CLINICAL OUTCOMES OF EARLY OR PRIMARY DECOMPRESSIVE CRANIECTOMY FOR TRAUMATIC BRAIN INJURY IN LATIN AMERICA: A SYSTEMATIC REVIEW

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Abstract

Background
Early or primary decompressive craniectomy (DC) is widely used to treat intracranial hypertension after traumatic brain injury (TBI), yet its clinical benefit remains debated. In Latin America, outcomes may be influenced by heterogeneity in trauma systems, neurocritical care resources, neuromonitoring availability, and access to rehabilitation.

Objective
To systematically review the available evidence on clinical outcomes of early or primary decompressive craniectomy for adult traumatic brain injury in Latin America.

Methods
We conducted a systematic review in accordance with PRISMA 2020 guidance. PubMed/MEDLINE, Scopus, Embase, Web of Science, SciELO, and LILACS were searched from inception to December 10, 2025. We included studies from Latin American countries enrolling predominantly adult patients with TBI undergoing early or primary DC, with or without a medical-management comparator. Primary outcomes were favorable functional outcome (Glasgow Outcome Scale [GOS] 4–5) at hospital discharge and at approximately 6 months. Secondary outcomes included mortality at discharge among DC-treated patients and comparative mortality when a non-DC comparator was available. Given substantial clinical and methodological heterogeneity across studies, findings were synthesized narratively.

Results
Fourteen studies involving 1,816 patients with TBI were included, of whom 1,075 underwent early or primary DC. Most studies were retrospective observational cohorts or case series. Reported outcomes varied widely across studies. Favorable functional outcome at discharge ranged from 26% to 66% among studies reporting this endpoint, while favorable outcome at approximately 6 months ranged from 21% to 80%. Mortality at discharge among DC-treated patients also varied substantially, ranging from 0% to 61%. Only two studies reported comparative mortality between DC and non-DC management, and these data were too limited and heterogeneous for firm inference. Definitions of "early" and "primary" DC, patient severity, injury phenotype, use of ICP monitoring, and follow-up time points were inconsistent across studies.

Conclusions
The available Latin American literature on early or primary decompressive craniectomy for TBI is limited, predominantly observational, and highly heterogeneous. Reported outcomes vary markedly across studies, likely reflecting differences in case mix, treatment indication, timing, neuromonitoring, and health-system capacity. Current regional evidence remains insufficient to support firm comparative conclusions regarding the benefit of DC versus medical management. Prospective multicenter studies with standardized definitions, outcome reporting, and longer-term follow-up are needed.

Keywords: Decompressive craniectomy; Traumatic brain injury; Intracranial hypertension; Neurocritical care; Latin America.

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RESULTADOS CLÍNICOS DE LA CRANEOTOMÍA DESCOMPRESIVA TEMPRANA O PRIMARIA PARA LA LESIÓN CEREBRAL TRAUMÁTICA EN AMÉRICA LATINA: UNA REVISIÓN SISTEMÁTICA.

Resumen

Antecedentes: La craneectomía descompresiva (CD) temprana o primaria es ampliamente utilizada para tratar la hipertensión intracraneal después de una lesión cerebral traumática (LCT); sin embargo, su beneficio clínico sigue siendo motivo de debate. En América Latina, los resultados pueden verse influenciados por la heterogeneidad de los sistemas de trauma, los recursos de cuidados neurocríticos, la disponibilidad de neuromonitoreo y el acceso a rehabilitación.

Objetivo: Realizar una revisión sistemática de la evidencia disponible sobre los desenlaces clínicos de la craneectomía descompresiva temprana o primaria en adultos con lesión cerebral traumática en América Latina.

Métodos: Se realizó una revisión sistemática de acuerdo con las directrices PRISMA 2020. Se buscaron estudios en PubMed/MEDLINE, Scopus, Embase, Web of Science, SciELO y LILACS desde su inicio hasta el 10 de diciembre de 2025. Se incluyeron estudios de países latinoamericanos que incorporaran predominantemente pacientes adultos con LCT sometidos a CD temprana o primaria, con o sin un comparador de manejo médico. Los desenlaces primarios fueron el resultado funcional favorable (Escala de Resultado de Glasgow [GOS] 4–5) al alta hospitalaria y aproximadamente a los 6 meses. Los desenlaces secundarios incluyeron la mortalidad al alta entre los pacientes tratados con CD y la mortalidad comparativa cuando existía un grupo comparador sin CD. Debido a la considerable heterogeneidad clínica y metodológica entre los estudios, los hallazgos se sintetizaron de manera narrativa.

Resultados: Se incluyeron catorce estudios con un total de 1.816 pacientes con LCT, de los cuales 1.075 fueron sometidos a CD temprana o primaria. La mayoría de los estudios fueron cohortes observacionales retrospectivas o series de casos. Los resultados reportados variaron ampliamente entre los estudios. El resultado funcional favorable al alta osciló entre 26% y 66% entre los estudios que reportaron este desenlace, mientras que el resultado favorable aproximadamente a los 6 meses varió entre 21% y 80%. La mortalidad al alta entre los pacientes tratados con CD también mostró una variabilidad considerable, con rangos entre 0% y 61%. Solo dos estudios reportaron mortalidad comparativa entre el manejo con CD y sin CD, y estos datos fueron demasiado limitados y heterogéneos para permitir conclusiones sólidas. Las definiciones de CD "temprana" y "primaria", la gravedad de los pacientes, el fenotipo de la lesión, el uso de monitoreo de presión intracraneal (PIC) y los puntos temporales de seguimiento fueron inconsistentes entre los estudios.

