Interventional treatment of Vascular Abnormalities

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Comprehensive treatment of Neurovascular Abnormalities
Disclosures
Tools for treatment

• Open neuro-vascular surgery
• Neuro-Endovascular surgery
• Radiosurgery
• Critical care
Vascular abnormalities

- 15% of strokes are intracranial hemorrhage (ICH)
- Incidence 25 per 100,000 person-years
- 40% mortality within one month
- Causes:
  - Trauma
  - Hypertension
  - Cerebral amyloid angiopathy
  - Hemorrhagic conversion of ischemic infarction
  - Cerebral Aneurysms
  - Cerebral AVM
  - Dural AV fistulas
  - Venous sinus thrombosis
Trauma, Hypertension, amyloid, hemorrhagic conversion.

- **Tools:** Neuro ICU
**Increased ICP management.**

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<thead>
<tr>
<th>TIER 1</th>
<th>HOB 30* &amp; midline</th>
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<tbody>
<tr>
<td></td>
<td><strong>Ensure ABC</strong>: oxygenation → sPo2 &gt;92%</td>
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<td>Ensure normovolemia</td>
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<td>Ensure circulation → Normal BP</td>
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<td></td>
<td>Osmotic diuretic → Mannitol, 3% (250cc), 23% (30cc Saline bolus)</td>
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<td>Dexamethasone → cytotoxic edema</td>
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<td>CSF drainage → Transducer leveled. Troubleshoot monitor and system</td>
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<tr>
<th>TIER 2</th>
<th>Hyperventilation (paCO2 30-35 mmHg)</th>
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<tr>
<td></td>
<td>Sedation: Fentanyl, Versed, Propofol (short acting)</td>
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<td>Moderate hypothermia (32-34*c)</td>
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<th>TIER 3</th>
<th>Deep Sedation, Paralysis, Hypothermia</th>
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<tr>
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<td>Barbiturate Coma (Pentobarbital)</td>
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<td>Decompressive craniectomy / lobectomy</td>
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<td></td>
<td>Profound hyperventilation PaCO2 &lt;30 (transient)</td>
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ICP Catheters
Trauma, Hypertension, amyloid, hemorrhagic conversion.

- Tools:
  - MIS clot evacuation
Trauma, Hypertension, amyloid, hemorrhagic conversion.

- **Tools:** *Hemicraniectomy*
Cerebral aneurysms
How common are brain aneurysms?

- Prevalence in adults → 2% → Approx 6 million people in the US.
- Every 8 minutes an aneurysm ruptures in the USA

Feigin et al., 2009; Vlak et al., 2011; Schievink et al., 1995; Truelsen et al., 1998; Rinkel and Algra, 2011
What are the symptoms of a brain aneurysm rupture:

**Aneurysm symptoms**

- **Ruptured aneurysm:**
  - Sudden severe headache
  - Nausea and vomiting
  - Stiff neck
  - Sensitivity to light
  - Confusion
  - Loss of consciousness
  - Blurred or double vision
  - Seizure

- **Unruptured aneurysm:**
  - Change in vision or double vision
  - Pain above or behind he eye
  - Dilated pupils
  - Drooping eyelid
  - Numbness, weakness or paralysis of one side of the face.

- **Leaking aneurysm:**
  - Sentinel bleed
  - Sudden severe headache.
What happens when an aneurysm **Ruptures**?

- Death
- Death IH
- Neuro-deficit
- Cognitive Deficit
- NO deficit
Treatment options for brain aneurysm?

- Conservative
- Intervention:
  - Surgery-clipping / Parent artery deconstruction.
  - Endovascular Minimally invasive: through a small incision in the leg:
    - Intrasacular (coiling, liquid embolic 1991),
    - Extrasacular (flow diverters, 2011)
Surgery - clipping.
1968
- The first generation YASARGIL Aneurysm Clips were made from steel with a half spring coil and no jaw guidance.

1970
- The YASARGIL Aneurysm Clip with 1.5 spring coil and safety ring were introduced to enhance closing force and stability.

1983
- The YASARGIL Aneurysm Clip made from Phynox increases MRI compatibility. A patented box lock improves the characteristics with regard to alleviating the "scissoring" effect.

1995
- The YASARGIL Aneurysm Clip with 1.5 spring coil made from titanium improves postoperative control and diagnosis by reducing the number of artifacts in CT and MRI scans.

2004
AVM Microclip introduced.

Courtesy of Aesculap, Inc.
2004
- The XS Clip Applier was introduced to support keyhole surgery.

2006
- The YASARGIL Aneurysm T-Bar and AVM Clips made from titanium and Phynox aid and expand treatment possibilities.

