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## Outcome of Decompressive Craniectomy in Traumatic Closed Head Injury

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### Abstract

#### Objective:

The aim of the current study was to observe functional outcomes of patients undergoing decompressive craniectomy (DC) for raised intracranial pressure (ICP) after blunt head injury and to assess possible predictive factors.

#### Methodology:

This study was a prospective cohort study which was conducted at Aga Khan University Hospital, Karachi over a period of 2 years (January 2015–December 2016). Adult patients, aged between 15 and 65 years of both genders undergoing DC during the study period were selected. Outcomes of DC were assessed at an interval of 3 months following injury using the Glasgow outcome score. The data were analyzed on IBM statistics SPSS version 21.

#### Results:

Seventy-two patients underwent DC for raised and refractory ICP. Glasgow Outcome Scale (GOS) at discharge, 1-month and 3-month follow-up were reported. GOS at 3-month follow-up showed 21 patients (29.2%) patients had a good recovery, moderate disability was reported in 16 patients (22.2%), and severe disability in 12 patients (16.7%), persistent vegetative state was seen in five patients (6.9%). Eighteen patients had in hospital mortality (25.0%). Tracheostomy and sphenoid fractures were found to be negative predictors of good functional outcome.

#### Conclusions:

DC is associated with an in hospital mortality of 25.0%. Favorable outcomes were seen in 51.4% patients. Tracheostomy and sphenoid fractures were negative predictors of good functional outcome. The results are comparable to international literature.

**Keywords:** *Decompressive craniectomy, intracranial pressure, Traumatic head injury*

## Introduction

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Morbidity and mortality of patients with severe traumatic brain injury (TBI) is high. Approximately 60% either die or survive with severe disability. Raised intracranial pressure (ICP) does not respond to medical management, mannitol and hyperventilation in 10%–15% of patients with severe TBI.[1] Surgical decompressive craniectomy (DC) is recommended in such cases, intervention being aimed at lowering ICP to minimize secondary brain damage.[2,3]

DC has been used to treat severe intracranial hypertension secondary to various causes.[4] This involves removal of a part of the calvarium, with or without duraplasty to create extra volume for intracranial contents thereby reducing ICP.[5] DC may improve oxygen delivery to brain cells by improving blood flow.[6] It is still unclear that DC improves functional outcome in patients with severe TBI and refractory raised ICP.[7] In a recent study, 25% of patients had good functional outcome.[8] Gupta in his study analyzed 15 studies with the total number of 129 patients and showed reduction in mortality of 25%–30%.[9]

Several studies on DC have reported high occurrence of poor functional outcomes.[10] There is paucity of data from the developing countries, where unfavorable functional outcomes after DC can have much larger financial and social impact. The objective of this study was to observe functional outcomes patients undergoing DC for raised ICP after blunt trauma to head and to assess possible predictive factors.

## Methodology

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This was prospective cohort study, conducted over a period of 2 years (2015–2016) at the Department of Neurosurgery, the Aga Khan University Hospital, Karachi (AKUH). We included all patients undergoing DC after closed head injury due to blunt trauma. Patients operated outside AKUH were excluded from the study.

This study was approved by research evaluation unit, College of Physicians and Surgeon Pakistan. Informed consent was taken from all the participants at the time of inclusion in the study. Participants Information regarding demography, trauma history, clinical status, and radiographic findings were collected through predesigned pro forma.

## Procedure

A standard procedure recommended in international literature was employed. In brief, in the operating room under general anesthesia, incisions were given as required (bicoronal for bilateral or frontotemporal trauma flap for unilateral) and scalp flap was raised. After making burr holes, craniotome was used to raise a bone flap, which was removed and stored in refrigerator. The dura was incised (durotomy) and then augmented using temporal fascia, pericranial fascia, or artificial fascia (duroplasty). Patients were ventilated for 24–48 h. All the patients were followed by principal investigator himself at both hospitals and at clinics after discharge for outcome. Good functional outcome was assessed using Glasgow outcome score (GOS). Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 21 (IBM corporation, Armonk, New castle, New York, United states of America). Categorical variables such as sex, preoperative GCS, preoperative pupil response to light, good functional outcome were analyzed using frequencies and percentages. Whereas continuous variables like age, time interval from incident to arrival and arrival to surgery were summarized using means  $\pm$  standard deviation. Inferential analysis was done for age, mode of injury, time from injury to arrival in the emergency room, arrival to DC,

preoperative GCS, and preoperative pupillary response to light. Chi-square test was used to compare the outcomes in different strata. Binary logistic regression was also done to calculate the predictability of independent variables on the dependent variable.  $P < 0.05$  was considered statistically significant.

## Results

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A total of 72 blunt trauma patients presenting with closed head injury at AKUH, Karachi, were enrolled in this study. Average age of patients was  $26.0 \pm 20.50$  years. Sixty-two (85.9%) were males and 10 (14.1%) were females.

