Enhanced Myometrial Vascularity
a.k.a.: Arterio-Venous Malformations

More common than you think!

Ilan Timor-Tritsch, MD*
Ana Montegudo, MD**

* Department of Obstetrics & Gynecology New York University School of Medicine and Langone Medical Center New York, NY
** MFM Associates, Carnegie Hill Imaging, New York, NY
Enhanced Myometrial Vascularity
a.k.a.: Arterio-Venous Malformations

More common than you think!

Ilan Timor-Tritsch, MD*
Ana Montegudo, MD**

* Department of Obstetrics & Gynecology New York University School of Medicine and Langone Medical Center New York, NY
** MFM Associates, Carnegie Hill Imaging. New York, NY
Enhanced Myometrial Vascularity
a.k.a.: Arterio-Venous Malformations

Ilan Timor-Tritsch, MD*
Ana Montegudo, MD**

Department of Obstetrics & Gynecology New York University School of Medicine and Langone Medical Center New York, NY
MFM Associates, Carnegie Hill Imaging. New York, NY
Disclosure

• Nothing to disclose
Objectives

- The participants will be able to:
  - Realize the existence and clinical reality of Enhanced Myometrial Vascularity aka AVM
  - Learn the typical sonographic image of EMV
  - Be able to make the diagnosis relying on using several Doppler techniques
  - Use the US based information to triage patients according to a combination of clinical and sonographic presentation
Outline
What I want to achieve with this talk

• It is a clinical entity few are familiar with
• Familiarize Ob/Gyn’s with EMV/AVM
• It is a pathology some deny its existence
• Convince skepticals that it is real
• It is a disease that has different terms
• Provide an all inclusive term for it
Typical presentation

- Failed 9 weeks IUP. Misopristol given for TOP
- Increasing amount of bleeding for last 1 week
- Referred for US. Here is the image:

22mm
The typical report would be

- Uterus of NL size (97 x 57 x 60mm)
- Uterine cavity contains slightly echogenic material measuring 22mm
- Ovaries: NL
- CDS: no fluid
- IMPR: Retained products of conception
Typical management of the “Impression” would be:

• D&C - Hysteroscopy under GA
• Removal of RPOC
• Unexpected “faucet-like” bleeding approximately 750ml
• Insertion of Foley balloon to tamponade
Fortunately there was a different scenario...
The astute sonographer took some more pictures using color Doppler
She even recorded some flow data on the blood vessels.
......and searched until she found the highest blood flow velocity!!
The real diagnosis therefore is:

Enhanced Myometrial Vascularity

aka

Arteriovenous Malformation
New plan of action

• Weekly hCG ordered until it drops to 0
• Weekly TV-US to evaluate trend of vascularity
• Intervene (UAE?) if significant vaginal bleeding, or if vascularity persists for weeks (give bleeding precautions!).
• If any RPOC’s seen after vascularity disappears: perform safe D&C.
The terms used for the above case

- Retained products of conception (RPOC)
- Arterio-Venous Malformation (AVM)
- Newly proposed term:
  - Enhanced Myometrial Vascularity (EMV)
The terms used in this presentation

• Referring to articles published BEFORE the proposal and introduction of the new term of EMV, I will use the original term of AVM.

• Anywhere else I will use EMV
What is a uterine AVM?

• Clinically: uncommon vascular lesions; may cause life-threatening hemorrhage
• Seen almost exclusively in reproductive years & rarely without Hx of IUP
• This may occur when the thin wall of the abnormal vessels are disrupted after menstruation, miscarriage or after uterine instrumentation.

Pathology of AVM

• An arterio-venous malformation (or AVM) is a pathological phenomenon described as a faulty “short circuit” of the blood stream between an organ’s arterial & venous supply.

• The blood stream assumes an unusually high velocity, rendering vessels into vascular fistulas.

• They have been reported in patients between ages 18 and 72 years and are broadly classified as either congenital or acquired.

Schematic representation of congenital vascular malformation with dominant feeding artery and multiple secondary feeders (top). After proximal ligation of major feeding artery, there is rapid hypertrophy of the multiple secondary feeders (bottom).

