

Research Article

Combined Use of STUMBL Score and Chest CT Findings for Risk Stratification in Blunt Thoracic Trauma

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Abstract: **Introduction:** Blunt thoracic trauma is a common surgical emergency associated with complications such as pneumothorax, hemothorax, pulmonary contusion, respiratory failure, and prolonged hospitalization. The STUMBL score is a useful clinical tool for risk prediction, while chest CT provides detailed anatomical assessment of thoracic injuries. Aim of the study was to evaluate the combined use of STUMBL score and chest CT findings for risk stratification in patients with blunt thoracic trauma. **Materials and Methods:** This hospital-based observational study was conducted in the Department of General Surgery, Mamata Medical College and General Hospital, Khammam. A total of 80 patients with blunt thoracic trauma were included and divided into two groups of 40 each. Group I was assessed using STUMBL score alone, while Group II was assessed using combined STUMBL score and chest CT findings. Demographic details, clinical presentation, CT findings, complications, ICU admission, ventilator requirement, and hospital stay were recorded and analyzed. **Results:** Road traffic accident was the commonest mode of injury. Rib fracture was the most frequent CT finding, followed by pulmonary contusion, pneumothorax, and hemothorax. Combined STUMBL and CT assessment upgraded risk category in 30% of patients and showed higher sensitivity, diagnostic accuracy, negative predictive value, and AUC compared with STUMBL score alone. **Conclusion:** Combined STUMBL score and chest CT findings provide better risk stratification than STUMBL score alone in blunt thoracic trauma.

Keywords: Blunt thoracic trauma, STUMBL score, chest CT, rib fracture, pulmonary contusion, risk stratification.

INTRODUCTION

Blunt thoracic trauma is one of the common and clinically important forms of trauma encountered in emergency and surgical practice. It includes a wide spectrum of injuries ranging from simple chest wall contusion and isolated rib fractures to life-threatening pneumothorax, hemothorax, flail chest, pulmonary contusion, respiratory failure, and associated mediastinal or vascular injuries. Early identification of patients at risk of deterioration is essential because many patients may appear clinically stable during initial assessment but later develop delayed respiratory complications, need for tube thoracostomy, intensive care admission, ventilatory support, prolonged hospitalization, or death. Chest computed tomography has become central to the evaluation of thoracic trauma because it detects rib fractures, fracture displacement, pulmonary contusion, pneumothorax, hemothorax, subcutaneous emphysema, and occult injuries more accurately than plain radiography [1]. Recent imaging reviews have emphasized that CT not only improves diagnostic detection but also provides anatomical and severity-related information that may influence triage, monitoring, referral, and intervention decisions [1]. Alongside radiological assessment, clinical risk prediction tools have been developed to support

emergency department decision-making. The STUMBL score, derived from the "Study of the Management of Blunt Chest Wall Trauma," is a practical bedside tool based on age, number of rib fractures, chronic lung disease, pre-injury anticoagulant use, and oxygen saturation. It is intended to estimate the risk of complications and guide decisions regarding discharge, ward admission, high-dependency care, ICU review, and multidisciplinary involvement. Mukerji et al. externally validated the STUMBL score in patients with blunt chest trauma and demonstrated its potential role in risk stratification [2]. Callisto et al. compared the STUMBL score with emergency physician judgement and found that although the score had good discriminatory ability, a low admission threshold could increase hospital admissions without clearly outperforming clinician judgement [3]. Giamello et al. further validated the STUMBL score among emergency department patients with blunt thoracic trauma and supported its usefulness for predicting adverse outcomes [4]. In an updated systematic review, Battle et al. showed that advanced age, multiple rib fractures, comorbidities, injury severity, pneumonia, and mechanical ventilation remain important predictors of mortality in blunt chest wall trauma [5]. A later systematic review of prediction models also suggested that STUMBL and thoracic trauma severity models show better predictive

performance than several other tools, although concerns remain about bias, calibration, external validation, and clinical implementation [6].

Recent CT-based studies have shown that specific imaging variables add meaningful prognostic value. Lee et al. reported that quantification of pulmonary contusion volume on initial chest CT could identify patients at higher risk of delayed respiratory complications such as pneumonia and acute respiratory distress syndrome [7]. Aydın et al. found that the number, displacement, and anatomical location of rib fractures were associated with hemothorax risk, with four or more rib fractures, displaced fractures, and lateral/posterior fractures requiring closer observation [8]. In another multicenter study, Aydın et al. reported that younger age, displaced rib fracture, and four or more rib fractures were associated with traumatic pneumothorax, highlighting the value of CT-based rib fracture characterization in emergency risk assessment [9]. Yılmaz et al. recently validated the STUMBL score for predicting in-hospital complications and reported strong predictive utility in blunt chest trauma patients [10].

