Research Article

The Role of Decompressive Craniectomy in Traumatic Brain Injury: An Institutional Experience in a Tertiary Care Hospital

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Abstract:Background: Traumatic brain injury can damage the brain on permanent basis, to protect the brain Decompressive can play a pivot role to protect from secondary brain injury.

Objective: To assess the prognosis and functional outcomes in role of decompressive craniectomy in traumatic brain injury in tertiary care hospital.

Materials and Methods: This study conducted at Jinnah Post Graduate Medical Institute (JPMC) in Karachi from January 2018 to April 2022, comprises of 304 patients who underwent decompressive craniectomy following traumatic brain injury, specifically those with traumatic mass lesions. Our aim was to gain insight into their functional outcomes over a period of six months, utilizing the Glasgow Outcome Score at intervals of one month, three months, and six months, employing the chi-squared test, to identify any parameters that correlated with poor outcomes. This helped us discern potential factors contributing to unfavorable results.

Result: The current study comprised 304 individuals, with a median age of 48 years (IQR: 43-53). The majority of patients (66.1%) were older than 45 years. The median time since injury was 10 hours (IQR: 7-13.75). The median GCS score was (IQR: 5-7). The majority of patients had ASDH + Contusion (44.1%) and ASDH (42.1%) on CT scans. In our study, 38.5% of patients had a good outcome, whereas 61.5% had a poor outcome. The outcome was significantly associated with gender ($p=0.033$), age group ($p <0.001$), time since injury ($p<0.001$), GCS score ($p<0.001$), midline shift ($p<0.001$), mass lesion volume ($p<0.001$), and CT findings ($p=0.002$).

Conclusion: Decompressive craniectomy stands as a pivotal intervention in the management of severe traumatic brain injury (sTBI) patients grappling with traumatic mass lesions.

Keywords: Brain Injuries, Traumatic, Craniectomy, Intracranial Pressure, Glasgow Coma Scale, Cerebral Edema; Intracranial Hypertension.

INTRODUCTION

Traumatic injury ranks as the top cause of death among individuals aged 15 to 44, affecting both genders. The aftermath of such injuries can be deeply distressing for those involved. Every year, there are around 1.2 million lives are lost due to accidental injuries, with an additional 50 million individuals sustaining various injuries. Studies reveal that RTAs are particularly more observed in middle- or low-income countries. Pakistan, is one of the countries among along with several other nations, plays a significant role in the mortality rate resulting from these accidents [1]. Pakistan is considered among countries which has high ratio of head trauma globally. In a survey carried out in the 2004 National Injury Survey, traumatic brain injury in association with Road Accidents (RTAs) was around 1500 per 100,000 people per annual [2]. It must be kept in mind that in many developing nations, trauma patients are received in hospital care by not well trained staff in trauma, which may result in improper monitoring and stabilization of patient state such as hypoxia and hypotension [3]. In majority of patient high mortality or morbidity is due to raised intracranial pressure (ICP) [4]. The patient of intracranial pressure (ICP) is managed first hand by conservative options that may include the administration of analgesia, hyperosmolar agents, deep sedation [5].

The decompressive craniectomy may not reverse primary injury to the brain, but associated secondary damage induced by refractory intracranial hypertension can be minimized in moderate to severe head injury [6, 7]. The decompressive surgery can improve the patient but still there outcome is based on time duration and other prognostic factors, a multicenter, randomized, controlled based trail DECRA had raised similar concerns [8, 9].

Traumatic brain injury significantly contributes to global morbidity and mortality, often necessitating ICU admissions. Elevated intracranial pressure is a critical concern in these cases. While medical therapies like Mannitol or hyperventilation can initially manage it, decompressive craniectomy becomes an

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option when these treatments fail. Our study evaluates the role of decompressive craniectomy in traumatic brain injury patients, focusing on its outcomes and efficacy in severe TBI cases treated at our facility.

