When good placentas go bad: The morbidly adherent placenta
Ultrasound and MRI Aspects

Ilan E. Timor-Tritsch

Objectives
• The participants will be able to:
• Realize the histological and clinical connection between Cesarean Scar Pregnancy (CSP) and the Morbidly Adherent Placenta (MAP)
• Learn the sonographic building blocks of the MAP
• Have an insight into the MRI features of MAP and the clinical situation when MRI present added value to the diagnosis.

• If you have never noticed: there is an almost world-wide “epidemic” of hysterectomies for placenta accreta/percreta

• In the last year at NYU/Bellevue there were 13 hysterectomies for US and MRI diagnosis of that were histologically proven as placenta accreta/percreta

Without any doubt, and all agree: the main reason for this abundance of Pathologically Adherent Placentas is the large number of cesarean deliveries

In the literature ..........

Placental Attachment Disorders (PAD) aka: Morbidly Adherent Placenta (MAP) 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


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.

Risk factors:

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

1. Vaginal ultrasound for diagnosis of placenta previa.
2. Ultrasonographic evaluation of uteroplacental (lacunar) blood flow patterns of abnormally located and adherent placentas.
3. Is it really a placenta previa?
4. Placenta previa—is the traditional diagnostic approach satisfactory?
   Farine D, Peisner DB, Tritsch IE. J Clin Ultrasound; 1990:18:328
5. Diagnosis of placenta previa by transvaginal sonography.
6. Confirming the safety of transvaginal sonography in patients suspected of placenta previa.
7. Saline infusion sonohysterography in nonpregnant women with previous cesarean delivery: the "niche" in the scar.
   Monteagudo A, Camero C, Tritsch IE. J Ultrasound Med 2001; 20:110

The three clinical forms of PAD

- In 1st ∆: Cesarean scar pregnancy
- In 2nd ∆: “Early” placenta accreta
- In 3rd ∆: Placenta accreta, increta, percreta
- Each has its own sonographic appearance, clinical signs, natural Hx & clinical consequence
- Each could be considered a different clinical entity, however I will present proof that they are expressions of the same histopathologic entity

9. The diagnosis, treatment & follow-up of cesarean scar pregnancy.
10. Unforeseen consequences of the increasing rate of cesarean deliveries: early placenta accreta & cesarean scar pregnancy: A review.
11. Cesarean scar pregnancy and early placenta accreta share common histology.
12. Cesarean scar pregnancy is a precursor of morbidity adherent placenta.
13. Four consecutive recurrent cesarean scar pregnancies in a single patient.
14. How to identify and manage cesarean scar pregnancy.
The main & necessary statistics

Cesarean delivery: background trends and epidemiology

USA: Cesarean delivery rate
- 1970: 5.5%
- 1988: 24.7%
- 1996: 20.7%
- 2002-2006: 30.5%
- 2007: C/S rate is 32.8%
  - 4,247,694 deliveries
  - 1,393,244 cesarean deliveries

USA:
- Cesarean delivery rate
  - 1970: 5.5%
  - 1988: 24.7%
  - 1996: 20.7%
  - 2002-2006: 30.5%
  - 2007: C/S rate is 32.8%

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

Relatively good news

Definition, prevalence and relative incidence of MAP
- Accreta (80%)
- Superficial myometrial invasion of chorionic villi
- Increta (15%)
- Deep myometrial invasion of chorionic villi
- Percreta (5%)

A new report by the Centers for Disease Control and Prevention reveals that the overall rate of Cesarean Section births has stopped increasing and has been steady from 2009 to 2011.


Source: OECD Health Data 2006


Source: OECD Health Data 2006

Am J Obstet Gynecol 1977;17: 210
### Risk of placenta accreta

<table>
<thead>
<tr>
<th>Prior C/S</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 in scarred areas of the lower uterine segment**

Theories of pathogenesis.

- **Thin or absent decidua basalis in scarred areas**
- The Nitabuch fibrinoid layer is thinned or missing, and the placenta will attach itself too deeply into the uterine wall.