However, an important research gap persists. Most available studies have evaluated either clinical scoring systems such as STUMBL or individual CT findings separately. Few studies have systematically examined whether combining STUMBL score with chest CT findings improves risk stratification compared with either method alone. This gap is clinically relevant because the STUMBL score captures patient physiology and vulnerability, whereas CT captures anatomical injury burden and occult thoracic pathology. A combined clinical-radiological approach may therefore provide a more comprehensive assessment of risk, especially in patients with apparently stable vital signs but significant CT findings, or in elderly/comorbid patients with limited radiological injury but high physiological vulnerability. Hence, the present study aims to evaluate the combined use of STUMBL score and chest CT findings for risk stratification in patients with blunt thoracic trauma, with the objective of improving early identification of high-risk patients, guiding appropriate level of care, and reducing preventable thoracic trauma-related complications.

MATERIALS AND METHODS

The present hospital-based observational study was conducted in the Department of General Surgery, Mamata Medical College and General Hospital, Khammam, among patients presenting with blunt thoracic trauma. The study was carried out over a period of six months, from December 2025 to May 2026. A total of 80 patients fulfilling the eligibility criteria were included in the study. The patients were divided into two equal groups of 40 each for comparative risk stratification. The study was carried out after obtaining

institutional permission, and informed consent was obtained from all eligible patients or their attendants wherever required.

Study Population

The study population included patients of both sexes presenting to the general surgery department with a history of blunt injury to the chest due to road traffic accidents, fall from height, assault, occupational injuries, or other blunt trauma mechanisms. Detailed clinical examination, radiological evaluation, and risk stratification were performed in all selected cases.

Sample Size

A total sample size of 80 patients was included in the study and divided into two groups:

- **Group I:** 40 patients assessed using STUMBL score
- **Group II:** 40 patients assessed using combined STUMBL score and chest CT findings

Inclusion Criteria

- Patients with a history of blunt thoracic trauma.
- Patients aged 18 years and above.
- Patients presenting within the study period to Mamata Medical College and General Hospital, Khammam.
- Patients who underwent clinical evaluation and chest imaging.
- Patients willing to participate in the study.
- Patients with complete clinical, radiological, and outcome data available for analysis.

Exclusion Criteria

- Patients with penetrating chest injuries.
- Patients below 18 years of age.
- Patients with severe polytrauma requiring immediate life-saving intervention before complete assessment.
- Patients with pre-existing severe thoracic deformity or chronic advanced lung disease interfering with assessment.
- Patients who were referred after definitive treatment from another hospital.
- Patients unwilling to participate in the study.
- Patients with incomplete clinical or radiological records.

Study Tool

The main study tools used for assessment were:

- Pre-designed structured proforma for recording demographic details, mode of injury, clinical findings, vital parameters, and outcome variables.
- STUMBL score, calculated using clinical variables such as age, number of rib fractures, oxygen saturation, pre-existing lung disease, and use of anticoagulants.
- Chest CT findings, including number and site of rib fractures, displaced rib fractures, pulmonary contusion, pneumothorax, hemothorax, flail chest,

subcutaneous emphysema, and other associated thoracic injuries.

- Hospital records, laboratory reports, radiological reports, and treatment charts were used for follow-up and outcome assessment.

Data Collection

Data were collected systematically in the following manner:

- Demographic details such as age, sex, and occupation were recorded.
- Mode of injury, including road traffic accident, fall, assault, or other causes, was documented.
- Clinical symptoms such as chest pain, breathlessness, cough, hemoptysis, and respiratory distress were noted.
- Vital parameters including respiratory rate, pulse rate, blood pressure, and oxygen saturation were recorded at admission.
- Details of comorbidities, especially chronic respiratory disease and anticoagulant use, were collected.
- STUMBL score was calculated for each patient based on standard scoring parameters.
- Chest CT findings were recorded and analyzed for type and severity of thoracic injury.
- Patients were followed during hospital stay for complications such as pneumonia, respiratory failure, need for intercostal drainage, ICU admission, ventilator requirement, duration of hospital stay, and mortality.
- The predictive value of STUMBL score alone and combined STUMBL score with CT findings was compared between the two groups.

Outcome Measures

The main outcome measures assessed in the study included:

- Development of thoracic complications.
- Requirement of intercostal tube drainage.
- ICU admission.
- Requirement of ventilatory support.
- Duration of hospital stay.
- Mortality, if any.
- Accuracy of risk stratification using STUMBL score alone versus combined STUMBL score and chest CT findings.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using SPSS statistical software. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean and standard deviation. Comparison between the two groups was done using the Chi-square test or Fisher's exact test for categorical variables and Student's t-test for continuous variables. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated to assess the predictive ability of STUMBL score alone and combined STUMBL score with chest CT findings. A p-value of less than 0.05 was considered statistically significant.