Acquired AVM

- Acquired uterine AVMs result from prior D&C,* TOP, uterine surgery also after laparoscopic myomectomy. **

- It was reported even after diagnostic curettage considered as “uterine trauma” *** or after medical TOP****

- Endometrial ca., Cx ca and GTD have also been implicated to cause acquired AVMs.^

---

Histopathology

- Uterine AVMs are seen almost exclusively in reproductive years & rarely without Hx of IUP
- Common to all AVMs is that they involve abnormal communication between the branches of the UA and the venous plexuses within the myometrium.
- AVM may co-exist with RPOC.
- Lately seen in cesarean scar pregnancy*

Histopathology.

- It can be caused by the erosive property of the syncytiotrophoblastic tissue & chorionic villi during placentogenesis (NL or abnormal including CSP*)
- The faulty decidua induces the generation of abnormal connections among the above vascular structures
- AVM may co-exist with RPOC of trophoblastic proliferation.

The histology resembles a hemangioma

Flemming et al
Uterine vascular malformations.
Obstet Gynecol 1989; 73:209
AVMs demonstrate a muscular, thin walled capillary network of vessels of different proportions & sizes.

Vessels have characteristics of both arteries and veins with prominent fibrous thickening with some elastin due to the high intraluminal blood pressure.

(EVG stain x 25) Picture showing an arterialized vein. The elastica can be seen beneath the thickened intima.

• It is also suggested that AVM arise when venous sinuses become incorporated into scar tissue after necrosis of chorionic villi.

• Mulliken and Glowacki view AVMs as errors in morphogenesis with stable cellularity not showing any spontaneous regression.
These anomalies are composed of tortuous vascular channels of varying size and shape, lined by a continuous endothelium and surrounded by abnormal complement of mural cells.

After TOP the remaining villi show variable vascularity and increasing fibrosis which may result for the diversity in the vascularity of RPOCs at Doppler testing.
• Timmerman suggest that the AVM represents a subinvolution of the placental bed with failed obliteration of its vessels in the absence of RPOCs after cessation of the pregnancy.

• This explains severe bleeding following a delayed postabortal hemorrhage, or (for that matter) after D&C performed for a CSP.

Proposed change of term

• Following a scientific session at the ISUOG in Montreal (Oct 2015) it was proposed that the term “AVM” should be changed to “Enhanced Myometrial Vascularity”*

Clinical aspects of EMV
Clinical aspects

• Clinical symptom is mostly heavy “faucet-like” or even prolonged vaginal bleeding after miscarriage, D&C or CSP

• May cause life-threatening gynecologic hemorrhage

• To repeat: Many claim that they never recognized it as a diagnostic entity
The diagnosis of EMV

- Historically the Dx of EMV/AVM was made at laparotomy.
- Subsequently **angiography** became the gold standard technique and is still used at the time of a **Uterine Artery Embolization** process.

The diagnosis of AVM

• Lately ultrasound has been used and proven to be effective in diagnosing as well determining clinical management of EMV

The diagnosis of EMV

• In recent years TVS “gray scale” and color or power Doppler became the primary diagnostic tool, triaging as well as following patients with EMV leaving angiography as a therapeutic tool.

The diagnosis of EMV

- **Gray scale** (black and white) US characteristics are **nonspecific** and include the presence of irregular hypoechogenic, tortuous, tubular structures within the myometrium.

- **Without using Doppler interrogation they are easily missed.**

The diagnosis of EMV

• It is therefore that we consider a pelvic US as incomplete without applying color or power Doppler interrogation.

• We do first a “panoramic” gray scale image, followed by Doppler focusing on suspicious areas for more information.
Severity of the AVM

- The **severity** of the AVM is expressed by the velocity of the blood flow measured as “peak systolic velocity” (PSV) & the resistance the of the vessel wall to the flow, expressed as “resistive index” (RI).
Where to measure to pick-up the highest PSV?

