Case Report

Bilateral blunt diaphragmatic rupture

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ABSTRACT

Blunt diaphragmatic rupture is an uncommon injury and even less common is the bilateral form. This entity poses diagnostic and therapeutic challenges to the treating team. Despite the advances in diagnostic modalities, it remains a difficult diagnosis leading to missed or late presentations with increased risk of morbidity and mortality. We report a case of a 12-year-old girl who sustained a blunt abdominal trauma and found to have left hemidiaphragmatic rupture for which she underwent laparotomy and repair. Postoperatively, persistent elevation of the right hemidaiphragm was noticed, and right-side rupture was suspected and confirmed by collar sign on repeated computed tomography scan. The second repair was done successfully through a right posteriolateral thoracotomy. She improved dramatically and was discharged in an optimal state to be followed in the surgical outpatient department.

KEY WORDS: Blunt trauma, diaphragm, repair

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INTRODUCTION

Diaphragmatic rupture can result from blunt or penetrating trauma. Its incidence ranges between 1% and 7% of severe blunt trunk trauma cases. Diagnostic techniques include imaging such as chest X-ray (CXR), computed tomography (CT), and surgical exploration such as laparotomy or thoracotomy. Blunt diaphragmatic rupture rarely accounts for immediate mortality and may be clinically dormant till complications occur leading to significant mortality and morbidity.[1] Despite that various imaging modalities have been proven unsuccessful in the diagnosis of blunt diaphragmatic rupture,[2] diaphragmatic injuries, especially those on the right side, most frequently have remained undiagnosed on CT during the initial survey of major trauma patients.[3] The explanations for incorrect CT interpretations include the usually associated and distracting thoracic and abdominal injuries, lack of awareness of bilateral blunt diaphragmatic rupture, and discreet abnormalities on axial CT slices. The purpose to present this case was to highlight the importance of CT findings in bilateral blunt diaphragmatic rupture and their impact on clinician performance in diagnosis.

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CASE REPORT

A 12-year-old girl unrestrained rear seat passenger was involved in a motor vehicle accident (MVA) as a head on collision. There was no history of ejection. She was received in the emergency room unconscious with glasgow coma scale 8/15, and her initial vital signs were as follows: Blood pressure 110/67 mm Hg, pulse rate 141, saturation 96%, and she was breathing with difficulty. Her chest exam revealed reduced air entry on the left hemithorax. She was intubated and ventilated. Her abdominal exam revealed a soft and laxed abdomen. Her initial CXR showed lung contusion and raised left hemidiaphragm [Figure 1a]. The suspicion of left diaphragmatic rupture was raised for which a nasogastric tube was inserted and CXR was taken again confirming the intrathoracic herniation of the stomach [Figure 1b]. The patient was sent for pan CT scan. It confirmed the presence of left diaphragmatic rupture, left pneumothorax, right lung contusion, and right hemothorax with no evidence of intra-abdominal injuries [Figure 2a]. The patient underwent an emergency exploratory laparotomy. Exploration revealed ruptured left diaphragm extending medially from the left edge of the liver laterally with herniation of the left lobe of the liver, stomach, and spleen. They were reduced, and closure of the diaphragmatic tear was done in a double-

