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Quantification of rib fractures by different scoring systems

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ABSTRACT

Background: The three known systems for evaluation of patients with rib fractures are rib fracture score (RFS), chest trauma score (CTS), and RibScore (RS). The aim was to establish critical values for these systems in different patient populations.

Methods: Retrospective cohort study included 1089 patients with rib fractures, from level-1 trauma center; divided into two groups: first group included 620 nongeriatric patients, and second group included 469 geriatric patients (≥65 y.o.). Additional variables included mortality, injury severity score (ISS), hospital and intensive care unit lengths of stay (HLOS, ICULOS), duration of mechanical ventilation, rate of pneumonia (PN), tracheostomy, and epidural analgesia.

Results: RFS critical values were 10 for nongeriatric and eight for geriatric patients, CTS were four and six respectively, and RS were one for both. Nongeriatric patients with RFS ≥10 *versus* RFS <10, had higher mortality, ISS, HLOS, ICULOS, and tracheostomy (P <0.03). Geriatric patients with RFS ≥8 *versus* RFS <8, had higher mortality, ISS, HLOS, ICULOS, and PN (P <0.03). Nongeriatric patients with CTS ≥4 *versus* CTS <4, had higher mortality, ISS, HLOS, ICULOS, duration of mechanical ventilation, and PN (P < 0.02). Geriatric patients with CTS ≥6 *versus* CTS <6 had greater values for all variables (P < 0.01). Both groups with RS ≥1 *versus* RS <1, had greater values for all variables (P < 0.05). In geriatric group, prediction of PN was good by CTS (c = 0.8) and fair by RFS and RS (c = 0.7).

Conclusions: Physicians should choose score to match specific population and collected variables. RFS is simple but sensitive in elderly population. CTS is recommended for geriatric patients as it predicts PN the best. RS is recommended for assessment of severely injured patients with high ISS.

An abstract containing findings from this study was presented at the 13th Annual Academic Surgical Congress (January 30-February 1, 2018, Jacksonville, FL).

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Introduction

Rib fractures are among the most common injuries associated with blunt trauma.[1] Surgical interventions or conservative treatment, related to rib fracture management, vary depending on the severity of injuries.[2] When it comes to assessment of patients with rib fractures, there are no standardized guidelines and no universal scoring system for quantifiable evaluation. There are five major rib scoring systems that have been developed, to date, using different patient populations and including different variables.[3-7] Rib scoring systems are aimed to provide more specific assessment of patients with rib fractures. The three commonly described systems are rib fracture score (RFS), chest trauma score (CTS), and RibScore (RS). RFS, CTS, and RS each include a different set of variables (Table 1). All these systems are intended to act as a simple tool of evaluation, assisting in treatment decisions and prognosticating outcomes of patients with rib fractures. Reports are scarce on the application of these systems, and their usability in different patient populations has yet to be delineated. Therefore, the goals of this study were to: (1) evaluate trauma patients with rib fractures using RFS, CTS, and RS, (2) determine score values in different age categories of trauma patients, and (3) provide practical recommendations and possibly predict rib fractures-related complications and outcomes.

Methods

This institutional review board–approved study was granted a waiver for informed consent and conducted at a state certified level I trauma center. The retrospective cohort included 1089 patients, with radiologically confirmed rib fractures (computed tomography, X-ray), who were delivered to the hospital as trauma alert, upgrade or transfer, between January 2011 and June 2017. Patients were further divided into two cohorts, the nongeriatric and geriatric. The first group included 620 nongeriatric patients between 15 and 64 y of age, and the second group comprised 469 geriatric patients, aged 65 y and over. Patients' data were extracted from the trauma registry and supplemented with additional variables from medical records and radiological reports. International Classification of Diseases ninth and 10th versions were used to identify patients with rib fractures. Collected variables included age, injury severity score (ISS), number of ribs fractured, number of total fractures of the ribs, segmental location of fractures, bilaterality of fractures, presence of flail chest, presence and severity of pulmonary contusion, mortality, hospital length of stay (HLOS), intensive care unit length of stay (ICULOS), duration of mechanical ventilation (DMV), rate of tracheostomies, pneumonia (PN), and epidural analgesia.

RFS was calculated as number of total fractures of the ribs (breaks) multiplied by the number of sides (× 1 for single side fractures or × 2 for bilateral fractures) plus the age factor (51-60 = 1; 61-70 = 2; 71-80 = 3; >80 = 4).[3]

CTS was calculated as a sum of points from: the age factor (<45 = 1; 45-65 = 2; >65 = 3), number of ribs fractured (<3 = 1; 3-5 = 2; >5 = 3), additional two points if the fractures were present on both sides, and pulmonary contusion points (mild = 1; severe = 2; bilateral = 3).[4] Pulmonary contusion severity was defined by radiologist.

RS gave one point for presence and zero points for absence of each of the following injuries: six or more ribs fractured, bilateral rib fractures, occurrence of flail chest, more than three displaced rib fractures, first rib fractured, fractures present in all three segmental locations (anterior, lateral, and posterior).[5]

Statistical analysis was performed using IBM SPSS Statistics version 24.0 software (IBM Corporation, Armonk, NY). The analyses included group characteristics, bivariate correlation comparisons, linear regression, and receiver operator characteristics (ROC) models. For group characteristics, calculations included mean values for variables and inter quartile range for rib scores. Categorical variables were analyzed with χ^2 test. Two-sided independent samples *t*-tests for normally distributed variables and Wilcoxon rank sum tests for nonparametric data were used to compare variable means. Statistical significance was assumed, when calculated *P* value was below 0.05. In linear regression models, Pearson coefficient (r) of $0.1< |r| <0.3$ denoted a weak correlation, $0.3< |r| <0.5$ a moderate correlation, and $0.5< |r|$ a strong correlation. The ROC area under the curve (AUC) prediction values (*c*) were as follows: $0.5 < c < 0.6$ denoted failed prediction, $0.6 < c < 0.7$ poor prediction, $0.7 < c < 0.8$ fair prediction, $0.8 < c < 0.9$ good prediction, and $0.9 < c < 1$ an excellent prediction.

Determination of critical values for each score included calculation of the cut points. A number of cut points, for a set of variables (mortality, ISS, lengths of stay, DMV), were assessed to determine if there are significant differences in outcomes within groups. The comparison was initiated at a value of one, for each scoring system, and that value was increased by one point until the statistical difference in variable means for population below and above that cut point became significant. The lowest score that showed a significant difference in relation to evaluated variables was considered a critical value for the score in each group. The critical score signifies the value above which the patients have significantly worse outcomes and therefore should alert the clinicians and prompt considerations for more aggressive treatment options.

Table 1 – RFS, CTS, and RS variables.

Variable	RFS	CTS	RS
Number of ribs fractured		✓	
Number of breaks	✓		
Bilateral fractures	✓	✓	✓
Flail chest			✓
≥3 displaced rib fractures			✓
≥6 ribs fractured			✓
First rib fractured			✓
Fracture in each rib segment			✓
Age	✓	✓	
Pulmonary contusion (severity and laterality)		✓	