Decompressive Craniotomy after Traumatic Brain Injury: Post Operative Clinical Outcome

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ABSTRACT

Background: A decompressive craniotomy can relieve critically increased intracranial pressure. Objective: to assess the postoperative clinical outcome and compare it with other series. Methods: (a) patient selection: patients presented to the Neuroemergency unit in Kasr El-Eini Hospitals from January 2006 to December 2007 with traumatic brain injury and fulfilling the following criteria 1) clinical deterioration to Glasgow coma scale (GCS) 11 or presented to us with GCS (5-11) and refractory to conservative treatment of increased intracranial tension, 2) age ranging from 20 to 60 years, 3) radiological criteria: unilateral brain swelling with midline shift. (b) procedure: decompressive hinge craniotomy. (c) Evaluation of postoperative clinical outcome by the Glasgow outcome scale (GOS) at the time of hospital discharge and at 6-months thereafter, then comparing the clinical outcomes with those of in other researches. Results: The overall outcomes at 6-months follow up were good in 9 patients (45%), fair in 2 patients (10%), poor in 9 patients (45%).mortality in 6 cases (30%), vegetative state was seen in 3 cases (15%), overall survival was 70% with favorable outcome in 65% of the survivors. Conclusion: Age and initial posttraumatic GCS remain to be the most important factors in determining the postoperative clinical outcome. Decompressive hinge craniotomy provided favorable clinical results in nearly 45% of patients who were otherwise most likely to die. (Egypt J Neurol Psychiat Neurosurg. 2010; 47(2): 255-259)

Key words: Decompressive hinge craniotomy, traumatic brain injury.

INTRODUCTION

Decompressive craniectomy is performed in the treatment of uncontrollable unilateral cerebral edema resulting from trauma and other conditions. This procedure and its indications remain controversial, yet much study data suggest the procedure is beneficial for some conditions, particularly head trauma. Conservative treatment options for brain edema, which include hyperventilation, mannitol or hypertonic saline solution, and barbiturate coma, often cannot control rapidly increasing intracranial pressure (ICP) resulting from brain swelling after severe traumatic brain injury (TBI). Techniques of neuromonitoring certainly have improved the management of comatose patients. The clinical status of the patient can be monitored continuously, and the resulting therapy will be adjusted accordingly. However, faced with the constant increase in ICP despite aggressive medical treatment, a critical situation arises. The last option is left with the decompressive craniectomy. One important drawback of this operation seems to be the unsatisfactory long-term outcome, new surgical modality for craniotomy appears to reduce the need for subsequent cranioplasty among patients undergoing surgical cerebral decompression. The efficacy of the hinge craniotomy technique in reducing the mortality rate remains undetermined due to the absence of comparable groups undergoing craniotomy/craniectomy techniques. Therefore, we have examined the postoperative clinical outcome of decompressive hinge craniotomies after TBI associated with unilateral brain edema and midline shift.

PATIENTS AND METHODS

Patient Population

In a two-year period from January 2006 to December 2007, twenty patients (14 males and 6 females) with TBI underwent decompressive hinge craniotomy to control raised ICP. The age ranged from 20 to 60 years (Table 1). On admission, the initial GCS score was assigned by the evaluating neurosurgeon present in the emergency department, Cairo University hospitals after resuscitation, to establish a diagnosis; a cranial CT scan was obtained. Unilateral brain edema, compression of the cortical gyri or basal cisterns, signs of incipient herniation, midline shift, were indicators of raised ICP.

After completing the diagnostic procedures, the patients either underwent emergency surgery or were admitted to the ICU and the following protocol for treating raised ICP was used, The patient’s head was elevated up to 30°. Patients were ventilated artificially, and the PaCO2 was kept between 30 and 35 mm Hg. Extensive hyperventilation was avoided. Hypersomotic
solutions such as mannitol were used as bolus infusions up to 6 times per day. If mannitol was not sufficient in decreasing ICP, we also used barbiturates in patients with extensive global brain swelling.

