



ORIGINAL CASE REPORT

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TRAUMATIC DIAPHRAGMATIC INJURY IN PATIENTS WITH MULTIPLE RIB FRACTURES (FLAIL CHEST): A RETROSPECTIVE STUDY

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ABSTRACT

Traumatic diaphragmatic injury has been found in 3%–8% of patients undergoing surgical exploration after blunt trauma and in 10% of patients with penetrating trauma (Larici *et al.*, 2002; Nchimi *et al.*, 2005). Traumatic diaphragmatic injury (TDI) needs early diagnosis and operation. However, the early diagnosis is usually difficult, especially in the patients without diaphragmatic hernia. The rate of initially missed diagnoses on computed tomography (CT) ranges from 12% to 63%. A missed diagnosis can later present as intrathoracic visceral herniation and strangulation with a mortality rate of 30%–60% (Nchimi *et al.*, 2005; Chen *et al.*, 2010).

Methods: Between 2005 and 2015 a total of 34 patients were diagnosed with TDI, (Male 76% (n: 26) and Female) of these 34 patients with TDI, 18 patient's combinations of TDI and rib fractures (Male: 88% (n: 15) and Female: 24% (n: 8) 12% (n: 3) following blunt trauma. Table A

Results: The Average age was: 57 ± 27 and the mechanism of injury were MVA 47% (n:18), fall 38% (n:13). Tab- 1, Number of patients, age, and sex. The ISS for TDI with multiple rib fracture was ($17,9 \pm 32,1$ * and for TDI following trauma was $25,9 \pm 26,1$), the mechanism of injury was MVA, Fall and other. Tab- 2&3 The TDI was diagnosed by CT/CXR or suspected TDI on CT. Associated injuries in 18 patients were pulmonary contusion and rib fractures, but we demonstrated other injuries as injury to liver and spleen. Tab- 4&5 Surgical management of our patients included thoracotomy, thoracoplasty (for flail chest or instable thoracic cage) or laparotomy. Tab- 5 * $P < 0,005$ compared to Blunt trauma TDI.

Conclusions: Patients suffering multiple rib fractures may have a "silent" TDI despite a normal imaging. When performing rib plating examination of the diaphragm is of paramount importance to rule out TDI.

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INTRODUCTION

In the 20th century of high-speed travel and violence, chest trauma is occurring with ever increasing frequency. Today, death resulting from thoracic trauma ranks third after cancer and cardiovascular diseases. Despite major developments in

the management of trauma, it remains the leading cause of mortality. (Ceran *et al.*, 2002) The most common and well described traumatic injury to the diaphragm following blunt trauma is a rupture of the left hemi-diaphragm, an injury most commonly caused by the sudden increase in intra-abdominal pressure secondary to blunt trauma to the abdomen (Ties *et al.*, 2014). The focus of this study is the less well described group of patients suffering a traumatic diaphragmatic injury (TDI) following blunt trauma to the thorax that also causes multiple

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rib fractures. Rib fractures are common, patients manifesting in 8,98-10% of trauma patients (Flagel *et al.*, 2005; Ziegler and Agarwal, 1994). As the number of fractured ribs increase the patient mortality increases (Flagel *et al.*, 2005) reflecting the greater amount of force applied to the chest wall needed to cause multiple fractures compared to single fractures. Ruptures of the diaphragm are more uncommon in trauma patient but easy to miss as they can be asymptomatic or if there are symptoms they are often vague and unspecific. In the absence of herniation of abdominal organs into the pleural space through the rupture they are hard to diagnose even using CT (Tresallet *et al.*, 2004). A missed TDI is a potentially dangerous condition as they do not seem to heal and abdominal organs can herniate into the thorax and strangulate or disturb respiration and circulation years later. A persisting TDI can also cause persistent pain to prevent late complications of a TDI diagnosis and treatment is paramount but as others have shown (Flagel *et al.*, 2005) and we will show even modern imaging techniques are inadequate for ruling out TDI.

MATERIALS AND METHODS

We identified all patients admitted to Sahlgrenska University Hospital in Gothenburg Sweden between 2005 and 2015 that where diagnosed with both TDI and multiple rib fractures. Table A Patient charts, surgeons note and radiological findings where reviewed for information about mechanism of injury, when the diagnosis was made, surgical management and sex, age etc. of patients. Tab-1 These patients where compared to all patients suffering TDI following blunt trauma during the same time span. Person's Chi-Squared test was used for comparing percentages between groups and a Student T-test to compare means

RESULTS

Between 2005 and 2015 a total of 34 patients were diagnosed with TDI following blunt trauma. Mortality in the multiple rib fracture group was zero and 6% in the blunt trauma TDI group. Tab-2 Out of these 18 also suffered simultaneous multiple rib fractures. For our results see Table A.

