Hemicraniectomy for Large MCA Infarction

Guideline of Care

The goal of this guideline is to facilitate the early identification and treatment of patients at high risk for developing malignant MCA infarction.

Space-occupying ‘malignant’ middle cerebral artery territory (MCA) infarction accounts for over 10% of supra-tentorial strokes. Patients with malignant MCA infarction show clinical worsening with progressive deterioration in their level of consciousness within the first 24-48 hours after stroke onset, culminating in brain herniation and death in over 80% of patients [1]. While pharmacological strategies such as mannitol and hypertonic saline are routinely used, their efficacy remains unproven. A pooled analysis of clinical trials [2] show that the mortality rate can be reduced to 20% with timely decompressive hemicraniectomy -- the number needed to treat (NNT) to prevent one death is only 2.

Early surgery (<48 hrs since onset of stroke) appears to be important. The efficacy of hemicraniectomy to improve functional outcome has been the subject of debate. However, these trials show that in patients under the age of 60, decompressive surgery can improve long-term functional outcome, with a NNT of 2 to achieve a modified Rankin Scale (mRS) score of ≤4, and a NNT of 4 to achieve a mRS score of ≤3 at one year. These benefits stand regardless of the hemisphere affected. In patients ages 60-80 there is a clear survival benefit, but an increased proportion of patients surviving with mRS 4 or 5. While there is still some debate about the ideal timing of hemicraniectomy, age cut-off, and ethical considerations about functional outcome in surviving patients, hemicraniectomy is increasingly used for the management of malignant MCA infarction.

Patient Selection

1. Patients who are ≤82yrs of age with large MCA infarction evident on the admission head CT or brain MRI. Large MCA infarct is preferably defined as an ischemic lesion volume >150 cm³ (using the ABC/2 criteria for estimating lesion volume), or >50% MCA territory infarction by visual inspection.

2. Apply STATE Criteria to determine eligibility for hemicraniectomy (see below).

Treatment Algorithm

Assign the patient into one of 3 categories:

a. Most likely to benefit from early hemicraniectomy (meets all STATE criteria)
   i. Consult neurosurgery emergently
   ii. Proceed for hemicraniectomy within the defined timeframes
   iii. Admit to the Neuro ICU before and after the procedure for close neurological monitoring and medical treatment.
iv. For patients who meet all STATE criteria except for drowsiness, these patients should be admitted the Neuro ICU and closely monitored. If they develop drowsiness, they should be sent for hemicraniectomy.

b. **May benefit from early hemicraniectomy** (age ≤82 yrs and meets many but not all STATE criteria)
   i. Hemicraniectomy is offered if there is consensus among the treating teams and family that the patient would want to proceed, recognizing that there is a survival benefit but an increase in the likelihood of severe disability.
   ii. Regardless of the decision to proceed with hemicraniectomy, if full aggressive treatment is requested by family and felt appropriate by treating team, then admit the patient to an intensive care unit, preferably the Neuro ICU, for close neurological monitoring and medical treatment.

   c. **Unlikely to benefit from early hemicraniectomy** (age >82 yrs or terminal illness or signs of active herniation)
      i. Hemicraniectomy will not be offered
      ii. If full aggressive treatment is requested by family and felt appropriate by treating team, then admit the patient to an intensive care unit, preferably the neuroICU, for close neurological monitoring and medical treatment. If there are previously expressed wishes about limitations on aggressive care or the treating team feels that the patient’s prognosis is so poor that aggressive treatment is not warranted, then an informed discussion with the family should precede a decision about intensive care admission and management.

**Pre-surgical and Surgical Management**

   a. If hemicraniectomy is offered, withhold anti-coagulation and anti-platelets until deemed safe post-procedure with input from neurosurgery
   b. For adequate external decompression, the size of the bone flap removed should ideally be 12 cm (anterior-posterior) by 9 cm (superior-inferior), combined with duraplasty [4].
   c. Temporal lobectomy may be considered during the procedure, at the neurosurgeon’s discretion. If performed, tissue should be submitted for neuropathological examination.
   d. The bone flap should be placed in a subcutaneous abdominal pouch or stored in the bone bank.

