OPEN ACCESS
Research Paper

Effect of Decompressive Craniectomy with or Without Cisternostomy on Prognosis in Severe Traumatic Brain Injury

Ayyam Ali Hussein[1], Ahmed A.Salam Al.Atraqchi[2]

ABSTRACT:

BACKGROUND:

Decompressive craniectomy alleviates intracranial pressure allows brain tissue to expand without diminishing edema.

OBJECTIVE:

Assess the effects of decompressive craniectomy alone with decompressive craniectomy with cisternostomy on the Glasgow Coma Scale in cases with severe brain trauma.

METHODS:

A prospective randomized cohort research involving 40 patients with severe brain trauma was conducted from August 2022 to February 2023, with data collected from a neurosurgical teaching hospital. All patients exhibit brain trauma accompanied by a diminished Glasgow Coma Scale score. Decompressive craniectomy, with or without cisternostomy, aimed to eliminate underlying disease or hematoma and reduce intracranial pressure.

RESULTS:

A research including 40 patients. In the post-operative assessment, the Glasgow Coma Scale for the Decompressive Craniectomy group recorded 8 cases with a score below 7, while the Decompressive Craniectomy with Cisternostomy group had 4 cases. the Decompressive Craniectomy group exhibited 12 cases with scores from 8 to 15, compared to 16 cases in the Decompressing Craniectomy with Cisternostomy group. About duration of assisted ventilation is shorter in patients who underwent decompressive craniectomy and cisternostomy, with 12 instances requiring less than one week and 8 cases requiring one to two weeks. only 2 cases of decompressive craniectomy required ventilation for less than one week, 18 cases required it for more than one week. In the Decompressive Craniectomy group, 8 out of 20 cases survived, resulting in a survival rate of 40%. in the Decompressive Craniectomy group, 15 out of 20 cases survived, yielding a survival rate of 75%.

CONCLUSION:

The therapy of patients with severe brain trauma through decompressive craniectomy with cisternostomy enhances Glasgow Coma Scale scores of patients.

KEYWORDS: cisternostomy ,hemicraniectomy, decompressive craniectomy, severe brain trauma

[1]Resident Neurosurgery, Baquba teaching Hospital, Dyala, Iraq.
[2]Consultant Neurosurgeon, Saad Al Wittry Neuroscience Hospital, Baghdad, Iraq.

Iraqi Postgraduate Medical Journal, 2026; Vol. 25(1): 34-39
DOI: 10.52573/ipmj.2025.157665 *Received: March 26, 2025* *Accepted: May 5, 2025*

INTRODUCTION:

Decompressive craniectomy is a surgical intervention utilized for the treatment of severe traumatic brain injury [1], involving the excision of a portion of the skull to accommodate cerebral swelling without compression.[2,3] and to perform repair of cerebral blood flow to enhance patient outcomes.

Cisternostomy involves creating an opening in the basal cisterns to the atmospherie pressure, a method that may reduce intracranial pressure by facilitating the movement of cerebrospinal fluid in the edematous brain to the cisterns by the Virchow Robin gaps.[2] and the elimination of waste resulting from the heightened metabolic activity of the brain following trauma. In a decompression hemicraniectomy, regarding patient's position is supine, with slightly extending the head and rotated approximately 15° to the contralateral side. Subsequently, exposure of the sphenoid wing ridge to the superior orbital fissure using a rongeur and incise the dura mater inferiorly as far as possible. lateral subfrontal approach may be utilized to access the inter-optic cistern. Upon the opening of the opticocarotid and lateral carotid cisterns, brain laxity is augmented, allowing for the membrane of Liliequist to be accessed through these apertures. Following a frontotemporal craniotomy, incising the lateral orbitomeningeal band will creates a plane that allows for the separation of the frontal side dura on the anterior clinoidal process from the temporal dura on the lateral wall of the cavernous sinus, thereby revealing the anterior clinoid process and facilitating access to the cisterns through a direct lateral pathway between the frontal and temporal lobes. The anterior clinoid process may be excised using rongeurs. The temporal aspect of the dura mater is detached from the cavernous sinus, and the frontal portion of the dura mater is elevated, allowing access to the cisterns extradurally. A linear incision of the dura may be performed just superior to optic nerve to access a subfrontal corridor laterally. Minimal cerebral retraction is required to access the interoptic cistern. Consequently, this induces relaxation in the brain, allowing us to retract the arachnoid membrane covering the opticocarotid cistern and release the blood.

