

# Decompressive Hemicraniectomy for Malignant Middle Cerebral Artery Infarct

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## ABSTRACT

**Objective:** To know outcome of Decompressive hemicraniectomy in patients presented with malignant middle cerebral artery (MCA) infarct.

**Materials and Methods:** This prospective study was conducted in Neurosurgery department of Lady Reading Hospital, from December 2011 to November 2014. A total number of 10 patients were included in the study. All patients were admitted in neurosurgery ward through emergency, were subjected to detail history and examination. After preoperative workup patients were operated in emergency. We analyzed gender, age, Glasgow Coma Scale (GCS) on admission, pre-surgical evaluation, clinical status on pre-surgical exam, and Glasgow Outcome Scale (GOS), immediate postoperatively, at 3 months and 6 months after discharge. We assessed outcome by Glasgow outcome score and modified Rankin scale (mRS). Data was analyzed by SPSS version 17.

**Results:** Of the total 10 patients, 8 (80%) were male and 2 (20%) were female. Age ranged from 40 to 75 years (mean  $62.7 \pm 11.19$  years). On admission, the mean GCS was 10 (Ranged from 8 to 12). Time between onset of symptoms and decompressive craniectomy was less than 24 hours in 2 (20%), 24-48 hours in 3 (30%), 48 – 72 hours in 1 (10%) and 72-96 hours in 4 cases (40%). Early surgery ( $\leq 48$  hours) was carried out in 5 (50%) cases and late surgery ( $\geq 48$  hours) in other 5 (50%) patients. Length of stay in the hospital was 7 to 16 (mean 11.5) days. Surgery improved significantly the GCS of patients comparing the immediate preoperative scores (6 to 10) and immediate post-operative GCS 5 to 15 (mean 10).

**Conclusion:** Decompressive hemicraniectomy increases the probability of survival without increasing the number of very severely disabled survivors. Still, the decision to perform surgery should be made on an individual basis in every patient.

**Keywords:** Decompressive Hemicraniectomy, Middle Cerebral Artery, Infarct, Outcome.

**Abbreviations:** GOS: Glasgow Outcome Scale. mRS: Modified Rankin Scale. GCS: Glasgow Coma Scale. MCA: Malignant Middle Cerebral Artery. DHC: Decompressive Hemicraniectomy. MRI: Magnetic Resonance Imaging. ICP: Intra Cranial Pressure. CT: Computed Tomography.

## INTRODUCTION

Brain infarction involving supratentorial compartment, 10 to 15% cases involve the entire MCA territory with mortality rate of 80% despite aggressive medical treatment.<sup>1-4</sup> This type of extensive ischemic stroke has termed as malignant MCA infarction and is associated with severe brain edema, causing raised Intra Cranial Pressure (ICP) and ultimately leading to brain herni-

ation.<sup>5</sup> In these types of cases of cerebral infarction, usually medical treatment remains ineffective.<sup>6</sup> Decompressive hemicraniectomy has shown to reduce mortality and improve functional outcome following malignant MCA infarction in healthy young patients.<sup>7-</sup>

<sup>10</sup> The technique of this treatment modality consists of opening the skull, removal of a bone flap to allow the edematous brain to swell outward, and so preventing

intracranial tissue shifts and life-threatening downward brain herniation.

The use of decompressive hemicraniectomy (DHC) for ischemic brain edema had been reported already in 1956.<sup>11</sup> Since that time, DHC has been increasingly used in the setting of different conditions, including traumatic brain injury, subarachnoid hemorrhage and malignant MCA infarction. In diffuse brain edema without a midline shift, as commonly seen in traumatic brain injury, bilateral craniectomy has been advocated. Hemicraniectomy, or removal of a frontotemporoparietal bone flap, is suitable in patients with unilateral hemisphere swelling as seen after ischemic stroke.<sup>12</sup> Indication of surgical treatment for malignant MCA infarct varies however. Neuroimaging criteria is: infarct volume on diffusion-weighted magnetic resonance imaging (MRI) of more than 145cm<sup>3</sup>; brain computed tomography (CT) ischemic changes affecting more than two-thirds of the MCA territory and including the basal ganglia; brain CT ischemic changes affecting at least two-thirds of the MCA territory with space-occupying edema.<sup>13,14</sup>