**Post-surgical Management**

   a. Admit the patient to an intensive care unit, preferably the Neuro ICU. The Neurocritical Care attending will be the attending of record.
b. Once appropriate, a protective helmet should be worn until the bone flap is replaced.

c. The bone flap should be replaced as soon as the patient can tolerate the surgery, preferably within 12 weeks, unless the patient develops intercurrent infections or other complications requiring delay.

d. Subsequent care: please refer to the management of patients with ischemic stroke [https://hub.partners.org/neuro/file-storage/download/Acute+Stroke+Management+and+Acute+Stroke+Care?file_id=13039791]

### Adjunctive Therapy

Although not proven efficacious, medical strategies may reduce the risk of developing fulminant brain edema. These strategies should be used in all patients with large MCA stroke and as an adjunct to hemicraniectomy (if the patient is deemed eligible). They should not be used to defer or delay hemicraniectomy if STATE criteria are met.

e. **General management:** patients with raised intracranial pressure require special attention to pain relief, avoidance of noxious stimuli, proper head positioning, adequate oxygenation, maintenance of normothermia, and prevention of DVT. Avoid oral or gastric feedings if the patient is likely to go to surgery imminently.

f. **Hyperventilation:** a temporary measure to reduce ICP if signs of brain herniation develop. Should be avoided unless other measures are exhausted and there is a plan to proceed immediately to surgery.

g. **Osmotic therapy:** please refer to our existing protocols for the prevention and treatment of cerebral edema. [https://hub.partners.org/neuro/file-storage/download/Brain+Edema+Management?file_id=13039964]

h. **Invasive ICP monitoring** (subarachnoid screw or bolt) is not required to determine suitability for decompressive surgery. An external ventricular drain should be considered if brain imaging shows evidence of acute hydrocephalus. It may be useful to monitor the ICP post-operatively if there is concern that the decompression was insufficient.

### Post-Thrombolysis Stroke Patients

The benefit of hemicraniectomy has not been studied in patients who fail to improve 24 hours after intravenous or intra-arterial thrombolysis, or who develop acute complications such as post-ischemic hemorrhage. Nevertheless, post-thrombolysis patients who are at risk for developing malignant MCA infarction also have a high mortality rate, and may benefit from early hemicraniectomy.

a. Consider hemicraniectomy if STATE criteria are met at the 24 hour post chemical thrombolysis time point (i.e. around the time of the 24-hour CT scan).
b. Consider hemicraniectomy in patients who develop symptomatic post-ischemic brain hemorrhage or malignant cerebral edema after thrombolysis. Given the wide range of clinical deterioration and size of post-ischemic hemorrhage, the decision should be made on a case-by-case basis, with consensus between the treating neurology and neurosurgical teams.

c. Decompressive hemicraniectomy should only be performed after normalization of coagulation parameters. Guidelines for reversal of abnormal coagulation parameters are similar to those developed for patients with brain hemorrhage [https://hub.partners.org/neuro/file-storage/download/ED+Management+of+ICH+6.2.15?file_id=13639801]
**STATE Criteria**

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<th>Factor</th>
<th>Criteria</th>
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<td><strong>Score</strong>, **</td>
<td>NIHSS item 1a ≥1 or GCS ≤ 8, and</td>
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<tr>
<td><strong>Time</strong></td>
<td>≤48 hr since last seen without neurological deficits</td>
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<tr>
<td><strong>Age</strong></td>
<td>≤ 60 years</td>
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<tr>
<td>** Territory**</td>
<td>Infarct lesion volume &gt;150 cm³ (use ABC/2 criteria for estimating lesion volume), or &gt;50% MCA territory infarction</td>
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<td><strong>Expectations</strong></td>
<td>Life expectancy ‘reasonable’ in the opinion of the Neurology Attending or NeuroICU Fellow. In addition, the health care proxy or family members understand that while the procedure is proven to reduce disability and mortality, the patient may still survive with severe disability.</td>
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If all the above “STATE” criteria are met, proceed to hemicraniectomy urgently (to OR within 4-6 hrs).

*for intubated/sedated patients, monitoring of the level of alertness can be challenging and the clinical judgment of the Neurology Attending is important in determining whether a patient meets this criterion.

**for patients who meet all STATE criteria except the level of drowsiness, patients should be triaged to the Neuro ICU for close neuromonitoring.

**Indications for emergent hemicraniectomy:**  STATE criteria met above, AND

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<th>Early Signs of Herniation</th>
<th>Asymmetry in pupil size</th>
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<td>Midline Shift</td>
<td>&gt;10mm at septum pellucidum, or &gt;5mm at pineal gland</td>
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References


Authors

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Approval

Neurology Quality and Safety Committee
Acute Stroke Quality Taskforce
Neuro ICU Clinical Practice Committee  7/7/2015