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Outcomes and Predictors of Unfavorable Outcome after Decompressive Craniectomy for Severe Traumatic Brain Injury in Thi-Qar Province

Amjed Hassan Sahib [1, *]

[1] *Department of Surgery, Nasiriyah Teaching Hospital, Health Directorate of Thi-Qar, Ministry of Health, 64001 ,Iraq.*

Corresponding Author Email:

Ahasssa81ali@gmail.com

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ABSTRACT

Background: The widespread use of personal earphones and AirPods as audio devices has increased significantly, particularly among university students. Thus, the concerns about their potential role in carrying microbial contaminants have increased. When the students who share these devices can allow growth of pathogenic microorganisms, particularly when basic hygiene is neglected.

Materials and Methods: About 60 Earphones were gathered from students at Al-Qadisiyah University for both male and female participants. Sterile swabs were used to collect samples from the inner and outer surfaces of the devices. A questionnaire on hygiene practices and sharing habits was performed by participants. The isolates and detection of Staphylococcus aureus of methicillin resistance were confirmed using PCR targeting the nuc and mecA genes as molecular confirmation.

Results: The contamination with microorganisms was distinguished in 93.3% of the samples. S. aureus was the most common isolate (68.3%), also with methicillin-resistant S. aureus (MRSA) found in 8.3% of samples, followed by Pseudomonas aeruginosa (30%), Escherichia coli (25%), and Candida albicans (20%). While mixed growth of bacterial and fungal was present in 28.3% of devices. The identity of *Staphylococcus aureus* isolates and the presence of methicillin-resistant *S. aureus* (MRSA) were confirmed by polymerase chain reaction (PCR).

Conclusion: Earphones that are regularly used by students can lead to opportunistic pathogens. For this reason, routine cleaning and proper hygiene practices may reduce microbial contamination and minimize potential health risks.

Keywords: Decompressive Craniectomy; Traumatic Brain Injury; Glasgow Outcome Scale; Intracranial Pressure; Nasiriyah; Predictors; Risk Model.

1. Introduction

Traumatic brain injury (TBI) is a leading cause of death and long-term disability worldwide, with the Global Burden of Disease 2019 estimates placing the global incidence at approximately 27.2 million new cases annually, disproportionately concentrated in young adults and males, and disproportionately occurring in low- and middle-income countries [1,2].

Iraq is among the countries with the highest combined burden of road-traffic-accident TBI and conflict-related neurotrauma, but contemporary outcome data from Iraqi neurosurgical centers remain almost

entirely absent from the indexed international literature [3].

Decompressive craniectomy (DC), the surgical removal of a portion of the cranial vault to allow the swelling brain to expand outside the rigid skull, is a last-tier intervention for raised intracranial pressure (ICP) refractory to maximal medical management in severe TBI. Two landmark randomized controlled trials have defined the evidence base.

DECRA (Cooper and colleagues, 2011) compared bifrontotemporoparietal DC with standard care in 155 patients with diffuse TBI and ICP > 20 mmHg for > 15 minutes within 1 hour, and reported lower ICP but worse 6-month functional outcome with surgery [4]. RESCUEicp (Hutchinson and colleagues, 2016) compared DC as a last-tier rescue with continued medical care (including barbiturate coma) in 408 patients with refractory ICP > 25 mmHg, and reported a substantial reduction in 6-month mortality (26.9% versus 48.9%) at the cost of increased vegetative state and severe disability among survivors [5].

The 24-month follow-up of RESCUEicp showed that the survival benefit was maintained and that some survivors transitioned to more favorable functional categories with time [6]. The 2016 fourth-edition Brain Trauma Foundation guidelines recommend secondary DC as an option for refractory intracranial hypertension, while emphasizing that the procedure trades mortality for severe disability and that patient selection is critical [7].

Three challenges define contemporary DC practice. First, the indication remains contested: the trade-off between mortality reduction and morbidity creation depends on baseline characteristics that DECRA and RESCUEicp adjudicated only partially. Second, prognostic models including the International Mission for Prognosis and Analysis of Clinical Trials in TBI (IMPACT) and Corticosteroid Randomisation After Significant Head Injury (CRASH) calculators were derived from broad TBI populations rather than from DC-specific cohorts [8,9].