This is the “trial-and-error” (‘fishing’) method. Time consuming. May be inaccurate missing the highest PSV leading to inadequate management.
Gradually increase the PRF until only a few vessels are seen. Then measure the velocity and the resistance index being the one to use in the clinical, management
The effect of angle correction in measuring PSV
3D angio in the diagnosis of AVM

- The clinical necessity of 3D color or power Doppler angiographic rendering of the involved vessels may raise valid discussion.
- However in almost every case it provided us with a more specific image and presented a 3D perspective of the “knotted” vessel complex.
- Angiographic rendering can direct the attention of the observer to the largest blood vessels and measure their flow characteristics.
Cross section with 3D angiogram of the AVM

Uterus

The AVM

Ut cavity

LEFT

UA & V
Managing patients with EMV
Managing patients with EMV

- In order to render the least invasive and most successful treatment the correct diagnosis has to be established.
- This has to be performed swiftly using simple diagnostic means such as US.
- The patient’s hemodynamic status will dictate the urgency of the treatment.
Triage by severity of the EMV

Depending on the **PSV** of the blood flow and the vessel’s RI, as well as upon the **severity of clinical symptoms**, the care provider can triage patients at different levels of risk selecting the appropriate treatment.

* No bleeding \(\rightarrow\) Observation

* Persistent high PSV; with or without bleeding \(\rightarrow\) ?UAE

Managing patients with EVM

Patients with a stable blood count having PSV below 40cm/s are considered less dangerous and usually regress without interventions, requiring only f/u.

Those between 40 and 60cm/s can be expectantly managed, if there is no prolonged or severe bleeding.

Above 60-70cm/s, however, UAE may be considered to be the treatment of choice; again, bleeding may dictate the need for it.
Managing patients with EMV

- Since the severity of the pathology is shown to be linked to the quantitative measurement of blood flow velocities we suggest that such determinations are important for the clinical management of patient.

- Such approach will avoid overtreatment (i.e. UAE) of cases that can be managed by conservatively and conversely, to institute definitive treatment to those with significant pathology.
Managing patients with AVM

- **REMEMBER:** Patient with significant and life-threatening vaginal bleeding have to be treated regardless of their qualitative or quantitative US appearance and flow values.

- It also appears that an EMV on US with PSV <40cm/s (the “safe area” by Timmerman) with no or significant bleeding can be followed by serial US & clinical developments.
Managing patients with EMV

- EMV may be managed expectantly and will often regress, however patients with symptomatic bleeding often require treatment.
- EMV with PSV over 60-70cm/s may need UAE.
- Lately definitive treatment of EMV was replaced by UAE which is a highly successful and allows retaining fertility.
CSP and EMV

- The association between EMV and CSP deserves some more attention.

- This apparently strange phenomenon became evident only after the gradual global increase of CDs became obvious.
CSP and EMV

• The first 3 cases were reported in 1999* (Walter AJ et al. Obstet Gynecol 1999;93:846).

• The last 9 cases were reported in & after 2010 (Timor-Tritsch IE, Monteagudo A. AJOG 2012;207:14-29).

• Based upon the rate of CSPs that parallel the rate of CDs it is not unreasonable to expect more cases of EMVs in CSPs.

Kim D et Taiwanese J Obst Gynecol 2013;52:590-592
Kochhar PK et al J Reprod Med 2013;58:81-
CSP and EMV

• It is a fact that patients with RPOCs are at risk for EMV,** and since a treated CSP in which the gestation was left in place can be considered as a RPOC, it therefore can present a risk for developing an EMV.


Our experience at NYU
MATERIALS AND METHODS

• Retrospective study

• 1/1/2011 – 8/31/2014
MATERIALS AND METHODS

• **US Diagnostic criteria** for the AVM were:

  – 1. **Subjectively** an unusually **rich vascular network** with tortuous, irregular appearing blood vessels concentrated in a relatively small area of the myometrium and adjacent to the uterine cavity **with or without clearly visible POCs** on color/power Doppler.
MATERIALS AND METHODS

• **US Diagnostic criteria** for the AVM were:
  
  – 2. **Objectively**: Demonstration of measurable high velocity blood flow within the vascular web with a peak systolic velocity of ≥20 cm/s

• Exclusion criteria included patients who were pregnant at the time of AVM diagnosis.
Clinical presentation (n=27):

- 10 after incomplete Ab:
  - 2 after medical termination
  - 2 after surgical termination
  - 1 after second tri induction for termination
  - 1 after second trimester preterm delivery
  - 4 after spontaneous incomplete Ab
- 6 after missed abortion
- 5 after spontaneous abortion
- 5 after cesarean scar pregnancy
- 1 after molar pregnancy
Clinical complaint (n=27):

