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Comparison of Chest Trauma Score, Revised Trauma Score, and Glasgow Coma Scale in Patients Visiting with Chest Trauma at the Emergency Department

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Abstract

Objective: Thoracic trauma is a significant cause of morbidity and mortality. Accurate assessment of trauma severity is essential for guiding treatment and predicting patient outcomes. This study aims to evaluate the comparative utility of the Glasgow coma scale (GCS), revised trauma score (RTS), and chest trauma score (CTS) to determine the most reliable tool for clinical decision-making in thoracic trauma cases.

Materials and Methods: This prospective, observational cohort study was conducted at a level 1 trauma center between January and June 2015. A total of 110 patients presenting to the emergency department with thoracic trauma were included. Vital signs, trauma scores (GCS, RTS, and CTS), and clinical outcomes were recorded. Primary outcomes included the need for intubation, presence of pneumothorax, and discharge status. Statistical analyses included correlation tests and receiver operating characteristic curve analysis to assess the predictive power of trauma scores.

Results: The patients included in the study were 67.3% male and the mean age was 50.42 years. Patients requiring intubation had significantly lower GCS and RTS scores and higher CTS scores ($p<0.001$). CTS was significantly higher in patients with pneumothorax ($p=0.007$). A strong positive correlation was found between GCS and RTS ($r=0.853$, $p<0.001$), while CTS showed a low negative correlation with both scores ($r=-0.283$, $p=0.003$). CTS showed superior discriminatory power in predicting hospitalization (area under the curve:0.800).

Conclusion: GCS and head revised trauma score are more reliable for assessing overall trauma severity, whereas CTS is more effective in evaluating the severity of chest trauma. A combined approach utilizing all three scores may enhance risk stratification and improve clinical outcomes in patients with thoracic trauma.

Keywords: Chest trauma score, revised trauma score, Glasgow coma scale, thoracic trauma

Introduction

Thoracic trauma is a significant cause of morbidity and mortality, often resulting from mechanisms such as blunt force, penetrating injuries, or motor vehicle accidents. The timely and accurate assessment of patients with chest injuries is crucial for improving clinical outcomes. In the emergency department, various scoring systems are utilized to evaluate trauma severity, guide treatment decisions, and predict patient prognosis [1,2]. Among these, the chest trauma score (CTS), the revised trauma score (RTS), and the Glasgow coma scale (GCS) are widely used to assess different aspects of trauma severity [3-5].

Developed by Teasdale and Jennett [5] in 1974, the GCS is the most commonly used scoring system worldwide for evaluating the level of consciousness in patients with head trauma. The scale comprises three components: eye opening, verbal response, and motor response, with scores ranging from 3 to 15. Lower

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scores indicate a deterioration in the level of consciousness. The RTS is a broader tool that assesses trauma patients based on physiological parameters such as respiratory rate (RR), systolic blood pressure (SBP), and GCS [4]. The CTS, specifically designed to evaluate the severity of chest injuries, considers factors such as rib fractures and pulmonary contusions [3].

The aim of this study is to analyze the concordance of GCS, RTS, and CTS in predicting the prognosis of patients presenting to the emergency department with thoracic trauma. By comparing these trauma scoring systems, the study seeks to identify the most reliable tool for clinical decision-making in the management of thoracic trauma cases.

Materials and Methods

Study Setting and Design

This prospective, observational cohort study was conducted in the Department of Emergency Medicine, Göztepe Prof. Dr. Süleyman Yalçın City Hospital, a level 1 trauma center that serves approximately 300,000 patients annually, including 30,000 trauma cases. The study was carried out using a consecutive sampling of patients presenting with thoracic trauma between January 1, 2015, and June 30, 2015.

Patient Selection and Inclusion/Exclusion Criteria

The study population consisted of all patients who were triaged to the red zone for acute care and received trauma management upon admission. The inclusion criteria were as follows:

• Vital signs and trauma score components were recorded within 30 minutes of admission.

