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A Comparative Study to Analyse the Effectiveness of Basal Cisternostomy and Its Impact on the Outcome of Moderate and Severe Head Injury Patients.

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KEYWORDS

Basal cisternostomy, Decompressive craniectomy, Traumatic brain injury, Intracranial pressure, Glasgow Outcome Scale, Neurosurgery, Mortality

ABSTRACT:

Background:

Severe traumatic brain injury (TBI) is a major cause of morbidity and mortality worldwide, often resulting in raised intracranial pressure (ICP) and secondary brain injury. While decompressive craniectomy (DC) remains the standard surgical option to relieve ICP, basal cisternostomy (BC) has emerged as a potential alternative aimed at restoring cerebrospinal fluid (CSF) dynamics and improving outcomes. This study compares the effectiveness and outcomes of basal cisternostomy versus decompressive craniectomy in patients with moderate and severe TBI.

Materials and Methods:

A prospective randomized controlled trial was conducted at SRM Medical College Hospital, Chennai, from December 2022 to December 2023. Fifty patients aged 18–65 years with moderate or severe TBI were randomly assigned to the basal cisternostomy group (n=25) or the decompressive craniectomy group (n=25). Demographic data, Glasgow Coma Scale (GCS), Marshall CT score, and postoperative variables including duration of ventilation, ICU stay, hospital stay, complications, and Glasgow Outcome Scale (GOS) at 3 months were recorded and statistically analyzed using IBM SPSS 20.0.

Results:

The mean postoperative GOS was significantly higher in the BC group (3.44 ± 1.50) compared with the DC group (2.68 ± 1.72; $p = 0.010$). Mortality was lower in the BC group (20%) than in the decompressive craniectomy group (44%). Patients undergoing basal cisternostomy required shorter ventilator support and ICU stay. Those with severe TBI (GCS < 9) showed better outcomes in the BC group ($p = 0.02$).

Conclusion:

Basal cisternostomy offers improved functional outcomes and lower mortality compared with decompressive craniectomy in moderate and severe Head injury. However, larger multicenter trials are needed to validate its long-term efficacy and feasibility.

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Introduction

Severe traumatic brain injury [TBI] is a life-threatening condition which is associated with substantial morbidity and mortality [1].

The pathogenesis of TBI includes a primary injury related to a physical injury to the brain and a delayed secondary injury caused by the subsequent molecular, chemical and inflammatory cascades that can result in brain oedema,ischemia and intracranial hypertension.

The burden of traumatic brain injury [TBI] is enormous and disproportionate. TBI causes 111 years of life lived with disability per 100 000, and 80% of its burden occurs in low- and middle-income countries [2]. Cisternostomy in the context of severe TBI aims at opening the basal cisterns to atmospheric pressure and tackle the vicious process leading to posttraumatic brain swelling [3]. There are two types of cisternostomy based on the mechanism of action: outflow and inflow cisternostomy [4]. Outflow cisternostomies were the first to be described in modern neurosurgery. Arne Torkildsen performed the first successful ventriculo cisternostomy in 1937 for cerebrospinal fluid [CSF] diversion, and the intervention was the preferred treatment of non communicating hydrocephalus after World War II [5]. The idea of inflow cisternostomy was developed in the context of vascular neurosurgery and still represents a valuable microsurgical step routinely carried out during clipping of anterior circulation aneurysms [6].

Cisternostomy is a novel surgical technique that has been proposed to prevent the development of secondary brain injury and treat associated increase in intracranial pressure [7, 8]. Decompressive craniectomy is the time-tested and most commonly used neurosurgical procedure available to decrease ICP in TBI. Decompressive craniectomy has been shown to reduce ICP, but it actually provides an outlet for brain tissue to expand without reducing edema[9]

A previous clinical study of one group [10] has showed that adjuvant cisternostomy is associated with an improved outcome [both at early and long term], improved brain oxygenation, better control of ICP and shorter ICU stay when compared to standard decompressive craniectomy .Recently, a cerebrospinal fluid [CSF] circulation model has been reconsidered, and it has been stated that CSF can be produced and absorbed throughout the entire CSF system. Pericapillary Virchow-Robin spaces play a critical role in the CSF system.[11]

The glymphatic system has proven that CSF from the cisterns [and not from the ventricles] does communicate with the parenchyma through Virchow-Robin spaces.[12,13]It has been suggested that in TBI, there is a decrease in glymphatic removal of solutes from interstitial fluid, allowing CSF to be shifted from the cerebral cisterns to the brain following TBI[14]. Therefore, the rationale of cisternostomy is to open and rinse the basal cisterns allowing a removal of blood products and addressing the altered gradient pressure between subarachnoid space and the brain parenchyma [15]

Aims and Objectives

To assess effectiveness of Basal cisternostomy surgery with Decompressive Craniectomy surgery, its impact and outcome postoperative complications, morbidity , mortality in moderate and severe brain injury.