Conclusiones: La literatura disponible en América Latina sobre la craneectomía descompresiva temprana o primaria para la LCT es limitada, predominantemente observacional y altamente heterogénea. Los resultados reportados varían marcadamente entre los estudios, probablemente reflejando diferencias en la mezcla de casos, las indicaciones de tratamiento, el momento de la intervención, el neuromonitoreo y la capacidad de los sistemas de salud. La evidencia regional actual sigue siendo insuficiente para sustentar conclusiones comparativas firmes sobre el beneficio de la CD frente al manejo médico. Se necesitan estudios prospectivos multicéntricos con definiciones estandarizadas, reporte uniforme de desenlaces y seguimiento a largo plazo.

Palabras clave: Craneectomía descompresiva; Lesión cerebral traumática; Hipertensión intracraneal; Cuidados neurocríticos; América Latina.

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INTRODUCTION

Traumatic brain injury (TBI) remains a leading cause of death and long-term disability worldwide, with a disproportionate burden in low- and middle-income countries (LMICs), where prehospital care, neurocritical infrastructure, and timely neurosurgical access are often limited [1,2]. A major mechanism of secondary brain injury after severe TBI is intracranial hypertension, driven by hemorrhage, edema, and evolving disturbances in cerebrospinal fluid dynamics; sustained elevations in intracranial pressure (ICP) compromise cerebral perfusion pressure and may precipitate ischemia and herniation [2,3]. Contemporary evidence-based management therefore emphasizes early prevention of secondary injury through optimized cerebral perfusion, tiered ICP control, and standardized neurocritical care pathways [3].

Decompressive craniectomy (DC) is a surgical strategy to reduce ICP by removing a bone flap and expanding intracranial volume when medical therapies are insufficient [2,4]. While DC reliably lowers ICP and improves survival in selected populations, its impact on longer-term functional outcomes remains controversial, with concerns regarding survival accompanied by severe disability in some cohorts [5,6]. The uncertainty is compounded by heterogeneity in patient selection (diffuse injury vs mass lesions), timing (primary/early vs secondary), neuromonitoring, and post-acute rehabilitation, all of which can influence neurological recovery and the balance of benefit versus harm [2,5,6].

In Latin America, these uncertainties may be magnified by variability in trauma systems, ICU resources, neuromonitoring availability, and neurosurgical workforce distribution, which can materially affect both perioperative safety and long-term outcomes after DC [7]. Although several single-center and multicenter regional studies have reported outcomes of early or primary DC, the evidence remains fragmented, with inconsistent definitions of "early," variable reporting of functional endpoints, and limited comparative data versus medical management.

Accordingly, this systematic review aims to synthesize the available Latin American evidence on early or primary DC for adult TBI, focusing on functional recovery, mortality, neuromonitoring practices, and the limited comparative evidence versus medical management.

METHODS

Study Design and reporting

We conducted a systematic review in accordance with PRISMA 2020 reporting guidance [8]. The protocol was registered a priori in PROSPERO (CRD420251012612).

Eligibility criteria

We included studies conducted in Latin American countries that enrolled predominantly adult patients with TBI and reported extractable outcomes for early or primary DC. We defined primary DC as decompression performed during the index neurosurgical procedure (e.g., bone flap not replaced after initial evacuation/damage-control surgery). We defined early DC as decompression performed in the acute phase after injury (≤24 hours when explicitly reported; otherwise according to each study's operational definition). Studies were eligible regardless of whether a medical-management comparator group was present. Studies were excluded if >50% of participants were <18 years or if an adult-majority could not be reasonably inferred from reported age distribution.

Information sources and search strategy

We searched PubMed/MEDLINE, Scopus, Embase, Web of Science, SciELO, and LILACS from database inception to 10 December 2025. No language restrictions were applied. The complete search strategies for each database are provided in **Supplementary Table 1**. Reference lists of included studies and relevant reviews were screened to identify additional eligible studies.

Study selection and Data extraction

Two reviewers independently screened titles/abstracts and assessed full texts for eligibility. Disagreements were resolved by consensus; a third reviewer adjudicated when necessary. Two reviewers independently extracted data using a piloted standardized form. Extracted items included country, study design, sample size, patient demographics, injury severity distribution, DC definition/timing, comparator characteristics (when present), neuromonitoring/ICP reporting, and outcomes. When outcomes were reported at multiple time points, we prioritized hospital discharge and the closest follow-up to 6 months (±1 month).

OUTCOMES

Primary outcomes were the proportion of patients with favorable functional outcome (Glasgow Outcome Scale [GOS] 4–5) at (1) hospital discharge and (2) 6 months.

Secondary outcomes included (1) mortality at discharge among DC-treated patients and (2) comparative mortality at discharge (DC vs medical management) when a comparator was reported. ICP-related outcomes (e.g., proportion achieving postoperative ICP <20 mmHg) were summarized descriptively when available.

Risk of bias

We assessed risk of bias according to study design. For nonrandomized comparative studies

evaluating early/primary decompressive craniectomy (DC) versus a non-DC comparator (medical management or non-DC surgical approach), we used the ROBINS-I tool [9]. For single-arm observational cohorts/case series without a comparator, we used the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Series [10]. Two reviewers independently performed all assessments; disagreements were resolved by consensus, with third-reviewer adjudication when necessary. ROBINS-I judgments followed the standard categories (low, moderate, serious, critical risk of bias, or no information) across seven domains.

