



Increasing number of fractured ribs is not predictive of the severity of splenic injury following blunt trauma: An analysis of a National Trauma Registry database



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ABSTRACT

Background: Association between rib fractures and incidence of abdominal solid organs injury is well described. However, the correlation between the number of fractured ribs and severity of splenic injury is not clear. The purpose of this study was to assess whether an increasing number of rib fractures predicts the severity of splenic injury in blunt trauma patients.

Study design: A retrospective cohort study involving blunt trauma patients with concomitant splenic injuries and rib fractures, between the years 1998 and 2012, registered in the Israeli National Trauma Registry.

Results: Of 321,618 patients with blunt mechanism of trauma, 57,130 had torso injuries, and of these 14,651 patients sustained rib fractures, and 3691 patients suffered from splenic injury. Concomitant splenic injury occurred in 1326 of the patients with rib fractures (9.1%), as compared to 2365 patients sustaining splenic injury without rib fractures (5.6%). The incidence of splenic injury among patients sustaining 5 or more rib fractures was significantly higher compared to patients suffering from 1 to 4 rib fractures. Among patients with splenic injury, the tendency to sustain associated rib fractures increased steadily with age. Patients with concomitant rib fractures had higher Injury Severity Score (ISS), but similar mortality rates, compared to patients with splenic injury without rib fractures. Among patients with concomitant rib fractures and splenic injury, there was no relation between the number of fractured ribs and the severity of splenic injury, neither as a whole group, nor after stratification according to the mechanism of injury.

Conclusions: Although the presence of rib fractures increases the probability of splenic injury in blunt torso trauma, there is no relation between the number of fractured ribs and splenic injury severity.

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Introduction

Rib fractures are considered a marker of severe injury, predictive of higher mortality and higher rates of associated injuries [1]. In elderly patients, rib fractures increase the risk of in-

hospital mortality regardless of the presence or absence of other injuries [2]. The number of ribs broken has been found to be an independent risk factor for patient death [3].

Abdominal solid organ injuries are not uncommon in patients suffering from rib fractures following blunt trauma. Splenic injury, specifically, has been found to occur in as many as 6.3–23% of this patient population [4–6]. This high occurrence of associated splenic injury has led to the common practice of obtaining abdominal imaging for patients with multiple rib fractures.

The primary aim of this study was to examine the relationship between the number of fractured ribs to the presence and severity of splenic injury following blunt trauma. The secondary aim was to assess the relationship between splenic injury and other factors,

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such as mechanism of trauma and age, within the group of patients with rib fractures.

Methods

We performed a retrospective cohort study involving blunt trauma patients with concomitant splenic injuries and rib fractures, between the years 1998 and 2012. The data was obtained from the records of The Israeli National Trauma Registry (INTR) maintained by Israel's National Centre for Trauma and Emergency Medicine Research, in the Gertner Institute for Epidemiology and Health Policy Research. This institute records information concerning trauma patients hospitalised in 19 hospitals of which six are Level I trauma centres and thirteen are Level II trauma centres. Close to its foundation in 1998, INTR included 8 trauma centres and with gradual accreditation, in 2012 it incorporated 19 trauma hospitals.

Data collected in the registry include age, gender, mechanism of injury, number of fractured ribs, severity of the splenic injury, Injury Severity Score (ISS), and mortality. Whenever present, splenic injuries were classified as either minor (AAST grade I and II injuries), moderate (AAST grade III), major (AAST grade IV), or massive (AAST grade V). We compared the severity of splenic injury among patients suffering from different numbers of rib fractures.

Statistical analysis was performed using GraphPad InStat® Version 3.10 (GraphPad Software Inc., San Diego, CA). Statistical tests performed included Chi-square test for independence and two-sided Fisher's exact probability test. To allow subgroup analysis according to mechanism of trauma, patients with laceration and massive disruption were grouped together and compared according to predefined subgroups of 1–3, 4–5 and 6 or more broken ribs. A *p*-value of less than 0.05 was considered statistically significant.

