

# SPECTRUM OF NEUROSURGICAL TRAUMATIC BRAIN INJURY ADMISSIONS: AGE-SEX PROFILE, TREATMENT PATTERNS, AND OUTCOMES AT A TERTIARY-CARE HOSPITAL

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## ABSTRACT

Traumatic brain injury (TBI) constitutes a major proportion of neurosurgical admissions. We aimed to describe the diagnostic spectrum of neurosurgical head injury admissions within the TBI spectrum, along with the age-sex profile, treatment patterns, and short-term neurologic outcomes at discharge in a tertiary neurosurgical referral center in India. We retrospectively reviewed all neurosurgical head injury admissions at a single tertiary-care center between April 2022 and April 2024 (n = 158). Included cases comprised neuroimaging-confirmed TBI or neurosurgically relevant head trauma admitted under neurosurgery. Each case was assigned to one mutually exclusive primary diagnostic category based on the dominant clinically significant lesion or primary injury. Descriptive statistics were used; continuous variables are presented as mean  $\pm$  standard deviation and categorical variables as frequencies and percentages. Of the 158 patients, 77.2% were male, with a mean age of 34 years. Extra-axial hematomas were the most common diagnosis (37.3%), followed by skull fractures (29.7%), minor head injury or soft-tissue injuries (13.9%), parenchymal brain injuries (12.0%), and polytrauma-related TBI (7.0%). Overall, 57.0% of patients were managed conservatively and 43.0% underwent surgical intervention. Severe outcomes were most frequent among patients with polytrauma-related TBI (45.5%). Focal hemorrhagic TBIs, particularly acute subdural hematomas, predominated in this tertiary-care cohort and accounted for much of the operative workload. Poorer short-term outcomes among surgically treated patients likely reflect greater initial injury severity rather than adverse effects of surgery itself.

**KEYWORDS:** Brain Injuries, Traumatic; Hematoma, Subdural; Hematoma, Epidural, Cranial; Neurosurgery; Treatment Outcome; India

## INTRODUCTION

Traumatic brain injury (TBI) is a major cause of death and disability worldwide<sup>1,2</sup>. Low- and middle-income countries shoulder a disproportionate share of this burden, and India contributes substantially to global trauma-related mortality<sup>3,4</sup>. Despite this burden, detailed Indian hospital-based datasets describing diagnosis patterns, management pathways, and early outcomes remain limited<sup>3,4</sup>.

TBI includes a wide pathologic spectrum, from extra-axial hematomas and skull fractures to contusions, diffuse axonal injury, and traumatic subarachnoid hemorrhage<sup>5,6</sup>. Management depends on lesion type, mass effect, and physiologic impact. Early evacuation of surgically significant epidural and acute subdural hematomas remains standard practice, whereas the role of decompressive craniectomy and surgery for parenchymal lesions must be individualized<sup>7-10</sup>.

Hospital-based studies from South Asia consistently show a predominance of young male patients with TBI<sup>11,12</sup>. Tertiary referral centers also see a higher proportion of surgically important injuries than primary or secondary care facilities<sup>13,14</sup>. The present study was undertaken to describe the diagnostic spectrum, age-sex profile, treatment patterns, and discharge outcomes of neurosurgical head injury admissions in a tertiary-care cohort from India.

## MATERIAL AND METHODS

### Study design and setting

This retrospective observational cohort study was conducted at the National Institute of Medical Sciences and Research (NIMS), Jaipur, Rajasthan, India, a tertiary-care academic neurosurgical center. All consecutive head injury admissions under the Department of Neurosurgery between April 2022 and April 2024 were reviewed. The study protocol was approved by the Institutional Ethics Committee of NIMS, Jaipur (IEC/P-816/2024). Owing to the retrospective use of anonymized records, the requirement for informed consent was waived<sup>15,16</sup>.

## Participants

Patients were identified from hospital records. Inclusion criteria comprised any neurosurgical admission for head injury with either (i) neuroimaging-confirmed intracranial pathology or (ii) minor head injury with scalp or soft-tissue trauma requiring neurosurgical inpatient care. During the study period, 158 head injury admissions were recorded among 279 total neurosurgical admissions. Analysis was restricted to patients discharged alive with complete discharge documentation.

## Variables and data sources

Data were extracted from medical records, operative registers, imaging reports, and the radiology Picture Archiving and Communication System. Recorded variables included age, sex, diagnosis, treatment modality, and neurologic outcome at discharge. Admission Glasgow Coma Scale scores, mechanism of injury, computed tomography severity scores, intensive care requirements, and time to surgery were incompletely documented and were not suitable for systematic analysis.

## Diagnostic classification

Each case was assigned to one primary diagnostic category on the basis of the dominant lesion most relevant to neurosurgical decision-making<sup>7,8</sup>. The five groups were skull fractures, extra-axial hematomas, parenchymal injuries, polytrauma-related TBI, and minor head injury/soft-tissue injuries. Extra-axial hematomas included epidural hematoma (EDH) and subdural hematoma (SDH), with SDH subclassified as acute, subacute, chronic, or acute-on-chronic. Parenchymal injuries included contusions, diffuse axonal injury, and traumatic subarachnoid hemorrhage. Polytrauma-related TBI denoted head injury accompanied by major extracranial trauma such as chest, abdominal, or orthopedic injury. Minor head injury/soft-tissue injuries included concussion without a dominant focal intracranial lesion and scalp or soft-tissue injuries requiring neurosurgical inpatient care.

