Diaphragmatic rupture due to blunt trauma: a limited series case report

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Background
Traumatic diaphragmatic rupture is an uncommon but potentially serious injury. Over the last 2 decades, the prevalence of blunt trauma as a cause of diaphragmatic rupture has increased five-fold. Five such patients surgically treated in two hospitals from Iraq are described herein.
Methodology
A retrospective analysis.
Results
All patients were men with a mean age of 31.6 years (range: 26–40 years). The cases consisted of injury following road traffic accidents (n=4) or falling from a height (n=1). Time intervals between trauma and diagnosis were 2 h, 3 days, 3, 7 and 20 years. The diagnosis was based on clinical grounds besides plain chest radiography, contrast gastrography and abdominal ultrasonography. Computed tomography scan of the chest and abdomen was carried out twice, whereas oesophagogastrodudenoscopy was perfeormed once. Tube thoracostomy was placed twice but failed to drain significant blood and/or air. The tear involved the whole diaphragm in two cases, whereas it was 6–10 cm long in others. Three diaphragmatic tears were directly closed by thoracotomy, one by left thoracoabdominal approach and one by laparotomy. There were no complications, and all patients survived.
Conclusion
Chronic diaphragmatic ruptures are actually missed rather than late-presented. High clinical index is essential to early diagnosis and prompt treatment of traumatic diaphragmatic rupture.

Keywords:
blunt injury, diaphragm, rupture

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Introduction

The term (diaphragm) is derived from the Greek, dia meaning in between and phragma meaning barrier. This muscular partition between the chest and abdomen is the most important muscle in the human body after the heart [1]. The three muscular components of the diaphragm (pars costalis, pars sternalis and pars lumbaris) converge on the central tendon [2]. In between these parts, there are gaps of potential weakness consisting of pleura, peritoneum and two facial layers through which traumatic diaphragmatic rupture (TDR) with or without visceral herniation is possible [3].

Reports of TDR date back at least as far as the 17th century. In 1888, Naumann repaired a hernia of the stomach into the left chest that was caused by trauma [4]. Rupture of the diaphragm can be produced by blunt, penetrating or iatrogenic injuries. There are five grades of diaphragmatic rupture (DR): grade I (contusion), grade II (laceration≤2 cm), grade III (laceration 2–10 cm), grade IV (laceration> 10 cm; tissue loss≤25 cm^2) and grade V (laceration and tissue loss> 25 cm^2) [5]. Blunt DR is rare and represents a challenge to diagnosis and management [6,7]. Herein, five patients with left TDR after blunt trauma are described. The patients were received in Sulaimaniyah Teaching Hospital (STH), Sulaimaniyah and Subspecialty Surgical Hospital (SSH), Baghdad, Iraq, through the years 2004–2016. The surgical management of these patients is discussed in view of the published literature.

Case histories

Case 1

A 30-year old man was admitted to STH on 10 April 2004 complaining of shortness of breath (SOB). He gave a history of blunt trauma due to road traffic accident (RTA) 3 years earlier. Plain chest radiograph (CXR) and

barium meal showed an apparent elevation of the left diaphragm and intrathoracic stomach. A diagnosis of chronic DR was thus made. Left thoracotomy revealed a 10-cm defect. It was repaired by a series of 0-silk sutures in two layers, interrupted mattress and continuous layers. The postoperative course was uneventful (Fig. 1a–f).

Case 2

A 35-year old man had sustained injuries in RTA with blunt trauma to the chest. He presented with chest pain and SOB. He was admitted to STH on 5 March 2005. Left-sided chest tube placed by a resident doctor drained little blood and did not relieve the SOB. Air entry to the left chest was diminished. CXR revealed indistinct left diaphragm and gas-fluid level with a slight shift of the mediastinum to the right side. Traumatic rupture of the left diaphragm was suspected. A nasogastric tube was placed. A repeat CXR and barium meal as well as left thoracotomy revealed intrathoracic stomach. The stomach was replaced into the abdomen by gentle pushing with swab on a stick. An 8-cm posteromedial diaphragmatic tear extending into the hiatus was found and directly sutured. The chest was closed after placement of one tube drain. The postoperative course was uneventful (Fig. 2a–e).

