Multi-modality Management of Dural Arterio-Venous Fistulas (DAVFs)

Michael Horowitz
Clinical presentation of DAVFs

- CCF
- Sagittal sinus
  - Often have aggressive course with seizures, hemorrhage, neuro deficit
- Transverse/Sigmoid sinus
  - Headache, bruit
  - Often indolent
## Classification of DAVFs

- **Djindjian 1978/Cognard 1995**
  - I Anterograde into sinus
  - IIa Retrograde into sinus
  - IIb Retrograde into cortical veins
  - IIa and IIb Both of above
  - III Direct cortical venous drainage without ectasia
  - IV Direct cortical venous drainage with ectasia

- **Borden 1995**
  - I Direct into dural sinus or menigeal veins
  - II Retrograde into subarachnoid veins
  - III Subarachnoid venous drainage without dural sinus drainage
  - IV Direct cortical venous drainage with ectasia
Barrow’s classification and etiology of CCF (1985)

A – Traumatic, Aneurysm rupture

B, C, D -- Spontaneous (indirect/dural)

- Middle-aged women

- Thrombosis

- Congenital

- Vessel rupture

- Angiopathy (Ehlors-Danlos, FMD)
Location of DAVFs

**Distribution and Clinical Course of 377 Dural AVM's**

- **Convexity-Sagittal Sinus**: 7.4%
  - A/NA = 1/1
- **Orbital-Anterior Falx**: 5.8%
  - A/NA = 2.1/1
- **Sylvian-Middle Fossa**: 3.7%
  - A/NA = 2.5/1
- **Cavernous Sinus**: 11.9%
  - A/NA = 1/6.5
- **Tentorial-Incisural**: 8.4%
  - A/NA = 31/1
- **Transverse-Sigmoid**: 62.6%
  - A/NA = 1/8.8

A = Aggressive
NA = Non-Aggressive
Role of Location on treatment outcome

- **CCF**
  - Transvenous embo more successful than transarterial
- **Tentorial**
  - Combined embo and surgery better than embo alone
- **Anterior fossa**
  - Surgery alone is highly effective (95%)
- **TS/SS**
  - Combined endo and surgery better than either modality alone
  - Simple ligature of feeding vessels not recommended
Surgical treatment

- Often reserved for residual DAVF after other modalities exhausted
- Highly effective but risk of poor outcomes high without preoperative embolization

Day and Fukushima, Neurosurgery 1997

Endo et al., JNS 1998
Embolization-transvenous vs. transarterial

Transvenous
--Definitive occlusion of fistula outflow
--Minimal risk of venous infarct

(Roy and Raymond, Neurosurgery 1997)
Transarterial embolization

High-risk
-Thromboembolic events
-Venous thrombosis
-Lower rate of definitive cure when multiple feeders involved
-UCSF study on CCF
Radiosurgery for DAVFs

Mayo Clinic experience

-Gamma Knife performed followed by embolization in patients with high-risk features or intolerable symptoms

-95% symptom resolution/improvement

-Angiographic obliteration in 93% of CCF and 65% of TS/SS fistulas

-No ICH/Radiation-related complications

-10% of CCF patients had symptomatic venous thrombosis after embolization

-10% recurrence rate
University of Pittsburgh experience

- 18 patients (9 men: 9 women, mean age = 65 yo)
- Location: 10 CCF, 4 TS/SS, 3 SSS, 1 Tentorial
- 16 embolization procedures on 10 patients
  - Only 2 done post-GKR (referral bias)
- Mean margin dose: 20 Gy
- Mean max dose: 42.6 Gy
- Mean nidus volume: 2.16 cm
- Mean dose to optic nerve in CCF: 5 Gy
Clinical presentation

<table>
<thead>
<tr>
<th></th>
<th>Chemosis / Proptosis</th>
<th>H A</th>
<th>Bruit</th>
<th>EOM defect</th>
<th>Pulsatile Tinnitus</th>
<th>Increased IOP</th>
<th>ICH</th>
<th>Eye Pain</th>
<th>Intermitent Visual Loss</th>
<th>Transient Hemiparesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotid-Cavernous Sinus (n=10)</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tentorial-Sigmoid Sinus (n=5)</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Convexity-Sagittal Sinus (n=3)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total # of patients affected by symptom</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: 3 of 4 patients with CVD presented with ICH
Case example

74 yo woman with bilateral CCF

- Transarterial ECA and IC embolization
- Post-embo GKR
- MRI showed resolution of CVD
Case example

49 yo woman with severe headaches and pulsatile tinnitus

-GKR as initial treatment

Immediate post-GKR transarterial embo of multiple ECA feeders
Case examples (cont.)
## Clinical Outcomes

<table>
<thead>
<tr>
<th>Location</th>
<th>Excellent</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotid-Cavernous Sinus (n=10)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tentorial-Sigmoid Sinus (n=5)</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Convexity-Sagittal Sinus (n=3)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>9</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

excellent response: complete resolution of all clinical symptoms

good response: resolution of all but one presenting symptom
## Angiographic outcomes

<table>
<thead>
<tr>
<th></th>
<th>Angiography</th>
<th>Computed Tomography Angiography (CTA)</th>
<th>Magnetic Resonance Angiography (MRA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Obliteration</td>
<td>Partial Obliteration</td>
<td>Complete Obliteration</td>
</tr>
<tr>
<td>Carotid-Cavernous Sinus (n=10)</td>
<td>2</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Tentorial-Sigmoid Sinus (n=5)</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Convexity-Sagittal Sinus (n=3)</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Impact of timing of embolization on outcome

<table>
<thead>
<tr>
<th>Clinical Response</th>
<th>Excellent Response</th>
<th>Good Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiosurgery Alone (n=8)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Embolization followed by Radiosurgery (n=9)</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Radiosurgery followed by Embolization (n=1)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total: 10</td>
<td>Total: 8</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

• When treating a disease with a “benign” course, the least invasive procedure must be performed without complication.

• Radiosurgery and embolization provide clinical and angiographic cure of DAVFs.

• DAVFs should be evaluated by a team of experts in each aspect of multi-modality treatment options.