**Table 1.** Age distribution of patients.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of patients</th>
</tr>
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<tbody>
<tr>
<td>20-30 years</td>
<td>5</td>
</tr>
<tr>
<td>31-40 years</td>
<td>6</td>
</tr>
<tr>
<td>41-50 years</td>
<td>3</td>
</tr>
<tr>
<td>51-60 years</td>
<td>6</td>
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In this study, a decompressive hinge craniotomy was performed when the following criteria were met:
1. Clinical criteria: Clinically deteriorating patient to GCS 11 or presented by GCS (5-11) and refractory to conservative treatment (Table 2).
2. Radiological criteria: Unilateral brain swelling with midline shift more than 5 mm.
3. The patient’s age was 20-60 years.

**Operative Procedure**

With the patient is under general anesthesia, a large unilateral question mark skin incision is made. An approximately (12x15 cm) bone flap is removed based on the temporals muscle, taking in consideration that the craniotomy should be done with good beveling. A large dural opening is done by stellate manner and if there is accompanying subdural hematoma, it should be evacuated. The dura was left open but laid back over the brain, and the exposed brain is covered with a sheet of compressed gel foam. The bone flap was then returned to the operative field. A two long 0 prolene sutures were taken at two medial angles of bone flap (sutting the peristium of the bone flap to that of the skull) to hold the flap insitu and to allow the bone flap to rise as cerebral edema occurs. Then closure of the galea and skin with suction drain, and the head was gently wrapped with gauze.

**Table 2.** Glasgow coma scale of the patients at the time of operation.

<table>
<thead>
<tr>
<th>Glasgow coma scale</th>
<th>Number of patients</th>
</tr>
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<tbody>
<tr>
<td>GSC 11</td>
<td>7</td>
</tr>
<tr>
<td>GSC 8-10</td>
<td>5</td>
</tr>
<tr>
<td>GCS 5-7</td>
<td>8</td>
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</table>

**Postoperative Evaluation**

Postoperatively, regular clinical monitoring of the patient using GCS and cranial CT scans were obtained in all patients on days 1, 3, and 5 to assess the brain swelling, midline shift, the adequacy of decompression and assess for additional pathological findings such as contusions or new hemorrhages. After a few weeks, with the relaxation of brain edema, the bone flap returns to a more anatomically correct position helped by elastic bandage application for three weeks. Follow up cranial CT scan (bone window) was done and the bone flap is assessed as regarding its position and cosmetic aspect.

In our study, Post operative clinical outcome was assessed at discharge and six months after discharge using Glasgow outcome scale.

**Statistical Analysis:**

Data were statistically described in terms of frequencies (number of cases) and relative frequencies (percentage). Yates correction equation was used when the expected frequency is less than 5. A probability value (p-value) less than 0.05 was considered statistically significant. All statistical calculations were done using computer program Microsoft Excel version 7 (Microsoft Corporation, NY, USA) and PASW (formerly SPSS, statistical package for the social sciences; SPSS Inc., Chicago, IL, USA) version 17 for Microsoft Windows.

**RESULTS**

From January 2006 to December 2007, twenty patients; sixteen men and four women with age ranged from 20 to 60 years were admitted to our hospital presented with traumatic brain injury associated with unilateral hemispheric swelling and midline shift. The apillary status was assessed on admission and hourly afterward by the staff of the ICU. Of the 20 patients, 15 patients initially had normal-sized pupils, 5 patients showed unilateral wide pupils.

Ten patients were found to have small cortical contusions and six patients were found to have acute subdural hematoma, which was evacuated during the craniotomy and four patients had posttraumatic infarction.

Unilateral brain swelling and midline shift, cortical gyri and lateral ventricles compression were seen on the initial cranial CT scan in 8 patients while present later on subsequent follow up C.T in the remaining 12 patients. Signs of brain stem compression were seen in 8 patients.

