



Research Article

Prognosis and Outcome of Severe Traumatic Brain Injury Following Decompressive Craniectomy- A Single Center Study

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Abstract

Objective: To evaluate the clinical outcome of patients undergoing Decompressive Craniectomy (DC) after severe Traumatic Brain Injury (TBI) and to identify predictive factors associated with good and poor prognosis.

Methods: Data were collected retrospectively from case report, clinical analysis, radiological imaging and post-surgical follow-up from patients who underwent Decompressive Craniectomy (DC) following severe TBI, admitted in our hospital during a period of 3-years.

Results: We included 126 patients. Eight two (82 = 65.1%) patients were younger than 60 years of age and forty four (44 = 34.9%) were more than 60 years of age. All patients were GCS \leq 8 at arrival in ER. DC was done within the first 6 h for 65 patients (51.5%). A mortality rate was at 12.6% at 6 months follow-up. Independent factors associated with mortality were age > 50 years, brain stem involvement, recurrent intracranial hematoma who needed re-surgery. Independent factors associated with poor outcome at discharge were meningitis and hyponatremia > 145 mmol. Independent factors associated with poor outcome at 6 months were Hydrocephalus and diffuse axonal injury .

Conclusion: DC is a gold standard life-saving procedure for patients with severe TBI which decreases the mortality significantly, though morbidity cannot be individually associated with DC or conservative management. Primary injury to the brain parenchyma plays a major role in the prognosis of severe TBI.

Keywords : Decompressive craniectomy; Diffuse axonal injury; Glasgow coma scale; Traumatic brain injury

Abbreviations: TBI: Traumatic Brain Injury; DC: Decompressive Craniectomy; DAI: Diffuse Axonal Injury; GCS: Glasgow Coma Scale; GOS: Glasgow Outcome Score; CSF: Cerebrospinal Fluid; CPP: Cerebral Perfusion Pressure; ICP: Intracranial Pressure; SDH: Subdural Hematoma; EDH: Extradural Hematoma; ICH: Intracerebral Hemorrhage

Introduction

According to World Health Organization (WHO) estimates, each year around 1.5 to 2 million persons are injured and 1 million succumb to death every year in india [1]. Road traffic injuries are

the leading cause (60%) of TBIs followed by falls (20%-25%) and violence (10%). Alcohol involvement is known to be present among 15%-20% of TBIs at the time of injury. Traumatic Brain Injury (TBI) stands out among other injuries for its significant contribution to mortality, disability, and health costs.

Monro-Kellie doctrine states that the sum of volumes of brain, CSF, and intracranial blood is constant. An increase in one should cause a decrease in one or both of the remaining two [2]. The treatment goal of traumatic brain injury (TBI) [3] is to reduce and prevent intracranial hypertension (ICH). A pathological increase in intracranial pressure (ICP) that may compromise cerebral perfusion pressure (CPP) and lead to neurologic deficit and fatal brain herniation syndromes [4]. Medical management with

anti-oedema measures and surgical procedures are the available mode of treatment to reduce ICP and prevent brain herniation. In 2011, the DC in Diffuse Traumatic Brain Injury (DECRA) study showed that bifrontal surgical DC reduces intracranial pressure [5]. However, the RESCUEicp trial, showed better intracranial-pressure control, lower mortality, and higher rates of vegetative state, lower severe disability, and upper severe disability in the surgical group than in the medical group [6]. Severe traumatic head injury leads to intracranial hematomas namely SDH, EDH, ICH and cerebral parenchymal contusion with oedema, which ultimately leads to Increased Intracranial Pressure (ICP), reduced cerebral blood flow, hypoxia, ischemia and brain parenchymal damage. Strategies to control ICP and maintain an adequate Cerebral Perfusion Pressure (CPP) comprise a central principle in managing severe TBI. In some cases, ICP is refractory medical management, and requires emergency surgical intervention with Decompressive Craniectomy (DC).

