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# Surgical Outcome of Decompressive Craniectomy in Traumatic Brain Injury: A study in a tertiary care hospital of Bangladesh

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## Abstract

**Background**: Head injury is one of the most important causes of death caused by trauma. Decompressive craniectomy is said to be the best way to reduce otherwise intractable intracranial pressure and its complications in traumatic brain injury. But we have not enough information regarding the outcomes and effectiveness of decompressive craniectomy in traumatic brain injury. The aim of this study was to assess the outcomes and effectiveness of decompressive craniectomyin in traumatic brain injury. **Material & Methods:** This prospective observational study was conducted in Khwaja Yunus Ali Medical College and Hospital, Sirajganj and TMSS Medical College & Hospital, Bogura, Bangladesh in collaboration with the Department of Neurosurgery during the period from July 2018 to December 2021. In total 32 patients with severe traumatic brain injury diagnosed and treated in the above-mentioned hospitals were recruited as the samples for this study. The outcomes of the patients evaluated by the Glasgow Coma Scale (on which scores range from 3 to 15, with lower scores indicating reduced levels of consciousness). All patient data were collected, processed, analyzed as well as disseminated by using MS Office 2019 and SPSS version 23 programs as per the necessity. **Results:** In analyzing the duration of hospitalization we observed, the mean (±SD) days of mechanical ventilation, days of ICU staying and days of hospitalization were 8.88 ± 2.54, 10.21 ± 3.16 and 15.57 ± 4.51 days respectively. Finally, the mean (±SD) Extended Glasgow Outcome Scale score of all the patients was found as 9.1. On the other hand, the unfavorable Extended Glasgow Outcome Scale score (1 to 4) was found in 56% patients. In this study, finally death cases were found 22%. **Conclusion:** Decompressive craniectomy ensures better outcome in term of survival but the limitation is quality of life issues after survival especially among poor GCS (3-6) group. Prompt hospitalization, early diagnosis and proper ICU and ventilation facilities can ensure more satisfactory outcomes for the patients with traumatic brain injury.

**Keywords**:- Pattern, Skin Diseases, Dermatology, Venereology

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## INTRODUCTION

Head injury is one of the most important causes of death caused by trauma. Decompressive craniectomy is said to be the best way to reduce otherwise intractable intracranial pressure and its complications occur in traumatic brain injury. Traumatic brain injury is the most common cause of death in the western world among youth.[1] On the other hand, head injury is the most important cause of death caused by trauma.[2] Day by day the incidences of head injury as well as traumatic brain injury are increasing in Bangladesh also. Secondary brain injuries caused by "intracranial hypertension" is a modifiable as well as treatable complications of traumatic brain injury.[1] The methods usually used for treating increased intra-cranial pressure (ICP) are nonsurgical like osmotic diuretics, hyperventilation, barbiturate therapy and therapeutic hypothermia, which may be inactive in some cases and a surgical technic which is known as decompressive craniectomy has been advocated.[3] Basically, decompressive craniectomy is used to reduce the ICP. Decompressive craniectomy is applied by surgical removal of the skull on the most affected side.[3] It is also used in other situations like middle cerebral artery infarction as well as aneurysmal subarachnoid hemorrhage, for getting better results.[4] Decompressive craniectomy demonstrates an expandable skull volume and allows better oxygenation as well as increased cerebral blood flow.[5] The efficacy and outcome findings of such operation are usually evaluated using Glasgow Outcome Scale (GOS) which was first developed in 1975.[6] After bone removal, usually there is an increase in brain compliance and a shift of the pressure volume curve to the right.[7] On the other hand, the rationale behind decompressive craniectomy is to convert an injury within a closed box, with a fixed volume as well as limited reserve into an "open system" with an increased capacity to accommodate mass.[8] After severe traumatic brain injury, medical and surgical therapies are performed to minimize secondary brain injury.[9] Noted that, increased intracranial pressure, typically caused by cerebral edema, is an important secondary insult.[10] Although there is very few information regarding the monitoring of intracranial pressure is available from several studies, some sort of specific monitoring is advised for such cases by "international clinical practice guidelines" and "first-tier therapies" are usually used to control intracranial pressure.[11]

