validate the fact that CSP is a precursor of MAP
- Pregnancies that start out as CSP may achieve birth of a live neonate.
- Case series present evidence upon which to counsel patients with CSP, enabling them to make an informed choice between 1st TOP and continuation of the pregnancy, risk in premature delivery, hysterectomy, losing fertility.

Suggested management of CSP

- FH + CSP: Evidence based counseling
- No FH: Weekly hCG and US

- Select treatment that stops heart activity with no or least delay
- Provide bleeding precautions
- Manage by multidisciplinary team. Deliver by CS at 0b indicated age. Be prepared for cesarean hysterectomy
- Follow by US until hCG zero!

6. First trimester treatment choices, if continuing the pregnancy is NOT an option

The major treatment modalities

- Surgical requiring general anesthesia
  - Major: laparotomy
  - Minor: Laparoscopy, Hysteroscopy; D&C
- Minimally invasive: Local injection (MTX/KCl)
- Systemic
  - Major: UAE
  - Minor: IM Methotrexate (single/multiple)
- Different combinations of the above
  - Simultaneously
  - Sequentially

Treatment

1. Choices in the literature
2. Management complications
3. Best treatment: Is there any single one?
**Primary treatment in 751 cases**

1. Hysterectomy
2. Hysteroscopy by TAS guidance
3. Hysteroscopy & Mifepristone
4. Laparotomy & excision
5. Laparotomy with elective TAH
6. Laparotomy & systemic MTX
7. Laparotomy & hysterectomy
8. TAS guided local MTX injection
9. TAS guided local KCI injection
10. TAS guided local & systemic MTX
11. TVS guided local MTX injection
12. TVS guided local KCI injection
13. TVS guided local & systemic MTX
14. Local injection of Vasopressin
15. UA embolization alone

**After 2012 an additional 5-6 treatments were published**

**Complication rate**

- **Definition of “complication”:**
  - Immediate or delayed need for a 2nd treatment involving: blood loss > 200 ml, blood transfusion, general anesthesia, surgical approach/es
  - The above were applied alone or in combination

**Complication rate in 751 cases**

<table>
<thead>
<tr>
<th>Treatment</th>
<th># of cases</th>
<th># of complications</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTX alone</td>
<td>87</td>
<td>54</td>
<td>62.1</td>
</tr>
<tr>
<td>D&amp; C</td>
<td>305</td>
<td>189</td>
<td>61.9</td>
</tr>
<tr>
<td>UA embolization</td>
<td>64</td>
<td>30</td>
<td>46.9</td>
</tr>
<tr>
<td>Hysteroscopy</td>
<td>119</td>
<td>22</td>
<td>18.4</td>
</tr>
<tr>
<td>Local injection of MTX/KCI (TAS or TVS guidance)</td>
<td>81</td>
<td>8</td>
<td>9.6</td>
</tr>
</tbody>
</table>

**Treatment**

1. Choices in the literature
2. Management complications
3. Best treatment: Is there any single one?
1. Treatment
   1. Choices in the literature
   2. Management complications
   3. Best treatment: Is there any single one?

Which treatment to use??

The sporadic, mostly individual cases, case series and their results were insufficient to enable a clear conclusion as to which was the most effective, least invasive management protocol leading to the minimal or no complications.

Are there guidelines??

In 2016: none of the countries, USA included, have a set of guidelines at hand when a patient with an early, 1st trimester placenta accreta or a cesarean scar pregnancy presents.

Analysis of the most frequently used treatments based upon a review of 751 cases and case series published until 2012

Systemic MTX alone

- As a single agent treatment had a 64.6% complication rate.
- Its slow action may take days
- Questionable ability to stop the heart
- Often require additional treatment.

Sequential, multidose systemic MTX

- Be aware of its side effects.
- Even such treatment fails at times
- However MTX can be used as an adjuvant therapy with other treatments

Suction aspiration and/or SHARP D&C alone or in combined with inflation of Foley balloon

About 305 D&C cases reviewed in the literature with about 62% (29-86%) mostly bleeding complications. If planning D&C: have blood & a Foley balloon handy

3D US display of rich vascular supply surrounding the chorionic sac of a scar pregnancy

This explains the possible bleeding complication of a D&C when the scar pregnancy is subjected to curettage
Uterine Artery Embolization alone or in combination with other treatments

As single treatment has 47% complications/failure*
Not the best "single" or "first line" treatment**
Adequate adjuvant to other treatments.


