Paediatric Traumatic Rupture of the Diaphragm

Augustine Olugbemi,[1] Ezekiel Ogunleye,[1] Olowoyeye OA,[1] Eyekpegha JO,[2] Akerele Oluwaseye,[1] Daniel Kehinde,[1] Oyebola Adekola[1]

[1] Lagos University Teaching Hospital, Lagos, Nigeria
[2] Obafemi Awolowo University Teaching Hospital, Nigeria

Correspondence to: Dr. Adekola Oyebola, CMUL/LUTH PMB 12003, Surulere, Lagos, Nigeria;
email: oyebolaadekola@yahoo.com

Summary
Traumatic diaphragmatic rupture is not a common injury in children. It is an important cause of morbidity and mortality, though diagnosis may be missed or delayed with atypical clinical presentation and confounding radiological features. A 4-year-old male presented with periumbilical abdominal pain, bilious vomiting, fever and progressive difficulty in breathing for two days. He had complained of vague left-side chest pain on return from the swimming pool about 6 weeks earlier. An initial chest radiograph showed a non-outlined left hemidiaphragm, a left pneumothorax, rightward mediastinal shift and suspected bowel in the chest. He could not afford a CT scan, hence a repeat chest radiograph was performed, which outlined the stomach with an air-fluid level in the left hemithorax.

Keywords: Traumatic Diaphragmatic Rupture, Child, Atypical Chest pain, Blunt injury
Ann Afr Surg. 2020; 17(1):35–38.
DOI: http://dx.doi.org/10.4314/aas.v17i1.9
Conflicts of Interest: None
Funding: None

Introduction

Traumatic diaphragmatic rupture (TDR) in the presence of other injuries and owing to its rarity may be easily missed in children (1,2). When presentation is delayed, morbidity and mortality rates increase proportionately (1,2). TDR may mimic conditions such as pneumothorax and bowel obstruction. It is important to make the correct diagnosis as management for these entities is different, and the wrong treatment may be catastrophic. A 4-year-old boy was referred to us following a 2-day history of periumbilical abdominal pain and bilious vomiting. There was no abdominal distension or constipation. He had developed a fever and progressive difficulty with breathing at presentation. Further history obtained from the parents revealed that he had complained of vague left side chest pain on return from the swimming pool about 6 weeks earlier. The pool attendant did not report witnessing any trauma. The househelp was said to have used hot compress on the chest for several days without the knowledge of the parents. Findings at presentation revealed a conscious child, well oriented in time, place and person and febrile (37.8°C). No physical evidence of trauma was seen. Child was in severe respiratory distress (RR, 46 breaths per minute). The trachea was deviated to the right. There was increased percussion notes and reduced air entry on the left hemithorax. Chest auscultation produced no bowel sounds. The abdomen was flat and moved with respiration. No abdominal wall tenderness or palpably enlarged organs were seen, and bowel sounds were normal.

He had emergency exploratory thoracotomy; operative findings revealed a 4-cm tear through the tendinous part of the left hemidiaphragm through which the stomach and omentum had herniated.

The initial assessment was small bowel obstruction to R/O left pneumothorax. A nasogastric tube was passed, which drained bilious fluid. Full blood count, electrolytes, urea and creatinine were within normal range. The chest radiograph revealed a non-outlined left hemidiaphragm, a left pneumothorax, rightward mediastinal shift and suspected bowel in the chest (Fig. 1).

An emergency left posterolateral exploratory thoracotomy was performed under general anaesthesia relaxant technique.

Operative findings and surgical intervention

A mal-united 6th rib fracture anteriorly, a 4-cm tear

through the tendinous part of the left hemidiaphragm through which the stomach and omentum had herniated (Fig. 2), and 40 mL of serosanguinous fluid in the left hemithorax were evident.

The fundus of the stomach had two 5-mm perforations (~1 cm apart) that had been walled off by fibrinous adhesions between the fundus of the stomach and the diaphragmatic surface of the left lower lung lobe. The entire left lung was collapsed. These operative findings were what prompted further history obtained from the parents.

The gastric perforation was repaired with absorbable Vicryl 3/0 suture in double layers. The stomach was returned into the abdomen, the diaphragmatic tear was repaired with non-absorbable continuous polypropylene 1 sutures, and a chest tube was left in situ.

The postoperative course was uneventful. The patient started oral feeding on the 3rd day postoperative, and the chest tube was removed. He was discharged home on the 5th day postoperative. The postoperative chest x-ray showed satisfactory lung re-expansion and a well-outlined left hemidiaphragm (Fig. 3).