## MATERIAL AND METHODS

This prospective observational study was conducted in Khwaja Yunus Ali Medical College and Hospital, Sirajganj and TMSS Medical College & Hospital, Bogura, Bangladesh in collaboration with the Department of Neurosurgery during the period from July 2018 to December 2021. In total 32 patients with severe traumatic brain injury diagnosed and treated in the mentioned hospitals during the study period were recruited as the samples for this study. As per the inclusion criteria of this study, only patients from all age groups and from both the genders had a severe, non-penetrating traumatic brain injury were included. The outcomes of the patients evaluated the Glasgow Coma Scale (on which scores range from 3 to 15, with lower scores indicating reduced levels of consciousness.[12] According to the exclusion criteria of this study, patients who were not

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deemed suitable for full active treatment by the clinical staff caring for the patient or if they had dilated pupils, mass lesions, unreactive pupils, spinal cord injury, or cardiac arrest at the scene of the injury were excluded. Written informed consents were taken in favor of all the participants before data collection. All patients were treated with advanced neurosurgical management capabilities and equipment, including the availability of intra- cranial-pressure monitoring with the use of either an external ventricular drain or a parenchymal catheter. Patients received treatment for intracranial hypertension whenever the intracranial pressure was greater than 20 mm Hg.[13] We defined an early refractory elevation in intracranial pressure as a spontaneous increase in intracranial pressure for more than 15 minutes within a 1 hour period, despite optimized first-tier interventions. Such interventions included optimized sedation, the normalization of arterial carbon dioxide pressure, and the use of hypertonic saline, mannitol, neuromuscular blockade, and external ventricular drainage. Within the first 72 hours after injury, patients were randomly assigned either to undergo decompressive craniectomy plus standard care or to receive standard care alone, using anautomated telephone system. A standardized surgical approach, modeled on the Polin technique,[14] was used. This approach included a large "temporoparietal craniectomy" with dural opening for maximizing the reduction in intracranial pressure after craniectomy,[15] the excised bone was stored in a "subcutaneous abdominal pouch", as per the standard practice manure of the operating surgeon. After all the swellings and infectionshad resolved, 2-3 months after craniectomy, the bone was totally replaced. Standard care from the time of enrollment followed clinical practice guidelines that were based on those recommended by the Brain Trauma Foundation.[15,16] For patients receiving standard care, the trial protocol permitted the use of lifesaving decompressive craniectomy after a period of 72 hours had elapsed since admission. The original primary outcome was the proportion of patients with an unfavorable outcome, a vegetative state, a composite of deathor severe disability (A score of 1 to 4 on the Extended Glasgow Outcome Scale), as assessed with the use of a structured, validated questionnaire at 6 months after injury.[17] The Extended Glasgow Outcome Scale ranges from 1 to 8, with lower scores indicating a poorer functional outcome.) Secondary outcomes were intracranial pressure measured hourly, the intracranial hypertension index 23 (The end-hourly measures of intracranial pressure of >20 mm Hg divided by the total number of measurements, multiplied by 100), the proportion with a score of 2 to 4 on the Extended Glasgow Outcome Scale, the numbers of days in the ICU and in the hospital, and mortality in the hospital and at 6 months. All patient data were collected, processed, analyzed as well as disseminated by using MS Office 2019 and SPSS version 23 programs as per the necessity.

## RESULTS

In this study, among total 32 participants, 72% were male whereas the rest 22% were female. So male participants were dominating in number and the male-female ratio was 2.6:1. Among all the participants, in 50% general falls was found as the most common mechanism of injury. As the baseline status of blood pressure of the participants, the mean (±SD) SBP and DBP were

