ORIGINAL ARTICLE

Bilateral decompressive craniectomy with expansile duraplasty in patients with severe traumatic brain injury for the management of increased intracranial pressure (intracranial hypertension)

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Abstract

Objectives: To evaluate the efficacy of bifrontal decompressive craniectomy in patients with severe traumatic brain injury

Study Design: Retrospective analytical

Patients and methods: The study was conducted at the Neurosurgery Department, Dow University of Health Sciences and Civil Hospital, Karachi. 15 patients with severe TBI were retrospectively analyzed from November 2005 through November 2009. Glasgow coma outcome scale at 6 month was used as the main tool for outcome assessment.

Results: Out of the 15 patients, 12 males and 3 females, overall mortality was 33 %. Of the survivors good outcome was in 7 of the patients

Conclusion: Bilateral decompressive craniectomy may offer early correction by reduction of raised intracranial pressure and hence give a beneficial outcome for the patients with bilateral diffuse brain swelling following severe traumatic brain injury, especially in younger patients. This needs a larger prospective study for generalization.

Key Words: Bilateral decompression, Craniectomy, Traumatic brain injury, Raised intracranial pressure

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Introduction:

Severe traumatic brain injury occurs in a large population of patients coming in after road traffic accidents and with a history of fall, and is associated with very high morbidity and mortality rates especially in a country like ours, due to lack of emergency trauma teams at the site of injury. The primary aim in these patients is to maintain normal ICP and prevent excessive brain swelling therefore maintaining good cerebral perfusion pressures. There has been a significant improvement in the non invasive management of raised ICP, primarily including drugs like frusemide and barbiturates, hyperosmotic agents like mannitol, hypertonic saline and hyperventilation. Bifrontal craniectomy has always been considered as the last resort for management of raised/intractable ICP but has now started to regain therapeutic importance especially in those patients who are either non responsive or deteriorate significantly on medical management. The aim of the study was to analyze our surgical experience in managing severe head injury as the last therapeutic option for the management of raised ICP.

Patients and Methods:

A retrospective review of all the patients admitted to the Neurosurgery Department Civil Hospital Karachi between November 2005 and November 2009 with severe traumatic brain injury and intractable ICP were evaluated. Patients with mass lesions like intracranial hematomas requiring surgical evacuation were excluded from the study population.

Severe head injury was defined as one which led to a GCS of 8 or less. After initial airway management and hemodynamic stabilization all these patients underwent a routine plain CT scan to

identify and evaluate diffuse brain swelling and raised ICP. The patients with positive findings were treated with head elevation, mild hyperventilation (maintaining PaCO2 between 4 to 4.5KPa) and IV mannitol infusion of 0.25 - 1.0 g/kg. Patients also had central venous and systemic arterial pressure monitoring. To maintain a sufficient cerebral perfusion pressure of 50-60 mmHg, all patients received catecholamine as needed. Where needed a ventricular drain was placed. All patients were treated with maximum medical therapies and if these measures failed the patient was diagnosed with refractory ICP. All of these patients underwent early decompressive craniectomy. During conservative management cerebral perfusion pressure was attempted to maintain above 50mm Hg.

A total of 15 patients were identified for the study, with a mean age of 26.6 years with a range of 16 – 48 years and a mean GCS of 5 ranging from 4 – 8. For each patient we recorded the Glasgow Coma Score (GCS) and pupillary reaction at the time of presentation along with initial CT scan, the length of neurosurgical ICU stay, total hospital stay and the Glasgow Outcome Score (GOS) at 6 month interval.

The surgical technique carried out included bifrontal craniectomy. At this time the brain and dura were noted to be protruding out. Bifrontal fish mouth dural incisions and expansile duraplasty was performed. In all the patients no attempt was made for evacuation of contused brain and the scalp was reapproximated. The bone flaps were then inserted into the abdomen by placing a 5-7cm incision in the right hypochondrium separating the subcutaneous tissue and placing it above the rectus sheath. The incision was then closed in layers. All patients were monitored in an intensive care unit setting postoperatively. Upon improvement and the brain returning back to normal the bone flap were replaced back into position.

Results:

During the follow-up time of 6 months, 5 (33%) patients died postoperatively, 3 (20%) patients were discharged with a GOS of 5, 2 (13%) patients were discharged with a GOS of 4, 3(20%) patients were discharged with a GOS of 3. Favorable clinical outcome was seen in 7 (46%) patients after moderate rehabilitation, 4 with a GOS of 5 and 3 with a GOS of 4. 2 (13%) patients were left in a permanent vegetative state (GOS of 2) (Table 1 & 2). Good clinical outcome was seen in 7 (46%) patients. All the patients who showed good recovery were young patients with a mean age of 23 years with a range of 18 to 33 years compared to older patients with a mean age of 41 years. As expected in most cases a better preoperative GCS correlated with a better GOS at discharge.