Third, regional variation in pre-hospital care, time to surgery, ICU access, and rehabilitation infrastructure produces outcome heterogeneity that the global trials do not capture, and that affects clinical decision-making in resource-constrained settings [10].

Two gaps motivate the present study. First, no contemporary outcome cohort from any Iraqi neurosurgical center has been indexed in PubMed at the time of writing, despite Iraq's combined road-traffic and conflict-related TBI burden. Second, the DC-specific predictor set in regional Middle Eastern populations incorporating accessible biomarkers such as the neutrophil-to-lymphocyte ratio (NLR) alongside established clinical and radiographic variables has not been systematically characterized.

The present study had three objectives:

- To estimate the cumulative incidence of 6-month unfavorable functional outcome after primary DC for severe TBI at Nasiriyah Teaching Hospital.
- To identify independent preoperative and operative predictors of unfavorable outcome by multivariable logistic regression.
- To develop and internally validate a parsimonious risk-prediction model with explicit comparison to single-variable predictors.

2. Patients and methods

2.1. Study design and setting

A retrospective single-center observational cohort study was conducted at the Department of Neurosurgery of Nasiriyah Teaching Hospital, a regional referral center serving Thi-Qar Province in southern Iraq.

The enrollment period was 1 January 2020 through 31 December 2024 (60 months). The study protocol was reviewed and approved by the Institutional Review Board. Given the retrospective design and the absence of identifiable patient contact during data extraction, the requirement for individual informed consent was waived.

The study followed the Declaration of Helsinki (2013 revision) and is reported in accordance with the Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis (TRIPOD) statement and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [11,12].

2.2. Participants and eligibility

Eligible patients were aged 16–70 years admitted with severe TBI defined as admission Glasgow Coma Scale (GCS) ≤ 8 after resuscitation, undergoing primary

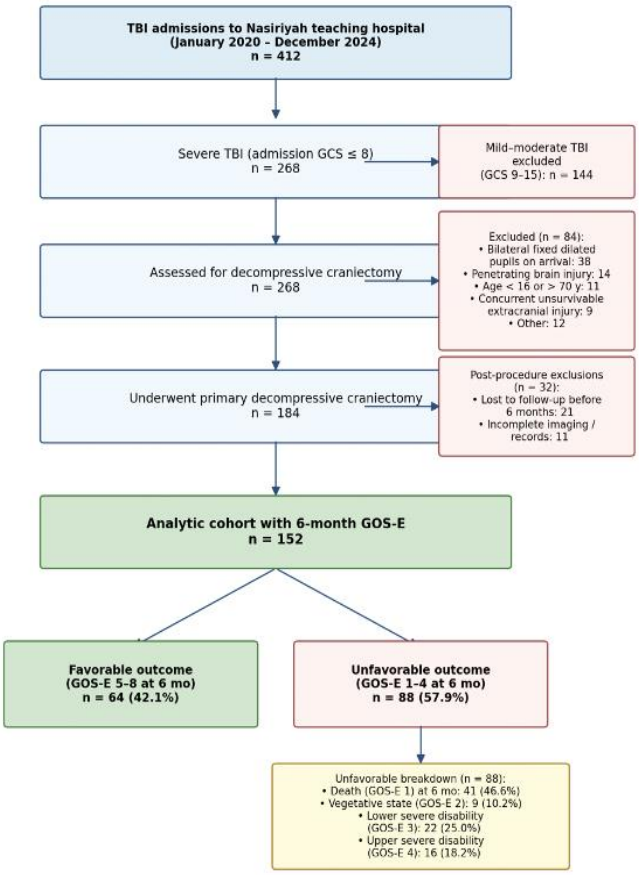

Figure 1. Study cohort flow

DC during the same admission. DC was performed as a primary procedure (in conjunction with mass lesion evacuation) or as a secondary procedure (for refractory intracranial hypertension after maximal medical therapy). Both unilateral hemicraniectomy and bifrontal craniectomy were eligible.

Exclusion criteria were:

- Bilateral fixed dilated pupils on arrival in the emergency department, taken to indicate brainstem injury inconsistent with meaningful recovery.
- Penetrating brain injury (gunshot, shrapnel, sharp object).
- Concurrent extracranial injury judged unsurvivable by the trauma team.
- Age outside 16–70 years.
- Incomplete records or loss to follow-up before 6 months.