Synthesis of Results

Given the expected clinical and methodological heterogeneity across studies, we performed a narrative synthesis of the findings [11]. Outcomes were summarized descriptively according to the reported timepoint, including hospital discharge and the follow-up closest to 6 months when available. We focused on variation in favorable functional outcome, mortality, comparator availability, neuromonitoring practices, and operational definitions of early or primary DC. Because of substantial heterogeneity in study design, patient selection, injury phenotype, timing definitions, and outcome reporting, a quantitative pooled analysis was not performed.

RESULTS

Search Results and Study Selection

The database search identified 4,677 records. After removal of 1,310 duplicates, 3,367 titles and abstracts were screened and 83 full texts were assessed for eligibility. Fourteen studies met inclusion criteria and were included in the systematic review (**Figure 1**).

Study Characteristics

The 14 included studies comprised 1,816 patients with TBI, of whom 1,075 underwent early or primary DC. Most studies were retrospective observational cohorts, with a smaller number of case series and nonrandomized comparative designs. Across studies, participants were predominantly male, and most cohorts were composed mainly of severe TBI, although several studies included mixed-severity populations. Only two studies reported extractable discharge mortality data for both a DC group and a non-DC comparator, underscoring the scarcity of comparative regional evidence (**Table 1**)

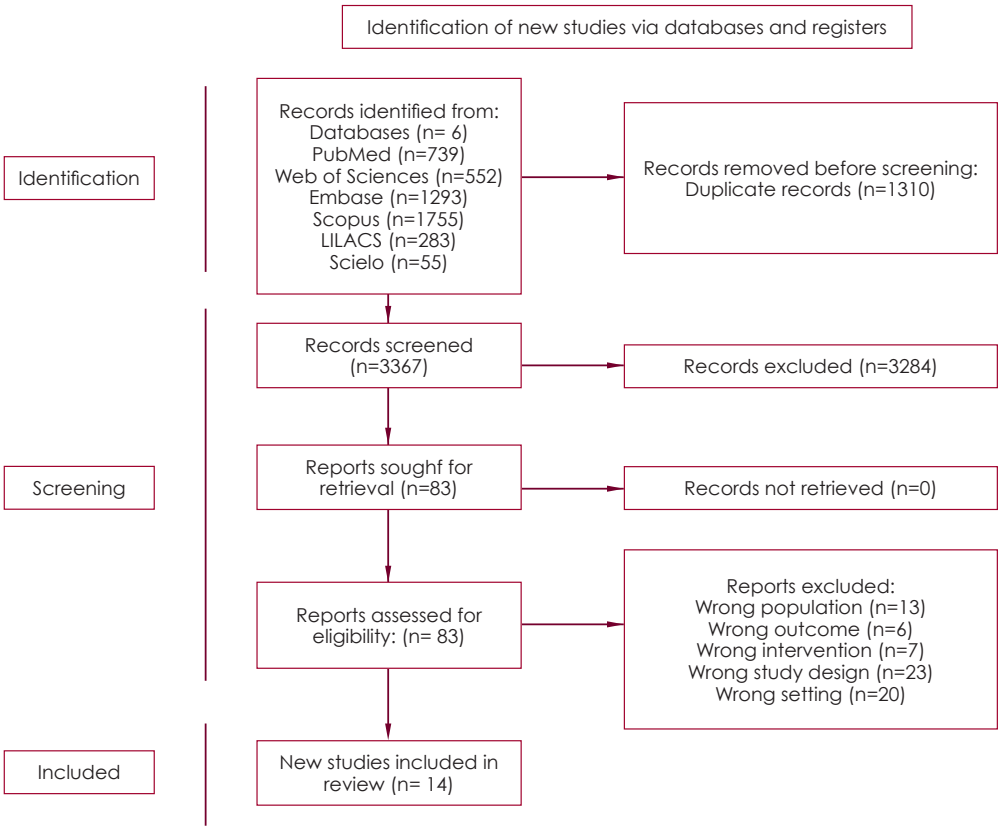

Figure 1. PRISMA flow diagram
PRISMA 2020 flow diagram summarizing study identification, screening, eligibility assessment, and final inclusion of studies evaluating early/primary DC for adult TBI in Latin America.

Table 1: Characteristics of the studies included in the systematic review.