Theories of pathogenesis: Low O₂

- Rosen* invokes theories** about the role of a **low oxygen tension** stimulating the cytotrophoblast to deeply invade the scarred area.
- Kleiman*** believes that trophoblasts have a strong propensity for attaching to **exposed extracellular matrix** at the scar tissue.
- Other, less proven theories were also published.

Theories of pathogenesis.

- These theories may support the fact that as the number of previous C/S increases, so does the risk of MAP & CSP, both due to increasingly larger areas of “denuded” scar tissue exposed to the blastocyst.

Theories of pathogenesis: Exposed scar tissue.

- The same basic idea of a facilitated implantation fertilized eggs on a “denuded” area of the uterine cavity created by an endometrial biopsy prior to embryo transfer was entertained in two articles.
- The authors hypothesize that the “local injury” of the EM inducing an **inflammatory response** that prompts implantation.

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*** Kleiman HJ et al, Placenta 1990; 11:349-367

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Kleiman HJ et al, Placenta 1990; 11:349-367
The review

I will review the two major diagnostic modalities: Ultrasound and MRI used at the present time to attempt prenatal diagnosis.

I base it upon the significant changes in the past several years in the evidence for various techniques used to make the diagnosis.

Ultrasound in the First Trimester

Is there an entity, such as placenta accreta/percreta in the 1st Δ of the pregnancy?

Placenta accreta and percreta can occur in the 1st trimester

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

An illustrative case that supports the causative connection between 1st Δ CSP and placenta accreta

** Comstock CH et al. JUM 2003
*** Ballas J et al. JUM 2012
Remember the issue of: **on** the scar vs. **in** the scar/niche?

- The blastocyst implants in a microscopic or macroscopic tract **on the uterine scar or in the “niche”, in the faulty anterior wall**
- Mechanism similar to implantations after uterine surgery (myomectomy, curettage, endometrial ablation, manual removal of placenta etc)

**EARLY sonographic appearance:** Placenta **"on the scar"**...

**EARLY sonographic appearance:** Placenta **"in the niche"**...
Differentiation at time almost impossible
In either case, the outcome is probably the same

Is it really........?

Some think that the course of the pregnancy is different depending on the implantation site

Does the distance between the gestational sac and the anterior uterine surface/bladder predict outcome?

- By clinical impression, some think that if a deeply embedded sac, **in a niche** or close to the uterine serosa or the bladder with thin or no visible myometrium will result in a more ominous outcome that if it is implanted **on top of a scar** with some thickness to it

- Comstock et al and Cali et al mention in that CSPs implanted **ON the scar** have a chance to proceed to 3rd trimester giving rise to MAP and referred to these as “low lying sacs”

Is there any research on this???

- Rao et al studied among other variables the **thickness of the myometrial layer** between the bladder and the gestational sac in 39 patients of which 14 had histologically confirmed MAP.
- The **smallest myometrial thickness (<5mm)** was one variable associated with invasion.
- Presented in Barcelona at the 2014 ISUOG meeting
- More research is needed, however if proven and confirmed by other studies, the gestational sac-to-bladder distance has potential to become useful in counseling patients presenting with CSP in the 1st trimester of the pregnancy.

Are Cesarean Scar Pregnancy (CSP) and Early Placenta Accreta (EPA) the same disease?

Let us look at their histologic picture
In the last decade, diagnosis of caesarean scar pregnancy (CSP) and abnormal placental invasion has gone up significantly. It appears that the history of previous CS is the predisposing factor common to both conditions. Until now, these are treated as a separate entity and therefore managed differently. Recent available evidence suggests that these are not a separate entity but rather a continuum of the disease. If CSP is managed expectantly in the 1st trimester, most likely it evolves into placenta accreta. This leads invariably to peripartum hysterectomy for postpartum haemorrhage (PPH) & severe maternal morbidity. Early diagnosis and intervention may give a favourable outcome.

We evaluated histological slides, images and descriptions of early, 2nd trimester placenta accreta and CSP, & whether these are pathologically distinguishable and whether they both represent different stages in the disease continuum leading to MAP in the 3rd trimester.

