

# Decompressive Hemicraniectomy in the Treatment of Malignant Middle Cerebral Artery Infarction

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## Abstract

**Background:** Malignant middle cerebral artery infarctions affecting about 10% of stroke patients. Formed of huge space-occupying infarctions with extensive edema which lead to herniation, and usually death. Treatment includes medical treatment in addition to decompressive hemicraniectomy associated with duroplasty in many cases. Decompressive craniectomy has a great effect in reduction of mortality rates and improving the functional outcome of the patients.

**Aim of Study:** We reviewed the outcome of decompressive hemicraniectomy in the treatment of Malignant Middle Cerebral Artery infarction.

**Patients and Methods:** The study includes 14 patients of malignant middle cerebral artery infarctions operated upon by decompressive surgery (from January 2015 to August 2018). We evaluated the outcome by estimation of the mortality rate after one month, Glasgow Outcome Score (GOS) on leaving the hospital, at 3 months, and 6 months by modified Rankin scale (mRS).

**Results:** Decompressive craniectomy leads to decrease in mortality rate at 30 days and acceptable GOS outcome at discharge. At 3 months and 6 months good functional outcome based on mRS occurred in cases of the infarction volume below than 250ml, midline shift below 10mm, good Glasgow Coma Scale (GCS) score before surgery and rapid surgical intervention (within 24 hours).

**Conclusion:** Decompressive craniectomy gets great functional outcome in cases of young cases with acceptable GCS score before surgery, fair radiological pictures, and operated upon in less than 24 hours of onset.

**Key Words:** *Malignant cerebral infarction – Decompressive craniectomy – Outcomes.*

## Introduction

**THE** incidence of malignant Middle Cerebral Artery (MCA) infarction in cases diagnosed as

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ischemic stroke is up to 10% of all patients. It is defined as an infarction affecting an area including at least two thirds of that supplied by the MCA [1]. Huge space-occupying infarctions with extensive edema which lead to herniation, and usually death. Extensive cerebral edema and infarcted brain tissue cause mass effect which leads to brain tissue displacement and increasing in Intracranial Pressure (ICP). Early clinical pictures include manifestation of MCA occlusion, like hemiparesis, hemiplegia,, and altered consciousness [2]. Rapid deterioration occur in these patients within first 48 hours as a result of mass effect that may leads to death [3]. Intensified medical treatment with mechanical and hyperventilation, hypothermia, osmotic diuretics, and sedation, not effective enough with noted mortality rates up to 80% in spite of ideal medical management [4]. Decompressive craniectomy has been recommended as a management option for huge hemispheric infarctions with cerebral edema [5]. The philosophy of the therapy is to make a space to adapt for expansion of the swollen brain, to allow normalization of intracranial pressure, avoiding brain tissue herniation, and maintaining cerebral blood flow to avoid secondary brain insult [6]. Decompressive craniectomy was initially suggested as a management option for malignant MCA infarction in 1956 by Scarcella [7]. Early expert cited the poor functional outcome, moreover, the surgical complications and non resolved several points continued in early studies which included age limit, timing of surgery, the limits of satisfactory results and selection of the patients. Then the rates of death reduced significantly and functional outcome improved in cases managed by decompressive craniectomy in three randomized controlled trials, the DECIMAL [8], HAMLET [9], and DESTINY [6] key factors associated with encouraging result include younger age and rapid surgical treatment.

### Patients and Methods

Malignant MCA infarction and their mass effect diagnosed by non contrasted CT scan Fig. (1). The study included 14 patients of malignant middle cerebral artery infarctions operated upon by decompressive surgery (from January 2015 to August 2018). Pre-treatment clinical evaluation was based on the Glasgow Coma Scale (GCS). We assessed results by estimation of the rate of mortality after one month, Glasgow Outcome Score (GOS) (Table 1) on discharge, and after 3 and 6 months by modified Rankin scale (mRS) months.