AIM OF THE STUDY:

The objective of the study is to examine the effects of decompressive craniectomy performed alone versus in conjunction with cisternostomy on the Glasgow Coma Scale and survival rates of patients with traumatic brain injury.

PATIENTS AND METHODS:

Patient population: forty individuals (28 males and 12 females) in a prospective controlled trial conducted from 2022 to 2023 at a neurosurgical facility. The candidates were selected from a cohort of patients exhibiting traumatic brain damage. Patients who met the inclusion criteria were included. The surgeries done with permission from the manager and explained to the relatives of the patients and consent taken from them. All patients exhibited altered levels of consciousness and diminished Glasgow Coma Scale scores

Criteria of inclusion

1. age older than 14 years and younger than 70 year
2. contusions of brain parenchymal with mass effect and shifting of midline
3. Glasgow Coma Scale (GCS) score >6.
4. acute subdural hematoma and mass effect and shifting of midline
5. subarachnoid hemorrhage due to trauma with mass effect and shifting of midline,
6. diffuse edema post trauma with mass effect and shifting of midline.

Criteria of exclusion

1. age groups of 13 years old.
2. GCS score 6 and below
3. extradural hemorrhage alone
4. non-traumatic subarachnoid hemorrhage
5. acute infarcts and mass effect.

the cases were monitored after operation for the period of ventilator support needed; time in the intensive care unit (ICU); development of new neurological deficits like cognitive, motor, or sensory impairmentafter operation; time in the hospital; complications after surgery; and during follow-up mortality and morbidity after two months with the Glasgow.

Surgical procedures:

In the decompressive craniectomy cohort, a typical decompression craniectomy with an extensive flap was performed, accompanied by the implantation of the bone flap in the abdominal wall anteriorly.

In the cisternostomy cohort, following craniotomy and dural incision, basal cisternostomy was performed, encompassing the opening of the interoptic, opticocarotid, and lamina terminalis, lateral carotid cisterns, and Liliequist membrane. A cisternal drain was inserted and maintained for two days during the postoperative period. Duraplasty was performed either primarily or utilizing a pericranial transplant.

RESULTS:

A study of 40 patients, age groups (14 – 30) = 12 case, and (31 – 65) =28 case. The GCS of patients at admission of DC group (6 – 9) was 11 cases and (10 – 14) was 9 cases, where was the AC group (6 – 9) was 16 and (10 – 14) was 4 cases. Post-operative GCS of DC group <7 was 8 cases, where AC group was 4 cases, and the GCS (8-15) post op in DC group was 12, and in AC was 16 (Table 1-2). Regarding the time needed on assisted ventilation its lower in patients of group AC 12 cases of less than one week and 8 cases of one to two weeks, where it was 2 cases of DC need ventilator less than one week and 18 of more than one week (Table 1-3). Shorter time for ICU stay post operation of AC group (10-20) days was 14 cases and (21-30) cases was 6 where it was 5 cases between (10-20) and 15 cases between (21-30). 5 cases of DC group had associated other injuries, where there was 7 in AC group. From the DC group 8 cases survived of 20 with a survival rate of 40%, but in AC group 15 cases survived of 20 (75%) Figure (1). For the weakness post op. of the survived patients 6 cases from 8 of the DC group discharged with motor weakness, in AC group 10 of the survived 15 discharged with motor weakness. (Figure 2).

Table 1: GCS pre operation of decompressive craniectomy without and with cisternostomy.

GCS of patients	No. of patient without cisternostomy	Percentage%	No. of patients with cisternostomy	Percentage%
6 - 9	11	55%	16	80%
10 - 14	9	45%	4	20%

Table 2: GCS post operation of Decompressive Craniectomy without and with cisternostomy.

GCS of patients	No. of patient without cisternostomy	Percentage%	No. of patients with cisternostomy	Percentage %
< 7	8	40%	4	20%
8 - 15	12	60%	16	80%

The statistic of chi-square is 1.9048. The p-value is .167546.
Not significant at $p < .05$.

Table 3: Duration of ICU stay of post operation patients with decompressive craniectomy without and with cisternostomy.

ICU stay of patients	No. of patient without cisternostomy	Percentage%	No. of patients with cisternostomy	Percentage %
10 – 20 days	5	25%	14	70%
21 – 30 days	15	75%	6	30%

The p-value is .004377. Significant at $p < .05$

Table 4: Time of assisted ventilation needed post decompressive craniectomy without and with cisternostomy.