The 2 pathologists reported:
- All histologic pictures revealed placental villi invading the myometrium without intervening decidua.
- It was impossible to determine the clinical diagnosis based upon the histologic picture.
- They were all consistent with adherent placentae.
Conclusions:
• EPA and CSP are histopathologically indistinguishable and may represent different stages in the disease continuum leading to morbidly adherent placenta in the 3rd trimester.
• They probably are early manifestations of MAP.

Teaching points
• Once a live, anterior, low lying gestation is identified in a woman with previous cesarean delivery: IT IS A CSP!
• CSP and MAP share the same histology.

Is cesarean scar pregnancy a precursor of PAD/MAP?

32 cases of CSP diagnosed in the 1st trimester resulting in liveborn neonates by CD and TAH with histology of MAP:

<table>
<thead>
<tr>
<th>#</th>
<th>GA (wk)</th>
<th>CSA</th>
<th>Placenta previa</th>
<th>Ant. Plac.</th>
<th>Surgical Hx</th>
<th>GA Delivery</th>
<th>Histology</th>
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<tbody>
<tr>
<td>1</td>
<td>12+1</td>
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<td>No</td>
<td>No</td>
<td>None</td>
<td>35+1</td>
<td>CSx1+</td>
</tr>
<tr>
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<td>12+4</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>None</td>
<td>35+1</td>
<td>C/Hist Ant Percreta</td>
</tr>
<tr>
<td>3</td>
<td>12+1</td>
<td>Y</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>36+0</td>
<td>Accreta</td>
</tr>
<tr>
<td>4</td>
<td>12+4</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>36+0</td>
<td>Accreta</td>
</tr>
<tr>
<td>5</td>
<td>12+1</td>
<td>Y</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>32+6</td>
<td>C/Hist Ant Percreta</td>
</tr>
<tr>
<td>6</td>
<td>12+1</td>
<td>Y</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>32+6</td>
<td>C/Hist Ant Percreta</td>
</tr>
<tr>
<td>7</td>
<td>13+1</td>
<td>Y</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>34+0</td>
<td>C/Hist Ant Percreta</td>
</tr>
<tr>
<td>8</td>
<td>12+2</td>
<td>Y</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>35+1</td>
<td>C/Hist Ant Percreta</td>
</tr>
<tr>
<td>9</td>
<td>12+4</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>None</td>
<td>34+0</td>
<td>C/Hist Ant Percreta</td>
</tr>
<tr>
<td>10</td>
<td>8+4</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>None</td>
<td>34+0</td>
<td>C/Hist Ant Percreta</td>
</tr>
</tbody>
</table>

Identifying Sono markers for MAP in the 1st trimester

Findings suggests that signs of placenta accreta are present in the first trimester.

These findings suggests that signs of placenta accreta are present in the first trimester.

Ballas J et al JUM 2012;31:1835
Is Cesarean Scar Pregnancy (CSP) a precursor of Morbidly Adherent Placenta (MAP)

Our Hypothesis: In the 1st ∆ CSP is the clinical expression of placenta accreta and percreta

Objective

• To provide further sonographic, clinical and histological evidence that CSP is a precursor to and an early form of 2nd- and 3rd-trimester morbidly adherent placenta (MAP).

Results

• Nine of the 10 patients delivered liveborn neonates between 32 and 37 weeks.
• One had shortening of the cervix, intractable vaginal bleeding had TOP & hysterectomy, at 20wks
• All patients underwent hysterectomy at the time of Cesarean Delivery, with total blood loss ranging from 300 to 6000 mL.
• Placenta percreta was the histopathological Dx. in all 10 cases.
Case 2
9w2d
23w
34w

Case 3
7w4d
22w
36w

Case 4
8w
12w5d
23w5d

Case 5
9w4d
16w
26w,4d

Case 6
9w2d
15w2d
17w 2 d

Case 7
6w
18w
21 w

Giuseppe Cali MD

Ilan Timor - Tritsch and Anthony Vintzileos MD

Peer Dar MD
The cases in this series validate the hypothesis that CSP is a precursor of MAP, both sharing the same histopathology.

Our findings provide evidence that can be used to counsel patients with CSP, to enable them to make an informed choice between 1st ∆ TOP and continuation of the pregnancy, with its risk of premature delivery and loss of uterus and fertility.

