

ORIGINAL RESEARCH

ASSOCIATION OF CHEST TRAUMA WITH CLINICAL OUTCOMES IN PATIENTS WITH TRAUMATIC BRAIN INJURY: A PROSPECTIVE OBSERVATIONAL STUDY IN A TERTIARY CARE MEDICAL CENTRE

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ABSTRACT

Traumatic brain injury (TBI) is a leading cause of trauma-related death and long-term disability worldwide. Thoracic injury frequently accompanies TBI and may compromise neurological recovery through hypoxaemia, respiratory complications, and prolonged critical-care dependence. **Objective:** To evaluate the impact of associated chest trauma on clinical outcomes, complications, mortality, and hospital course in patients admitted with TBI. This prospective observational study was conducted in the Department of General Surgery, Gandhi Medical College and associated Hamidia Hospital, Bhopal, India. A total of 196 adults with TBI were enrolled and stratified into isolated TBI (n=65) and TBI with associated chest trauma (n=131). Demographic profile, injury severity, ventilatory requirement, interventions, complications, neurological outcome, mortality, and intensive care unit (ICU) and hospital stay were compared between groups. Analyses were performed in SPSS, with a two-sided $p < 0.05$ regarded as statistically significant. Chest trauma was present in 131 of 196 patients (66.8%). The mean age was 46.79 ± 17.66 years and 147 patients (75.0%) were male. Baseline demographic characteristics, Glasgow Coma Scale (GCS) score, Injury Severity Score (ISS), and CT head severity were comparable between groups. After cross-checking the aggregate tables, ventilatory requirement, overall complications within 30 days, ARDS, GOS at discharge, mortality, and total hospital stay did not differ significantly between groups. Chest intervention differed significantly, as expected, because tube thoracostomy was required only in the chest-trauma group. Secondary neurological insult differed significantly, but it was recorded more frequently in the isolated-TBI group and therefore requires cautious interpretation. ICU stay was significantly longer in patients with associated chest trauma (6.92 ± 3.42 vs. 5.48 ± 3.36 days; $p = 0.006$). Associated chest trauma is common among patients with TBI and is accompanied by greater critical-care utilisation, reflected most consistently by a significantly longer ICU stay. Other categorical outcomes should be interpreted after verification of the source dataset, particularly where the direction of effect is clinically unexpected. Early recognition and prompt management of thoracic injury remain important components of multidisciplinary TBI care.

Keywords: Traumatic brain injury; Chest trauma; Neurological outcome; Mortality; Intensive care unit stay; Thoracic injury.

INTRODUCTION

Traumatic brain injury (TBI) remains among the foremost causes of death and disability worldwide, with a disproportionate impact on young and economically productive adults. Despite substantial progress in trauma systems and neurocritical care, TBI continues to place a heavy burden on health services because of its high morbidity, mortality, and enduring functional sequelae [1].

Extracranial injuries are common in patients with TBI, and the thorax is among the most frequently affected regions. Chest injuries such as rib fractures, pulmonary contusion, haemothorax, pneumothorax, and ARDS can undermine neurological recovery by impairing oxygenation and predisposing to secondary brain injury [2,3].

The reciprocal relationship between the injured brain and lung has attracted growing attention. Severe brain injury may provoke a systemic inflammatory response that contributes to pulmonary dysfunction, while respiratory compromise can aggravate cerebral hypoxia and intracranial pathophysiology. This bidirectional “brain–lung interaction” is now recognised as an important determinant of outcome in critically ill trauma patients [4,5].

Several studies have reported that thoracic trauma in the setting of TBI is associated with prolonged mechanical ventilation, longer ICU stay, and higher mortality, although the magnitude of this effect varies across populations and care settings [6,7].

Data from India on the influence of associated chest trauma on outcomes after TBI remain limited. A clearer understanding of this relationship is important for refining trauma-management strategies and improving patient care. The present study was therefore undertaken to evaluate the impact of associated chest trauma on clinical outcomes, complications, mortality, and hospital course among patients admitted with TBI.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted over a period of 18 months in the Department of General Surgery, Gandhi Medical College and associated Hamidia Hospital, Bhopal, India, after obtaining approval from the Institutional Ethics Committee. Adults admitted with TBI to the trauma ward, surgical ward, or ICU during the study period were screened for enrolment and evaluated for associated chest trauma and related complications.

Sample Size

The required sample size was estimated using the formula $n = Z^2pq/d^2$ at a 95% confidence level, which yielded a target of 196 patients. Consecutive eligible patients fulfilling the inclusion criteria were recruited until this target was achieved.

