Role of Thoracic Trauma Severity Scoring (TTSS) system as a predictor of mortality, morbidity, and as a prognostic tool in thoracic trauma patients: A prospective observational study

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Abstract

Background and Aims: Prognostication of patients with chest trauma using scoring systems is an effective tool for predicting morbidity and mortality. This study aimed to evaluate the predictive and prognostic value of the thoracic trauma severity scoring (TTSS) system in thoracic trauma patients.

Material and Methods: This prospective observational study was conducted from January 2022 to December 2024 at the Department of General Surgery and Emergency Medicine of a tertiary care teaching hospital in Kerala, India. 200 patients with thoracic trauma were evaluated using the Thoracic Trauma Severity Score (TTSS), which comprises five parameters: 1) Age, 2) PaO2/FiO2 ratio, 3) Pleural injuries, 4) Lung contusion, and 5) Rib fractures. The score ranges from 0 to 25 points. Patients were followed for outcomes including ICU admission, need for mechanical ventilation, complications, and mortality.

Results: Among 200 patients (72% male), road traffic accidents were the predominant cause of injury (77.5%). TTSS ≥6 was significantly associated with increased morbidity (sensitivity 99.2%, specificity 100%, p<0.001), including need for ICU admission, ICD insertion, and development of complications (pneumonia, ARDS, metabolic complications). TTSS ≥8 was significantly associated with mortality (sensitivity, 84.6%; specificity, 80.7%; AUC, 0.872; p < 0.001). The overall mortality rate was 6.5%.

Conclusion: This study concludes that a TTSS score of 6 or higher is significantly associated with increased morbidity, and a TTSS score of 8 or higher is associated with increased mortality. The TTSS system can be a useful tool in predicting outcomes and guiding early intensive care management in patients with thoracic trauma.

Key words: Chest trauma, thoracic trauma severity score, pneumonia, ICU

Introduction

Trauma poses a serious threat to global public health owing to its high rates of morbidity and mortality in both industrialized and developing nations, with an estimated 5.8 million fatalities globally. In the first forty years of life, trauma has reportedly been linked to the majority of fatalities and hospitalizations [1]. India witnesses a high number of trauma-related deaths and injuries every hour. As per NCRB 2022 data, India witnessed approximately 4.3 lakh accidental deaths in 2022, out of which 1,71,100 deaths were due to road crashes alone. According to the report, 61.9% of all fatalities due to road crashes belong to the productive age group of 18-45 years, resulting in a huge economic, social, and financial loss to the country [2].

Thoracic trauma is a significant cause of mortality among polytrauma patients. Many of these deaths can be prevented with prompt diagnosis and treatment. Less than 10% of blunt chest injuries and only 15% to 30% of penetrating chest injuries require operative intervention. Thoracic trauma involves blunt or penetrating injury to the chest wall and intrathoracic organs and can manifest as rib fractures, lung parenchymal injuries, hemothorax, pneumothorax, and cardiac tamponade. Initial assessment and treatment involve primary survey with resuscitation of vital

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functions, detailed secondary survey, and definitive care [3].

Complications that can develop in thoracic trauma patients are secondary to altered chest wall mechanics from the fractures and fracture-associated pain. Pulmonary contusion can lead to hypoxia. The complex pathophysiology often necessitates endotracheal intubation, prolonged mechanical ventilation, tracheostomy, and prolonged intensive care unit (ICU) length of stay. Poor pulmonary function and mechanical ventilation increase the risk of the development of pneumonia, which is a frequent cause of death[4,5].

According to the literature, the incidence of ventilator-associated pneumonia (VAP) is highest in trauma patients, and it is a predisposition to trauma-associated ARDS and multiple organ failure[6].

Early accurate grading of the severity of thoracic trauma and the prediction of later complications is important because the degree of chest trauma has a significant impact on the requirements for resuscitation and intensive care unit support[7]. Previous studies have shown that a protocol-based approach created using scoring systems in **trauma** helps shorten the length of stay and improve treatment outcomes.

In 2000, Pape et al. described the thoracic trauma severity score (TTSS), which includes anatomical and functional parameters for the assessment of the severity of chest trauma. It is a handy tool for the assessment and stratification of patients with thoracic trauma. TTSS is composed of five parameters: 1) Age, 2) PaO2/FiO2 ratio, 3) Pleural injuries, 4) Lung contusion, and 5) Rib fractures. The score ranges from 0 to 25 points[7].