MATERIALS AND METHODS

This is the cross-sectional study conducted at Jinnah Post Graduate Medical Institute (JPMC) in Karachi from January 2018 to April 2022, ethical approval was obtained from the board, from the Institutional Review Board (IRB - F2-81/2023-GEN/151/JPMC). Consent was obtained from the patient. Our study focused on individuals aged 16 and above diagnosed with Traumatic Brain Injury (TBI) admitted to either the Intensive Care Unit (ICU) or High Dependency Unit, undergoing conservative or surgical management.

Exclusions were applied to patients with prior intracranial surgery at another facility or pre-existing intracranial infections. We included all eligible patients through convenience sampling, meticulously collecting data via manual chart review. Demographic details, injury mechanisms, treatment modalities, complications, and patient outcomes, notably mortality and central nervous system (CNS) infections, were recorded in a predefined format.

Brain Imaging and laboratory findings were extracted from the electronic medical record and meticulously documented. Traumatic brain injury (TBI) was defined according to the, which includes head injuries from blunt or penetrating trauma or acceleration-deceleration forces, resulting in neurological changes such as altered consciousness, intracranial lesions, memory impairments, skull fractures, or death.

Assessment of head injury severity utilized the Glasgow Coma Scale (GCS), with scores ranging from 3 to 15. Scores of 14 to 12 is mild head injury, while 11 to 9 moderate head injury and less than 8 severe head injury [10].

Sample size was computed using the WHO sample size calculator for health sciences with a prevalence of good outcome of 27.1% (26) and a margin of error of 5%, yielding a sample size of 304 with 95% confidence interval.

STATISTICAL ANALYSIS

The data was analyzed using IBM SPSS Statistics version 27. For quantitative data, the median and interquartile range were calculated, while qualitative variables were reported as frequency and percentage. The chi-square or Fisher exact test evaluated the association between qualitative variables. Binary logistic regression was used to compute odds. P-values below 0.05 were deemed statistically significant.

RESULT

The current study comprised 304 individuals, with a median age of 48 years (IQR: 43-53). The majority of patients (66.1%) were older than 45 years. The median time since injury was 10 hours (IQR: 7-13.75). The median GCS score was 6.00 (IQR: 5-7). The majority of patients had ASDH + Contusion (44.1%) and ASDH (42.1%) on CT scans. In our study, 38.5% of patients had a good outcome, whereas 61.5% had a poor outcome. Table **1** presents detailed descriptive statistics.

The outcome was significantly associated with gender (p=0.033), age group (p=0.000), time since injury (p=0.000), GCS score (p=0.000), midline shift (p=0.000), mass lesion volume (p=0.000), and CT findings (p=0.002). Table **2** shows the detailed association results.

Multivariate logistic regression revealed that male patients were less likely to have poor outcomes than female patients (OR=0.355, p=0.009), and patients under 45 years of age are less likely to have poor outcomes than those over 45 years of age (OR=0.713, p=0.291). Patients with ≤6 hours since surgery are less likely to have a poor outcome compared to those with >6 hours (OR=0.375, p=0.011). It was also observed that patients with GCS 3-5 are more likely to have a poor outcome than patients with GCS 6-8 (OR=18.763, p=0.00) as presented in Table **3**.

Table 1. Descriptive Statistics of Study Population (n=304).

Variable	n (%)
Gender	
Male	235(77.3)
Female	69(22.7)
Age(years)	
Median (IQR)	48.00(43.00-53.00)
Groups	
≤45 years	103(33.9)
>45 years	201(66.1)
Time Since Injury (hours)	
Median (IQR)	10.00(7.00-13.75)
Groups	
≤6 hours	61(20.1)
>6 hours	243(79.9)
GCS Score	
Median (IQR)	6.00(5.00-7.00)
Groups	
3-5	82(27)
6-8	222(73)
Midline Shift	
≤7.5 mm	83(27.3)
>7.5 mm	221(72.7)
Mass Lesion Volume (ml)	
Median (IQR)	35.00(33.00-39.00)

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Groups	
≤40 ml	240(78.9)
>40 ml	64(21.1)
CT Findings	
ASDH	128(42.1)
Contusion	27(8.9)
ICH	15(4.9)
ASDH + Contusion	134(44.1)
Outcome	
Good	117(38.5)
Poor	187(61.5)

Table 2. Characteristics of Traumatic Injury after Decompressive Craniectomy.

