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ORIGINAL RESEARCH

Outcome of Decompressive Craniectomy and Craniotomy for Severe Traumatic Head Injury in a Single Centre

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ABSTRACT
Introduction: Traumatic head injury accounts for around 5-10% of the trauma centre admission, with 10-15% of them who are required immediate surgical intervention. Delay in earlier neurosurgical management will lead to an increase in risk of morbidity and mortality.
Aim: To measure the outcome of emergency neurosurgical intervention in traumatic head injury patients and assessment of factors contributing to craniectomy.
Materials and methods: A retrospective study was conducted in a tertiary care hospital, Jamnagar, Gujarat from November2023 to March2024 which analysed 50 patients undergoing emergency neurosurgical intervention for traumatic brain injury. We have recorded mechanism of injury, Glasgow Coma Scale (GCS) score, pupil status, computed tomography findings, surgical treatment methods, time interval between clinical deterioration and surgery and outcome. CT scans were done in post operative period. After surgery follow up was done at 1,2,3 and 6 months interval. Outcome was assessed by Glassgow outcome scale.
Results: Fifty patients were included in the study. We performed DC (Decompressive craniectomy) in 35 patients while 15 underwent craniotomy. There were no statistically significant differences in the age, gender, or injury mechanism between the 2 groups. Factors like GCS, pupillary dilation, midline shift, hematoma type and timing of surgery were associated with DC.26 patients (52%) had good outcome at 6months interval. Factors associated with outcome were age, GCS, pupil dilation, type of hematoma and timing of surgery. Age more than 60 years, low GCS were associated with poor outcome.
Conclusion: Early neurosurgical intervention helps to decrease the mortality rate and helps in early recovery of the patient.
Keywords: Traumatic Brain Injuries, Neurosurgical Intervention, Glasgow Coma Scale.

INTRODUCTION

Traumatic brain injury (TBI) remains the main cause of mortality and morbidity worldwide.[1] It is due to external physical forces like falls, assault, transport related accidents which lead to disruption in brain physiology and anatomy in form of diffuse axonal injury, intracranial haemorrhage or cranial vault fracture.

TBIs are classified as focal or diffuse based on the presence or absence of focal lesions. Although injuries may be considered predominantly focal or diffuse, most injuries are heterogeneous with both focal and diffuse components.[2] Mass lesions, such as contusion, subdural hematoma, epidural hematoma, and intraparenchymal hemorrhage are considered focal injuries, whereas diffuse injury encompasses axonal injury, hypoxic-ischemic injury, and microvascular injury that affect widely distributed anatomic regions.[2]

The mortality rate for severe focal injuries is reported to be approximately 40% and, for severe diffuse injuries, approximately 25%.[2]

Primary injuries following TBI are those that are the direct result of the external mechanical forces producing deformation of the brain tissue and

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disruption of normal brain function. The types of mechanical forces involved in brain trauma include acceleration and deceleration linear forces, rotational forces, forces generated by blast winds associated with blast injury, blunt impact, and penetration by a projectile.

These forces directly damage the neurons, axons, dendrites, glia, and blood vessels in a focal, multifocal, or diffuse pattern and initiate a dynamic series of complex cellular, inflammatory, mitochondrial, neurochemical, and metabolic alterations.

The magnitude of the primary injury resulting from a traumatic impact can be modified by the use of preventative measures, such as protective equipment and helmets. However, once the trauma occurs, the immediate neurologic damage produced by the primary traumatic forces is usually not alterable.[2]

AIM

To measure the outcome of emergency neurosurgical intervention in traumatic head injury patients and assessment of factors contributing to craniectomy.

MATERIALS AND METHODS

A study was conducted in the Department of Neurosurgery, Shri M. P. Shah Government Medical College, Jamnagar, Gujarat from November 2023 to March 2024 for a period of 5 months. The study was conducted on patients undergoing neurosurgical intervention. 50 patients were included in the study. The patients were tracked for a period of 1,2,3 and 6 months in follow up period.