Amit et al. conducted a study in Rajasthan to validate the thoracic trauma scoring system and concluded that there was a direct correlation with higher TTSS and the need for oxygenation and ventilator, duration of hospital stays, mortality, or outcome in chest trauma patients[9]. Adel et al.'s study in 2016 revealed that a TTSS >7 can be used to predict mortality in trauma patients[10]. Isro et al. study on 238 patients in 2016 revealed TTSS as an appropriate and feasible tool to predict complications or mortality in thoracic trauma.

There are various scoring systems for trauma; however, thoracic injury severity grading remains difficult, and current assessment standards vary widely. Global trauma scoring systems, such as the Revised Trauma Score (RTS), the Injury Severity Score (ISS), and the Trauma and Injury Severity Score (TRISS), include thoracic injuries as part of the overall injury severity. The most common and clinically used chest-specific scoring system is the Abbreviated Injury Scale (AISchest), which gives a more trauma-related anatomical assessment of the thoracic trauma as part of the ISS. The Pulmonary Contusion score (PCS) and the CT-dependent Wagner score quantify the extent of pulmonary contusions. The Thoracic Trauma Severity score (TTSS) combines both anatomical and physiological parameters, making it potentially more comprehensive for trauma assessment[11].

While several studies have evaluated various trauma scoring systems, there remains a need for validation of the TTSS in diverse clinical settings, particularly in resource-constrained environments. This study aims to address this gap by investigating the predictive ability of TTSS for morbidity, mortality, and overall prognostication in patients with thoracic trauma in a tertiary care center in India.

Early, accurate grading of chest injury severity is decisive for the clinical course of multiple trauma patients. The severity of chest trauma influences decision-making in multiple traumas in terms of management and resource utilization to avoid post-traumatic complications.

Novelty and Contribution of This Study:

While several studies have evaluated various trauma scoring systems, there remains a need for validation of the TTSS in diverse clinical settings, particularly in resource-constrained environments typical of developing countries. This study addresses this gap by investigating the predictive ability of TTSS for morbidity, mortality, and overall prognostication in patients with thoracic trauma in a tertiary care center in India.

What makes this study unique is its comprehensive analysis of TTSS performance in a relatively large cohort of Indian patients, with a specific focus on identifying optimal cut-off values for both morbidity and mortality prediction. Unlike previous smaller studies, this research provides robust statistical validation with receiver operating characteristic (ROC) curve analysis and establishes clear clinical thresholds (TTSS ≥6 for morbidity and TTSS ≥8 for mortality) that can be readily implemented in clinical practice. Additionally, this study contributes to the existing literature by providing data from a South Asian population, which has been underrepresented in previous TTSS validation studies.

Materials and Methods

This prospective observational study was conducted from January 2022 to December 2023 in the Department of General Surgery and Emergency Medicine of a tertiary care teaching hospital. A total of 200 patients with thoracic trauma residing in Ernakulam and adjacent districts of Kerala were

included in the study through consecutive sampling.

Data were collected using a structured proforma capturing demographic parameters, history, vital parameters, and necessary investigations, including chest radiography and computed tomography (CT) chest. All patients were evaluated using the TTSS system at admission.

All categorical variables were summarized using frequencies and percentages. Quantitative variables were summarized using means and standard deviations. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to check the normality of the data. ROC analysis was performed to determine the predictive ability of the thoracic trauma scoring system for morbidity, mortality, and prognostication in thoracic trauma patients.

The study was initiated after obtaining permission from the institutional ethics and research committee. Written informed consent was obtained from the patient or their relatives.

Inclusion criteria: Age >12 years, patients with isolated blunt/penetrating trauma chest, patients with chest trauma along with abdominal trauma requiring only conservative management for abdominal trauma, patients with chest trauma with other trauma-related injuries requiring only conservative management, patients with Minor (GCS score 15 with No Loss of Consciousness) and mild (GCS 14-15 with Loss of Consciousness) head injuries

Exclusion criteria: Concomitant injury to other systems requiring surgical intervention, moderate (GCS 9-13) & severe (GCS 3-8) head injury, burns, chronic respiratory diseases, pregnancy, malignancy, pre-existing end-stage organ disease (Chronic Kidney Disease, Chronic Liver Disease, Congestive Cardiac Failure), long bone fractures and orthopedic injuries requiring surgical intervention