Variables	Outcome		p-value
	Good	Poor	
Gender			
Male	98(83.8)	137(73.3)	0.033*
Female	19(16.2)	50(26.7)	
Age Group			
≤45 years	55(47)	48(25.7)	< 0.001
>45 years	62(53)	139(74.3)	
Time Since Injury			
≤6 hours	43(36.8)	18(9.6)	< 0.001
>6 hours	74(63.2)	169(90.4)	
GCS Score			
3-5	3(2.6)	79(42.2)	< 0.001
6-8	114(97.4)	108(57.8)	
Midline Shift			
≤7.5 mm	62(53)	21(11.2)	< 0.001
>7.5 mm	55(47)	166(88.8)	
Mass Lesion Volume (ml)			
≤40 ml	107(91.5)	133(71.1)	< 0.001
>40 ml	10(8.5)	54(28.9)	
CT Findings			
ASDH	35(29.9)	93(49.7)	0.002*
Contusion	9(7.7)	18(9.6)	
ICH	6(5.1)	9(4.8)	
ASDH + Contusion	67(57.3)	67(35.8)	
Chi-square/fisher exact test was applied.			
*Significant at 0.05 level.			

DISCUSSION

In our study, we observed a predominance of male patients, comprising 77.3% (235 individuals), compared to 69 females, accounting for 22.7% (69 individuals). The median age of presentation was 48 years. Notably, the majority of patients, 79.9% (243 individuals), presented late, defined as more than 6 hours post-injury. Among those presenting late, 64 patients exhibited a brain hemorrhage volume of 40ml or greater, while 240 patients had a hemorrhage volume of less than 40ml. Acute subdural hematoma emerged as the most frequent pathology on CT scans, identified in 128 patients (42.1%). Analysis of outcomes revealed a favorable prognosis in 38.5% (117 patients) of cases, whereas a poor outcome was more prevalent, particularly among male patients. This disparity in outcomes may be attributed, at least in part, to delayed presentations, which could potentially

Table 3. Odds Ratio for Poor Outcome from Decompressive Craniectomy.

	Non-adjusted		Adjusted	
	p-value	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)
Gender				
Male	0.035*	0.531 (0.295-0.957)	0.009*	0.355 (0.163-0.773)
Female		Ref		Ref
Age Group				
≤45 years	0.000*	0.389 (0.239-0.635)	0.291	0.713 (0.381-1.336)
>45 years		Ref		Ref
Time Since Injury				
≤6 hours	0.000*	0.183 (0.099-0.339)	0.011*	0.375 (0.176-0.799)
>6 hours		Ref		Ref
GCS Score				
3-5	0.000*	27.796 (8.520-90.689)	0.000*	18.763 (5.486-64.174)
6-8		Ref		Ref
Midline Shift				
≤7.5 mm	0.000*	0.112 (0.063-0.201)	0.000*	0.153 (0.074-0.313)
>7.5 mm		Ref		Ref
Mass Lesion Volume (ml)				
≤40 ml	0.000*	0.230 (0.112-0.473)	0.014*	0.332 (0.137-0.801)
>40 ml		Ref		Ref
CT Findings				
ASDH	0.000*	2.657 (1.587-4.449)		
Contusion	0.118	2.000 (0.839-4.768)		
ICH	0.465	1.500 (0.506-4.448)		
ASDH + Contusion		Ref		
Binary logistic regression was applied.				
*Significant at 0.05 level.				

exacerbate the severity of the condition.

In our study, the majority of patients presenting with severe head injury and a Glasgow Coma Scale (GCS) below 8 were diagnosed with subdural hematoma. This finding contrasts with observations in China, where patients with severe head injury more frequently presented with intracerebral hematoma. In our cohort, subdural hematoma emerged as the predominant pathology associated with lower GCS scores [11].