RESULTS

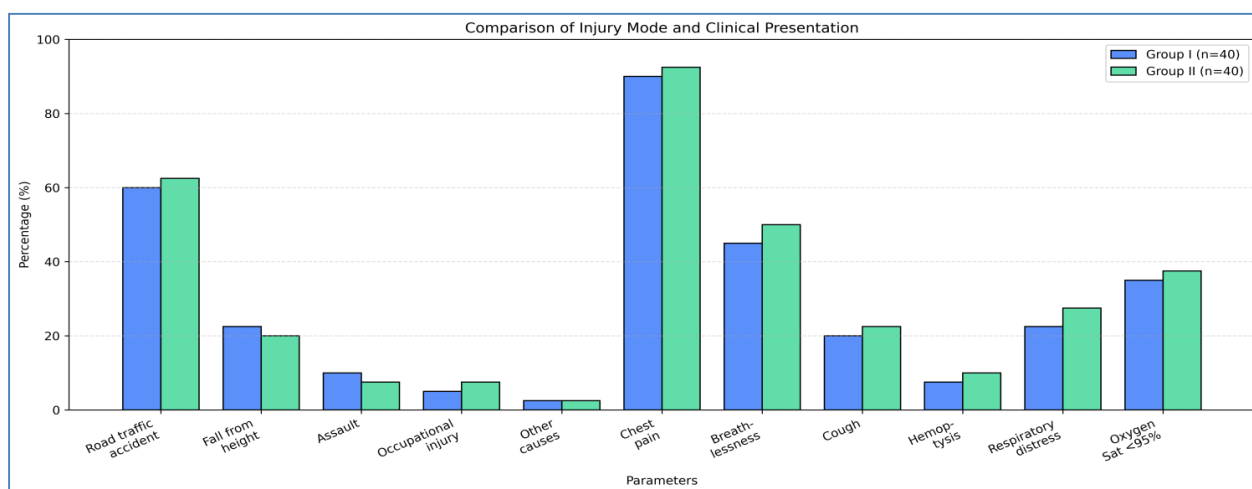
Table 1: Demographic and Baseline Characteristics of Study Participants

Parameter	Group I: STUMBL Alone (n=40)	Group II: STUMBL + CT (n=40)	Total (n=80)	p-value
Age, mean $\pm$ SD years	47.8 $\pm$ 15.6	49.5 $\pm$ 14.8	48.6 $\pm$ 15.2	0.618
18–30 years	8 (20.0%)	7 (17.5%)	15 (18.8%)	0.975
31–45 years	12 (30.0%)	11 (27.5%)	23 (28.8%)	
46–60 years	13 (32.5%)	14 (35.0%)	27 (33.8%)	
>60 years	7 (17.5%)	8 (20.0%)	15 (18.8%)	
Male	28 (70.0%)	29 (72.5%)	57 (71.3%)	1.000
Female	12 (30.0%)	11 (27.5%)	23 (28.7%)	
Rural residence	25 (62.5%)	23 (57.5%)	48 (60.0%)	0.819
Urban residence	15 (37.5%)	17 (42.5%)	32 (40.0%)	
Smoking history	13 (32.5%)	15 (37.5%)	28 (35.0%)	0.815
Chronic lung disease	5 (12.5%)	6 (15.0%)	11 (13.8%)	1.000
Anticoagulant use	3 (7.5%)	4 (10.0%)	7 (8.8%)	1.000

This table shows that the two groups were comparable regarding age, sex, residence, smoking history, chronic lung disease, and anticoagulant use. The mean age was slightly higher in Group II, but the difference was not statistically significant. Male predominance was observed in both groups, which is expected in blunt thoracic trauma because road traffic accidents commonly affect working-age males. The distribution of baseline comorbid factors was also similar between the groups. Since all p-values were greater than 0.05, there was no significant baseline difference between the two groups.

Table 2: Mode of Injury and Clinical Presentation among Study Participants

Parameter	Group I (n=40)	Group II (n=40)	Total (n=80)	p-value
Road traffic accident	24 (60.0%)	25 (62.5%)	49 (61.3%)	0.981
Fall from height	9 (22.5%)	8 (20.0%)	17 (21.3%)	
Assault	4 (10.0%)	3 (7.5%)	7 (8.8%)	
Occupational injury	2 (5.0%)	3 (7.5%)	5 (6.3%)	
Other causes	1 (2.5%)	1 (2.5%)	2 (2.5%)	
Chest pain	36 (90.0%)	37 (92.5%)	73 (91.3%)	1.000
Breathlessness	18 (45.0%)	20 (50.0%)	38 (47.5%)	0.823
Cough	8 (20.0%)	9 (22.5%)	17 (21.3%)	1.000
Hemoptysis	3 (7.5%)	4 (10.0%)	7 (8.8%)	1.000
Respiratory distress	9 (22.5%)	11 (27.5%)	20 (25.0%)	0.796
Oxygen saturation <95%	14 (35.0%)	15 (37.5%)	29 (36.3%)	1.000



Road traffic accident was the most common mode of injury in both groups, followed by fall from height. Chest pain was the most frequent presenting symptom, followed by breathlessness. Respiratory distress was seen in one-fourth of the total study population. Reduced oxygen saturation was observed in 36.3% of patients, indicating clinically relevant thoracic compromise. There was no statistically significant difference between the two groups regarding mode of injury or clinical presentation.