Author, Year	Country	Design	Total TBI (n)	Early/ primary DC (n)	Comparator (n) / definition of medical management	Age (mean±SD or median [IQR])	Male (%)	Severity of TBI n (%)	Operational definition of early/primary DC	Predominant TBI severity/ phenotype	ICP monitoring (yes/no; type)	Follow-up time points reported (discharge, 6 months, etc.)
Lacerda-Gallardo et al, 2008 [12]	Cuba	Non-randomized controlled quasi-experimental study	517	45	21	> 15 years	50 (76%)	Severe: 517 (100%)	Primary at index admission (based on CT), <12 h post-injury; no explicit ≤24 h cut-off	Severe only	Yes (continuous ventricular monitoring)	Discharge
Faleiro et al, 2008 [13]	Brazil	Retrospective analysis	89	89	0	21 - 50 years	77 (87%)	Severe: 57 (64%)	Early = <6 h or 6–24 h after admission	Mixed severity	Yes (post-op, 51/89 patients)	Discharge, 6 months
Hernández Segura, 2012 [14]	Colombia	Case series	53	44	NR	18-35 years	47 (89%)	Severe: 50 (94%)	defined as ≤6 h post-injury	Mixed severity	Yes (partial; ventriculostomy in 34/53 patients)	Discharge
Ramón Silva, 2012 [15]	Chile	Retrospective analysis	24	12	12	NR	18 (75%)	Severe: 24 (100%)	NR	Severe only	NR	Discharge
Saade et al, 2014 [16]	Brazil	Retrospective analysis	56	56	0	18-65 years	NR	Severe: 56 (100%)	NR	Severe only	No	6 months
Grille, 2015 [17]	Uruguay	Retrospective analysis	64	64	NR	31 ± 14 years	51 (79%)	Severe: 64 (100%)	Primary at index admission; no ≤24 h cut-off	Severe only	Yes (58/64)	Discharge
Charry et al, 2016 [18]	Colombia	Retrospective analysis	106	106	0	36 ± 16.05 years	90 (85%)	Severe: 106 (100%)	Early = <12 h post-injury; primary at index admission (CT-based damage control strategy).	Severe only	No	Discharge, 12 months
Bonadio et al, 2017 [19]	Brazil	Retrospective analysis	81	58	23	40.9 years	66 (81%)	Severe: 81 (100%)	Predominantly ≤24 h; primary at index admission during ASDH evacuation	Severe only	No	1 month
Silva et al, 2020 [20]	Brazil	Retrospective analysis	215	131	NR	36 years	118 (90%)	Severe: 63 (29%)	Predominantly primary DC at index admission	Mixed severity	Yes	Discharge
Celi, 2020 [21]	Perú	Retrospective analysis	33	33	0	52.18 years	27 (82%)	NR	Primary at index admission; no explicit ≤24 h cut-off.	Not clearly reported	Yes	Discharge
Leon-Palacios et al, 2021 [22]	Perú	Retrospective analysis	118	24	0	NR	103 (88%)	Severe: 11 (9%)	Primary at index admission	Mixed severity	No	1 month 6 months
Bertani et al, 2023 [23]	Brazil	Case series	37	20	NR	23-45 years	17 (85%)	Severe: 37 (100%)	Primary at index admission (CT-based damage control)	Firearm-related multilobar injury	No	2 months 6 months
Gamboa-Oñate et al,2024 [24]	Colombia	Retrospective cross-sectional study	50	20	NR	50.2 ± 18.6 years	39 (78%)	Severe: 33 (66%)	Primary at index admission	Mixed severity	No	Discharge
Egas-Terán, 2025 [25]	Ecuador	Retrospective cross-sectional study	373	373	NR	58 ± 21 years	294 (79%)	Mild: 125 (33%)	Not defined; "early" refers to time-to-hospital (<8 h)	Mixed severity	No	Discharge

TBI: Traumatic brain injury; **DC:** Decompressive craniectomy; **MM:** Medical management; **GOS:** Glasgow Outcome Scale; **NR:** Not reported
Source: Authors

Clinical heterogeneity was substantial. Some studies evaluated primary decompression performed during index surgery or damage-control procedures, whereas others examined early decompression for evolving intracranial hypertension. Several cohorts appeared centered on severe mass-lesion scenarios, while others included mixed injury phenotypes or broader TBI severity spectra. Reporting of focal versus diffuse injury, neuromonitoring use, and exact DC timing was inconsistent across studies.

Functional Outcomes

Reported functional outcomes varied markedly across studies. At discharge, favorable functional outcome (GOS 4–5) among DC-treated patients ranged from 26% to 66% in studies reporting this endpoint. At the longest follow-up closest to 6 months, favorable outcome ranged from 21% to 80%. This wide variability likely reflects differences in case mix, injury severity, phenotype, timing definitions, and follow-up completeness across studies (**Table 2**).

Mortality Outcomes

Mortality at discharge among DC-treated patients was also highly variable, ranging from 0% to 61% across reporting studies. Comparative mortality data between DC and a non-DC comparator were available in only two studies, and these data were too sparse and clinically heterogeneous to support firm conclusions regarding the relative effect of decompressive craniectomy versus medical management in Latin America.

Intracranial pressure monitoring and physiologic endpoints

Reporting of ICP monitoring and physiologic targets was inconsistent. Some studies described ventricular or postoperative monitoring, whereas others did not report neuromonitoring at all. In one cohort, postoperative ICP control below 20 mmHg was documented in a substantial proportion of DC-treated patients, supporting the phy-

Table 2. Clinical outcomes by study and reported timepoint

Author, year	Favorable outcome at discharge, n/N (DC)	Mortality at discharge, n/N (DC)	Favorable outcome at longest reported follow-up, n/N (timepoint)	Comparative mortality at discharge, n/N (DC vs comparator)
Lacerda-Gallardo et al, 2008 [12]	27/45	9/45	NR	9/45 vs 7/21
Faleiro et al, 2008 [13]	23/89	NR	21/89 (6 months)	NR
Hernández Segura, 2012 [14]	NR	26/44	NR	NR
Ramón Silva, 2012 [15]	NR	4/12	NR	4/12 vs 7/12
Saade et al, 2014 [16]	NR	33/56	12/56 (6 months)	NR
Grille, 2015 [17]	22/64	28/64	NR	NR
Charry et al, 2016 [18]	70/106	27/106	NR	NR
Bonadio et al, 2017 [19]	NR	26/58	NR	NR
Silva et al, 2020 [20]	34/131	46/131	NR	NR
Celi, 2020 [21]	NR	4/33	NR	NR
Leon-Palacios et al, 2021 [22]	NR	0/24	10/24 (6 months)	NR
Bertani et al, 2023 [23]	NR	NR	16/20 (6 months)	NR
Gamboa-Oñate et al,2024 [24]	NR	5/20	NR	NR
Egas-Terán, 2025 [25]	179/373	94/373	NR	NR

