Review Article

ISSN: 2675-3626

Clinical and tomographic criteria for neurosurgical approaches in children with severe traumatic brain injury: A systematic review

Ângelo Raimundo da Silva Neto [1, 2], Derick Pedrosa Pachá [2], Rui Manoel Moraes de Deus [2], Guilherme Lucas de Oliveira Lima [2]

[1] Integrated Medicine Department, Federal University of Rio Grande do Norte, Natal, Brazil

[2] Hospital Universitário Onofre Lopes, Federal University of Rio Grande do Norte, Natal, Brazil.

✉ Angelo Raimundo da Silva Neto, M.D, Ph.D

e-mail: angelorsn@gmail.com

Available at:
http://www.archpedneurosurg.com.br/

Background: Severe traumatic brain injury (sTBI) remains a major cause of mortality and disability in children worldwide. Intracranial pressure monitoring (ICPm) and decompressive craniectomy (DC) are commonly employed in the management of pediatric sTBI, the clinical and radiological criteria guiding these interventions remain heterogeneous.

Methods: A systematic review was conducted according to PRISMA 2020 guidelines. PubMed, Scopus, Web of Science, and LILACS were searched in March 2026 for studies published within the last 10 years. Eligible studies included pediatric patients (<18 years) with severe TBI (Glasgow Coma Scale [GCS] <9) and reported quantitative clinical or tomographic criteria for neurosurgical interventions.

Results: From 2,763 retrieved records, 21 studies met the inclusion criteria, including 10 focused on ICPm and 11 on DC. ICPm was primarily indicated in patients with GCS≤8 and abnormal computed tomography findings, particularly brain swelling and high Marshall scores. Intracranial hypertension thresholds varied between 15 and 20 mmHg, with some age-adjusted approaches. For DC, the most frequent radiological findings were acute subdural hematoma, midline shift, diffuse cerebral edema, and signs of herniation. Lower GCS scores and pupillary abnormalities were consistently associated with worse outcomes. While ICP-guided management and DC were associated with improved physiological control and, in some studies, better functional outcomes, consistent reductions in mortality were not demonstrated.

Conclusions: Current evidence reveals substantial heterogeneity in the clinical and tomographic criteria used for ICPm and DC in pediatric sTBI. Standardized prospective multicenter studies are needed to define optimal indications and improve outcome prediction.

Keywords: Brain injuries, Traumatic; Intracranial Pressure; Child; Decompressive Craniectomy; Intracranial Hypertension

INTRODUCTION

Approximately 69 million people worldwide sustain a traumatic brain injury (TBI) each year [1]. Severe TBI in children is defined by a Glasgow Coma Scale (GCS) score below 9 on admission [2] and remains a major cause of mortality and long-term disability. The leading

Submitted: 30 May 2026
Accepted: 09 September 2026
Published: 15 September 2026

causes include traffic accidents, falls, violence, and self-harm, with a higher incidence among males and in children younger than 2 years and adolescents aged 15–18 years [1,3].

Preventing secondary brain injury caused by hypoxia, hypotension, anemia, and intracranial hypertension is a cornerstone of management. Although several guidelines recommend standardized approaches for pediatric severe TBI, many recommendations rely on low-quality evidence, limiting their applicability, particularly in resource-constrained settings such as Brazil [2,4].

This systematic review summarizes the current clinical and radiological criteria guiding intracranial pressure monitoring (ICPm) and decompressive craniectomy (DC) in pediatric severe TBI, focusing on factors associated with improved functional and neurological outcomes.

MATERIALS AND METHODS

Study design, information sources, and search

This systematic review follows the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

The search strategy was constructed using Medical Subject Headings (MeSH) terms covering multiple domains: severe TBI, pediatric population, and neurosurgical interventions, and decision criteria. Boolean operators (AND, OR) were applied to combine search terms. The complete search strings adapted for each database are detailed in the Supplementary Material.

The search was performed on March 12, 2026, across four major databases: PubMed, Scopus, Web of Science, and LILACS. An automated filter for publication date over the last 10 years was applied.

Predefined Eligibility Criteria

Original research providing quantitative analysis into clinical and tomographic criteria for the surgical treatment of pediatric population (until 18 years) victims of severe TBI (GCS less than 9) was eligible. Prospective or retrospective design studies published in a peer-reviewed journal in English, Spanish, or Portuguese were retrieved. We excluded case reports, qualitative studies, mixed population studies (such as studies that did not perform analysis according to the different degrees of TBI (mild, moderate, and severe).