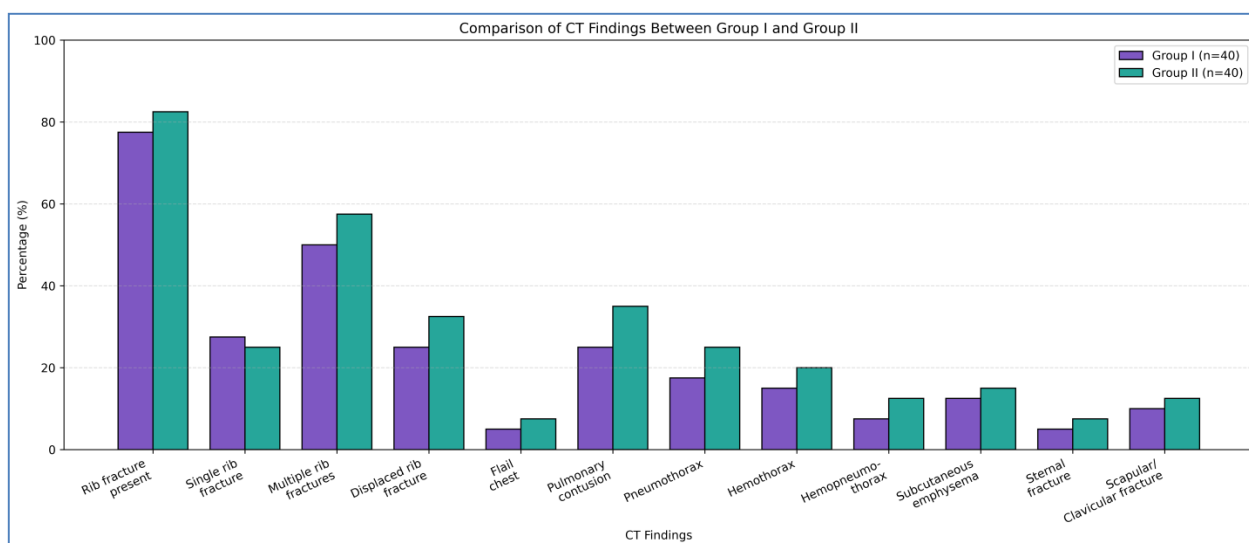
Table 3: Distribution of STUMBL Score Parameters among Both Study Groups

STUMBL Parameter	Group I (n=40)	Group II (n=40)	Total (n=80)	p-value
Age ≥65 years	6 (15.0%)	7 (17.5%)	13 (16.3%)	1.000
1–2 rib fractures	16 (40.0%)	15 (37.5%)	31 (38.8%)	1.000
3–5 rib fractures	17 (42.5%)	18 (45.0%)	35 (43.8%)	1.000
>5 rib fractures	7 (17.5%)	7 (17.5%)	14 (17.5%)	1.000
Oxygen saturation 90–94%	12 (30.0%)	13 (32.5%)	25 (31.3%)	1.000
Oxygen saturation <90%	2 (5.0%)	2 (5.0%)	4 (5.0%)	1.000
Chronic lung disease present	5 (12.5%)	6 (15.0%)	11 (13.8%)	1.000
Pre-injury anticoagulant use	3 (7.5%)	4 (10.0%)	7 (8.8%)	1.000
Mean STUMBL score ± SD	19.2 ± 8.4	20.1 ± 8.7	19.6 ± 8.5	0.639
Low-risk STUMBL score	13 (32.5%)	12 (30.0%)	25 (31.3%)	0.955
Moderate-risk STUMBL score	18 (45.0%)	18 (45.0%)	36 (45.0%)	
High-risk STUMBL score	9 (22.5%)	10 (25.0%)	19 (23.7%)	

This table presents the distribution of major STUMBL score components in both groups. Most patients had 1–5 rib fractures, while 17.5% had more than five rib fractures. Oxygen saturation below 95% was seen in a considerable proportion of patients, supporting its inclusion in clinical risk scoring. The mean STUMBL score was slightly higher in Group II but not statistically significant. Overall STUMBL risk categories were comparable between groups, suggesting that both groups had similar clinical severity at baseline.