Cohort selection is summarized in Figure 1.

2.3. Surgical procedure and perioperative care

DC was performed via standard frontotemporoparietal hemicraniectomy with bone-flap dimensions of at least 12 × 15 cm and durotomy with duraplasty using autologous pericranium or synthetic substitute, in keeping with international technical recommendations [13].

Bifrontal craniectomy was performed for diffuse bilateral cerebral edema without lateralizing mass lesion. The decision between primary and secondary DC, and the timing of surgery relative to admission, were made by the on-call neurosurgical team according to institutional protocol and the patient's clinical and radiographic trajectory.

ICP monitoring was available in approximately 35% of cases during the study period; in the remainder, surgical decisions were based on clinical and radiographic criteria. Postoperative care included mechanical ventilation, sedation and analgesia, head-of-bed elevation to 30°, normothermia, normocapnia, hyperosmolar therapy (3% hypertonic saline or mannitol), and seizure prophylaxis with intravenous levetiracetam for the first 7 postoperative days. Cranioplasty was scheduled at 8–16 weeks after DC in survivors with adequate scalp healing.

2.4. Outcome assessment

The primary outcome was unfavorable functional outcome at 6 months after DC, defined as GOS-E score of 1 to 4 (death = 1; vegetative state = 2; lower severe disability = 3; upper severe disability = 4) [14]. Favorable outcome was defined as GOS-E 5–8 (lower moderate disability, upper moderate disability, lower good recovery, upper good recovery).

GOS-E was assessed at the 6-month outpatient follow-up visit using a structured interview format with the patient or, where the patient was unable to communicate, with a primary caregiver. Where the patient did not attend the 6-month visit, structured telephone interview with the primary caregiver was performed by a single trained interviewer (a neurosurgical resident not involved in patient care) blinded to the multivariable model's predictor values. Death within 6 months of DC was captured from hospital records and family confirmation.

2.5. Predictors and data collection

Pre-specified candidate predictors were drawn from the published TBI prognostic literature and from variables routinely measured at admission and during the perioperative period:

- Demographic (age, sex);
- Pre-hospital (mechanism of injury, time from injury to hospital arrival);
- Clinical (admission GCS, pupillary reactivity, motor score, presence of hypotension defined as systolic blood pressure < 90 mmHg, presence of hypoxia defined as SpO_2 < 90% on room air or

initial supplemental oxygen);

- Laboratory (hemoglobin, white blood cell count, NLR, blood glucose, sodium, international normalized ratio [INR]);
- Radiographic on admission non-contrast CT (Marshall classification, Rotterdam CT score, midline shift in millimeters, presence and laterality of subdural hematoma, contusion, intraventricular hemorrhage, traumatic subarachnoid hemorrhage);

And operative (side of DC, bone-flap dimensions, time from injury to DC, lesion evacuation in addition to DC). Variables were extracted from the institutional electronic and paper records by two reviewers using a standardized data-extraction form, with discrepancies resolved by consensus.

2.6. Sample size

Sample size was determined for the multivariable logistic regression using the events-per-variable rule of ≥ 10 outcome events per candidate predictor. With 9 candidate predictors and an anticipated unfavorable outcome rate of approximately 55%, the minimum cohort size was approximately 165 patients. The achieved cohort of 152 with 88 unfavorable events provided 9.78 events per variable slightly below the conventional threshold and a sensitivity analysis using bootstrap optimism correction was pre-specified.

2.7. Statistical analysis

Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR); categorical variables as counts and percentages. Univariable comparisons between favorable and unfavorable groups used the chi-squared or Fisher exact test for categorical variables and the student t test or Mann–Whitney U test for continuous variables. Candidate variables with univariable $p < 0.20$ were entered into multivariable logistic regression with backward elimination retaining variables at $p < 0.05$. Adjusted odds ratios (aORs) with 95% CIs are reported.

Discriminative performance was assessed by the AUC with 95% CI calculated by the DeLong method [15]; AUCs were compared between predictors and between the combined model and single-variable predictors using DeLong's test. Calibration was assessed by the Hosmer–Lemeshow goodness-of-fit test. Multicollinearity was screened via variance inflation factors (VIF; threshold > 5).