Average ICU stay was 8 days ranging from 5 – 15 days and an average hospital stay of 20 days

Table 1:

	No. of Patients
Full recovery	7 (46.6)
Moderate disability	1 (6.67)
Severe disability	0 (0)
Vegetative state	2 (13.3)
Mortality	5 (33.3)
Lost to follow-up	0 (0)
Total	15 (100)

Table 2:

	No. of Patients	**Mean Age 30 years**	**Mean Age 43 years**	**Surgery within 24 Hours**	**Surgery within 48 hours**	**Lower GCS 3-5/15**	**Higher GCS 6-8/15**
Full recovery	4	4	0	3	1	1	3
Moderate disability	3	2	1	1	2	2	1
Severe disability	1	1	0	1	0	1	0
Vegetative state	2	0	2	0	2	2	0
Mortality	5	2	3	2	3	3	2
Total	15	9	6	7	8	9	6

range from 7 to 41 days.

Surgical Complication

The surgical complication rate was 13.3% and included two wound infections with mixed growth of gram positive organisms, treated successfully with intravenous antibiotics.

Discussion:

After exclusion or evacuation of traumatic hematomas surgically, prevention of secondary brain injury is the mainstay of treatment in severe traumatic brain injury. Diffuse brain swelling and multiple cerebral contusions are commonest cause of morbidity and mortality in patients with severe traumatic brain injury.

Brain swelling secondary to trauma with increasing ICP and subsequently low CPP leads to ischemia[1-4]. Reduced cerebral blood flow and or oxygenation lower than a certain threshold accompanied with increasing ICP causing cerebral herniation are the main determinants of brain damage and morbidity[4, 5]. The relationship between outcome and raised ICP has been recognized for the past few decades and has been repeatedly proven in recent studies[5-8].

With advances in intensive care and surgical intervention it has been shown in multiple studies[2,9-14] that there is decreased mortality with early surgical intervention in patients who fail to respond to medical therapy.[5, 7, 8, 15-17]

There are various new therapies being postulated in addition to the standard medical management for malignant intracranial hypertension, like high dose barbiturates[18, 19] and hyperventilation. Their efficacy and duration of usage is still being explored because their mode of action might not entirely be favorable, like in moderate hyperventilation. This method works by hypocapnic induction of cerebral vasoconstriction with a subsequent decrease in cerebral blood flow therefore limiting the use to only short durations in cases of acute neurological deterioration[20]. In cases where refractory ICP continues to persist even after aggressive medical therapy DC is considered as the last resort mainly because of the ethical issue of highly increased morbidity.