The DC procedure involves removal of portions of the cranial vault on the involved side and subsequent liberal durotomy that allows the swollen brain to expand beyond normal cranial limits to immediately alleviate elevated ICP while avoiding internal herniation and brainstem compression. The increased space can lead to improved cerebral compliance, a reduction in ICP, and an increase in CPP that together increase both cerebral blood flow and cerebral microvascular perfusion.

Material and Methods

Patients

A retrospective study was conducted over a period from oct 2018 to Jan 2022. We included patients who had severe TBI with GCS < 8 and underwent unilateral or bilateral DC following TBI. Exclusion criteria were TBI without DC, mild and moderate TBI.

Data collection and demography

The data were collected retrospectively from the hospital records including: age, sex, admission history, consciousness status was judged by the Glasgow Coma Scale (GCS) on arrival [7], pupil status, localization signs, seizure was evaluated along with mechanism of trauma and CT scan brain findings on admission. Routine blood investigations, heart rate, blood pressure and vitals were monitored in ICU. Patients were admitted in ICU with ventilator support. 126 severe TBI patients were included out of 348 head injury patients who got admitted in our hospital from oct 2018 to Jan 2022. Epidemiologically out of 126 patients, 82 patients were in the age group of less than 60 years and 44 were above 60 years of age. 88 were male patients and 38 were

female patients. 108 patients of severe TBI had history of RTA, 16 were due to fall from height and 2 patients had history of assault. Clinically all the included patients had GCS < 8 on arrival.

Management

Patients were intubated on their arrival in the emergency room in view of neurological status (GCS score ≤ 8) or respiratory distress. Mean blood pressure was kept ≥ 80 mmHg by fluid therapy using isotonic crystalloid solutions or vasopressors. 20% Mannitol or 3% NaCl was administered when the CT scan showed cerebral oedema or brain herniation. Assessment of intracranial hypertension was based on clinical findings and imaging results. All patients underwent a CT scan brain on admission and a follow-up CT scan was performed within 6 to 24 hours depending on neurological and hemodynamic status. The DC was indicated for patients with significant mass effect on the first CT scan or clinical worsening and radiological increase brain parenchymal oedema with herniation on follow-up scan or refractory to intravenous mannitol and hypertonic saline therapy. Clinical worsening was defined as a decrease of at least two points of GCS from admission status. Patient's underwent standard DC as per guidelines, either unilateral or bilateral depending on clinical and radiological assessment.

Follow-Up and prognosis assessment

All patients included in our study were followed up for a minimum period of 6 months. The outcome was assessed by recording mortality and neurological disability. Functional outcome was assessed by Glasgow Outcome Scale (GOS) [8] score at discharge and at 6 months. According to GOS score, patients can be divided into five groups with increasing severity ranging from good recovery to death.

Results

Clinical examination

During the study period 126 patients undergoing DC after TBI were admitted in our ICU. 82 patients (65.1%) were aged less than 60 years and 44 (34.9%) were above 60 years. 88 (69.8%) of our patients were male, and 38 (30.1%) were female. Among all patients, road traffic accident (RTA) was the leading cause of TBI, about 108 patients (85.7%) were due to RTA, fall from height was in 6 (12.7%) patients and assault with TBI was 2 (1.6%) patients. (Table 1) All the patients were intubated with standard protocol, CT scan brain was done and other radiological imaging like x-ray, ultrasound and CT scan was done for corresponding polytrauma. Patients were admitted in ICU on mechanical ventilation.

Parameters			
	in years	Number of patients	Percentage %
Age	<60	82	65.1
	>60	44	34.9
Sex	Male	88	69.8
	Female	38	30.1
Mechanism of injury	RTA	108	85.7
	Fall from height	16	12.7
	assault	2	1.6
Seizures	Yes	12	9.5
	no	114	90.5
Side of injury	Right	73	57.9
	Left	41	32.5
	Bilateral	12	9.5

Table 1: Epidemiology and Demography.

CT Scan brain findings

All of our patients had brain scans on admission. The most frequent cerebral injuries were acute subdural hematoma in 65 patients(51.6%), extra-dural hematoma in 17 patients (13.5%). MRI was done for 32 patients (25.4%) to confirm diffuse axonal injuries (DAI) (Table 3).