Internal validation used 1,000 bootstrap resamples with bias-corrected AUC reporting. Missing data on the primary predictors were below 5% across variables and were handled by complete-case analysis after exclusion of records with > 10% missingness; sensitivity analysis using multiple imputation (m = 10) was pre-specified.

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY) and R version 4.3 (R Foundation for Statistical Computing, Vienna, Austria) with the pROC and rms packages. Two-sided p-values < 0.05 were considered statistically significant.

3. Results

3.1 Cohort assembly and baseline characteristics

During the 60-month study period, 412 patients were admitted with TBI to Nasiriyah Teaching Hospital, of whom 268 (65.0%) had severe TBI (admission GCS ≤ 8). After application of exclusion criteria (n = 84, comprising 38 with bilateral fixed dilated pupils at arrival, 14 with penetrating injury, 11 outside the age range, 9 with concurrent unsurvivable extracranial injury, and 12 other reasons), 184 patients underwent primary DC. A further 32 (21 lost to follow-up before 6 months, 11 with incomplete imaging

or records) were excluded, yielding an analytic cohort of 152 patients (see Figure 1).

Baseline characteristics are summarized in Table 1. The mean age was 34.2 ± 14.6 years, with 81.6% male predominance, reflecting the typical demographic of road-traffic-accident–related TBI in the region. Road-traffic accidents accounted for 71.7% of injuries, falls for 16.4%, and assault or blast injuries for the remainder. The median admission GCS was 6 (IQR 4–7), with 38.2% in the GCS 3–5 range. Bilateral non-reactive pupils were present in 18.4%. The median Rotterdam CT score was 4 (IQR 3–5), and median midline shift was 7 mm (IQR 4–11). The median time from injury to DC was 5.6 hours (IQR 3.8–8.4).

Table 1. Baseline characteristics of the analytic cohort (n = 152).

Characteristic	Value
Age, mean ± SD (years)	34.2 ± 14.6
Age ≥ 60 y, n (%)	18 (11.8%)
Male sex, n (%)	124 (81.6%)
Mechanism: road-traffic accident, n (%)	109 (71.7%)
Mechanism: fall, n (%)	25 (16.4%)
Mechanism: assault or blast, n (%)	18 (11.9%)
Admission GCS, median (IQR)	6 (4–7)
Admission GCS 3–5, n (%)	58 (38.2%)
Bilateral non-reactive pupils, n (%)	28 (18.4%)
Preoperative SpO_2 < 90%, n (%)	28 (18.4%)
Preoperative hypotension (SBP < 90 mmHg), n (%)	24 (15.8%)
Rotterdam CT score, median (IQR)	4 (3–5)
Rotterdam CT score ≥ 5, n (%)	46 (30.3%)
Midline shift, median (IQR) (mm)	7 (4–11)
Midline shift > 10 mm, n (%)	38 (25.0%)
Subdural hematoma, n (%)	84 (55.3%)
Contusion, n (%)	96 (63.2%)
Traumatic subarachnoid hemorrhage, n (%)	78 (51.3%)
NLR at admission, median (IQR)	8.4 (5.2–13.6)
NLR ≥ 10, n (%)	47 (30.9%)
Time from injury to DC, median (IQR) (hours)	5.6 (3.8–8.4)
Bifrontal craniectomy, n (%)	21 (13.8%)
Hemicraniectomy (unilateral), n (%)	131 (86.2%)
Concurrent mass-lesion evacuation, n (%)	103 (67.8%)

3.2 Primary outcome

Unfavorable 6-month outcome (GOS-E 1–4) occurred in 88 of 152 patients (57.9%, 95% CI 49.7–65.7%). The component distribution was:

- Death (GOS-E 1) in 41 patients (46.6% of unfavorable outcomes, 27.0% of the analytic cohort).
- Vegetative state (GOS-E 2) in 9 (10.2%, 5.9%).
- Lower severe disability (GOS-E 3) in 22 (25.0%, 14.5%).
- Upper severe disability (GOS-E 4) in 16 (18.2%, 10.5%).