• Patients aged 18 years or older

• Patients who were assigned a red-zone triage code and underwent examination and follow-up in this area

• First-time presentation for the same trauma complaint.

Patients who initially consented but later withdrew their consent were excluded from the study sample.

Data Collection and Applied Protocol

As part of the study, trauma management was performed according to the advanced trauma life support guidelines by emergency medicine specialists and resident physicians at the time of initial presentation [6]. During this process, key parameters such as temperature, pulse, RR, peripheral oxygen saturation (SO_2), SBP, diastolic blood pressure (DBP), GCS, CTS, and RTS were recorded. Additionally, the clinical team noted the trauma mechanism.

All measurements and recordings were conducted using a standardized form. Subsequently, the study investigators supplemented the records with additional clinical information. The clinical course of the patients (discharge, hospitalization, mortality), the department or intensive care unit (ICU), to which they were admitted (if applicable), and the need for surgical intervention were retrieved from the hospital's electronic medical records system.

The collected data were transferred into a specially developed electronic calculation software, which automatically computed the patients' GCS, RTS, and CTS scores using the relevant formulas and calculation methods. To minimize bias, these calculations were conducted in a blinded manner, ensuring that patient data remained inaccessible to the study investigators and researchers.

Statistical Analysis

Continuous variables were expressed as mean, standard deviation, and 95% confidence interval (CI), while categorical variables were reported as frequency and percentage. For variables with less than 10% missing data, acute physiology and chronic health evaluation II (APS II) predictive modeling was applied assuming a normal distribution to complete the missing values. Depending on the distribution of continuous variables, comparisons between two groups were made using either the t-test or the Wilcoxon rank-sum test. Statistical significance was assessed using an independent samples t-test. Levene's test was performed to check for homogeneity of variances, and the p-value was calculated depending on whether variances were equal or unequal. The correlation analysis for continuous variables was conducted using Pearson's method. Receiver operating characteristic (ROC) curves were generated using SPSS v20 (IBM, USA) and MedCalc (MedCalc Software version 10.4.0.0; MedCalc, Mariakerke, Belgium), plotting sensitivity (true positive rate) against the false positive rate (1 -specificity). The area under the curve (AUC) was calculated for each decision criterion. The standard error of the ROC curves and p-values was compared using the method described by Hanley and McNeil. For all analyses, a p-value of <0.05 was considered statistically significant.

Trauma Scoring Systems

Glasgow Coma Scale

Developed by Jennett and Teasdale in 1974, the GCS is widely used to assess the level of consciousness in patients with head trauma. The scale consists of three parameters: eye opening, verbal response, and motor response. The total score ranges from 3 to 15, with lower scores indicating a deterioration in the patient's level of consciousness [5].

Revised Trauma Score

Introduced in the early 1980s, the RTS incorporates three specific physiological parameters: GCS, SBP, and RR. It is recommended for use at the scene of injury or upon the patient's initial evaluation in the emergency department.

In its triage form, each parameter is assigned a score between 0 and 4, resulting in a total score between 0 and 12. In the calculated form, weighting coefficients are applied to each parameter, yielding the RTS value (ranging from 0 to 7.8408) [4].

Head revised trauma score (hRTS)=0.9368×GCS score+ 0.7326×SBP score+0.2908×RR

Chest Trauma Score

The CTS is calculated based on age, the presence of pulmonary contusion, and rib fractures. It quantifies trauma severity on a scale ranging from 2 to 12. The assigned scores, determined according to age groups, pulmonary contusions, and rib fractures, serve as an additional parameter in the clinical assessment of patients [3].

Ethical Approval

The study was approved by the Göztepe Prof. Dr. Süleyman Yalçın City Hospital Ethics Committee on April 21, 2015. Patient confidentiality was strictly maintained, and the study was conducted in accordance with the Declaration of Helsinki (approval number: 2015/0029, date: 21.04.2015). Written informed consent was obtained from all patients.

