CEREBRAL ANEURYSM

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M.D.

Epidemiology

- 5-10% of all stroke
- 10.5/100,000 persons/yr
- Female predominant
- Most in anterior circulation
- Female -> ICA 36.8%
- Male -> Anterior Com. 46%

Number of Case per Year

Site of Aneurysm
Clinical Presentation
- Prehospital mortality 3-26%
- Only 36% of SAH refer to neurosurgeons
- Sudden onset of worst headache
- 20% associate with exertional activities
- Alteration of consciousness

Clinical Presentation (Con't)
- Confusion, lethargy 30%
- Transient loss of consciousness 30%
- Coma 17%
- Meningism 52%
- Focal neurological sign 21%
- Seizure 7-17%
- Warning leak 15-39%

Imaging
- CT Brain
- 4-vessels angiogram
Management of Rupture Aneurysm

- Without treatment 50% of aneurysmal SAH death
- Suspect SAH -> immediate evaluation, stabilization, refer to neurosurgical care
- Key -> aneurysm obliteration to prevent rebleeding and to prepare the stage for other management

Management implication

- Treatment should be initiated early to minimizing the complication of ischemia
- Surgery best perform soon after rupture
- Euvolemia for improve CBF
- Cerebral protection decrease effect of ischemia

Clinical Grading

- Outcome predictor: Patient clinical status at admission
- Hunt & Hess, WFNS, Fischer grading

Grade (WFNS)
Hunt and Hess Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Clinical Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Nonsubarachnoid hemorrhage</td>
</tr>
<tr>
<td>I</td>
<td>Asymptomatic or mild headache, mild nuchal rigidity</td>
</tr>
<tr>
<td>II</td>
<td>Moderate to severe headache, nuchal rigidity, no neurologic deficit except cranial nerve palsy</td>
</tr>
<tr>
<td>III</td>
<td>Drowsiness, confusion, or mild focal deficit</td>
</tr>
<tr>
<td>IV</td>
<td>Stupor or mild to moderate hemiparesis; possible early decerebrate rigidity</td>
</tr>
<tr>
<td>V</td>
<td>Deep coma, decerebrate posturing, moribund</td>
</tr>
</tbody>
</table>

World Federation of Neurosurgical Societies Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>GCS Score</th>
<th>Motor Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15</td>
<td>Absent and no subarachnoid hge</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>Absent</td>
</tr>
<tr>
<td>2</td>
<td>13 - 14</td>
<td>Absent</td>
</tr>
<tr>
<td>3</td>
<td>13 - 14</td>
<td>Present</td>
</tr>
<tr>
<td>4</td>
<td>7 - 12</td>
<td>Present or absent</td>
</tr>
<tr>
<td>5</td>
<td>3 - 6</td>
<td>Present or absent</td>
</tr>
</tbody>
</table>

Fischer Grade CT Scan Findings

<table>
<thead>
<tr>
<th>Fischer Grade</th>
<th>CT Scan Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No blood detected</td>
</tr>
<tr>
<td>2</td>
<td>Diffuse thin layer of subarachnoid blood (vertical layers &gt; 1 mm thick)</td>
</tr>
<tr>
<td>3</td>
<td>Localized clot or thick layer subarachnoid blood (vertical layers ≥ 1 mm thick)</td>
</tr>
<tr>
<td>4</td>
<td>Intracerebral or intraventricular blood with diffuse or no subarachnoid blood</td>
</tr>
</tbody>
</table>

Preoperative Care

- **Goal:** stabilize patient for aneurysm obliteration and prevent the development of systemic complication or secondary insult
- **ER -> ICU**
- **Good grade -> strict bed rest, neurologic assessment, IV fluid**
- **Poor grade -> ICP monitor, ventilation, sedation**

Pharmacologic Treatment

1. **BP control**
   - systolic BP > 180 mmHg
   - Morphine for control pain
   - Rapid acting IV agent: NTP, NTG, labetalol
2. **Seizure**
   - 10%
   - Anticonvulsant

Pharmacologic Treatment (Con’t)

3. **Nimodipine**
   - Improve outcome
   - Neuroprotectant, pia collateral circulation
4. **Steroid**
   - Controversy
Surgery or Endovascular?