Methods and Material

- All patients presenting to the Department of Neurosurgery at SRM Medical College Hospital and research centre , chennai , India, with TBI who needed surgical management
- Written informed consent from each patient or his or her family member were obtained before the study
- All enrolled patients who gave consent to participate in the study were randomly assigned to a decompressive craniectomy group and a cisternostomy group.
- The randomization sequence was generated before the start of the study
- Patients not willing to participate in the study were excluded from the study
- Computed tomography [CT] of the skull was performed for every patient, as per institute protocol, to determine the type of injury, hematomas or contusions of brain, volume of hematomas, mass effect, midline shift.
- All TBIs will classified as mild, moderate,and severe injuries based on the clinical findings, GCS and

CT findings by Marshall CT-based score .as shown in table 1 and table 2 respectively.

Table 1- Glasgow Coma Scale

Glasgow Coma Scale		
Response	**Scale**	**Score**
Eye Opening Response	Eyes open spontaneously	4 Points
	Eyes open to verbal command, speech, or shout	3 Points
	Eyes open to pain (not applied to face)	2 Points
	No eye opening	1 Point
Verbal Response	Oriented	5 Points
	Confused conversation, but able to answer questions	4 Points
	Inappropriate responses, words discernible	3 Points
	Incomprehensible sounds or speech	2 Points
	No verbal response	1 Point
Motor Response	Obeys commands for movement	6 Points
	Purposeful movement to painful stimulus	5 Points
	Withdraws from pain	4 Points
	Abnormal (spastic) flexion, decorticate posture	3 Points
	Extensor (rigid) response, decerebrate posture	2 Points
	No motor response	1 Point
Minor Brain Injury = 13-15 points; **Moderate Brain Injury** = 9-12 points; **Severe Brain Injury** = 3-8 points		

Table -2 Marshal CT Based Score

	Midline Shift	**CISTERNS**	**High Or Mixed Density Lesions**	**Notes**
I	None	Present	None	No visible pathology
II	0-5 mm	Present	None	
III	0-5 mm	Compressed	None	swelling
IV	>5 mm		None	
V	Any	Any	Any	Any lesion surgical evacuated
VI			>25 cm3	Not surgically evacuated

SURGERY METHODS

Decompressive Craniectomy:

In the decompressive craniectomy group, standard decompressive craniectomy with a large flap was done with placement of bone flap in the anterior abdominal wall.

Cisternostomy :

In the cisternostomy group, after craniectomy and dural opening, basal cisternostomy, including opening of the interoptic, opticocarotid, and lateral carotid cisterns was done. Duraplasty was done primarily or with a pericranial graft. The bone flap was replaced and fixed with miniplates and screws.

Postoperatively, the patients were monitored for the number of days of ventilator support needed; number of days in the intensive care unit [ICU] , any new neurological deficits in the form of cognitive, motor, or sensory impairment postoperatively; number of days in the hospital; postoperative complications; and mortality and morbidity during follow-up after 3months with the Glasgow Outcome Scale [GOS] shown in table 3

Table 3 – Glasgow Outcome Scale

Score	Descriptions
5	Good Recovery
4	Moderate Disability
3	Severe Disability
2	Vegetative state
1	Dead

Study design

- Randomized controlled trials
- Prospective study
- Duration –December 2022 – December 2023 [1 year]
- Place – SRM Medical college Hospital and research centre , Chennai
- Sample Size
- Patients will be randomly assigned into 2 groups each containing 25 patients
- Cisternostomy - -25 patients
- Decompressive Craniectomy -25 patients

Inclusion criteria

- Age >18 years and <65 years.
- Glasgow Coma Scale > 4.
- Brain parenchymal contusions with mass effect and midline shift.
- Acute subdural hematoma with mass effect and midline shift.
- Traumatic subarachnoid hemorrhage with mass effect and midline shift.
- Posttraumatic diffuse edema with mass effect and midline shift.

Exclusion criteria

- Age <18 years and age >65 years
- Gcs score < 4
- Extradural hemorrhage
- Nontraumatic subarachnoid hemorrhage
- Nontraumatic intraparenchymal bleed
- Acute infarcts with mass effect

Comparison between the 2 groups was done using Student t test, provided that the data were normally distributed. Statistical analysis was done using IBM SPSS Version 20.0 [IBM Corporation, Armonk, NewYork, USA].