Values are presented as n/N, where n is the number of patients with the outcome and N is the number of DC-treated patients with outcome data available for that specific timepoint. Long-term functional outcome is reported at the longest reported follow-up closest to 6 months. **Table 2** summarizes outcomes as reported in the original studies; not all outcomes were reported at the same timepoints or with comparable definitions, which limited direct cross-study comparison. **DC:** decompressive craniectomy; **MM:** medical management; **GOS:** Glasgow Outcome Scale; **NR:** not reported.

siologic rationale of decompression, but such endpoints were not reported consistently enough across studies to allow meaningful cross-study comparison.

Quality Assessment

Overall, the evidence base was predominantly observational and subject to important methodological limitations. The main concerns included confounding by indication, participant selection, inconsistent reporting of clinical variables, and incomplete outcome reporting. Comparative studies were judged at serious or moderate risk of bias, while several single-arm studies had multiple domains rated as unclear because of limited reporting. These limitations support cautious interpretation of the available evidence (Supplementary **Tables 2 and 3**).

DISCUSSION

Our systematic review shows that the Latin American evidence on early or primary decompressive craniectomy for adult TBI is limited, predominantly observational, and clinically heterogeneous. Across included studies, both functional outcomes and mortality varied markedly, and comparative evidence versus medical management was scarce. Rather than supporting a single regional estimate of benefit, the available literature suggests that outcomes after DC in Latin America are strongly shaped by differences in case selection, injury phenotype, timing and indication for decompression, neuromonitoring availability, and broader health-system capacity.

Principal findings and clinical interpretation

Three findings stand out. First, favorable functional recovery after early or primary DC was highly variable across studies, both at discharge and at follow-up closest to 6 months. Second, discharge mortality also varied substantially between cohorts. Third, comparative evidence versus medical management was very limited and insufficient for firm causal inference. Taken together, these findings suggest that early or primary DC in Latin America should not be interpreted as a uniform intervention with stable effects, but rather as a heterogeneous set of practices applied across diverse injury patterns and health-system contexts [2,3,5–7].

Why is heterogeneity so high? Classification, phenotype, and confounding by indication

The magnitude of heterogeneity across both functional outcomes and mortality is clinically plausible. Across included cohorts, the label "early/primary" likely captured at least three distinct scenarios: (1) primary or damage-control decompression performed during index surgery (e.g., bone flap not replaced after mass lesion evacuation with anticipated swelling), (2) early decompression for evolving intracranial hypertension within variable study-defined time windows, and (3) procedures performed with incomplete reporting of preoperative physiology and escalation thresholds [12–25]. This distinction is not semantic: timing and indication are key determinants of benefit–harm balance and of the survival–disability distribution observed in the broader DC literature and reflected in guideline recommendations [2,3,5].

Clinical phenotype likely further amplified variability. Several studies enrolled mixed-severity cohorts and heterogeneous mechanisms, including firearm-related multilobar injuries and mixed mild–moderate–severe populations, which do not map cleanly onto the trial populations of DECRA or RESCUE-ICP and may carry different prognostic baselines and goals of care [2,6,20,23,25]. Without consistent stratification by CT phenotype (diffuse injury vs mass lesion), pupillary status, admission severity, and trajectory of intracranial hypertension, reported outcomes inevitably reflect markedly different prognostic strata across studies [2,3,6].

Importantly, observational designs introduce substantial confounding by indication. Patients selected for DC are often those with rapid neurological deterioration, refractory intracranial hypertension, or the most severe physiological derangements—factors that independently increase mortality and reduce the likelihood of favorable recovery, potentially biasing comparative estimates even when DC is beneficial [9,10]. This is particularly relevant in health systems where delays to ICU admission, limited neuromonitoring, or constrained operating-room access may shift "early" decisions later along the physiological trajectory, thereby increasing both baseline risk and outcome variability [2,3,7]. Consequently, the limited comparative signal should be regarded as exploratory rather than definitive [12,15].

DC is pathway-dependent: systems of care as treatment-effect modifiers

A central implication of our findings is that DC outcomes in Latin America likely reflect the performance of an entire care pathway rather than the surgical procedure alone. Variation in prehospital triage and transport, time-to-CT, ICU bed availability, staffing ratios, sedation/ventilation practices, osmotherapy and transfusion capacity, infection control, and access to protocolized neurocritical care can materially shape secondary injury burden before and after decompression [2,3,7]. Thus, DC may achieve physiological ICP reduction yet yield variable patient-centered benefit if secondary insults (hypotension, hypoxemia, delayed escalation, sepsis) remain frequent.

Neuromonitoring illustrates this dependency. Contemporary severe TBI frameworks emphasize ICP monitoring to guide tiered escalation and clarify thresholds for interventions including DC [3]. Yet neuromonitoring was inconsistently reported across included studies, limiting mechanistic inference. Where physiological endpoints were available, DC achieved postoperative ICP control (e.g., ICP <20 mmHg in the majority of DC patients in one cohort), supporting the mechanistic efficacy of decompression under monitored

conditions [12]. However, the inability to pool neuromonitoring outcomes underscores a major evidence gap: the region lacks standardized reporting of monitoring availability, thresholds, and protocol context—exactly the variables most likely to modify DC effectiveness [2,3,7].