## Classification of multiple lesions

When multiple traumatic findings were present, a single primary category was assigned. For example, a skull fracture with only a very small associated SDH remained classified as skull fracture, whereas a large EDH or SDH with only a minor associated fracture was classified under the extra-axial hematoma group. Likewise, contusions, diffuse axonal injury, or traumatic subarachnoid hemorrhage were classified under parenchymal injury only when they represented the dominant intracranial pathology.

## Treatment modalities

Management was classified as conservative or surgical. Conservative treatment included observation, antiepileptic medication when indicated, hyperosmolar therapy, ventilatory support, and intensive care monitoring<sup>17</sup>. Surgical treatment included craniotomy or craniectomy for evacuation or decompression, elevation of depressed fractures, and burr-hole or mini-craniotomy drainage procedures<sup>7-10,17</sup>. In general, EDH or acute SDH exceeding accepted operative thresholds or associated with neurologic deterioration underwent urgent evacuation; smaller lesions without major mass effect were managed nonoperatively. Intracranial pressure monitoring was not available during the study period, so decisions relied on clinical assessment and computed tomography findings.

## Outcome measures

The primary outcome was neurologic status at hospital discharge, categorized as full recovery, partial deficit, or severe deficit<sup>18</sup>. These categories approximate Glasgow Outcome Scale states of 5, 4, and 2-3, respectively.

## Bias and statistical analysis

This was a descriptive cohort analysis. Data were cross-checked across multiple sources to improve internal consistency and were analyzed in Microsoft Excel. Continuous variables are summarized as means with standard deviations, and categorical variables as counts and percentages. No comparative hypothesis testing was planned. All 158 cases had complete data for age, sex, diagnosis, treatment, and discharge outcome; therefore, no imputation was required.