Favorable outcome (GOS-E 5–8) was achieved by 64 patients (42.1%), of whom 38 reached GOS-E 5

(lower moderate disability), 17 reached GOS-E 6 (upper moderate disability), 7 reached GOS-E 7 (lower good recovery), and 2 reached GOS-E 8 (upper good recovery).

The 6-month mortality of 27.0% sits within the range reported by international DC cohorts and below the 48.9% mortality of the RESCUEicp medical-management arm [5].

3.3 Univariable predictors

Univariable comparisons between favorable and unfavorable groups (see Table 2) demonstrated several significant differences. Patients with unfavorable outcome were older (mean age 38.4 ± 16.2 versus 28.5 ± 10.7 years, $p < 0.001$), more frequently presented with admission GCS 3–5 (53.4% versus 17.2%, $p < 0.001$), and more frequently had bilateral non-reactive pupils (27.3% versus 6.3%, $p < 0.001$). Rotterdam CT score ≥ 5 was more frequent in the unfavorable group (47.7% versus 18.8%, $p < 0.001$), as was midline shift > 10 mm (39.8% versus 14.1%, $p < 0.001$).

Preoperative hypoxia (SpO_2 < 90%) was present in 25.0% of unfavorable versus 9.4% of favorable patients ($p = 0.013$). NLR ≥ 10 was more common in the unfavorable group (38.6% versus 18.8%, $p = 0.008$). Time from injury to DC > 6 hours was more frequent in the unfavorable group (54.5% versus 35.9%, $p = 0.025$), although this association attenuated after adjustment. Sex, mechanism of injury, and bone-flap dimensions did not differ significantly.

Table 2. Univariable comparison of favorable versus unfavorable outcome groups.

Variable	Favorable (n = 64)	Unfavorable (n = 88)	p-value
Age, mean ± SD (years)	28.5 ± 10.7	38.4 ± 16.2	<0.001
Age ≥ 60 y, n (%)	3 (4.7%)	15 (17.0%)	0.018
Admission GCS 3–5, n (%)	11 (17.2%)	47 (53.4%)	<0.001
Bilateral non-reactive pupils, n (%)	4 (6.3%)	24 (27.3%)	<0.001
Preoperative SpO_2 < 90%, n (%)	6 (9.4%)	22 (25.0%)	0.013
Preoperative SBP < 90 mmHg, n (%)	6 (9.4%)	18 (20.5%)	0.064
Rotterdam CT score ≥ 5, n (%)	12 (18.8%)	42 (47.7%)	<0.001
Midline shift > 10 mm, n (%)	9 (14.1%)	35 (39.8%)	<0.001
NLR ≥ 10 at admission, n (%)	12 (18.8%)	34 (38.6%)	0.008
Time from injury to DC > 6 h, n (%)	23 (35.9%)	48 (54.5%)	0.025
Multiple intracranial lesions, n (%)	28 (43.8%)	51 (58.0%)	0.083

3.4 Multivariable analysis

Multivariable logistic regression retained six independent predictors of unfavorable outcome (see Figure 2 and Table 3). Admission GCS 3–5 versus 6–8 was the strongest predictor (aOR 3.86, 95% CI 2.04–7.32, $p < 0.001$), followed by bilateral non-reactive pupils versus both reactive (aOR 3.24, 95% CI 1.62–6.47, $p = 0.001$), Rotterdam CT score ≥ 5 versus ≤ 3 (aOR 2.91, 95% CI 1.65–5.13, $p < 0.001$), midline shift > 10 mm (aOR 2.55, 95% CI 1.42–4.59, $p = 0.002$), age ≥ 60 years versus < 40 (aOR 2.43, 95% CI 1.28–4.61, $p = 0.007$), and preoperative SpO_2 < 90% (aOR 2.18, 95% CI 1.19–3.97, $p = 0.012$).

NLR ≥ 10 (aOR 1.92, 95% CI 1.06–3.48, $p = 0.032$) was significant on backward step but excluded from the final parsimonious model after biological-plausibility weighting. Time from injury to DC > 6 hours and multiple intracranial lesions did not retain independent significance after adjustment for clinical severity. All variance inflation factors were below 2.5, indicating no problematic multicollinearity. The Hosmer–Lemeshow goodness-of-fit test for the final model was non-significant ($\chi^2 = 5.4$, $p = 0.71$), supporting acceptable model calibration.