Post-acute rehabilitation capacity likely further modulates the translation of survival to recovery. Even when DC prevents early death, long-term neurological improvement depends on rehabilitation intensity, continuity of care, caregiver support, and access to follow-up services, which are unevenly distributed in LMIC settings [2,6]. This may partly explain why favorable outcome proportions varied widely across cohorts at discharge [12,13,17,18,20,25]. From a systems perspective, improving the post-operative ecosystem may be as influential as refining operative timing in converting survival gains into meaningful recovery [2,7].

Relationship to DECRA, RESCUE-ICP, and guideline nuance

Our findings align with the broader literature that DC reliably lowers ICP, while functional outcomes remain context- and indication-dependent [5,6]. DECRA and RESCUE-ICP illustrate that DC can shift mortality and disability distributions depending on patient selection and timing along the ICP trajectory [5,6]. Reflecting this nuance, the 2020 guideline update emphasizes scenario-specific decision-making and shared decision-making given potential survival–disability trade-offs [3]. Extrapolating trial ecosystems to Latin America is challenging because randomized trials typically assume consistent access to neuromonitoring, standardized ICU protocols, and structured rehabilitation—elements that may vary substantially across regional trauma systems [3,7]. In this sense, the heterogeneity observed in our synthesis is not merely statistical noise but a clinical signal that system context may act as a treatment-effect modifier in real-world Latin American DC practice [2,7].

Implications for practice and research in Latin America

While comparative causal inference is currently limited, our synthesis supports pragmatic priorities that are feasible and potentially high-yield in the region. First, future studies—and ideally routine clinical documentation—should standardize classification of DC as primary/damage-control, early within a prespecified time window, or secondary for refractory intracranial hypertension, with consistent reporting of CT phenotype, pupillary status, admission severity, and pre-DC physiological trajectory [2,3,6]. Second, where feasible, implementing protocolized intracranial hypertension pathways aligned with guideline principles may reduce practice variability and improve escalation timing [3]. Where ICP monitoring is not available, pragmatic exam- and imaging-driven escalation bundles should be prospectively evaluated. Third, strengthening rehabilitation pathways and longitudinal follow-up should be considered core components of neurotrauma quality improvement, because functional recovery depends on post-acute systems as much as acute survival [2,7]. Finally, regional registries and multicenter prospective cohorts embedded within trauma networks may represent the most realistic near-term strategy to generate adjusted comparative effectiveness evidence, identify system-level determinants of favorable recovery, and inform context-specific guideline adaptation [2,7].

LIMITATIONS

This review is constrained by the underlying evidence base. Most included studies were retrospective and nonrandomized, with risks of confounding, selection bias, and incomplete reporting of key prognostic variables and outcomes. Definitions of "early/primary" DC varied across studies, and functional outcomes were not uniformly captured at standardized time points, limiting comparability. Comparative evidence versus medical management was limited to two studies and was summarized descriptively because the available data were too sparse and heterogeneous for robust inference [12,15]. Additionally, complications and safety outcomes beyond mortality (e.g., infection, hydrocephalus, seizures, syndrome of the trephined, and cranioplasty-related complications) were inconsistently reported, precluding a structured comparative synthesis of complications across studies.

In conclusion, early or primary decompressive craniectomy for traumatic brain injury in Latin America is supported by a limited and heterogeneous body of predominantly observational evidence. Reported outcomes vary widely across studies, and comparative data versus medical management remain insufficient for firm conclusions. Future regional research should prioritize standardized definitions of DC timing and indication, consistent neuromonitoring reporting, and longer-term functional follow-up through prospective multicenter designs.