Cerebral ischemia after stroke results in oedema formation in and around the affected area. In the case of malignant cerebral infarction, the entire territorial distribution of the MCA, and possibly the anterior cerebral artery, is compromised. A severe oedematous response starts throughout a large area.<sup>15</sup> Oedema is represented on CT brain as parenchymal hypodensity.<sup>16,17</sup> One of the basic pathophysiological processes after Cerebrovascular accident is the development and extension of an escalating cycle of brain swelling resulting an increase in ICP. The objective<sup>18</sup> of the decompressive hemicraniectomy consists of interrupting this cycle by controlling ICP and maintaining cerebral perfusion pressure and cerebral blood flow to avoid brain ischemia.

As many patient presents with malignant MCA infarct, we conducted this study to know about outcome of Decompressive hemicraniectomy for these patients. This study is important because it will open a gateway for future researchers on this topic by providing the statistics of disease burden and efficacy of this procedure. Furthermore by comparison with the results of both national and international studies it will provide us an idea about the skills and experience of our set up neurosurgeons, while operating the cases of malignant MCA infarct by this technique and this will be a set for the patient betterment and care.

## MATERIAL AND METHODS

This prospective study was conducted in Neurosurgery Unit of Lady Reading Hospital, from December 2011 to November 2014. A total number of 10 patients were included in the study.

### Inclusion Criteria

1. Patients of either age and sex.
2. Computed tomography documented unilateral MCA infarction, involving at least 2/3<sup>rd</sup> of the territory and including at least part of the basal ganglia, with or without additional ipsilateral infarction of the anterior or posterior cerebral artery.
3. Patients with massive middle cerebral artery infarction with impending herniation or early signs of herniation confirmed on neuroimaging, progression of neurological deterioration, GCS  $\leq$  8 and cistern compression or midline shift at CT scan.

### Exclusion Criteria

1. Bilateral fixed and dilated pupils.
2. Decreased consciousness because of medications or metabolic causes.
3. Alteplase in last 12 hours before surgery.
4. Known systemic bleeding disorder.
5. Contraindication for anesthesia.
6. Pregnancy.

All patients were admitted in neurosurgery ward through emergency, were subjected to detail history and examination. All patients had routine hematological and biochemical profile, ECG, echocardiography, CT brain, MRI brain with MRS in selected cases and carotid Doppler. After preoperative workup all patients were operated in emergency.

### Technique of Surgery

A question mark-shaped skin flap and a wide craniotomy was performed on the affected side with partial removal of the frontal, temporal, and parietal bones, and the bone flap have a minimum of 12 cm diameter. The dura was opened in a "C" shape all over and 2cm distant to the border of the craniotomy. Pericranium or temporalis fascia was placed into the incision with an aim to enlarge cranial cavity. The bone flap was placed in a subcutaneous pocket overlying the abdomen for preservation and was replaced back after 3 months.

Postoperatively patients were kept in ICU. We analyzed gender, age, Glasgow Coma Scale (GCS) on

admission, pre-surgical evaluation, clinical status on pre-surgical exam, and Glasgow Outcome Scale (GOS), immediate postoperatively, at 3 months and 6 months after discharge. We assessed outcome by Glasgow outcome score and modified Rankin scale (mRS). Data was analyzed by SPSS version 17.