Timor-Tritsch & Monteagudo

Laparotomy and Laparoscopy

14 cases reviewed in the literature with about 28% complications unless it results in TAH
(Complications were: infection, bleeding, anesthesia)

Timor-Tritsch 2012 AJOG

Operative hysteroscopy alone or in combination

About 119 cases reviewed in the literature with the second lowest (about 18%) complication rate (mostly bleeding)

Timor-Tritsch 2012 AJOG

Transabdominal or transvaginal US guided local, intra-gestational sac injection of MTX/KCl

About 100 cases in the literature with about an 9.6% (0-15%) complications

Michaels et al JUM 2015; Timor-Tritsch et al 2015; Zosmer et al UOG 2015

Transabdominal or transvaginal US guided Foley balloon placement to prevent bleeding after local injection of CSP (cervical pregnancy)

Use as an adjuvant to:
- Local injection
- Aspiration or D&C
- Hysteroscopic excision
- Uterine Artery Embolization
- Laparoscopic excision

Cesarean Scar Pregnancess

Experience of 60 Cases

JUltrasound Med 2016; 34:501-510

Timor-Tritsch & Monteagudo
The use of a single balloon Foley catheter as andjuvant to local, intragestational injection of MTX

Lately: New, minimally invasive treatment: Placing a double cervical ripening balloon

Reasons for its use:
- Simultaneously terminates pregnancy and prevents bleeding
- Simplify treatment: Minimize patient discomfort
- Adapt a catheter familiar to Ob in the L&D to treat CSP
- Also effective for cervical pregnancies

The double balloon catheter

The balloons inflated

Timor-Tritsch, Monteagudo, Bennett, Foley, Kaelin Agten. A new minimally invasive treatment for cesarean scar and cervical pregnancy. Article accepted for publication by AJOG
Our experience*

- 17 CSPs and 3 CxPs were treated.
- Patients tolerated balloon placement and inflation well
- Oral pain medication and antibiotics were given
- The last 6 patients in the series received paracervical block using 1% Lidocaine
- Minimal, "old", dark blood was seen after removal of the catheters probably from intracavitary accumulation of blood
- In all cases almost total resolution of the hCG, the sac site & its vascularity was seen within 50-80 days

* Ending June 2016

Cesarean scar pregnancy: a systematic review of treatment studies.

**OBJECTIVE:** To study treatment modalities for cesarean scar pregnancies (CSPs), focusing on efficacy & complications relative to study quality.

**DESIGN:** Systematic review.

**PATIENT(S):** A total of 2,037 women with CSP.

**MAIN OUTCOME MEASURE(S):** Successful 1st-line treatment. Complications were hysterectomy, laparotomy, bleeding >1,000 mL, or blood transfusion.


**RESULTS:** 52 studies included: 4 randomized, controlled trials and 48 case series.

- 15 of 52 analyzed studies scored as high quality.
- Treatment modalities condensed to 14 approaches
- Combining study quality, level of evidence, efficacy, and safety, 5 approaches for treating CSP recommended, depending on availability, severity of patient symptoms, and surgical skills:
  - [1] resection through a transvaginal approach,
  - [2] laparoscopy,
  - [3] UAE in combination with D&C and hysteroscopy,
  - [4] UAE in combination with D&C,


**CONCLUSION(S):**

- This review recommends treatment options for CSP in clinical practice, based on efficacy and safety.
- The literature supports an interventional rather than medical approach.
- Present recommendations are primarily based on case series.
- Multicenter, well-designed studies are needed to draw definite conclusions on how to treat CSP.