• 24 abnormal bleeding
  – 2 asymptomatic (seen on follow-up sonos after medical termination)
  – 1 fevers post-delivery
Inciting procedures before diagnosis (27)

- 15 had procedures
  - 10 D&C
  - 4 C/S
  - 1 with both C/S and D&C
- 12 no procedure
Overall surgical history (n=27):

- **19 with recent or remote uterine surgery**
  - 9 D&C alone (from 1-2 D&C per pt)
  - 5 both C/S and D&C (from 1-2 C/S and 1-4 D&C’s per pt)
  - 4 C/S alone (from 1-3 C/S per pt)
  - 1 with abdominal myomectomy and D&C

- **8 without any prior uterine surgery**
  - 1 prior AVM of spine requiring thoracic embolization
Peak Systolic Velocities (n=27)

• Overall range: 23-170cm/s
• Range of those who underwent UAE: 35-170cm/s
• Range of those who did not undergo UAE: 23-90cm/s
• P= 0.25
## CSP with AVM (n=5)

<table>
<thead>
<tr>
<th>Age</th>
<th>GP</th>
<th>Clinical Presentation</th>
<th>Preceding Procedure</th>
<th>Prior Surgical History</th>
<th>PSV</th>
<th>UAE</th>
<th>Transfusion</th>
<th>Clinical course</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>G2P0010</td>
<td>Incomplete Ab</td>
<td>None</td>
<td>None</td>
<td>90</td>
<td>No</td>
<td>No</td>
<td>Cytotec, serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>27</td>
<td>G1P0000</td>
<td>Incomplete Ab</td>
<td>None</td>
<td>UAE spine</td>
<td>78</td>
<td>Yes</td>
<td>No</td>
<td>UAE, hysteroscopic resection of placental polyp</td>
<td>UAE</td>
</tr>
<tr>
<td>35</td>
<td>G2P0010</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td></td>
<td>82</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>34</td>
<td>G5P4004</td>
<td><strong>Cesarean Scar Pregnancy</strong></td>
<td>D&amp;C, C/S</td>
<td>C/S x2</td>
<td>75</td>
<td>Yes</td>
<td>Yes</td>
<td>MTX IM, UAE, Hysterectomy</td>
<td><strong>Hysterectomy</strong></td>
</tr>
<tr>
<td>40</td>
<td>G2P0010</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>D&amp;C, Myomectomy</td>
<td>67</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>30</td>
<td>G4P1022</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>C/S x2</td>
<td>48</td>
<td>Yes</td>
<td>Yes</td>
<td>Serial imaging and bhCG</td>
<td>UAE</td>
</tr>
<tr>
<td>31</td>
<td>G1P0000</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td></td>
<td>65</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>37</td>
<td>G1P0000</td>
<td>Incomplete Ab</td>
<td>D&amp;C x 2</td>
<td></td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>29</td>
<td>G1P0000</td>
<td>Spontaneous Abortion</td>
<td>None</td>
<td></td>
<td>23</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>30</td>
<td>G3P2002</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td></td>
<td>122</td>
<td>Yes</td>
<td>No</td>
<td>CSP injection MTX, Serial imaging and bhCG, UAE</td>
<td>UAE</td>
</tr>
<tr>
<td>30</td>
<td>G9P1071</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>D&amp;C x4</td>
<td>&gt;60</td>
<td>Yes</td>
<td>Yes</td>
<td>CSP injection MTX, Balloon tamponade, UAE</td>
<td>UAE</td>
</tr>
<tr>
<td>40</td>
<td>G4P2012</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>C/S x2</td>
<td>80</td>
<td>No</td>
<td>Yes</td>
<td>Hysterectomy, Re-op</td>
<td><strong>Hysterectomy</strong></td>
</tr>
<tr>
<td>28</td>
<td>G1P0000</td>
<td>Incomplete Ab after Medical TOP</td>
<td>D&amp;C</td>
<td></td>
<td>170</td>
<td>No</td>
<td>No</td>
<td>CSP injection MTX, Serial imaging and bhCG</td>
<td>UAE</td>
</tr>
<tr>
<td>33</td>
<td>G1P0000</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td></td>
<td>103</td>
<td>No</td>
<td>No</td>
<td>CSP injection MTX, Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>27</td>
<td>G7P4024</td>
<td>Incomplete Ab after Medical TOP</td>
<td>None</td>
<td>C/S x1, D&amp;C x2</td>
<td>73</td>
<td>No</td>
<td>No</td>
<td>MTX IM, Serial imaging and serial bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>33</td>
<td>G3P0020</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td></td>
<td>40</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>33</td>
<td>G3P0020</td>
<td>Incomplete Ab after Medical IOL</td>
<td>None</td>
<td></td>
<td>35</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>33</td>
<td>G3P0020</td>
<td>Incomplete Ab after Medical IOL</td>
<td>None</td>
<td></td>
<td>35</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>42</td>
<td>G4P2012</td>
<td>Molar pregnancy / GTN</td>
<td>None</td>
<td></td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>MTX IM, serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>43</td>
<td>G3P1021</td>
<td>Missed Ab</td>
<td>C/S x1, D&amp;C x1</td>
<td></td>
<td>55</td>
<td>No</td>
<td>No</td>
<td>Cytotec, D&amp;C</td>
<td>D&amp;C</td>
</tr>
<tr>
<td>41</td>
<td>G3P2002</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>C/S x2</td>
<td>43</td>
<td>No</td>
<td>No</td>
<td>MTX IM, Balloon tamponade, serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>42</td>
<td>G3P1021</td>
<td>Incomplete Ab</td>
<td>D&amp;C</td>
<td></td>
<td>69</td>
<td>No</td>
<td>No</td>
<td>Serial imaging</td>
<td>Resolution</td>
</tr>
<tr>
<td>28</td>
<td>G1P0000</td>
<td>Incomplete Ab</td>
<td>D&amp;C x 2</td>
<td></td>
<td>34</td>
<td>No</td>
<td>No</td>
<td>Serial imaging</td>
<td>Resolution</td>
</tr>
</tbody>
</table>