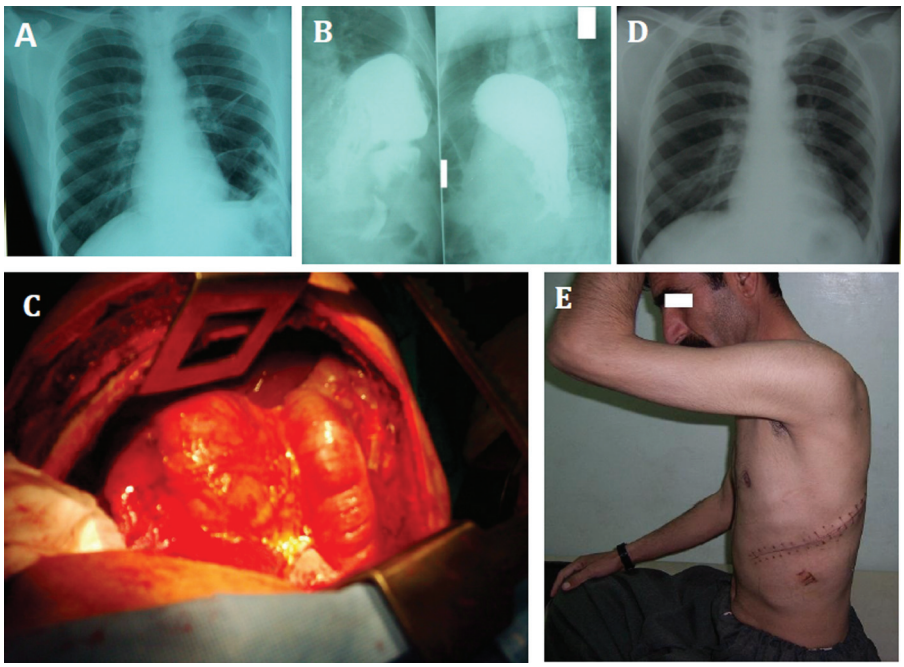
Case 3

A 40-year old man was admitted to STH on 23 November 2009 because of SOB and recurrent upper quadrant abdominal pain. These symptoms were previously mistaken for irritable bowel syndrome. Oesophagogastrodudenoscopy performed by the referring gastroenterologist showed external compression of the stomach thought to be a sign of hiatal hernia. The patient gave a history of falling from a height and rib fracture 7 years earlier. A chest tube was placed at that time but failed to drain blood and/or air. Physical examination at the time of his admission revealed a linear scar on the left anterior chest and a small scar of chest tube insertion. The left chest was dull to percussion with absent breath sounds. Plain CXR and barium study showed left-sided intrathoracic stomach. The diagnosis was a missed rupture of the left hemidiaphragm following blunt trauma. The patient was operated upon by left lateral thoracotomy through the seventh intercostal space. There was a 6-cm central diaphragmatic tear through which the stomach, colon and greater omentum had herniated with adhesions to the lung. Release of adhesions was performed and the herniated viscera were gently reduced. The defect was directly repaired in two layers. One wide-bore chest tube was placed and the chest wall was closed in layers (Fig. 3a–f).