Outcome variables: Need for ICU admission, need for mechanical ventilation/tracheostomy, need for ICD insertion, need for thoracotomy, development of pneumonia, development of ARDS, metabolic complications, mortality

TTSS is composed of five parameters: 1) Age, 2) PaO2/FiO2 ratio, 3) Pleural injuries, 4) Lung contusion, and 5) Rib fractures. The score ranges from 0 to 25 points. Patients were divided into those with TTSS <6 and ≥6 for analysis of morbidity, and <8 and ≥8 for analysis of mortality.

Results

This prospective observational study included 200 participants. The objective was to determine the predictive ability of the thoracic trauma severity score (TTSS) system for morbidity, mortality, and prognostication in thoracic trauma patients. Detailed assessment and presentation of the results are provided below.

Section I: baseline characteristics

This section discusses the distribution of baseline characteristics. The basic parameters considered in this study were age and gender.

Table 1: Age distribution of the study participants (n = 200)

Age (Years)	No. Of Participants	Percentage
<30	33	16
30-41	36	18
42-54	50	25
55-70	58	29
>70	23	12
Total	200	100

The majority of participants were in the 55-70 years age group (29%), followed by the 42-54 years age group (25%). [Table 1]

Gender Distribution

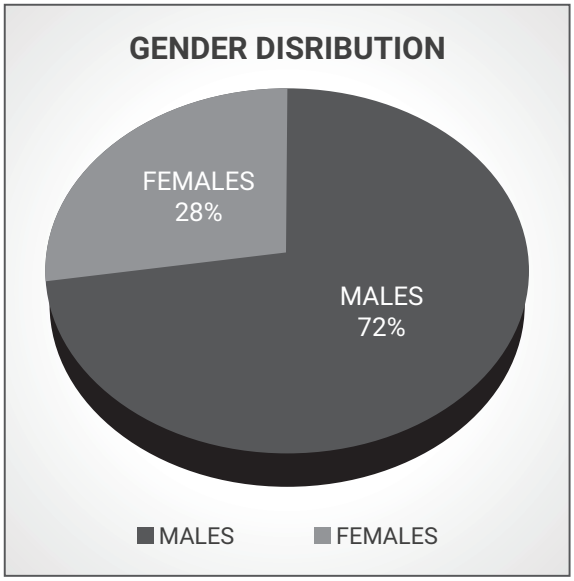

Figure 1: Gender distribution among study participants (n = 200)

Among the study participants, 145 males constituted 72% of the total, and 55 females comprised the remaining 28%. [Figure 1]

Table 2: Mode of injury among study participants (n = 200)

Mode of injury	No. of patients	Percentage
RTA	155	77.5
Fall	35	17.5
Assault	4	2
Hit by an animal	4	2
Others	2	1
Total	200	100

Road traffic accidents (RTA) were overwhelmingly the most prevalent mode of injury, accounting for 77.5% of cases, followed by falls at 17.5%. This distribution is consistent with the epidemiological pattern of trauma in developing countries. The high incidence of RTA-related thoracic trauma underscores the need for improved traffic safety measures and emergency response systems.[Table 2]

Section II: outcome variables

This section deals with the outcome variables, including: 1) ICU admission, 2) ICD insertion, 3) Mechanical ventilation, 4) Pneumonia, 5) ARDS, 6) Metabolic complications, and 7) Mortality and morbidity.

Table 3: ICU stay among study participants (n = 200)

ICU Admission	Number of participants	Percentage
No ICU admission	80	40
ICU admission	120	60
Total	**200**	**100**

A significant proportion (60%) of the participants required ICU care and intensive monitoring, indicating the severity of thoracic trauma cases in our study population. This high ICU admission rate emphasizes the resource-intensive nature of thoracic trauma management and the importance of early risk stratification.[Table 3]

Table 4: Need for ICD insertion among the study participants (n = 200)

ICD insertion	No. of participants	Percentage
No	158	79
Yes, unilateral	35	17.5
Yes, bilateral	7	3.5
Total	**200**	**100**