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found as 134.82 ± 31.16 and 89.74 ± 23.71 mm Hg respectively. At baseline, the mean overall Glasgow Coma Scale score was 9.1 and the mean Abbreviated Injury Scale score was 4.6. In this study as surgical procedure among two third patients (66%) unilateral craniectomy was performed whereas among the rest 34% patients bilateral craniectomy was applied. In majority of the patients 69% craniectomy was applied on the right side. After the completing surgical procedure, among all the alive participants, intracranial pressure after randomization (mm Hg), time (Hour) to intracranial pressure >20 mm Hg, intracranial hypertension index (Mean ± SD) and cerebral hypoperfusion index (Mean ± SD) were found as 14.51 ± 6.59, 8.91 ± 1.47, 11.31 ± 2.38 and 5.23 ± 1.33 respectively. In analyzing the duration of hospitalization, we observed, the mean (±SD) days of mechanical ventilation, days of ICU staying and days of hospitalization were 8.88 ± 2.54, 10.21 ± 3.16 and 15.57 ± 4.51 days respectively. Finally, the mean (±SD) Extended Glasgow Outcome Scale scores of all the patients were found as 9.1. On the other hand, the unfavorable Extended Glasgow Outcome Scale score (1 to 4) was found in 56% patients. In this study, finally death cases were found 22%.

**Table 1:** Baseline status of participants (N=32).

| **Parameters** | | **n=32** | **(%)** | **Mean** | **Mean±SD** |
|---|---|---|---|---|---|
| Age of participants in year | | | | | 30.66 ± 11.43 |
| Gender distribution | Male | 23 | 72% | | |
| | Female | 9 | 28% | | |
| Mechanism of injury | Fall | 16 | 50% | | |
| | Traffic accident | 12 | 38% | | |
| | Hit by object | 4 | 13% | | |
| Blood pressure status (Mean ±SD) | SBP (mm Hg) | | | | 134.82 ± 31.16 |
| | DBP (mm Hg) | | | | 89.74 ± 23.71 |
| Overall Glasgow Coma Scale score | | | | 9.1 | |
| Abbreviated Injury Scale score | | | | 4.6 | |
| Hemorrhagic & cranial status of patients | Subdural hematoma | 13 | 41% | | |
| | Epidural hematoma | 2 | 6% | | |
| | Midline shift > 5 mm | 14 | 44% | | |
| | Cerebral contusion | 8 | 25% | | |
| | Traumatic subarachnoid hemorrhage | 9 | 28% | | |
| | Cranial fracture | 6 | 19% | | |

**Table 2:** Outcomes of participants (N=32)

| **Parameters** | | **n (%)** | **Mean** | **Mean±SD** |
|---|---|---|---|---|
| | Intracranial pressure after randomization (mm Hg) | | | 14.51 ± 6.59 |

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| | | | | |
|---|---|---|---|---|
| Intracranial pressure and cerebral perfusion pressure | Time (Hour) to intracranial pressure >20 mm Hg | | | 8.91 ± 1.47 |
| | Intracranial hypertension index (Mean±SD) | | | 11.31 ± 2.38 |
| | Cerebral hypoperfusion index (Mean±SD) | | | 5.23 ± 1.33 |
| Duration of hospitalization | Days of mechanical ventilation | | | 8.88 ± 2.54 |
| | Days of ICU staying | | | 10.21 ± 3.16 |
| | Days of hospitalization | | | 15.57 ± 4.51 |
| Extended Glasgow Outcome Scale score | Mean | | 9.1 | |
| | Unfavorable score (1 to 4) | 18 (56%) | | |
| | Death | 7 (22%) | | |