Early or Delayed surgery?
Early surgery

Good point
- Prevention of rebleeding
- Aggressive management of vasospasm
  - Tripple H
  - angioplasty
- Remove of subarachnoid clot
  - mechanical, thrombolytic

Early surgery (con’t)

- Decrease hospital stay
- Prevent of medical complication like pneumonia or DVT
- Prevent hydrocephalus
- Decrease psychosocial stress

Early surgery (con’t)

Weak point
- Swollen brain
- Unstable patient
Endovascular
- Nonsurgery management
- Selected case

Postoperative Care
- ICU care at least in period of maximum vasospasm (10 days)
- Critical care monitor
- Careful attention to cardiorespiratory function, volume status, ICP, prevention of secondary insult and medical complication

Perioperative Management
- General care
  - Admitting Order
  - monitoring: V/S, N/S, arterial catheter, CVP
  - nursing care: bed rest, elevate head 30 degree, foley’s catheter, NG tube

medication: Stool softener, Laxative, Analgesic, IV fluid [3 L/day], sucralfate/omeprazole, Sedative [Lorazepam], anticonvulsant, Antihypertensive.
Management of blood pressure
- depend on: time, aneurysm clipped, premorbid BP.
- Analgesia: morphine
- Sedation: midazolam
- Antihypertensive – NTP, Nicardipine

Complication specific to SAH
- Surgical
  - Rebleeding
  - Hydrocephalus
  - ICH, IVH

Medical complication
- Respiratory complication
  - Pulmonary edema [neurogenic, cardiogenic, volume overload]
  - Pneumonia

Cardiovascular complication
- EKG abnormality
  - sympathetic hyperactivity -> arrhythmia
  - < 4% serious
  - Fluid/electrolytes
    - hyponatremia, hypernatremia, hypokalemia

Postoperative deterioration
- Multiple causes
- Neurogenic: rebleeding, hydrocephalus, vasospasm, ICH, cerebral edema
- Postoperative: vascular occlusion, cerebral edema, contusion, infection
- Systemic: hyponatremia, hypoxia, hypotension, hypercarbia

Cerebral vasospasm
- Angiographic/symptomatic vasospasm
- Diagnosis
  - clinical: neurological deterioration
  - TCD
  - angiography
  - SPECT/Xe CT
Vasospasm prevention

- Fluid management
  - Preventing hypovolemia, anemia, and antihypertensive
  - IV [3L/day], maintain high normotensive [120-160 mmHg], slight hypervolemia

Subarachnoid blood clot removal

- Calcium channel blockers
  - BRANT trial: nimodipine 60 mg q4 hr for 21 days

Improve Overall Outcome

- Early surgery
- Imaging technic
- Transcervical doppler ultrasound
- Hypervolemia
- Ca channel blocker
- Endovascular technic
- Identified secondary insult
- Aggressive monitoring & intensive care

FUTURE

1. Aneurysm formation and rupture primary prevention
   - Modified risk factor: smoking, atherosclerosis, HT
2. Systemic approach
   - Brain attack organization
   - Prehospital care, ER, preoperative care, rehabilitation

FUTURE (con't)

3. Specialized center
   - Successful treatment -> multidisciplinary team
     : neurosurgeon, neurologist, neuroanesthesiologist, neurointensivist intensive care unit nurse
4. Physician education: early Dx warning leak

FUTURE (con't)

5. Appropriate use of endovascular and surgical technic
6. Academic evaluation
   - Control randomized
   - Guideline
FUTURE (con’t)

5. Unrupture aneurysm and screening
   - treatment of unrupture aneurysm
     morbidity 41%, mortality 1%
   - family history of SAH, polycystic kidney, Marfan’s syndrome, Ehlers-Danlos syndrome
   - MRA & CTA