Selection of studies

All retrieved records were exported to Rayyan. This application was utilized to automatically detect and assist in the removal of duplicate records. Two authors independently screened titles and abstracts against the eligibility criteria. Studies that met the inclusion criteria, or those whose abstracts did not provide sufficient information, were selected for full-text evaluation. In the selection phase, the retrieved articles were reviewed independently by two authors. Any disagreements regarding study inclusion were addressed by consulting a third independent reviewer.

Data Extraction, Analysis, and Risk of Bias Assessment

Data extraction was independently performed by two authors using a standardized, pre-piloted data collection spreadsheet. Any discrepancies during the extraction process were resolved through discussion, and a third investigator cross-checked the data for accuracy and completeness. The extracted information included: bibliometrics (first author, publication year, country, and study design), patient demographics (sample size, age range, and gender distribution), clinical and tomographic presentation at admission (including the GCS score), specific indications and criteria for neurosurgical approaches (such

as ICPm, DC), and main outcomes (e.g., mortality, complications, and functional outcomes - Glasgow Outcome Scale - GOS).

The methodological quality and risk of bias of the included studies were evaluated using tools tailored to each study's design. For non-randomized studies of interventions, the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool was applied. All bias assessments were performed independently by two reviewers. Any disagreements regarding domain-level or overall judgments were addressed by consulting a third independent reviewer.

The meta-analysis of the results was not possible due to the varied ways of analyzing outcomes and inadequate patient categorization in most studies. Therefore, a qualitative synthesis of the most pertinent and recurring discussions found in the studies was conducted to address the research questions.

RESULTS

The systematic search retrieved 2,763 records, of which 21 original studies met the inclusion criteria, as presented in the flowchart (Figure 1). The main challenge during study selection was the lack of stratification by TBI severity, which precluded interpretation of clinical or imaging criteria for the proposed treatments. The included studies were distributed according to their main topic: ICPm (n=10) and DC (n=11). References cited in the Introduction and Discussion that did not meet the eligibility criteria were used solely for contextualization and interpretation and were not considered part of the systematic evidence synthesis.

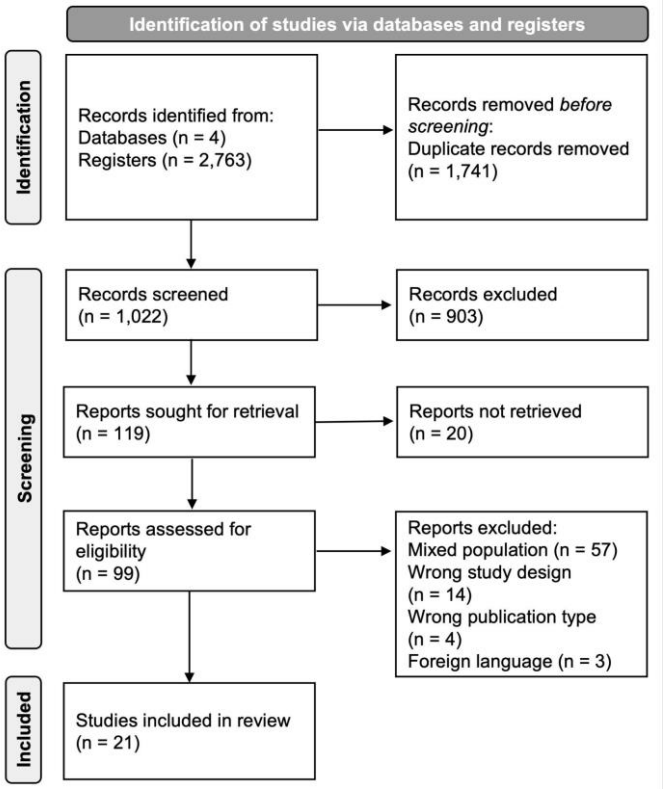

Figure 1. PRISMA Flowchart

DOI: 10.46900/apn.v8i3.387

Intracranial pressure monitoring

Analysis of the selected studies (Table 1) demonstrated a heterogeneous pediatric population with severe TBI, with median ages ranging from 2.4 to 10 years [5,6]. Male patients predominated, accounting for approximately 60–70% of the study populations [5–8]. Clinical severity at admission was consistently high, reflecting the inclusion criterion of post-resuscitation GCS <9 [5,7,9,10]. Several studies reported even lower median GCS values, including scores of 4 and 3, underscoring the severity of the enrolled patients [7,8].

Initial management generally consisted of sedation, analgesia, optimization of oxygen delivery, and hyperosmolar therapy [9,10]. Hypertonic saline was the most frequently reported osmotic agent in recent protocols, whereas barbiturate coma and therapeutic hypothermia were reserved for refractory intracranial hypertension [8,10,12].

