Hemicraniectomy: Is it time?

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Learning Objectives

At the conclusion of this course, participants should be able to

• Evaluate what constitutes Malignant Middle Cerebral Artery Infarction

• Describe randomized studies regarding Decompressive Craniectomy for middle cerebral artery stroke

• Identify reasonable candidates for Decompressive Craniectomy following middle cerebral artery stroke
Disclosures

• No actual or potential conflict of interest in regards to this presentation
• The planners, editors, faculty and reviewers of this activity have no relevant financial relationships to disclose
• This presentation was created without commercial support
Representative Case

- 50-something y.o. woman
- Presented with acute aphasia and right sided hemiplegia. Last known normal was 12 hours earlier
- Roughly 24 hours after presentation had decline in level of consciousness
- Occluded left MCA, and CCA bifurcation
Background

• 1-10% of completed strokes are associated with substantial cerebral edema
• This can result in elevated ICP and subsequent cerebral herniation, known as a malignant infarction
• Usually due to occlusion of ICA or the proximal segment of MCA, known as Malignant Middle Cerebral Artery Infarction, or MMI
• Associated with 80% mortality
Posterior Fossa Decompression

• For cerebellar stroke
• No randomized trials have been conducted due to the apparent benefits of surgery
• One large series showed 74% of patients with massive cerebellar strokes had very good outcomes (mRS 0-1)
Radiologic predictors of MMI

• CT head — > 50% of MCA territory hypodensity

• MRI —
  – Volume >82 mL predicts the development of MMI with a high specificity (98%)
  – combined occlusion of the internal carotid and middle cerebral arteries (OR 5.38, 95% CI 1.55-18.68)
  – lesion size on DWI (per 1 mL odds ratio [OR] 1.04, 95% CI 1.02-1.06)
Randomized Controlled Studies

- DECIMAL trial
- DESTINY trial
- HAMLET trial
- HeaDDFIRST trial
- DESTINY II trial

Question:
Decompressive surgery vs. medical management for MMI
## Design - DDH

<table>
<thead>
<tr>
<th></th>
<th>DECIMAL</th>
<th>DESTINY</th>
<th>HAMLET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of evidence</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Randomization</td>
<td>Surgery versus medical care</td>
<td>Surgery versus medical care</td>
<td>Surgery versus medical care</td>
</tr>
<tr>
<td>Number of patients</td>
<td>38</td>
<td>32</td>
<td>64</td>
</tr>
<tr>
<td>Follow-up</td>
<td>1 year</td>
<td>1 year</td>
<td>1 year</td>
</tr>
<tr>
<td>Primary endpoint:</td>
<td>Functional outcome at 6 months in</td>
<td>Primary endpoint: Mortality at</td>
<td>Primary endpoint: Functional</td>
</tr>
<tr>
<td>survivors</td>
<td>survivors</td>
<td>1 month</td>
<td>outcome (mRS score)</td>
</tr>
<tr>
<td>Secondary endpoints:</td>
<td>Survival at 6 and 12 months</td>
<td>Secondary endpoints: Functional</td>
<td>Secondary endpoints:</td>
</tr>
<tr>
<td></td>
<td>Functional outcome at 12 months</td>
<td>outcome at 6 and 12 months</td>
<td>Case fatality</td>
</tr>
<tr>
<td>Number of centres</td>
<td>13</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>
Decision-making process

• Decision to perform DECRA based on MMI criteria
  – NIHSS including a score of 1 or greater (not alert but arousable)
  – CT or MRI evidence of unilateral MCA infarction
  – Mass effect or shift not necessary
Criteria

Similar inclusion criteria
• Age: DECIMAL 18–55 y; DESTINY 18–60 y; HAMLET 18-70 y pooled analysis of DESTINY/DECIMAL/HAMLET 18–60 years.
• Time from onset of symptoms: DECIMAL <30 h; DESTINY <36 h; HAMLET <99 h.