Days on ventilator	No. of patient without cisternostomy	Percentage%	No. of patients with cisternostomy	Percentage %
< 7 days	2	10%	12	60%
> 7days	18	90%	8	40%

The statistic of chi-square is 10.989. The p-value is .000917. Significant at $p < .05$.

Table 5: Associated injuries to the traumatic brain injury of both groups decompressive craniectomy without and with cisternostomy.

Associated injuries	No. of patient without cisternostomy	Percentage%	No. of patients with cisternostomy	Percentage %
+ve	5	25%	7	35%
-ve	15	75%	13	65%

The chi-square statistic is 0.4762. The p-value is .490153. Not significant at $p < .05$.

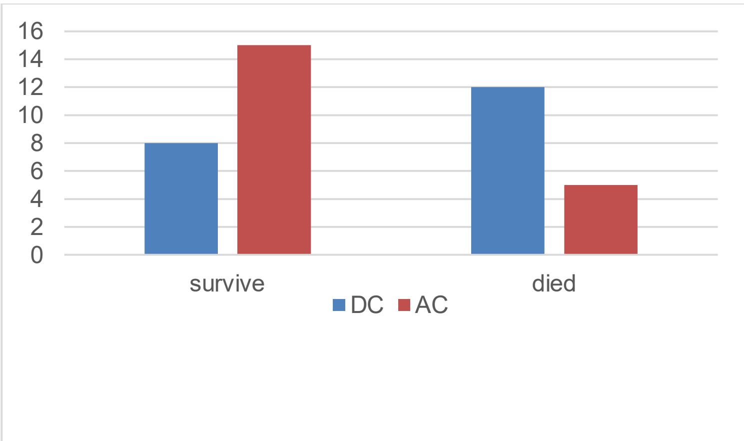

Figure 1: Post-operative death rate of decompressive craniectomy without and with cisternostomy.

The chi-square statistic is 5.0128. The *p*-value is .025161. Significant at $p < .05$.

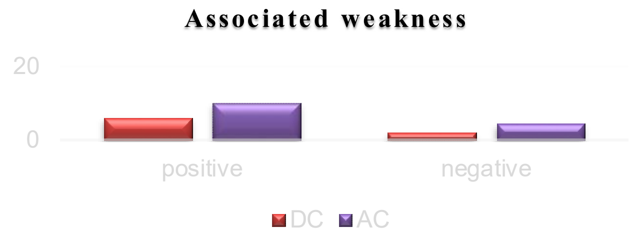

Figure 2: Post-operative disability of patients who survived of both groups.

The chi-square statistic is 0.1711. The p-value is .679109. Not significant at $p < .05$.

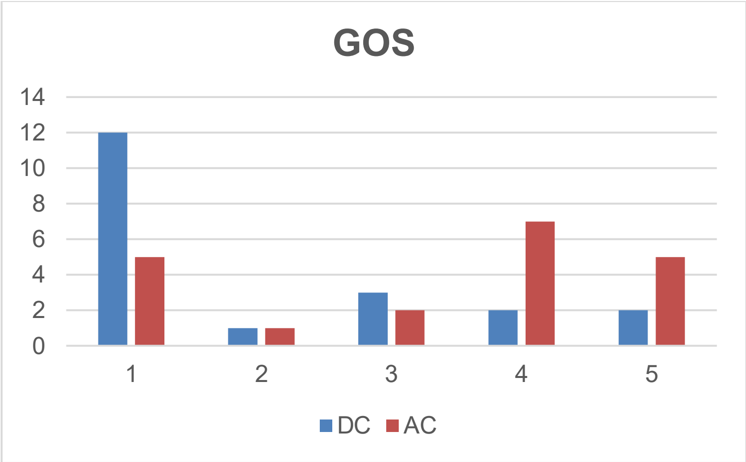

Figure 3: Post- operative GOS of AC decompressive craniectomy with (AC) or without cisternostomy (DC).

DISCUSSION:

Management of brain trauma aims to avert secondary brain injury by mitigating intracranial pressure (ICP) [5]. Various surgical techniques are employed, including extradural anterior clinoidectomy and other less invasive methods[6,7]. The initial phase of the procedure involves creating a "trauma flap" to facilitate a fronto parieto temporal craniotomy or craniectomy, which is extended to access the floor of middle fossa for adequate temporal lobe bone decompression. The execution of an anterior clinoidectomy extraduraly is occasionally unnecessary, as it is time-consuming, rendering it unsuitable for urgent interventions, and may result in vascular injury, thermal damage to the optic nerve, cerebrospinal fluid leakage, and third nerve palsy.