Table 4: Chest CT Findings among Patients with Blunt Thoracic Trauma

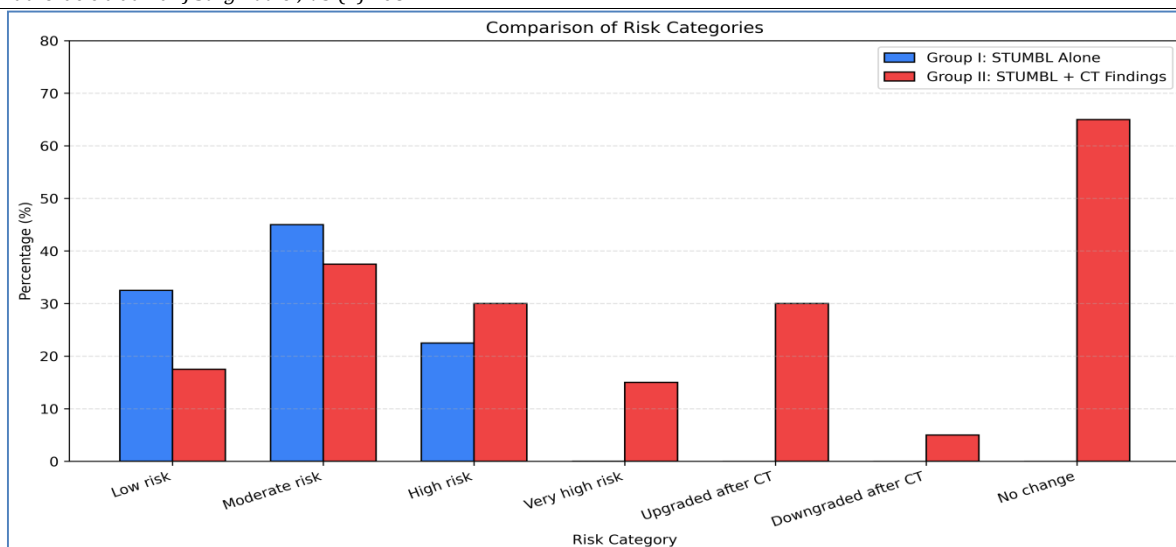
CT Finding	Group I (n=40)	Group II (n=40)	Total (n=80)	p-value
Rib fracture present	31 (77.5%)	33 (82.5%)	64 (80.0%)	0.780
Single rib fracture	11 (27.5%)	10 (25.0%)	21 (26.3%)	1.000
Multiple rib fractures	20 (50.0%)	23 (57.5%)	43 (53.8%)	0.654
Displaced rib fracture	10 (25.0%)	13 (32.5%)	23 (28.8%)	0.621
Flail chest	2 (5.0%)	3 (7.5%)	5 (6.3%)	1.000
Pulmonary contusion	10 (25.0%)	14 (35.0%)	24 (30.0%)	0.464
Pneumothorax	7 (17.5%)	10 (25.0%)	17 (21.3%)	0.585
Hemothorax	6 (15.0%)	8 (20.0%)	14 (17.5%)	0.769
Hemopneumothorax	3 (7.5%)	5 (12.5%)	8 (10.0%)	0.709
Subcutaneous emphysema	5 (12.5%)	6 (15.0%)	11 (13.8%)	1.000
Sternal fracture	2 (5.0%)	3 (7.5%)	5 (6.3%)	1.000
Scapular/clavicular fracture	4 (10.0%)	5 (12.5%)	9 (11.3%)	1.000



Rib fracture was the most common CT finding and was present in 80.0% of patients. Multiple rib fractures were seen in more than half of the study population, indicating significant chest wall injury. Pulmonary contusion, pneumothorax, and hemothorax were important intrathoracic findings detected by CT. Group II showed slightly higher detection of pulmonary contusion and pleural injuries, reflecting the value of CT-based stratification. However, the differences between the two groups were not statistically significant.

Table 5: Risk Stratification Based on STUMBL Score Alone versus Combined STUMBL Score and CT Findings