Inclusion criteria:

1. Acute SDH or haemorrhagic contusions with mass effect and neurological deficits.
2. Extradural haemorrhage size more than or equal to 15mm with deterioration of GCS.
3. Communited depressed skull fracture with parenchymal injury.

Exclusion criteria:

1. Patient with penetrating injury.
2. Patient with both pupils dilated and fixed with GCS of E1V1M1.
3. Patient with extracranial injury.

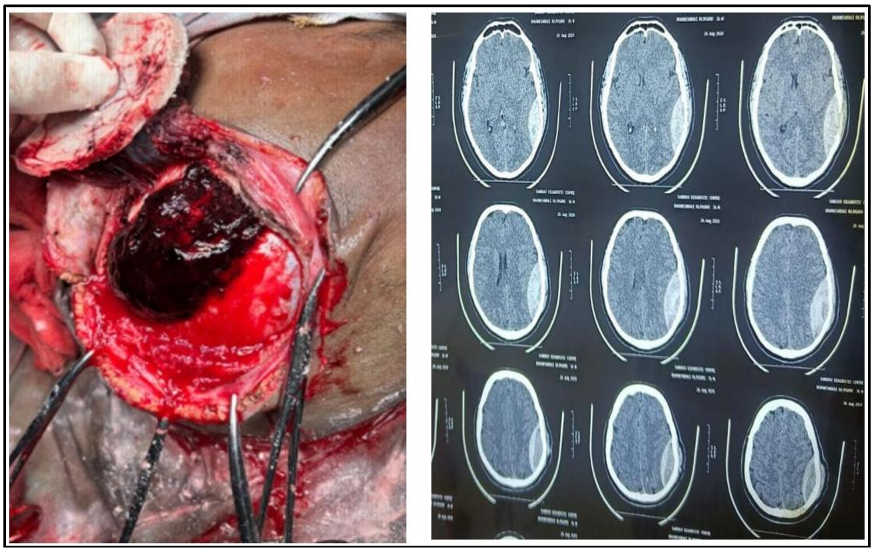

Fig 1: Extradural Hemorrhage A: Intra Operative Picture, B: NCCT Brain.

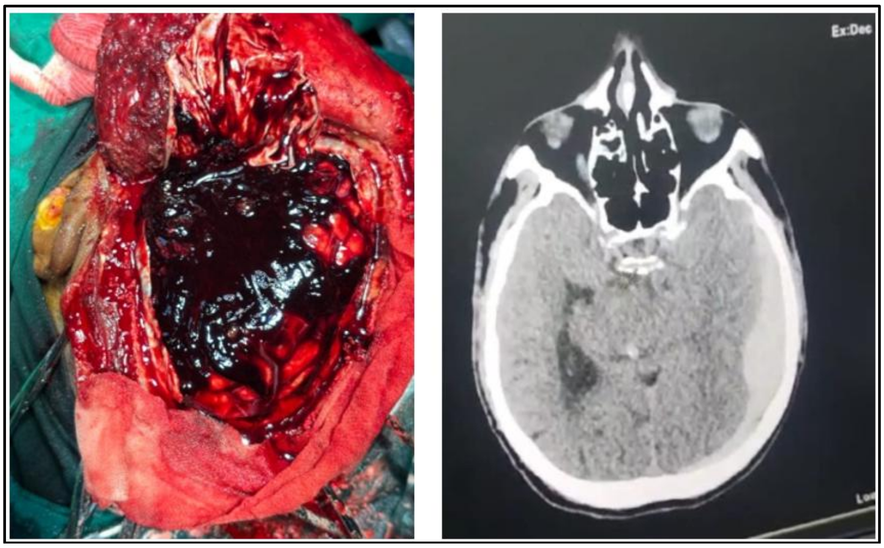

Fig 2: Subdural Hemorrhage. A: Intra Operative SDH, B: NCCT Brain Of SDH

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Pre-operative assessment:
Careful history and physical examination were done in all patients to look for any other injury. Non-contrast computed tomography(CT), Ultrasound examination with E-FAST protocol or CT with contrast of chest, abdomen was done in all patients. Patients were given IV antibiotic, anticonvulsant and mannitol according to CT scan report.

