Traumatic diaphragmatic rupture: look to see

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Abstract

Objective: Traumatic diaphragmatic rupture (TDR) is a rare but potentially life threatening clinical entity with a high incidence of associated injuries. In this article, our experience with this challenging diagnosis is presented. Methods: In this study, a total of 68 patients with TDR, were operated in our center between July 1994 and September 2005. Study group was analyzed retrospectively. The etiological factors, management and outcomes were discussed. Results: The mean age was 32.9 years with a female to male ratio of 9/59. TDR was right-sided in 16.2% (n = 11) and left-sided in 83.8% (n = 57). The cause of the rupture was penetrating trauma in 51 (75%), and blunt trauma in 17 (25%). Only three patients (4.4%) had late diagnosis. Associated injuries were seen in 91% (n = 62) of the patients. The most common used incision was a laparotomy incision (89.6%). Morbidity and mortality were encountered in 13.1% (n = 9) and 16.2% (n = 11) patients, respectively. Conclusions: Although rare, diaphragmatic rupture must be suspected in any patient with thoracoabdominal injury. Early diagnosis of TDR is sometimes difficult and depends on a high index of suspicion. Surgical repair is necessary even for small tears. The most common approach is the transthoracic approach, which allows a complete exploration of the abdominal organs for associated injuries. The transthoracic approach might be used in most cases with latent diaphragmatic rupture.

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1. Introduction

Diaphragmatic injuries were first described by Sennertus in 1541. Rioloff performed the first successful repair in 1886. Not until 1951, when Carter et al. [1] published the first case series, was this injury well understood and delineated. Until recently, the largest series has been reported by Williams et al. [2] in 2004.

Traumatic diaphragmatic rupture (TDR) occurs in approximately 5% of patients with major blunt thoracoabdominal trauma, most of them on the left side and an early correct diagnosis is made in less than 50% of cases [3–5]. The difficulty of the diagnosis and the high mortality and morbidity rates of the untreated cases make this clinical entity more important [6]. A 30% mortality rate has been found in cases with bowel strangulation associated with diaphragmatic hernia [7,8].

The purpose of this report is to review our experience with TDR, which to our knowledge, is one of the largest series in the English trauma literature.

2. Materials and methods

During the period from July 1994 to September 2005, a total of 68 patients underwent surgical treatment for TDR at a university teaching hospital. Data were obtained retrospectively from these patients from operative reports and hospital records. All patients were analyzed according to the etiological factors, Injury Severity Scores (ISS), time of diagnosis, associated injuries, managements and outcomes. For the classification of diaphragmatic injury, the American Association for the Surgery of Trauma (AAST) diaphragmatic injury score was used.

Data analysis was performed using SPSS version 10.0 for Windows. All quantitative data were presented as mean values ± standard error of the mean. Data were analyzed by using frequency tables.

3. Results

Descriptive data of patient demographics are described in Table 1. The mean age was 32.9 ± 13 years (range 16–75 years) with a female to male ratio of 9/59. Mean ISS score was 34.2 ± 0.7. Mean AAST diaphragmatic injury score was 2.3 ± 0.7. TDR was right-sided in 16.2% (n = 11) and left-sided...
in 83.8% (n = 57). The cause of the rupture was a penetrating trauma in 51 (75%), and blunt trauma in 17 (25%) patients. The three patients (4.4%) who had late diagnosis were diagnosed 6 days, 1 month and 17 months after the trauma respectively. The most common symptoms were dyspnea in 42 (61%) and upper abdominal pain in 25 (36%) patients. All three patients with late diagnosis also had dyspnea (Figs. 1 and 2).

The method for the diagnosis for right-sided TDR was chest X-ray in three (5%), thoracoabdominal computerized tomography (CT) in three (5%) and intraoperative exploration in five (7%) patients. The diagnostic method for left-sided TDR was chest X-ray in 24 (35%), thoracoabdominal CT in 23 (33%) and surgical exploration in 10 (15%) patients. Six (8.8%) patients had isolated TDR, where the etiology was penetrating in four and blunt trauma in two of them. The remaining patients (n = 62, 91%) had associated injuries and the most common ones were thoracic injury in 30 (44%), splenic injury in 28 (41%) and liver injury in 25 (36%) patients. Mean blood transfusion was 6 ± 3 units. Time elapsed between the injury and operation was 2.5 ± 0.5 h. Details of associated injuries are mentioned in Table 2.

