Management of diaphragmatic rupture from blunt trauma

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ABSTRACT

Introduction: Diagnosis of diaphragmatic rupture is difficult, and delays could result in a catastrophic outcome. We reviewed our institution's management of patients with diaphragmatic rupture after blunt trauma.

Methods: All patients in this study were treated at Tan Tock Seng Hospital, Singapore, from March 2002 to October 2008. Patients with penetrating injuries were excluded. The parameters included age, mechanism of injury, haemodynamic status at admission, Glasgow coma scale (GCS) score, injury severity score (ISS), imaging studies, location of diaphragmatic injuries, associated injuries and outcome.

Results: 14 patients with a median age of 38 years formed the study group. Vehicular-related incidents accounted for 71.4 percent of the injuries. The median GCS score on admission was 14 (range 3–15), while the median systolic blood pressure and heart rate were 94 (range 50–164) mmHg and 110 (range 76–140) beats per minute, respectively. The median ISS was 41 (range 14–66). All had chest radiographs performed in the emergency department, six (42.9 percent) had computed tomography performed before surgery, while the remaining eight (57.1 percent) were sent straight to the operating theatre from the emergency department. There were five (35.7 percent) right-sided and nine (64.3 percent) left-sided diaphragmatic ruptures. The mortality rate was 35.7 percent. Some of the associated injuries included eight (57.1 percent) splenic lacerations, five (35.7 percent) haemothorax and lung injuries, four (28.6 percent) bone fractures and three (21.4 percent) liver lacerations. 12 (85.7 percent) patients underwent repair of the diaphragmatic rupture using interrupted polypropylene suture, while the remaining two (14.3 percent) were too haemodynamically unstable to undergo definitive treatment. Advanced age, haemodynamic instability and raised ISS were associated with mortality.

Conclusion: An accurate diagnosis of diaphragmatic rupture in trauma patients is difficult, and a thorough examination of both the hemidiaphragms is mandatory during emergency laparotomy for these patients. Those with more severe injuries and decreased physiological reserves usually fare worse.

Keywords: blunt abdominal injuries, diaphragm, diaphragmatic rupture, emergency laparotomy, surgical emergency

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INTRODUCTION

Diagnosis of a diaphragmatic rupture after blunt trauma can be difficult and requires a high index of suspicion. Any delay could result in a catastrophic outcome.[1] To complicate matters, diaphragmatic rupture is usually associated with other significant injuries. The aim of this retrospective study was to review the surgical management of patients with diaphragmatic rupture after blunt trauma in our institution.

METHODS

All patients in this study were treated at Tan Tock Seng Hospital from March 2002 to October 2008. Tan Tock Seng Hospital is a 1,300-bed hospital in Singapore that provides medical care to over 1.5 million people. It handles the highest number of trauma patients in Singapore and admits an average of 1,000 serious trauma cases yearly, of which 96% were for blunt injuries, with 40% of trauma admissions having an injury severity score (ISS) of more than 16. All cases with penetrating injuries were excluded from this study. The variables recorded included age, gender, mechanism of injury, haemodynamic status at admission, Glasgow coma scale (GCS) score, ISS, imaging studies, location of diaphragmatic injuries, associated injuries, and eventual outcome.

RESULTS

During the study period, 14 patients with diaphragmatic

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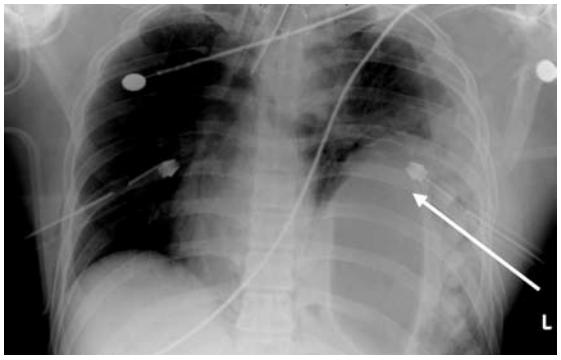

Fig. 1 Erect chest radiograph shows the raised left hemidiaphragm (arrow).

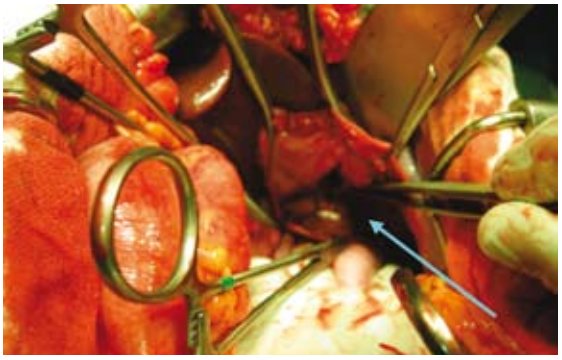

Fig. 3 Operative photograph shows the left-sided diaphragmatic rupture (arrow).