CSP: Summary and conclusions

1. The diagnosis of CSP is difficult.
2. CSP is often misdiagnosed as “low intrauterine pregnancy,” “cervical pregnancy,” or “miscarriage in progress.”
3. The best diagnostic tool is high frequency transvaginal ultrasound.
4. MRI does NOT add to the Dx.
5. The earlier the diagnosis was established, the better the outcome seemed to be
6. If possible, sharp curettage should be avoided, it can cause profuse bleeding and loss of the uterus. If still the choice: have blood and Foley catheter available

7. Systemic MTX as a one shot single agent treatment should be avoided.
   Good adjuvant to other treatments

8. UAE as single agent treatment should be used sparingly or not at all.
   Good adjuvant to other treatments or to save the uterus

   At the time of discharging women from the hospital after a CD, patients should be advised that in a future pregnancy, an early visit (1-2 weeks after a missed period) at the obstetrician for a TVS is of paramount importance.

Recurrent CSP is about 1%!!

Since Cesarean Scar Pregnancy is one of the precursors of Morbidly Adherent Placentae, the next section is devoted to that subject

Terms in the literature ..........

| Placental Attachment Disorders (PAD) |
| aka: Morbidly Adherent Placenta (MAP) |
| aka: Abnormal Invasive Placenta (AIP) |
| aka: Placenta accreta, increta & percreta |

PAD as a Major Health Care Problem

- PAD account for 33-50% of emergency peripartum hysterectomies *
- The consequences are:
  - Cesarean hysterectomy (loss of fertility)
  - Increased rate of blood loss & transfusion
  - Increased rate of ICU admission
  - Injury of adjacent organs

*GraziaS et al Obstet Gynecol 2008;111:732-8
*Esakoff TF et al Obstet Gynecol 2011;37:324-7

Risk factors:

- Most common risk factors:
  - Placenta previa
  - Previous cesarean delivery
  - Age
- Others
  - Asherman syndrome
  - Endometrial ablation
  - IVF pregnancy
  - Any intrauterine surgery/manipulation
The goal

To review the two major diagnostic modalities: Ultrasound and MRI used at the present time to attempt the most precise prenatal diagnosis.

The reason

There were significant changes in the past several years in the evidence for various techniques used to make the diagnosis. Also new clinical and histologic data about PAD.

The three clinical forms of PAD

- In the 1st Δ: Cesarean scar pregnancy
- In the 2nd Δ: “Early” placenta accreta
- In the 3rd Δ: Placenta accreta, increta, percreta

Each has its own sonographic appearance, clinical signs, natural history and clinical consequence.

Each could be considered a different clinical entity, however there is proof that they are expressions of the same histopathologic entity.

The main & necessary statistics

PAD as a Major Health Care Problem

- PAD account for 33-50% of emergency peripartum hysterectomies *
- The consequences are:
  - Cesarean hysterectomy (loss of fertility)
  - Increased rate of blood loss & transfusion
  - Increased rate of ICU admission
  - Injury of adjacent organs

*Habek D, Becarevic R. Fetal Diagn Ther 2007;2:135-7
*Rachman I et al. J Obstet Gynecol2008;2869-72
*GlazS et al Obstet Gynecol 2008;113:722-8
*Esakoff TF et al Obstet Gynecol 2011;37:324-7

Cesarean Rates (per 1,000 births), Industrialized Countries, 1990-2004

Definition, prevalence and relative incidence of MAP

- Accreta (80%) 16
  Superficial myometrial invasion of chorionic villi
- Increta (15%) 3
  Deep myometrial invasion of chorionic villi
- Percreta (5%) 1
  Invasion of chorionic villi through entire myometrial thickness (i.e., serosa or bladder)

The reported incidence of placenta accreta has increased from approximately 0.8 per 1000 deliveries in the 1980s to 3 per 1000 deliveries in the past decade.

Source: OECD Health Data 2006


Risk of placenta accreta

<table>
<thead>
<tr>
<th>Prior CS</th>
<th>With previa</th>
<th>Without previa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1-5%</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>11-25%</td>
<td>0.4%</td>
</tr>
<tr>
<td>2</td>
<td>35-47%</td>
<td>0.6%</td>
</tr>
<tr>
<td>3</td>
<td>40%</td>
<td>2.4%</td>
</tr>
<tr>
<td>4</td>
<td>50-67%</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Theories of pathogenesis.