In eight patients (40%) the operation was undertaken on admission as they present with clinical and radiological signs of brain stem compression. In the remaining 12 patients (60%) the operation was done later during their hospital stay, seven patients were operated in the next 48 hours. Five patients underwent decompressive craniectomy after two days of admission.

A large hinge hemisacraniotomy was performed in 20 cases (8 on the left side and 12 on the right).
**Postoperative Complications**

- **Postoperative early complications**: Reoperation occurred in two patients (10%) who had undergone a previous decompressive hinge craniotomy as their postoperative cranial CT showed new subdural hematoma so the patient underwent reoperation for evacuation.

- **Late Complications**: Three patients (15%) showed late complications, two patients developed hydrocephalus that needed a ventriculoperitoneal shunt, and 1 patient presented with meningitis 10 days after the operation. These complications were not attributable to the previous operation but were rather problems that arose from the severity of the trauma. Elective fixation of the bone flap was needed only in 4 cases of the survivors in whom the bone flap remained flail after wrapping the head for 3 weeks by elastic bandage.

![Table 3. Postoperative clinical outcome.](image)

<table>
<thead>
<tr>
<th>Outcome (GOS)</th>
<th>Discharge %</th>
<th>Last follow up %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good (GOS 4,5)</td>
<td>35%</td>
<td>45%</td>
</tr>
<tr>
<td>Fair (GOS 3)</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Poor (1,2)</td>
<td>45%</td>
<td>45%</td>
</tr>
</tbody>
</table>

Data are expressed as percentage

**Long-Term Results**

The overall outcomes at 6-months follow up were good (GOS 5 and GOS 4) in 9 patients (45%) , these patients could communicate well and showed only mild deficits of speech and memory, fair outcome (GOS 3) in 2 patients (10%) and poor outcome (GOS 1,2) in 9 patients (45%) (Table 3). Mortality was 6 cases (30%), five patients died within the 1st week after decompressive craniotomy. These patients had undergone emergency surgery; prior to the operation their pupils had been dilated, one patient died 5 weeks postoperatively due to multi-organ failure. Vegetative state was seen in 3 cases with them communication was not possible. Overall survival rate was 70% with favorable outcome in 65% of survivors.

**DISCUSSION**

The management of posttraumatic uncontrollable brain swelling remains a challenge for neurosurgeons, anesthesiologists, and intensivists. Cerebral ischemia seems to be one of the most important factors in regard to posttraumatic secondary brain damage and brain swelling. Faced with constantly rising ICP, only few treatment options exist. A unilateral or bilateral decompression with a dural graft for the treatment of malignant brain swelling after trauma has been used less often since the early 1980s. This was mainly due to the unsatisfactory long-term results.

Intracranial pressure monitoring is an important tool in evaluation of the patients with increased intracranial tension. Clinical and radiological evaluations were the cornerstone in selection and evaluation of the study group since the ICP monitoring is not feasible in every center.

In our study, the overall outcomes at last follow up were good (GOS 5 and GOS 4) in 9 patients (45%), fair outcome (GOS 3) in 2 patients (10%) and poor outcome (GOS 1,2) in 9 patients (45%). Mortality was 6 cases (30%) and vegetative state was seen in 3 (15%) cases. Overall survival rate was 70% with favorable outcome in 65% of the survivors.

Results from a late 1980s report showed that survival rates in patients suffering from head injury who underwent decompressive craniectomy were as high as 70% whenever the surgical procedure was accompanied by vigorous medical management. More recent data have revealed survival rates from 60 to 95%, with two thirds of those survivors having favorable outcomes.

Our results are slightly lower than that of the series of traditional decompressive craniectomy, because the age distribution in 45% of the cases of our study had age range 41-60 year while 55% of cases had range 20-40.

Gaab et al. performed a decompressive craniectomy in 37 patients with traumatic brain injury associated with unilateral brain swelling and midline shift with their age limit below 40 years and their GCS is equal to or more than 7, the survival in their study was 86.5% of the cases and mortality was 13.5%.