THE END

QUESTION

Perioperative and Intensive Care Unit of patient with SAH

- Medical complication of SAH
  - Volume and electrolyte
  - hypovolemia and hyponatremia
  - plasma volume decrease > 10% in 6 days
  - normovolemia and hypervolemia
  - hyperglycemia > 200 mg/dL
    (cerebral ischemia)

Cardiac Complication (50%)

- MI 0.7%
- Abnormal EKG -> MI
- Hypertension
  - sedation -> morphine, sedation, paralysis
  - not require treatment in all patient

Pulmonary Complication

- aspirate pneumonia
- pulmonary edema
- PE, atelectasis and bronchospasm
- neurogenic pulmonary edema
- Thromboembolic Events
  - DVT, PE
  - gradual stretching, intermittent calf compression
Fever and Infection
around 30%
antipyretic -> increase cerebral ischemic injury
Nutrition Support
within 48 hrs
GI Complication
GI bleeding
prophylactic therapy:H2 block, antacid, sucralfate

Sedation and Analgesic
pain, irritable and agitation -> increase risk of rupture
good grade -> paracetamol, morphine
poor grade -> short acting eg. Fentanyl, midazolam

• Neurologic Complication
1. Rebleeding
major cause of morbidity and mortality
7-19% rebleeding in 30 days
repeat CT Brain
aneurysm occlusion
2. Seizure and Epilepsy
initial seizure 4-25%
early seizure 1.5-5%
late seizure 3%
systemic effect devastating to SAH patient
low risk -> anticonvulsant for 1-2 wks
high risk -> anticonvulsant for 1 yr
3. Cerebral edema and intracranial hypertension
vasogenic edema -> breakdown of BBB
cytotoxic edema -> hypoxia, cerebral ischemia
interstitial edema -> hydrocephalus
24-30% develop IICP

Management of IICP

- ABC assessment
- CT brain emergency

surgical
- Hydrocephalus
  - EVD
  - ICH
    - clot evacuation
    - aneurysm clip
- Non-surgical
  - Maintain cerebral perfusion
  - Head position
  - Mannitol/ Lasix
    (hyperventilation, dexamethasone)

4. Hydrocephalus
- communicating or obstruction
ventriculostomy
Benefit: control ICP, clinical improve
monitor ICP
blood remove
Risk: rebleeding
Infarction
shunt dependent
### Protocol for initial management following subarachnoid hemorrhage

<table>
<thead>
<tr>
<th>Evaluation/stabilization</th>
<th>Airway, breathing, circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intubate if poor grade</td>
</tr>
<tr>
<td></td>
<td>Maintain normovolemic, normotensive</td>
</tr>
<tr>
<td></td>
<td>Complete examination</td>
</tr>
<tr>
<td></td>
<td>Assign GCS*</td>
</tr>
<tr>
<td></td>
<td>Baseline complete blood count, electrolytes, clotting studies</td>
</tr>
<tr>
<td></td>
<td>Correct electrolyte disturbances</td>
</tr>
<tr>
<td></td>
<td>Head computed tomography with infusion computed tomography</td>
</tr>
<tr>
<td></td>
<td>Determine amount of subarachnoid hemorrhage</td>
</tr>
<tr>
<td></td>
<td>Determine aneurysm location</td>
</tr>
<tr>
<td></td>
<td>Evaluate for intracranial hemorrhage, hydrocephalus</td>
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### Monitoring