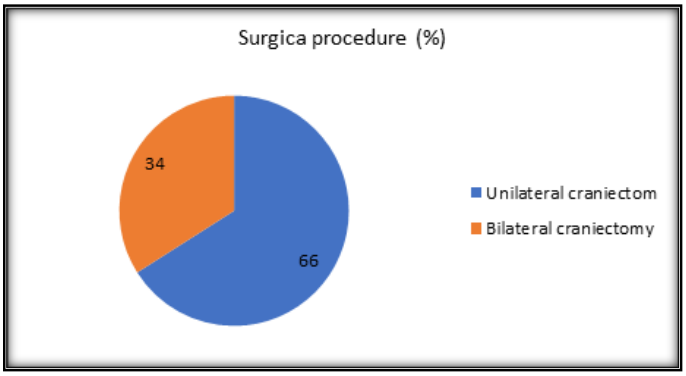


**Figure 1:** Surgical procedure distribution among participants (N=32).

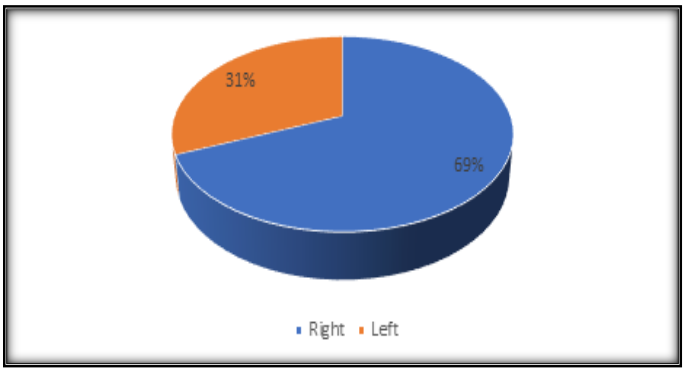


**Figure 2:** Side of the performed craniectomy (N=32).

## DISCUSSION

The aim of this study was to assess the outcomes and effectiveness of decompressive craniectomy in traumatic brain injury. In majority of the patients (69%) craniectomy was applied on the right side. After the completing surgical procedure, among all the alive participants, intracranial pressure after randomization (mm Hg), time (Hour) to intracranial pressure >20 mm Hg, intracranial hypertension index (Mean ± SD) and cerebral hypoperfusion index (Mean ± SD) were found as 14.51 ± 6.59, 8.91 ± 1.47, 11.31 ± 2.38 and 5.23 ± 1.33 respectively. In some studies, they reported that, intracranial hypertension was an independently associated with a higher risk of death and poor outcome following TBI and consequently,[17] management of brain swelling and elevated intracranial pressure (ICP) is a key component of acute TBI care.[18,19] In analyzing the duration of hospitalization, we observed, the mean (±SD) days of mechanical ventilation, days of ICU staying and days of hospitalization were 8.88 ± 2.54, 10.21 ± 3.16 and 15.57 ± 4.51 days respectively. In our study, in analyzing the final outcome, the mean (±SD) Extended Glasgow Outcome Scale scores of all the patients were found as 9.1. On the other hand, the unfavorable Extended Glasgow Outcome Scale score (1 to 4) was found in 56% patients. In this study, finally death cases were found 22%. In another study it was reported that, decompressive craniectomy instead shifted

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survivors from a favorable outcome to an unfavorable outcome specially because of the dependence on assistance to complete activities of daily living.[20,21] Generally, craniectomy allowed expansion of the swollen brain outside the skull and caused axonal stretch,[22] which in vitro causes neural injury.[23] Besides this, the alterations in cerebral blood flow as well as metabolism may also be relevant.[24] In these current settings, as surgical procedure among two third patients (66%) unilateral craniectomy was performed whereas among the rest 34% patients bilateral craniectomy was applied. Some surgeons prefer a unilateral procedure where it is possible because, bilateral approach may have more complications than that.[25] In this study we did not analyze the frequencies of several complications. But, craniectomy may also have had some harmful complications, including hydrocephalus.[21] However, complications occurred at the rates that were lower than those that have been reported previously.[26,27] Internationally, decompressive craniectomy procedures are increasingly performed in many neurotrauma centers now.[10] There are very few data from randomized, controlled trials comparing a neurosurgical procedure with standard care in adults with traumatic brain injury.[10]

## CONCLUSIONS

Decompressive craniectomy ensures better outcome in term of survival but the limitation is quality of life issues after survival especially among poor GCS (3-6) group. Prompt hospitalization, early diagnosis and proper ICU and ventilation facilities can ensure more satisfactory outcomes for the patients with traumatic brain injury. For getting more specific findings we would like to recommend for conducting similar more studies with larger sized samples in several places.

### Limitations of the Study

This was only dual centered study with a small sized sample. So, findings of this study may not reflect the exact scenario of the whole country.

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