*Gravidity, Papanic, Ab=abortion, TOP=termination of pregnancy, GTN=Gestational trophoblastic neoplasia, PTD=preterm delivery, D&C=diagnosis and curettage, C/S=cesarean section, bhCG=human chorionic gonadotropin hormone, MTX=methotrexate, IM=intramuscular, CYP=cesarean scar pregnancy, PSV=peak systolic velocity, UAE=uterine artery embolization*
CSP with AVM (n=5)

1. Dx, D&C at 7wks → bleeding, → IM MTX, → bleeding, → UAE, → bleeding, → hysterecyomy

2. Dx, intra-gestational MTX, → UAE

3. Dx, intra-gestational MTX with balloon tamponade, bleeding, → UAE

4. Dx, immediatee hysterectomy, transfusion/reop

5. Dx, IM MTX → bleeding → balloon tamponade
### UAE (n=9)

| Age | GP       | Clinical Presentation               | Preceding Procedure | Prior Surgical History | PSV | UAE | Transfusion | Clinical course                                                                 || Outcome          |
|-----|----------|------------------------------------|---------------------|------------------------|-----|-----|-------------|---------------------------------------------------------------------------------|------------------|
| 18  | G2P0010  | Incomplete Ab                      | None                | None                   | 90  | No  | No          | Cytotec, serial imaging and bhCG                                                | Resolution       |
| 27  | G1P0000  | Incomplete Ab                      | None                | None                   | 78  | No  | No          | UAE, hysteroscopic resection of placental polyp                                  | UAE              |
| 35  | G2P1001  | Missed Ab                           | D&C                 | \                       | 82  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 34  | G5P4004  | Cesarean Scar Pregnancy             | D&C, C/S            | C/S x2                 | 75  | Yes | Yes         | MTX IM, UAE, Hysterectomy                                                      | Hysterectomy     |
| 40  | G2P0010  | Spontaneous Ab                      | None                | D&C, Myomectomy         | 67  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 30  | G4P1022  | Spontaneous Ab                      | None                | C/S x2                 | 48  | Yes | Yes         | UAE                                                                          | UAE              |
| 33  | G1P0000  | Missed Ab                           | D&C                 | \                       | 65  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 37  | G1P0000  | Incomplete Ab                       | D&C x 2             | \                       | 60  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 29  | G1P0000  | Spontaneous Ab                      | None                | \                       | 23  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 30  | G3P2002  | Cesarean Scar Pregnancy             | C/S                 | \                       | 122 | Yes | No          | CSP injection MTX, Serial imaging and bhCG, UAE                        | UAE              |
| 30  | G9P1071  | Cesarean Scar Pregnancy             | C/S                 | D&C x4                 | >60 | No  | Yes         | CSP injection MTX, Balloon tamponade, UAE                                   | UAE              |
| 40  | G4P2012  | Cesarean Scar Pregnancy             | C/S                 | C/S x2                 | 80  | No  | Yes         | Hysterectomy, Re-op                                                            | Hysterectomy     |
| 28  | G1P0000  | Incomplete Ab after Medical TOP     | D&C                 | \                       | 170 | Yes | No          | UAE                                                                          | UAE              |
| 33  | G1P0000  | Missed Ab                           | D&C                 | None                   | 103 | No  | No          | UAE                                                                          | UAE              |
| 37  | G7P4024  | Incomplete Ab after Medical TOP     | None                | C/S x1, D&C x2         | 73  | No  | No          | MTX IM, Serial imaging and serial bhCG                                       | Resolution       |
| 28  | G2P0100  | Missed Ab                           | D&C                 | \                       | 40  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 33  | G3P0020  | Spontaneous Ab                      | None                | \                       | 61  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 29  | G3P0020  | Incomplete Ab after Medical IOL     | None                | \                       | 35  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 42  | G4P2012  | Molar pregnancy / GTN               | None                | \                       | 60  | No  | No          | MTX IM, serial imaging and bhCG                                                | Resolution       |
| 42  | G3P1021  | Missed Ab                           | C/S x1, D&C x1      | \                       | 55  | No  | No          | Cytotec, D&C                                                                  | D&C              |
| 20  | G2P0100  | Incomplete Ab after PTD             | D&C                 | \                       | 80  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 31  | G1P0000  | Missed Ab                           | D&C                 | \                       | 54  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |
| 28  | G5P1041  | Incomplete Ab after Surgical TOP    | D&C                 | C/S x1, D&C x4         | 35  | Yes | No          | UAE, Cytotec                                                                  | UAE              |
| 24  | G2P1001  | Incomplete Ab after Surgical TOP    | D&C                 | None                   | 76  | Yes | No          | UAE                                                                          | UAE              |
| 41  | G3P2002  | Cesarean Scar Pregnancy             | C/S                 | C/S x2                 | 43  | No  | No          | MTX IM, Balloon tamponade, serial imaging and bhCG                           | Resolution       |
| 32  | G3P0121  | Incomplete Ab                       | D&C                 | D&C x 2                | 69  | No  | No          | Serial imaging                                                                | Resolution       |
| 28  | G1P0000  | Spontaneous Ab                      | D&C                 | None                   | 34  | No  | No          | Serial imaging and bhCG                                                         | Resolution       |

*Gravida = Gravida, 
Ab = Abortion, TOP = termination of pregnancy, 
GTN = Gestational trophoblastic neoplasia, 
PTD = preterm delivery, 
D&C = dilation and curettage, 
C/S = Cesarean section, 
bhCG = human chorionic gonadotropin, 
MTX = methotrexate, IM = intramuscular, 
CSP = Cesarean scar pregnancy, 
PSV = peak systolic velocity, 
UAE = uterine artery embolization*
Treatment 1:

- 13 Expectant management with serial ultrasound +/- serial shCG

9 UAE:
- Dx: 4 incomplete ab, 3 CSP, 1 SAB, 1 missed ab
- Surgical hx: 8/9 with prior uterine surgery (1 none but AVM of spine)

- 7 resolved following UAE alone
- 1 hysteroscopy for retained placental polyp
- 1 hysterectomy for continued bleeding
# Hysterectomy (n=2)