Results

A total of 110 patients who visited our emergency department between January 2015 and June 2015 and met the study inclusion criteria were enrolled. Among the participants, 36 (32.7%) were female and 74 (67.3%) were male, with a statistically significant predominance of male patients (one-sample binomial test, $p<0.001$). A total of 32.7% (n=36) of the patients arrived at the emergency department via ambulance. The majority of patients (81.8%, n=90) had no history of comorbidities (Table 1).

In the study population, 11 patients (10.09%) developed pneumothorax. Among them, 3 patients (2.7%) underwent tube thoracostomy. Of the patients managed and treated in the emergency department, 83.6% (n=92) were discharged, while 5 patients (4.5%) were admitted to the ICU. The number of patients requiring intubation was 4 (3.6%), and 1 patient (0.9%) was recorded as deceased (Table 1).

The mean age of the patients was 50.42±20.46 years, with a median age of 49.5 years. The mean systolic and DBPs were 114.50±15.16 mmHg and 71.52±9.93 mmHg, respectively. The mean pulse rate was 79.05±13.15 beats per minute, the RR was 15.68±3.16 breaths per minute, and the body temperature was 36.55±0.20°C. The mean blood glucose level was 108.67±24.28 mg/dL, and the mean SO_2 was 97.45±2.16% (Table 2).

The study compared trauma scores based on the presence of pneumothorax, intubation requirement, and discharge status. While there was no significant difference in GCS and RTS scores between patients with and without pneumothorax ($p>0.05$), CTS was significantly higher in patients with pneumothorax (median: 5.00; 25^{th}-75^{th} percentile: 2.00-7.00; $p=0.007$). Patients requiring intubation had significantly lower GCS (median: 4.00; 25^{th}-75^{th} percentile: 3.00-8.00), hRTS (median: 4.05; 25^{th}-75^{th} percentile: 3.54-5.13), and CTS (median: 6.00; 25^{th}-75^{th} percentile: 5.00-9.50) compared to those who did not require intubation ($p=0.000$, $p=0.000$, $p=0.001$, respectively). When comparing discharged and non-discharged patients, non-discharged patients had lower GCS scores (median: 15.00, interquartile range (IQR): 12.00-15.00), lower hRTS

Table 1. Gender distribution and frequencies of patients

Variable	Category	n (%)
Gender	Female	36 (32.7)
	Male	74 (67.3)
Mode of arrival	By ambulance	36 (32.7)
	By own means	74 (67.3)
Chronic disease	None	90 (81.8)
	Hypertension	13 (11.8)
	Diabetes mellitus	3 (2.7)
	Dementia	2 (1.8)
	Nephrotic syndrome	1 (0.9)
	Depression	1 (0.9)
Tube thoracostomy	Yes	3 (2.7)
	No	107 (97.3)
Endotracheal intubation	Yes	4 (3.6)
	No	106 (96.4)
Pneumothorax	Present	11 (10.0)
	Absent	99 (90.0)
Disposition	Discharged	92 (83.6)
	ICU admission	5 (4.5)
	Ward admission	12 (10.9)
	Deceased	1 (0.9)

ICU: Intensive care unit

Table 2. Age and vital signs of patients

Parameter	Mean ± SD	Median (25^{th}-75^{th} percentile)
Age	50.42±20.46	49.5 (32.0-64.0)
Systolic BP (mmHg)	114.50±15.16	110.0 (110.0-120.0)
Diastolic BP (mmHg)	71.52±9.93	70.0 (67.0-80.0)
Heart rate (bpm)	79.05±13.15	76.0 (72.0-85.0)
Respiratory rate (breaths/min)	15.68±3.16	14.0 (14.0-17.0)
Temperature (°C)	36.55±0.20	36.6 (36.5-36.7)
Blood glucose (mg/dL)	108.67±24.28	102.0 (97.0-112.0)
SpO_2 (%)	97.45±2.16	98.0 (97.0-98.0)

SD: Standard deviation, min: Minimum, BP: Blood pressure, SpO_2 : Peripheral capillary oxygen saturation scores (median: 7.84, IQR: 6.90-7.84), and higher CTS scores (median: 4.50, IQR: 2.00-6.00) (p=0.000, p=0.000, p=0.004, respectively). These findings indicate significant relationships between trauma scores and pneumothorax development, intubation requirement, and discharge status (Table 3).