Supplementary materials
Supplementary table 1. Search strategies

Database	Search strategy	#
PubMed	((((“latin america”[Mesh] OR “latin america*”[tiab] OR latinamerica*[tiab] OR latinoamerica*[tiab] OR Hispanoamerica[tiab] OR iberoamerica*[tiab] OR “ibero americ*”[tiab] OR panamerican*[tiab] OR “central america”[Mesh] OR “central america*”[tiab] OR centroamerica*[tiab] OR mesoamerica*[tiab] OR “meso america*”[tiab] OR “middle america*”[tiab] OR “south america”[Mesh] OR “south america*”[tiab] OR southamerica*[tiab] OR sudamerica*[tiab] OR “America del sur”[tiab] OR “caribbean region”[Mesh] OR Caribbean[tiab] OR caribe*[tiab] OR “west indies”[Mesh] OR “west indi*”[tiab] OR antill*[tiab] OR “indians, south american”[Mesh] OR “indians, central american”[Mesh] OR amerindian*[tiab] OR Indians[tiab] OR “american indian*”[tiab] OR “native america*”[tiab] OR patagoni*[tiab] OR Andes[tiab] OR andean*[tiab] OR amazon*[tiab] OR argentin*[AD] OR argentin*[tiab] OR bolivia*[AD] OR bolivia*[tiab] OR brazil*[AD] OR brasil*[AD] OR brazil*[tiab] OR brasil*[tiab] OR colombia*[AD] OR colombia*[tiab] OR chile*[AD] OR chile*[tiab] OR ecuador*[AD] OR ecuator*[AD] OR ecuador*[tiab] OR guiana*[AD] OR guiana*[tiab] OR guyan*[AD] OR guyan*[tiab] OR paraguay*[AD] OR paraguay*[tiab] OR peru*[AD] OR peru*[tiab] OR surinam*[AD] OR surinam*[tiab] OR uruguay*[AD] OR uruguay*[tiab] OR venez*[AD] OR venez*[tiab] OR belize*[AD] OR belize*[tiab] OR “costa ric*”[AD] OR costarric*[AD] OR costaric*[AD] OR “costa ric*”[tiab] OR costarric*[tiab] OR costaric*[tiab] OR salvador*[AD] OR salvador*[tiab] OR guatemal*[AD] OR guatemal*[tiab] OR hondur*[AD] OR hondur*[tiab] OR nicaragu*[AD] OR nicaragu*[tiab] OR panam*[AD] OR panam*[tiab] OR mexico[Mesh] OR mexic*[AD] OR mexic*[tiab] OR mejic*[tiab] OR baham*[AD] OR baham*[tiab] OR cuba*[AD] OR cuba*[tiab] OR dominic*[AD] OR dominic*[tiab] OR haiti*[AD] OR haiti*[tiab] OR jamaic*[AD] OR jamaic*[tiab] OR “puerto rico”[Mesh] OR “puerto ric*”[tiab] OR puertorric*[tiab] OR puertoric*[tiab]))) AND (“Traumatic Brain Injury”[tiab] OR “Brain Injuries, Traumatic”[Mesh] OR “Traumatic Brain Injury” OR TBI OR “Brain Trauma” OR “Head Injury” OR “Head Trauma”)) AND (“Decompressive Craniectomy”[MESH] OR “Decompressive Craniectomy” OR “craniotomy” OR “craniectomy” OR “surgical” OR “surgery”)	739
Scopus	(INDEXTERMS(“latin america”) OR TITLE-ABS-KEY(“latin america”) OR TITLE-ABS-KEY(latinamerica*) OR TITLE-ABS-KEY(latinoamerica*) OR TITLE-ABS-KEY(hispanoamerica) OR TITLE-ABS-KEY(iberoamerica*) OR TITLE-ABS-KEY(“ibero americ*”) OR TITLE-ABS-KEY(panamerican*) OR INDEXTERMS(“central america”) OR TITLE-ABS-KEY(“central america”) OR TITLE-ABS-KEY(centroamerica*) OR TITLE-ABS-KEY(mesoamerica*) OR TITLE-ABS-KEY(“meso america*”) OR TITLE-ABS-KEY(“middle america*”) OR INDEXTERMS(“south america”) OR TITLE-ABS-KEY(“south america”) OR TITLE-ABS-KEY(southamerica*) OR TITLE-ABS-KEY(sudamerica*) OR TITLE-ABS-KEY(“america del sur”) OR INDEXTERMS(“caribbean region”) OR TITLE-ABS-KEY(caribbean) OR TITLE-ABS-KEY(caribe*) OR INDEXTERMS(“west indies”) OR TITLE-ABS-KEY(“west indi*”) OR TITLE-ABS-KEY(antill*) OR INDEXTERMS(“indians, south american”) OR INDEXTERMS(“indians, central american”) OR TITLE-ABS-KEY(amerindian*) OR TITLE-ABS-KEY(“american indian*”) OR TITLE-ABS-KEY(“native america*”) OR TITLE-ABS-KEY(andean*) OR TITLE-ABS-KEY(amazon*) OR AFFIL(argentin*) OR TITLE-ABS-KEY(argentin*) OR AFFIL(bolivia*) OR TITLE-ABS-KEY(bolivia*) OR AFFIL(brazil*) OR AFFIL(brasil*) OR TITLE-ABS-KEY(brazil*) OR TITLE-ABS-KEY(brasil*) OR AFFIL(colombia*) OR TITLE-ABS-KEY(colombia*) OR AFFIL(chile*) OR TITLE-ABS-KEY(chile*) OR AFFIL(ecuador*) OR AFFIL(ecuator*) OR TITLE-ABS-KEY(ecuador*) OR AFFIL(guiana*) OR TITLE-ABS-KEY(guiana*) OR AFFIL(guyan*) OR TITLE-ABS-KEY(guyan*) OR AFFIL(paraguay*) OR TITLE-ABS-KEY(paraguay*) OR AFFIL(peru*) OR TITLE-ABS-KEY(peru*) OR AFFIL(surinam*) OR TITLE-ABS-KEY(surinam*) OR AFFIL(uruguay*) OR TITLE-ABS-KEY(uruguay*) OR AFFIL(venez*) OR TITLE-ABS-KEY(venez*) OR AFFIL(belize*) OR TITLE-ABS-KEY(belize*) OR AFFIL(“costa ric*”) OR TITLE-ABS-KEY(“costa ric*”) OR AFFIL(costarric*) OR TITLE-ABS-KEY(costarric*) OR AFFIL(costaric*) OR TITLE-ABS-KEY(costaric*) OR AFFIL(salvador*) OR TITLE-ABS-KEY(salvador*) OR AFFIL(guatemal*) OR TITLE-ABS-KEY(guatemal*) OR AFFIL(hondur*) OR TITLE-ABS-KEY(hondur*) OR AFFIL(nicaragu*) OR TITLE-ABS-KEY(nicaragu*) OR AFFIL(panam*) OR TITLE-ABS-KEY(panam*) OR INDEXTERMS(mexico) OR AFFIL(mexic*) OR TITLE-ABS-KEY(mexic*) OR TITLE-ABS-KEY(mejic*) OR AFFIL(baham*) OR TITLE-ABS-KEY(baham*) OR AFFIL(cuba*) OR TITLE-ABS-KEY(cuba*) OR AFFIL(dominic*) OR TITLE-ABS-KEY(dominic*) OR AFFIL(haiti*) OR TITLE-ABS-KEY(haiti*) OR AFFIL(jamaic*) OR TITLE-ABS-KEY(jamaic*) OR INDEXTERMS(“puerto rico”) OR TITLE-ABS-KEY(“puerto ric*”) OR TITLE-ABS-KEY(puertorric*) OR TITLE-ABS-KEY(puertoric*))	1755
	AND (TITLE-ABS-KEY(“traumatic brain injury”) OR INDEXTERMS(“brain injuries, traumatic”) OR “traumatic brain injury” OR TBI OR TITLE-ABS-KEY(“brain trauma”) OR TITLE-ABS-KEY(“head injury”) OR TITLE-ABS-KEY(“head trauma”))	
	AND (INDEXTERMS(“decompressive craniectomy”) OR TITLE-ABS-KEY(“decompressive craniectomy”) OR TITLE-ABS-KEY(craniotomy) OR TITLE-ABS-KEY(craniectomy) OR TITLE-ABS-KEY(surgical) OR TITLE-ABS-KEY(surgery))	