The Brain Trauma Foundation advocates that the raised ICP can be worsen by high pressure so it is recommended to keep the blood pressure as low artificial hypothermia to minimize the brain metabolic activity to mitigate secondary brain injury following trauma [12].

The relation of traumatic brain injury (TBI) is directly associated with the mortality rates, severe injury can lead to prolong hospital stay, secondary complications and death while, intraventricular hemorrhage (IVH) non avoidable as a critical factor, showcasing an alarming mortality[13], in addition to this, acute subdural hematoma as the predominant leads to poor outcome.

Decompressive craniectomy (DC) has shown dual nature, the success rate can be very high and efficient with low morbidity [14]. While some study may show that DC can lead to high mortality in patients with severe traumatic brain injury. Additionally, the procedure does not seem to offer significant advantages over standard medical management [15]. Decompressive craniectomy is linked to improved clinical outcomes for traumatic brain injury patients by effectively reducing intractable elevated intracranial pressure [16].

In our cohort of traumatic brain injury patients who underwent decompressive craniectomy (DC), 39.1% achieved a favorable outcome at 3 months. Favorable outcomes were associated with age under 50, a Glasgow Coma Scale (GCS) score greater than 8 at presentation, intact pupillary reflexes, and lower Marshall grade injuries. Optimizing patient selection and using intracranial pressure (ICP) monitoring may improve the efficacy of DC. We recommend a larger prospective study to evaluate long-term functional outcomes post-DC using the Glasgow Outcome Scale Extended (GOSE) in Nepal [17]. while in our study Outcome analysis demonstrated a favorable prognosis in 38.5% (117 patients) of cases, while poor outcomes were more common, especially among male patients. This discrepancy in outcomes may be partially attributed to delayed presentations, potentially exacerbating the severity of the condition.

Existing literature on the role of decompressive craniectomy (DC) lacks diversity across geographical, racial, socioeconomic, and health infrastructure factors. Formulating institutional guidelines based on retrospective analyses and comparing them with standard guidelines can mitigate these disparities, offering improved treatment options tailored to specific situations [18].

Early decompressive craniectomy significantly reduces mortality in patients with closed head injury [19] similarly in our study < 6hours 43(36.8%) and > 6hoursly 74 (63.2%) shows that early surgery has better results.

Cisternostomy which need the microscope though not easily available for the traumatic surgery in our part of the world. Cisternostomy can emerge as a promising procedure for mitigating elevated intracranial pressure (ICP) in individuals suffering from traumatic brain injury (TBI) depends on availability of microsurgical tool. The procedure demonstrates notable efficacy, evidenced by a significant reduction in ICP levels post-cisternostomy. Furthermore, patients subjected to cisternostomy exhibit favorable outcomes, characterized by a commendable Glasgow Outcome Scale (GOS) score and a notably low incidence of complications during the postoperative phase [20].

Compared to our study, the populations in India, America, and Europe had a comparatively younger average age, while our study's mean age was higher [21-23]. Although cerebral infarction caused by brain edema can be lethal with a high mortality rate, the only definitive treatment to save the vasculature is decompressive craniectomy [24-26].

CONCLUSION

Decompressive craniectomy is the cornerstone and considered definitive treatment for traumatic brain injury (sTBI) patients, as it can be life-saving, its application demands a judicious approach. As per result of this study, early surgical intervention of decompressive hemicraniectomy based on clinical and radiological factor is important prognostic factors that can serve as guiding principles in the decision-making process surrounding that provides a positively impacting patient outcomes.

AUTHORS' CONTRIBUTION

- **Aurangzeb Kalhoro**: Study design, Methodology, Editing, Quality insurer.
- **Sher Hassan**: Paper writing.
- **Irum Bokhari**: Data collection, Calculations.
- **Ghulam Muhammad Brohi**: Data analysis, Results interpretation.
- **Faizyab Ahmed**: Literature review, Referencing.
- **Tanweer Ahmed**: Editing, Quality insurer.

CONFLICT OF INTEREST

Declared none.

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