<table>
<thead>
<tr>
<th>Age</th>
<th>GP</th>
<th>Clinical Presentation</th>
<th>Preceding Procedure</th>
<th>Prior Surgical History</th>
<th>PSV</th>
<th>UAE</th>
<th>Transfusion</th>
<th>Clinical course</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>G2P0010</td>
<td>Incomplete Ab</td>
<td>None</td>
<td>None</td>
<td>90</td>
<td>No</td>
<td>No</td>
<td>Cytotec, serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>27</td>
<td>G1P0000</td>
<td>Incomplete Ab</td>
<td>None</td>
<td>None</td>
<td>78</td>
<td>Yes</td>
<td>No</td>
<td>UAE, hysteroscopic resection of placental polyp</td>
<td>UAE</td>
</tr>
<tr>
<td>35</td>
<td>G2P1001</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td>\</td>
<td>82</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>34</td>
<td>G5P4004</td>
<td>Cesarean Scar Pregnancy</td>
<td>D&amp;C, C/S</td>
<td>C/S x2</td>
<td>75</td>
<td>Yes</td>
<td>Yes</td>
<td>MTX IM, UAE, Hysterectomy</td>
<td>Hysterectomy</td>
</tr>
<tr>
<td>40</td>
<td>G2P0010</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>D&amp;C, Myomectomy</td>
<td>67</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>UAE</td>
</tr>
<tr>
<td>30</td>
<td>G4P1022</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>C/S x2</td>
<td>48</td>
<td>Yes</td>
<td>Yes</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>17</td>
<td>G1P0000</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td>\</td>
<td>65</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>37</td>
<td>G1P0000</td>
<td>Incomplete Ab</td>
<td>None</td>
<td>D&amp;C x2</td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>29</td>
<td>G1P0000</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>\</td>
<td>23</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>30</td>
<td>G3P2002</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>\</td>
<td>122</td>
<td>Yes</td>
<td>No</td>
<td>CSP injection MTX, Serial imaging and bhCG, UAE</td>
<td>UAE</td>
</tr>
<tr>
<td>30</td>
<td>G9P1071</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>D&amp;C x4</td>
<td>&gt;60</td>
<td>Yes</td>
<td>Yes</td>
<td>CSP injection MTX, Balloon tamponade, UAE</td>
<td>UAE</td>
</tr>
<tr>
<td>40</td>
<td>G4P2012</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>C/S x2</td>
<td>80</td>
<td>No</td>
<td>Yes</td>
<td>Hysterectomy, Re-op</td>
<td>Hysterectomy</td>
</tr>
<tr>
<td>28</td>
<td>G1P0000</td>
<td>Incomplete Ab after Medical TOP</td>
<td>D&amp;C</td>
<td>\</td>
<td>170</td>
<td>Yes</td>
<td>No</td>