Results

In our study, 50 patients who given consent to participate were randomly assigned to 2 groups with 25 patients each.Comparison between the 2 groups was done using Student t test, provided that the data were normally distributed. Statistical analysis was done using IBM SPSS Version 20.0 [IBM Corporation, Armonk, NewYork, USA].

Table -4 Age distribution Of patients

Variable	Cisternostomy group	Decompressive craniectomy group	P value
Age , years	32.88 +/-10.89	37.72 +/-12.27	0.443
18-30	13 [52%]	07 [28%]	
31-40	06 [24%]	07 [28%]	
41-50	03 [12%]	06 [24%]	
>50	03 [12%]	05 [20%]	

The mean age of the patients was 32.88 +/-10.89 years in the cisternostomy group and 37.72 +/- 12.27 in the decompressive craniectomy group. There were 06

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[24%] patients in the cisternostomy group and 11[44%]patients in the decompressive craniectomy group >40 years old.

Table-5 GCS distribution of patient

Variable	Cisternostomy group	Decompressive craniectomy group	P value
GCS	7.96 +/- 3.12	8.44 +/- 3.12	0.694
Mild [14-15]	0	0	
Moderate [9-13]	09 [36%]	12 [48%]	
Severe [< 9]	16 [64%]	13 [52%]	

Preoperative GCS score was 7.96 +/- 3.12 in the cisternostomy group and 8.44 +/- 3.12 in the decompressive craniectomy group. There were 16 [64%] patients in the cisternostomy group and 13 [52%] patients in the decompressive craniectomy group with severe head injury with GCS score < 9 at the time of presentation .

Table -6 Marshall CT score Destribution

Variable	Cisternostomy group	Decompressive craniectomy group	P value
Marshall CT score	4.28+/-1.27	4.20+/- 1.25	0.570
1	00 [0%]	00 [0%]	
2	02 [8%]	02 [8%]	
3	04[16%]	05 [20%]	
4	11 [44%]	10 [40%]	
5	01 [4%]	02 [8%]	
6	07 [28%]	06[24%]	

The mean preoperative Marshall CT score was 4.28+/-1.27 in the cisternostomy group and 4.20+/- 1.25 in the decompressive craniectomy group.

Table-7 Immediately Post operative Course

Post operative period	Cisternostomy group	Decompressive craniectomy group	P value
M V support	4.40 +/- 1.00	5.00 +/- 0.95	0.088
Duration of ICU stay	5.88 +/- 0.92	6.68 +/-0.90	0.143
Total duration of hospital stay	8.60 +/- 1.00	9.92 +/- 1.151	0.582

The mean duration of mechanical ventilation support was 4.40 +/- 1.00 days in the cisternostomy group and 5.00 +/- 0.95 days in the decompressive craniectomy group. The mean duration of ICU stay was 5.88 +/- 0.92 days in the cisternostomy group and 6.68 +/-0.90 days in the decompressive craniectomy group. The mean duration of hospital stay was 8.60 +/- 1.00 days in the cisternostomy group and 9.92 +/- 1.151 days in the decompressive craniectomy group.

Table 8 – Glasgow Outcome Score after 3 months Follow-up

GOS	3.44 +_ 1.50	2.68 +_ 1.72	0.010
5	08 [32%]	06 [24%]	
4	06 [24%]	04 [16%]	
3	05 [20%]	02 [08%]	
2	01 [04%]	02 [08%]	
1	05 [20%]	11 [44%]	

The mortality rate in this study was 20% [n = 5 patients] in the cisternostomy group and 44% [n = 11 patients] in the decompressive craniectomy group. These were assigned a GOS score of 1. In this study, mean GOS was 3.44 +_ 1.50 in cisternostomy group and 2.68 +_ 1.72 in decompressive craniectomy group. ; this was statistically significant [P = 0.010].

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Table 9 -Relation of prognostic factor of GCS to GOS

Prognostic factor	Cisternostomy group	Decompressive craniectomy group	P value
Moderate [9 – 13]	1.8 +_ 1.30	2.6 +_ 1.51	0.44
Severe [< 9]	2.50 +_ 0.54	1.8 +_ 1.47	0.02

Patients with severe head injury [presenting GCS < 9] showed better outcome in the cisternostomy group, which was statistically significant compared with the decompressive craniectomy group [P = 0.02].