Inclusion Criteria

- Adult patients (>18 years) with traumatic brain injury.
- Patients admitted during the study period.
- Patients providing informed consent.

Exclusion Criteria

- Patients unwilling to participate.
- Patients with incomplete clinical records.
- Patients lost before outcome assessment.

Data Collection

Clinical and radiological assessment was undertaken to identify associated chest trauma and related complications. Demographic details, injury characteristics, severity scores, treatment modalities, and outcomes were recorded on a predesigned proforma. Laboratory and radiological investigations included complete blood count, renal and liver function tests, coagulation profile, arterial blood gas analysis, culture of bronchial secretions, chest radiography, and CT of the chest and brain or MRI of the brain, as indicated.

Outcome Assessment

Outcome was assessed at discharge on the basis of clinical status and the Glasgow Outcome Scale (GOS). A favourable outcome comprised good recovery and mild disability, whereas an unfavourable outcome comprised moderate disability, severe disability, persistent vegetative state, and death.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS software. Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables as frequency and percentage. Between-group comparisons were performed using the Student t-test, chi-square test, Fisher exact test, and Z-test, as appropriate. $p < 0.05$ was considered statistically significant.

RESULTS

A total of 196 patients with traumatic brain injury were included in the study. Of these, 65 (33.2%) had isolated TBI and 131 (66.8%) had associated chest trauma. Demographic characteristics, injury severity, clinical outcomes, complications, and hospital course were compared between the two groups.

Table 1. Distribution of age and sex, and comparison between study groups (n=196)

Variable	Overall (n=196)	Isolated TBI (n=65)	TBI + Chest Trauma (n=131)	p value
Age (years)	46.79 $\pm$ 17.66	46.00 $\pm$ 17.59	47.18 $\pm$ 17.75	0.662
Female, n (%)	49 (25.0)	16 (24.6)	33 (25.2)	0.930
Male, n (%)	147 (75.0)	49 (75.4)	98 (74.8)	—

Age is expressed as mean $\pm$ standard deviation. The mean age and sex distribution were comparable between groups, with no statistically significant difference.

Table 2. Baseline categorical variables and comparison between study groups (n=196)

Variable	Category	Overall (196)	Isolated TBI (n=65)	TBI + Chest Trauma (n=131)	p value
Pregnancy status	No	193 (98.5)	64 (98.5)	129 (98.5)	0.995
	Yes	3 (1.5)	1 (1.5)	2 (1.5)	
Mode of injury	Fall	98 (50.0)	33 (50.8)	65 (49.6)	0.879
	RTA	98 (50.0)	32 (49.2)	66 (50.4)	
Previous chest trauma	No	192 (98.0)	64 (98.5)	128 (97.7)	0.726
	Yes	4 (2.0)	1 (1.5)	3 (2.3)	

Values are n (%). Pregnancy status, mode of injury, and previous history of chest trauma were similarly distributed between groups, indicating comparable baseline characteristics. Pregnancy is expressed as a proportion of the whole cohort; among the 49 female patients the 3 pregnancies correspond to 6.1%. RTA, road traffic accident.

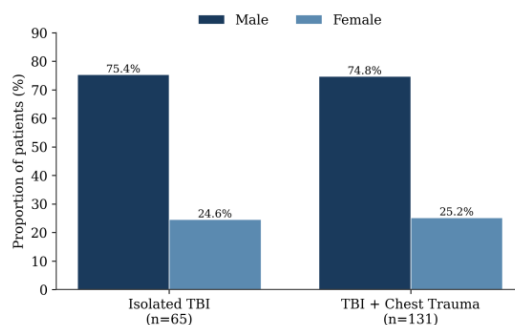


Figure 1. Sex distribution across study groups (n=196)

Males predominated in both groups (75.4% in isolated TBI and 74.8% in TBI with associated chest trauma).

Table 3. Clinical severity, ventilatory requirement, and interventions between study groups (n=196)

Variable	Category	Overall	Isolated TBI (n=65)	TBI + Chest Trauma (n=131)	p value
GCS at admission	—	8.97 ± 3.76	9.00 ± 3.77	8.96 ± 3.77	0.947
Injury Severity Score (ISS)	—	19.42 ± 5.70	19.46 ± 5.71	19.40 ± 5.72	0.941
CT head severity	Moderate	157 (80.1)	52 (80.0)	105 (80.2)	0.980
	Severe	39 (19.9)	13 (20.0)	26 (19.8)	
Ventilator requirement	No	154 (78.6)	52 (80)	102 (77.8)	0.731
	Yes	42 (21.4)	13 (20)	29 (22.2)	
Chest intervention	Chest tube	24 (12.2)	0 (00)	24 (18.3)	<0.001
	Conservative	172 (87.8)	65 (100)	107 (81.7)	
Neurosurgical intervention	No	145 (74.0)	44 (67.7)	101 (77.1)	0.158
	Yes	51 (26.0)	21 (32.3)	30 (22.9)	