Operative procedure:
Patients underwent craniotomy or decompressive craniectomy according to CT report and patient condition. Pupil status was the key factor to assess raised intracranial pressure. A large fronto-parieto temporal skin flap and craniotomy was often used. Based on intraoperative findings the bone flap was removed or replaced. Bones were removed in case of severe cerebral edema. Patients with pupillary dilation and midline shift more than 10 mm underwent decompressive craniectomy.

Postoperative care:
All patients were given injectable antibiotics, analgesics, anticonvulsant, and sedation in post operative period.
Inj. Mannitol given according to indication.
Mechanical ventilation as and when required.
Outcomes were determined by the Glasgow Outcome Scale (GOS) score at 1,2,3 and 6 months after injury. The 5 GOS categories (dead, vegetative state, severe disability, moderate disability, and mild disability)

RESULTS
Out of 50 patients 40 male (80%) and 10 female (20%) patients, with age group between 5 years to 85 years: with mean age 29years.4 patients were under 12 years of age.30 patients (60%) had road traffic accidents, while in 15 patients (30%) mode of injury was fall from height and 5 patients (10%) had assault injury. Out of 50patients, 13 patients (26%) had extradural haemorrhage ,33 patients (66%) had subdural haemorrhage with contusions,4 patients (8%) had depressed comminuted skull fractures with parenchymal injury. Out of 50 patients, 20 patients (40%) had GCS more than 8,30 patients (60%) had GCS less than or equal to 8.35 patients underwent decompressive craniotomy including 30 patients with acute subdural haemorrhage,3 patients with acute extradural haemorrhage and 2 patients with depressed comminuted fracture.15 patients were operated for craniotomy. The mean operative time was 124 minutes (ranging from 32 minutes to 248 minutes).
Patients needed 1 to 20 days of ICU stay. Postoperative seizure episodes were noted in 9 patients (18%) who were treated with double anticonvulsant drugs. Complications like meningitis were noted in 3 patients (6%), wound infection in 8 patients (16%), pneumonia in 14 patients (28%), CSF leak in 5 patients (10%) and hydrocephalus in 4 patients(8%). Postoperative mortality was seen in 10 patients (20%), in which 7 patients were over 60 years of age. Out of 40 patients, 23 patients had good outcome ,10 patients were severely disabled and 7 patients were vegetative based on glassgow outcome scale.
P value <0.05 was considered statistically significant. There are no significant differences between craniotomy and craniectomy groups in factors like age, mode of injury, and sex (Table 2). Factors like pupil dilation, midline shift, timing of surgery, type of brain injury and GCS were significantly associated with decompressive craniectomies. Logistic regression analysis revealed that type of hematoma was associated with DC (Table 3).
Majority of patients with subdural haemorrhage underwent DC. Factors associated with poor outcome were older age, pupil dilation and GCS(Table 4).Logistic regression analysis revealed that GCS less than 8 was associated with poor outcome(Table 5).Mortality was high in patients with time of surgery more than 6 hours from incidence, GCS <8,bilateral pupil dilation and subdural hemorrhage.(Table 4).Patients’ glassgow outcome scores 6 months after injury shown in table 4.23 patients had favourable outcome.17 patients had unfavourable outcome and 10 patients(20%) died. There were decreased numbers of patients in DC group with good outcome compared to craniotomy group.(10/35=28.5% vs 13/15=86.7%).