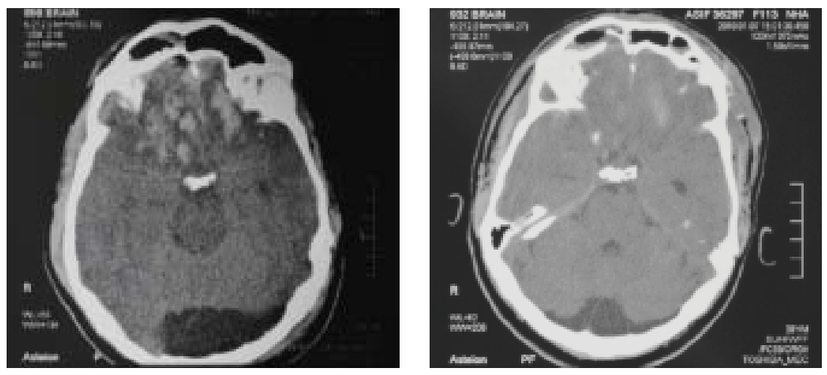

Figure 1: *Pre-Surgery*

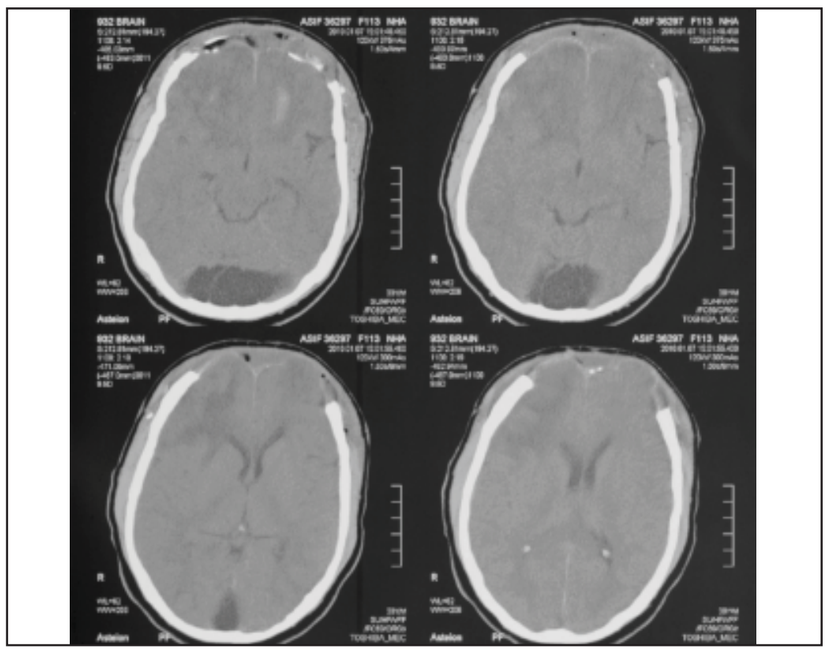

Figure 2: *Post-Surgery*

In the past decade clinical studies investigating prognosis of patients undergoing DC show mortality rates ranging from 12.5% to 90%. But various factors make the comparison of results considerably difficult. These include majorly the superior surgical techniques and major progress in intensive care. Others like heterogenecity of patients and different indications used in treating the patients are also important considerations[11].

Various studies now show good outcome (GOS 4 and 5) in patients with severe traumatic brain injury. Salvatore et al[21] reported good outcome (GOS 4 and 5) in 55% and a mortality rate of 12.5%. Polin et al[12] in his series reported a good outcome (GOS 4 and 5) in 37% with a mortality rate of 27%. A recent study reported a favorable outcome in 56%, a severe disability (GOS 3) in 18%, a vegetative state (GOS 2) in 15% and a mortality rate of 11%[2].

Our study shows similar results, with a favorable outcome (GOS 4 and 5) of 53% though with a considerably higher mortality rate of 33%, main-

ly attributed to the delay in care as initial life saving treatment was provided at other health-care facilities before being shifted to our center which resulted in considerable delay in surgical treatment.

As shown in various other studies and also in ours that patients in whom decompressive craniectomy was performed earlier along with a higher GCS preoperatively and who were younger, achieved better results.

Timing of DC is likely to be important factor as emphasized in various studies. There were 3 patients in our study that underwent late decompressive craniectomy i.e. 48 hours after the initial injury. These were the patients who started out with a poor preoperative GCS and ended with a poor outcome. Guerra et al[22], in his series emphasized that decompressive craniectomy should be performed early in the course of STBI before brain tissue hypoxia and irreversible damage has occurred. Albanese et al, in his analysis noted that 19% of patients who underwent decompressive craniectomy in less than 24 hours had good recoveries, 8 (30%) patients were left in a permanent vegetative state or with a severe disability and 14(52%) patients died.

Regarding comparison of the operative technique, unilateral vs. bilateral craniectomy, could not be analyzed it because only bilateral DC was performed at our centre. The decision was basically made with respect to edema/contusion. If there was generalized brain edema as seen in all of our cases the only preferred option was of a bilateral DC. This falls in accordance with most previous reports[2, 11-13].

The most common complications include hygroma (26%), hydrocephalus (14-29%), surgical site infection, meningitis, bone resorption and parenchymal lucencies[11-13]. In our study we noted 2 surgical site infections which were effectively treated with intravenous antibiotics. This indicates that DC is a relatively secure procedure

As discussed in literature the time between DC and final cranioplasty varies between 4 weeks to 12 months[23] depending on the patient's condition to undergo a second procedure and his recovery. During this time the brain though covered by the above scalp is exposed to the atmospheric pressure that causes local vascular dysfunction which might possibly delay recovery. Also the unprotected brain lies at a higher risk of local injuries, those injuries which are of no harm with an intact skull. Though it is our strategy to perform the cranioplasty as soon as possible, even as early as a few weeks, the mean time of cranioplasty was almost 3 months.

Conclusion:

The satisfactory results achieved during the study indicate positively towards carrying out the procedure and strongly supports the need for multiple large prospective studies[24] to evaluate the efficacy, timing and surgical techniques of DC. Other conditions where DC shows positive results like infarction and low CPP indicate the brighter future of this technique. There is also a need to identify ideal cranioplasty time. Coupled with advancing neurocritical care it appears to be promising.

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