Diagnosis and Management of AVM in the Pregnant Patient

Wade Cooper, D.O.
University of Michigan
Assistant Professor
Departments of Neurology & Anesthesiology
Disclosures

Wade Cooper

- None
Developmental Venous Anomaly

- “Venous Angioma”
- Most common cerebral vascular malformation
  - 55% of all vascular lesions in head
- Do not confuse with arteriovascular malformation
Developmental Venous Anomaly

- Vestigial draining vein from the cortex
  - Dural sinus
  - Deep ependymal vein
- Incidental finding
- <3% hemorrhage
- Minimal link to neurologic conditions
  - Ischemic stroke
  - Epilepsy
Developmental Venous Anomaly
Pregnancy Considerations

• Observation only
• Requires reassurance
• No impact
  – Pregnancy
  – Delivery
  – Fetal health

Developmental venous anomaly (DVA)
Draining vein
Cerebral Aneurysm

- Outpouching of blood vessel

- Etiology
  - Degenerative vascular injury
  - Atherosclerosis
  - Congenital
    - Fibromuscular dysplasia
  - Trauma
  - Infection
  - Drug use
    - Cocaine
Cerebral Aneurysm - Symptoms

- Non ruptured
  - Asymptomatic
  - Rarely associated with seizure
    - Away from cortex
  - Headache?
  - Incidental finding
  - 2% of population
  - <2mm no intervention needed
Cerebral Aneurysm - Symptoms

- Ruptured – intracranial hemorrhage
  - 80-90% of intracranial hemorrhage 2° to aneurysm
  - Severe headache
    - Thunderclap
  - Nausea / vomiting
  - ↓ Consciousness
  - Visual changes
  - Seizure
Saccular Aneurysm

Middle cerebral artery aneurysm (left)
Fusiform Aneurysm

- 3-13% of intracranial aneurysms
- Most common in vertebrobasilar circulation
- Circumferential arterial dilatation
- Typically clinically observed
Unruptured Cerebral Aneurysm
Pregnancy Considerations

- >6mm – consider interventional tx prior to conception
  - Cesarean Section typically recommended
    - Limited data to support this
    - Risk of rupture
      - ↑ blood pressure
      - ↑ intracranial pressure
    - Maintain normal blood pressure
      - Systolic < 140 mm/hg
Ruptured Cerebral Aneurysm
Pregnancy Considerations

- Cesarean Section as soon as able

- Requires interventional treatment
  - Risk of rebleed
    - 25% in 2 weeks
    - 50% in 6 months
Cerebral Aneurysm - Treatment

- Intracranial aneurysm clip
- Saccular aneurysms
- Easy to access locations
- Quick and permanent
- Minimal risk for device migration
- Requires craniotomy
Cerebral Aneurysm - Treatment

- Intravascular Coil therapy
- Considered in hard to access regions
- Applied via catheter from inguinal artery

- Filament is entered into aneurysm dome
- “Coiled” within sacular component
  - Guidewire is severed
  - Coil is permanent
- Coil acts as thrombotic element
  - Aneurysm is thrombosed
Cerebral AVMs

- 0.14-0.5% - Prevalence (Autopsy Series)¹
- 2% of all hemorrhagic strokes²
- 10-20% with associated aneurysms³
  - Intranidal
  - Feeding pedicle
  - Venous

¹McCormick et al 1984
²McCormick et al 1976
³Choi et al 2005
AVM - Pathology

- Abnormal connection between arteries and veins
- Most commonly prenatal in origin
- First described by Luschka and Virchow in the 1800s
- First successful surgical excision in 1932
AVM - Pathology

Normal

Artery supplying oxygen-rich blood from heart to brain

Healthy capillaries slowly deliver oxygen to surrounding tissues

AVM

In an AVM, blood passes quickly from artery to vein, bypassing the normal capillary network