Previous uterine surgery or uterine interventions: lead to thin or absent decidua basalis and the Nitabuch fibrinoid layer in scarred areas of the lower uterine segment.

Ultrasound signs of MAP

- Four GRAY SCALE markers
  - Clear space
  - Bladder line interruption
  - Lacunae
  - Myometrial thickness
- Two COLOR DOPPLER markers
  - Irregular tortuous vessel crossing the width of placenta
  - Hypervascularity of uterine serosa-bladder wall interface
- COMBINATION of the above

Gray scale signs

- In normal placentation: a hypoechoic space between the placenta & myometrium
- In MAP: Loss of normal hypoechoic zone

Ultrasound in the Second and Third Trimester

ACOG Committee Opinion. #529, July 2012.
3. Gray scale sign: ‘Lacunae’
Intraplacental vascular lacunae.

- **Grey-scale**: Irregular shape not round as placental lakes (Swiss cheese appearance).
- **Doppler**: Turbulent, pulsatile, low resistance, high velocity jet-like blood flow extending from the placenta into the surrounding uterine or cervical tissues.
- They are located deep in the placenta, (not under the fetal surface of the placenta)
3. Gray scale sign: ‘Lacunae’

- The more lacunae the more likely it is placenta percreta.
- Finberg et al (scale 1 to 3);
- Yang et al (grades 0 to 4);
- Cali et al (6 or more = percreta in 100%);

Gray scale sign: ‘Lacunae’

- Yang JI, Lim YK, Kim HS, Chang KH, Lee JP, Ryu HS. Sonographic findings of placental lacunae and the prediction of adherent placentas in women with placenta previa and prior Cesarean section. UOG 2006;28:178-82.

4. Gray scale sign: ‘Myometrial thickness’ between the placenta and uterine serosa/bladder

- Same value as the ‘clear space’ represents the same “gray scale” US sign
- The measurement of < 1mm was suggested as indicative of MAP
- Probably the least specific and sensitive sign

Utility of ‘lacunae’ in Dx of MAP

<table>
<thead>
<tr>
<th>Author</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comstock*</td>
<td>93</td>
<td>93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wong^</td>
<td>100</td>
<td>28</td>
<td>21</td>
<td>100</td>
</tr>
<tr>
<td>Cali~</td>
<td>73</td>
<td>86</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Yang (Gr ≥1)</td>
<td>87</td>
<td>79</td>
<td>77</td>
<td>88</td>
</tr>
<tr>
<td>Yang (Gr ≥2)</td>
<td>100</td>
<td>98</td>
<td>94</td>
<td>100</td>
</tr>
<tr>
<td>D’Antonio</td>
<td>77.4</td>
<td>95.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


5. Color/power Doppler signs

- Same value as the ‘clear space’ represents the same “gray scale” US sign
- The measurement of < 1mm was suggested as indicative of MAP
- Probably the least specific and sensitive sign
A. Irregular intraplacental tortuous vessels crossing the placental width

Increased vascularity extending from side-to-side, in the width, as well as into the depth of the placenta

B: Hypervascularity of uterine serosa-bladder wall interface

3D angiographic rendering of the entire placenta

Summary of the sonographic basis diagnosing MAP

Number of positive sonographic diagnostic criteria for MAP in 187 patients with placenta previa and history of uterine surgery

<table>
<thead>
<tr>
<th>Number of criteria</th>
<th>No MAP (n=141)</th>
<th>MAP (n=41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIVE</td>
<td>0</td>
<td>8 (all percreta)</td>
</tr>
<tr>
<td>FOUR</td>
<td>0</td>
<td>8 ACCR + 8 PERCR</td>
</tr>
<tr>
<td>THREE</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>TWO</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>ONE</td>
<td>49</td>
<td>0</td>
</tr>
<tr>
<td>NONE</td>
<td>97</td>
<td>0</td>
</tr>
</tbody>
</table>

G. CALÎ*, L. GIAMBANCO% G. PUCCIOf and F. FORLANI
Selection of pertinent article regarding sonographic diagnosis of MAP

**ABSTRACT:** The goal was to provide up-to-date and evidence-based answers to common clinical questions regarding the diagnosis and management of MAP.