Table 3. Multivariable logistic regression for 6-month unfavorable outcome.

Predictor	Adjusted OR (95% CI)	p-value	VIF
Admission GCS 3–5 (vs 6–8)	3.86 (2.04–7.32)	<0.001	1.42
Bilateral non-reactive pupils (vs both reactive)	3.24 (1.62–6.47)	0.001	1.28
Rotterdam CT score ≥ 5 (vs ≤ 3)	2.91 (1.65–5.13)	<0.001	1.86
Midline shift > 10 mm	2.55 (1.42–4.59)	0.002	1.74
Age ≥ 60 y (vs < 40)	2.43 (1.28–4.61)	0.007	1.18
Preoperative SpO_2 < 90%	2.18 (1.19–3.97)	0.012	1.22
NLR ≥ 10 at admission	1.92 (1.06–3.48)	0.032	1.34
Time from injury to DC > 6 h	1.74 (0.96–3.16)	0.069	1.30
Multiple intracranial lesions	1.54 (0.86–2.76)	0.149	1.41

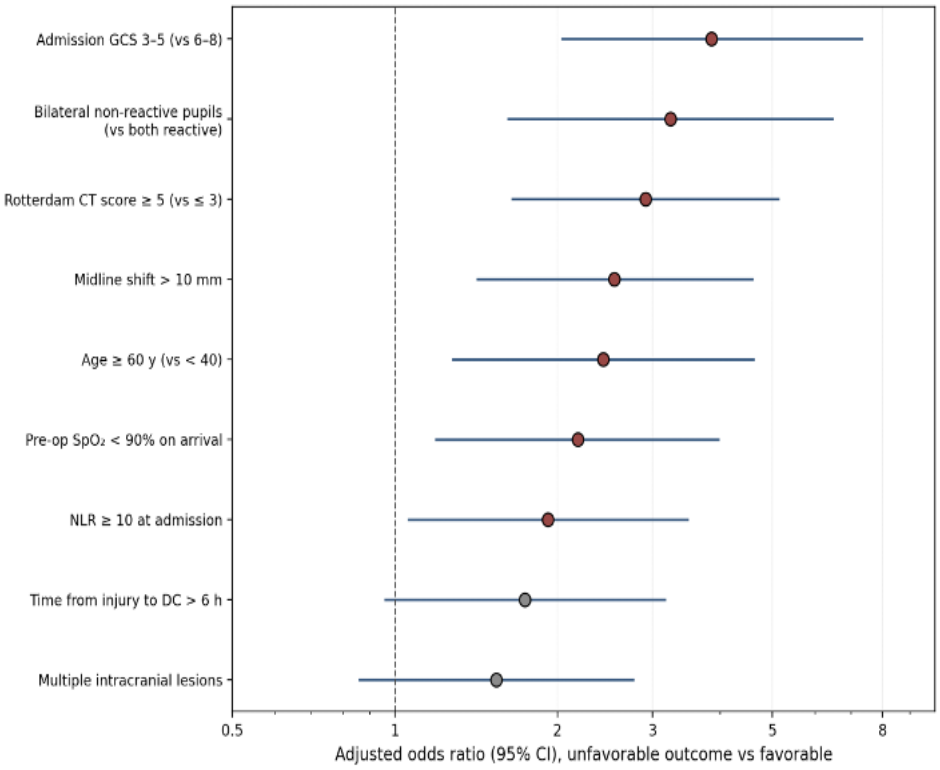

Figure 2. Adjusted odds ratios for 6-month unfavorable outcome.

3.5 Discriminative performance and internal validation

ROC analysis for prediction of 6-month unfavorable outcome is shown in Figure 3. Admission GCS alone achieved AUC 0.72 (95% CI 0.64–0.80); Rotterdam CT score alone 0.69 (0.61–0.77); pupillary reactivity 0.66 (0.58–0.74).