<table>
<thead>
<tr>
<th>Oxgenation</th>
<th>Pulse oximetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial blood gases</td>
<td>Arterial catheter, blood pressure cuff</td>
</tr>
<tr>
<td>Hemodynamics</td>
<td>Central venous catheter (good grade)</td>
</tr>
<tr>
<td></td>
<td>Swan - Ganz catheter (poor grade or medical indications)</td>
</tr>
<tr>
<td></td>
<td>Intracranial pressure</td>
</tr>
<tr>
<td></td>
<td>Intracranial pressure monitor</td>
</tr>
<tr>
<td></td>
<td>Vasoopasm</td>
</tr>
<tr>
<td></td>
<td>Baseline transcranial Doppler ultrasonographic evaluation</td>
</tr>
<tr>
<td></td>
<td>Fluid balance</td>
</tr>
<tr>
<td></td>
<td>Bladder catheterization</td>
</tr>
<tr>
<td></td>
<td>Hourly intake and output</td>
</tr>
</tbody>
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### Cerebral perfusion

| Establish normovolemia if low vasospasm |
| Consider hyperemia if high vasospasm risk |
| Do not lose systemic blood pressure |
| < 180 mmHg |

### Ensure pain control/secdation

| Acetaminophen + morphine + benzodiazepines |
| Fentanyl (propofol if intubated) if necessary |
| Fusphenytoin or phenytoin for 1-2 weeks unless high risk |

### Initiate seizure prophylaxis

| Pneumatic compression stockings |
| Subcuteaneous heparin postoperatively |
| Low molecular weight heparin postoperatively |
| Main normovolemia, normonatremia Nimodipine |

### Begin deep vein thrombosis prophylaxis

| Hydrocephalus |
| Intracranial hemorrhage |
| Maintain cerebral perfusion |
| Head positioning |
| Mannitol / Furosemide (Lasix) |
| Hyperventilation |
| Desamethasone |

### Begin vasospasm prophylaxis

| Emergent Head CT scan |
| Surgical |
| Nonsurgical |

| Hydrocephalus |
| Intracranial hemorrhage |
| Clot evacuation |
| Aneurysm clipping |
VASCULAR MALFORMATION
- AVM
- CAVERNOUS MALFORMATION
- CAPILLARY TELANGIECTASIA
- VENOUS ANGIOMA

Ateriovenous Malformation
- Abnormality connection between arteries and venous system that lack an intervening capillary bed
- Most lesion < 40 years
- Leading cause of non traumatic ICH in young people

Clinical presentation
- Hemorrhage (ICH, IVH, SAH, Combine)
- mortality 10-29%
- annual risk 2-4% per year
- Seizure
- Focal neurologic deficit
- Headache

IMAGING
- CT
- CT ANGIOGRAM
- MRI
- ANGIOGRAM
TREATMENT

- GRADING – Spetzler – Martins Scale
  - Lesion size
    - small < 3 cm: 1
    - medium 3-6 cm: 2
    - large > 6 cm: 3

Location
- noneloquent: 0
- eloquent: 1

Venous drainage
- superficial: 0
- deep: 1
- Grade 1-5

RISK OF HEMORRHAGE

- Deep seated lesion
- Small size
- Single draining vein
- Deep venous drainage
- Associate aneurysm
TREATMENT OPTION

- **OBSERVATION**
  - Thalamic and basal ganglion > 6 cm
  - Intrinsinc brainstem AVM > 2.5 cm
  - Elderly grade 4-5

- **EMBOLIZATION**
  - Adjunct to microsurgery and radiosurgery
  - Suggest in: grade 4-6
  - Critical brain region
  - Associate aneurysm
  - Inadequate Rand prospective study

- **MICROSURGERY**
  - Convexity AVM grade 1-3
  - Cerebellar and pial AVM
  - Thalamic and basalglion AVM
STERIOTACTIC RADIOSURGERY
- Small, unruptured AVM in deep and critical area
- Obliterate rate 60-85% after 2 years

CAVERNOUS MALFORMATION
- Angiographic occult
- Sinusoid, thin wall, dilated and single cell endothelial layer

clinical
- Headache
- Seizure
- Focal neurologic deficit
- Hemorrhage
- Annual risk 0.7% per year
- After hemorrhage 4.5% per year

IMAGING
- CT
- MRI
**TREATMENT**

- Complete surgical excision
- Surgery - symptomatic lesion
Vasospasm Reversal

- Triple- H therapy
- Intra- aortic balloon
- Endovascular therapy
- Balloon angioplasty