Failure of medical management resulted in neurosurgical intervention in a substantial proportion of patients. Decompressive craniectomy was performed in 31.9–66.7% of cases [6,11,12]. ICP monitoring guided therapeutic escalation and surgical decision-making, allowing intervention before the development of clinical signs of neurological deterioration [12].

Functional outcomes showed considerable variability across studies. Arunkumar et al. reported unfavorable outcomes in 16.7% of monitored patients compared with 55% of controls [9], whereas Banik et al. found no reduction in mortality or improvement in functional outcome at hospital discharge associated with ICP monitoring [13]. Overall mortality ranged from 12% to 33.3% [6,8,9,13,14].

Abreu-Pérez et al. reported that maintaining ICP and cerebral perfusion pressure within age-adjusted physiological ranges was associated with favorable neurological recovery, with 85% of patients achieving GOS 5 [12]. Conversely, Miles et al. observed that 85% of monitored patients developed at least one episode of intracranial hypertension and that refractory ICH was associated with a threefold higher risk of death [7]. O'Lynnger et al. reported reduced mortality and improved discharge disposition following implementation of a standardized multidisciplinary management protocol [10].

Decompressive craniectomy in children with severe TBI

Across all included studies (Table 3), male patients predominated in both the decompressive craniectomy (DC) and control groups, accounting for more than 60% of the study populations from Europe, South America, and Asia [15–18]. Most studies enrolled fewer than 100 patients; however, multicenter investigations included substantially larger cohorts, reaching more than 2,000 patients in the study by Bruns et al. [19].

Table 1. Bibliometric and clinical data of the selected studies for Intracranial pressure monitoring in children with severe TBI.

Author (Year)	Country	Study Design	N	Male (%)	Age (years)	GCS	Clinical Criteria	Imaging Criteria	Mortality	Prognosis
Abreu Pérez (2015)	Cuba	Prospective	33	NR	5–18 (81.8%)	8 (48%); 7–6 (15%); 5–4 (18%); 3 points (18%)	GCS ≤ 8	Marshall CT score; midline shift > 5 mm for aggressive treatment	33.33%	Direct relationship between normal ICP and better outcomes (85% favorable outcomes with controlled ICP).
Arunkumar (2016)	India	Prospective	50	62%	8.5	7 (mean for both groups)	GCS < 8 after resuscitation	Marshall CT score on admission	16.7% (ICPm) vs. 55% (Control)	ICP-guided therapy resulted in significantly better outcomes (16.7% unfavorable outcomes vs. 55% in the non-monitored group).
Banik (2019)	India	Retrospective	61	68.8%	5	I (GCS 3–5) and II (GCS 6–8)	GCS ≤ 8	Marshall CT score; hematomas or diffuse axonal injury	35% (ICPm) vs. 32% (Control)	Monitoring did not reduce mortality or ventilation duration; age and GCS subgroup were the main predictors.
Brensing (2024)	Germany	Prospective	102	60.8%	3.3 (ICP) / 2.4 (No ICP)*	4 (median in ICPm) / 5 (mean in no ICPm)	GCS ≤ 8	Brain swelling (68% of monitored patients) or subarachnoid hemorrhage	32% (ICPm) vs. 22% (No ICP)	Mortality was 32% in the monitored group versus 22% in the non-monitored group, reflecting greater initial clinical severity.
Guerra (2020)	Brazil	Prospective	198	70.2%	9*	Median 6; 35.9% with GCS 3–5 and 64.1% with GCS 6–8	GCS ≤ 8	Marshall III and IV (brain swelling)	22.2%	Mortality was 22.2%; patients with Marshall III and IV lesions had 14- and 24.9-fold higher odds of developing intracranial hypertension.
Kannan (2017)	USA	Retrospective	224	70%	13–17 (39%)	All patients had post-resuscitation GCS ≤ 8	GCS ≤ 8 or intubation > 48 h	Abnormal CT scan on admission	12%	No difference in mortality or discharge GOS between early (ED) and delayed (ICU/CC) monitoring.
Laws (2023)	USA	Retrospective	33	54.5%	7.5–9	Median 4 (IQR 3–6) before monitoring	GCS < 8 after resuscitation	NR	9.1%	Survival rate was 91%; ketamine use was associated with reduced ICP during crises without acute adverse effects.
Miles (2020)	USA	Retrospective	321	64.2%	7.5 (ICP) / 5.8 (No ICP)*	3 (IQR 3–5) in the ICH group and 5 in the non-ICH group	GCS < 8 after resuscitation	Marshall or Rotterdam CT score	23.3% (ICP) vs. 4% (No ICP)	Mortality was 23.3% in the intracranial hypertension group; pre-ICU hypoxia and higher ISS were risk predictors.
O'Lynnger (2016)	USA	Retrospective	128	53.1%	6.54 (Pre) / 5.89 (Post)	5.43 (mean pre) and 5.28 (mean post)	GCS < 8 after resuscitation	Abnormal CT scan on admission	31% (Pre) vs. 21% (Post)	Implementation of a standardized protocol reduced mortality from 31% to 21% and improved discharge home rates (69% vs. 36%).
Rakkar (2023)	USA	Retrospective	138	65.2%	5*	4 (IQR 3–7)	GCS ≤ 8	Abnormal CT scan on admission	18.1%	Presence of a $PbtO_2$ monitor was associated with survival; a $PbtO_2$ threshold < 30 mmHg predicted mortality.