**RESULTS**

Of the total 10 patients, 8 (80%) were male and 2 (20%) were female. Age ranged from 40 to 75 years (mean 62.7 ± 11.19 years). On admission, the mean GCS was 10 (Ranged from 8 to 12). The mean GCS on immediate pre-surgical evaluation was 6 to 10 (mean 8) (Table 1). Four patients (40%) presented with pupillary changes on pre-surgical evaluation; aphasia occurred in 4 cases (40%) and hemiplegia presented in all (100%) patients. Eight patients (80%) had malignant MCA infarction and 2 (20%) had associated ACA territory infarction. The dominant hemisphere was affected in 3 cases (30%) and the non-dominant hemisphere in 7 cases (70%). Time between onset of symptoms and decompressive craniectomy was less than 24 hours in 2 (20%), 24 – 48 hours in 3 (30%), 48 – 72 hours in 1 (10%) and 72 – 96 hours in

4cases (40%). Early surgery (≤ 48 hours) was carried out in 5 (50%) cases and late surgery (≥ 48 hours) in other 5 (50%) patients. Length of stay in the hospital was 7 to 16 (mean 11.5) days. Surgery improved significantly the GCS of patients comparing the immediate preoperative scores (6 to 10) and immediate post-operative GCS 5 to 15 (mean10) (Table 1).

Occurrence of GCS < 8 in the pre-surgical evaluation was associated to a higher length of hospital stay (16 days). There was no statistical significance difference in the outcome between men and women, surgery before and after 24 hours, left and right side stroke groups. Patients older than 60 years presented worst outcome at six months. Post operatively outcome was measured using Glasgow outcome scale (GOS) (Table 2) and modified Rankin score (mRS) (Table 3). Based on outcome, patients were grouped in to 4 grades (Table 4). Four patients (40%) presented a good outcome (2 functionally independent, 2 with moderate disability) at 6 months evaluation. Four (40%), patients who survived had a poor outcome (2 severely disabled, 2 died). Remaining two (20%) patients of our series died after the surgical procedure, secondary to the presented brain lesion and hemodynamic instability.

**Table 1:** Characteristics of Patients (n = 10).

Patient No.	Gender	Age (in years)	Stroke Side	Preop. GCS	Postop. GCS	GOS
1.	M	72	Right	8	12	3
2.	M	61	Right	8	8	3
3.	M	58	Left	8	6	2
4.	F	40	Right	6	5	1
5.	M	74	Right	12	15	4
6.	M	59	Right	10	8	2
7.	F	75	Left	11	15	4
8.	M	51	Right	11	15	4
9.	M	70	Right	10	15	4
10.	M	67	Left	7	6	1

**Table 2:** Glasgow Outcome Scale.

Score	Description
1	Death
2	Persistent Vegetative state
3	Severe Disability
4	Moderate Disability
5	Good recovery

**Table 3: Modified Rankin Scale.**

Level	Description
0	No symptoms
1	No significant Disability despite symptoms
2	Slight disability; inability to perform all previous activities
3	Moderate disability; Able to walk without assistance
4	Moderately severe disability; Unable to walk without assistance
5	Severe disability; bed ridden, requires constant nursing care

**Table 4: Grading for Outcome.**

Grade	Characteristics	Outcome
G1	Functionally independent, MRS 0 to 1 or GOS 5	Good
G2	Mild to moderate disability, MRS 2 to 3 or GOS 4	Good
G3	Severely disabled, MRS 4 to 5 or GOS 2 to 3	Poor
G4	Death	Poor