The data reveal that 42 (21%) of the participants required ICD insertion, with the majority (17.5%) requiring unilateral drainage. Additionally, 3 patients (1.5%) required thoracotomy for management of massive hemothorax. The relatively low rate of surgical intervention (1.5%) supports the literature indicating that most thoracic trauma cases can be managed conservatively. [Table 4]

Table 5: Requirements for mechanical ventilation among the study participants (n = 200)

Required mechanical ventilation	No. of participants	Percentage
No	185	92.5
Yes	15	7.5
Total	200	100

Only 7.5% of the participants required mechanical ventilation during their hospital stay, those requiring ventilation likely represented the most severe cases with significant pulmonary compromise.[Table 5]

Development of complications

Table 6: Development of pneumonia among the study participants (n = 200)

Developed pneumonia	Number of participants	Percentage
No	163	81.5
Yes	37	18.5
Total	**200**	**100**

Pneumonia developed in 37 patients (18.5%), making it the most common complication in our study population. This finding is consistent with the literature, indicating that pneumonia is a frequent and serious complication of thoracic trauma, often related to impaired respiratory mechanics and prolonged immobilization. [Table 6]

Table 7: Development of ARDS among the study participants (n = 200)

ARDS	No. of participants	Percentage
No	181	90.5
Yes	19	9.5
Total	**200**	**100**

Acute Respiratory Distress Syndrome (ARDS) developed in 19 patients (9.5%), representing a significant complication that often requires intensive care management and mechanical ventilation. The development of ARDS is associated with increased morbidity and mortality in thoracic trauma patients. [Table 7]

Table 8: Development of metabolic complications among the study participants (n = 200)

Metabolic complications	No. of participants	Percentage
No	183	91.5
Yes	17	8.5
Total	200	100

Metabolic complications occurred in 17 patients

(8.5%), which include electrolyte imbalances, hyperglycemia, and other metabolic derangements commonly seen in critically ill trauma patients. The relatively low incidence suggests effective metabolic monitoring and management in our study population. [Table 8]

The above data provides a detailed overview of the distribution of complications among the study participants. The data reveal that 18.5% of the participants developed pneumonia, which was the most common complication among the study population, followed by 9.5% developing ARDS and 8.5% developing metabolic complications. [Table 6,7,8]

We also looked into individual parameters (age>70 years, pulmonary contusion, and bilateral rib fractures/ flail chest) as predictors of mortality and morbidity.

Table 9: Age and morbidity (number of participants, n = 200)

Age	Morbidity		Total
	Yes	No	
<70	76 (42.9%)	101 (57.1%)	177
>70	3 (13%)	20 (87%)	23

Eighty-seven percent of patients aged more than 70 years experienced morbidity compared to 42.9% of patients aged <70 years (p = 0.006). This significant difference highlights the impact of advanced age on outcomes in thoracic trauma patients. [Table 9]

Pulmonary contusion as a predictor of morbidity and mortality:

86.2% of participants with lung contusions had morbidity compared to 19.5% of participants without pulmonary contusions (p <0.001). Mortality among patients with pulmonary contusions was 9.8 % as compared to 1.3 % among patients without pulmonary contusions. (p = 0.018)

Rib fractures as a predictor of morbidity and mortality:

35 of 200 patients had bilateral rib fractures or flail chest. Of these, 32 patients (92.4%) experienced morbidity. (p<0.001). The mortality among these patients was 17.1%, as opposed to 4.2% among patients who did not have a flail chest/bilateral rib fracture. (p=0.015)

Mortality and Morbidity

Table 10: Mortality following chest trauma in the study participants (n = 200)

Mortality	No. of participants	Percentage
No	187	93.5
Yes	13	6.5
Total	200	100

The overall mortality rate in our study was 6.5% (13 patients), which reflects effective trauma management protocols and timely intervention in our tertiary care setting. [Table 10]

Table 11: Morbidity following chest trauma in the study participants (n = 200)

Morbidity	No. of participants	Percentage
No	80	40
Yes	120	60
Total	200	100

Sixty percent of patients experienced some form of morbidity, indicating the significant impact of thoracic trauma on patient outcomes. Morbidity was defined as the need for ICU admission, mechanical ventilation, or the development of complications.[Table 10]

Role of TTSS in predicting mortality and morbidity

The ROC curve was used to find an ideal cutoff for predicting morbidity and mortality.