* median years. NR: not reported. ICPm: group of ICP monitored patients

Table 2. Risk of bias for included articles for Intracranial Pressure Monitoring

Study (Year)	Confounding (D1)	Selection (D2)	Classification (D3)	Deviations (D4)	Missing Data (D5)	Measurement (D6)	Selective Reporting (D7)	Overall
Abreu Pérez (2015)	Critical	Serious	Low	Low	Low	Moderate	Low	**Critical**
Arunkumar (2016)	Serious	Moderate	Low	Low	Low	Moderate	Low	**Serious**
Banik (2019)	Serious	Moderate	Low	Low	Low	Moderate	Low	**Serious**
Brensing (2024)	Serious	Low	Low	Low	Low	Low	Low	**Serious**
Guerra (2020)	Critical	Moderate	Low	Low	Low	Low	Low	**Critical**
Kannan (2017)	Moderate	Moderate	Low	Low	Low	Low	Low	**Moderate**
Laws (2023)	Moderate	Moderate	Low	Low	Low	Low	Low	**Moderate**
Miles (2020)	Serious	Moderate	Low	Low	Moderate	Moderate	Low	**Serious**
O'Lynnger (2016)	Serious	Moderate	Low	Low	Low	Moderate	Low	**Serious**
Rakkar (2023)	Serious	Moderate	Low	Low	Low	Low	Low	**Serious**

Table 3. Articles included in this review for analysis of Decompressive craniectomy in children with severe TBI.

Author (Year)	Country	n	Male (%)	Type of study	GCS / pupillary reaction	CT data	Mortality
Bruns et al. (2022)	Germany	2507	65.3%	retrospective, cohort	7.3± 4.4(DC) 9.4± 4.8(control)	SDH 45.5% (DC) x 29.7% EDH 28.4% (DC) x 10.5% Brain edema 31.3%(DC) 13.7%	DC (20.6%) vs 13,7%; OR 1.2 (0.74-1.95)
Hubertus et al. (2022)	Germany	101	69%	retrospective, cohort	DC (3-3); No DC (3-8); p 0.0365	median MLS: DC: 3(0-9); No DC: 1(0-12) p 0,624	no differences
Ballestero et al. (2019)	Brazil	16	58.5%	retrospective	average GCS 5.2; 75% P.A	Skull fractures 62.5% SDH 56.3%	37,5% at 6 months
Ahmed et al. (2026)	USA	273	67%	retrospective, cohort	medianGCS 5(3-7); 63.4%(173) both pupil reactivity 26.4%(72) No pupil reactivity	No description	Early DC 6 (13.6%) vs Late DC 5 (11.4%)
Manfiotto et al. (2019)	France	150	67.7%	retrospective	medianGCS 6(3-15); Group A Median GCS 7 (3-15); Group B Median GCS 4 (3-15) p=0,03 P.A 31.4% 26 anisocoria	Rotterdam score > 4 (p=0.01) Absence of cisterns(p=0.0003) MLS > 5mm(p=0.019)	17%
Hojeij et al. (2026)	Germany	598	67.5%	retrospective, cohort	No description	No description	Early DC OR 2.89(1.43-5.85)
Xu et al. (2025)	China	53	63.2 %	retrospective, matched	DC GCS 7(4.5-8) Non DC GCS 6 (4.5-7) p=0.075	SDH DC 23 Non DC 12P 0,023	Did not differ 17% vs 28.4% (p=0.239)
Jaradat et al. (2025)	Jordan	45	75.6%	retrospective	P.A and bad outcome (p=0.004) GCS < 7 32(82%) GCS of 8, 8(18%)	42% SDH ;48.9% MLS> 15mm 34% diffuse brain edema 15% uncal herniation	
Semenova et al. (2025)	Russia	64		retrospective	GCS 6 ± 2	Marshall 3(52.5%)	18.7% (12)
Ocasio-Rodriguez et al. (2023)	Puerto Rico	20	65%	retrospective	DC group GCS 4 (IQR 3-5); Control GCS 6 (IQR 3-7.5) p=0.33	Brain herniation DC 11 (73%)	10% (2/20)
Yew et al. (2025)	Singapore	232 (18DC)	72.2%	retrospective, cohort	No description	DC SDH (61.1% vs 25.1%, p<0.001), uncal herniation (44.4% vs 9.5%, p<0.001) MLS DC) (61.1% vs 11.6%, p<0.001)	16.7% no differences (DC and no

DC (decompressive craniectomy); GCS (Glasgow Coma Scale); P.A (pupillary abnormalities); SDH (subdural hematoma); EDH (epidural hematoma); MLS (midline shift).