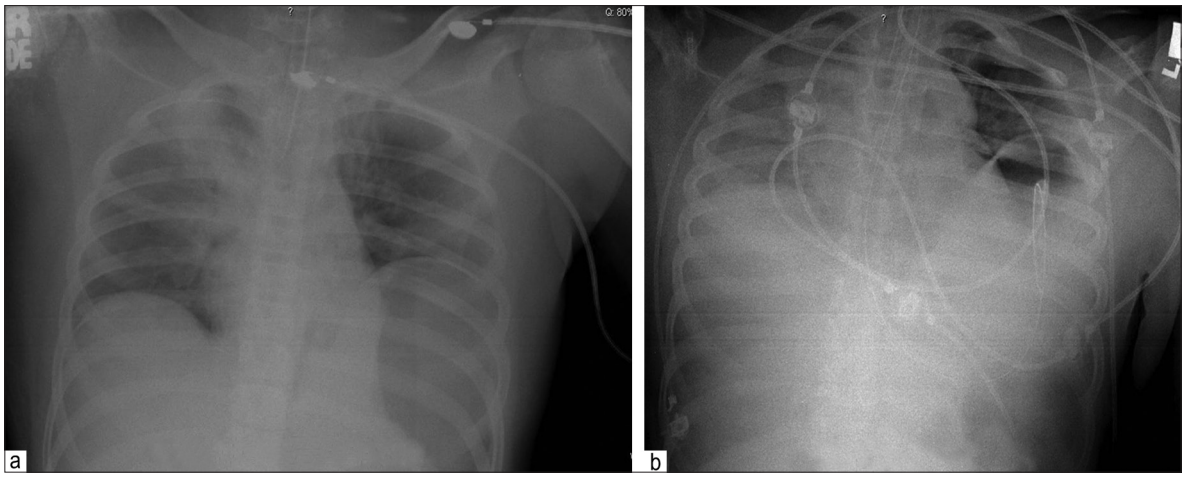

Figure 1: (a) Initial CXR showing elevation of left hemidiaphragm with suspension of stomach herniation into the thorax; (b) CXR after insertion of nasogastric tube showing coiling to the thorax

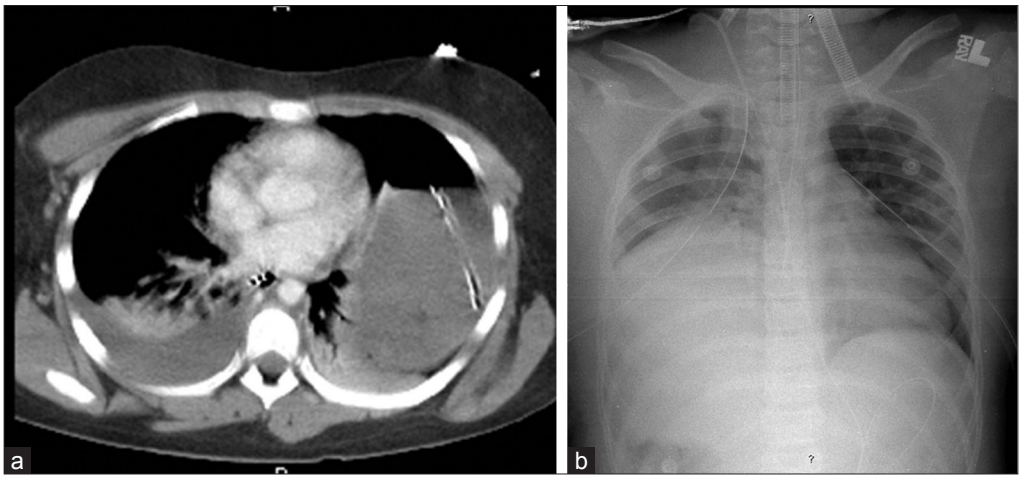

Figure 2: (a) Initial CT scan confirmation the intrathoracic herniation indicating left hemidiaphragmatic rupture; (b) Post operative CXR showing elevation of the right hemidiaphragm raising the suspicion of right diaphragmatic rupture

breast fashion using 1 Prolene suture. Formal laparotomy at the time was negative for other injuries. Bilateral intercostal tubes were inserted, and the patient was shifted to intensive care unit. Her postoperative CXR showed persistent elevation of the right hemidiaphragm [Figure 2b]. A second urgent CT scan was done which pointed out to the possibility of right diaphragmatic rupture [Figure 3]. The patient underwent right exploratory posteriolateral thoracotomy on the second day postoperatively. It revealed a missed tear of the diaphragm's dome with limited herniation of the right posteriosuperior surface of liver. Repair was done successfully and the patient had an uneventful postoperative course and was discharged in a good condition.

Figure 3: Second CT scan (coronal view) confirming the collar sign indicating right hemidiaphragmatic rupture (collar sign)

DISCUSSION

The first description of diaphragmatic rupture was written by Sennertus to Hildani in 1541 as documentation on autopsy.[1] In 1791, Pare described two patients who died from strangulated intra-abdominal organs drawn into the thoracic cavity.[1] In 1853, Bowditch made the first ante-mortem diagnosis and successful repair was done by