Table 12: Relationship between TTSS and morbidity following chest trauma

TTSS	Morbidity		TOTAL	P value
	No	Yes		
<6	79 (98.8%)	1 (1.3%)	80	<0.001
≥6	0	120 (100%)	120	
Total	79	121	200	

Table 12 demonstrates the strong predictive ability of TTSS for morbidity and supports the use of TTSS ≥6 as a cut-off for predicting increased morbidity.

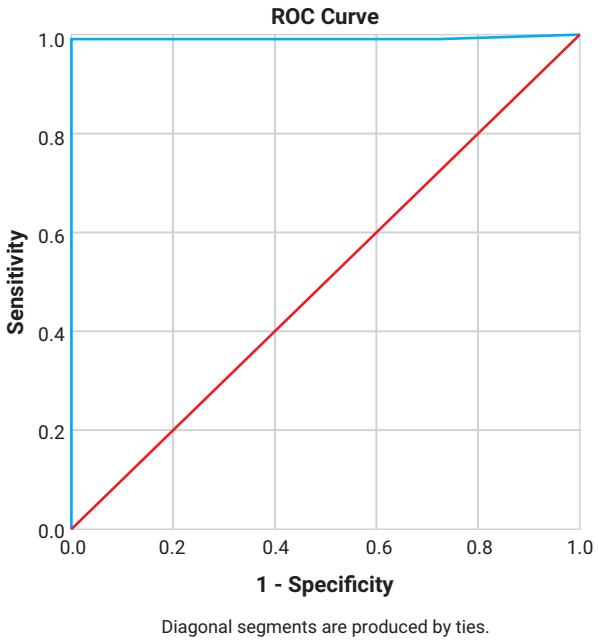

Figure 2: ROC curve – TTSS in predicting morbidity

Figure 2 shows the ROC curve of TTSS in predicting morbidity.

Table 13: Sensitivity and specificity of TTSS in predicting morbidity

Diagnostic measures	Percentage	95% CI
Sensitivity	99.2	95.5 – 100
Specificity	100	93.2 – 100
Positive predictor value	100	95.5 – 100
Negative predictor value	98.8	93.2 – 100
Diagnostic accuracy	99.5	97.2 – 100
Area under the curve (AUC)	0.998	0.994 - 1.000

The diagnostic performance of TTSS ≥6 for predicting morbidity shows sensitivity - 99.2% and specificity of 100%. The AUC of 0.998 indicates good discriminative ability. [Table 13]

Table 14: Relationship between TTSS and mortality following chest trauma

TTSS	Mortality		Total	P value
	No	Yes		
<8	151	2	153	<0.001
≥8	36	11	47	
Total	187	13	200	

Table 14: Among 47 patients with TTSS ≥8, 11 (23.4%) died, compared to only 2 deaths (1.3%) out of 153 patients with TTSS <8. The odds ratio for mortality with TTSS ≥8 was 23.2 (95% CI: 4.93-108.97), indicating a very strong association between high TTSS and mortality risk.

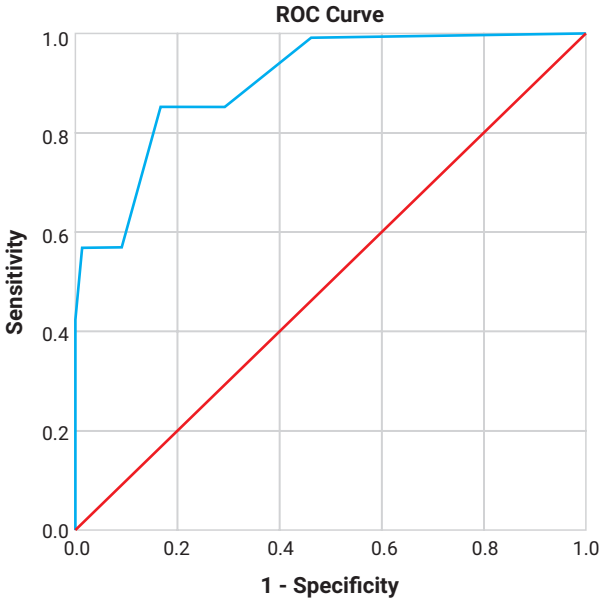

Figure 3: ROC curve – TTSS predicting mortality

Figure 3 depicts the ROC curve of TTSS in predicting mortality.