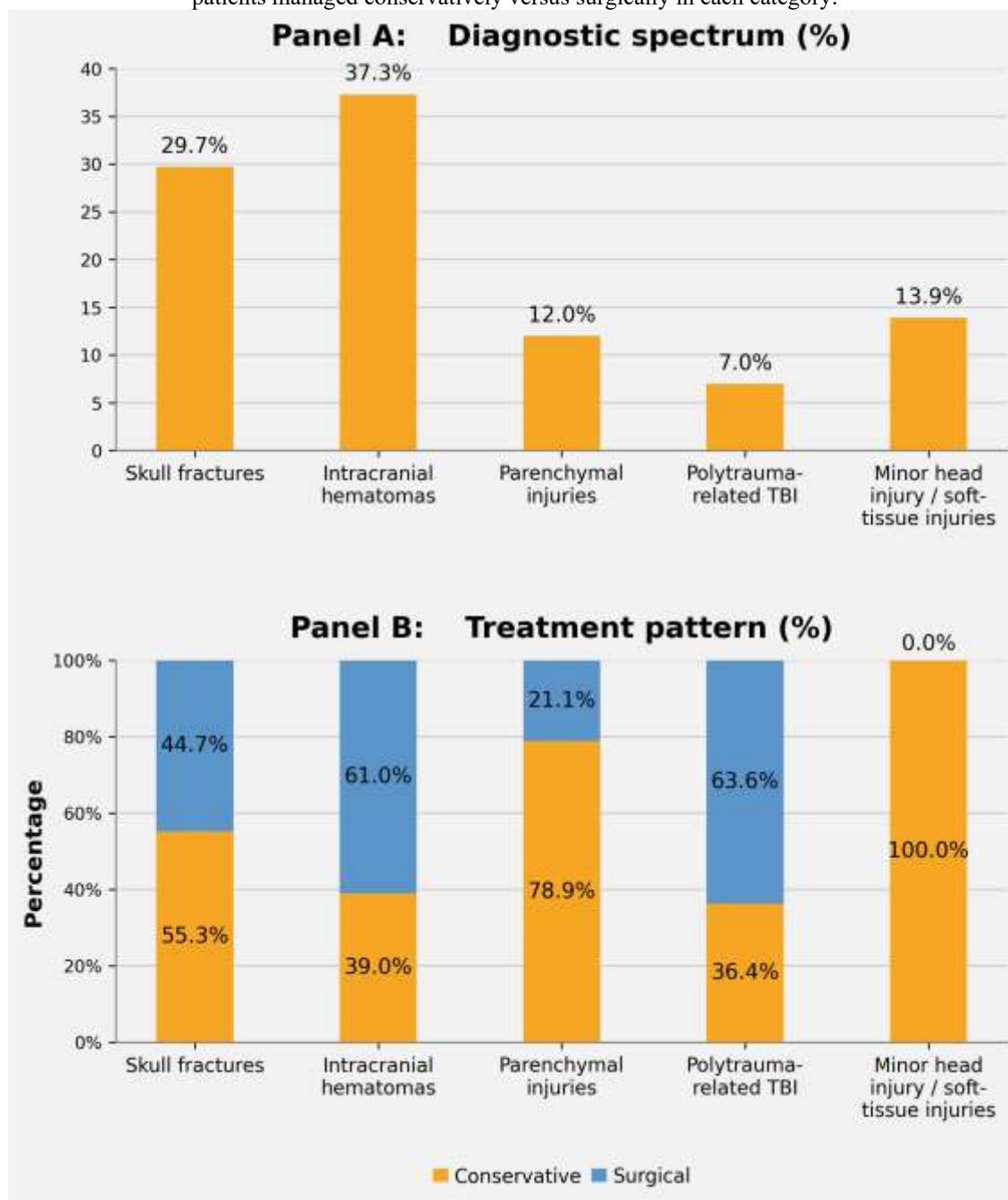
## RESULTS

### Patient characteristics and diagnostic spectrum

Over the 2-year study period, 158 patients met the inclusion criteria. The cohort was predominantly male (77.2%), with a mean age of  $34 \pm 17$  years. Young adults aged 18-45 years comprised nearly 60% of admissions, whereas patients older than 60 years accounted for approximately 12%.

Extra-axial hematomas were the largest diagnostic group (59/158, 37.3%), followed by skull fractures (47/158, 29.7%), minor head injury/soft-tissue injuries (22/158, 13.9%), parenchymal injuries (19/158, 12.0%), and polytrauma-related TBI (11/158, 7.0%) (Figure 1A; Table 1). Acute SDH was the most common individual lesion (28 cases), followed by EDH (13 cases). Skull fracture subtypes included depressed, linear, compound, and basal fractures. Parenchymal injuries comprised 12 contusions, 4 diffuse axonal injuries, and 3 traumatic subarachnoid hemorrhages. The minor head injury/soft-tissue group included 8 concussions, 6 scalp laceration or hematoma cases, and 8 other mild head injuries. Polytrauma subgroup patterns were head + chest (5 cases), head + abdomen (2 cases), and head + orthopedic injury (4 cases).

**Figure 1.** Diagnostic spectrum and management patterns in traumatic brain injury (TBI) admissions (n = 158). (A) Distribution of primary diagnostic categories assigned according to the dominant primary injury. (B) Proportion of patients managed conservatively versus surgically in each category.



**Table 1.** Diagnostic spectrum, age-sex profile, and treatment patterns in 158 neurosurgical head injury admissions (TBI spectrum).

Primary TBI category	N (%)	Mean age (±SD)	Males N (%)	Females N (%)	Cons Rx total	Surg Rx total
1. Skull Fractures (Total)	47 (29.7%)	29 ± 12	38 (80.9%)	9 (19.1%)	26 (55.3%)	21 (44.7%)
– 1A1. Depressed ± hemorrhage	10 (6.3%)	28 ± 10	8 (80.0%)	2 (20.0%)	2 (20.0%)	8 (80.0%)
– 1A2. Depressed, no hemorrhage	6 (3.8%)	30 ± 11	5 (83.3%)	1 (16.7%)	2 (33.3%)	4 (66.7%)
– 1B1. Linear/compound ± hemorrhage	18 (11.4%)	35 ± 13	14 (77.8%)	4 (22.2%)	11 (61.1%)	7 (38.9%)

Primary TBI category	N (%)	Mean age (±SD)	Males N (%)	Females N (%)	Cons Rx total	Surg Rx total
– 1B2. Linear/compound, no hemorrhage	9 (5.7%)	27 ± 11	7 (77.8%)	2 (22.2%)	8 (88.9%)	1 (11.1%)
– 1C1. Basal fracture + CSF leak	3 (1.9%)	29 ± 11	3 (100.0%)	0 (0.0%)	2 (66.7%)	1 (33.3%)
– 1C2. Basal fracture + CN deficit	1 (0.6%)	35 ± 0	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
2. Extra-axial hematomas (EDH/SDH) (Total)	59 (37.3%)	45 ± 18	44 (74.6%)	15 (25.4%)	23 (39.0%)	36 (61.0%)
– 2A. Epidural (EDH)	13 (8.2%)	25 ± 9	10 (76.9%)	3 (23.1%)	4 (30.8%)	9 (69.2%)
– 2B. Acute SDH	28 (17.7%)	50 ± 17	21 (75.0%)	7 (25.0%)	13 (46.4%)	15 (53.6%)
– 2C. Subacute SDH	6 (3.8%)	55 ± 18	5 (83.3%)	1 (16.7%)	3 (50.0%)	3 (50.0%)
– 2D. Chronic SDH	9 (5.7%)	68 ± 12	6 (66.7%)	3 (33.3%)	2 (22.2%)	7 (77.8%)
– 2E. Acute-on-chronic SDH	3 (1.9%)	60 ± 15	2 (66.7%)	1 (33.3%)	1 (33.3%)	2 (66.7%)
3. Parenchymal Injuries (Total)	19 (12.0%)	36 ± 12	14 (73.7%)	5 (26.3%)	15 (78.9%)	4 (21.1%)
– 3A. Lobar contusions	8 (5.1%)	37 ± 12	6 (75.0%)	2 (25.0%)	6 (75.0%)	2 (25.0%)
– 3B. Multi-lobar contusions	4 (2.5%)	38 ± 13	3 (75.0%)	1 (25.0%)	3 (75.0%)	1 (25.0%)
– 3C. Diffuse axonal injury	4 (2.5%)	32 ± 12	3 (75.0%)	1 (25.0%)	4 (100.0%)	0 (0.0%)
– 3D. Traumatic SAH	3 (1.9%)	41 ± 15	2 (66.7%)	1 (33.3%)	2 (66.7%)	1 (33.3%)
4. Polytrauma-related TBI (Total)	11 (7.0%)	34 ± 14	9 (81.8%)	2 (18.2%)	4 (36.4%)	7 (63.6%)
– 4A. Head + Chest	5 (3.2%)	32 ± 15.5	4 (80.0%)	1 (20.0%)	2 (40.0%)	3 (60.0%)
– 4B. Head + Abdomen	2 (1.3%)	34 ± 15.5	2 (100.0%)	0 (0.0%)	1 (50.0%)	1 (50.0%)
– 4C. Head + Orthopedic	4 (2.5%)	36.5 ± 15.5	3 (75.0%)	1 (25.0%)	1 (25.0%)	3 (75.0%)
5. Minor head injury / soft-tissue injuries (Total)	22 (13.9%)	22 ± 9	17 (77.3%)	5 (22.7%)	22 (100.0%)	0 (0.0%)
– 5A. Concussion, no major bleed	8 (5.1%)	21 ± 9	6 (75.0%)	2 (25.0%)	8 (100.0%)	0 (0.0%)
– 5B. Scalp laceration / hematoma	6 (3.8%)	23 ± 9	5 (83.3%)	1 (16.7%)	6 (100.0%)	0 (0.0%)
– 5C. Soft-tissue injuries / minor TBI	8 (5.1%)	24 ± 9	6 (75.0%)	2 (25.0%)	8 (100.0%)	0 (0.0%)
Total unique TBI cases	158 (100.0%)	34 ± 17	122 (77.2%)	36 (22.8%)	90 (57.0%)	68 (43.0%)

