Original Article (BRAIN)

Outcome & Complications of Decompressive Craniectomy with Expansion Duroplasty in Severe Head Injury

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ABSTRACT

Objective: A descriptive case series was conducted to find the frequency of complications and complications of decompressive craniectomy with expansion duraplasty in severe head injury.

Material and Methods: 189 patients fulfilling the selection criteria were included. All patients had TBI which was confirmed by CT scan. Surgery was performed on the day of admission under general anesthesia and a large trauma flap. Patients were monitored daily by evaluators from the date of surgery until hospital discharge or death. Patients were followed up for 3 months and the outcome was assessed using the Glasgow outcome scale (GOS).

Results: Mean age of the patients was 36.57 years. There were 61.4% (116) males and 38.6% (73) females. 3.7% had CSF leakage. 1.6% had meningitis. Wound infection was seen in 7.4% of patients. Forty percent had a favorable outcome and 60% had a poor outcome. Fifty patients out of 111 patients between 18 – 40 years showed good outcomes. Twenty-six out of 78 from the 41 – 60 years age group showed good outcomes. Out of 189 total, 76 patients had a good outcome. The outcome was good in 63 patients out of 148 patients with GCS 5 – 8, whereas 13 (out of 41) patients had a good outcome with GCS below 5.

Conclusion: We discovered that the result was good in 40% of patients, with 11 percent of complications recorded. Therefore, we concluded that decompressive craniectomy with expansion duraplasty is an effective procedure for the treatment of the severe head injury.

Keywords: Decompressive craniectomy, Traumatic head injury, Expansion duraplasty.

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INTRODUCTION

Traumatic Brain Damage (TBI) is described as a non-progressive injury to the brain caused by trauma. It happens when an external force strikes the brain, most commonly from a blow, bump, jolt, or penetrating wound to the head. It is

estimated that traumatic brain injury affects 54 to 60 million individuals each year, resulting in hospitalization or death, with poor and middle-income nations having approximately three times the number of cases as high-income ones. It is a primary cause of mortality and disability globally, with massive economic ramifications.[1-2] Decompressive craniectomy (DC) is a frequently utilized surgery in neurosurgical practice for the treatment of intractable intracranial hypertension. In patients with traumatic brain injury (TBI), decompressive craniectomy (DC) has become more common in recent years to manage medically intractable intracranial hypertension. Even though DC is a potentially life-saving operation for TBI patients, it is not without risks.[3-4] CSF leak, which occurs in 4 – 32% of treatments, as well as post-traumatic cerebral infarction (PTCI) and infections, are well-known TBI sequelae that have been related to poor clinical outcomes.[3-4] The present descriptive case series was conducted to find the frequency of complications and complications of decompressive craniectomy with expansion duraplasty in severe head injury.[5-6]

The interruption in brain function or other signs of brain illness produced by an external physical impact is known as traumatic brain injury (TBI).[7] TBI is predicted to affect 50 million people globally each year, which means that over half of the world's population will have a TBI at some point in their lives.[7] It is the leading cause of mortality and disability among those under the age of 40 in the United Kingdom. Furthermore, low- and middle-income nations have considerably greater rates of morbidity and death.[8-9] TBI will be a major health issue and the leading cause of disability in 2020, according to the World Health Organization.[10] TBIs, both primary and secondary, induce temporary and/or permanent brain damage, limiting a patient's activities, affecting their social involvement, and lowering their quality of life. In TBI patients, this can result in depression and other chronic disorders.[11-12] In general, the position and

trajectory of the item involved will establish the profile of injury including brain material penetration. Various high-risk brain areas are sensitive to neurotrauma's effects; however, it is vital to remember that these brain regions are important nodes in frontal-subcortical circuits that support cognition and social behavior. The usual areas sensitive to TBI injury coincide strongly with critical regions and nodal sites in these frontal-subcortical circuits, indicating that cognition, social comportment, and excitation are all impacted.[13]