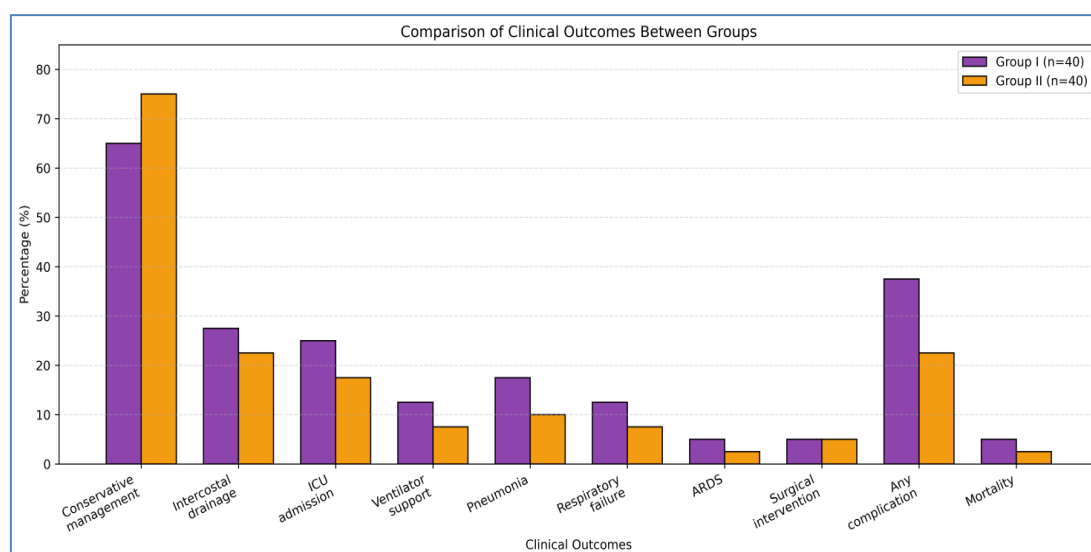
Risk Category	Group I: STUMBL Alone (n=40)	Group II: STUMBL + CT Findings (n=40)	p-value
Low risk	13 (32.5%)	7 (17.5%)	0.037
Moderate risk	18 (45.0%)	15 (37.5%)	
High risk	9 (22.5%)	12 (30.0%)	
Very high risk	0 (0.0%)	6 (15.0%)	
Patients upgraded after CT assessment	NA	12 (30.0%)	NA
Patients downgraded after CT assessment	NA	2 (5.0%)	NA
No change in risk category	NA	26 (65.0%)	NA



This table shows that adding chest CT findings to the STUMBL score changed the risk category in a clinically meaningful number of patients. In Group II, 30.0% of patients were upgraded after CT assessment, mainly due to pulmonary contusion, multiple/displaced rib fractures, pneumothorax, or hemothorax. The proportion of high and very high-risk patients was greater in the combined assessment group. The difference in risk distribution between the two groups was statistically significant. This supports the concept that CT findings add prognostic information beyond clinical scoring alone.

Table 6: Comparison of Clinical Outcomes between the Two Study Groups

Clinical Outcome	Group I (n=40)	Group II (n=40)	Total (n=80)	p-value
Conservative management	26 (65.0%)	30 (75.0%)	56 (70.0%)	0.464
Intercostal drainage required	11 (27.5%)	9 (22.5%)	20 (25.0%)	0.796
ICU admission	10 (25.0%)	7 (17.5%)	17 (21.3%)	0.585
Ventilator support required	5 (12.5%)	3 (7.5%)	8 (10.0%)	0.709
Pneumonia	7 (17.5%)	4 (10.0%)	11 (13.8%)	0.516
Respiratory failure	5 (12.5%)	3 (7.5%)	8 (10.0%)	0.709
ARDS	2 (5.0%)	1 (2.5%)	3 (3.8%)	1.000
Surgical intervention	2 (5.0%)	2 (5.0%)	4 (5.0%)	1.000
Any complication	15 (37.5%)	9 (22.5%)	24 (30.0%)	0.223
Mean hospital stay, days $\pm$ SD	6.4 $\pm$ 2.8	5.3 $\pm$ 2.2	5.8 $\pm$ 2.5	0.055
Mortality	2 (5.0%)	1 (2.5%)	3 (3.8%)	1.000



Most patients in both groups were managed conservatively. The requirement for intercostal drainage, ICU admission, and ventilator support was lower in Group II compared with Group I. The overall complication rate was also lower in the combined STUMBL + CT group, although the difference was not statistically significant. Mean hospital stay was shorter

in Group II and approached statistical significance. These findings suggest that combined clinical and radiological risk stratification may help in earlier identification and better monitoring of high-risk patients.

Table 7: Diagnostic Performance of STUMBL Score Alone and Combined STUMBL Score with CT Findings for Predicting Complications

Diagnostic Parameter	STUMBL Score Alone	STUMBL + CT Findings	p-value / 95% CI
True positive	17	21	—
False positive	14	10	—
True negative	42	46	—
False negative	7	3	—
Sensitivity	70.8%	87.5%	0.041
Specificity	75.0%	82.1%	0.218
Positive predictive value	54.8%	67.7%	0.046
Negative predictive value	85.7%	93.9%	0.039
Diagnostic accuracy	73.8%	83.8%	0.048
Area under ROC curve	0.79	0.89	0.036
False positive rate	25.0%	17.9%	—
False negative rate	29.2%	12.5%	—

The combined STUMBL + CT method showed better diagnostic performance than STUMBL score alone. Sensitivity increased from 70.8% to 87.5%, indicating improved identification of patients who developed complications. Negative predictive value also improved, suggesting that combined assessment was better at ruling out high-risk outcomes. Diagnostic accuracy increased from 73.8% to 83.8%. The higher AUC value in the combined model indicates better overall discrimination for predicting complications.