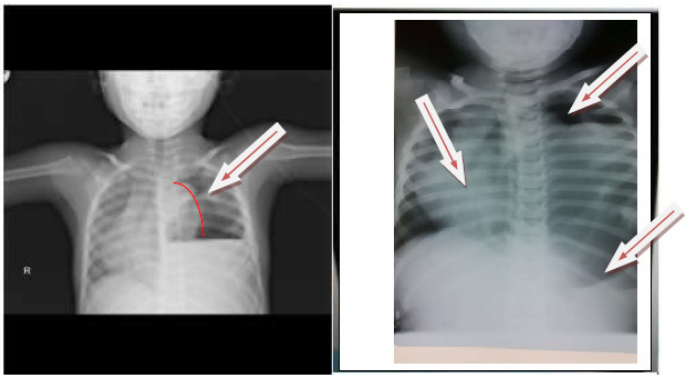

Figure 1. Left, outline of the stomach with an air-fluid level in the left hemithorax; right, revealed a non-outlined left hemidiaphragm, a left pneumothorax, rightward mediastinal shift and suspected bowel in the chest.

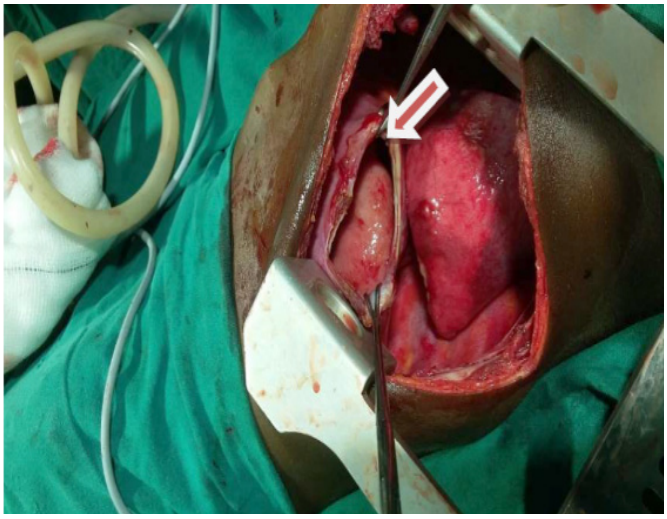

Figure 2. 4-cm tear through the tendinous part of the left hemidiaphragm.

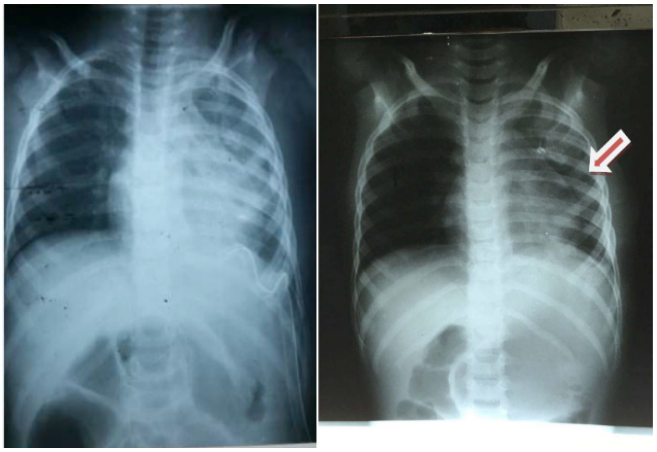

Figure 3. Left, CXR – postoperative day 2 (AP view); right, CXR – postoperative day 4 (AP view)

Discussion

The diaphragm serves as the anatomic division between the thoracic and abdominal cavities (3) and is the major muscle of respiration (4). We present a 4-year-old male child with left side TDR, following blunt chest trauma. Diaphragmatic injuries are relatively rare, occurring in 0.8–8% of patients suffering blunt chest trauma (1) and more often in males (7,8).

TDR is seen more in blunt trauma (75%) than in penetrating trauma (9). The left hemidiaphragm is more commonly affected than the right, as seen in our index patient (7,8), but in 1.5% of cases diaphragmatic injuries are bilateral, and in 0.9% of TDR the pericardium is involved (8). The higher incidence of left hemidiaphragm rupture is usually ascribed to the presence of the liver on the right side, the relatively weaker diaphragm on the left side (7), and under-diagnosis of right-side tears (10). The diaphragm can rupture in any location, but the most common parts are the central tendon, as seen in our patient, and lateral attachments to the body wall (11).

The common etiologies of blunt TDR include motor vehicular accidents, fall from heights and crush injuries (7,12). Diaphragmatic rupture has also been reported following labor (13,14).