<td>UAE</td>
<td>UAE</td>
</tr>
<tr>
<td>33</td>
<td>G1P0000</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td>None</td>
<td>103</td>
<td>No</td>
<td>No</td>
<td>UAE</td>
<td>UAE</td>
</tr>
<tr>
<td>37</td>
<td>G7P4024</td>
<td>Incomplete Ab after Medical TOP</td>
<td>None</td>
<td>C/S x1, D&amp;C x2</td>
<td>73</td>
<td>Yes</td>
<td>No</td>
<td>MTX IM, Serial imaging and serial bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>28</td>
<td>G2P0010</td>
<td>Missed Ab</td>
<td>D&amp;C</td>
<td>\</td>
<td>40</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>33</td>
<td>G3P0020</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>D&amp;C</td>
<td>61</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>33</td>
<td>G3P0020</td>
<td>Incomplete Ab after Medical IOL</td>
<td>None</td>
<td>\</td>
<td>35</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>42</td>
<td>G4P2012</td>
<td>Molar pregnancy / GTN</td>
<td>None</td>
<td>\</td>
<td>60</td>
<td>Yes</td>
<td>Yes</td>
<td>Hysterectomy</td>
<td>Hysterectomy</td>
</tr>
<tr>
<td>42</td>
<td>G3P1021</td>
<td>Missed Ab</td>
<td>None</td>
<td>C/S x1, D&amp;C x1</td>
<td>55</td>
<td>No</td>
<td>No</td>
<td>Cytotec, D&amp;C</td>
<td>D&amp;C</td>
</tr>
<tr>
<td>20</td>
<td>G2P0100</td>
<td>Incomplete Ab after PTD</td>
<td>D&amp;C</td>
<td>D&amp;C</td>
<td>80</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>31</td>
<td>G1P0000</td>
<td>Missed Ab</td>
<td>None</td>
<td>None</td>
<td>54</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>28</td>
<td>G5P1041</td>
<td>Incomplete Ab after Surgical TOP</td>
<td>D&amp;C</td>
<td>C/S x1, D&amp;C x4</td>
<td>35</td>
<td>Yes</td>
<td>No</td>
<td>UAE, Cytotec</td>
<td>UAE</td>
</tr>
<tr>
<td>24</td>
<td>G2P1001</td>
<td>Incomplete Ab after Surgical TOP</td>
<td>D&amp;C</td>
<td>None</td>
<td>76</td>
<td>Yes</td>
<td>No</td>
<td>UAEMethotrexate</td>
<td>UAE</td>
</tr>
<tr>
<td>41</td>
<td>G3P2002</td>
<td>Cesarean Scar Pregnancy</td>
<td>C/S</td>
<td>C/S x2</td>
<td>43</td>
<td>No</td>
<td>No</td>
<td>MTX IM, Balloon tamponade, serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
<tr>
<td>32</td>
<td>G3P1021</td>
<td>Incomplete Ab</td>
<td>D&amp;C</td>
<td>D&amp;C x2</td>
<td>69</td>
<td>No</td>
<td>No</td>
<td>Serial imaging</td>
<td>Resolution</td>
</tr>
<tr>
<td>28</td>
<td>G1P0000</td>
<td>Spontaneous Ab</td>
<td>None</td>
<td>D&amp;C</td>
<td>34</td>
<td>No</td>
<td>No</td>
<td>Serial imaging and bhCG</td>
<td>Resolution</td>
</tr>
</tbody>
</table>