Vein carrying oxygen-depleted blood away from brain
AVM Pathology

- Shunting of blood from high pressure artery to low pressure venous system

- Mortality rate
  - initial bleed 10%
  - Second bleed 13%
  - Subsequent bleeds 20%

- Meningeal irritation
  - Seizure
  - Headache
<table>
<thead>
<tr>
<th>Table 6. Common Signs and Symptoms of Arteriovenous Malformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
</tr>
<tr>
<td>Epilepsy</td>
</tr>
<tr>
<td>Muscle weakness</td>
</tr>
<tr>
<td>Paralysis</td>
</tr>
<tr>
<td>Vertigo</td>
</tr>
<tr>
<td>Dysarthria</td>
</tr>
<tr>
<td>Aphasia</td>
</tr>
<tr>
<td>Apraxia</td>
</tr>
<tr>
<td>Numbness/tingling</td>
</tr>
<tr>
<td>Spontaneous pain</td>
</tr>
<tr>
<td>Confusion</td>
</tr>
<tr>
<td>Dementia</td>
</tr>
<tr>
<td>Hallucinations</td>
</tr>
<tr>
<td>Bruit</td>
</tr>
</tbody>
</table>
## AVM Prospective Studies

<table>
<thead>
<tr>
<th>Study Design</th>
<th>N</th>
<th>Mean Age</th>
<th>Female (%)</th>
<th>ICH Presentation (%)</th>
<th>Sz (%)</th>
<th>Headache (%)</th>
<th>Neurological Deficit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 Prosp.</td>
<td>1289</td>
<td>31.2</td>
<td>45</td>
<td>53</td>
<td>40</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>39 Prosp.</td>
<td>135</td>
<td></td>
<td></td>
<td>69.6</td>
<td>14.8</td>
<td>3.7</td>
<td>5.9</td>
</tr>
<tr>
<td>29 Mixed</td>
<td>240</td>
<td>34.1</td>
<td>44.2</td>
<td>58.75</td>
<td>29.6</td>
<td>8.3</td>
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<tr>
<td>40 Prosp.</td>
<td>92</td>
<td>46</td>
<td>46.7</td>
<td>42</td>
<td>25</td>
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</tr>
<tr>
<td>42 Prosp.</td>
<td>284</td>
<td>35</td>
<td>49</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Prosp.</td>
<td>623</td>
<td>34</td>
<td>52</td>
<td>45</td>
<td>29</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>43 Mixed</td>
<td>793</td>
<td>37</td>
<td>51</td>
<td>47</td>
<td>24</td>
<td>14</td>
<td>&lt;15</td>
</tr>
</tbody>
</table>

Choi et al 2005 (Columbia University)
Risk of Spontaneous Hemorrhage After Diagnosis of AVM

<table>
<thead>
<tr>
<th>Feature</th>
<th>% with ICH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location (Deep)</td>
<td>63.7%</td>
</tr>
<tr>
<td>Location (Superficial)</td>
<td>29.4</td>
</tr>
<tr>
<td>Size (&lt; 3 Cm)</td>
<td>47.6%</td>
</tr>
<tr>
<td>Size (&gt; 6 cm)</td>
<td>20%</td>
</tr>
<tr>
<td>Venous Drainage (Deep)</td>
<td>44.2%</td>
</tr>
<tr>
<td>Venous Drainage (Superficial)</td>
<td>20%</td>
</tr>
<tr>
<td>Single Draining Vein</td>
<td>57.6%</td>
</tr>
<tr>
<td>Multiple Draining Veins (≥3)</td>
<td>17.8%</td>
</tr>
</tbody>
</table>