The differences between the results of our study and that of Gaab et al are attributed to two important factors that directly affect the final outcome, the age limit was 40 their study while it is 60 in our study and the initial post traumatic GCS in their study was equal to or above 7 but GCS in our study was 7-11 so the difference in age and initial GCS could explain the difference in results.

The age of the patient and initial post traumatic GCS are of the main prognostic factors and most important criteria for good postoperative results. Different retrospective analyses have confirmed the fact that younger patients benefit from a decompressive craniectomy. In our study the age of the patients was range 20–60 years. The age of the 6 patients who died postoperatively was 51–60 years. The age of the 3 patients who revealed a poor postoperative result was 41–50 years. This was significantly older than the age of the group in which patients could be rehabilitated fully (20–40 years). Patients with a GOS 5 postoperatively were 20–30 years. Therefore, age per se seems to determine the final outcome.

Meier et al. stated that a decompressive craniectomy should not be performed in patients > 60 years because of the functional unsatisfactory results. Schneider and his colleagues determined the age limit for a decompressive craniectomy at 50 years. Nearly all of his patients < 30 years (91.6%) survived the trauma.
According to the literature there is no clear limit regarding age. Most of the reports discussing the influence of the age are based on small studies only. Therefore, a statistical comparison between different age groups seems difficult in many of the reports. The two age limits most often are 40 and 50 years.

The initial GCS of the cases died in our study was less than 7 this is similar to what was mentioned by Gaab et al., that the best predictor of favorable outcome was an initial posttraumatic GCS equal to or more than 7.18

Hesdorffer et al. performed study on 50 patient with traumatic brain injury underwent decompressive craniectomy for increased intracranial tension due to unilateral brain swelling and midline shift, the initial posttraumatic GCS of all cases was equal to or above 7.24 the survival in this study was 73% with favorable outcome 67% of the survivors and that is nearly equal to the results in our study.

In comparison to the study of Schmidt et al which performed in 2007 on 25 patients underwent decompressive hinge craniotomy, the survival rate was 52%16, the survival rate in our study is higher than that of Schmidt et al may be attributed to the way we used to hold the bone flap insitu using long prolene sutures while Schmidt and his colleagues used miniplates to hold it insitu, that may hinder free elevation of the bone flap when the ICP increases.

The most significant finding of our study is that only four of the survivors required elective fixation of bone flap, because of improper fusion of the bone flap. With a traditional craniectomy, during which bone is removed without immediate replacement, surviving patients are then subjected to additional surgical procedures. But with the series of Schmidt et al., only one patient needed cranioplasty due to infection. No patient developed sunken flap in our study.

At the time of the reexamination 6 patients (30%) had died five patients died within the 1st week after decompressive craniotomy. These patients had undergone decompressive craniotomy on admission as they had signs of brain stem compression. one patient died 5 weeks postoperatively due to multi-organ failure. And this is mentioned in the study performed in 2008 by Morgalla et al., in which The worst results were in the emergency group rather than the delayed group and they attributed that to the severity of injury in the emergency group.22

After a few weeks postoperatively, with the relaxation of brain edema, the bone flap returns to a more anatomically correct position helped by elastic bandage application limiting the need for subsequent surgical procedures could result in a potential significant reduction in costs.

**Conclusion**

In summary, this surgical modality of decompressive hinge craniotomy appears to reduce the need for subsequent cranioplasty. Age and initial posttraumatic GCS remain to be of the most important factors determining the final outcome results. Decompressive craniotomy provided favorable clinical results in nearly 45% of patients who were otherwise most likely to die. Although the number of cases is small in this study yet might be a potential for a larger combined series aiming to assess the efficacy of the hinge craniotomy technique in reducing the mortality rate. Our favorable results call for a reexamination of the common practice of craniectomy for cerebral decompression.

### REFERENCES