The correlation between trauma scores and ED discharge status was assessed using Spearman's rho test. The analysis revealed a strong positive correlation between GCS and RTS (r=0.853, p<0.001). A moderate negative correlation was observed between CTS and GCS (r=-0.337, p<0.001), and a significant negative correlation was also found between CTS and hRTS (r=-0.283, p=0.003). These results suggest that GCS and RTS exhibit similar trends, whereas CTS demonstrates an inverse relationship with these scores (Table 4).

The CTS score demonstrated the highest discriminative power with an AUC of 0.800 (95% CI: 0.713-0.871), whereas the GCS and RTS scores had AUC values of 0.633 (95% CI: 0.536-0.723) and 0.655 (95% CI: 0.559-0.743), respectively. Based on the highest Youden index (J), a cut-off value of ≤3 was determined for the CTS score, yielding a sensitivity of 72.6% and a specificity of 80.0% (Figure 1).

Discussion

In our country, approximately 130 million emergency visits occur annually, with around 1,600 emergency thoracic surgeries performed each year [7,8]. The timely and accurate assessment of patients with chest trauma is crucial for improving clinical outcomes. In the emergency department, various scoring systems are utilized to determine trauma severity, guide treatment decisions, and predict patient prognosis [3-5]. This study aimed to evaluate trauma severity using GCS, RTS, and CTS in patients presenting with thoracic trauma and to analyze the correlation between these scoring systems.

In our study, the comparison of trauma scores based on discharge status revealed a strong positive correlation between

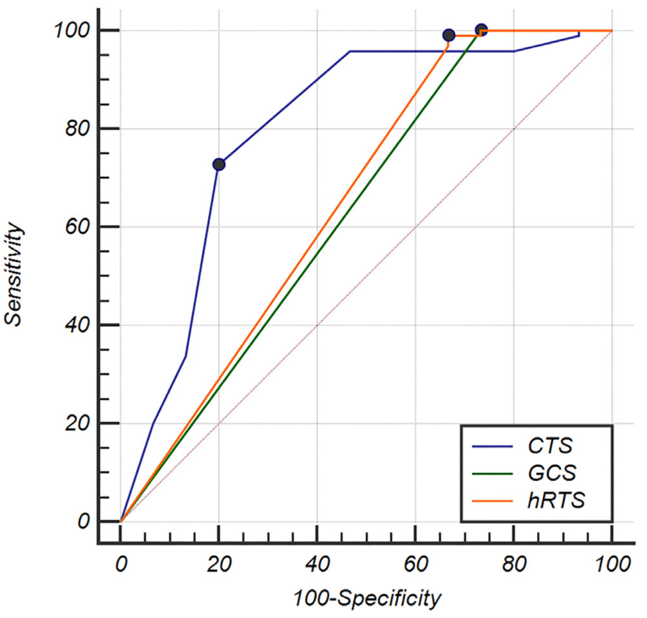

Figure 1. Area under the curve analysis of the CTS, RTS, and GCS for predicting hospitalization in patients with thoracic trauma

CTS: Chest trauma score, GCS: Glasgow coma scale, RTS: Revised trauma score

Table 3. Distribution of severity scores according to pneumothorax, intubation, and emergency department outcomes