Exclusion criteria
• significant pre-stroke disability; significant hemorrhagic infarction; coagulopathy

Neuroimaging criteria
• DECIMAL: $V_{\text{infarct}}$ diffusion-weighted MRI >145 cm
• DESTINY: CT ischemic changes affecting > 2/3 of the MCA + including the basal ganglia
• HAMLET: CT ischemic changes affecting > 2/3 of the MCA + space-occupying edema
Outcomes (D+D)

- DECIMAL was discontinued following recruitment problems with interim significant benefit on mortality
- DESTINY was discontinued for predetermined significant benefit on mortality

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>DECIMAL</th>
<th>DESTINY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surgery</td>
<td>Medical care</td>
</tr>
<tr>
<td>'Favourable' functional outcome (mRS ≤3, 6 months)</td>
<td>25%</td>
<td>6%</td>
</tr>
<tr>
<td>mRS ≤4 (6 months)</td>
<td>65%</td>
<td>23%</td>
</tr>
<tr>
<td>mRS 4 (6 months)</td>
<td>40%</td>
<td>17%</td>
</tr>
<tr>
<td>Survival at 30 days</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Survival at 6 months</td>
<td>75%</td>
<td>22%</td>
</tr>
</tbody>
</table>
Outcomes (HAMLET)

- Absolute risk reduction on mortality of 37%
- No reduction in poor functional outcome
  - >99 hours timing
- DECRA was not cost-effective at 3 y

<table>
<thead>
<tr>
<th>Outcomes at 1 year</th>
<th>Surgery</th>
<th>Medical care</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good functional outcome (mRS ≤3)</td>
<td>25%</td>
<td>25%</td>
<td>None</td>
</tr>
<tr>
<td>Poor functional outcome (mRS ≥4)</td>
<td>75%</td>
<td>75%</td>
<td>None</td>
</tr>
<tr>
<td>Mortality</td>
<td>22%</td>
<td>59%</td>
<td>0.002</td>
</tr>
</tbody>
</table>
DDH

• All 3 showed reduced mortality when compared with medical management
• No individual study showed improvement in good outcome (mRS 0-3)
Pooled Analysis

Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials

Katayoun Vahedi, Jeannette Hofmeijer, Eric Juettler, Eric Vicaut, Bernard George, Ale Algra, G Johan Amelink, Peter Schmiedek, Stefan Schwab, Peter M Rothwell, Marie-Germaine Bousser, H Bart van der Worp, Werner Hacke, for the DECIMAL, DESTINY, and HAMLET investigators
Pooled Analysis

Primary outcome at 1 year
- Favorable (0–4) vs unfavorable (5 and death)

• Secondary outcome
- case fatality rate at 1 year
- Good mRS (0–3) vs 4-death

Panel: Eligibility criteria for the pooled analysis

Inclusion criteria
Age 18–60 years
Clinical deficits suggestive of infarction in the territory of the MCA with a score on the National Institutes of Health stroke scale (NIHSS) >15
Decrease in the level of consciousness to a score of 1 or greater on item 1a of the NIHSS
Signs on CT of an infarct of at least 50% of the MCA territory, with or without additional infarction in the territory of the anterior or posterior cerebral artery on the same side, or infarct volume >145 cm³ as shown on diffusion-weighted MRI
Inclusion within 45 h after onset of symptoms
Written informed consent by the patient or a legal representative

Exclusion criteria
Prestroke score on the mRS ≥2
Two fixed dilated pupils
Contralateral ischaemia or other brain lesion that could affect outcome
Space-occupying haemorrhagic transformation of the infarct (≥parenchymal haemorrhage grade 2)
Life expectancy <3 years
Other serious illness that could affect outcome
Known coagulopathy or systemic bleeding disorder
Contraindication for anaesthesia
Pregnancy
DDH Inclusion into Pooled Analysis

• All DECIMAL and DESTINY patients were included

• 23 of 57 HAMLET patients were included
  – 34 excluded for randomization >45 hours

• Total of 93 patients
  – Randomization
    • 51 to surgery
    • 42 to conservative management
Distributions of the scores on the mRS and death after 12 months

Conservative treatment:
- MRS=2: 2% (1/42)
- MRS=3: 19% (8/42)
- MRS=4: 2% (1/42)
- MRS=5: 5% (2/42)
- Death: 71% (30/42)

Surgery:
- MRS=2: 14% (7/51)
- MRS=3: 29% (15/51)
- MRS=4: 31% (16/51)
- MRS=5: 4% (2/51)
- Death: 22% (11/51)
Significantly fewer patients had an unfavourable outcome (mRS>4) after surgery but also significantly fewer patients had an mRS >3 after surgery.