- **US** is the 1st method for diagnosing MAP with good accuracy.
- Color Doppler seems to provide the best detection performance.
- **MRI** has the same accuracy as US.
- **MRI** should be considered when hysterectomy is planned as it can provide detailed information about the topography of placental invasion and predict difficulties at surgery.

Two authors independently abstracted data from 23 studies of 3707 pregnancies at risk for MAP.

Sensitivity, specificity, positive and negative likelihood ratios (LR+ and LR−), the diagnostic odds ratio (DOR) and their 95% CIs for each study were calculated.

Overall performance of US for the antenatal detection of invasive placentation was:

- Sensitivity, 90.7% (95% CI, 87.2-93.8);
- Specificity, 96.9% (95% CI, 96.3-97.5);
- LR+, 11.01 (95% CI, 6.1-20.0);
- LR−, 0.16 (95% CI, 0.11-0.23); and
- DOR, 98.5 (95% CI, 48.8-199.0).

Among the different US signs, **color Doppler** had the best predictive accuracy:

- Sensitivity, 90.7% (95% CI, 85.2-94.7);
- Specificity, 87.6% (95% CI, 84.6-90.4);
- LR+, 7.7 (95% CI, 3.3-18.4);
- LR−, 0.17 (95% CI, 0.10-0.29); and
- DOR, 69.0 (95% CI, 22.8-208.9).

The NIH consensus panel issued the following statistics for the US Dx of MAP:

- **Sensitivity** 77% (95% CI, 60-80%);
- **Specificity** 96% (95% CI, 93-97%);
- PPV 65% (95% CI, 60-80%);
- NPV 98% (95% CI, 95-98%).

"**US should be the primary tool for the Dx. and can be the only modality in the majority of cases. The sensitivity and specificity of MRI are comparable to US.**"

- **MY COMMENT:** US markers did not include evaluation of the "bladder line" and "3D US".
- If included, it would have resulted in better metrics.
- Reason for excluding 3D Doppler was: it is not universally used and its use can not be mandated.
Accuracy of ultrasound for the prediction of placenta accreta

- Objective: To test if previously reported US sensitivity of >90% for Dx of PA is valid
  - 6 observers blinded to clinical status
- Design: 1 center, retro study. PA matched c. controls (pts c. previa)
- Results: 229 USs (55 with PA & 56 with previa) 1374 observations
  - 30.8% true positives,
  - 6.7% false positives,
  - 44.2% true negatives,
  - 18.3% false negatives,
  - 12.0% = “unable to be determined,”

Timor-Tritsch & Monteagudo Am J Obstet Gynecol 2015;212:343.e1

Ultrasound predictors of placental invasion: the Placenta Accreta Index

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 3 lacunae</td>
<td>10.0</td>
<td>1.4–80</td>
</tr>
<tr>
<td>No. of cesarean deliveries</td>
<td>9.6</td>
<td>2.5–37.1</td>
</tr>
<tr>
<td>Placental location</td>
<td>5.9</td>
<td>1.1–14.1</td>
</tr>
<tr>
<td>Grade 2 lacunae</td>
<td>2.9</td>
<td>0.6–12.7</td>
</tr>
<tr>
<td>Bridging vessels</td>
<td>2.3</td>
<td>0.6–8.7</td>
</tr>
<tr>
<td>Sagittal smallest myometrial thickness</td>
<td>1.0</td>
<td>0.8–1.2</td>
</tr>
</tbody>
</table>

Modified after A. Abuhamad

For best diagnostic results of MAP

- 1. First evaluate patient risk
- 2. Optimize imaging by using transvaginal US with “comfortably full” bladder (= 300cc)
- 3. Use Color Doppler with low pulse repetition frequencies (=0.9kHz)
- 4. Report findings as: high risk, low risk or intermediate risk for bleeding
  - If unsure, be conservative: false positive results are acceptable

Does MRI help?