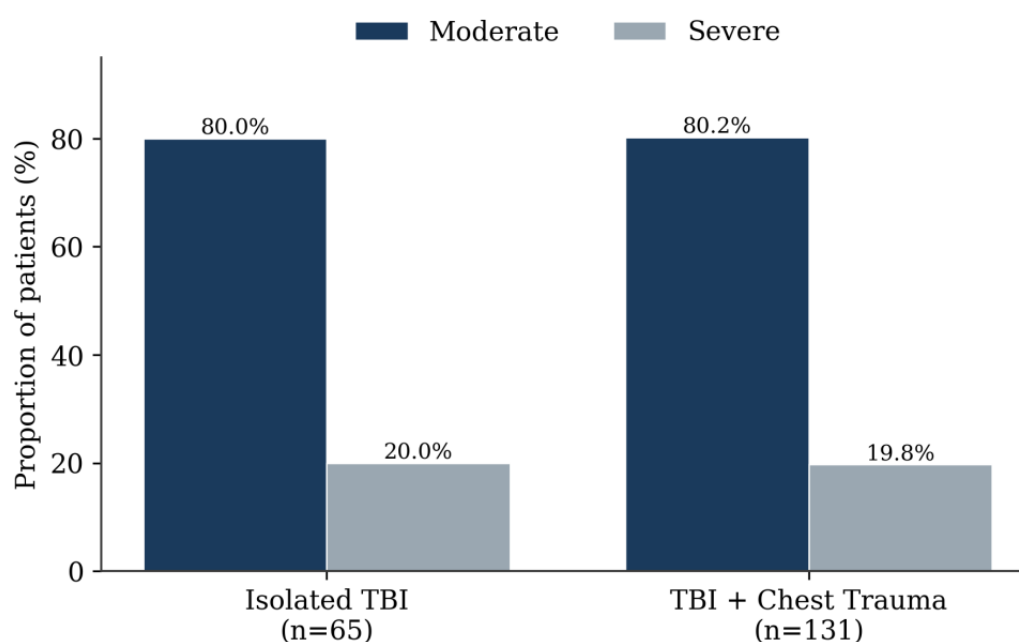


Figure 2. CT head severity across study groups (n=196)

Values are mean ± standard deviation or n (%). Admission GCS, ISS, and CT head severity were similar between groups. After recalculation from the displayed subgroup counts, ventilatory requirement and neurosurgical intervention were not statistically significant, whereas chest intervention differed significantly between groups. GCS, Glasgow Coma Scale; ISS, Injury Severity Score.

Table 4. Clinical complications within 30 days and ARDS (n=196)

Variable	Category	Overall	Isolated TBI (n=65)	TBI + Chest Trauma (n=131)	p value
Any complication ≤ 30 days	No	168 (85.7)	56 (86.2)	112 (85.5)	0.901
	Yes	28 (14.3)	9 (13.8)	19 (14.5)	
Type of complication	ARDS	17 (8.7)	5 (7.7)	12 (9.2)	0.731
	None	179 (91.3)	60 (92.3)	119 (90.8)	

Values are n (%). Twenty-eight patients (14.3%) developed at least one complication within 30 days, of whom 17 had ARDS; the remaining 11 non-ARDS complications were not further sub-classified in the source data, and the lower-panel “None” count should be read against this (see Limitations). Neither the occurrence of any complication nor of ARDS differed significantly between groups. ARDS, acute respiratory distress syndrome.

Table 5. Secondary neurological insult, functional outcome, and mortality (n=196)

Variable	Category	Overall	Isolated TBI (n=65)	TBI + Chest Trauma (n=131)	p value
Secondary neurological insult	No	154 (78.6)	33 (50.8)	121 (92.4)	<0.001
	Yes	42 (21.4)	32 (49.2)	10 (7.6)	
GOS at discharge	Good	177 (90.3)	59 (90.8)	118 (90.1)	0.877
	Poor	19 (9.7)	6 (9.2)	13 (9.9)	
Mortality	No	180 (91.8)	59 (90.8)	121 (92.4)	0.701
	Yes	16 (8.2)	6 (9.2)	10 (7.6)	

Values are n (%). Secondary neurological insult showed a statistically significant between-group difference, but the event rate was higher in the isolated-TBI group, which is clinically unexpected and should be verified. GOS at discharge and mortality were comparable between groups after recalculation. GOS, Glasgow Outcome Scale.