Initial neurological status was generally more severe among patients undergoing DC than among controls. Lower admission GCS scores were consistently reported in the surgical groups, although statistical significance was not observed in all studies. Hubertus et al. demonstrated significantly lower GCS scores in children treated with DC ($p = 0.003$), whereas Xu et al. found no significant difference between groups [18,20].

Pupillary abnormalities were frequently associated with worse outcomes. Jaradat et al. reported a significant association between abnormal pupillary findings and poor prognosis ($p = 0.004$) [16]. Similarly, Manfiotto et al. observed lower functional outcomes among patients presenting with mydriasis at admission [15].

Acute subdural hematoma (SDH) was the most frequently reported tomographic finding among patients undergoing DC, followed by midline shift, diffuse cerebral edema, and brain herniation. Bruns et al. reported SDH in 45.5% of surgically treated patients compared with 29.7% of controls [19]. Xu et al. also observed a significantly higher prevalence of SDH in the DC group ($p = 0.023$) [20], while Yew et al. reported SDH in 61.1% of operated patients versus 25.1% of controls ($p < 0.001$) [21].

Midline shift and signs of herniation were consistently more frequent in children undergoing DC. Among studies using standardized radiological classifications, Manfiotto et al. associated Rotterdam scores ≥4, absent basal cisterns, and midline shift >5 mm with poorer functional outcomes [15]. Likewise, Semenova et al. reported that 52.5% of patients with unfavorable outcomes presented Marshall grade III lesions [22]. Ocasio-Rodríguez et al. reported brain herniation in 73% of children undergoing DC [23].

Mortality and functional outcomes varied considerably across studies. Ahmed et al. and Hojeij et al. reported similar mortality rates between early and delayed DC, although early surgery was associated with shorter intensive care unit stay and reduced duration of mechanical ventilation [24,25]. Ballestero et al. observed favorable functional recovery (GOS 4–5) in 70% of operated patients at 6 months [17], whereas several comparative studies found no significant improvement in mortality or functional outcome following DC [18–20].

Risk-of-bias assessment (Table 4) demonstrated baseline imbalance across all studies due to confounding by indication. Although four investigations achieved an overall moderate risk of bias through propensity score matching or multivariable adjustment [20,21,24,25], residual confounding remained unavoidable because of the observational design. Additional limitations included heterogeneous definitions of surgical timing, inconsistent comparator groups, and variable reporting of long-term functional outcomes.

DOI: 10.46900/apn.v8i3.387

Table 4. Risk of bias for included articles for Decompressive craniectomy in children with severe TBI.

Study (Year)	Confounding (D1)	Selection (D2)	Classification (D3)	Deviations (D4)	Missing Data (D5)	Measurement (D6)	Selective Reporting (D7)	Overall
Ahmed (2026)	Moderate	Low	Low	Low	Low	Low	Low	**Moderate**
Ballestero (2019)	Critical	Serious	Low	Low	Low	Moderate	Low	**Critical**
Bruns (2022)	Serious	Low	Low	Low	Low	Moderate	Low	**Serious**
Hojeij (2026)	Moderate	Low	Low	Low	Low	Moderate	Low	**Moderate**
Hubertus (2022)	Serious	Serious	Low	Low	Low	Low	Low	**Serious**
Jaradat (2025)	Serious	Moderate	Low	Low	Moderate	Moderate	Low	**Serious**
Manfiotto (2019)	Critical	Serious	Low	Low	Low	Moderate	Low	**Critical**
Ocasio-Rodriguez (2023)	Serious	Serious	Low	Low	Moderate	Moderate	Low	**Serious**
Semenova (2025)	Serious	Serious	Low	Low	Low	Moderate	Low	**Serious**
Xu (2025)	Moderate	Low	Low	Low	Low	Low	Low	**Moderate**
Yew (2025)	Moderate	Low	Low	Low	Low	Low	Low	**Moderate**

DISCUSSION

Intracranial pressure monitoring

The present review demonstrates that the application of ICP monitoring in pediatric severe TBI remains highly heterogeneous, reflecting important differences in patient selection, monitoring thresholds, and institutional practices. Age appears to be a key determinant of intracranial physiology. In infants, open fontanelles and cranial sutures increase intracranial compliance, potentially delaying the clinical manifestations of intracranial hypertension despite ongoing cerebral injury [9,14]. Consequently, reliance on neurological examination alone may underestimate disease severity in this age group [9]. Nevertheless, infants remain the least frequently monitored population, probably because of technical challenges and the perception that invasive monitoring provides limited therapeutic benefit following severe trauma [5,14]. In older children, whose cranial compliance resembles that of adults, intracranial hypertension tends to develop more rapidly after space-occupying lesions [12,13].