Three questions

- There are three areas to be addressed when assessing MRI to rule in or out MAP:
  - which is/are the best MRI sign/s,
  - are the sensitivity & specificity of MRI & US comparable, since US is done first (bias??)
  - at what GA can MRI (a more expensive test) contribute additional information.
The best MRI signs MAP

- Dark intra-placental bands* on T2 are most predictive (equivalent to lacunae by US)
- Vessels of 6 mm or greater (presumably correspond to large vessels).
- Focally interrupted myometrial border.
- Infiltration of pelvic organs.
- Tenting of the bladder
- Placental protrusion into the internal os


MRI: intraplacental ‘dark bands’

MRI: ‘dark bands’

Focally interrupted myometrial border

Novel MRI sign: ‘placental protrusion sign’

65 patients: MRI (1.5T unit) coronal & sagittal T2-weighted half-Fourier single-shot turbo spin echo imaging. In 15 pts the Dx was invasive placenta praevia.

The MRI features of placental adhesion disorder and their diagnostic significance: systematic review

N.S.A. Rahaim, E.H. Whitby

AIM: To identify the most frequently used MRI features in the diagnosis of placenta adhesion disorder (PAD) in the antenatal period and their significance.
**RESULTS**: 614 relevant articles identified. Only 11 met the inclusion criteria.

- The commonest MRI criteria used were
  - T2 dark intraplacental bands,
  - heterogeneity of placenta,
  - abnormal uterine bulging, and
  - disruption of the utero-placental zone.
- A newly described criterion is disorganised vasculature of placenta.
- **MRI sensitivity and specificity varied between 75-100% and 65-100% respectively.**

**CONCLUSION**: MRI diagnosis of PAD relies on unstandardised criteria of diagnosis.

- However, it is still has a high diagnostic accuracy and frequently aids in surgical planning, supporting US.
- Most studies are of a small sample size.
- **Additional multicentre studies are recommended** to enhance the generalisability of the findings and assess the value of the newly described criteria.

Why is it hard to evaluate MRI articles?

- Study designs are different with mostly multiple different interpreters
- The low number of women in studies (power)
- A variation of US criteria used for comparison

Underpowered MRI studies

All studies of comparing MRI vs US are underpowered.

Dwyer et al. calculate that 194 women would need to have both US and MRI in a paired study design to have an 80% power to detect a difference at the P = 0.05 level, and even more women would be needed in an unpaired study design.


The use of MRI in the diagnosis of MAP Conclusions

- MRI is a reasonable diagnostic imaging modality. It is more costly (∼4x) than US
- It requires dedicated expertise
- It is not a primary imaging test
- Its real effectiveness is hard to evaluate, however it is close to that of US
- It should be used if US is inconclusive
- **Disadvantage**: no blood vessel info!

Answers to the 3 MRI questions

Q: Which is/are the best MRI sign/s?
A: Probably the dark bands (lacunae on US)

Q: Are the sensitivity & specificity of MRI & US comparable?
A: Yes they are, if US is done first

Q: At what GA can MRI contribute additional information?
A: Inconclusive before 24 wks. The later, the higher the accuracy (still no vessel info)
The diagnosis of CSP is difficult.
CSP is often misdiagnosed as "low intrauterine pregnancy," "cervical pregnancy," or "miscarriage in progress."
The best diagnostic tool is high frequency transvaginal ultrasound
MRI does NOT add to the Dx.
There is no consensus on its management
If TOP is the choice, proceed ASAP
CSP and MAP share a common histology
CSP is a precursor of MAP
Continuing a CSP can result in a live neonate with
Prenatal diagnosis became more reliable due to the experience & knowledge gained
Gray scale, but mostly color Doppler US are the primary, dependable imaging modalities
If US is inconclusive, MRI helps
The best diagnostic tool is high frequency gray scale, but mostly color Doppler US are the primary, dependable imaging modalities
Continuing a CSP can result in a live neonate with
Due to the increase of CDs MAP became almost a daily diagnostic problem of the Ob/Gyn and the imaging laboratories
Sonographic detection became more reliable due the experience & knowledge gained
Gray scale, but mostly color Doppler US are the primary, dependable imaging modalities
If US is inconclusive, MRI helps
The best diagnostic tool is high frequency gray scale, but mostly color Doppler US are the primary, dependable imaging modalities
Continuing a CSP can result in a live neonate with
The review
These are some of the articles used for...