Case 4

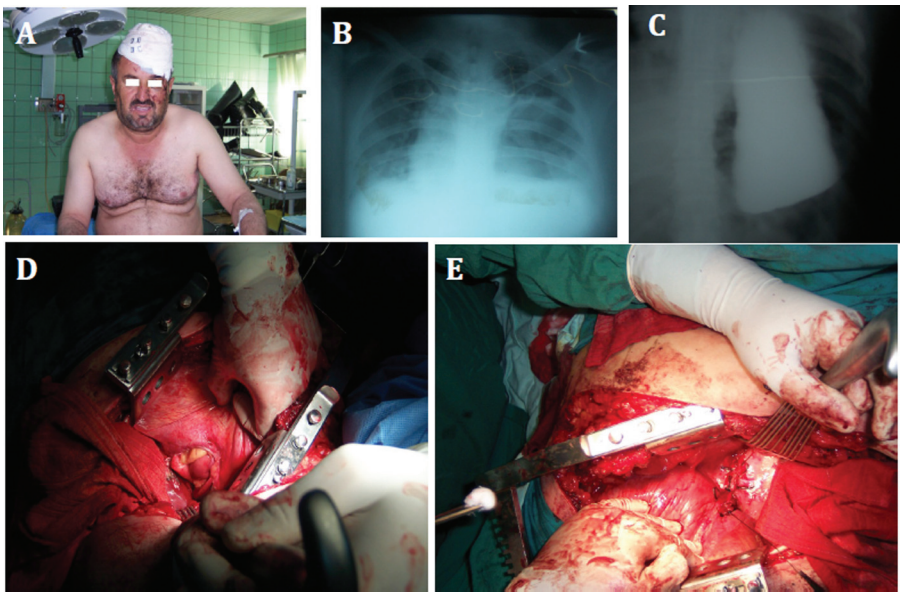
A man of 26 presented with chronic SOB and history of RTA 20 years earlier. He was admitted to SSH on 10 May 2016. Physical examination revealed a reduced air entry and audible bowel sounds over the chest. CXR and computed tomography (CT) scans showed

Figure 1



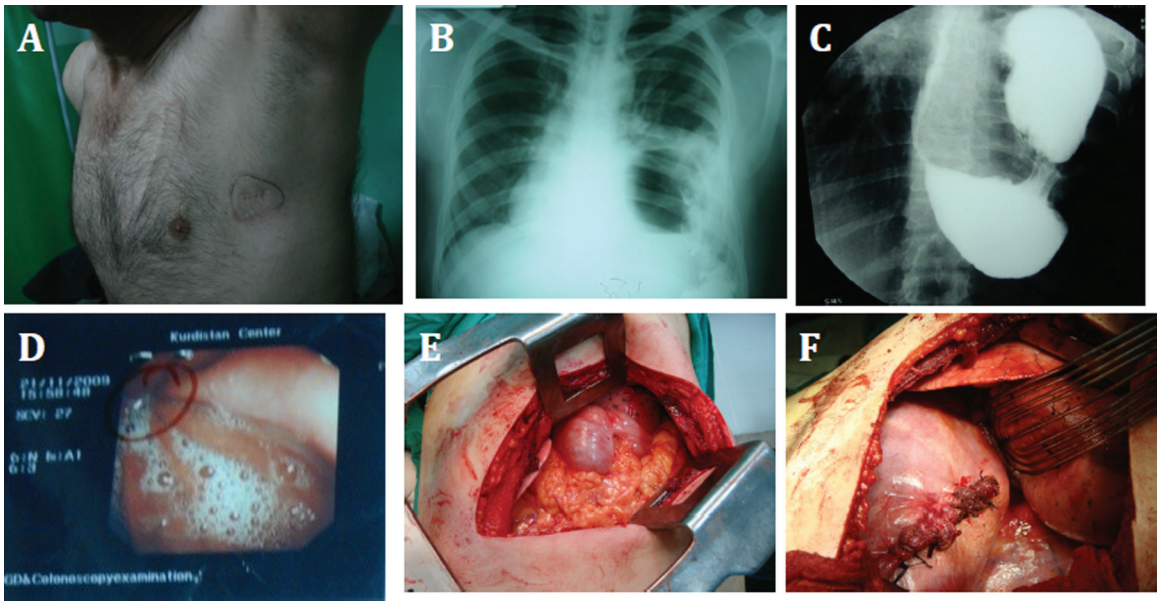
(a) Plain chest radiograph; (b) barium meal; (c) operative picture; (d) postoperative chest film; (e) postoperative patient's picture.

Figure 2



(a) The patient before surgery; (b) preoperative CXR; (c) barium meal; (d) intraoperative picture showing the tear in the diaphragm; (e) the tear has been repaired.