Considerable variability was also observed in monitoring practices. Adherence to Brain Trauma Foundation recommendations remains inconsistent across healthcare systems. For example, the nationwide German surveillance study reported ICP monitoring in only 36% of eligible patients [2,5]. Moreover, important methodological details—including monitor insertion timing and device-related infectious complications—were inconsistently reported, limiting comparisons among studies [5,7,14].

Interpretation of the available evidence must also consider the methodological limitations of the included studies. Most investigations were retrospective or observational, introducing substantial selection bias because patients with greater neurological severity were more likely to undergo invasive monitoring [5,10]. This imbalance may partially explain why several studies failed to demonstrate improvements in mortality despite better physiological control of intracranial pressure. Although most ROBINS-I domains showed low risk of bias, only two studies achieved an overall moderate risk of bias [11,14]. Additional heterogeneity in age-specific ICP thresholds, treatment-escalation protocols, and long-term functional outcome assessment further limits direct comparison across studies.

Overall, the available evidence suggests that ICP monitoring should be considered an adjunct to structured neurocritical care rather than an isolated therapeutic intervention. Future prospective multicenter studies using standardized age-adjusted ICP thresholds, uniform treatment algorithms, and long-term neurological follow-up are needed to better define its role in pediatric severe TBI.

Decompressive craniectomy

Although decompressive craniectomy is an established treatment for refractory intracranial hypertension, its role in pediatric severe TBI remains incompletely defined [19,20]. The current evidence is derived predominantly from retrospective observational studies with heterogeneous inclusion criteria, limited sample sizes, and variable definitions of clinical outcomes. These methodological differences substantially reduce comparability across studies and preclude robust conclusions regarding treatment effectiveness.

One of the major sources of heterogeneity concerns outcome assessment. While the Glasgow Outcome Scale remains the most frequently used instrument, several studies adopted pediatric-specific scales, including the King's Outcome Scale for Childhood Head Injury (KOSCHI) and the Pediatric Cerebral Performance Category (PCPC) [15,21]. This variability complicates comparisons between studies and limits the feasibility of quantitative synthesis.

Surgical timing also remains poorly standardized. Primary decompressive craniectomy is generally performed during initial hematoma evacuation in the presence of marked cerebral swelling, whereas secondary decompressive craniectomy is reserved for refractory intracranial hypertension despite maximal medical treatment. However, the definition of “early” surgery varied considerably among the included studies, ranging from within 2 hours to within 24 hours after admission [16,24,25]. Such variability probably contributes to the inconsistent findings regarding mortality and functional outcomes.

DOI: 10.46900/apn.v8i3.387

Another important limitation is the inconsistent characterization of maximal medical therapy before surgery. Escalation strategies differed substantially among institutions, and only a few studies explicitly described the use of therapies such as barbiturate coma or therapeutic hypothermia before proceeding to decompressive craniectomy [22]. Differences in available technological resources across healthcare systems may also have influenced surgical decision-making.

Collectively, these findings indicate that current evidence supports decompressive craniectomy as a potentially valuable option for carefully selected pediatric patients with refractory intracranial hypertension. Importantly, previous literature outside the eligibility window has also shown that meaningful recovery may occur even in children presenting with unilateral or bilateral mydriasis [26]. However, the absence of standardized treatment algorithms and the predominance of retrospective studies prevent definitive conclusions regarding optimal timing, patient selection, and long-term functional benefit.

CONCLUSION

This review demonstrated substantial heterogeneity in the clinical and radiological criteria used to indicate ICPm and DC in children with severe TBI. Current evidence does not consistently demonstrate that ICPm alone improves mortality or functional outcomes, while clinical status, age, and computed tomography findings remain the main determinants of prognosis.

Although DC appears to be a valuable option for selected patients with refractory intracranial hypertension, the available evidence is based predominantly on retrospective studies with heterogeneous methodologies, limited sample sizes, and variable outcome measures. Poor neurological status, pupillary abnormalities, subdural hematoma, midline shift, and herniation are frequently associated with worse outcomes, although meaningful recovery remains possible in selected cases.