Database	Search strategy	#
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SciELO	((((“latin america” OR “latin america*” OR latinamerica* OR latinoamerica* OR Hispanoamerica OR iberoamerica* OR “ibero americ*” OR panamerican* OR “central america” OR “central america*” OR centroamerica* OR mesoamerica* OR “meso america*” OR “middle america*” OR “south america” OR “south america*” OR southamerica* OR sudamerica* OR “America del sur” OR “caribbean region” OR Caribbean OR caribe* OR “west indies” OR “west indi*” OR antill* OR “indians, south american” OR “indians, central american” OR amerindian* OR Indians OR “american indian*” OR “native america*” OR patagoni* OR Andes OR andean* OR amazon* OR argentin* OR argentin* OR bolivia* OR bolivia* OR brazil* OR brasil* OR brazil* OR brasil* OR colombia* OR colombia* OR chile* OR chile* OR ecuador* OR ecuator* OR ecuador* OR guiana* OR guiana* OR guyan* OR guyan* OR paraguay* OR paraguay* OR peru* OR peru* OR surinam* OR surinam* OR uruguay* OR uruguay* OR venez* OR venez* OR belize* OR belize* OR “costa ric*” OR costarric* OR costaric* OR “costa ric*” OR costarric* OR costaric* OR salvador* OR salvador* OR guatemal* OR guatemal* OR hondur* OR hondur* OR nicaragu* OR nicaragu* OR panam* OR panam* OR mexico OR mexic* OR mexic* OR mejic* OR baham* OR baham* OR cuba* OR cuba* OR dominic* OR dominic* OR haiti* OR haiti* OR jamaic* OR jamaic* OR “puerto rico” OR “puerto ric*” OR puertorric* OR puertoric*))) AND (“Traumatic Brain Injury” OR “Brain Injuries, Traumatic” OR “Traumatic Brain Injury” OR TBI OR “Brain Trauma” OR “Head Injury” OR “Head Trauma”)) AND (“Decompressive Craniectomy” OR “Decompressive Craniectomy” OR craniotomy OR craniectomy OR surgical OR surgery)	55

Database	Search strategy	#
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Supplementary Table 2. ROBINS-I assessment

Study	D1	D2	D3	D4	D5	D6	D7	Overall
Lacerda-Gallardo et al, 2008 [12]	Moderate	Moderate	Low	Moderate	Low	High	Moderate	Serious
Bonadio et al, 2017 [19]	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate
Ramón Silva et al, 2012 [15]	Moderate	Moderate	Low	Low	Moderate	Low	Low	Moderate

ROBINS-I domains: D1 Confounding; **D2** Selection of participants; **D3** Classification of interventions; **D4** Deviations from intended interventions; **D5** Missing data; **D6** Measurement of outcomes; **D7** Selection of reported results.

Supplementary Table 3. Joanna Briggs Institute (JBI)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Overall
Bertani et al, 2023 [23]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Low
Charry et al, 2016 [18]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Low
Celi et al, 2020 [21]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Low
Saade et al, 2014 [16]	Yes	Yes	Yes	Unclear	Unclear	Unclear	Yes	Yes	Yes	Yes	Moderate
Leon-Palacios et al, 2021 [22]	Yes	Yes	Yes	Unclear	Unclear	Unclear	Yes	Yes	Yes	Yes	Moderate
Hernández Segura et al, 2012 [14]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Low
Grille et al, 2015 [17]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Moderate
Faleiro et al, 2008 [13]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Moderate
Silva et al, 2020 [20]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Moderate
Gamboa-Oñate et al,2024 [24]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Low
Egas-Terán, 2025 [25]	Yes	Yes	Yes	Unclear	Unclear	Unclear	Unclear	Yes	Yes	Yes	Moderate

JBI items: Q1 Clear inclusion criteria; **Q2** Condition measured in a standard, reliable way; **Q3** Valid methods used for identification of the condition; **Q4** Consecutive inclusion of participants; **Q5** Complete inclusion of participants; **Q6** Clear reporting of participant demographics; **Q7** Clear reporting of clinical information; **Q8** Clear reporting of outcomes or follow-up results; **Q9** Clear reporting of presenting site(s)/clinic(s) demographic information (as applicable) and adequate follow-up/reporting; **Q10** Appropriate statistical analysis.

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