Figure 3



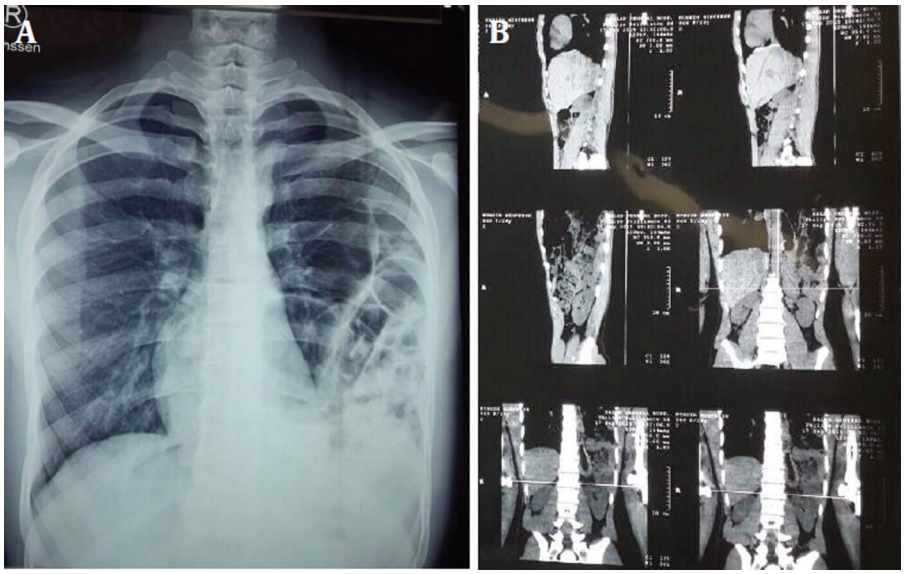
(a) The scar of the old chest tube; (b) preoperative chest radiograph; (c) barium meal; (d) oesophagogastrodudenoscopy picture showing external compression of the stomach; (e) operative picture viewing the herniated viscera; (f) the repair completed.

intrathoracic bowel loops. A left thoracoabdominal approach revealed a very big defect involving the whole diaphragm with herniation of the left hepatic lobe and the small and large bowel. The tear was directly closed and a 'wandering' spleen was removed (Fig. 4a–b).

Case 5

A man aged 27 years presented with cough, SOB and abdominal pain 2 h following RTA. He was admitted to SSH on 29 February 2016. Physical examination revealed a tender rigid abdomen, reduced air entry to the left chest and right-sided mediastinal shift. Plain CXR and CT scan of the chest and abdomen showed a collapsed left lung, mediastinal shift and intrathoracic viscera. A diagnosis of acute abdomen and DR of the left diaphragm was made. Exploratory laparotomy revealed a big tear involving the entire diaphragm through which the stomach and large bowel had herniated. The herniated viscera were reduced and

Figure 4



(a) Plain chest radiographic film; (b) computed tomography scan of the chest.

the tear was directly sutured. The postoperative course was smooth (Fig. 5a–d).

Discussion

The literature relevant to TDR on the net was searched. Four previous Iraqi studies were found [8–11]. The main findings are summarized in the table below. All studies were retrospective [9–11] except that of Al-Chalabi and Al-Najafi [8] (Table 1).

Injury to the diaphragm is reported to be present in 8% of cases of blunt chest trauma [4]. Although Al-Chalabi and Al-Najafi [8] and the present study presented TDR solely due to blunt trauma (33 and five patients, respectively), other authors reported blunt DR in a minority of their patients (9/30 [9], 3/38 [10] and 16/67 [11]). Worthy of mention is that the prevalence of blunt trauma as a cause of DR has increased five-fold over 2 decades [12,13].