Overall, patient selection, injury severity, and institutional resources strongly influence outcomes. Well-designed prospective multicenter studies with standardized protocols and long-term follow-up are needed to define the optimal indications, timing, and effectiveness of ICPm and DC in pediatric severe TBI.

DISCLOSURES

Ethical approval

Ethical approval was not required for this systematic review, as it involved the analysis of previously published and publicly available data and did not involve the collection of primary data from human participants.

Consent to participate

Consent was not required.

Conflict of interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Artificial intelligence

DOI: 10.46900/apn.v8i3.387

The authors affirm that all artificial intelligence tools applied to improvement of text comprehension, readability were assessed by the authors.

CONTRIBUTIONS

- **Angelo Raimundo da Silva Neto:** contributed to the conceptualization, literature search, supervision, validation, writing original draft, review & editing.
- **Guilherme Lucas de Oliveira Lima:** contributed to the conceptualization, literature search, supervision, validation, writing original draft, review & editing.
- **Derick Pedrosa Pachá:** performed the literature search, data extraction, and drafted the manuscript. All authors have read and approved the final version.
- **Rui Manoel Morais de Deus:** performed the literature search, data extraction, and drafted the manuscript. All authors have read and approved the final version.

REFERENCES

1. Dewan MC, Rattani A, Gupta S, Baticulon RE, Hung YC, Punchak M, et al. Estimating the global incidence of traumatic brain injury. J Neurosurg. 2019;130(4):1080-97. doi: 10.3171/2017.10.JNS17352.
2. Kochanek PM, Tasker RC, Carney N, Totten AM, Adelson PD, Selden NR, et al. Guidelines for the Management of Pediatric Severe Traumatic Brain Injury, Third Edition: Update of the Brain Trauma Foundation Guidelines, Executive Summary. Pediatr Crit Care Med. 2019;20(3):280-9. doi: 10.1097/PCC.0000000000001736.
3. Hyder AA, Wunderlich CA, Puvanachandra P, Gururaj G, Kobusingye OC. The impact of traumatic brain injuries: a global perspective. NeuroRehabilitation. 2007;22(5):341-53. PMID: 18162698.
4. de Souza LC, Mazzu-Nascimento T, de Almeida Ballestero JG, de Oliveira RS, Ballestero M. Epidemiological study of paediatric traumatic brain injury in Brazil. World Neurosurg X. 2023;19:100206. doi: 10.1016/j.wnsx.2023.100206.
5. Brensing P, Greve S, Hojeij R, Dammann P, Felderhoff-Müser U, Dohna-Schwake C, et al. Current practice of intracranial pressure monitoring in children with severe traumatic brain injury-a nationwide prospective surveillance study in Germany. Frontiers in pediatrics. 2024;12:1355771. 10.3389/fped.2024.1355771
6. Guerra SD, Ferreira AR. Events associated with the occurrence of intracranial hypertension in pediatric patients with severe cranioencephalic trauma and monitoring of intracranial pressure. Rev Paul Pediatr. 2020;38:e2019123. doi: 10.1590/1984-0462/2020/38/2019123.
7. Miles DK, Ponisio MR, Colvin R, Limbrick D, Greenberg JK, Brancato C, et al. Predictors of intracranial hypertension in children undergoing ICP monitoring after severe traumatic brain injury. Child's Nervous System. 2020;36(7):1453-60. doi: 10.1007/s00381-020-04516-7.
8. Rakkar J, Azar J, Pelletier JH, Au AK, Bell MJ, Simon DW, et al. Temporal Patterns in Brain Tissue and Systemic Oxygenation Associated with Mortality After Severe Traumatic Brain Injury in Children. Neurocritical Care. 2023;38(1):71-84. doi: 10.1007/s12028-022-01602-3.
9. Arunkumar S, Devi BI, Shukla D, Reddy M. Is intracranial pressure monitoring useful in children with severe traumatic brain injury? Neurol India. 2016;64(5):958-61. doi: 10.4103/0028-3886.190259.
10. O'Lynnger TM, Shannon CN, Le TM, Greeno A, Chung D, Lamb FS, et al. Standardizing ICU management of pediatric traumatic brain injury is associated with improved outcomes at discharge. J Neurosurg Pediatr. 2016;17(1):19-26. doi: 10.3171/2015.5.PEDS1544.
11. Laws JC, Vance EH, Betters KA, Anderson JJ, Fleishman S, Bonfield CM, et al. Acute Effects of Ketamine on Intracranial Pressure in Children with Severe Traumatic Brain Injury. Critical Care Medicine. 2023;51(5):563-72. doi: 10.1097/CCM.0000000000005806.