Whelan-Goodinson et al[14] discovered a substantial link between depression, anxiety, and outcome after a TBI. In mouse model research, the events of posttraumatic fluid buildup (cerebral edema), disruption of the blood-brain barrier (BBB), and histological alterations were investigated. Following a closed-head injury, researchers detected considerable neuronal cell loss in specific parts of the left hippocampus. In the striatum, corpus callosum, and damaged cortex, immunohistochemistry utilizing several antibodies to the amyloid precursor protein and/or amyloid precursor protein-like proteins revealed a new axonal degeneration. An extension of the cerebral cavity, enlargement of the lateral ventricles, distortion of the hippocampus, and thalamic calcifications were all seen histologically in wounded brains.[15]

A decompressive craniectomy is a type of neurosurgery that involves removing a part of the skull to allow a bloated brain to develop without being compressed. It is used on people who have had a traumatic brain injury, a stroke, a Chiari Malformation, or other diseases that cause high intracranial pressure. The surgery's use is debatable. ICP was controlled by DC in patients with aberrant conditions such as cerebral neoplasms, ischemic illness, and diffuse edema after TBI. Guerra et al.[16] conducted 19 bifrontal craniectomies and 18 hemicraniectomies on 37 patients less than 40 years old in a prospective trial in 1990. They recorded 5 deaths, with the

others making a complete recovery or remaining mildly impaired. The initial posttraumatic GCS 7 had the most impact on the treatment success.[17]

MATERIALS AND METHODS

We determined the frequency of complications and outcome of decompressive craniectomy with expansion duraplasty in severe head injury.

Study Design and Setting

Descriptive case series was conducted at Neurosurgery Unit 3, LGH, Lahore, for six months from 27-02-2021 to 27-08-2021.

Sample Size and Selection

A consecutive sampling (non-probability) was considered. A sample size of 189 is calculated using a 95% confidence level with a 3.9% margin of error and an expected frequency of complications after expansion duraplasty of 8%.

Inclusion Criteria

Patients between 18 to 60 years of age from both genders, with traumatic brain injury requiring decompressive craniectomy with GCS of 8 or less were included in the study.

Exclusion Criteria

Patients with intra-axial contusions or hematomas requiring surgical evacuation (patients with acute subdural & epidural hematoma were not excluded), polytrauma patients, and those with bleeding diathesis were excluded from the study. Patients with brainstem contusions & diffuse axonal injury were excluded from the study. Patients without midline shift with post-traumatic intracranial HTN requiring bifrontal craniotomy were also excluded from the study. Patients/ attendants who were unwilling to participate or those who require posterior fossa decompression were not included in the study.

Clinical and Surgical Management

This study was carried out with the agreement of the Hospital Ethical Committee. The study comprised 189 patients who met the above-mentioned selection criteria. Following admission, informed written permission for participation in the study investigation was obtained. All patients who suffered TBI as determined by a CT scan. The Glasgow Coma Scale and Degree of Consciousness, as well as mental function and the existence of focused impairments, were used in the clinical examination. On the day of admission, surgery was conducted under general anesthesia, and a huge trauma flap (i.e., a large reverse question mark starting at the tragus and extending to the midline) was performed. The skin, galea, and muscle layers were raised to the surgeon's liking. As a result, a broad (at least 12 15 cm) craniotomy was done, and the temporal bone was removed until it was flush with the floor of the middle fossa. Following dural opening and evacuation of the ASDH (acute subdural hematoma), duraplasty with pericranium or an artificial graft (at the surgeon's option) was done. The usual closing procedure was then followed. Evaluators then followed up on patients daily from the time of surgery until they were discharged from the hospital or died. Patients were tracked for three months to see how they fared and the Glasgow outcome scale was used to document their status at 3 months. GOS 4 & 5 were considered good outcomes, whereas 2-4 were considered poor outcomes & GOS 1 was given for mortality within 3 months of surgery.

Our study's end aim was the occurrence of problems, specifically GCS, GOS, and CSF leak (CSF drainage through the surgical wound). Cranial CT images were taken regularly as needed.