The mean postoperative stay of the patients in the hospital was  $14.93 \pm 10.55$  days. The mean GCS was  $7.26 \pm 3.83$ . The GOS at discharge showed mortality in 18 patients (25%), vegetative state in 5 patients (6.9%), severely disabled in 14 patients (19.4%), moderately disabled in 14 patients (19.4%), and good recovery in 21 patients (29.2%).

The mean GOS at 1-month follow-up showed no further mortality. One patient improved GOS from severely disabled to moderately disabled.

Glasgow Outcome Scale (GOS) at 3-month follow-up is shown in [Figure 1](#). The GOS at different period of follow-up is compared below in [Table 1](#).

Thirty-one percentage were anisocoric. Majority of patients (59.2%) were injured by RTA, followed by fall (22.5%) and assault (18.3%). Tracheostomy was done in 32 (44.4%) patients.

Extradural hematoma was present in 25.7% of the patients while subdural was present in 55.7% of patients. Subarachnoid hemorrhage and contusions were present in 32.4% and 16.2%, respectively.

Facial fractures were found in 16.2%, parietal fractures in 30.9% temporal fractures among 34.3%, occipital fractures in 17.9%. Sphenoid fractures were present in 17.9%.

Significant association was found between tracheostomy and good functional outcome ( $P = 0.017$ ) and between sphenoid fractures and good functional outcome ( $P = 0.030$ ). Both sphenoid fractures and tracheostomy were negatively associated with good functional outcome.

The binary logistic model was also performed to ascertain the effects of tracheostomy and sphenoid fractures on the likelihood of good functional outcome in patients with DC. The model was statistically significant ( $P < 0.05$ ). The model explained 25.5% variance and correctly classified 55% of the cases. Tracheostomy 4.9 times and sphenoid fractures 6.7 times likely to reduce good functional outcome.

## Discussion

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In this study, we evaluated the outcome of DC in 72 consecutive patients with traumatic head injury. DC was effective in reducing the ICP, and it was also associated with good functional outcomes in term of good recovery and moderate disability, in survivors. As a developing country, we do not have the facility of ICP monitoring to objectively document the reduction in postoperative ICP. Decompressive craniectomy in diffuse traumatic brain injury (DECRA) investigators reported results from a multi-centered, randomized clinical trial comparing DC and standard care in the management of diffuse severe TBI.[7] The results suggested that though DC lowers refractory ICP, therapeutic intensity levels and intensive care unit days, it does not improve mortality and may even worsen functional outcome at 6 months in patients with diffuse severe TBI. However, DECRA was for diffuse injury patients while most of our patients had an intracranial hematoma as well.

A study by Jagannathan *et al.* reported similar outcomes.[11] It was a retrospective review of prospectively acquired data of children who underwent DC at the authors' institution between January 1995 and April 2006. Although the mortality rate for children with severe TBI remains high, DC was effective in reducing

ICP and is associated with good outcomes. Another study revealed that DC was associated with a better than expected functional outcome in patients with medically uncontrollable ICP and brain herniation, compared with outcome in other control cohorts reported on in the literature.[8]

We observed better outcomes in younger patients. GCS score of 8 and above is associated with favorable outcome, while mortality rates and the incidence of residual disabilities are much higher in patients with admission GCS of 5 and below, which is comparable to other studies.[12,13,14] Other factors that have been associated with poor outcome include polytrauma and significant pupillary abnormalities (anisocoria or mydriasis). However, only GCS had statistically significant association. Despite the fact that ICP monitoring was not performed in any of our patients our results are comparable to other studies from west, where ICP monitoring is considered a standard of care. This supports the idea that adequate monitoring of clinical parameters is equally valuable in the management of head injury.[15,16,17,18,19] Few other studies from our institute have evaluated Rotterdam score and optic nerve sheath diameter as predictors of functional outcomes and mortality in patients undergoing decompressive craniectomy.[20,21] Both are noninvasive methods of measuring ICP. Optic nerve sheath diameter was found to have no relationship with functional outcomes or mortality in patients undergoing DC. On the other hand, Rotterdam score of computed tomography scan for TBI had a significant correlation with unfavorable outcomes and mortality of TBI patients.[20] These parameters were not studied in the current study as they are not part of the current guidelines or recommendations on the management of TBI. Another aspect of DC patients is cranial reconstruction in the form of cranioplasty. We recently presented our data on cranioplasties in children and found no relationship of the timing of cranioplasty and complication rate and cosmetic outcomes of these patients.[22] The complication rate of cranioplasty should be considered along with the complications of DC when counseling families and decision making.