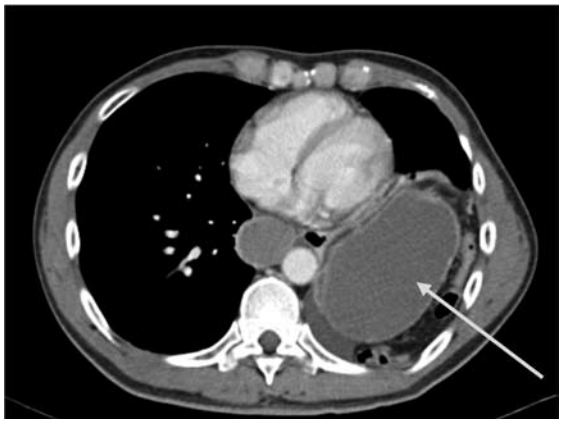

Fig. 2 Axial CT image shows the stomach located in the left hemithorax (arrow).

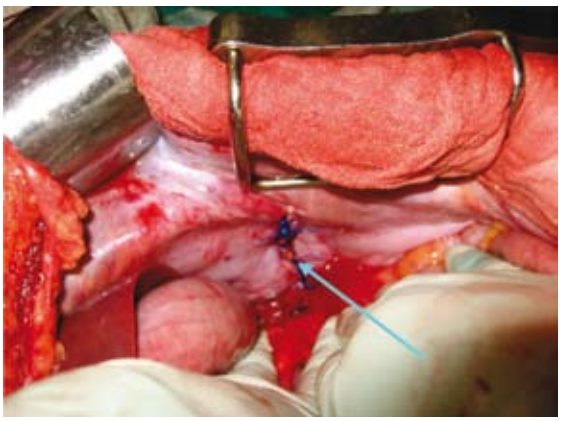

Fig. 4 Operative photograph shows the repair of the rupture using interrupted polypropylene sutures (arrow).

rupture underwent exploratory laparotomy. The median age of this group was 38 (range 23–81) years, with a male (85.7%) predominance. Vehicular-related incidents accounted for 71.4% of the injuries. The median time taken from the activation of the ambulance to its arrival in the emergency department was 34 (range 24–68) minutes. The median GCS score on arrival was 14 (range 3–15), while the median systolic blood pressure and heart rate were 94 (range 50–164) mmHg and 110 (range 76–140) beats per minute, respectively. The median ISS was 41 (range 14–66).

All had chest radiographs performed in the emergency department (Fig. 1), with nine (64.3%) patients suspicious of a diaphragmatic rupture. Six (42.9%) patients underwent computed tomography (CT) subsequently (Fig. 2) and the majority (five) showed diaphragmatic rupture. The remaining eight (57.1%) patients were sent straight to the operating theatre for their injuries. There were five (35.7%) right-sided and nine (64.3%) left-sided diaphragmatic ruptures. The mortality rate of this study group was 35.7% (five). Table I illustrates the characteristics of the study group.

The associated injuries in these patients included splenic laceration in eight (57.1%) patients, haemothorax and lung injury in five (35.7%), long bone fracture in four (28.6%), pelvic fracture in four (28.6%), vertebral compression fracture in three (21.4%), liver laceration in three (21.4%), colonic laceration in three (21.4%), injury to major vessels in three (21.4%), significant cranial injury in three (21.4%), kidney laceration in two (14.3%), small bowel laceration in two (14.3%) and gastric perforation in one (7.1%) patient. Primary repair of the diaphragm using interrupted polypropylene suture was only performed in 12 (85.7%) patients (Figs. 3 & 4), while the remaining two (14.3%) were deemed too haemodynamically unstable and were sent to the surgical intensive care unit for further resuscitation after surgery. Both these patients died from their extensive injuries shortly after. A comparison of the factors of age, GCS score, heart rate, systolic blood pressure and ISS between the group of patients who died (n = five, 35.7%) and the group who survived (n = 9, 64.3%), is shown in Table II.

DISCUSSION

The incidence of acute diaphragmatic rupture has been reported in up to 7% in blunt trauma, to as high as 15% in penetrating injuries.[2] The underlying mechanism for

Table I. Characteristics of the patients with diaphragmatic rupture after blunt abdominal trauma.

Variable	Median (range)/ no. (%)
Age (years)	33 (23–81)
Gender	
Male	12 (85.7)
Female	2 (14.3)
Mechanism of injuries	
Road traffic accident	10 (71.4)
Assault	2 (14.3)
Fall	1 (7.1)
Falling object	1 (7.1)
Heart rate (beats/minute)	110 (76–140)
Systolic blood pressure (mmHg)	94 (50–164)
Glasgow coma scale score	14 (3–15)
Injury severity score	41 (14–66)
Length of hospital stay (days)	8 (1–56)
Suspected diaphragmatic rupture on chest radiograph	
Yes	9 (64.3)
No	5 (35.7)
Computed tomography performed	
Yes	6 (42.9)
No	8 (57.1)
Side of diaphragmatic rupture	
Left	9 (64.3)
Right	5 (35.7)
Outcome	
Alive	9 (64.3)
Died	5 (35.7)

Table II. Comparison of the factors between the group of patients who died and the group that survived.

