

Decompressive Craniectomy in Moderate to Severe Traumatic Brain Injury: A Prospective Observational Study

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Abstract: Background: Decompressive craniectomy (DC) is an important surgical option for selected patients with traumatic brain injury and refractory intracranial hypertension. Outcomes are influenced by age, neurological status, pupillary response, timing of surgery, associated injuries and radiological factors. Methods: This prospective observational study included 136 patients with moderate to severe traumatic brain injury who underwent decompressive craniectomy at Government General Hospital, Kurnool Medical College, between March 2024 and March 2026. Patients aged 12–70 years with admission GCS 4–13 and radiological evidence of raised intracranial pressure/mass effect were included. Clinical, radiological and operative variables were recorded. Functional outcome was assessed using the Glasgow Outcome Scale (GOS), with GOS 4–5 considered favourable and GOS 1–3 unfavourable as specified in the thesis. Results: Of 136 patients, 123 (90.4%) were male and 13 (9.6%) female. Road traffic accidents accounted for 103 cases (75.7%). Surgery was performed within 24 hours in 92 patients (67.6%). Overall survival was 56/136 (41.2%) and mortality was 80/136 (58.8%). Favourable outcome was reported in 49 patients (36.0%; thesis reports 36.1%) and unfavourable outcome in 87 (64.0%; thesis reports 63.9%). Younger age, earlier surgery, absence of associated injuries, higher preoperative GCS, normal pupillary reaction, postoperative basal cistern opening and adequate bone removal were associated with better outcomes in the thesis analysis. Conclusion: In this single-centre prospective cohort, decompressive craniectomy was associated with substantial mortality but meaningful functional recovery in a proportion of patients. Early intervention and favourable preoperative neurological status were associated with better outcomes. Careful patient selection, adequate decompression and intensive postoperative care remain essential.

Keywords: traumatic brain injury; decompressive craniectomy; intracranial hypertension; Glasgow Coma Scale; Glasgow Outcome Scale; traumatic cerebral edema; neurotrauma.

1. Introduction

Traumatic brain injury (TBI) is a major cause of death and disability, particularly among young adults. Secondary brain injury related to cerebral edema, ischemia, hypoxia and intracranial hypertension contributes substantially to neurological deterioration. When intracranial hypertension remains refractory despite optimized medical treatment, decompressive craniectomy may be used as a rescue intervention. [1–4]. Decompressive craniectomy increases intracranial volume by removing a large portion of the skull and opening the dura, permitting outward expansion of swollen brain tissue. It may be performed as part of primary surgery for traumatic mass lesions or as secondary decompression for refractory intracranial hypertension. Randomized trials including DECRA and RESCUEicp have demonstrated important effects on intracranial pressure and mortality, while also highlighting the complex relationship between survival and functional outcome. [5,6]

The present study was undertaken to evaluate clinical and radiological factors associated with outcome following decompressive craniectomy in moderate to severe traumatic brain injury in a tertiary-care hospital setting.

2. Aims and Objectives

- To evaluate the role and outcome of decompressive craniectomy in moderate to severe traumatic brain injury.
- To study the clinical profile of patients undergoing

decompressive craniectomy.

- To assess functional outcome using the Glasgow Outcome Scale.
- To evaluate the relationship between preoperative GCS and postoperative outcome.
- To assess radiological factors including midline shift, cerebral edema and basal cistern status.
- To evaluate the effect of timing of surgery on outcome.
- To identify postoperative complications.

3. Materials and Methods

- 1) **Study design and setting:** A prospective observational study was conducted in the Department of Neurosurgery, Government General Hospital, Kurnool Medical College, over 24 months from March 2024 to March 2026. A total of 136 patients were enrolled.
- 2) **Eligibility:** Patients aged 12–70 years, presenting within 48 hours of injury, with traumatic brain injury and GCS 4–13, and with radiological evidence of raised intracranial pressure such as acute subdural hematoma with diffuse cerebral edema or midline shift >5 mm were included. Patients below 12 or above 70 years, non-traumatic causes, post-resuscitation GCS 3, bilateral fixed and dilated pupils, absent brainstem reflexes, and those not consenting to surgery were excluded.
- 3) **Management:** Patients underwent neurological assessment including GCS and pupillary examination, systemic assessment and non-contrast CT brain. Initial treatment included ATLS-based resuscitation, head

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elevation, sedation/analgesia, mechanical ventilation when required, hyperosmolar therapy and cerebral perfusion optimization. Patients with refractory intracranial hypertension, progressive neurological deterioration or significant radiological mass effect underwent decompressive craniectomy.