Table 8: Correlation between STUMBL Score, CT Severity Findings, and Clinical Outcomes

Parameter Correlated	Correlation Coefficient / χ^2 Value	p-value
STUMBL score vs duration of hospital stay	$r = 0.52$	<0.001
STUMBL score vs ICU admission	$r = 0.44$	<0.001
STUMBL score vs ventilator requirement	$r = 0.38$	0.001
Number of rib fractures vs hospital stay	$r = 0.47$	<0.001
Pulmonary contusion vs respiratory complications	$\chi^2 = 7.96$	0.005
Pneumothorax/hemothorax vs ICD requirement	$\chi^2 = 28.65$	<0.001
Combined STUMBL + CT risk category vs complications	$r = 0.62$	<0.001

This table demonstrates that both clinical severity and CT-based injury burden were significantly related to adverse outcomes. STUMBL score showed moderate positive correlation with duration of hospital stay, ICU admission, and ventilator requirement. Number of rib fractures also correlated significantly with hospital stay. Pulmonary contusion was significantly associated with respiratory complications. Pleural injuries such as pneumothorax and hemothorax showed a strong association with intercostal drainage requirement.

Table 9: Association of CT Findings with High-Risk Clinical Outcomes

CT Finding	Complications Present (n=24)	Complications Absent (n=56)	χ^2 Value	p-value
Multiple rib fractures	18 (75.0%)	25 (44.6%)	5.07	0.024
Displaced rib fracture	12 (50.0%)	11 (19.6%)	6.15	0.013
Flail chest	4 (16.7%)	1 (1.8%)	4.06	0.044
Pulmonary contusion	13 (54.2%)	11 (19.6%)	7.96	0.005
Pneumothorax	9 (37.5%)	8 (14.3%)	4.11	0.043
Hemothorax	8 (33.3%)	6 (10.7%)	4.49	0.034
Hemopneumothorax	6 (25.0%)	2 (3.6%)	6.36	0.012
Subcutaneous emphysema	6 (25.0%)	5 (8.9%)	2.43	0.119

This table identifies CT findings associated with high-risk clinical outcomes. Multiple rib fractures, displaced rib fractures, pulmonary contusion, pneumothorax, hemothorax, and hemopneumothorax were significantly associated with complications. Flail chest showed a high odds ratio, suggesting a strong relationship with poor outcomes, although the number of cases was small. Subcutaneous emphysema showed increased odds but was not statistically significant. These findings support the role of CT in improving risk stratification beyond clinical scoring alone.

DISCUSSION

The present study evaluated the combined use of STUMBL score and chest CT findings for risk stratification in patients with blunt thoracic trauma. In the present results, the mean age of the study population was 48.6 ± 15.2 years, with male predominance of 71.3%. Road traffic accidents were the commonest mode of injury, accounting for 61.3% of cases, followed by fall from height. This pattern is consistent with the usual epidemiology of blunt thoracic trauma, where high-energy mechanisms such as road traffic accidents commonly affect young and middle-aged males. Mistry and Moore also emphasized that blunt thoracic trauma is frequently encountered after high-energy trauma and requires structured assessment because clinical deterioration may occur after the initial presentation [11].

In the present study, chest pain was the most common symptom, followed by breathlessness, respiratory distress, and reduced oxygen saturation. These findings indicate that although chest pain is the usual presenting complaint, physiological parameters such as oxygen saturation are more useful for early risk stratification.

In the present study, both groups were comparable with respect to baseline demographic variables, mode of injury, clinical presentation, and STUMBL score parameters. This comparability strengthens the interpretation that the observed difference in risk categorization and diagnostic performance was mainly due to the addition of CT findings rather than baseline variation between groups. Rib fracture was the commonest CT finding and was seen in 80.0% of patients. Multiple rib fractures were observed in 53.8%, displaced rib fractures in 28.8%, pulmonary contusion in 30.0%, pneumothorax in 21.3%, and hemothorax in 17.5% of patients. These findings highlight that CT detects both chest wall and intrathoracic injuries, which may not be fully appreciated by clinical scoring alone. Harfouche et al. reported that patients undergoing surgical stabilization of rib fractures had more severe chest trauma, reflected by higher RibScore and longer hospital and ICU stay, supporting the concept that rib fracture burden is closely related to trauma severity and resource requirement [12].