Table 15: Sensitivity and specificity of TTSS in predicting mortality

Diagnostic measures	Percentage	95% CI
Sensitivity	84.6	54.6 – 98.1
Specificity	80.7	74.4 – 86.1
Positive predictor value	23.4	12.3 – 38
Negative predictor value	98.7	95.4 - 99.8
Diagnostic accuracy	81	74.9 - 86.2
Area under the curve (AUC)	0.872	0.797 - 0.947

TTSS ≥8 demonstrates good diagnostic performance for mortality prediction with high sensitivity (84.6%) and specificity (80.7%). The AUC of 0.872 indicates good discriminative ability for mortality prediction. [Table 15]

In the present study, TTSS ≥6 had a sensitivity of 99.2% and specificity of 100% in predicting morbidity in chest trauma patients, and TTSS ≥8 had a sensitivity of 84.6% and specificity of 80.7% in predicting mortality.

Discussion

Thoracic injury accounts for 25% of all severe injuries. In a further 25%, it may be a significant contributor to the subsequent death of the patient. More than 80% of patients with chest injuries can be managed non-operatively. The key to a good outcome is early physiological resuscitation followed by a correct diagnosis[8].

Accurate evaluation of the severity of chest trauma helps initiate prompt treatment, including adequate

analgesia, oxygen support, and ICU admission, which will help in preventing complications. Scales such as the ISS (Injury Severity Score) or the TRISS (Trauma Injury Severity Score), which are widely used, are not specific for chest trauma. TTSS is a specific scale designed for thoracic trauma, which combines both anatomical and physiological parameters, and is a useful tool in the identification of trauma patients at risk of pulmonary complications, using parameters available during the initial emergency medical evaluation.

The present study is a prospective observational study done on 200 patients at a tertiary care hospital to determine the predictive ability of the thoracic trauma severity scoring (TTSS) system in predicting morbidity, mortality, and prognostication in thoracic trauma patients.

Amit K Sharma et al. in their study validated the thoracic trauma severity score in chest trauma patients with 110 patients aged >18 years with isolated chest injury. Similar to the present study, the most common mode of chest injury was blunt trauma, and the most common age group affected was 42-54 years. They concluded that TTSS has a direct correlation with the need for oxygenation, ventilator need, duration of hospital stay, mortality, and outcome in chest trauma patients. In the present study, a TTSS of more than 6 was associated with the need for ICU stay, and a TTSS of more than 8 with higher mortality. They recommended and validated TTSS as a useful score for evaluation of prognosis, outcome, and mortality in chest trauma patients. Their study suggested low TTSS values were associated with a good prognosis, and high TTSS values were associated with higher morbidity and mortality[9].

A cross-sectional study by Adel Elbaih et al. on the evaluation of thoracic trauma severity score in predicting the outcome of isolated blunt chest trauma patients included 30 participants, with the majority being males, and the most common mode of injury being motor vehicle collision, similar to the current study. TTSS larger than 7 was found to be a good predictor of mortality among the studied patients. Their study revealed 100% sensitivity and 100% specificity for the prediction of poor outcome (death and ICU admission) versus good outcome (discharge from ER and inpatient admission) with 100% positive predictive value and 100% negative predictive value[10]. Our study showed slightly lower but still high sensitivity (84.6%) and specificity (80.7%) for mortality prediction, possibly due to our larger and more diverse patient population.

Isidro Martínez Casas conducted a retrospective study in 238 patients to determine the predictive and diagnostic value of the thoracic trauma severity score (TTSS) in a population of thoracic trauma patients admitted to a secondary-level trauma center. TTSS with a cut-off value of 8 points had a sensitivity of 66% and specificity of 94% to predict complications and 80% sensitivity and 94% specificity for predicting mortality[11]. In our study, TTSS ≥6 had a higher sensitivity of 99.2% and specificity of 100% in predicting morbidity, while TTSS ≥8 showed comparable results with 84.6% sensitivity and 80.7% specificity for mortality prediction.

A prospective observational cross-sectional study by Vijay Kanake et al. on 284 patients at a tertiary care center concluded that a score of 7.5 and above was associated with morbidity and mortality, and a score of 20 and above predicted a fatal prognosis. In their study, 17.3% had unilateral closed thoracostomy, and 3.9% of patients required bilateral thoracostomy, which is comparable to our findings of 17.5% patients requiring unilateral ICD and 3.5% requiring bilateral ICD. Thoracotomy was required in 3 patients, similar to our study[12].