Data Analysis

All the data was recorded on a proforma. All data were entered and analyzed using SPSS Version 26. Mean and standard deviation was computed for numerical variables like age, pre-procedure GCS, and post-procedure GCS. Frequency and percentages were used to describe the categorical variable like gender, complication, and outcome (good or poor). Data was stratified for age, gender, pre-op GCS & GOS at 3 months. Post stratifications Chi-square test was used. Significance was kept at a p-value less than 0.05.

RESULTS

A total of 189 fulfilling the inclusion/exclusion criteria were enrolled to study the frequency of complications and outcome of decompressive craniectomy with expansion duraplasty in severe head injury.

Age Distribution

The mean age of the patients was 36.57 years. Out of 189 patients, 58.7% (n = 111) were in the age group of 18 – 40 years whereas 41.3% (n = 78) were between 41 – 60 years of age, the mean age was calculated as 36.57 ± 11.36 years **(Table 1).**

Table 1: Distribution of age (N = 189).

Age Range	Frequency	Percent
18 – 40 years	111	58.7
41 – 60 years	78	41.3
Mean ± SD = 36.57±11.36 years		

Gender Distribution

116 (61.4%) males and 73 (38.6%) females from 189 patients **(Table 2).**

Clinical Information

In 189 patients, the mean GCS in the preoperative

period was 5.23, while after the procedure it was 12.49 at 3 months post-op **(Table 3)**. Only 7 (3.7%) patients out of 189 had CSF leakage **(Table 4)**. Out of 189 patients, 3 (1.6%) had meningitis **(Table 5)**. Wound infection was seen in 14 (7.4%) patients **(Table 6)**. Out of 189 patients, 40 % (n76) had a favorable outcome and 42.6% (n80) percent had a poor outcome & mortality was 17.4% (n33) **(Table 7)**.

Table 2: Distribution of gender (N = 189).

Gender	Prevalence	%
Male	116	61.4
Female	73	38.6

Table 3: Distribution of pre and post-procedure GCS score (N = 189).

Variable	Mean ± SD
Pre-procedure GCS score	5.23±0.93
Post-procedure GCS score	12.49±2.60

Table 4: Distribution of CSF leak (N = 189).

	Prevalence	%
Yes	7	3.7
No	182	96.3
Total	189	100.0

Table 5: Distribution of meningitis (N = 189).

	Prevalence	%
Yes	3	1.6
No	186	98.4
Total	189	100.0

Table 6: Distribution of wound infection (N= 189).

	Prevalence	%
Yes	14	7.4
No	175	92.6
Total	189	100

Table 7: Distribution of outcome (N = 189).

Outcome	Prevalence	%
Good	76	40
Poor	80	42.6
Mortality	33	17.4
Total	189	100.0

Stratification of the Presence of Complications Concerning Age

Out of 189 patients, complications were stratified, 15 patients from the 18 – 40 years age group had complications, while 6 patients from the 41 – 60 years age group developed complications. A total of 21 patients had complications out of 189 **(Table 8)**. This was an insignificant correlation (p-value = 0.210 > 0.050).

Table 8: Stratification of complication with respect to age using the chi-square test (N = 189).

Age Groups	Complications		Total	p-value
	Yes	No		
18 – 40 Years	15	96	111	Chi Sq: 1.57
41 – 60 Years	6	72	78	P value:
Total	21	168	189	0.210

Stratification of Complications Concerning Gender

Out of 189 patients, 11 males and 10 females developed complications as shown in the stratified **(Table 9)**, an insignificant correlation (p-value = 0.369 > 0.050).

Table 9: Stratification of complication with respect to gender using the chi-square test (N= 189).

Gender	Complications		Total	p-value
	Yes	No		
Male	11	105	116	Chi Sq: 0.80
Female	10	63	73	P value:
Total	21	168	189	0.369

Stratification of Complication Concerning Pre-procedure GCS Score

Five patients who had GCS between 3 and 4 preoperatively, developed complications and 16 patients between 5-8 GCS showed complications **(Table 10)**. A high p-value of 0.803>0.050 shows an insignificant correlation.

Table 10: Stratification of complication with respect to pre-procedure GCS score using the chi-square test (N= 189).