#### The Modified Rankin Scale (mRS) [10]:

The scale runs from 0-6, running from perfect health without symptoms to death.

- 0- No symptoms at all.
- 1- No significant disability. Able to carry out all usual activities, despite some symptoms.
- 2- Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities.
- 3- Moderate disability. Requires some help, but able to walk without assistance.
- 4- Moderately severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted.
- 5- Severe disability. Requires constant nursing care and attention, bedridden, incontinent.
- 6- Dead.

Table (1): The Glasgow Outcome Scale (GOS) [11].

| (GOS) score | Functional status   |
|-------------|---|
| 5           | • Good recovery: Resumption of normal life despite minor deficits.                  |
| 4           | • Moderate disability: Disabled but independent; can work in sheltered setting.     |
| 3           | • Severe disability: Conscious but disabled; dependent on others for daily support. |
| 2           | • Persistent vegetative state: Minimal responsiveness.                              |
| 1           | • Death.  |

Surgical treatment by decompressive craniectomy measure about 10 X 12cm in width Fig. (2) with duroplasty Fig. (3). Inclusion criteria include age range 18-65 years, GCS score more than 6, less than 48 hours from the symptoms onset to surgery, progressive decrease in the level of consciousness, CT picture of infarction in the MCA territory not less than 50%, or infarct volume at least 145cm<sup>3</sup>. We excluded patients had GCS equal or less than 6 and patient with loss of brain stem reflexes, prestroke score on the MRS >2, other

serious illness, contralateral ischemia, or other brain pathology.

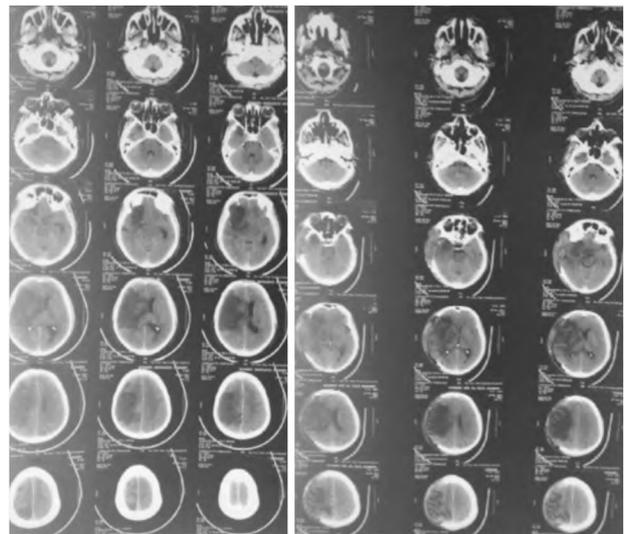


Fig. (1): (A) CT scan of right malignant middle cerebral artery infarction. B) After decompressive hemicraniectomy.

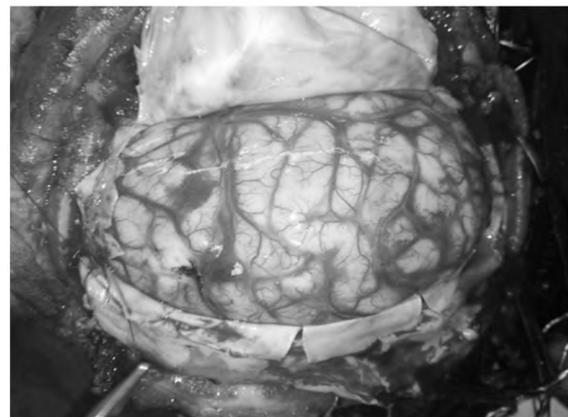


Fig. (2): Standardized decompressive craniectomy measuring 10 X 12cm in diameter.