Teaching Points
1. Some CSPs have reached term or near term and resulted in live newborns
2. All had C/D, all had MAP and all had hysterectomies
3. Leaving the placenta in-situ OR excising the uterine wall with the area of invasion are possibilities (not discussed today!)
6. Our counseling of patients with CSP changed over the last several years

Suggested management of a patient with diagnosed CSP
Suggested management of CSP

<table>
<thead>
<tr>
<th>FH +</th>
<th>CSP</th>
<th>No FH</th>
</tr>
</thead>
<tbody>
<tr>
<td>FH +</td>
<td>CSP</td>
<td>No FH</td>
</tr>
<tr>
<td>Evidence based counseling</td>
<td>No FH after 3 scans or at 7 wks by reliable dating</td>
<td></td>
</tr>
<tr>
<td>FH +</td>
<td>CSP</td>
<td>No FH</td>
</tr>
<tr>
<td>Patient requests TOP</td>
<td>Recheck q 3 days</td>
<td></td>
</tr>
<tr>
<td>Select treatment that stops heart activity with no or least delay</td>
<td>Provide bleeding precautions</td>
<td></td>
</tr>
<tr>
<td>Local injection (MTX/KCl) is selected, do hCG weekly. Scan by gray scale &amp; Doppler. Watch for possible AVM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manage by multidisciplinary team. Deliver by C/S at Ob indicated age. Be prepared for cesarean hysterectomy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ultrasound signs of MAP

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

1. Gray scale US: ‘clear space’
   - In normal placentation: a hypoechoic space between the placenta & myometrium
   - In MAP: Loss of normal hypoechoic zone

Gray scale signs

Ultrasound in the Second and Third Trimester

ACOG Committee Opinion. #529, July 2012.
Utility of the ‘clear space’ 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>73</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wong^</td>
<td>100</td>
<td>35</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Cali~</td>
<td>90</td>
<td>81</td>
<td>57</td>
<td>97</td>
</tr>
<tr>
<td>D'Antonio</td>
<td>66.7</td>
<td>95.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Loss of the normal bladder line

Best seen with 300ml urine/fluid in bladder!!!

Gray scale US: ‘Bladder line’ interruption

Can also be seen with Color Doppler

Utility of the ‘bladder line’ in Dx of MAP

<table>
<thead>
<tr>
<th>Author</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV</th>
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</tr>
</thead>
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<tr>
<td>Comstock*</td>
<td>20</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wong^</td>
<td>11</td>
<td>100</td>
<td>100</td>
<td>88</td>
</tr>
<tr>
<td>Cali~</td>
<td>70</td>
<td>99</td>
<td>96</td>
<td>92</td>
</tr>
<tr>
<td>D’Antonio</td>
<td>49.7</td>
<td>99.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Probably the 3rd best US marker of MAP!

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)

Guy GP, Timor-Tritsch IL et al. AJOG 1990;163:723
Lerner JP, Timor-Tritsch et al UOG 1995;5:198
Finberg H et al JUM 1992;11:333
3. Gray scale US: ‘Lacunae’

Gray scale US: ‘Lacunae’ GUI pulsatile flow


Gray scale US: ‘Lacunae’ turbulent, pulsatile flow

4. ‘Myometrial thickness’

• Same value as the ‘clear space’ represents the same gray scale 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>
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<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>77.9</td>
<td>95.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gr 1 = grade 1 (one to three lacunae), Gr 2 = four to six lacunae

6. Color/power Doppler signs

**A. Irregular intraplacental tortuous vessels crossing the placental width**

Increased vascularity extends from side-to-side and into the depth of the placenta.


**B. Hypervascularity of uterine serosa-bladder wall interface**

The vascularization along the incision line.