CT scan findings	Number of patients	Percentage %
Acute SDH	65	51.6
Acute EDH	17	13.5
ICH	13	10.3
Haemorrhagic Contusion with mass effect	23	18.2
Depressed fracture with contusion	8	6.35
Above said Hematomas associated with DAI (Diffuse axonal injury)	32	25.4

Table 3: Radiological Findings.

Medical management

All of our patients required sedation, intubation, and mechanical ventilation. Other treatments consisted on fluid resuscitation, anti-oedema measures with either mannitol 20% or 3% NACL depending on serum sodium status and anticonvulsant therapy especially levetiracetam for all the patients.

Decompressive craniectomy

DC was done for 65 patients (51.5%) with 6 hours of

admission and for 48 (38.1%) with in 6 to 24 hours of admission. 13 (10.3%) patients underwent DC after 24 hours, who got deteriorated neurologically in spite of initial medical management in ICU. Depending on the neurological assessment and radiological imaging, patients were planned for either tracheostomy or extubation. Out of 126 patients 87 patients needed tracheostomy , which was performed within 3rd to 5th post-operative day. Other patients were extubated depending on their neurological recovery (Table 2).

		Number of patients	Percentage %
Timing of surgery	Within 6 hours	65	51.5
	6-24 hours	48	38.1
	>24 hours	13	10.3
Tracheostomy		77	61.1
Complications after DC	Meningitis	3	2.4
	Brain abscess	2	1.6
	Rebleeding on same side	6	4.8
	EDH on contralateral side	3	2.4
	Hypernatremia	24	19.0
	Hyponatremia	14	11.1
	Hydrocephalus	7	5.5

Table 2: Decompressive Craniectomy.

DC procedure related complications

Eleven patients (8.7%) were reoperated, 6 (4.8%) were due to rebleeding on the ipsilateral operated site, 3 (2.4%) due to EDH on contralateral side and 2 due to brain abscess/empyema . Other complication related to DC was meningitis, which was noticed in 3 patients (2.4%), they were managed with higher antibiotics appropriately and improved significantly.

Mortality and Morbidity analysis in post DC patients

Among the operated patients who were managed in ICU ,Sixteen (12.7%) mortality was noticed during the hospital stay. Main factors associated with mortality were initial poor GCS (GCS 3 to GCS 5) on arrival due to extensive severe brain injury, hypovolemic shock due to polytrauma, hypoxia and ischemic brain injury due to delay in transporting the patient to hospital premises. DC within 6 hours or with in 24 hours though had good prognosis , it cannot be associated as an independent criteria for good prognosis because most of our patients (89.6%) were operated with in 24 hours of trauma. Patients with TBI developed complications like hypernatremia (18.2%) and hyponatremia (11.1%) (Table 2), patients who developed hypernatremia have deteriorated neurologically with a significant fall of more than 2 scores of GCS in our study group and had very poor outcome. Out of 24 hypernatremia patients,7 patients (29%) had mortality and 4 (16.7%) were in GOS-2 vegetative state in 6 months follow-up. Post-traumatic hydrocephalus was seen in 7 patients (5.5%) in 6 months follow-up, VP-shunt was done for 5 patients and the other 2 patients lost follow-up. We could not find a significant association between neurological prognosis and injury to dominant cerebral hemisphere, since most of severe TBI patients had multiple

contusions , hematoma and DAI.