A proficient basal craniotomy and expedited extradural sphenoidal drilling to the superior orbital fissure is efficiently performed with an additional time of roughly 15–20 minutes compared to a conventional trauma flap. Chandra et al. [7] have also seen this marginal increase in the duration.

A substantial durotomy will lead to brain herniation, accompanied by venous kinking and lacerations of cortical regions near the bony margin, resulting in secondary brain damage and subsequent cerebral edema. To prevent these complications, it is essential to initiate a basic durotomy near the optico-carotid cistern for early access to the cisterns. This minor durotomy will avert brain herniation and preserve most of the frontal lobe under the dura, hence minimizing contusions. If necessary, this minor basal durotomy will be expanded to reach additional lesions located more posteriorly, such as contusions or hematoma. The opening of the Liliequist membrane facilitates a connection between the infratentorial and supratentorial basal cisterns. The structure of this membrane may vary, as demonstrated by Froelich et al. [14].

In the event of a primary surgery, following evacuating a space-occupying lesion like acute subdural hematoma, the determination to replace the bone flap is contingent upon clinical and intraoperative factors. The prospective benefits of reattaching the bone flap during the initial surgery eliminate the necessity for a subsequent cranioplasty[10], which has been linked to complications such as reoperations, infections, extra-axial fluid collections, resorption of bone flap, and scalp necrosis. Traumatic brain injury is prevalent among individuals aged 31 to 65, primarily affecting the workforce, indicating that this demographic requires hospitalization more than others. Despite a higher number of admissions with a Glasgow Coma Scale score exceeding 10 in the decompressive craniectomy cases compared to the acute craniotomy group, this did not enhance postoperative outcomes, and the acute craniotomy group demonstrated superior results [11].

Patients with traumatic brain injury exhibiting brain pathologies such as acute subdural hematoma and intracerebral hematoma underwent decompressive craniectomy with aided cisternostomy, resulting in improved Glasgow Coma Scale scores postoperatively by reducing intracranial pressure [12,13].

In the study by Ramesh Chandra et al., the mortality rate was 32% in the AC group and 44% in the DC group; in our study, it is 25% in the AC group and 60% in the DC group. In the study conducted by Cherian et al., the mortality rate was 13.8% for the AC group and 34.8% for the DC group. Despite the elevated mortality rate observed in our study, the rate was lower in the AC group, which was also influenced by the availability of ICU equipment .

The average length of ventilator use and ICU care in this study was more than that reported by Ramesh Chandra et al. in 2022 and Lorenzo et al. in 2020, although it was lower in the AC group compared to the DC group.

The GOS scores were superior for patients undergoing basal cisternostomy at the two-month mark. Goyal et al.[18] reported a cohort of 9 patients who received both basal cisternostomy and decompressive craniectomy[15,16]. They exhibited a notable disparity between open and close pressures of paranchyma[17].

CONCLUSION:

1. Cisternostomy is a good surgical approach for severe TBI. The technique is an additional surgery that is complementary to DC rather than in replacing to it, and if its proved to be effective, it has the potential to replace DC in the treatment of severe head trauma. Large multicenter trials are required to monitor the efficacy and safety of the technique in brain trauma.
2. Despite longer surgical times, technical challenges, the benefit for decide doing cisternostomy as an adjuvant to Decompressive craniectomy is beneficial to the outcome.
3. Well-trained team is necessary before surgery decision and importantly the good follow up is necessary
4. using magnification tools important to avoid damage to large vessels and nerves.
5. The need for larger randomized studies in multiple centers and more follow up times.

Recommendations:

1. Its recommended to do more broad studies with more case numbers and more time for follow up.
2. Make a workshop from neurovascular and skull base surgery teams to teach the cisternostomy technique to neurosurgeons who deal with trauma patients and to do it as adjuvant with decompressive craniectomy to improve the patients' outcome and make the microscope available in those departments.

Authors' contributions: all authors contributed to the design, conception, data analysis and manuscript preparation and approved the final version submitted.

The surgeries done with permission from the manager and explained to the relatives of the patients and consent taken from them.

Funding: none.

Conflict of interest: none.