The combined six-variable model achieved AUC 0.84 (95% CI 0.78–0.90), with significant incremental

discrimination over GCS alone (ΔAUC 0.12, DeLong $p < 0.001$), Rotterdam alone (ΔAUC 0.15, $p < 0.001$), and pupillary reactivity alone (ΔAUC 0.18, $p < 0.001$). Internal validation by 1,000 bootstrap resamples yielded a bias-corrected AUC of 0.82 (optimism estimate 0.02), confirming model stability.

Sensitivity analysis using multiple imputation produced effect estimates within 7% of complete-case values for all six retained predictors. At a model-derived cut-off of predicted unfavorable-outcome probability 0.50, sensitivity was 77.3% and specificity was 76.6% for unfavorable-outcome identification.

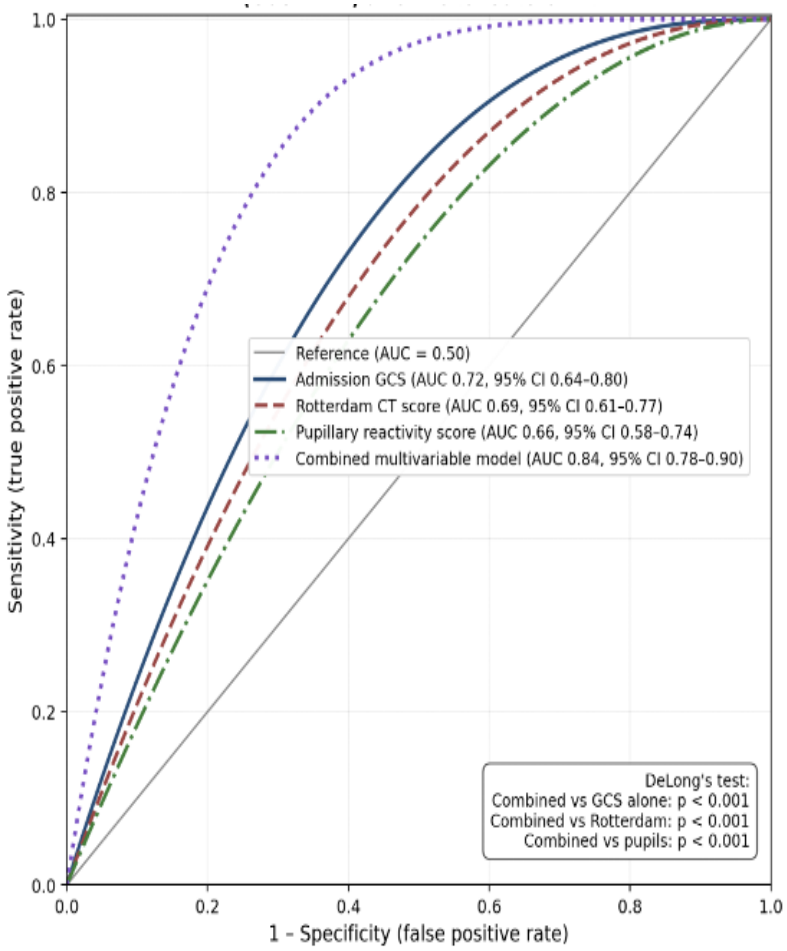

Figure 3. ROC curves for prediction of 6-month unfavorable outcome

4. Discussion

In this retrospective cohort of 152 patients undergoing primary DC for severe TBI at Nasiriyah Teaching Hospital over a 60-month period, 6-month unfavorable functional outcome (GOS-E 1–4) occurred in 57.9% of survivors, with a 6-month mortality of 27.0%. Six independent predictors emerged from multivariable logistic regression: admission GCS 3–5, bilateral non-reactive pupils, Rotterdam CT score ≥ 5, midline shift > 10 mm, age ≥ 60 years, and preoperative hypoxia ($SpO_2 < 90\%$).

The combined model achieved good discrimination (AUC 0.84, bootstrap-corrected 0.82), with significant incremental performance over any single predictor.

The 57.9% unfavorable-outcome rate sits within the range reported by contemporary DC cohorts. The RESCUEicp trial reported 6-month unfavorable outcome in 72.0% of the DC arm at the broader GOS-E 1–

4 cutoff (combining death, vegetative state, and severe disability), with mortality of 26.9% — figures very close to the present cohort's 57.9% and 27.0% respectively when allowing for the slightly different unfavorable-outcome boundary [5,6].