Table 1. Number of patients, age and sex

Patients:	TDI w multiple rib fractures:	TDI following Blunt trauma:
Number of patients:	18	34
Average age:	57 ± 27	48 ± 36 Years
Sex:		
Male:	88% (n:15)	76% (n:26)
Female:	12% (n:3)	24% (n:8)

Table 2. ISS score and location of injuries

Patients:	TDI w multiple rib fractures:	TDI following Blunt trauma:
Number of patients:	18	34
Average ISS score:	17,9 ± 32,1 *	25,9 ± 26,1
Injury localisation:		
-Right	61% (n:11)	47% (n:16)
-Left	39% (n:7)	53% (n:18)

Table 3. Mechanism of injuries

Patients:	TDI w multiple rib fractures:	TDI following Blunt trauma:
Number of patients:	18	34
Mechanism of injury:		
MVA:	44% (n:8)	47% (n:18)
Fall:	39% (n:7)	38% (n:13)

Table 4. Diagnosis and Associates injuries

Patients:	TDI with multiple rib fractures:	TDI following Blunt trauma:
Number of patients:	18	34
Diagnosis:		
TDI diagnosis on initial CT/CXR:	22% (n:4) *	50% (n:11)
-suspected TDI on CT:	11% (n:2)	18% (n:4)
TDI diagnosed during first operation:	67% (n:12)	35% (n:12)
Associated Injuries:		
Liver:	16% (n:3)	29% (n:10)
Spleen:	11% (n:2)	34% (n:14)

Table 5. Management

Patients:	TDI w multiple rib fractures:	TDI following Blunt trauma:
Number of patients:	18	34
Management:		
Thoracotomy:	94% (n:17) *	53% (n:18)
-Thoracoplasty:	89% (n:16)	
Laparotomy:	6% (n:1) *	47% (n:16)

Table A: TDI with and without multiple rib fractures

Patients:	TDI w multiple rib fractures:	TDI following Blunt trauma:
Number of patients:	18	34
Average age:	57 ± 27	48 ± 36 Years
Sex:		
Male:	88% (n:15)	76% (n:26)
Female:	12% (n:3)	24% (n:8)
Average ISS score:	17,9 ± 32,1 *	25,9 ± 26,1
Injury localisation:		
-Right	61% (n:11)	47% (n:16)
-Left	39% (n:7)	53% (n:18)
Mechanism of injury:		
MVA:	44% (n:8)	47% (n:18)
Fall:	39% (n:7)	38% (n:13)
Other:	17% (n:3)	12% (n:4)
Diagnosis:		
TDI diagnosis on initial CT/CXR:	22% (n:4) *	50% (n:11)
-suspected TDI on CT:	11% (n:2)	18% (n:4)
TDI diagnosed during first operation:	67% (n:12)	35% (n:12)
Associated Injuries:		
Liver:	16% (n:3)	29% (n:10)
Spleen:	11% (n:2)	34% (n:14)
Management:		
Thoracotomy:	94% (n:17) *	53% (n:18)
-Thoracoplasty:	89% (n:16)	
Laparotomy:	6% (n:1) *	47% (n:16)

* $P < 0,005$ compared to Blunt trauma TDI

DISCUSSION

Compared to all our blunt trauma TDI patients the patients with multiple rib fractures and TDI where older but at the same time had lower ISS scores. Tab- 1&2 We believe the cause for this is that older patients are more osteoporotic lowering the amount of force necessary to cause multiple rib fractures compared the force necessary to cause the same number of fractures in a younger patient. Simultaneous damage to liver or spleen is also less common than in the blunt trauma TDI group, we hypothesize that the diaphragm rupture caused by a deformation of the ribcage sufficient to cause multiple rib fractures is less likely to involve damage to abdominal organs adjacent to the diaphragm than a TDI caused by increased intra-abdominal pressure as the spleen likely to be damaged either directly or indirectly when the pressure pushes it through the hernia. Tab- 4&5 In both groups, 50 % in blunt trauma TDI and 67% in TDI with simultaneous multiple rib fractures, many or a majority of TDIs are diagnosed during operation. Tab- 4 In our patients with multiple rib fractures 89% where diagnosed while thoracoplasty was performed to

stabilize the thoracic cage. This underscores the importance of the surgeon examining the diaphragm.

Conclusion

Patients suffering multiple rib fractures may have a “silent” TDI despite a normal imaging. When performing rib plating examination of the diaphragm is of paramount importance to rule out TDI.

Disclosure: The authors declare no conflicts of interest.

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