Factor	Median (range)	
	Died (n = 5)	Survived (n = 9)
Age (years)	74 (23–81)	38 (26–61)
Glasgow coma scale score	12 (3–15)	15 (8–15)
Heart rate (beats/min)	117 (92–136)	92 (76–140)
Systolic blood pressure (mmHg)	65 (49–127)	109 (76–164)
Injury severity score	50 (41–66)	27 (14–59)

diaphragmatic rupture in blunt injuries is due to a high-energy acceleration-deceleration impact that results in a sudden surge in the intra-abdominal pressure. The left diaphragm is more commonly involved, as the weakest point of the diaphragm is at the left posterolateral aspect as it originates from the pleuroperitoneal membrane.[3] This was seen in 64.3% in our series. The right diaphragm is congenitally stronger, and any impact is further cushioned by the liver.

The typical organs that herniate into the thoracic cavity include the stomach, spleen, colon, small bowel and liver, similar to those seen in our patients. Furthermore, even if the herniation does not take place initially, the significant discrepancy between the higher intra-abdominal and the lower intrathoracic pressures will result in the herniation eventually.[4] The herniated contents can result in significant complications, such as respiratory or circulatory embarrassment from the compression, collapse of the lung and the possible shift of the mediastinum.[5] Signs and symptoms of the herniated organs, such as intestinal obstruction or even haematemesis, could also be present. However, in the acute trauma setting, these symptoms are often missed unless they are chronic.

The chest radiograph is indispensable in the management of all trauma patients as it is readily performed in the emergency department and is regarded as the first-line diagnostic imaging tool in identifying a diaphragmatic rupture.[6] The specific signs of diaphragmatic rupture include intrathoracic herniation of the abdominal viscera, demonstration of a nasogastric tube tip in the thorax, marked elevation of the hemidiaphragm, and even mediastinal shift.[7] The sensitivity of the chest radiograph has been reported to be as high as 70%,[6] almost similar in our series (64.3%). The CT has become indispensable in the current management of haemodynamically-stable patients after blunt trauma. Helical CT has been reported to be able to identify diaphragmatic injuries with a much higher sensitivity and specificity than chest radiographs.[8] Some of the typical CT signs include direct visualisation of injury to the diaphragm, segmental diaphragm non-visualisation and intrathoracic herniation of the abdominal viscera.[8]

Even though magnetic resonance imaging allows an excellent imaging of the entire diaphragm and could differentiate between the diaphragm and the adjacent structures, it has no role in the initial management of patients after trauma. It is only reserved for selected haemodynamically-stable patients.[9] Despite continual advances in our diagnostic armamentarium, the diagnosis of significant diaphragmatic rupture can be elusive in an acute setting. The diagnosis is usually only confirmed at the time of surgery. Thus, all surgeons must be vigilant during any exploratory laparotomy to exclude any associated diaphragmatic injury. As shown in our study, it would appear that an advanced age, higher ISS and initial haemodynamic instability were associated with poorer outcome. These findings are consistent with those reported in the literature.[10,11] The underlying pathophysiology is due to the severity of the injuries and the compromised physiological reserves of the patients.

Surgical approach to managing diaphragmatic rupture includes laparotomy, thoracotomy or both. This decision is dependent on the associated injuries and

surgeons' preference. Laparotomy is more appropriate in unstable patients when associated intra-abdominal injuries are present or suspected. A thorough examination of both hemidiaphragms is mandatory. Furthermore, this incision can be extended to a thoracolaparotomy if there are significant intrathoracic injuries or when safe reduction of the herniated viscera is not possible.[12] Thoracotomy is more suitable for stable patients without intra-abdominal injuries or contralateral diaphragmatic injuries. The diaphragm is better visualised and repaired through the chest. This decision must be handled with caution as the patient must be able to withstand one-lung ventilation and any intra-abdominal injury would be missed.[13]

Some reports have supported the role of video-assisted thoracoscopic surgery (VATS) in the management of diaphragmatic injury, with a sensitivity and specificity of 100% being quoted.[14] The authors feel that VATS is best reserved for stable patients when intra-abdominal and contralateral diaphragmatic injuries are excluded. Routine surgical repair of any diaphragmatic defect is accomplished by interrupted or continuous non-absorbable sutures and placement of chest tube(s) in the affected thoracic cavity. Some have performed the same procedure using absorbable material, but the authors feel that they may not be as reliable, and thus were not used in our institution. Very large diaphragmatic defects may require closure with a non-absorbable patch.

There were several limitations in the present study. This series of patients was enrolled from a single institution, and the data was retrospectively reviewed. The small number of patients may also mask several other important factors that could be accountable for the outcomes identified. Although these limitations are significant, this study remains important in reviewing the numerous issues surrounding the management of diaphragmatic rupture after blunt trauma, especially since this condition is not commonly highlighted in the literature. In conclusion, an accurate diagnosis of diaphragmatic rupture in trauma patients is difficult. Despite the numerous new imaging technologies, there is no consensus on the gold standard. A thorough examination of both hemidiaphragms is mandatory for all trauma patients undergoing emergency laparotomy.

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