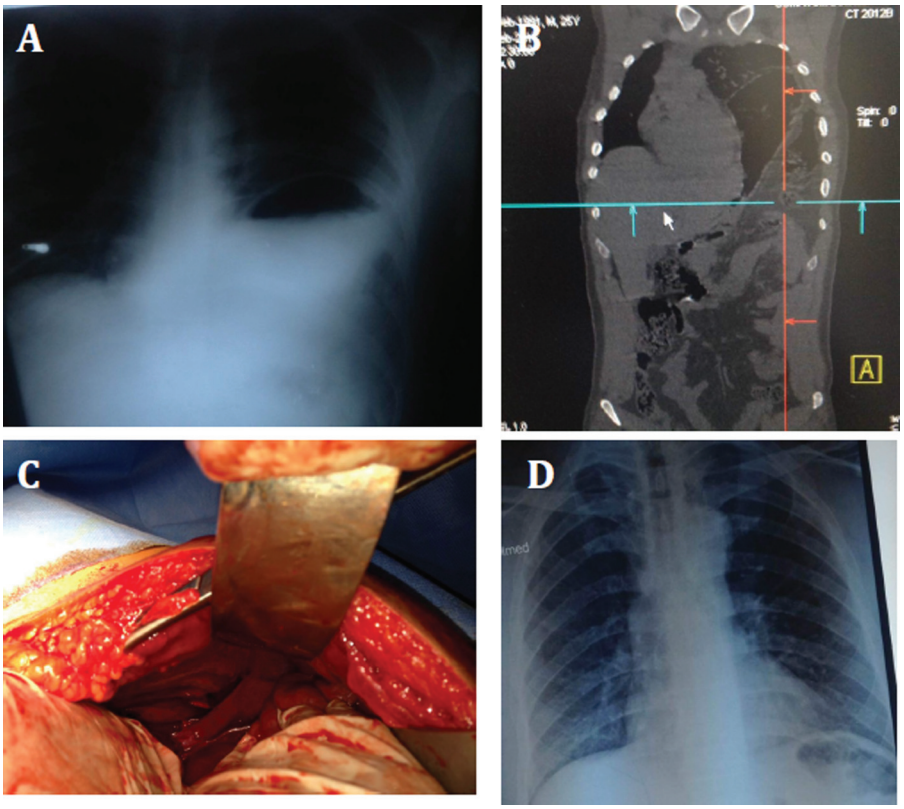
All patients in the present series were men. Similarly, three previous studies from Iraq found a male predominance [9–11]. Likewise, the male to female ratio was 21 : 4 in the study by Radjou *et al.* [14] from India. This finding is most probably due to greater vulnerability of men to accidents in general.

Between 50 and 80% of DRs occur on the left side [2,4]. An area of congenital weakness in the posterolateral aspect of the left hemidiaphragm is thought to explain the more frequent left-sided injuries (Sliker cited in [2]), [3,6]. Moreover, left-sided diaphragmatic tears are easily diagnosed by plain CXR compared with right-sided tears. In addition, on the right side, the liver acts as a cushion [4] and plays a protective role in preventing herniation of the abdominal viscera [2,4,6,7]. However, the incidence of injuries to the right side of the diaphragm may be higher in countries where vehicles are driven on the right side of the road (Thakore *et al.* cited in [6]). The present series as well as the previous series from Iraq reported higher rate of involvement of the left diaphragm [8–11].

The main presenting symptom in all patients was SOB, whereas acute abdomen was diagnosed once. Stark and Jacobson (cited in [2]) state that up to 70% of diaphragmatic tears can be initially missed. Incorrect interpretation of the radiograph is a frequent reason for incorrect diagnosis of DR [15,16]. An intrathoracic gas-fluid level may be mistaken for haemopneumothorax, whereas it is actually due to a stomach herniated into the chest. Such a mistake can lead to placement of unnecessary chest tubes (cases 2 and 3) and potential iatrogenic injuries.

As a matter of fact, apart from the fifth patient in this series, all others were initially missed rather than late-presented. Pakula *et al.* from the USA described a man of 37 who presented with left-sided DR due to blunt trauma 25 years earlier [17]. The high index of suspicion of the clinician is the main factor for correct early diagnosis of TDR. Subsequently, investigations can be tailored to suite the clinical situation. Correlation of clinical and radiographic findings is essential. Although CT scan of the chest

Figure 5



(a) Preoperative chest radiograph; (b) computed tomography scan of chest and abdomen; (c) operative photo showing a big tear; (d) postoperative chest radiograph.