Condition	Subgroup	GCS median (IQR)	RTS median (IQR)	CTS median (IQR)	p-value
Pneumothorax	Present (n=11)	15.0 (15.0-15.0)	7.84 (7.84-7.84)	5.0 (2.0-7.0)	0.057
	Absent (n=99)	15.0 (15.0-15.0)	7.84 (7.84-7.84)	3.0 (2.0-4.0)	0.007
Intubation	Yes (n=4)	4.0 (3.0-8.0)	4.05 (3.54-5.13)	6.0 (5.0-9.5)	<0.001
	No (n=106)	15.0 (15.0-15.0)	7.84 (7.84-7.84)	3.0 (2.0-4.0)	0.001
Emergency department outcome	Discharged (n=92)	15.0 (15.0-15.0)	7.84 (7.84-7.84)	3.0 (2.0-4.0)	<0.001
	Hospitalized (n=18)	15.0 (12.0-15.0)	7.84 (6.90-7.84)	4.5 (2.0-6.0)	0.004

IQR: Interquartile range, GCS: Glasgow coma scale, RTS: Revised trauma score, CTS: Chest trauma score

Table 4. Correlation of trauma scores with emergency department discharge

Scores	SD	GCS	hRTS	CTS
GCS	Correlation coefficient	1.000	0.853	-0.337
	p*	.	<0.001	<0.001
RTS	Correlation coefficient	0.853	1.000	-0.283
	p*	<0.001	.	0.003
CTS	Correlation coefficient	-0.337	-0.283	1.000
	p*	<0.001	0.003	.

*Spearman's rho test.

SD: Standard deviation, CTS: Chest trauma score, GCS: Glasgow Coma Scale, RTS: Revised trauma score, hRTS: Head revised trauma score

GCS and RTS (r=0.853, p<0.001). This finding aligns with the reliability of GCS in assessing consciousness levels and the RTS's ability to integrate physiological parameters such as RR, SBP, and GCS score, thereby reflecting the overall trauma severity. Similarly, literature reports indicate that hRTS is particularly effective in predicting prognosis in critically ill patients [4,9]. The negative correlation between CTS and other scoring systems (GCS: r=-0.337, p<0.001; hRTS: r=-0.283, p=0.003) is because CTS evaluates thoracic trauma severity based on different parameters. Specifically, CTS incorporates factors such as age, pulmonary contusion, and rib fractures, making it a chest trauma-specific score that functions independently from other general trauma scoring systems [3,10].

In our study, CTS values were significantly higher in patients who developed pneumothorax (p=0.007), whereas no significant difference was observed in GCS and RTS scores. This finding suggests that CTS better reflects the severity of specific chest injuries such as pneumothorax [3,11]. The findings obtained in this study align with the existing literature regarding the relationship between chest trauma scoring systems and clinical outcomes [3,12]. Specifically, we observed that patients with higher CTSs had a greater need for intubation and a higher incidence of pneumothorax. Similarly, a study by Pressley et al. [13] demonstrated that higher CTS values were associated with an increased likelihood of pulmonary complications and intubation. Additionally, Chen et al. [3] reported that patients with a CTS score of ≥5 had a significantly higher risk of developing pneumonia and requiring mechanical ventilation. These findings are consistent with our study's results regarding the role of CTS in predicting respiratory complications.

Similarly, in patients requiring intubation, GCS, RTS, and CTS values were significantly different (p=0.000, p=0.000, p=0.001, respectively). In particular, lower GCS and RTS scores indicate a deterioration in clinical condition. Given that intubation necessity is directly related to a patient's level of consciousness and respiratory capacity, it can be inferred that GCS and hRTS are more sensitive in determining the need for intubation [5,6].

In the analysis based on discharge status, non-discharged patients had lower GCS and hRTS scores but higher CTS scores (p=0.000, p=0.000, p=0.004). These findings suggest that higher CTS values in patients with severe chest trauma are associated with an increased need for hospitalization. On the other hand, lower GCS and RTS values are linked to greater systemic trauma severity and are considered important indicators of mortality risk [14,15].