2013
- The first Mini clips with fenestration allow for a more precise reconstruction of the vascular structures in narrow spaces.
Endovascular: Intra-sacular coiling
Endovascular Extrasacular: Flow diverters

- Pipeline embolization Device™ (PED) was FDA approved in April 2011.
Kallmes DF, Ding YH, Dai D, Kadirvel R, Lewis DA, Cloft HJ.
Future technology:
Extrasacular: FRED flow diverter
Intrasacicular: Medina coil
Intrasacicular aid: PulseRider
Intrasacular: WEB
Intrasacular: LUNA
Cerebral aneurysms

- Endovascular VS Open craniotomy???
  - Aneurysm anatomy
  - Age of the patient
  - Recurrence rate of aneurysm
  - Length of stay
  - Ruptured VS non-ruptured

- Endovascular AND open craniotomy VS aneurysm
Vascular malformations

• AVM
• Arterio-Venous fistula
• Cavernous malformation
• Capillary telangiectasia
• Venous angioma
Epidemiology

• Congenital $\rightarrow$ risk of bleeding is lifelong $\rightarrow$ 2 -4 % per year.

• AVM vs Aneurysms:
  – Incidence 1 : 5.3
  – Age of diagnosis: 33 vs 40s. (10 years younger)

• Peaks between ages 15 – 20 years (10% mortality, 30-50% morbidity for EACH BLEED)

• Risk of bleeding: 105 – AGE
  – Assuming 3% annual risk of hemorrhage.
  – ROB: 105 – 45 = 60
Presentation.

- Hemorrhage (most common) 50% (vs 92% of aneurysms)
- Seizures
- Mass effect → V neuralgia from CPA AVM
- Ischemia (steal effect)
- HA
- Bruit
- Increased ICP
- PEDS: hydrocephalus, CHF, prominence of forehead veins.
AVM anatomy
AVM Treatment options

• ARUBA trial: medical treatment VS intervention???

• Surgical resection is Treatment of choice.
  – Eliminates risk of bleeding immediately, better seizure control.
AVM treatment: embolization

- When surgical risk is unacceptably high
- Used pre-op for deep feeders → **complete cure 20%**.
  - ONYX → not adhesive → ideal for AVM.
  - PVA particles (polyvinyl alcohol)
  - Acrylates → adhesives (risk of gluing catheter to artery)
Radiation

• Conventional Rxtx → < 20% effectiveness.

• SRS:
  ⊙ Takes 1-3 years to work → still risk of bleeding.
  ⊙ Done as outpt, non invasive.
  ⊙ SRS can be first line
• 34 y.o. female, hospital house keeper, presented to the ER after she was found unresponsive on the ground in a hospital room.
• Initial exam: GCS E2 V5 M6, c/o headaches and MAE full strength.
COMPREHENSIVE NEUROVASCULAR TREATMENT

- Neuro-ICU: Pt became more drowsy and was intubated for airway protection.
- Pt had EVD placement for control of ICP
- Cardene drip for SBP control
• Neuro-ICU: Patient was extubated / stabilized medically for 6 days
• Endo-vascular: Pre-op Onyx embolization.
• Open Vascular: Surgical resection.
Endovascular: Intraop
• EVD was removed on POD#6 without problems.
• PT was discharged on POD #9 with outpatient PT/OT.
Dural AVF

- Mean age 50 to 60 years
- 10% to 15% of intracranial vascular malformations.
Clinical picture DAVF.

- Asymptomatic.
- Pulse-synchronous tinnitus and headache.
- Proptosis is frequent with carotid-cavernous DAVFs.
- Venous hypertension → encephalopathy, ataxia, seizures, myelopathy, cerebral edema, ischemia, subarachnoid hemorrhage.

Natural History.

• Cortical venous reflux $\rightarrow$ 10% may spontaneously close.

• Persistence of cortical venous reflux in DAVFs $\rightarrow$
  – 15% annual risk for hemorrhagic/nonhemorrhagic neurological deficit
  – 10.4% annual mortality rate.

• Risk of rebleeding $\rightarrow$
  – Up to 43% within the first few days of hospitalization
  – 35% in the initial 2 weeks after the first hemorrhage

• Overall 20% annual morbidity and mortality rate after first bleeding with neurological deficits.
Treatment.

- Compression Tx → 30 min per day.
- Endovascular
- Surgical
- Radiosurgery
Endovascular

• Transvenous embolization → best chance of cure
• BTO is recommended to assess the impact of embolizing a sinus in communication with normal cortical veins
• Trans-arterial: high cortical venous reflux.
Endovascular Treatment of Cranial Arteriovenous Malformations and Dural Arteriovenous Fistulas
Radvany, Martin G., MD, Neurosurgery Clinics of North America, Volume 23, Issue 1, 123-131
Surgery.

• Coagulation, excision, or ligation of the draining vein is performed at the point of the fistula.
Radiosurgery.

• Secondary or tertiary option to obviate a craniotomy
• Used in small DAVF
• Disadvantages: waiting period of at least 2 years, intermittent cerebral angiography.
• 14 Gy minimum dose required for DAVF occlusion.
66 y/o female with headaches and first time seizure.
Endovascular approach.
Three month vascular follow-up
Surgical clipping of the fistula