Table 1 Summary of previous Iraqi studies on traumatic diaphragmatic rupture

Variables	Study 1	Study 2	Study 3	Study 4	Present study
References	Jabbo [9]	Al-Chalabi and Al-Najafi [8]	Mohi-Aldeen [10]	Ahmed and Hammoud [11]	This study
Type	Retrospective	Prospective	Retrospective	Retrospective	Prospective
Place	Baghdad	Mosul	Baghdad	Baghdad	Baghdad and Sulaimaniyah
Male/female	6/1	NA	18/1	2.4/1	Males only
Mechanism of injury	Penetrating (21), blunt (9)	Blunt (33)	Penetrating (35), blunt (3)	Penetrating (51), blunt (16)	Blunt (5)
Side	L: 20, R: 10	L: 25, R: 6, Both: 2	L: 37, R: 1	L: 32, R: 24, Both: 11	L: 5
Main approach	Laparotomy	Laparotomy (all)	Laparotomy, thoracotomy (numbers=NA)	Laparotomy	Thoracotomy (*n*=3), laparotomy (*n*=1), thoracolaparotomy (*n*=1)
Morbidity (%)	46.7	NA	41.9	52.2	Nil
Mortality (%)	10	18	7.8	7.5	Nil

L, left; NA, not available; R, right.

and abdomen was used only twice in the present series, it is considered the reference standard for the diagnosis of diaphragmatic injury [7]. Before surgery, all the cases described here were correctly diagnosed. This is in contrast to Al-Chalabi and Al-Najafi [8] who discovered 73% of DRs during laparotomy.

All DRs in this series were isolated. No other organs were simultaneously injured. This is an unusual finding [4], as 77% of left-sided DRs are associated with other injuries, commonly of the spleen [6]. Blunt DR may be clinically silent, until complications occur, which can be life threatening. Intrathoracic herniation of abdominal viscera through a ruptured diaphragm may lead to various complications such as gastric outlet obstruction, large and small bowel obstruction, volvulus and tension gastrothorax [2,8]. Because of the large size of tears in this series, all patients had herniated viscera (stomach, colon, omentum, small bowel and left hepatic lobe). Fortunately, no patient had obstruction or strangulation of herniated

viscera, and no significant complications were reported in this series. However, morbidity reached 52.2% in the previous national reports [11].

With regard to repair of the diaphragmatic tears, there are many approaches; the choice depends on the circumstances of each case besides the preference and expertise of the surgeon. Laparotomy is considered by some authors as the gold standard. In contrast, thoracotomy is preferred by others [18,19]. This is particularly true in the long-standing cases with possible intrathoracic adhesions that need to be divided by direct dissection. Moreover, intra-abdominal injuries usually do not exist in the chronic cases; hence, laparotomy would not be necessary [6,19]. In the present study, three diaphragmatic tears were repaired by thoracotomy for the aforementioned reasons. Laparotomy was chosen in the fifth patient, as he had acute abdomen. The fourth patient in this series was approached by left thoracolaparotomy. Similarly, Kastanakis *et al.* [20] from Greece used right thoracoabdominal approach for repair of a missed rupture of the right diaphragm with total hepatothorax in a man of 67. Hwang *et al.* [19] performed thoracotomy for 14 (35%) of his patients and combined thoracotomy and laparotomy in 15/40 (37.5%) patients. Unlike the current study, which mainly used the transthoracic approach for repair of DR (4/5), previous studies from Iraq preferred laparotomy [8–11].

The reported death rate for DR after blunt trauma is 15–40% [4]. Immediate mortality is rare [2]. Mortality was nil in the present series, whereas it was 18% (n=6) in a previous study [8]. This figure is relatively high, but still within the reported range [4]. This difference could be related to the high percentage of concomitant intra-abdominal injuries reported by Al-Chalabi and Al-Najafi [8] (84.8%) and their absence in the present series. It is of interest to note that left DR was associated with the lowest death rate (4%) compared with the right (50%) and the bilateral DR (100%) [8].

Conclusion

Although the number of patients in this series is too small to draw many conclusions, it seems that chronic DRs are actually missed rather than late-presented. High clinical index is essential to early diagnosis and prompt treatment of TDR.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Anraku M, Yaron Shargall Y. Surgical conditions of the diaphragm: anatomy and physiology. Thorac Surg Clin 2009; 19:419–429.