Riolfi in 1886.[1] Since then, reports and case series were published to aid in full understanding of this entity. The incidence varies between reports but the range is 1–7% in cases of blunt trauma. The incidence rises to 15% in cases of penetrating trauma.[1] Over 90% of blunt diaphragmatic ruptures are caused by MVA,[4] and it is reported that 1–5% of MVAs could hide a diaphragmatic ruptures.[5] In blunt injuries, the left hemidiaphragm is involved in 70–80%, the right in 15–24%, and bilaterally in 5–8%.[6] It is reported that left-side involvement is nine times higher than the right side.[7] It is attributed to the protective effect of the liver and the embryological weak point in the left diaphragm (lumobocostal trigone).[5] But this notion was challenged by Scots where they concluded that right-hand drive vehicles have more incidence of right-side rupture.[8] Usually the victim has polytrauma where sudden compression of the torso leads to rise in the intra-abdominal pressure (normally 7–20 cm H_2O), and because the intra-thoracic pressure is negative, the net result is herniation of abdominal viscera into the thorax. It was found that the time of impact and respiratory cycle are crucial elements in causing the rupture.[9] Moreover, it was found that lateral compression causes more incidence of rupture compared with the frontal impact.[5] This force causes rupture, enlarges it, and even causes avulsion of the diaphragm from its attachments.[7] Spontaneous diaphragmatic injury has been reported following bouts of coughing, child birth, and heavy exercise.[1] In pediatric population, it is more difficult to diagnose and treat because compliance of the chest wall results in internal injuries without evident external ones. Their mediastinum is mobile and readily compromised by other intra-thoracic lesions such as pneumothorax.[9] Due to the magnitude of trauma, traumatic diaphragmatic injury is usually associated with other organs injury identified in 50–100% of the cases.[10] Abdominal organs that could be involved are spleen, liver, mesentery, and large and small bowel; in the thorax, fracture rib, hemo or pneumothoraces, pulmonary contusion, or mediastinal hematoma; others like pelvic fracture, vertebral, or head injury.[8] The stomach most commonly herniates (31%) into the thorax in left-sided rupture followed by the colon (27%).[6] In right-sided rupture, the liver most commonly herniates.[11] The presentation of these patients fall into three types: (1) immediate and early after trauma; (2) delayed >48 h; and (3) delayed with obstructive symptoms.[6] The most commonly experienced symptoms are dyspnea, chest pain, abdominal pain, and vomiting.[6] Physical findings are not specific and this adds to the diagnostic challenge. Although a decrease in the respiratory sounds is the primary finding, bowel sounds in the thorax and the pathognomic finding of intestinal herniation are detectable in some patients.[6] CXR remains the initial diagnostic modality in the context of trauma. It is normal and nonspecific in 27–62% of the cases.[12] It is only diagnostic in 33% of left-sided rupture compared with 18% in right-sided rupture.[12] Helical CT scan has sensitivity of 71%, specificity 100%, but when using the reformatted forms it increases the sensitivity.[9] Suggested signs on CT include collar sign indicating focal constriction of viscus at the herniation site and sinu cut-off or dependent viscera signs which is reported 100% sensitivity in left-sided rupture and 83% in the right-sided rupture.[10] It is important to keep in mind that during ventilation, the diaphragm would be pushed down and this could affect the diagnostic accuracy. Other modalities such as magnetic resonance imaging, barium studies, and ultrasound or fluoroscopy are helpful in the delayed type because the acute traumatic setting requires hemodynamic stable patients to perform the study.

The theories behind these missed injuries are postulated by two hypothesis: The first is that the cause for delayed rupture is resultant of weakness as a consequence of tissue devitalization at the time of trauma. The second reason for delayed rupture where evident herniation presents after admission and typically after extubation is attributed to the return of intrathoracic pressure to negative value.[13] General rules for treatment dictate the search for other injuries and repair them. Laparotomy is advised in the acute form but in the right side, the liver has to be mobilized partially to avoid missing posteriorly located ruptures as in our case. Thoracotomy is advised in the delayed form because of adhesions between the viscera and the pleura. Some authors advocate thoracotomy in acute right-sided rupture for better access and repair.[14] Laparoscopy and video-assisted thoracoscopic surgery are new options but they require hemodynamically stable patients which is a limitation in acute trauma settings.

Recognized associated complications such as ileus (40%), pneumonia (30%), pancreatitis (20%), surgical site infection (20%), intestinal obstruction (20%), atelactasis (10%), and renal failure (6%), with hospital stay range 7–54 days (mean 24 days).[13] Diaphragmatic rupture is a marker for severity of injury.[13] Mortality in pediatric population ranges 9–15% compared with adults 4–37% with right-sided rupture contributing more of this percentage.[13] Death occurs acutely from hypovolemic shock and later from multiorgan failure.[13]

In conclusion, blunt diaphragmatic rupture is uncommon and even less common is the bilateral form. It remains a challenge due to the limited sensitivities of the existing diagnostic modalities. Therefore, high index of suspension remains a crucial part in the management of such entity.

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