Our patient had a history of unwitnessed chest trauma that made initial diagnosis troublesome. The patient presented with atypical symptoms such as periumbilical abdominal pain and bilious vomiting, which may mimic acute abdomen. The initial diagnosis at presentation was intestinal obstruction, despite absence of abdominal swelling. Such bizarre presentation can lead to misdiagnosis and delay in presentation and intervention,

as illustrated in our case. A high index of suspicion is necessary to recognize TDR in a child. Therefore, the diagnosis of TDR should be suspected in any child who has suffered major thoraco-abdominal trauma. TDR shows no specific signs, but these patients may have dyspnea, chest pain, abdominal pain and vomiting. With examination, mediastinal shift, abnormal percussion notes, reduced air entry in the affected hemithorax and presence of bowel sounds in the chest should raise the suspicion of TDR (12,15). Though in our patient other signs and symptoms were present, the classical bowel sounds were not heard on chest auscultation.

We observed two gastric perforations and fracture of the 6th rib anteriorly. The mechanism of these perforations is however unclear. It could have been from direct trauma from the fractured rib, or from necrosis of the stomach fundus in contact with the fractured rib over time. Other researchers have reported associated injuries which may include injuries to the lungs, liver, spleen, stomach, mesentery, esophagus, pancreas and kidneys (7,10). Other injuries include fractured ribs, haemothorax, haemoperitoneum and distant organ injuries (10).

Chest x-rays may be sufficient for diagnosis but where confusion exists a chest computerized tomographic scan would be adequate for diagnosis. Initial radiographs would allow the diagnosis of 27–60% of left side injuries and 17% of right-side injuries (16). Specific diagnostic features on chest radiographs that indicate TDR include intrathoracic herniation of a hollow viscus, which was present in this patient, and visualization of a nasogastric tube in the left hemithorax. Other suggestive features include elevation of the left hemidiaphragm, distortion of the outline of the hemidiaphragm and contralateral mediastinal shift (17). These also featured in our patient. Concurrent anomalies such as effusions, pulmonary contusions, atelectasis and phrenic nerve injuries may mimic TDR or mask it (17). In patients who do not require emergency surgery, the diagnosis may also be confirmed by barium studies of the upper or lower gastrointestinal tract (12). Our patient's chest radiograph revealed left pneumothorax, which made diagnosis a dilemma as the cause could not be traced to the initial history of the patient, which necessitated further discussions with radiologists. Operative findings in this patient were therefore much anticipated not just by the surgeons but also by the radiologists.

Ultrasound may have a role in diagnosis of TDR, but there is no consensus on its sensitivity (18). Features seen on ultrasound that may indicate TDR include free floating or non-visualized diaphragm, visualization of bowel loops with peristalsis above the level of the diaphragm, and abnormal diaphragmatic excursions on M mode (18). Ultrasound was not done on this patient. Multidetector CT (MDCT) is the method of choice for diagnosing TDR (19). MDCT signs have been divided into direct and indirect signs. Direct signs include discontinuity of the diaphragm and the dangling diaphragm sign (19). Indirect signs are intrathoracic herniation of abdominal contents, the collar sign, dependent viscera sign and sinus cut-off sign (19).

Initial approach to patient with suspected acute diaphragmatic rupture should follow the ATLS protocol, and the patient should be scheduled for surgery once stable (4).

The surgical approach to TDR may be via laparotomy, thoracotomy, laparoscopy or thoracoscopy. In an acute trauma setting, the diaphragmatic injury should be approached via the incision that would be required to repair other organ injuries (12). Thus laparotomy is advised in acute injuries to address concomitant abdominal injuries (8) except in right side diaphragmatic injuries when a thoracotomy may be employed for better access to the diaphragm (12,20). Diaphragmatic injuries presenting at the latent phase are best approached via a thoracotomy, as adhesions would have formed between the abdominal and thoracic viscera (8). Laparoscopy and thoracoscopy have both diagnostic and therapeutic roles and are increasingly being used to manage these patients (7,15). Patients undergoing laparoscopy or thoracoscopy should be hemodynamically stable and should ideally be suspected of having isolated TDR (4). Our patient had left exploratory thoracotomy.

The diaphragm may be repaired directly using continuous monofilament 1/0 sutures (21), which was done in our patient, or with interrupted figure-of-eight large caliber sutures (12). When the diaphragmatic defect is large and tension would be unacceptable, the defect may be repaired with a mesh.