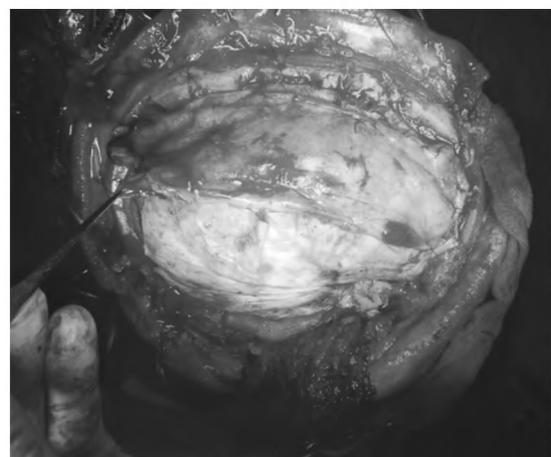


Fig. (3): Augmentation duroplasty done by pericranium.

**Results**

The study included 14 patients with malignant MCA infarction during the study period. Mean age of the patients was 52.7 (±8.17) years. Ranging from 34 to 65 years, the most of patients between 46-55 years of age (43%). Non dominant hemisphere was involved in 6 patients (42.9%) while dominant hemisphere affection was seen in 8 patients (57.1%). Mean time from stroke onset to brain CT scan was 11.2 hours. Infarct volume ranged between 200ml and 330ml, and was classified as either less than or exceeding 250ml. Infarct volume exceeding 250ml was seen in 64.3% of the total sample (9 patients) median midline shift in this was 8.2mm, and a cut off of 10mm was used to classify cases. Midline shift exceeding 10mm was noted in (57%) 8 of the patients.

Most of the patients (71.4%) 10 had a GCS score of between 6 and 9 before surgery. Mean time (±SD) between stroke onset and surgery was 27.3h (±8.6).

Mortality rate was (35.7%) 5. Favorable outcome based on GOS at discharge (33%) 3 from 9. Good outcome based on (mRS <4) was seen in (44.4%) 4 patients after 3 months. (66.6%) 6 patients after 6 months. Table (2).

Table (2): Outcome in patients with malignant MCA.

| Outcome measure                   |                |
|-----------------------------------|----------------|
| <i>Mortality rate at 30 days:</i> |                |
| Alive                             | 64.3% (9/14)   |
| Death                             | 35.7% (5/14)   |
| <i>GOS at discharge:</i>          |                |
| Unfavorable <=3                   | 67%            |
| Favorable 4-5                     | 33% 3 patients |
| <i>mRS at 3 months:</i>           |                |
| Poor outcome <=3                  | 56%            |
| Good outcome 4-6                  | 44% 4 patients |
| <i>mRS at 6 months:</i>           |                |
| Poor outcome                      | 33%            |
| Good outcome                      | 67% 6 patients |

**Discussion**

The outcome of the patients after 6 month of surgery had a significant affection with pre-operative GCS score, the GCS score was used as the primary tool of evaluation in this study. Consistent with the findings from previously published papers, the GCS score is accurate in predicting outcome of the patients with malignant MCA territory infarction. GCS score has a strong predictive value for outcome, good functional outcome was obtained in cases with GCS 10-13 before surgery

at 6 months (90.9%), in contrast to those with GCS score 6-9 before surgery (45.6%) [12]. In our study pre-op. GCS 10-13 had a good functional outcome in 75% poor in 25% and GCS 6-9 had a good functional outcome in 30% poor in 70%. Good functional outcome after 6 months was obtained in patients aged 56-65 years and operated upon by decompressive craniectomy (64.4% good outcome), in contrast to cases managed medically (25% good outcome), this indicate the advantage of decompressive craniectomy this age group [13,14]. In our study good functional outcome at 6 months was obtained in (66.6%) of cases younger than 56 years. Results from [5,6,9] showed that outcome form dominant hemisphere involvement was unfavorable comparable with that from non dominant hemispheric infarction similar findings were noted in this study. Poor outcome at 6 months obtained in cases infarct volume more than 250ml and managed surgically [15] similar findings were noted in our study infarction volume of less than 250 had a GOOD result in 80% and poor result in 20% infarct volume of more than 250 had a good result in 22% poor in 78%. Midline shift more than 10mm associated with bad outcome at 6 months [15] similar findings were noted in our study midline shift less than 10mm good result in 83%, poor in 17% midline shift more than 10mm good result in 12.5% poor in 87.5% (Table 3).