**Table 5: Prospective RCTs on Hemicraniectomy in Malignant MCA Infarction.**

Mortality and Outcome (Hemicraniectomy Versus Conservative)						
Study Name	Inclusion Criteria	Primary Outcome Measure	No.	Mean Age, years	Mortality, %	Good Outcome, %
Decimal 12	Age 18–55 years within 24 hours from symptom onset	mRS<4 at 6 months	20 versus 18	43.5 versus 43.4	25.0 versus 77.8	50.0 versus 22.2
Destiny 13	Age 18–60 years 12–36 hours from symptom onset to surgery	mRS<4 at 6 months	17 versus 15	43.2 versus 53.3	17.6 versus 53.0	47.1 versus 26.7
Hamlet 14	Age 18–60 years within 96 hours from symptom onset	mRS<4 at 12 months	32 versus 32	50.0 versus 47.4	22.0 versus 59.0	25.0 versus 25.0
He Add First	Clinical and radiological	Death, functional outcome, quality of life,	Stopped at		Awaiting publication	
	deterioration within 96 hours from symptom onset	patient perceptions, acute healthcare use after 21, 90, and 180 days	N = 26			
He MMI	Clinical deterioration within 72	mRS and Barthel Index at discharge, 2			No data available	
	hours from symptom onset	weeks, 1, 3, and 6 months				

**DISCUSSION**

Decompressive hemicraniectomy has been studied as a way to relieve mass effect related to mass lesions. Hemicraniectomy and durotomy can relieve the pre-

ssure from swollen, infarcted brain tissue, preventing brain herniation and death.<sup>19</sup> Decompressive craniectomy procedures have been used to relieve increased ICP and cerebral oedema caused by a variety of patho-

logical events. Cushing<sup>20</sup> reported in 1905, the use of this procedure to relieve the pressure caused by the growth of an intracranial tumour.<sup>21-23</sup> After that, surgical decompression has been reported as a treatment option for traumatic head injury,<sup>24,25</sup> subdural haematoma,<sup>26,27</sup> cerebral venous and dural sinus thrombosis,<sup>28</sup> cerebellar infarction<sup>29,30</sup> and supratentorial cerebral ischemia.<sup>31,32</sup>

Three European randomized controlled trials (Table 5) with primary end points based on functional outcome have recently been completed: DECIMAL (decompressive craniectomy in malignant middle cerebral artery infarcts)<sup>33</sup>; DESTINY (decompressive surgery for the treatment of malignant infarction of the middle cerebral artery)<sup>34</sup> and HAMLET (hemicraniectomy after middle cerebral artery infarction with life-threatening edema trial).<sup>35</sup> We studied 10 cases of supratentorial malignant MCA infarct that were subjected to decompressive craniectomy. The ages of the patient ranged from 40 to 75 years. We had poor outcome in patients with age more than 60 years. In previous studies age has been suggested as a key factor to benefit from decompressive surgery after malignant cerebral infarct.<sup>36,37</sup> This might be due to the diminished capacity for neuroplasticity in elderly patients.<sup>38</sup>

In the present study dominant side was involved in 3 (30%) patients and in literature there is no difference based on the side involved. Gupta et al<sup>39</sup> reviewed the functional outcomes of 27 patients with decompression of the dominant hemisphere and 111 patients who had non-dominant infarcts and found that the outcomes were similar. We had good outcome (MRS 0 to 3, GOS 4 to 5) in 4 (40%) patients. Study conducted by Joao paulomattosetal<sup>40</sup> with decompressive hemicraniectomy for malignant MCA infarct had ten patients (47.61%) presented a good outcome at the 6 months evaluation. We had outcome lower as compared to international study, it might be due to late referral/access and least facilities. Another international study conducted by Abdolkarim Rahmanian et al<sup>41</sup> in Shiraz university of medical sciences Tehran, had reduced mortality to 20% with decompressive surgery as compared to 67% in patients who were managed with aggressive medical therapy. So our results are also comparable with their results regarding outcome.

We had mortality in 20% patients. Ralph Rahme et al<sup>42</sup> had literature review of 382 patients and they had mortality 24.3% (93 patients), it is because of large sample size. Our results regarding mortality are better, but we had small sample size and short follow up.

## CONCLUSION

Decompressive hemicraniectomy increases the probability of survival without increasing the number of very severely disabled survivors. Still, the decision to perform surgery should be made on an individual basis in every patient.

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