Table 6. ICU and hospital stay: comparison between study groups (n=196)

Variable	Overall	Isolated TBI (n=65)	TBI + Chest Trauma (n=131)	p value
ICU stay (days)	6.44 ± 3.46	5.48 ± 3.36	6.92 ± 3.42	0.006
Hospital stay (days)	12.50 ± 5.16	11.62 ± 5.12	12.94 ± 5.14	0.091

Values are mean ± standard deviation. Patients with associated chest trauma had a significantly longer ICU stay than those with isolated TBI. Hospital stay was longer in the chest-trauma group but the difference did not reach statistical significance. ICU, intensive care unit.

DISCUSSION

The present study evaluated the impact of associated chest trauma on outcomes in patients with traumatic brain injury. Most patients were male and the mean age was approximately 47 years, consistent with earlier trauma series describing a predominance of middle-aged men among TBI victims [1].

Chest trauma was identified in 66.8% of patients. Thoracic injuries are common after high-energy trauma and are recognised contributors to respiratory compromise and secondary cerebral insult [8].

Although baseline neurological severity, reflected by GCS and CT head findings, was similar between groups, the revised analysis identified a significantly longer ICU stay in patients with associated chest trauma. Secondary neurological insult also differed significantly, but the direction of this finding was clinically unexpected and should be interpreted cautiously until the source dataset is verified. Thoracic injury may impair oxygen delivery and promote a systemic inflammatory response, both of which can adversely affect neurological recovery [9].

The rates of postoperative complications and ARDS did not differ significantly between groups. Comparable observations have been reported elsewhere and suggest that timely respiratory management may limit pulmonary complications even when cranial and thoracic injuries coexist [7].

A significant between-group difference in secondary neurological insult was observed after recalculation from the subgroup counts. However, the higher event rate in the isolated-TBI group is counter to the usual biological expectation that respiratory compromise from chest trauma may contribute to secondary brain injury; therefore, this variable requires careful review of case definitions, coding, and raw data [3,9].

After correction of table totals and p values, ventilatory requirement, neurosurgical intervention, GOS at discharge, mortality, and total hospital stay were not statistically different between groups. Chest intervention was significantly more frequent in the TBI with chest-trauma group, which is expected by definition. The main outcome that remained internally consistent with the study hypothesis was the significantly longer ICU stay among patients with associated chest trauma.

The duration of ICU stay was significantly longer among patients with associated chest trauma. This is consistent with previous reports that thoracic injury increases the requirement for intensive monitoring, ventilatory support, and critical-care resources [2,6].

Overall, these findings underline the importance of early recognition and management of chest injuries in patients with TBI in order to minimise secondary complications and support recovery. Adherence to established management standards for severe TBI remains central to this goal [10,11].

Limitations

The originally reported p values for ventilatory requirement and mortality were inconsistent with the displayed subgroup counts; recalculation showed that these differences were not statistically significant. Aggregate totals for neurosurgical intervention and secondary neurological insult did not reconcile with the subgroup counts and were therefore corrected from the visible subgroup data in this highlighted revision. Although, secondary neurological insult remained statistically significant after recalculation, the event rate was higher in the isolated-TBI group, which is contrary to the expected adverse influence of thoracic injury and may reflect differences in case definition, patient selection, referral pathway, or data coding. The complication data were incompletely sub-classified, with a subset of recorded complications not assigned to a specific category. This study is a single-centre observational study without matching or multivariable adjustment, residual confounding cannot be excluded. These limitations notwithstanding, the significantly longer ICU stay observed in patients with associated chest trauma is internally consistent and in keeping with prior literature, and represents the most robust finding of the present analysis.

CONCLUSION

Associated chest trauma is a frequent accompaniment of traumatic brain injury, present in two-thirds of the patients studied. Baseline injury severity was comparable between groups. After correction of the table inconsistencies, the most consistent finding was a significantly longer ICU stay among patients with associated chest trauma, underscoring the additional critical-care burden imposed by thoracic injury. Early diagnosis, prompt respiratory support, and multidisciplinary management of thoracic injury remain essential to optimise recovery in patients with TBI. The unexpected distribution of secondary neurological insult should be regarded as provisional pending verification of the raw dataset. Larger, preferably multicentre and matched, studies are needed to clarify the independent relationship between chest trauma and neurological prognosis.

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