*Gravida, Parietal, Ab=abortion, TOP termination of pregnancy, GTN gestational trophoblastic neoplasia, PTD preterm delivery, D&C = dilation and curettage, C/S = cesarean section, bhCG = human chorionotrophin hormone, MTX = methotrexate, IM = intramuscular, CSP = cesarean scar pregnancy, PSV = peak systolic velocity, UAE = uterine artery embolization*
Treatment 2:

- **6 MTX:**
  - 4 with CSP (2 injected locally, 2 systemically):
  - 3 also needed UAE for continued bleeding, of whom 1 required hysterectomy
  - 2 required Foley balloon tamponade
    - 1 for incomplete medical TOP
    - 1 for GTD after molar pregnancy

- **2 Hysterectomy:**
  - 1 planned for CSP
  - 1 after failed MTX/UAE as above

- **3 Cytotec** (1 serial US, 1 D&C, and 1 UAE)

- **1 D&C**
Time to resolution

• Range time from procedure to diagnosis of AVM: 2-10 weeks (avg 5.5 weeks)

• Range time from diagnosis to resolution on ultrasound: 2-8 weeks (avg 4.5 weeks)

• Overall episode time: 2-15 weeks
Figure 4
In conclusion

• Acquired AVM, is relatively rare in early pregnancy.

• It occurs following unsuccessful pregnancies and mostly triggered, or as a consequence of intrauterine treatment procedures.

• Spontaneous abortions, sharp uterine curettage and CSP seem to present the known risk for an acquired AVM.
In conclusion

- TVS with gray scale and color Doppler US evaluation is the simplest, best, as well as the most cost effective diagnostic imaging modality.

- **Triage** of patients for conservative follow-up or UAE based upon to their **clinical picture** and objective measurement of **blood velocity** measurement in the AVM appear to be the most successful clinical approach.
In conclusion

- Prevention of potentially life-threatening hemorrhagic events and preservation of fertility are some of the main advantages that embolization for AVMs has over more definitive surgical options such as hysterectomy.

- Routine gray scale and color Doppler US evaluation of patients with early pregnancy failure or CSP is strongly indicated to detect a possible AVM as early as possible.
In conclusion

- **Gynecologists** providing surgical and medical abortions or encounter patients after miscarriage or **CSP have to be aware** of the existence of this entity to rule it out before a D&C or suction aspiration is triggering severe uterine bleeding.

- Waiting for the hCG to recede and evaluating hemodynamic parameters is the way to go

- It is unclear if this pathology recurs in a subsequent pregnancy.
Since the acceptance of this article to the Am J Obstet Gynecol in December 2015, we had an additional 12 cases of AVM of which 2 were embolized due to severe bleeding.
Thank you for listening