2 Kaur R, Prabhakar A, Kochhar S, Dalal U. Blunt traumatic diaphragmatic hernia: Pictorial review of CT signs. Indian J Radiol Imaging. 2015; 25: 226–232.

3 Chayovan T, Tangsittitum C. Diaphragmatic hernia (unpublished lecture notes). Available at: http://www.slideshare.net/fernferretie/diaphragmatic-hernia-and-injury?qid=798f677d-0ab2-4270-a63d-e06cc263a2d9&v=&b=&from_search=2. [Accessed 30 September 2016]

4 Wikipedia, the free encyclopedia. Diaphragmatic rupture. Available at: https://en.wikipedia.org/wiki/Diaphragmatic_rupture. [Accessed 30 September 2016]

5 Department of Surgery/Songkhla Hospital. Diaphragmatic injury (unpublished lecture notes on the net). Available at: http://www.slideshare.net/notenoteenote/diaphragmatic-injury?qid=51013fbd-850d-4639-b379-b8fe1c340081&v=&b=&from_search=1. [Accessed 28 August 2016]

6 Chughtai T, Ali S, Sharkey P, Lins M, Rizoli S. Update on managing diaphragmatic rupture in blunt trauma: a review of 208 consecutive cases. Can J Surg 2009; 52:177–181.

7 William RR, Sankhla D, Al-Qassabi B, Al Ramadani K. Traumatic rupture of the right hemidiaphragm: diagnosis aided by computerized tomography and image reformation a case report. Sultan Qaboos Univ Med J 2008; 8:219–222.

8 Al-Chalabi FM, Al-Najafi HH. Blunt traumatic rupture of the diaphragm: study of 33 cases. Ann Coll Med Mosul 2006; 32:1–6.

9 Jabbo NS. Penetrating and blunt diaphragmatic injuries. Saudi Med J 2003; 24:199–202.

10 Mohi-Aldeen SA. Traumatic diaphragmatic rupture. AJPS 2014; 14: 108–115.

11 Ahmed RJ, Hammoud HA. Traumatic diaphragmatic injuries: a hospital-based study at Al-Yarmouk Teaching Hospital. Med J Babylon 2015; 12: 428–436.

12 Lopez PP, Arango J, Gallup TM, Cohn SM, Myers J, Corneille M, *et al.* Diaphragmatic injuries: what has changed over a 20 year period? Am Surg 2010; 76:512–516.

13 Sliker CW. Imaging of diaphragm injuries. Radiol Clin N Am 2006; 44: 199–211.

14 Radjou AN, Balliga DK, Uthrapathy M, Pal R, Mahajan P. Injury to the diaphragm: our experience in Union Head quarters Hospital. Int J Crit Illn Inj Sci 2013; 3:256–261.

15 Rashid F, Chakrabarty MM, Singh R, Iftikhar S. A review on delayed presentation of diaphragmatic rupture. World J Emerg Surg 2009; 4:32.

16 DeBlasio R, Maione P, Avallone U, Rossi M, Pigna F, Napolitano C. Late posttraumatic diaphragmatic hernia. A clinical case report. Minerva Chir 1994; 49:481–487.

17 Pakula A, Jones A, Syed J, Skinner R. A rare case of chronic traumatic diaphragmatic hernia requiring complex abdominal wall reconstruction. Int J Surg Case Rep 2015; 7:157–160.

18 Barbiera F, Nicastro N, Finazzo Lo, Casto A, Runza G, Bartollota TV, Midiri M. The role of MRI in traumatic rupture of the diaphragm. Our experience in three cases and review of the literature. Radiol Med 2003; 105: 188–194.

19 Hwang S-W, Kim H-Y, Byun JH. Management of patients with traumatic rupture of the diaphragm. Korean J Thorac Cardiovasc Surg 2011; 44:348–354

20 Kastanakis M, Anyfantakis D, Kokkinos I, Petrakis G, Bobolakis E. Delayed posttraumatic diaphragmatic rupture complicated by total hepatothorax: a case report. Int J Surg Case Rep 2013; 4:537–539.