Pre-procedure GCS	Complications		Total	p-value
	Yes	No		
3 – 4	5	36	41	Chi Sq:0.062
5 – 8	16	132	148	P value:0.803
Total	21	168	189	

Stratification of Outcome Concerning Age

The age-related outcome is shown in **Table 11** in two age groups. Fifty out of 111 patients between 18 and 40 years showed good outcomes. Twenty-six out of 78 from the 41 – 60 years age group showed good outcomes. Out of 189 total, 76 patients had a good outcome. Outcome related to age showed an insignificant association (p-value: 0.105 > 0.05).

Table 11: Stratification of outcome with respect to age using the chi-square test (N = 189).

Age Group	Outcome		Total	p-value
	Good	Poor		
18 – 40 Years	50	61	111	Chi Sq: 2.6
41 – 60 Years	26	52	78	P value:
Total	76	113	189	0.105

Stratification of Outcome Concerning Gender

Outcomes related to gender showed an insignificant correlation (p-value = 0.086). The better outcome was seen in 49 males out of 116 males as opposed to only 27 females showing a

good outcome out of 73 **(Table 12)**. There existed an insignificant association (p-value: 0.473>0.050) between gender with good/poor outcomes.

Table 12: Stratification of outcome with respect to gender using the chi-square test (N = 189).

| Gender | Outcome | | Total | p-value |
	Good	Poor		
Male	49	67	116	Chi Sq: 0.51
Female	27	46	73	P value:
Total	76	113	189	0.473

Stratification of Outcome Concerning Pre-procedure GCS Score

Pre-procedure GCS and outcome were stratified in **Table 13**. 35 out of 41 patients with GCS under 4 showed good outcomes and 128 out of 148 had a good outcome in the 5-8 GCS group of patients. This was an insignificant correlation (p-value= 0.209 > 0.050).

Table 13: Stratification of outcome with respect to pre-procedure GCS score using the chi-square test (N = 189).

| Pre-procedure GCS | Outcome | | Total | p-value |
	Good	Poor		
3 – 4	13	28	41	Chi Sq: 1.57
5 – 8	63	85	148	P p-value:
Total	76	113	189	0.209

DISCUSSION

Decompressive craniectomy is a neurosurgery treatment intended to reduce elevated intracranial pressure in individuals suffering from severe traumatic brain damage (TBI). Although there is still debate over the procedure's effectiveness in improving patient outcomes, it is nevertheless commonly utilized as a last option in patients with unmanageable intracranial pressure (ICP). Decompressive craniectomy is currently referred to as a second-tier treatment for refractory intracranial hypertension that does not respond to standard therapeutic methods for severe TBIs. In the current study, the preoperative mean GCS was 5.23, while the postoperative mean GCS was 12.49 at 3 months post-op in surviving patients. Only 3.7 percent of patients reported CSF leaking. Meningitis affected 1.6 percent of the population. 7.4 percent of patients had wound infections. Forty percent had a positive outcome, while 42.6 percent had a poor outcome & mortality was 17.4%. Fifty of 111 individuals between the ages of 18 and 40 had a favorable result. Twenty-three out of 78 people between the ages of 41 and 60 had a positive outcome. Seventy 3 patients out of a total of 189 had a favorable result. Thirteen of 41 patients with GCS 4 or less had a good prognosis, while 63 of 148 patients with GCS 5 – 8 had a favorable outcome. This correlation was significant (p-value). Five patients with GCS between 3 and 4 post-operatively suffered problems, whereas 16 patients with GCS between 5 – 8 developed issues (p-value: 0.803). Jeong et al.[18] conducted a study on non-suture duroplasty performed in TBI patients as part of a DC. Non-suture duraplasty required less time to perform and resulted in less blood loss than suture duraplasty. Other problems and outcomes were comparable in both groups. As a result, non-suture duraplasty in DC may be regarded to be a safe and practical procedure.