Results

The registry included 321,618 blunt trauma patients, of whom 57,130 were identified as suffering from torso injuries. Of the patients with torso injuries, 14,651 (25.6%) sustained rib fractures, and 3691 suffered from blunt splenic injury. Table 1 shows the distribution of patients with and without rib fractures and/or splenic injury. Splenic injury was associated with rib fractures in 1326 (9.1%) patients, as compared to 2365 (5.6%) patients with splenic injury but without rib fractures (*p* < 0.001).

Table 2 shows the incidence of rib fractures in patients with splenic injury according to age group. There was a steady increase in the relative incidence of rib fractures with increasing age of the victims (*p* < 0.001). While only 10.2% of the 0–14 years' age group had concomitant rib injuries, this incidence increased to more than 66% in patients aged 60 years and over.

Table 3 shows the incidence of rib fractures in patients with splenic injury stratified according to the Injury Severity Score (ISS). Patients with rib fractures had a significantly higher ISS (*p* < 0.001). In some patients this increase in ISS was secondary to the additive value of rib fractures abbreviated injury scale only,

Table 1
Distribution of patients suffering from torso blunt trauma: with and without splenic injury, with and without rib fractures.

	Patients without rib fractures	Patients with rib fractures	Total
No splenic injury	40,114 (94.4%)	13,325 (90.9%)	53,439
Splenic injury	2365 (5.6%)	1326 (9.1%)	3691
Total	42,479	14,651	57,130

Table 2
Presence of rib fractures by age groups of patients with splenic injury.

Age (years)	No rib fractures (n = 2365)	Rib fractures (n = 1326)	Total (n = 3691)
0–14	768 (89.8%)	87 (10.2%)	855
15–29	980 (68.2%)	457 (31.8%)	1437
30–44	321 (51.8%)	299 (48.2%)	620
45–59	184 (42%)	254 (58%)	438
60–74	71 (33.3%)	142 (66.7%)	213
75+	41 (32%)	87 (68%)	128

Table 3
Presence of rib fractures by Injury Severity Score (ISS) of patients with splenic injury.

ISS	No rib fractures (n = 2365)	Rib fractures (n = 1326)	Total (n = 3691)
1–8	516 (87.9%)	71 (12.1%)	587
9–14	523 (78.1%)	147 (21.9%)	670
16–24	546 (64%)	307 (36%)	853
25–75	780 (49.3%)	801 (50.7%)	1581

while in others this was secondary to associated injuries. Whatever the cause for increased ISS, the mortality rate in those with rib fractures and those without was similar, 9.6% and 8.4% respectively (*p* = 0.27).

The incidence of splenic injury was assessed according to the number of fractured ribs. Of the 14,651 patients with rib fractures, 2624 were excluded because they sustained an unknown number of fractured ribs (Table 4). The incidence of splenic injury was significantly higher among patients suffering from 5 or more fractured ribs, compared to patients sustaining up to 4 fractured ribs (*p* value < 0.0001) (see Table 5).

Table 6 shows the distribution of splenic injury severity according to the number of fractured ribs and according to the mechanism of injury. Again, no differences were found in the distribution of severity of splenic injury or mechanism of injury according to the number of fractured ribs within each of the subgroups of patients.

Discussion

Several studies describe rib fracture as an indicator of blunt trauma severity. Both number of fractured ribs and patients age have been described as risk factor for increase in mortality and morbidity rates [7]. Higher mortality rates in patients with rib fractures mainly affects patients older than 65 years [8–10]. Nevertheless, tendency towards higher morbidity and mortality has also been described in younger patients as well [12].

An association between rib fractures and intra-abdominal solid organ injuries is well described [8]. Al-Hassani found that 28% of

Table 4
Incidence of concomitant splenic injury in patients with rib fractures, according to number of fractured ribs.

Number of fractured ribs	No splenic injury	Splenic injury	Total
1 RIB	2210 (92.2%)	185 (7.7%)	2395
2 RIBS	2726 (93.5%)	188 (6.4%)	2914
3 RIBS	2386 (92.5%)	192 (7.4%)	2578
4 RIBS	1383 (92.4%)	113 (7.5%)	1496
5 RIBS	880 (90.7%)	90 (9.2%)	970
6 RIBS	559 (89.8%)	63 (10.1%)	622
7 RIBS	362 (88.9%)	45 (11%)	407
8+ RIBS	532 (82.5%)	113 (17.5%)	645
Total	11,038	989	12,027

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