- 4) **Surgical technique:** A large frontotemporoparietal craniectomy with adequate temporal decompression and wide dural opening was performed under general anaesthesia. Evacuation of associated hematoma or contusions was undertaken when indicated. The bone flap was preserved for later cranioplasty.
- 5) **Outcome and follow-up:** Functional neurological outcome was assessed using GOS. The thesis defined favourable outcome as GOS 4–5 and unfavourable outcome as GOS 1–3. Mortality, radiological changes and postoperative complications were recorded. Follow-up was planned at 2 weeks, 4 weeks and 6 months.
- 6) **Ethics:** The thesis states that institutional human ethics committee approval was obtained, informed written consent was taken, and confidentiality was maintained.
- 7) **Statistical analysis:** The thesis reports use of MANOVA with $p < 0.05$ considered statistically significant. The categorical association results below reproduce the thesis-reported analyses. The statistical method should be independently rechecked against the raw dataset before final journal submission.

4. Results

A total of 136 patients underwent decompressive craniectomy. Overall mortality was 58.8%, while 41.2% survived. The thesis reported 49 patients with favourable outcome and 87 with unfavourable outcome.

Table 1: Overall outcome distribution

Outcome	Patients	Percentage
Death	80	58.80%
Vegetative state	3	2.20%
Outcome category reported as moderate disability	4	2.90%
Outcome category reported as mild disability	19	14.00%
Good recovery	30	22.10%
Total	136	100%

Note: Outcome labels are reproduced from the thesis table. Standard GOS terminology should be verified before final submission.

Table 2: Baseline characteristics

Variable	Category	n (%)
Sex	Male	123 (90.4%)
	Female	13 (9.6%)
Mechanism	Road traffic accident	103 (75.7%)
	Fall	26 (19.1%)
	Assault	7 (5.1%)
Timing	<24 h	92 (67.6%)
	>24 h	44 (32.4%)
Associated injury	Present	30 (22.1%)
	Absent	106 (77.9%)
Preoperative GCS	4–8	82 (60.3%)
	9–13	54 (39.7%)
Pupils	Normal	23 (16.9%)
	Anisocoria	113 (83.1%)

Table 3: Factors associated with favourable outcome

Factor	Favourable	Unfavourable	p value
Age >40 years	53/72	18/72	<0.001*
Age 41–70 years	13/64	51/64	<0.001*
Male sex	45/123	78/123	0.508
Female sex	4/13	9/13	0.508
RTA	35/103	68/103	<0.001*
Fall	8/26	18/26	<0.001*
Assault	6/7	1/7	<0.001*
Surgery <24 h	61/92	31/92	0.009*
Surgery >24 h	6/44	38/44	0.009*
Associated injury present	2/30	28/30	<0.001*
Associated injury absent	47/106	59/106	<0.001*
GCS 4–8	13/82	69/82	<0.001*
GCS 9–13	36/54	18/54	<0.001*
Normal pupils	20/23	3/23	<0.001*
Anisocoria	29/113	84/113	<0.001*

*p values as reported in the thesis.

Table 4: Selected radiological/operative associations

Variable	Category	Favourable	Unfavourable	p value
Postop midline shift	Not reduced	0	41	0.062
	Reduced	49	46	
Postop basal cisterns	Not opened	11	80	<0.001*
	Opened	38	7	
Bone removal	Adequate	49	77	see note
	Inadequate	0	10	see note

The thesis reports postoperative basal cistern opening as significantly associated with favourable outcome ($p < 0.001$), while postoperative midline-shift reduction was not significant for outcome ($p = 0.062$).

Table 5: Survival associations

Factor	Survival	Death	p value
Surgery <24 h	48	40	<0.001*
Surgery >24 h	8	40	
GCS 4–8	18	64	<0.001*
GCS 9–13	38	16	
Normal pupils	20	3	<0.001*
Anisocoria	36	77	
Basal cisterns not opened	18	73	<0.001*
Basal cisterns opened	38	7	
Adequate bone removal	56	70	0.006*
Inadequate bone removal	0	10	

*p values as reported in the thesis.