The most common incision used for surgery was a laparotomy incision in 61 (89.6%) patients, followed by thoracotomy incision in 5 (17.4%), thoracoabdominal incision in 1 (1.5%) and sternotomy in 1 (1.5%). Patients treated with thoracotomy and thoracic injuries are mentioned in detail in Tables 3 and 4, respectively. All the diaphragmatic defects were repaired by interrupted suture technique with number 1 non-absorbable suture material. No grafts were used in any of the procedures. Nine patients (13.1%) developed complications (Table 5), and the mortality rate was 16.2% (n = 11). The causes of the death were related to associate injuries except one patient who was operated for a gunshot wound and had colonic perforation to left hemithorax, severe chest wall defect and lung laceration and needed prolonged ventilatory support postoperatively and died of septic complications. The remaining 10 patients died of exsanguination (n = 5) and multiorgan failure (n = 5). Five of these patients had a history of penetrating trauma, while six had blunt trauma. To analyze the predictors of mortality, the mean ISS, blood transfusion required, time between injury and operation and kind of trauma did not differ significantly between the mortal group and the group where patients did survive.

4. Discussion

Traumatic diaphragmatic rupture presents a challenging emergency because of the high injury severities of the associated injured organs and generally requires a high interest of diagnostic suspicion. If TDR cannot be diagnosed and treated in the acute phase of the trauma, the affected structures may strangulate into the thoracic cavity and the mortality rate may increase dramatically [9].

Most of the patients suffer from dyspnea and pain in the upper abdomen. Generally, patients present with symptoms related to the associated injuries. Other factors that should arise suspicion for TDR and prompt further diagnostic investigation are the following: pericostal injury, fracture
of pelvis or lumbar spine, auscultation of bowel sounds in the chest and dullness on percussion of the chest [9—11]. Meanwhile, in cases with a small tear and no herniation, specific signs and symptoms may not be present during the acute phase [12]. The most common symptoms of the current study population were dyspnea and upper abdominal pain. All three patients with late diagnosis complained of dyspnea.

Following blunt trauma, the injury of the left hemidiaphragm occurred three times more frequently than injury of the right side. Nevertheless, the less common right-sided ruptures had more severe associated injuries and resulted in greater hemodynamic instability. They required greater force of impact, possibly because the liver provides protection or because of weakness of the left hemidiaphragm [1]. The estimated ratio of right-sided versus left-sided (2:1) and produce small diaphragmatic holes, usually <1 cm diameter, except some gunshot injuries that can provide defects up to 10 cm in size [17]. Therefore, the etiological factor of a diaphragmatic hernia, which refers as delayed case, is mostly a penetrating injury [17]. The cause of the rupture was a penetrating trauma in 51 (75%), and blunt trauma in 17 (25%) patients in our study, which is different to most of the published series [9,11,15]. Most of the severe penetrating trauma cases were referred to our center from surrounding medical centers. This might be an explanation for a higher ratio of penetrating trauma. Another explanation might be because of the existing shift in the etiology of trauma, from blunt to penetrating trauma.

When diagnosed, surgery must be performed as soon as possible, as any delay might cause a herniation of any abdominal organ. The pressure difference between the two cavities causes a herniation and this may result in strangulation and perforation of the abdominal organs, which will increase the morbidity and mortality rate. The choice of surgical approach can be thoracotomy, laparotomy or both if necessary [18]. The laparotomy is recommended for early-diagnosed patients who allow exploration of the intra-abdominal organs for any associated injury. Thoracotomy is necessary for late cases to safely separate the adhesions between the abdominal organs and the thoracic wall [12]. Sixty-five patients in our series were operated in the first 24 h after the trauma. We performed 61 laparotomies which was the most preferred incision. All the patients with late diagnosis were approached with a thoracotomy incision. Although video-assisted thoracic surgery (VATS) is suggested to confirm or rule out TDR, we did not perform VATS in any of our patients [19]. Most of our patients had other emergent indications for surgical intervention. Meanwhile, the diagnostic work-up in three late cases already revealed the diagnosis of TDR, where a VATS procedure would be unnecessary. Only one patient underwent sternotomy for internal mammarian artery injury with a high preoperative suspicion of cardiac laceration. The thoracoabdominal incision was used for one patient with a penetrating trauma, a gunshot injury, who had colonic perforation to left