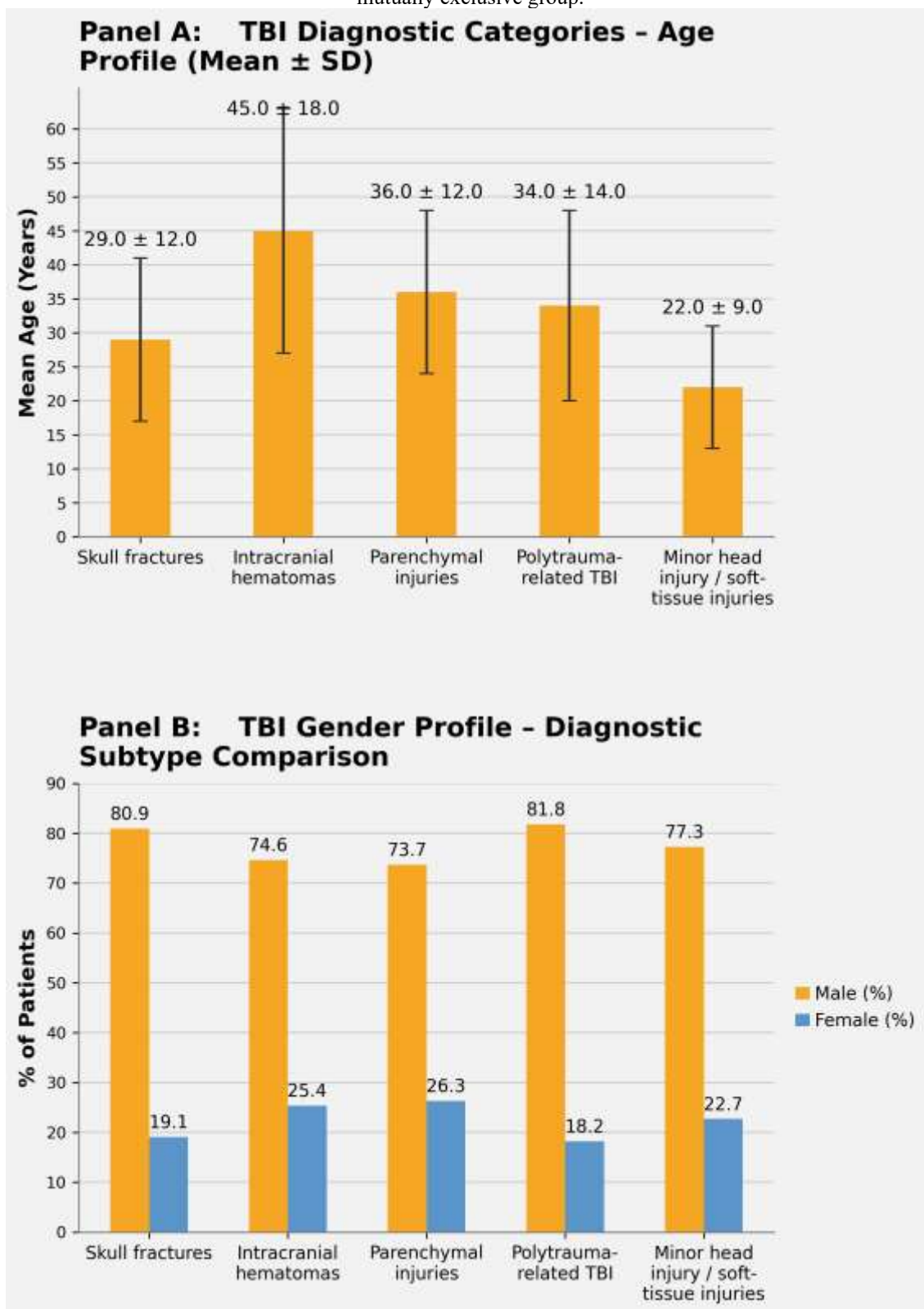
Note: CN, cranial nerve; CSF, cerebrospinal fluid; EDH, epidural hematoma; Rx, treatment; SAH, subarachnoid hemorrhage; SD, standard deviation; SDH, subdural hematoma; TBI, traumatic brain injury.