Tjeerd S Aukema et al conducted a study on 712 patients aimed at validation of the Thorax Trauma severity score for mortality and its value for the development of acute respiratory distress syndrome. They reported a mortality of 10%, while our study had a slightly lower mortality rate of 6.5%. Similar to our findings, patients who developed ARDS or mortality had higher TTSS scores[13].

Rajasekarn Narayanan et al. conducted a study on an analysis of the presentation, pattern, and outcome of chest trauma patients at an urban level 1 trauma center. As per the study, chest trauma occurs in a significant number of trauma patients (30.9%) and commonly affects young males of the productive age group (mean age: 37.8). Road traffic accidents are the leading cause of chest trauma. Only 10% of patients were brought within the Golden Hour, and the majority could be reached within 6 hours of injury. Rib fractures were the most frequent injury, followed by hemothorax and pneumothorax. 73.35% of patients required ICD insertion. 18.68% of patients required mechanical ventilation. 22.25% of patients developed complications, with an overall mortality of 11%[14]. Pradeep et al. conducted a prospective observational study on the clinical profile of chest injury in 150 patients, the majority being males, and a mean age of 37.7. Similar to our study, the majority of patients were males. RTA was the common mechanism of blunt injury affecting 59.86% of patients. Rib fracture was the most common type of chest injury, followed by pneumothorax, 88% and 62%, respectively.

The majority of patients (66.67%) were treated successfully with tube thoracostomy. Their mortality rate was 11.97%[15]. Compared to the demographics of patients in our study, 72% of participants were males. The most common mode of injury was road traffic accidents (77.5%). 21% of participants required ICD insertion, and 7.5% of patients required mechanical ventilation. Our mortality was 6.5%.

A study by Ebel et al. on the evaluation of thoracic trauma severity score in predicting the outcome of isolated blunt chest trauma patients in 30 participants found that 66.6% of patients had a score > 6, and 53.3% of patients required ICU admission. They reported a mortality of 13.3% [16].

Unsworth et al in their study revealed that the majority of reviewed papers recommended a multi-disciplinary approach; however, there was a paucity of evidence describing methods to implement such interventions [17]. TTSS can be used as an effective tool for initial assessment and implementation of care.

Clinical implications:

The findings of this study suggest that TTSS can be implemented as a rapid and effective tool for risk stratification in thoracic trauma patients. Patients with TTSS ≥6 should be considered for early ICU admission and aggressive management to prevent complications. Similarly, patients with TTSS ≥8 should be recognised as high-risk for mortality and managed accordingly. This scoring system can be particularly valuable in resource-constrained settings where optimal allocation of intensive care resources is crucial.

Conclusion

The thorax trauma severity score (TTSS) is an appropriate and viable tool to predict the outcome, morbidity, and mortality in thoracic trauma and is useful in prognostication of thoracic trauma patients across various settings. This scoring system may assist in the triage and resource utilization, such as ICU beds and ventilators. In patients with high TTSS on admission, earlier implementation of treatment strategies such as adequate analgesia, supportive ventilation, and intercostal drainage (ICD) can be applied to reduce morbidity and mortality.

Future research should focus on validating these findings in multicenter studies with larger sample sizes and incorporating TTSS into algorithmic approaches for thoracic trauma management. Additionally, comparative studies with other scoring systems could further establish the relative utility of TTSS in various clinical scenarios.

Recommendations

1. TTSS should be routinely calculated for all thoracic trauma patients at admission to facilitate early risk stratification and appropriate resource allocation.
2. Patients with TTSS ≥6 should be considered for early ICU admission and aggressive monitoring to prevent complications.
3. Patients with TTSS ≥8 should be recognized as high-risk for mortality and managed with intensive care protocols.
4. Future research should focus on validating these findings in multicenter studies with larger sample sizes and incorporating TTSS into algorithmic approaches for thoracic trauma management.
5. Comparative studies with other scoring systems could further establish the relative utility of TTSS in various clinical scenarios.
6. Implementation of TTSS-based protocols in emergency departments and trauma centers should be considered to improve patient outcomes.

Limitations of the study:

1. This was a single-centre study, which may limit the generalizability of the findings.
2. The sample size, though adequate based on power calculations, is still relatively modest.

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