12. Abreu Pérez D, Lacerda Gallardo AJ, Díaz Agramonte JA, Martín Chaviano D. Neuromonitorización en el trauma craneoencefálico grave en pediatría. Neurocirugía. 2016;27(4):176-85. doi: 10.1016/j.neucir.2015.11.004.
13. Banik S, Rath GP, Lamsal R, Sinha S, Bithal PK. Intracranial Pressure Monitoring in Children with Severe Traumatic Brain Injury: A Retrospective Study. J Pediatr Neurosci. 2019;14(1):7-15. doi: 10.4103/jpn.JPN_18_19.
14. Kannan N, Quistberg A, Wang J, Groner JI, Mink RB, Wainwright MS, et al. Frequency of and factors associated with emergency department intracranial pressure monitor placement in severe paediatric traumatic brain injury. Brain Injury. 2017;31(13):1745-52. doi: 10.1080/02699052.2017.1346296.
15. Manfiotto M, Beccaria K, Rolland A, Paternoster G, Plas B, Boetto S, et al. Decompressive Craniectomy in Children with Severe Traumatic Brain Injury: A Multicenter Retrospective Study and Literature Review. World Neurosurg. 2019;129:e56-e62. doi: 10.1016/j.wneu.2019.04.215.
16. Jaradat A, Al Barbarawi MM, Jamous M, Jarrar S, Daoud SS, Rawabdeh SA, et al. Early versus Late Decompressive Craniectomy in Pediatrics with Traumatic Brain Injuries: A Retrospective Study. World Neurosurg. 2025;196:123827. doi: 10.1016/j.wneu.2025.123827.
17. Ballestero MFM, Furlanetti LL, Augusto LP, Chaves PHC, Santos MV, de Oliveira RS. Decompressive craniectomy for severe traumatic brain injury in children: analysis of long-term neuropsychological impairment and review of the literature. Childs Nerv Syst. 2019;35(9):1507-15. doi: 10.1007/s00381-019-04274-1.
18. Hubertus V, Finger T, Drust R, Al Hakim S, Schaumann A, Schulz M, et al. Severe Traumatic Brain Injury in children-paradigm of decompressive craniectomy compared to a historic cohort. Acta Neurochir (Wien). 2022;164(5):1421-34. doi: 10.1007/s00701-022-05171-4.
19. Bruns N, Kamp O, Lange K, Lefering R, Felderhoff-Müser U, Dudda M, et al. Functional Short-Term Outcomes and Mortality in Children with Severe Traumatic Brain Injury: Comparing Decompressive Craniectomy and Medical Management. J Neurotrauma. 2022;39(13):944-53. doi: 10.1089/neu.2021.0378.
20. Xu J, Zhou R, Li J, Liu C, Dang H. The Short-Term Impact of Decompressive Craniectomy in Pediatric Patients with Severe Traumatic Brain Injury: A Retrospective Matched Cohort Study. Children (Basel). 2025;12(10). doi: 10.3390/children12101374.
21. Yew WX, Lee JH, Dang HX, Low SYY, Dewi DS, Chong SL. Decompressive Craniectomy in Pediatric Traumatic Brain Injury: A Retrospective Cohort Study. J Pediatr Intensive Care. 2025;14(3).
22. Semenova ZB, Meshcheryakov SV, Rogozhin EA, Lukyanov VI. [Risk factors of unfavorable outcome after decompressive craniectomy in children with severe traumatic brain injury]. Zh Vopr Neirokhir Im N N Burdenko. 2025;89(3):42-7. doi: 10.17116/neiro20258903142.
23. Ocasio-Rodríguez CM, Puig-Ramos A, García-De Jesús R. Long-Term Pediatric Outcomes of Decompressive Craniectomy after Severe Traumatic Brain Injury. P R Health Sci J. 2023;42(2):152-7. PMID: 37352538.
24. Ahmed N, Russo L, Kuo YH. Long-term outcomes of early decompressive craniectomy in pediatric severe traumatic brain injury. J Neurosurg Pediatr. 2026:1-9. doi: 10.3171/2025.9.PEDS25326.
25. Hojeij R, Brensing P, Kowall B, Stang A, Nonnemacher M, Felderhoff-Müser U, et al. Timing of decompressive craniectomy and short-term outcomes in pediatric severe traumatic brain injury: a nationwide observational study in Germany. Sci Rep. 2026;16(1):35837. doi: 10.1038/s41598-026-35837-3.
26. Guresir E, Schuss P, Seifert V, Vatter H. Decompressive craniectomy in children: single-center series and systematic review. Neurosurgery. 2012;70(4):881-8; doi: 10.1227/NEU.0b013e318237a6a6. DOI: 10.1055/s-0043-1761939