### Age and sex distribution

Age and sex distribution varied across categories (Figure 2; Table 1). Patients with extra-axial hematomas were older on average (45 ± 18 years) than those with minor head injury/soft-tissue injuries (22 ± 9 years). Mean ages were

approximately  $29 \pm 12$  years for skull fractures,  $34 \pm 14$  years for polytrauma-related TBI, and  $36 \pm 12$  years for parenchymal injuries. Males predominated in every category, accounting for 80.9% of skull fracture cases, 74.6% of extra-axial hematoma cases, and 77.3% of minor head injury/soft-tissue injury admissions.

**Figure 2.** Age and sex profile of patients with TBI by diagnostic category. (A) Mean age (years)  $\pm$  standard deviation for each primary diagnostic category. (B) Percentage of male and female patients within each primary diagnostic category. Categories were assigned by the dominant primary injury so that each patient appears once in a single mutually exclusive group.



### Treatment patterns

Overall, 90 patients (57.0%) were managed conservatively and 68 (43.0%) underwent one or more neurosurgical procedures (Figure 1B; Tables 1 and 2). All 22 patients with minor head injury/soft-tissue injuries were managed conservatively, and 15 of 19 patients (78.9%) with parenchymal injuries were treated without surgery. In contrast, 36 of 59 patients (61.0%) with extra-axial hematomas underwent surgery. Craniotomy was performed in 9 of 13 EDH cases (69.2%), whereas 15 of 28 acute SDH cases (53.6%) underwent surgery. Among skull fracture cases, 21 of 47 patients (44.7%) were operated on, usually for depressed or compound fractures. In the polytrauma group, 7 of 11 patients (63.6%) required surgery.

**Table 2.** Diagnosis-wise treatment modality patterns in 158 neurosurgical head injury admissions (TBI spectrum).

TBI category	N (%)	Observation / AED (n, %)	Mannitol ± HTS (n, %)	Craniotomy / Craniectomy / Elevation (n, %)	Burr-hole / mini-craniotomy (n, %)
1. Skull Fractures	47 (29.7%)	24 (51.1%)	2 (4.3%)	19 (40.4%)	2 (4.3%)
1A1. Depressed ± bleed	10	2 (20%)	–	8 (80%)	–
1A2. Depressed, no bleed	6	2 (33.3%)	–	4 (66.7%)	–
1B1. Linear ± bleed	18	9 (50%)	2 (11.1%)	5 (27.8%)	2 (11.1%)
1B2. Linear, no bleed	9	8 (88.9%)	–	1 (11.1%)	–
1C1. Basal fracture + CSF leak	3	2 (66.7%)	–	1 (33.3%)	–
1C2. Basal fracture + CN deficit	1	1 (100%)	–	–	–
2. Extra-axial hematomas	59 (37.3%)	18 (30.5%)	5 (8.5%)	23 (39%)	13 (22%)
2A. Epidural (EDH)	13	4 (30.8%)	–	9 (69.2%)	–
2B. Acute SDH	28	10 (35.7%)	3 (10.7%)	12 (42.9%)	3 (10.7%)
2C. Subacute SDH	6	3 (50%)	–	1 (16.7%)	2 (33.3%)
2D. Chronic SDH	9	–	2 (22.2%)	–	7 (77.8%)
2E. Acute-on-chronic SDH	3	1 (33.3%)	–	1 (33.3%)	1 (33.3%)
3. Parenchymal Injuries	19 (12.0%)	15 (78.9%)	–	4 (21.1%)	–
4. Polytrauma-related TBI	11 (7.0%)	4 (36.4%)	–	7 (63.6%)	–
5. Minor head injury / soft-tissue injuries	22 (13.9%)	22 (100%)	–	–	–
TBI totals	158	83 (52.5%)	7 (4.4%)	53 (33.5%)	15 (9.5%)

Note: AED, antiepileptic drug; CSF, cerebrospinal fluid; EDH, epidural hematoma; HTS, hypertonic saline; SDH, subdural hematoma; TBI, traumatic brain injury.