Table 1: Patient characteristics

Parameter	No. of Patients
Age	
<12	4(8%)
13-60	26(52%)
>60	20(40%)
Sex	
M	40(80%)
F	10(20%)
Mode of injury:	
Road traffic accident	30 (60%)
Fall from height	15(30%)
Assault	5(10%)
Pupil dilation:	
Unilateral	23(46%)
Bilateral	27(54%)

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Midline shift: **<5mm** **>5mm**	 22(44%) 28(56%)
GCS **>8** **<8**	 20(40%) 30(60%)
Type of brain injury: **EDH** **SDH with contusions** **Comminuted fracture with contusions**	 13(26%) 33(66%) 4(8%)
Type of surgery: **Craniotomy** **Decompressive craniectomy**	 15 35
Time of surgery from incidence: **<6hrs** **>6hrs**	 14(28%) 36(72%)
Complications: **Meningitis** **Wound infection** **CSF leaf** **Pneumonia** **Hydrocephalus**	 3(6%) 8(16%) 5(10%) 14(28%) 4(8%)

Table 2: Different factors and type of procedure.

Parameter	No. of craniotomy (%)	No. of DC (%)	P value
Age **<12** **13-60** **>60**	 2(4%) 7(14%) 6(12%)	 1(2%) 27(54%) 7(14%)	 0.08
Sex **M** **F**	 13(26%) 2(4%)	 27(54%) 8(16%)	 0.7
Mode of injury: **Road traffic accident** **Fall from height** **Assault**	 10(20%) 2(4%) 3(6%)	 20(40%) 13(26%) 2(4%)	 0.09
Pupil dilation: **Unilateral** **Bilateral**	 12(24%) 3(6%)	 11(22%) 24(48%)	 0.002*
Midline shift: **<5mm** **>5mm**	 13(26%) 2(4%)	 9(18%) 26(52%)	 0.0001**
GCS **>8** **<8**	 12(24%) 3(6%)	 8(16%) 27(54%)	 0.0003**
Type of brain injury: **EDH** **SDH with contusions** **Comminuted fracture with contusions**	 10(20%) 2(4%) 3(6%)	 3(6%) 31(62%) 2(4%)	 <0.001**
Time of surgery from incidence: **<6hrs** **>6hrs**	 10(20%) 5(10%)	 4(8%) 31(62%)	 0.0002**
Complications: **Meningitis** **Wound infection** **CSF leak** **Pneumonia** **Hydrocephalus**	 0 2(4%) 1(2%) 2(4%) 0	 3(6%) 6(12%) 4(8%) 12(24%) 4(8%)	 0.74

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Table 3: Statistical analysis for factors leading to decompression craniectomy.

	P value	Lower 95%	Upper 95%
GCS **<8** **>8**	0.22	-0.013	0.054
Pupil dilation	0.82	-0.32	0.25
Midline shift **<5mm** **>5mm**	0.42	-0.41	0.17
Hematoma **EDH** **SDH**	0.01	0.09	0.65
Time >6 hrs	0.71	-0.26	0.38

Table 4: Relationship between various factors and outcome

Parameter	Favourable outcome (%)	Unfavourabe outcome (%)	Death (%)	P value
Age				
<12	3(6%)	1(2%)	0	0.03*
13-60	16(32%)	7(14%)	3(6%)	
>60	4(8%)	9(18%)	7(14%)	
Sex				
M	18(36%)	16(32%)	6(12%)	0.08
F	5(10%)	1(2%)	4(8%)	
Pupil dilation:				
Unilateral	16(32%)	5(16%)	2(4%)	0.008*
Bilateral	7(14%)	12(24%)	8(16%)	
Midline shift:				
<5mm	14(28%)	6(12%)	2(4%)	0.08
>5mm	9(18%)	11(22%)	8(16%)	
GCS				
>8	17(34%)	2(4%)	1(2%)	<0.001**
<8	6(12%)	15(26%)	9(18%)	
Type of brain injury:				
EDH	10(20%)	2(4%)	1(2%)	0.09
SDH with contusions	11(22%)	14(28%)	8(16%)	
Comminuted fracture with contusions	2(4%)	1(2%)	1(2%)	
Time of surgery from incidence:				
<6hrs	10(20%)	2(4%)	2(4%)	0.08
>6hrs	13(26%)	15(30%)	8(16%)	

Table 5: Statistical analysis for clinical outcome.