The outcome of TDR is usually determined by other associated injuries in the acute setting; in the unrecognized latent TDR, it is determined by the effect of the resulting hernia (8). Outcome is usually good in isolated diaphragmatic injuries. Recovery of our patient was uneventful.

Conclusion

A high index of suspicion is needed for an accurate diagnosis of traumatic diaphragmatic rupture in a child. This is important for the primary physician to avert delayed presentation and intervention. The choice of

treatment will depend on the patient's clinical condition and the duration of injury before presentation.

References

1. Gmachowska A, Pacho R, Anysz-Grodzicka A, et al. The role of computed tomography in the diagnostics of diaphragmatic injury after blunt thoraco-abdominal trauma. Pol J Radiol. 2016; 81:522–8.
2. Marzona F, Parri N, Nocerino A, et al. Traumatic diaphragmatic rupture in pediatric age: Review of the literature. Eur J Trauma Emerg Surg. 2016; 1–10.
3. Shields TW. The diaphragm. In: Shields TW, Locicero J, Reed CE, Feins RH, editors. General thoracic surgery. 7 ed. Philadelphia: Lippincott Williams & Wilkins; 2009. 713 pp.
4. Vyas PK, Godbole C, Bindroo SK, et al. Case-based discussion: An unusual manifestation of diaphragmatic hernia mimicking pneumothorax in an adult male. Int J Emerg Med. 2016; 9(1):11.
5. Maish MS. The diaphragm. Surg Clin North Am. 2010; 90(5):955–68.
6. Nason LK, Walker CM, McNeeley MF, et al. Imaging of the diaphragm: Anatomy and function. Radiographics. 2012; 32(2):51–70.
7. Okur MH, Uygun I, Arslan MS, et al. Traumatic diaphragmatic rupture in children. J Pediatr Surg. 2014; 49(3):420–3.
8. Shah R, Sabanathan S, Mearns AJ, et al. Traumatic rupture of diaphragm. Ann Thorac Surg. 1995; 60(5):1444–9.
9. Dwivedi S, Banode P, Gharde P, et al. Treating traumatic injuries of the diaphragm. J Emerg Trauma Shock. 2010; 3(2):173–6.
10. Mala TA, Gupta P, Gupta R, et al. Delayed presentation of diaphragmatic rupture: Our experience with six cases. Sch J App Med Sci. 2014; 2(2):516–21.
11. Mahesh SS. Pediatric Thoracic Trauma. 2016. http://emedicine.medscape.com/article/905863-overview#a9.
12. Julian G, Howington J, Joseph LoCicero III. Diphragmatic injuries. In: Shields TW, Locicero J, Reed CE, Feins RH, editors. pp. 937–43. General thoracic surgery, 7 ed. Philadelphia: Lippincott Williams & Wilkins; 2009.
13. Mutanen A, Sandelin H, Nieminen A, et al. Diaphragmatic rupture: Case report of a rare complication of labor. Duodecim. 2015; 131(8):753–6.
14. Boufettal R, Lefriyekh MR, Boufettal H, et al. Spontaneous diaphragm rupture during delivery. Case report. J Gynecol Obstet Biol Reprod (Paris). 2008; 37(1):93–6.
15. Sözübir S, Tander B, Bernay F, et al. Traumatic diaphragmatic rupture in children. Ulus Travma Acil Cerrahi Derg. 2005; 11(1):64–8.
16. Shanmuganathan K, Mirvis SE. Imaging diagnosis of nonaortic thoracic injury. Radiol Clin North Am. 1999; 37(3):533–51.
17. Iochum S, Ludig T, Walter F, et al. Imaging of diaphragmatic injury: A diagnostic challenge? Radiographics. 2002; 22:S103–S16.
18. Bothwell J, Della-Giustina D, Laselle B, et al. Ultrasound diagnosis of diaphragmatic rupture. Crit Ultrasound J. 2011; 3(3):153–4.
19. Panda A, Kumar A, Gamanagatti S, et al. Traumatic diaphragmatic injury: A review of CT signs and the difference between blunt and penetrating injury. Diagn Interv Radiol. 2014; 20(2):121–8.
20. Payne JH, Yellin AE. Traumatic diaphragmatic hernia. Arch Surg. 1982; 117(1):18–24.
21. Karmy-Jones R, Gregory J. Managent of blunt chest and diaphragmatic injuries. In: Patterson AG, Cooper JD, Jean D, Lerut A, et al., editors. Pearson thoracic and esophageal surgery, 3rd ed. Philadelphia: Churchill Livingstone; 2008. pp. 1769–75.