### Discharge outcomes

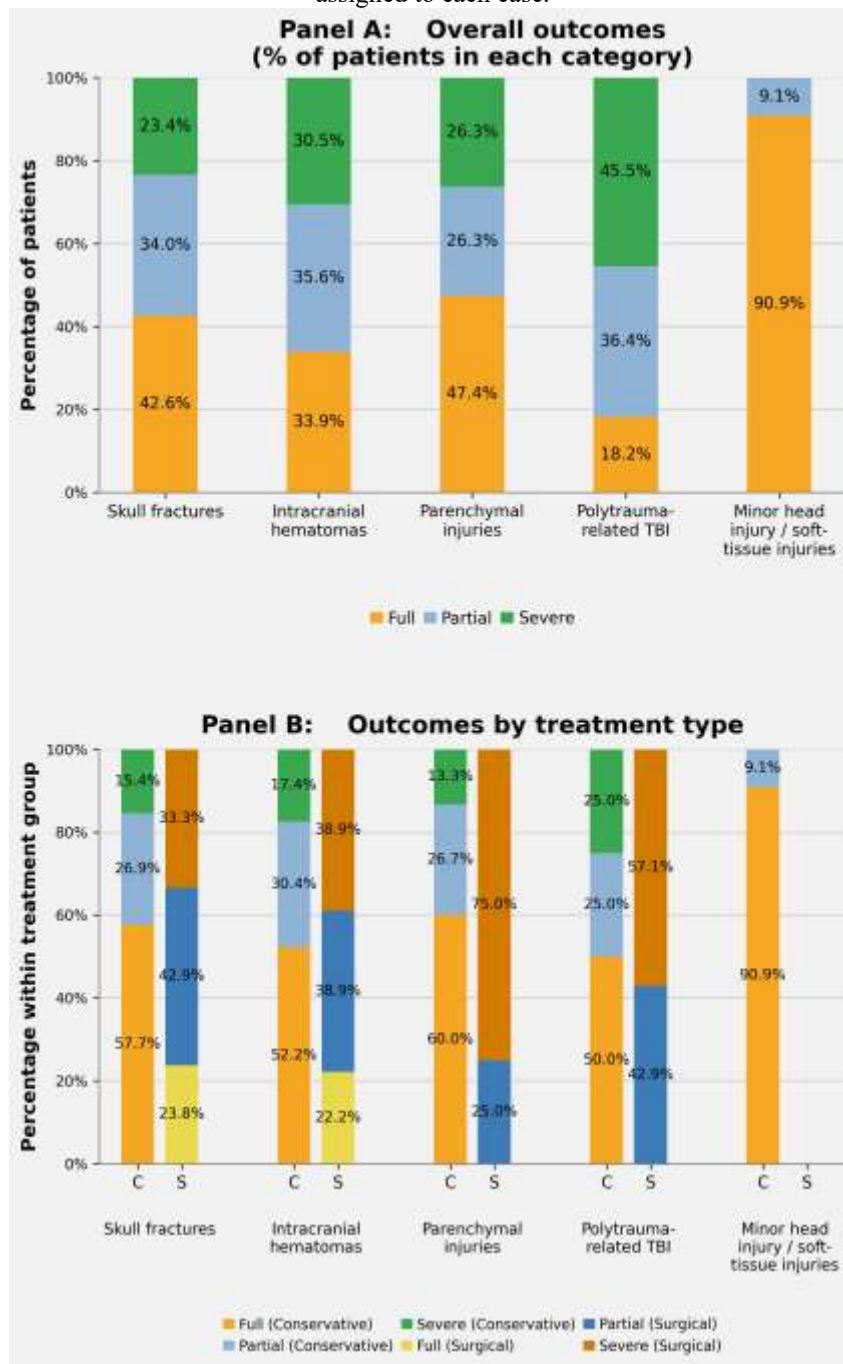
Neurologic outcomes at discharge are shown in Figure 3 and Table 3. Overall, 71 patients (44.9%) achieved full recovery, 48 (30.4%) had partial deficits, and 39 (24.7%) had severe outcomes. Minor head injury/soft-tissue injuries had the most

favorable outcomes, with 20 of 22 patients (90.9%) achieving full recovery and no severe outcomes. Skull fracture cases had intermediate outcomes (42.6% full recovery, 34.0% partial deficits, and 23.4% severe outcomes). Extra-axial hematomas had poorer outcomes overall (33.9% full recovery, 35.6% partial deficits, and 30.5% severe outcomes), and acute SDH fared worse than EDH. Polytrauma-related TBI had the poorest outcomes, with 18.2% full recovery and 45.5% severe outcomes.

**Outcomes by treatment modality**

Among conservatively managed patients, 58 of 90 (64.4%) achieved full recovery, whereas 13 of 68 surgically treated patients (19.1%) did so. Severe outcomes occurred in 11 of 90 conservatively managed patients (12.2%) and 28 of 68 surgically treated patients (41.2%). These differences almost certainly reflect baseline injury severity and treatment selection rather than a harmful effect of surgery.

**Figure 3.** Discharge outcomes by diagnostic category and treatment modality in TBI admissions. (A) Percentage of patients with full recovery, partial neurologic deficit, or severe deficit in each diagnostic category. (B) Overall discharge outcomes stratified by conservative versus surgical treatment. Diagnostic categories reflect the dominant primary injury assigned to each case.



**Table 3.** Discharge outcomes by diagnosis and treatment modality in 158 neurosurgical head injury admissions (TBI spectrum).