Few limitations of the study were observed. There was no comparison group, and the sample size was relatively small. The study, therefore, cannot be generalized to all patients with severe brain injury. A very important drawback of DC is the increased risk of brain injury. These patients are also at high risk of repeat injury due to lack of protection as reported by Honybul.[23]

Additional multicenter Randomized Control Trials (RCTs) are necessary to provide more evidence and further conclusions on the efficacy of this DC procedure.[24,25,26]

## Conclusions

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DC is associated with favorable outcomes in 51.4% patients. It has in hospital mortality of 25%, with tracheostomy and sphenoid fractures being negative predictors of good functional outcome. The results are comparable to international literature.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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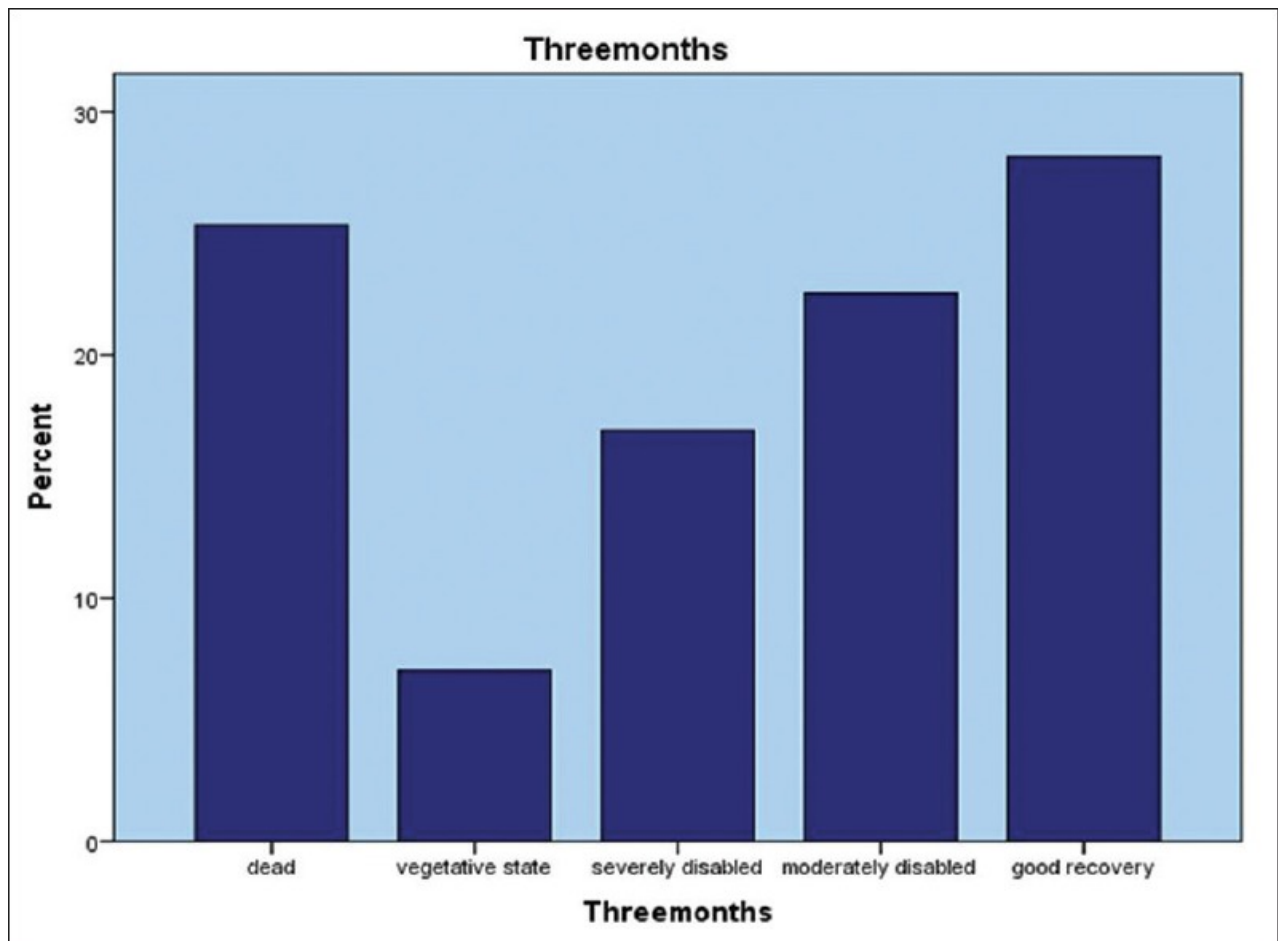
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## Figures and Tables

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**Figure 1**



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Glasgow Outcome Scale at 3 months' follow-up

**Table 1**

Comparison of GCOS at different periods of follow-up

	Frequency (%)
<b>At discharge</b>	
Dead	18 (25.0)
Vegetative state	5 (6.9)
Severely disabled	14 (19.4)
Moderately disabled	14 (19.4)
Good recovery	21 (29.2)
Total	72 (100.0)
<b>At 1 month</b>	
Dead	18 (25.0)
Vegetative state	5 (6.9)
Severely disabled	13 (18.1)
Moderately disabled	15 (20.8)
Good recovery	21 (29.2)
Total	72 (100.0)
<b>At 3 months</b>	
Dead	18 (25.0)
Vegetative state	5 (6.9)
Severely disabled	12 (16.7)
Moderately disabled	16 (22.2)
Good recovery	21 (29.2)
Total	72 (100.0)

GOS: Glassgow outcome score

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