	P value	Lower 95%	Upper 95%
Age **13-60** **>60**	0.67	-0.18	0.28
GCS **<8** **>8**	<0.001	0.038	0.079
Pupil dilation	0.34	-0.12	0.33
Midline shift **<5mm** **>5mm**	0.29	-0.11	0.35
Hematoma **EDH** **SDH**	0.11	-0.41	0.05
Time >6 hrs	0.23	-0.39	0.10

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DISCUSSION

In our study, we have assessed effectiveness of DC on clinical outcome of patients with severe traumatic brain injury. Patients with GCS more than 8 had favourable outcome. Some studies have shown that DC does not lead to better outcome compared to maximum medical management[3,4]. In areas with limited resources, DC has proven to be beneficial when performed less than 5 hours after head injury in younger patients with GCS more than 5[3]. Grandhi et al indicated, that DC was associated with worst post operative outcome[5].

Nirula et al indicated that, early DC does not improve outcomes in patients with refractory intracranial hypertension as compared to medical management[6]. Park et al also indicatd, that early DC for intracranial hypertension does not improve patient outcome[7]. Bor-Seng-Shu et al observed that DC was not necessary for some patients after evacuation of hematoma[8]. In our study, SDH was associated with unfavourable outcome after DC.

In our study, factors leading to DC were GCS, pupillary dilation, Midline shift, hematoma type and timing of surgery.

The rate of DC in patients with GCS<8 was significantly higher than that of GCS>8.(P=<0.001) Phan et al reported that lower GCS was correlated with higher proportion of patients requiring DC[9]. In this study, the rate of DC was high in patients with bilateral pupil dilation compared to patients with unilateral dilation(48% vs 22%,P=0.002). Patients with SDH had higher chances of undergoing DC compared to patients with EDH. Studies have demonstrated that, in patients with SDH, the force at the time of injury caused more damage to cerebral vasculature leading to ischemic brain damage and brain swelling.[7,10]

Currently, the timing of early surgical decompression is still controversial. Nevertheless, several authors are of the view that, early DC is capable of reversing expectant or initially secondary ischemia, or axonal injury due to refractory intracranial hypertension in TBI patients[11, 12, 13]. In our study, logistic regression analysis revealed that patients with EDH has lesser chances of undergoing DC while patients with SDH as well as timing of surgery >6 hours from injury were the factors responsible for DC.

Studies have proven that, GCS, pupillary reactivity, and types of mass lesion are indicators of outcome in patients with TBI[14, 15]. Also, MLS was an indicator of hematoma volume and thus an indicator of patients' outcomes.[16]. In our study, we found that MLS was not associated with outcomes. Lee et al demonstrated that, the prognostic value of MLS should be limited to patients with unilateral mass lesions[17].

Bor-Seng-Shu et al indicated that, DC can effectively reduce ICP and increase cerebral perfusion pressure in patients with TBI and refractory elevated ICP[18]. However, majority of deaths following decompression occurred as a result of uncontrolled brain swelling and extensive brain infarction[19]. In our study, severe cerebral edema in post operative period was associated with worst outcome.

Howard et al reported a mortality rate of 74% in those >65 years of age, in contrast to an 18% mortality rate in those aged between 18 and 40 years[10]. Wilberger et al also found a significantly higher mortality rate in >65-years group than <65 years group[20,21]. In our study, mortality rate was high in patients >60 years of age.

ICP monitoring was not possible at our centre so, the decision to perform DC or craniotomy was determined intraoperatively. Further logistic regression analysis showed that lower GCS, bilateral pupil dilation, a timing of surgery >6 hours, and advanced age were independent risk factors of poor outcomes.

CONCLUSION

In our study, SDH, lower GCS, bilateral pupil dilation, a timing of surgery >6 hours, and advanced age were the factors responsible for unfavourable outcome. Our analysis revealed that patients with EDH have lesser chances of undergoing DC while patients with SDH as well as timing of surgery >6 hours from injury were the factors responsible for DC. Factors like pupil dilation, midline shift, timing of surgery, type of brain injury and low GCS were significantly associated with decompressive craniectomies.

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