Primary TBI category	N (%)	Cons F/P/S	Surg F/P/S	Overall F/P/S
1. Skull Fractures (Total)	47 (29.7%)	15 (31.9%); 7 (14.9%); 4 (8.5%)	5 (10.6%); 9 (19.1%); 7 (14.9%)	20 (42.6%); 16 (34.0%); 11 (23.4%)
– 1A1. Depressed ± hemorrhage	10 (6.3%)	1 (10.0%); 1 (10.0%); 0 (0.0%)	2 (20.0%); 4 (40.0%); 2 (20.0%)	3 (30.0%); 5 (50.0%); 2 (20.0%)
– 1A2. Depressed, no hemorrhage	6 (3.8%)	1 (16.7%); 1 (16.7%); 0 (0.0%)	1 (16.7%); 2 (33.3%); 1 (16.7%)	2 (33.3%); 3 (50.0%); 1 (16.7%)
– 1B1. Linear/compound ± hemorrhage	18 (11.4%)	6 (33.3%); 3 (16.7%); 2 (11.1%)	2 (11.1%); 3 (16.7%); 2 (11.1%)	8 (44.4%); 6 (33.3%); 4 (22.2%)
– 1B2. Linear/compound, no hemorrhage	9 (5.7%)	5 (55.6%); 2 (22.2%); 1 (11.1%)	0 (0.0%); 0 (0.0%); 1 (11.1%)	5 (55.6%); 2 (22.2%); 2 (22.2%)
– 1C1. Basal fracture + CSF leak	3 (1.9%)	1 (33.3%); 0 (0.0%); 1 (33.3%)	0 (0.0%); 0 (0.0%); 1 (33.3%)	1 (33.3%); 0 (0.0%); 2 (66.7%)
– 1C2. Basal fracture + CN deficit	1 (0.6%)	1 (100.0%); 0 (0.0%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 0 (0.0%)	1 (100.0%); 0 (0.0%); 0 (0.0%)
2. Extra-axial hematomas (EDH/SDH) (Total)	59 (37.3%)	12 (20.3%); 7 (11.9%); 4 (6.8%)	8 (13.6%); 14 (23.7%); 14 (23.7%)	20 (33.9%); 21 (35.6%); 18 (30.5%)
– 2A. Epidural (EDH)	13 (8.2%)	3 (23.1%); 1 (7.7%); 0 (0.0%)	3 (23.1%); 3 (23.1%); 3 (23.1%)	6 (46.2%); 4 (30.8%); 3 (23.1%)
– 2B. Acute SDH	28 (17.7%)	5 (17.9%); 4 (14.3%); 4 (14.3%)	2 (7.1%); 6 (21.4%); 7 (25.0%)	7 (25.0%); 10 (35.7%); 11 (39.3%)
– 2C. Subacute SDH	6 (3.8%)	2 (33.3%); 1 (16.7%); 0 (0.0%)	1 (16.7%); 1 (16.7%); 1 (16.7%)	3 (50.0%); 2 (33.3%); 1 (16.7%)
– 2D. Chronic SDH	9 (5.7%)	1 (11.1%); 1 (11.1%); 0 (0.0%)	4 (44.4%); 2 (22.2%); 1 (11.1%)	5 (55.6%); 3 (33.3%); 1 (11.1%)
– 2E. Acute-on-chronic SDH	3 (1.9%)	1 (33.3%); 0 (0.0%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 2 (66.7%)	1 (33.3%); 0 (0.0%); 2 (66.7%)
3. Parenchymal Injuries (Total)	19 (12.0%)	9 (47.4%); 4 (21.1%); 2 (10.5%)	0 (0.0%); 1 (5.3%); 3 (15.8%)	9 (47.4%); 5 (26.3%); 5 (26.3%)
– 3A. Lobar contusions	8 (5.1%)	4 (50.0%); 1 (12.5%); 1 (12.5%)	0 (0.0%); 1 (12.5%); 1 (12.5%)	4 (50.0%); 2 (25.0%); 2 (25.0%)
– 3B. Multi-lobar contusions	4 (2.5%)	2 (50.0%); 1 (25.0%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 1 (25.0%)	2 (50.0%); 1 (25.0%); 1 (25.0%)
– 3C. Diffuse axonal injury	4 (2.5%)	2 (50.0%); 1 (25.0%); 1 (25.0%)	0 (0.0%); 0 (0.0%); 0 (0.0%)	2 (50.0%); 1 (25.0%); 1 (25.0%)
– 3D. Traumatic SAH	3 (1.9%)	1 (33.3%); 1 (33.3%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 1 (33.3%)	1 (33.3%); 1 (33.3%); 1 (33.3%)
4. Polytrauma-related TBI (Total)	11 (7.0%)	2 (18.2%); 1 (9.1%); 1 (9.1%)	0 (0.0%); 3 (27.3%); 4 (36.4%)	2 (18.2%); 4 (36.4%); 5 (45.5%)
– 4A. Head + Chest	5 (3.2%)	1 (20.0%); 1 (20.0%); 0 (0.0%)	0 (0.0%); 2 (40.0%); 1 (20.0%)	1 (20.0%); 3 (60.0%); 1 (20.0%)
– 4B. Head + Abdomen	2 (1.3%)	0 (0.0%); 0 (0.0%); 1 (50.0%)	0 (0.0%); 0 (0.0%); 1 (50.0%)	0 (0.0%); 0 (0.0%); 2 (100.0%)
– 4C. Head + Orthopedic	4 (2.5%)	1 (25.0%); 0 (0.0%); 0 (0.0%)	0 (0.0%); 1 (25.0%); 2 (50.0%)	1 (25.0%); 1 (25.0%); 2 (50.0%)
5. Minor head injury / soft-tissue injuries (Total)	22 (13.9%)	20 (90.9%); 2 (9.1%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 0 (0.0%)	20 (90.9%); 2 (9.1%); 0 (0.0%)
– 5A. Concussion, no major bleed	8 (5.1%)	7 (87.5%); 1 (12.5%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 0 (0.0%)	7 (87.5%); 1 (12.5%); 0 (0.0%)
– 5B. Scalp laceration / hematoma (wound procedure)	6 (3.8%)	6 (100.0%); 0 (0.0%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 0 (0.0%)	6 (100.0%); 0 (0.0%); 0 (0.0%)