*Placenta previa accreta 20 weeks C/Sx2*
B. Hypervascularity of uterine serosa-bladder wall interface

Serial sagittal plane cine

Placenta previa accreta
20 weeks C/Sx2

2. Hypervascularity of uterine serosa-bladder wall interface

Rotational cine loop

Placenta previa accreta
20 weeks C/Sx2

Summary of the sonographic basis in diagnosing MAP

Number of positive sonographic diagnostic criteria for morbidly adherent placenta (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 accreta + 8 percreta</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>


Prenatal identification of invasive placentation using ultrasound: systematic review and meta-analysis

F. D’ANTONIO, C. IACOVELLA and A. BHIDE

Fetal Medicine Unit, Division of Developmental Scans, St George’s University of London, London, UK

G. CALI*, L. GIAMBANCO% G. PUCCIOf and F. FORLANI

Objective

- The accuracy of prospective sonographic prenatal detection of invasive placentation is unclear.
- The objective was a systematic review and meta-analysis to assess the performance of US in at-risk women for prenatal identification of invasive placentation.

Methods

- MEDLINE, EMBASE, The Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE) and The Cochrane Central Register of Controlled Trials (CENTRAL) were searched using the search terms ‘placenta accreta’, ‘placenta increta’, ‘placenta percreta’, ‘ultrasound’, ‘magnetic resonance imaging (MRI)’, ‘invasive placenta’ and ‘infiltrative placenta’.
- Two authors independently abstracted data from the articles.
- Sensitivity, specificity, positive and negative likelihood ratios (LR+ and LR−), the diagnostic odds ratio (DOR) and their 95% CIs for each study were calculated.
- Forest plots and summary receiver–operating characteristics curves were produced. Between-study heterogeneity was explored both graphically and statistically.
- The MOOSE (meta-analysis of observational studies in epidemiology) guidelines were followed.

Results

- 23 studies involving 3707 pregnancies at risk for invasive placentation were included.
- Overall performance of US for the antenatal detection of invasive placentation was:
  - sensitivity, 90.7% (95% CI, 87.2–93.6);
  - 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).
Pooled values for US overall and the different US signs in the identification of invasive placentation

<table>
<thead>
<tr>
<th>Dx Method</th>
<th>Studies</th>
<th>Pts</th>
<th>SENS</th>
<th>SPEC</th>
<th>LR+</th>
<th>LR-</th>
<th>DOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>US overall</td>
<td>23</td>
<td>3707</td>
<td>90.7</td>
<td>96.9</td>
<td>11.0</td>
<td>0.16</td>
<td>96.6</td>
</tr>
<tr>
<td>Lacunae</td>
<td>13</td>
<td>2775</td>
<td>77.4</td>
<td>95.1</td>
<td>4.5</td>
<td>0.29</td>
<td>24.4</td>
</tr>
<tr>
<td>Loss clear space</td>
<td>10</td>
<td>2633</td>
<td>66.7</td>
<td>95.8</td>
<td>5.6</td>
<td>0.38</td>
<td>25.0</td>
</tr>
<tr>
<td>Abnormal Bladder Line</td>
<td>9</td>
<td>2579</td>
<td>49.7</td>
<td>99.75</td>
<td>30.6</td>
<td>0.5</td>
<td>93.7</td>
</tr>
<tr>
<td>Abnormal Color Doppler</td>
<td>12</td>
<td>714</td>
<td>96.7</td>
<td>87.7</td>
<td>7.77</td>
<td>0.17</td>
<td>69.1</td>
</tr>
</tbody>
</table>


Conclusions

• Ultrasound has a high accuracy for prenatal diagnosis of disorders of invasive placentation in high-risk women.

• The use of color Doppler improves the test performance.

NIH publication 2014

• The NIH consensus panel issued the following statistics for the US Dx of placenta accreta:
  - 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 is comparable to US and can be helpful when additional information is needed.”

--Reddy UM, Abuhamad AZ, Levine D, Saade GR
Executive Summary of a NICH&DH, SMFM, AIUM, ACOG, ACR, SPR, SRU: FETAL IMAGING WORKSHOP 2014 Unpublished but accepted for publ

Comment on the NIH publication

1. The sonographic markers considered by the panel did not include evaluation of the “bladder line” and “3D US”
2. If the above would be included, it would result in better metrics
3. The reason for not including 3D Doppler US was that it is not universally used and its practice cannot be mandated

Accuracy of ultrasound for the prediction of placenta accreta

• Objective: USs previously reported to be >90% sensitive for Dx of PA
  - US tested to predict PA by 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.”
  - Sens: 53.5%, Spec: 88.1%, +Pred Val: 82.1%, -Pred Val: 64.8%. Accuracy: 65.8%.
  - PA was found to be associated with placental lacunae, loss of retro-placental clear space, irregular bladder wall & abnormalities of color Doppler.
• Conclusion: US may not be as sensitive as previously described for the prediction of PA.