Data reconciliation flag: the thesis distribution table records 92 patients operated <24 h and 44 >24 h, whereas the survival table records 88 and 48 respectively. This must be reconciled with the master chart before journal submission.

Table 6: Postoperative complications

Complication	Frequency	Percentage
Subdural hygroma	10	7.40%
Blossoming of contusion	8	5.90%
Wound infection	8	5.90%
External cerebral herniation	6	4.40%
Metabolic complications	4	2.90%
Pulmonary complications	4	2.90%
Hydrocephalus	3	2.20%
Meningitis	2	1.50%
Trephine syndrome	1	0.70%

5. Discussion

The present prospective study included 136 patients undergoing decompressive craniectomy for moderate to severe traumatic brain injury. Males constituted 90.4% of the cohort and road traffic accidents were the predominant mechanism (75.7%). Overall survival was 41.2%, mortality was 58.8%, and approximately 36% achieved a favourable outcome according to the thesis-defined grouping.

- 1) **Age:** Younger age was strongly associated with favourable outcome and survival. The thesis reported $p=0.001$ for age–outcome and age–survival associations.
- 2) **Mechanism:** Road traffic accidents accounted for 103 of 136 cases. The thesis reported significant associations between mechanism of injury and functional outcome ($p<0.001$) and survival ($p=0.004$).
- 3) **Timing:** Surgery within 24 hours was associated with better functional outcome (61/92 favourable) than surgery after 24 hours (6/44 favourable), with $p=0.009$ as reported in the thesis. However, the survival table has a different timing denominator and must be reconciled before publication.
- 4) **Neurological status:** Preoperative GCS and pupillary status were strong prognostic factors. Patients with GCS 9–13 had 36/54 favourable outcomes and 38/54 survived, compared with 13/82 favourable outcomes and 18/82 survivors among those with GCS 4–8. Normal pupils were associated with better outcome and survival than anisocoria.
- 5) **Radiological/operative factors:** Postoperative basal cistern opening was strongly associated with favourable outcome and survival ($p<0.001$). Postoperative midline-shift reduction was not significantly associated with outcome ($p=0.062$) or survival ($p=0.166$). Adequate bone removal was present in 126 patients; all 10 patients with inadequate bone removal died, with $p=0.006$ reported for survival.
- 6) **Complications:** Subdural hygroma was the most frequent recorded complication (7.4%), followed by blossoming of contusions and wound infection (5.9% each), external cerebral herniation (4.4%) and hydrocephalus (2.2%).

These findings should be interpreted alongside randomized evidence. DECRA demonstrated effective control of intracranial pressure but raised concerns regarding functional outcome, whereas RESCUEicp demonstrated a mortality benefit with some survivors experiencing severe disability. [5,6] Decompressive craniectomy should therefore be regarded as a carefully selected, potentially life-saving intervention rather than a guarantee of functional recovery.

6. Limitations

- Single-centre observational design limits generalizability.
- No non-surgical control group; causal effects cannot be established.
- Heterogeneous traumatic lesions and clinical severity.
- The statistical method reported in the thesis should be rechecked against the raw dataset.
- Some tables contain denominator/label inconsistencies that require reconciliation with the master chart.

- GOS terminology in the thesis table should be verified against standard definitions.

7. Conclusion

In this prospective cohort of 136 patients with moderate to severe traumatic brain injury undergoing decompressive craniectomy, mortality was 58.8% and approximately 36% achieved a favourable outcome according to the thesis-defined grouping. Younger age, higher preoperative GCS, normal pupillary reaction, earlier surgery, absence of associated injury, postoperative basal cistern opening and adequate bone removal were associated with better outcomes. Decompressive craniectomy remains an important rescue strategy for selected patients with refractory traumatic intracranial hypertension, but outcomes depend strongly on patient selection, timing, severity of primary injury and quality of neurocritical care.

Declarations

Ethics approval: Institutional human ethics committee approval was obtained as stated in the thesis.

Informed consent: Written informed consent was obtained as stated in the thesis.

Funding: Not stated in the thesis manuscript.

Conflict of interest: Author declaration required before submission.

Data availability: Journal-specific statement required before submission.

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