Stefani et al 2002
## Spetzler-Martin AVM Grading System

<table>
<thead>
<tr>
<th>Feature</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td></td>
</tr>
<tr>
<td>Small (&lt;3 cm)</td>
<td>1</td>
</tr>
<tr>
<td>Medium (3-6 cm)</td>
<td>2</td>
</tr>
<tr>
<td>Large (&gt;6 cm)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Eloquence of Adjacent Brain</strong></td>
<td></td>
</tr>
<tr>
<td>Non - Eloquent</td>
<td>0</td>
</tr>
<tr>
<td>Eloquent</td>
<td>1</td>
</tr>
<tr>
<td><strong>Pattern of Venous Drainage</strong></td>
<td></td>
</tr>
<tr>
<td>Superficial Only</td>
<td>0</td>
</tr>
<tr>
<td>Deep</td>
<td>1</td>
</tr>
</tbody>
</table>

*Spetzler et al 1986*
# Spetzler-Martin AVM Grade Clinical Outcome

<table>
<thead>
<tr>
<th>SM Grade</th>
<th>No Deficit</th>
<th>Minor Deficit</th>
<th>Major Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>95%</td>
<td>5%</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>84%</td>
<td>12%</td>
<td>4%</td>
</tr>
<tr>
<td>4</td>
<td>73%</td>
<td>20%</td>
<td>7%</td>
</tr>
<tr>
<td>5</td>
<td>69%</td>
<td>19%</td>
<td>12%</td>
</tr>
</tbody>
</table>

100 consecutive cases operated on by Dr. Spetzler

Minor Deficit: mild aphasia, mild ataxia, mild brainstem deficit

Major Deficit: hemiparesis, increased aphasia, homonymous hemianopsia
Bleeding Risk of AVM in Pregnancy

451 women with known AVM

Hemorrhagic risk
  During pregnancy – 3.5%
  Non pregnancy – 3.1%

After first hemorrhage during pregnancy, risk of 2nd hemorrhage is 6% at 1 year

Similar to non pregnant population

Increased Risk of AVM Hemorrhage in Pregnancy

- Retrospective review
- 270 patients
- 191 pregnancies
- 175 (91.6%) term deliveries
- 16 (8.4%) abortions
- 149 hemorrhages / 11,097 patient years

- Annual hemorrhage rate
  - 5.7% pregnant women
  - 1.34% non pregnant women

Cerebral AVM Hemorrhage During Pregnancy

- Substantial health impact if occurs during pregnancy
- Maternal Mortality – 28%
- Fetal Death – 14%
- Miscarriage at early pregnancy

Cerebral AVM Hemorrhage During Pregnancy

- Most likely to occur between 20 weeks pregnant and 6 weeks postpartum
- Related to maternal hemodynamic changes

- Cardiac output $\uparrow$ 30-60%
- Noted at 3 months
- Maximum at 6 months
- Return to baseline 2 weeks after delivery

- Blood pressure and blood volume $\uparrow$
- Peaks in late pregnancy

Computed Tomography

- Must shield fetus / pregnant uterus
- First line imaging for thunderclap headache
- Advantages
  - Quick
  - Blood resolution
  - Initial evaluation for staging of ICH
- Overall poor resolution
CT Angiography

- Must shield fetus / pregnant uterus
- Provides detailed view of vasculature
  - Nidus views
  - Inflow evaluation
  - Resolution
- Limited use in pregnancy
- Conventional Angiogram favored
Magnetic Resonance Imaging

- No Radiation exposure
- May help distinguish
  - Eclampsia
    - 15% of women with ICH
  - Pre-eclampsia
  - Intracranial hemorrhage
- Evaluates surrounding structures
- Evaluates for previous hemorrhage
- Excellent resolution
Cerebral Angiogram

- Recommended in pregnant women with ICH
- Fetus risk is minimal with appropriate lead shielding
- Iodine exposure minimal
Cerebral Angiogram

- Demonstrates characteristics of AVM
  - Location
  - Size
  - Feeding artery
  - Flow rate
  - Ateriovenous fistula
  - Aneurysm
  - Venous drainage
  - Estasia of draining vein
Surgical Excision

• Most commonly done

• Advantages:
  – Instant reduction of hemorrhage risk
  – Typically complete resolution