Primary TBI category	N (%)	Cons F/P/S	Surg F/P/S	Overall F/P/S
– 5C. Soft-tissue injuries / minor TBI	8 (5.1%)	7 (87.5%); 1 (12.5%); 0 (0.0%)	0 (0.0%); 0 (0.0%); 0 (0.0%)	7 (87.5%); 1 (12.5%); 0 (0.0%)
Total unique TBI cases	158 (100.0%)	58 (64.4%); 21 (23.3%); 11 (12.2%)	13 (19.1%); 27 (39.7%); 28 (41.2%)	71 (44.9%); 48 (30.4%); 39 (24.7%)

Note: Cons, conservative treatment; F/P/S, full recovery/partial neurologic deficit/severe deficit; Surg, surgical treatment; TBI, traumatic brain injury.

## DISCUSSION

This study provides a diagnosis-based overview of neurosurgical TBI admissions at a tertiary-care center in India. The cohort profile—predominantly young male patients with a mean age of about 34 years—resembles other Indian tertiary-care reports<sup>19–21</sup>. Because mechanism-of-injury data were not systematically recorded in our dataset, the dominant mechanism cannot be identified directly; however, road traffic injury has been a leading cause of TBI in comparable South Asian cohorts<sup>19,20</sup>. The predominance of focal hemorrhagic lesions in our cohort also differs from many high-income-country series, which report larger proportions of diffuse injury and geriatric fall-related TBI<sup>22</sup>.

Acute SDH was the most common individual lesion, and extra-axial hematomas accounted for most surgical workload. This pattern is clinically important because these lesions are time-sensitive and potentially reversible when triaged rapidly. The relatively favorable outcomes of chronic SDH in our cohort are consistent with published studies supporting burr-hole-based management in appropriately selected patients<sup>23,24</sup>. The high surgical burden for EDH, acute SDH, and depressed skull fractures was also in line with other Indian tertiary-care series and with established operative guidance for focal traumatic lesions<sup>7,19,25</sup>.

Outcome patterns followed expected gradients of injury severity. Minor head injury/soft-tissue injury cases had the best outcomes, whereas acute SDH and polytrauma-related TBI had the worst. Recent South Asian cohort data likewise show a substantial burden of severe TBI in similar referral settings<sup>26</sup>. The poorer outcomes seen in surgically treated patients should be interpreted as confounding by indication, because surgery was concentrated among patients with more severe focal lesions. This interpretation is consistent with contemporary literature showing that surgery for acute SDH is often lifesaving even in high-risk cohorts<sup>27–29</sup>. At the public-health level, the concentration of TBI in younger male patients remains consistent with broader regional and global data and supports continued emphasis on prevention, helmet use, and system-level trauma care improvement<sup>21,30</sup>.

## Limitations

This study is limited by its retrospective single-center design, referral bias, and reliance on discharge-focused records. Mechanism-of-injury data, standardized severity measures, intensive care variables, and time-to-surgery data were not available. Follow-up beyond discharge was unavailable.

## CONCLUSIONS

In this tertiary-care neurosurgical cohort, extra-axial hematomas and skull fractures accounted for most admissions, and focal hemorrhagic lesions generated much of the operative workload. Minor head injury/soft-tissue injury cases had excellent short-term outcomes, whereas acute SDH and polytrauma-related TBI carried the greatest risk of disability. These findings support rapid imaging, timely neurosurgical access, coordinated multidisciplinary care for polytrauma, and continued preventive efforts targeting avoidable head injury in young adults.

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## Declaration of generative AI and AI-assisted technologies in manuscript preparation

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist with language editing, journal formatting, and submission-file organization. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

## Ethical approval

The study protocol was approved by the Institutional Ethics Committee of NIMS, Jaipur (IEC/P-816/2024). Owing to the retrospective nature of the study and the use of anonymized patient records, the requirement for informed consent was waived.

## Declaration of patient consent

Patient consent was waived by the Institutional Ethics Committee because this was a retrospective analysis of anonymized records and no identifiable patient information is presented in this manuscript.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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