Malignant Edema and Hemicraniectomy After Stroke

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No Discussion of Off-Label Usage

Objectives
1. Review the pathophysiology of edema after ischemic stroke
2. Review disability and complications after large hemispheric stroke
3. Review the literature on decompressive hemicraniectomy
4. Discuss patient and family communication regarding operative intervention and disability
Disability from Large MCA stroke

- **Left Hemisphere**
  - Speech/Language
  - Right-sided motor function
  - Neglect
  - Vision on the right

- **Right Hemisphere**
  - Left-sided motor function
  - Rarely speech
  - Neglect (profound)
  - Vision to the left

Brain Edema After Stroke

- Reperfusion – free radical-induced injury
- Cytotoxic edema from cell death
- Vasogenic edema from blood-brain barrier disruption

- Intracranial pressure is often normal or near-normal!
  - Shift and compression are the problems

- Onset 2-7 days from stroke onset

Diagram showing:
- Edema
- Mass Effect
- Tissue Shift
- Tissue Compression
- Tissue Damage or Herniation
Malignant Cerebral Edema

- Edema due to stroke resulting in life-threatening brain injury
- May be refractory to treatment
- Risk Factors:
  - Multiple vascular territories involved
  - Younger age
  - NIHSS > 25

Recognizing Clinical Deterioration

- Drowsiness
- Change in breathing pattern
  - Hyperventilation
  - Periodic breathing
- Pinpoint, reactive pupils (diencephalon compression)
- Anisocoria/blown pupil

What can we do?

- Medical Management (limited effect)
  - Osmotherapy (mannitol or hypertonic saline)
  - Maintain normal sodium, temperature
  - Neutral head position (facilitate venous return)
  - Consider intubation/mechanical ventilation for depressed mental status – aim for normal CO2 (between 35-40) and hyperventilate with decompensation
What can we do?

- Surgical Management
  - Definitive therapy
  - ± Drain CSF if hydrocephalus is present (via EVD)
    - Allows ICP monitoring
  - Not the major problem though…
  - Decompressive Hemicraniectomy

IF ONLY IT WAS THAT EASY

What Do We Know?

- Trials for Decompressive Hemicraniectomy
  - DESTINY (2007)
  - DECIMAL (2007)
  - HAMLET (2009)
  - DESTINY 2 (2014)
DESTINY

- 32 patients – randomized to medical vs surgical management
- Inclusion:
  - Ages 18-60, between 12.36 h of onset
  - NIHSS >18 (non-dominant), 20 (dominant)
  - Decreased LOC
- Outcome measures: mortality @ 30 days, mRS @ 6 months, mRS at 12 months

DESTINY

- 17 pts in surgery arm, 15 in medical arm
- Mean age low-mid 40s
- Survival @ 30 days: 88% surgical, 47% medical
- All pts/caregivers agreed with surgical decision @ 12 month follow-up

DECIMAL

- 38 patients – medical vs surgical management
- Ages 18-55, within 24 hours of stroke
- Inclusion criteria:
  - NIHSS > 16
  - Altered LOC
  - >50% of MCA infarcted on CT/DWI
- Outcome measures: mRS 0-3 @ 6 mos, survival, mRS 0-3 @ 12 mos
HAMLET

- 64 patients randomized to medical vs surgical management
- Ages 18-60 years
- Inclusion:
  - Onset of symptoms within 96 hours
  - NIHSS >16 (non-dominant) or >20 (dominant)
  - Imaging with >2/3 of MCA territory affected
- Outcomes measured: mRS @ 1 year (0-3 was good), mortality, depression and quality of life.

Hofmeijer, et al. Surgical decompression for space-occupying cerebral infarction (the Hemispherectomy After Middle Cerebral Artery Infarction with Life-threatening Edema Trial [HAMLET]): a multicentre, open, non-blinded trial. Lancet Neurol. 2009.

HAMLET

- 32 pts surgical, 32 pts medical
- Avg time to randomization: 41-45 hours

Overall poor outcome was no different – less died with surgery, but those who survived had high chance of mRS>3.
What we learned

- Mortality is reduced with hemicraniectomy
- Over time patients can have good outcomes (mRS 3 or less)
- If surgery is delayed (>48 h) the likelihood of a good outcome is much less (HAMLET)
- What about patients >60 years old???

DESTINY 2

- 112 patients randomized to medical vs surgical management
- Age >61 years (range 61-82)
- Inclusion criteria:
  - Onset within 48 hours
  - NIHSS >14 (non-dominant) or 19 (dominant)
  - Altered LOC
  - 2/3 of MCA territory affected on imaging


DESTINY 2

Outcomes

- mRS @ 6 months – scores of 0-4 were considered ‘good’
- Survival @ 12 months
- mRS @ 12 months
- NIHSS @ 12 months

Modified Rankin Scale (mRS)
- 0: No symptoms
- 1: No significant disability despite symptoms able to perform all usual duties and activities
- 2: Slight disability, unable to perform all usual duties; able to walk without assistance
- 3: Moderate disability; requires some help or necessitates a wheelchair
- 4: Moderately severe disability; unable to walk without assistance
- 5: Severe disability; bedridden, requires constant nursing care and attention
- 6: Dead
What we learned...

- DESTINY 2 met its primary endpoint of a ‘good’ outcome in patients > 60 years old.

- What is a good outcome?
  - Less death?
  - Quality of life?

Communication for these Patients

- Who?
  - Typically family members
  - Patients with right hemisphere stroke (unless anosognosia/neglect)
  - Pts with limited life expectancy (cancer, severe CHF/COPD) often are not offered surgery

- When?
  - When offered, hemicraniectomy should be discussed early – usually on hospital day 1
Necessary Components of the Discussion

- Deficits from the stroke will not improve with surgery
- Surgery is a life-saving measure to prevent swelling from compressing parts of the brain not affected by stroke
- Swelling can still be life-threatening after surgery
- Older patients don’t do as well, even with surgery
- Would surgery be consistent with the patient’s wishes?

Edema Despite Surgery

CT at Presentation 20 Hours Post-op – Day 2.5

An interesting perspective

- Anesthesiologist
- Left MCA stroke in 50s
- Hemicranietomy
- Extensive rehab
- Ambulatory, persistent but incomplete aphasia

<table>
<thead>
<tr>
<th>Trial</th>
<th>Age</th>
<th>Number Enrolled</th>
<th>Outcome</th>
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<tr>
<td>DESTINY</td>
<td>18-60</td>
<td>32</td>
<td>Mortality @ 1 mo</td>
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<tr>
<td>DECIMAL</td>
<td>18-55</td>
<td>38</td>
<td>mRS @ 6 mos</td>
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<tr>
<td>HAMLET</td>
<td>18-60</td>
<td>64</td>
<td>mRS @ 12 mos</td>
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<td>DESTINY 2</td>
<td>&gt;61</td>
<td>112</td>
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