• Disadvantages
  – Craniotomy
  – Immediate complications
Surgical Excision

• Location is important
  – Easy access
  – Not near “eloquent” areas
• Acceptable size
• Non complicated
  draining venous system
Resection of AVM
AVM Embolization

- Concept - restrict arterial flow to AVM

- Advantages
  - Reduce size of AVM
  - Relatively safe
  - No Craniotomy
  - May be repeated

- Disadvantages
  - <15% cure rate
  - May need surgical intervention after

Left temporal avm/ ICH
SM Grade III

Pre Embolization
Post Embolization
AVM - Radiation Therapy

- Focal beam Radiation
- Less radiation than whole head
- Causes degradation of targeted blood vessels
- Maximum benefit seen in 2-4 years

AVM - Radiation Therapy

- Advantages
  - No Craniotomy
  - Ideal for non surgical cases
    - Eloquent location
    - Large size
    - Complicated venous drainage

- Disadvantages
  - Not precise
  - Radiation effect to surrounding structures
Aruba Study

- Unruptured AVMs
- Intervention vs. Medical Management
- Primary Outcome Events
  - Symptomatic stroke
  - Death
- 223 patients randomized
- 109 Medical Management
- 114 Intervventional Therapy
  - 17 patients - surgical resection (12 with embol)
  - 30 patients - embolization
  - 46 patients - radiation (15 with embol)
  - 1 patient - combination therapy

Aruba Study

- Symptomatic Stroke or Death
  - 33 month f/u
  - Medical Therapy 10.1%
  - Interventional Therapy 30.7%
  - P<0.0001

Unruptured AVM
Conservative Vs. Interventional Management

- Prospective population based study of patients harboring unruptured AVMs
- 12 year follow up
- 103 patients with intervention
- 101 patients with medical management

Progression to the Primary Outcome During 12 Years of Prospective Follow-up

The primary outcome was first occurrence after inception of death due to any cause or handicap (Oxford Handicap Scale score 2-5) sustained for 2 or more successive years. Error bars indicate 95% CIs of the cumulative proportions at 4 and 12 years after inception.

Progression to the Secondary Outcome During 12 Years of Prospective Follow-up

The secondary outcome was first occurrence after inception of a nonfatal intracranial hemorrhage, cerebral infarction, or persistent/progressive nonhemorrhagic focal neurological deficit or death due to a brain arteriovenous malformation or intervention complication. Error bars indicate 95% CIs of the cumulative proportions at 4 and 12 years after inception.

Triptans are probably safe in patients with aneurysm / AVM

- Prospective study on subcutaneous sumatriptan
  - N = 12,399
  - 12 months duration
  - No associated intracranial hemorrhage
  - Cerebral aneurysm prevalence is estimated between 1-2%
  - Most common age is 35-60

Triptans are probably safe in patients with aneurysm / AVM

- Retrospective review of 20 patients with cerebral aneurysm
  - 10 surgically untreated aneurysms
  - 10 post-coiled aneurysms
  - No negative outcomes over multiple treatments

- Main concern is legal risk


Sumatriptan 50mg available over the counter in several European countries.
Case Study

- 42 year old female
- Chronic headache
- MRI findings...

- SM grade IV
  - 4mm size
  - Eloquent location
  - Deep venous drainage
Case Study

- Cerebellar AVM
- Scheduled Radiation Therapy
- Pregnancy test positive
  - (unplanned)
Case Study

- Treatment course
  - Delayed radiation therapy
  - Cesarean section at 36 weeks
  - Successful radiation therapy 4 weeks after delivery
Summary

• Pregnancy increases risk of AVM hemorrhage
• Ruptured AVM should be actively treated in pregnancy
• Angiography should be performed in pregnant women with intracranial hemorrhage
• Endovascular / Stereotactic radiosurgery has acceptable radiation exposure
• Unruptured AVM without increased hemorrhagic risk factors may be observed throughout pregnancy
Thank You