REFERENCES:

1. Hyder AA, Wunderlich CA, Puvanachandra P, et al. The impact of traumatic brain injuries: a global perspective. NeuroRehabilitation. 2007;22(5):341–53.
2. Maas AIR, Menon DK, Adelson PD, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. Lancet Neurol. 2017;16(12):987–1048.
3. Timofeev I, Hutchinson PJ. Outcome after surgical decompression of severe traumatic brain injury. Injury. 2006;37:1125–32.
4. Brasil A.V., Schneider F.L. Anatomy of Liliequist's membrane. Neurosurgery. 1993;32:956–60.
5. Di Cristofori A, Gerosa A, Panzarasa G. Is neurosurgery ready for cisternostomy in traumatic brain injuries? *World Neurosurg.* 2018; 111:427. doi: 10.1016/j.wneu.2017.11.139
6. Iype Cherian , Antonio Bernardo , Giovanni Grasso , Cisternostomy for Traumatic Brain

Injury: Pathophysiologic Mechanisms and Surgical Technical NotesWorld Neurosurgery 2016;89:51-57.
7. Cherian, G. Yi, S. Munakomi Cisternostomy: replacing the age old decompressive hemicraniectomy? Asian J Neurosurg, 2013;8:132-38.
8. Giammattei, L., Starnoni, D., Maduri, R. et al. Implementation of cisternostomy as adjuvant to decompressive craniectomy for the management of severe brain trauma. Acta Neurochir 2020;162: 469–79. https://doi.org/10.1007/s00701-020-04222-y
9. Hutchinson PJ, Kolias AG, Tajsic T, Adeleye A, Aklilu AT, Apriawan T, et al. Consensus statement from the international consensus meeting on the role of decompressive craniectomy in the management of traumatic brain injury : consensus statement. *Acta Neurochir (Wien)*. 2019 ;161(7):1261–74. doi: 10.1007/s00701-019-03936-y
10. Parthiban JKBC, Sundaramahalingam S, Rao JB, Nannaware VP, Rathwa VN, Nasre VY, et al. Basal cisternostomy - a microsurgical cerebro spinal fluid let out procedure and treatment option in the management of traumatic brain injury. Analysis of 40 consecutive head injury patients operated with and without bone flap replacement following cisternostomy in a tertiary care centre in India. *Neurol India*. 2021;69(2):328–33. doi: 10.4103/0028-3886.314535
11. Kulwin C, Tubbs RS, Cohen-Gadol AA. Anterior clinoidectomy: description of an alternative hybrid method and a review of the current techniques with an emphasis on complication avoidance. *Surg Neurol Int*. 2011; 2:140. doi: 10.4103/2152-7806.85981
12. Alves OL, Bullock R. « Basal durotomy » to prevent massive intra-operative traumatic brain swelling. Acta Neurochir (Wien). 2003;145(7):583–86; discussion 586. doi: 10.1007/s00701-003-0055-9
13. Shi L, Sun G, Qian C, Pan T, Li X, Zhang S, et al. Technique of stepwise intracranial decompression combined with external ventricular drainage catheters improves the prognosis of acute post-traumatic cerebral hemispheric brain swelling patients. Front Hum Neurosci. 2015;9:535. doi: 10.3389/fnhum.2015.00535
14. Froelich SC, Abdel Aziz KM, Cohen PD, van Loveren HR, Keller JT. Microsurgical and endoscopic anatomy of Liliequist's membrane: a complex and variable structure of the basal cisterns. Neurosurgery. 2008;63(1Suppl1):ONS1-8; discussion ONS8-9. doi: 10.1227/01.neu.0000335004.22628.ee
15. Ruggeri AG, Cappelletti M, Tempestilli M, Fazzolari B, Delfini R. Surgical management of acute subdural hematoma: a comparison between decompressive craniectomy and craniotomy on patients treated from 2010 to the present in a single center. J Neurosurg Sci. 2022;66(1):22–27. doi: 10.23736/S0390-5616.18.04502-2
16. Cho YJ, Kang SH. Review of cranioplasty after decompressive craniectomy. Korean J Neurotrauma. 2017; 13(1):9–14. doi: 10.13004/kjnt.2017.13.1.9
17. V.V. Ramesh Chandra, Bodapati Chandra Mowliswara Prasad, Hanuma Naik Banavath, Kalakoti Chandrasekhar Reddy, World Neurosurgery 2022;162: e58-e64.
18. N. Goyal, P. Kumar Putting 'CSF-shift edema' hypothesis to test: comparing cisternal and parenchymal pressures after basal cisternostomy for head injury World Neurosurg, 2021;148:e252-63.