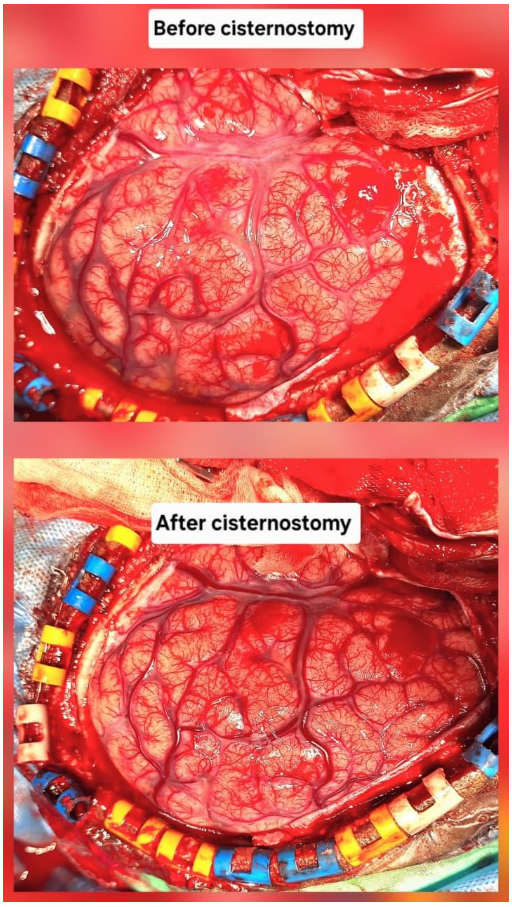

Fig : Before and after Cisternostomy image , you can see Decrease In Cerebral Oedema

Discussion

In Traumatic Brain Injury (TBI), cerebrospinal fluid (CSF) quickly moves into the brain tissue. This is indicated by the absence of visible cisterns and the compression of the ventricles.. Therefore, external ventricular drainage is very difficult, and the CSF is not drained from brain parenchyma effectively. [16]. Cisternostomy has been recently proposed in the setting of severe TBI as an adjuvant surgical technique that may have a potential for effectively improving ICP control and outcomes. [17] . In this study, we randomly assigned 50 patients to a decompressive craniectomy group and a cisternostomy group [25 patients in each group]. We studied these groups in terms of their outcome and effect of prognostic factors on them. Both groups were comparable in terms of age, presenting GCS score, Marshall CT score, , Glasgow outcome score. Intraoperative and Postoperative Period

In the study by Cherian et al.,[17] the mortality rate 13.8% for cisternostomy and 34.8% for decompressive hemicraniectomy [DHC], and in our study, the mortality rate was 20% in the cisternostomy group and 44% in the decompressive craniectomy group. Even though the mortality rate was high in our study, it was less in the cisternostomy group. The mean duration on ventilator support and ICU care in this study was lower in the cisternostomy group compared with the decompressive craniectomy group.

Glasgow Outcome Scale

According to Cherian et al.,[17] the mean GOS score was 2.8 for patients treated with decompressive craniectomy and 3.9 for patients treated with cisternostomy. Our study results with a mean GOS score of 2.68 +_ 1.72 in the decompressive craniectomy group and 3.44 +_ 1.50 in the cisternostomy group with statistically significant [P value = 0.010] .

These results were also supported by Giammattei et al.[3] in a retrospective series of 40 patients who underwent either basal cisternostomy or decompressive craniectomy alone. The GOS scores were also significantly better for basal cisternostomy patients at 6 months [61% for basal cisternostomy vs. 35% for decompressive craniectomy].

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In a study by Parthiban et al.,[4] basal cisternostomy alone had a favorable GOS score compared with basal cisternostomy combined with decompressive craniectomy [82% vs. 62%].

prognostic factor of GCS to GOS

Patients with severe head injury [presenting GCS < 9] showed better outcome in the cisternostomy group, which was statistically significant compared with the decompressive craniectomy group [P = 0.02].

Conclusion

Patients have a good GOS score in the postoperative period following cisternostomy. Cisternostomy decreases the number of days of ventilator support , the length of ICU stay and total duration of hospital stays.

Therefore, basal cisternostomy seems like a promising procedure, but performing cisternostomy in TBI is challenging ,which requires expertise of the surgeon in skull base surgeries and availability of a microscope. With this single randomized controlled trial ,we cannot state that it is an alternative procedure for decompressive craniectomy to treat patients with TBI. More large multicenter randomized trials are needed to establish the effectiveness of cisternostomy in the management of TBI.

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