Table (3): Factors influencing outcome at 6 months.

| Factors                  | N  | Good outcome 6M | Poor outcome 6M |
|--------------------------|----|-----------------|-----------------|
| <i>Age:</i>              |    |                 |                 |
| <56                      | 6  | 66% (4/6)       | 33% (2/6)       |
| >56                      | 8  | 25% (2/8)       | 75% (6/8)       |
| <i>Site infarction:</i>  |    |                 |                 |
| LT                       | 8  | 37.5% (3/8)     | 62.5% (5/8)     |
| RT                       | 6  | 50% (3/6)       | 50% (3/6)       |
| <i>Volume:</i>           |    |                 |                 |
| <250                     | 5  | 80% (4/5)       | 20% (1/5)       |
| >250                     | 9  | 22.2% (2/9)     | 77.8% (7/9)     |
| <i>Midline shift:</i>    |    |                 |                 |
| <10                      | 6  | 83.3% (5/6)     | 16.7% (1/6)     |
| >10                      | 8  | 12.5% (1/8)     | 87.5% (7/8)     |
| <i>Pre-op. GCS:</i>      |    |                 |                 |
| 10-13                    | 4  | 75% (3/4)       | 25% (1/4)       |
| 6-9                      | 10 | 30% (3/10)      | 70% (7/10)      |
| <i>Surgery interval:</i> |    |                 |                 |
| <24h                     | 5  | 80% (4/5)       | 20% (1/5)       |
| >24h                     | 9  | 22.2% (2/9)     | 77.8% (7/9)     |

**Conclusion:**

Decompressive craniectomy gets great functional outcome in cases of young cases with acceptable GCS score before surgery, fair radiological

pictures, and operated upon in less than 24 hours of onset.

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## قطع القحف لعلاج جلطات المخ النتيجة عن الإنسداد الخبيث للشريان الدماغى الأوسط

مقدمة: يمثل الإنسداد الخبيث للشريان الدماغى الأوسط حوالى ١٠٪ من مرضى جلطة المخ. يتكون من حجم ضخم من المخ المحتشى مع إرتشاح كبير على المخ مما يؤدي إلى زيادة ضغط المخ وغالباً الوفاة. العلاج يشمل إما علاج نوائى أو علاج جراحى عن طريق قطع القحف وترقيع اللأم الجافية. يؤدي قطع القحف إلى تقليل معدلات الوفاة وتحسين الحالة الوظيفية للمرضى.

الطرق: الدراسة تضمنت ١٤ مريض مصابين بجلطة المخ نتيجة الإنسداد الخبيث للشريان الدماغى الأوسط تم علاجهم جراحياً فى الفترة من يناير ٢٠١٥ إلى أغسطس ٢٠١٨. تم تقييم النتائج عن طريق تحديد معدل الوفاة بعد ٣٠ يوم وتحديد المعدل الوظيفى للمريض بعد ٣ و٦ شهور.

النتائج: قطع القحف يؤدي إلى تقليل معدل الوفاة للمرضى بعد ٣٠ يوم والحصول على معدل وظيفى جيد للمرضى بعد ٣ و٦ شهور فى حالة أن يكون حجم إحتشاش المخ أقل من ٢٥٠ ملل ودرجة الوعي جيدة قبل الجراحة والتدخل الجراحى السريع.

الخلاصة: قطع القحف لعلاج جلطات المخ الناتج عن الإنسداد الخبيث للشريان الأوسط للمخ يؤدي إلى نتائج وظيفية جيدة فى حالات صغر عمر المريض ودرجة وعى جيدة للمريض قبل الجراحة وصورة أشعة معقولة والتدخل الجراحى فى زمن أقل من ٢٤ ساعة.