Survival rate at 12 months was higher after surgical treatment than after conservative treatment.
Surgery was beneficial (p<0.01) in all subgroups, as measured by mRS of 4 or less at 12 months, with no significant subgroup-treatment effect interactions.
Pooled Analysis Summary

<table>
<thead>
<tr>
<th>Outcomes at 12 months</th>
<th>Surgery</th>
<th>Medical care</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>22%</td>
<td>71%</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>mRS 4</td>
<td>31%</td>
<td>2%</td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>mRS &lt;4</td>
<td>74%</td>
<td>23%</td>
<td>$p &lt; 0.0001$</td>
</tr>
</tbody>
</table>

- Patients randomized within 48 hours showed risk reduction in case fatality and poor outcome
- No patients had mRS 0-1, 14% had mRS = 2
- mRS 2-3 (good outcome) was 43% in surgery vs 21%
- NNT
  - 6 to prevent poor outcome (mRS >3)
  - 2 to prevent mRS >4
  - 2 to prevent death
HeaDDFIRST trial

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<th>Statistical significance</th>
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</thead>
<tbody>
<tr>
<td>Mortality at 21 days</td>
<td>23%</td>
<td>40%</td>
<td><em>p &lt; 0.05</em></td>
</tr>
<tr>
<td>Mortality at 180 days</td>
<td>37.5%</td>
<td>40%</td>
<td>None</td>
</tr>
</tbody>
</table>

- Inclusion criteria: Ages 18–75; NIHSS > 18; premorbid mRS <2 with complete MCA + /– ACA or PCA infarction; infarct volume > 50 % MCA territory or > 90 cm³ on early CT, or > 180 cm³ on late CT.
- Randomization triggered by development of midline shift (> 7 mm septal or > 4 mm pineal gland displacement).
- Follow up: 180 d, primary endpoint - mortality / secondary endpoint – functional outcome
- Statistically non-significant reduction in mortality
- Improved outcomes felt to be due to standardized medical management protocol
DESTINY 2

• Looked at patients older than 60 (61-82)
• 112 patients randomized to Conservative vs Surgical tx
• Primary endpoint = survival without severe disability (mRS 0-4)
• DECRA improved primary outcome (38% vs 18%)
• mRS 3 in 7% vs 3%
• No patients had mRS 0-2
• 33% mortality vs 70% in medical group
Summary

• DECIMAL:
  – Surgery improves survival in young MMI patients
  – Increased number of patients with moderately severe disability

• DESTINY:
  – Early decompressive surgery for MMI reduces mortality
  – Increased favorable functional outcome

• HAMLET:
  – Reduction in fatality
  – No improvement in functional outcomes

• HeaDDFIRST:
  – No difference in mortality at 180 days

• DESTINY II:
  – Increased survival without severe disability in patients >60
Endorsed by AANS, CNS and Neurocritical Care Society

American Academy of Neurology “affirms the value of this statement”
Decompressive hemicraniectomy for malignant middle cerebral artery territory infarction: is life worth living?

Clinical article

RALPH RAHME, M.D.,¹ MARIO ZUCCARELLO, M.D.,¹ DAWN KLEINDORFER, M.D.,² OPEOLU M. ADEOYE, M.D.,¹ AND ANDREW J. RINGER, M.D.¹

• Literature analysis
• 157 survivors had quality of life assessment
• Mean overall reduction in QOL was 45% (67% for physical, and 37% for psychosocial)
• Depression in 56% of patients, moderate/severe in 25%
• 77% of patients and caregivers interviewed were satisfied and would give consent again
Why not DECRA on everyone?

- Complication rates of 30-40% are seen with DECRA
  - Infection
  - Wound issues
  - Hematomas
  - Hydrocephalus
• Wound vac
• IV Abx
• Intraventric Abx
Patients were managed in neurocritical care unit with serial CTs

- Neurosurgical consultation, Hourly neurochecks, CT on admission, and HD#1 and #2, and otherwise as clinically indicated
- Patients with mass effect were monitored through post-stroke day #4

DECRA was reserved for CVA with concerning mass effect

- Hypothesized that “only risks and no benefit of DC for hemispheric stroke patients, if the stroke did not cause mass effect”

DECRA rates were decreased by 60% when compared to early prophylactic surgery

No increase in death or survival with severe disability
Conclusions

• Decompressive craniectomy reduces mortality when compared to medical management
• DECRA is likely associated with improved functional outcomes for survivors
• What constitutes an acceptable functional outcome remains controversial
• Complications can be catastrophic, and therefore the decision to offer DECRA should consider a combination of neurological exam, radiological findings, and patient/family wishes