Bowman Z et al. Accuracy of predicting placenta accreta AJOG August 2014

Always be vigilant for placenta accreta

• Background:
  - Placenta accreta results from a defect of the decidua basalis, preventing normal separation of the placenta from the uterine wall at the time of delivery.
  - Risks include a 7% maternal mortality rate, as well as increased maternal morbidity.
• Results from the Bowman et al. study suggest that ultrasound as a predictor for PA may not be as sensitive as previously reported. However, it should be noted:
  - Cine clips, 3-D imaging and real-time recordings were not included.
  - The type and duration of the ultrasound performed is affected by clinical information, which the observers were blinded to.
• This study demonstrates that we should not rely on a negative ultrasound when one clinically suspects placenta accreta.
  - There is an 18.3% false negative rate, suggesting that nearly 1/5 patients with placenta accreta would have been misdiagnosed antenatally.
  - This may lead to unanticipated or tragic consequences during delivery.
• Conclusion:
  - Every effort should be made to appropriately suspect placenta accreta before delivery.
  - Imaging should be considered as an adjunct to the clinical history and intraoperative findings if placenta accreta is suspected.
  - Ultimately, placenta accreta is a surgical diagnosis.
Many providers in the world as well as in the USA are skeptical about ultrasound and turn to MRI thinking that it will be more effective in diagnosing or ruling out MAP.

Three questions
• There are three areas to be addressed when assessing MRI to rule in or out PAD:
  – 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.

MRI signs of 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 (NEW)

*MRI signs of MAP

Interpretation of MRI articles
• These are the articles used for the review
- Reddy UM, Alahmamed AZ, Levine D, Saade GR. Executive Summary of a NICH &HD, SMFM, AIUM, ACOG, ACR SPR SRU FETAL IMAGING WORKSHOP. 2014 Unpublished but accepted simultaneously in 3 journals
  - Derman AY et al. MRI of placenta accreta: a new imaging perspective. AJR Am Roentgenol 2011

MRI: ‘dark bands’

MRI: ‘dark bands’

Placenta accreta but not previa


Novel MRI sign: ‘placental protrusion sign’

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

Short summary of the main MRI studies

Lim etal

• Performed MRI on at-risk women regardless of positive or negative US
• Had pathological proof of MAP from hysterectomies
• Included considerable clinical information.
• MRI was interpreted by one experienced person.
• The volume of dark placental bands (first described by Lax) was the most predictive finding in true MAP
• These bands were also seen without MAP but in those they were quite small


Lim etal

• Not enough data to determine the sensitivity & specificity, NPV & PPV of US versus MRI.
  However, the authors state that MRI was more sensitive. The difference was only 1 case.
• Lacunae found in US of all true positives and none in true negatives.
• Unfortunately, US criteria did not include evaluation of the uterine–bladder wall line required by transvaginal US.

Dwyer et al

• In Dwyer’s study no significant difference between the US & MRI could be shown.
• They did find them to be complementary—
  — when US was inconclusive MRI provided the correct diagnosis in 4 of 5 women
  — when MRI was inconclusive US provided the correct DX in 7 of 8 women.
• They found that the ability to correctly diagnose MAP was not affected by history of uterine surgery or placental location.


Woodward LA et al

• The goal was to evaluate possible incremental benefit of MRI after US
• M&M: A retrospective review of outcomes
• High-risk women with MAP on US or operative DX of placenta accreta, with or without a prenatal MRI were studied.
• Delivery mode, DX & transfusion requirements compared

Woodward LA et al. Assessing the role of magnetic resonance imaging in the management of gravid patients at risk for placenta accreta. Acad Radiol. 2011;18:1175

Woodward LA et al

• RESULTS: 28.7% (40) of 139 women had MRI
• US, MRI, and operative diagnoses were highly correlated (P < .001).