In patients with traumatic brain injury (TBI), decompressive craniectomy (DC) has become more common in recent years to manage medically intractable intracranial hypertension.[3-4] Although DC is an effective treatment for TBI, there is a greater than 50% chance of complications. Age and initial neurologic state are two risk factors for complications (lower GCS). Invasion of the orbital roof during DC, closeness to the facial sinuses, and major contour anomalies with associated big dead spaces are all risk factors for infection rate. CSF absorption problem (subdural hygroma and hydrocephalus),

postoperative hematoma enlargement, syndrome of the trephined, and surgical site infection are all possible consequences of DC. DC's emergency surgery can harm the STA (superficial temporal artery) and limit blood supply to the scalp flap, resulting in necrosis of the surrounding tissue. The surgical area can be contaminated if the frontal sinus is accidentally opened, especially during bifrontal craniectomy. Early cranioplasty, performed before the skin flap sinks, can minimize the condition, but it increases the risk of infection and is hence not suggested.[16-17] A ventriculoperitoneal (VP) shunt may be necessary in some cases. CSF leakage is the most common CSF complication, which can result in wound problems, infection, and a longer recovery time. Initially, a simple CSF leak should be addressed by tightening the wound suture and performing a ventriculostomy.[16-17]

Following severe traumatic brain injury (sTBI) with unmanageable high intracranial pressure (ICP), neurosurgeons' key issue today is to determine who may benefit from DC and which factors following DC impact the prognosis of these patients. Nasi et al.[19] investigated the pre- and postoperative predictors of outcome following DC. The development of hydrocephalus following DC for sTBI and delayed cranial reconstruction were observed to be related to adverse results in their research. Several large multicenter randomized studies have been conducted to investigate the surgical effectiveness of the operation. These studies indicated a survival advantage in individuals who were randomly assigned to surgical decompression. However, demonstrating an improvement in outcome requires changing the definition of favorable to include individuals with either a modified Rankin score of 4 or higher severe impairment.[20]

Two randomized controlled trials (RCTs) using decompressive craniectomy (DC) in traumatic brain injury (TBI) have had dismal results, although there are questions about how these procedures apply to real-world practice. Wettervik et al.[21] compared the efficacy and safety of DC and thiopental at a single center. The role of DC in TBI therapy has to be thoroughly examined, and they feel that future RCTs should include clearer and less lenient ICP criteria for when thiopental should be followed by DC and DC followed by thiopental. Mhanna et al.[22] determined if DC improves survival and/or quality of life in pediatric patients with severe TBI. Early DC in children's patients with severe TBI improves prognosis in survivors, according to the authors. Prospective randomized controlled trials are required in the future to validate these findings. One of the primary causes of death in children is head trauma. Various medical techniques, such as osmotic diuresis, sedation, and pentobarbital-induced coma, have been used to reduce excessive intracranial pressure (ICP). In severe traumatic brain injury, surgical methods such as decompressive craniectomy (DC) have been proposed to reduce ICP (TBI). However, the use of DC is still debatable, and if the treatment is to be performed, a craniectomy that is too tiny might be harmful to the patient. Craniectomy has been established in animal models and clinical situations to enhance survival. Pediatric patients have a better prognosis than adult patients and can recover from extremely high ICPs. Finally, facts show that early DC saves lives. However, there is no clinically meaningful difference between the two groups in terms of positive and negative clinical outcomes.[23]

CONCLUSION

We studied the frequency of complications and outcome of decompressive craniectomy with expansion duraplasty in severe head injuries. We found that a good outcome was 40% and a poor outcome was 42.6% with mortality at 17.6% and complications found in 11.1% of patients. Therefore, we concluded that decompressive craniectomy with expansion duraplasty is an

effective procedure for the treatment of the severe head injury.

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Additional Information

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Ethical Review Board Approval: The study was conformed to the ethical review board requirements.

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Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

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AUTHOR CONTRIBUTIONS

Sr. No.	Author's Full Name	Intellectual Contribution to Paper in Terms of;
1.	Zubair Mustafa Khan	Study Design, Methodology, and Paper Writing.
2.	Zehra Safdar	Data Calculation and Data Analysis.
3.	Syed Ahmad Faizan	Interpretation of Results.
4.	Asif Shabir	Statistical Analysis.
5.	Muhammad Shakir	Literature Review.
6.	Asif Bashir	Literature Review and Quality Insurer.