The STUMBL score alone classified 32.5% of patients as low risk, 45.0% as moderate risk, and 22.5% as high risk. However, when chest CT findings were added, the proportion of low-risk patients decreased to 17.5%, while high-risk and very high-risk categories increased to 30.0% and 15.0%, respectively. Importantly, 30.0% of patients were upgraded after CT assessment. This is one of the key observations of the present study. It suggests that patients who appear low or moderate risk clinically may have significant anatomical injury on CT, such as pulmonary contusion, displaced rib fracture, pneumothorax, or hemothorax. Battle et al., in a scoping review of the STUMBL score, noted that the score has evolved from a tool for predicting respiratory complications to a broader clinical decision support tool,

but also highlighted the need for further evaluation and calibration in different clinical settings [13]. The present study adds to this gap by suggesting that CT findings may improve the practical usefulness of STUMBL-based triage.

The clinical outcomes in the present study showed that the combined STUMBL + CT group had lower rates of ICU admission, ventilator requirement, pneumonia, respiratory failure, and overall complications compared with the STUMBL-alone group. Although many of these differences were not statistically significant, the trend is clinically meaningful. The overall complication rate was 37.5% in Group I and 22.5% in Group II. Mean hospital stay was also shorter in Group II, with values approaching statistical significance. This may indicate that combined clinical and radiological stratification allows earlier recognition of high-risk patients, closer monitoring, timely intervention, and more appropriate level-of-care decisions. Park et al. showed that CT was useful in detecting occult pneumothorax in blunt chest trauma and that CT-based findings may guide the need for closer observation or intervention [14]. The present results similarly support the value of CT in identifying patients who may not be adequately risk-classified by clinical parameters alone.

The diagnostic performance analysis further supports the benefit of combined assessment. STUMBL score alone showed sensitivity of 70.8%, specificity of 75.0%, diagnostic accuracy of 73.8%, and AUC of 0.79 for predicting complications. In comparison, the combined STUMBL + CT model showed higher sensitivity of 87.5%, specificity of 82.1%, diagnostic accuracy of 83.8%, and AUC of 0.89. The improvement in sensitivity and negative predictive value is particularly important in emergency and surgical practice because missing a high-risk thoracic trauma patient can lead to delayed respiratory failure, pneumonia, or unplanned ICU admission. Shearer et al. recently reported that higher STUMBL scores were associated with acute pain management decisions and ICU referrals in rib fracture care, supporting the role of STUMBL as a practical triage tool [15]. However, the present study suggests that adding CT findings strengthens this clinical decision-making process.

Correlation analysis in the present study showed that STUMBL score correlated significantly with duration of hospital stay, ICU admission, and ventilator requirement. The number of rib fractures was also significantly associated with longer hospital stay. Pulmonary contusion showed significant association with respiratory complications, while pneumothorax and hemothorax were strongly associated with intercostal drainage requirement. Yalçın and Özkaya similarly studied blunt trauma patients with occult pneumothorax and developed a model to predict the need for tube thoracostomy, emphasizing that CT-detected pleural injury should be interpreted along with clinical status

rather than managed by imaging alone [16]. These observations are in agreement with the present study, where CT findings had stronger predictive value when combined with STUMBL score.

The association table further showed that multiple rib fractures, displaced rib fractures, flail chest, pulmonary contusion, pneumothorax, hemothorax, and hemopneumothorax were associated with high-risk clinical outcomes. This is clinically relevant because these CT findings represent not only structural injury but also the potential for respiratory compromise. Recent WSES-AAST thoracic trauma guidelines also emphasize that management decisions in thoracic trauma should consider physiology, anatomical injury severity, pleural complications, respiratory compromise, and available resources [17]. The recent external validation of STUMBL in a frontline military hospital also supports the broader applicability of the score in thoracic trauma, while reinforcing the need to evaluate performance in different populations and trauma settings [18]. Thus, the present study supports a combined clinical-radiological model rather than dependence on either STUMBL score or CT findings alone.

The main strength of the present study is its direct comparison of STUMBL score alone with combined STUMBL and CT-based risk stratification. The findings suggest that combined assessment improves risk categorization and diagnostic performance. However, the study has some limitations. The sample size was relatively small, with 80 patients divided into two groups of 40 each. The study was conducted at a single tertiary care hospital, and the findings may not be generalizable to all trauma settings. Some outcome differences did not reach statistical significance, possibly due to limited sample size. Larger multicentric prospective studies are required to validate the combined model and determine standard CT-weighted risk categories.

CONCLUSION

The present study concludes that combining STUMBL score with chest CT findings provides better risk stratification than STUMBL score alone in patients with blunt thoracic trauma. CT findings such as multiple rib fractures, displaced rib fractures, pulmonary contusion, pneumothorax, hemothorax, and hemopneumothorax significantly influenced risk categorization and were associated with adverse clinical outcomes. The combined model showed higher sensitivity, diagnostic accuracy, negative predictive value, and AUC for predicting complications. Therefore, STUMBL score should be used as an initial bedside clinical tool, while chest CT findings should be incorporated for more accurate triage, monitoring, and management planning in blunt thoracic trauma patients.

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