### Table 3
Patients with thoracic incisions

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of injury</th>
<th>Injured organ</th>
<th>Time to operation</th>
<th>Incision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blunt trauma</td>
<td>—</td>
<td>17 Months</td>
<td>Thoracotomy</td>
</tr>
<tr>
<td>2</td>
<td>Blunt trauma</td>
<td>—</td>
<td>1 Months</td>
<td>Thoracotomy</td>
</tr>
<tr>
<td>3</td>
<td>Penetrating trauma</td>
<td>Lung</td>
<td>6 Days</td>
<td>Thoracotomy</td>
</tr>
<tr>
<td>4</td>
<td>Penetrating trauma</td>
<td>Right internal mammarian artery injury + lung</td>
<td>Same day</td>
<td>Thoracotomy</td>
</tr>
<tr>
<td>5</td>
<td>Penetrating trauma</td>
<td>Intercostal artery + lung</td>
<td>Same day</td>
<td>Thoracotomy</td>
</tr>
<tr>
<td>6</td>
<td>Penetrating trauma</td>
<td>Left internal mammarian artery injury</td>
<td>Same day</td>
<td>Median sternotomy</td>
</tr>
<tr>
<td>7</td>
<td>Penetrating trauma</td>
<td>Spleen + stomach + colon + rib fractures + lung</td>
<td>Same day</td>
<td>Thoracoabdominal</td>
</tr>
</tbody>
</table>

### Table 4
Thoracic injuries in detail

<table>
<thead>
<tr>
<th>Injury</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rib fractures</td>
<td>22</td>
</tr>
<tr>
<td>Lung injury</td>
<td>14</td>
</tr>
<tr>
<td>Right internal mammarian artery injury</td>
<td>1</td>
</tr>
<tr>
<td>Left internal mammarian artery injury</td>
<td>1</td>
</tr>
<tr>
<td>Cardiac injury</td>
<td>1</td>
</tr>
<tr>
<td>Pericardial injury</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5
Postoperative complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number of patients</th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atelectasis</td>
<td>4</td>
<td>5.8</td>
</tr>
<tr>
<td>Wound infection</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2</td>
<td>2.9</td>
</tr>
</tbody>
</table>
hemithorax, severe chest wall defect and lung laceration which gave an opportunity to access both left hemithorax and abdominal cavity at the same session. The colonic perforation was not caused by strangulation.

The anatomic location, its close relationship to adjacent intrathoracic and intra-abdominal organs, and the severity of trauma account for associated injuries in 52—100% of patients with diaphragmatic rupture [14,20]. Common associated injuries include pelvic fractures (40—55%), splenic injuries (60%) and renal injuries [14,20]. In our series, in six (8.8%) patients, the only injury was a TDR. The rest of the patients had associated injuries with thoracic injury in 30 (44%), splenic injury in 28 (41%) and liver injury in 25 (36%).

The mortality rates of TDR are reported as 1—28% in the literature and it is generally associated injuries that are accused [18,21]. In our series the mortality rate is 16.1% (n = 11). Ten patients died because of the associated injuries and one patient died of septic complications. There was no specific predictor found for mortality, since parameters like ISS, blood transfusion, time elapsed between the injury and operation and type of injury revealed no difference. Nine patients (13.1%) had postoperative complications and all recovered and discharged.

In conclusion, a high index of suspicion is of utmost importance for the diagnosis of diaphragmatic rupture in any patient with thoracoabdominal injury. Early diagnosis is often difficult. Surgical repair is necessary even for small tears as soon as diagnosed. The most common approach is a transabdominal one that allows a complete exploration of the entire abdomen for associated injuries. The transthoracic approach might be used in most cases with latent diaphragmatic rupture.

References