Discussion

The first randomized controlled trial on DC for adult patients with severe TBI , the DECRA study [5,9] showed that the mean intracranial pressure was lower in the craniectomy group than in the standard-care group. Patients in the craniectomy group had a shorter duration of mechanical ventilation and a shorter stay in the ICU than patients in the standard care group but had more medical or surgical complications. Six months after injury, the primary outcome (functional assessment on the Extended Glasgow Outcome Scale (GOS-E) was worse in the craniectomy group than in the standard care group. There were no difference in mortality [5]. Twelve months after severe diffuse TBI and early refractory intracranial hypertension, decompressive craniectomy did not improve outcomes and increased vegetative survivors [9]. The Randomised Evaluation of Surgery with Craniectomy for Un- controllable Elevation of Intracranial Pressure (RESCUEicp) trial involving patients with sustained and refractory intracranial hypertension (ICP) after TBI (i.e., ICP >25 mm Hg > for 1 to12 hours) [6] showed that the GOS-E distribution differed between the two groups (surgical group vs medical group) and it was associated with reduced 6- month mortality, increased persistent vegetative state, lower severe disability, and upper severe disability than medical care. The control of intracranial pressure was better in the surgical group than in the medical group. Adverse events were more reported in the surgical group than in the medical group⁶. It confirm that DC reduce mortality but with severe disability.

Dhandapani et al., [10] demonstrated that age was an independent predictor of outcome in those with severe TBI. As

in our series age more than 60 years were an independent factor associated with mortality. Among 16 mortality in the ICU after DC, 12 patients were above 60 years of age. Few studies has shown timing of surgery was a predicting factor in some studies. A Turkish study showed that patient with severe traumatic brain injury who underwent early bilateral DC had a better outcome [11]. Hosseinali et al [12] in a retrospective cross-sectional study including patients with TBI who had undergone DC, the final outcome was found to be unfavourable in 54.2%. Unfavourable outcome was associated with lower GCS on admission as well as occurrence of post- operative hydrocephalus. In our study we had demonstrated that most of the patients undergoing DC would have favourable outcome determined by GOS at discharge and at 6 months.

In our study hypernatremia was independently associated with mortality and morbidity, Out of 24 hypernatremia patients, 7 patients (29%) had mortality (GOS 1) and 4 (16.7%) were in (GOS-2) vegetative state in 6 months follow-up (Table 4&5). A nationwide study by Hoffman et al has proven, hypernatremia was associated with poorer outcomes in patients with severe TBI [13].

GOS	Number of patients	Percentage %
GOS 1	16	12.7
GOS 2	37	29.3
GOS 3	27	21.4
GOS 4	22	17.5
GOS 5	24	19

Table 4: Gos at Discharge.

GOS	Number of patients	Percentage %
GOS 1	22	17.5
GOS 2	8	6.3
GOS 3	13	10.3
GOS 4	31	24.6
GOS 5	34	27
Lost follow up	18	14.3

Table 5: Gos at 6 Months Follow-Up.

Diffuse axonal injury (DAI) was present in 32 patients (25.4%) among the 126 patients (Table 3). Out of these 32 patients there was 8 mortality (GOS 1), 6 patients were in vegetative state (GOS 2) at 6 months follow-up. (Table 4&5). The existence and quantity of DAI haemorrhagic lesions revealed by MRI have been linked to outcome of the patient in severe TBI [14]. The incidence of seizures and epilepsy after Decompressive hemicraniectomy-

DHC might be high, related to the large stroke volume and the large cortical ischemic area seem to be the main risk factors for seizure or epilepsy development in this subtype of stroke [15].

Clinical Significance of the Study

Favourable outcome was seen in 36.5% of patients at discharge GOS score of 4 & 5 respectively. Favourable outcome after 6 months follow-up was 51.6%. Age <60 years, on arrival GCS, severity of brain damage in CT scan and timing of surgery were significantly associated with favourable outcome. Procedure related complications were seen in 11.2%.

Limitation

We note some limitations to our study. We did not monitor intracranial pressure with ICP monitors. We did not compare medical versus surgical group.

Conclusion

DC is a life-saving procedure for patients with severe TBI with increased ICP and for patients who are refractory to medical anti-oedema therapy. Independent factors associated with mortality in severe TBI are primary injury to the brain parenchyma, age of the patient, time of arrival to ER, GCS on arrival, hypernatremia and polytrauma with shock. Independent factors associated with poor outcome at 6 months follow-up are diffuse axonal injury and hydrocephalus. This study results strongly support further large randomised prospective clinical trials to assess the effect of DC following severe TBI.

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