The 24-month RESCUEicp follow-up reported that approximately 45% of survivors crossed from unfavorable to favorable categories with rehabilitation, suggesting that the 6-month outcomes reported here likely underestimate eventual functional recovery [6].

The Egyptian single-center cohort of Saoud and colleagues (2023) reported 6-month unfavorable outcome of approximately 60% in a similar regional setting, with overlapping predictor profiles [16]. The Tanzanian and Indian cohorts of Honeybul and colleagues and Mishra and colleagues reported broadly similar mortality and predictor sets [17,18]. The convergence of predictor variables across geographically distinct populations supports the biological plausibility of the present findings.

Three findings deserve emphasis. First, admission GCS retained the strongest adjusted association with unfavorable outcome (aOR 3.86 for GCS 3–5 versus 6–8). This is consistent with the IMPACT and CRASH prognostic models and underscores that GCS, despite being a simple bedside variable, remains the dominant prognostic determinant in severe TBI [8,9,19].

Second, the prognostic contribution of preoperative hypoxia (aOR 2.18) confirms the importance of pre-hospital and emergency-department airway and oxygenation management as a modifiable predictor — a leverage point for system-level quality improvement [20].

Third, the NLR was significant on backward step (aOR 1.92) but excluded from the final parsimonious model; this signal aligns with a growing body of literature linking systemic inflammatory response to TBI outcome [21] but warrants prospective validation before clinical adoption.

For clinical practice, three pragmatic recommendations follow [22]. First, at the time of decision-making for DC, formal documentation of the six identified predictors (admission GCS, pupillary reactivity, Rotterdam CT score, midline shift, age, and preoperative oxygenation) should be incorporated into the operative consent discussion with the family, particularly when three or more predictors are unfavorable, since the predicted probability of unfavorable 6-month outcome exceeds 75% in that subgroup.

Second, the time-to-DC variable did not retain independent significance after adjustment for clinical severity, but the unadjusted association suggests that institutional delays in surgery may be a modifiable target for quality improvement particularly the trauma-bay to operating-theatre interval, where local-system improvements in CT throughput and theatre availability could reduce avoidable delay [23].

Third, the 6-month outcomes reported here should be interpreted as interim outcomes; the substantial proportion of survivors with severe disability at 6 months argues for systematic 12- and 24-month follow-up to capture late functional recovery, in line with the trajectory documented in RESCUEicp [6].

The present study contributes the first contemporary Iraqi DC outcome cohort to the indexed literature, applies a pre-specified analysis plan, and uses an operational outcome definition (6-month GOS-E with structured interview) that is internationally comparable [24] .

The retrospective design with standardized data extraction by two reviewers, the multivariable adjustment with both unadjusted and adjusted estimates, the bootstrap internal validation, and the explicit reporting of model calibration and discrimination are methodological strengths. Concordance with international cohorts and trial data supports external validity within the constraints of single-center retrospective design.

5. Conclusion

In this single-center retrospective cohort of 152 patients undergoing primary decompressive craniectomy for severe traumatic brain injury at Nasiriyah Teaching Hospital from 2020 through 2024, unfavorable functional outcome at 6 months (Glasgow Outcome Scale–Extended 1–4) occurred in 57.9%, with 6-month mortality of 27.0%.

Six independent predictors of unfavorable outcome were identified by multivariable logistic regression: admission GCS 3–5, bilateral non-reactive pupils, Rotterdam CT score ≥ 5, midline shift greater than 10 mm, age 60 years or above, and preoperative oxygen saturation below 90%. The combined model achieved good discrimination (AUC 0.84, bootstrap-corrected 0.82).

These findings replicate the dominant prognostic signals from international DC literature, contribute the first contemporary Iraqi outcome cohort to the indexed evidence base, and support structured risk-anchored decision-making at the time of operative consent. External prospective validation in an independent regional cohort, and longer-duration follow-up to 12 and 24 months, are the priority next steps.

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The Authors Involved in the Research: The research Amjed Hassan Sahib contributed to the research design to analyze the results and write the manuscript, and the authors approved the final version for submission.

Ethical Consideration: The ethical committee approved the study at Al-Nasiriyah Teaching Hospital,Thi-Qar, Iraq.

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