The results of our study indicate that trauma scoring systems can be utilized in different clinical domains for patients with chest trauma. While GCS and RTS appear to be more suitable for the general assessment of systemic trauma and prognosis prediction, CTS may be more effective in specifically evaluating the severity of chest trauma. In this context, adopting a combined scoring approach in the management of chest trauma patients may enable a more accurate risk stratification, ultimately leading to improved patient outcomes.

In this study, the CTS score demonstrated superior discriminative power in predicting hospital admission in patients with thoracic trauma compared to the GCS and RTS scores. These findings suggest that the CTS score is a more reliable predictor of hospital admission, effectively identifying patients requiring hospitalization while minimizing unnecessary admissions. Its ability to balance sensitivity and specificity highlights its potential utility in clinical decision-making, ensuring both timely identification of at-risk patients and optimal resource allocation. Future research should explore the prognostic value of the CTS score beyond hospital admission, particularly its association with mortality and clinical outcomes. Additionally, its performance across different trauma mechanisms warrants further investigation. Exploring whether the CTS score can enhance predictive accuracy when combined with existing scoring systems, such as GCS and RTS, may further refine risk stratification strategies in emergency trauma care.

The most significant strength of this study is its direct comparison of different scoring systems in patients with chest trauma, allowing for an evaluation of each system's relationship with clinical outcomes within the same cohort. While most studies in the literature focus on the validation or prognostic value of a single scoring system, our study simultaneously analyzed CTS, RTS, and GCS, providing a comparative perspective. Additionally, the sequential inclusion of patients presenting to the emergency department ensures that the study reflects real-world data, which helps minimize selection bias. Another methodological strength is that all scoring data were obtained from the initial assessment within the same time frame, enhancing consistency between scores. Lastly, the alignment of our findings with the existing literature supports the generalizability of our results.

However, this study also has certain limitations. One of the main limitations is that it was conducted in a single center, which may restrict the external validity of the findings. Additionally, the study primarily focused on short-term clinical outcomes, such as hospital admission and ICU requirement, while long-term outcomes, including functional status and quality of life, were not evaluated. Another potential limitation concerns the calculation of CTS, as some of its parameters, such as pulmonary contusion scoring, require a standardized protocol [16]. Although all imaging studies in our research were performed using a consistent protocol, variations in interpretation could have influenced CTS calculations. Furthermore, commonly used anatomical trauma scores, such as the injury severity score and the abbreviated ınjury scale, were not included in the analysis, preventing a comparative perspective on overall trauma severity [17,18]. The relatively limited sample size may have also reduced the statistical power of subgroup analyses. For instance, if the number of penetrating chest trauma cases was low, it might have prevented a separate evaluation of the performance of scoring systems within this subgroup.

Study Limitations

Despite these limitations, our study provides a meaningful contribution to the literature. Given the limited number of studies in Türkiye that evaluate chest trauma scoring systems collectively, our findings offer valuable insights for both clinicians and researchers. To address these limitations and strengthen the evidence base, we believe that future studies with larger sample sizes and prospective designs should be planned.

Conclusion

In patients presenting to the emergency department with chest trauma, GCS, RTS, and CTS are scoring systems that assess different clinical conditions while maintaining interrelated characteristics. While GCS and RTS appear to be more reliable in determining overall trauma severity, CTS more accurately reflects the severity of chest trauma. Therefore, utilizing these scores collectively in emergency settings may provide a more comprehensive assessment, ultimately enhancing patient management.

Ethics

Ethics Committee Approval: The study was approved by the Göztepe Prof. Dr. Süleyman Yalçın City Hospital Ethics Committee on April 21, 2015. Patient confidentiality was strictly maintained, and the study was conducted in accordance with the Declaration of Helsinki (approval number: 2015/0029, date: 21.04.2015).

Informed Consent: Written informed consent was obtained from all patients.

Footnotes

Authorship Contributions

Concept: İ.Y., D.A., Design: İ.Y., D.A., Data Collection or Processing: İ.Y., D.A., Analysis or Interpretation: İ.Y., D.A., Literature Search: İ.Y., D.A., Writing: İ.Y., D.A.

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