Woodward LA et al. Assessing the role of magnetic resonance imaging in the management of gravid patients at risk for placenta accreta. Acad Radiol. 2011;18:1175...

Woodward LA et al

• This study failed to demonstrate that the accuracy of MRI in the setting of placenta accreta is sufficient to use the results to advocate for attempted uterine-sparing procedures.
• MRI, however, may have a role in confirming the severity of disease, which should be helpful in determining the resources that need to be available at the time of delivery.


Ueno et al.

• CONCLUSION: The novel MRI finding of a placental protrusion sign is a useful addition to the established MRI findings for the diagnosis of invasive placenta praevia.


Interpretation of articles

• Why is it hard to evaluate MRI articles?

  – Study designs are different c. mostly multiple interpreters
  – The low number of women in studies (power)
  – A variation of US criteria used for comparison
Almost all studies required a suspicious US: ascertainment bias

Authorship bias

Many studies did not provide enough clinical information to judge in which women MRI would provide better information than US.

No clear answer about the most predictive gestational age for the scan

Interpretation of articles

• 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.

Underpowered studies

There is usually a high pretest probability for MAP in patients referred for MR imaging

A smooth myometrial-placental interface makes a diagnosis of MAP unlikely

The probability of MAP increases with the # of risk factors & individual signs on imaging

Teaching points

• Suspicious findings should be confirmed in more than 1 imaging plane

• Outward placental bulge with distortion/interruption of the external myometrial contour, hypointense intraplacental bands on T2-weighted imaging, and direct invasion of adjacent pelvic organs strongly suggest a MAP

Teaching points

Some degree of placenta-myometrial interface lobulation & myometrial thinning is seen in NL patients

Hourglass-shaped uterus may occasionally be seen in NL patients, particularly when other signs of abnormal placentation are absent

Pitfalls:

Placental heterogeneity is subjective and difficult to quantify, and normally increases with increasing gestational age during the 3rd trimester

Some imaging planes can lead to a false-positive Dx. of abnormal placentation or invasion of adjacent structures, owing to the curved shape of the uterus

Pitfalls:

The use of MRI in the diagnosis of MAP

Conclusions

- MRI is a reasonable diagnostic imaging modality. It is more costly (x4) 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)

Means to reduce the risk & increase good outcome

- Forewarning: timely Dx, early counseling
- Preparation
- Timing strategies**** (Scheduled delivery at 34w)

*Al-Khan A et al. Maternal fetal outcomes in placenta accreta after institution of team management Reprod Sci 2014 e-Publication
**Slegovskikh D et al. Anesthetic management of patients with placenta accreta and resuscitation strategies for massive hemorrhage Curr Opin Anesthesiol 2011;24:274
***Wright ID et al. Predictors of massive blood loss in women with placenta acferta. AIOG 2011;205-38 e1-6
****Robinson BK, Grobman WA. Effectiveness of timing strategies for delivery of individuals with placenta previa and accreta Obstet Gynecol 2010;116:835

Means to reduce the risk& increase good outcome

- Delivery at institution with:
  - Experience
  - Operative resources
  - Access to large amounts of blood & its products, since prediction of which women will loose the most is not possible

In our department...

- We formed an inter-departmental “group” involving MFM, US and MRI to jointly evaluate every patient referred to us by our referring practitioners who are suspected of MAP.
- After evaluation, if so desired, they will be jointly followed by the referring MD and the above “group”.

It is all about clinical results!!
Final Conclusions: CSP
• CSP is a dangerous entity and it is a precursor of MAP
• If termination of a CSP is desired, it should be done without delay avoiding systemic MTX trial
• If left alone CSP may result in a live offspring at the expense of sacrificing the uterus

Final Conclusions: MAP
• Due to the increase of CDs MAP became almost a daily problem of the Ob/Gyn and the imaging laboratories
• Prenatal diagnosis became more reliable due the experience & knowledge gained
• Gray scale and color Doppler US are the primary imaging modalities
• If US is inconclusive, MRI helps
• Multidisciplinary approach” imperative!

Thank you for listening!