

**Case
Report**

Delayed Right-Sided Diaphragmatic Rupture and Laparoscopic Repair with Mesh Fixation

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Diaphragmatic rupture is usually an immediate, left-sided complication of high-velocity thoraco-abdominal trauma. Here we present a rare case of delayed, right-sided diaphragmatic rupture and its laparoscopic mesh repair.

Keywords: right-sided diaphragmatic rupture, delayed presentation, high velocity trauma, laparoscopic mesh repair

Introduction

Diaphragmatic ruptures (DRs) are found in 0.8%–5.8% of cases after high velocity blunt thoraco-abdominal trauma.^{1,2} They mostly occur immediately after the trauma but may also have a delayed onset in 14.6% of cases.³ At the time of injury, the pressure gradient between the abdominal compartment and the thorax may suddenly increase, causing the abrupt separation of the diaphragm from the chest wall, thus determining an early rupture. Less frequently, DR may have a delayed presentation. In these cases, the stretching of the diaphragm causes stress damage to the muscular fibres and vascular structures, inducing local ischemia and thus, leading to late DR.⁴ The inflamed diaphragm can act as a “barrier” until the inflammation dispels,⁴ making it impossible to foresee the delay of presentation of late DRs.⁵ Here we

present a case of rare delayed right-sided diaphragmatic rupture and its laparoscopic mesh repair.

Case Report

A 59-year-old woman presented with a 3-month history of breathing discomfort, nausea, and abdominal pain. The patient underwent a 12-year psychiatric therapy for severe depression and multiple suicide attempts (by defenestration and phlebotomy). Two years earlier, she had a bilateral hemo-pneumothorax due to a fourth floor defenestration, requiring thoracic drainage. She was addicted to alcohol without known cirrhosis and had been smoking two packs a day for 40 years with sporadic night cough crisis.

Physical examination revealed diffuse abdominal tenderness, without weight loss or hyperpyrexia. The electrocardiogram was normal. Laboratory exams showed white blood cells count, CRP, pH, pO₂ and pCO₂ within the usual limits. Chest X-Ray revealed a diffuse opacity of the right inferior pulmonary field with some hypo-dense content within it, at the level of the mamillary line (**Fig. 1**). The chest computed tomography (CT)-scan showed a right-sided Diaphragmatic Rupture (DR) with right/transverse colon and liver herniated in the thorax (**Fig. 2**).

A laparoscopic repair with mesh fixation was planned. A 12 mmHg pneumoperitoneum was induced by open technique at the umbilicus. Three more trocars (two 10 mm and one 5 mm one) were introduced under vision. A 30° laparoscope, bipolar graspers and electrocautery (scissors)

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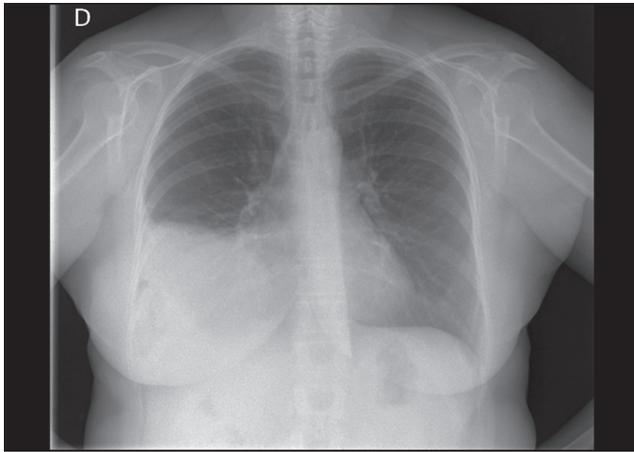


Fig. 1 Preoperative Chest X-Rays performed before thoraco-abdominal CT-scan, and showing thoracic lower right opacity with air component.

were used. The herniated right/transverse colon and (partially) the right lobe of the liver were reduced in the abdomen. The right triangular and round ligaments of the liver were sectioned in order to allow a complete mobilisation of the right lobe of the liver until visualising the right aspect of the inferior Vena Cava. The diaphragm defect did not present any hernia sac and a veritable communication between the abdomen and the thorax was noticed. The defect was closed by discontinuous non-absorbable sutures the diaphragm. Then, a flat absorbable 15 cm × 15 cm mesh was placed to cover the sutured diaphragm; the left side of the mesh (close to the Vena Cava) was discontinuously stitched to the diaphragm, while the rest of the fixation was realised by absorbable staples. Two drains were left in place (right thorax, sub-prosthetic). The procedure lasted 195 minutes. Patient's outcome was uneventful, drains were removed and the patient was discharged on postoperative day 7. The patient is well twenty months after surgery, without any recurrence (**Fig. 3**).

Discussion

Regardless of the delay of presentation, left-sided DR are reported to be more frequent than right ones in symptomatic patients after thoraco-abdominal traumas, ranging from 56% to 75%.^{6,7)} A protective role of the liver has been advocated to explain the lower incidence of right-sided DRs.⁸⁾ Interestingly, autopsic series on patients deceased because of major thoraco-abdominal trauma show the same incidence of left-sided and right-sided DRs.⁹⁾ Thus, considering the increasing survival of



Fig. 2 Preoperative Thoraco-Abdominal CT Scan. Coronal section. Thoraco-Abdominal CT-scan showing liver and colonic herniation through right diaphragmatic rupture (white arrow).

high-velocity accident's patients, it may be argued that the incidence of DR in general (and of right-sided DR in particular) is likely to increase in the future. Concerning the pathogenetic mechanism responsible of DR onset, no hernial sac was found, confirming that diaphragmatic necrosis secondary to trauma may have caused DR, as already suggested by others.⁴⁾

Diagnosis of delayed DR may be challenging. Differently from emergency situations following high-velocity trauma, where imaging is routinely performed, thus allowing an early diagnosis of DR, thoraco-abdominal trauma occurring years before the onset of symptoms can pass unnoticed or be underestimated. Moreover, unless we consider the rare presentation of DR with sudden onset of life-threatening acute complications (herniated organs' strangulation or acute respiratory distress), symptoms are usually ambiguous and non-specific, namely chest pain and respiratory discomfort.¹⁰⁾ In the present case, a patient with late DR complained of abdominal pain and respiratory discomfort for months before being explored by thoracic roentgenography and CT-scan. This latter, as already reported,³⁾ allowed achieving a correct diagnosis (**Fig. 2**). In our opinion, a meticulous, complete report of medical history, including research of high-velocity trauma, should be routinely performed in patients presenting with long-lasting respiratory discomfort. Moreover, patients having major thoraco-abdominal trauma should

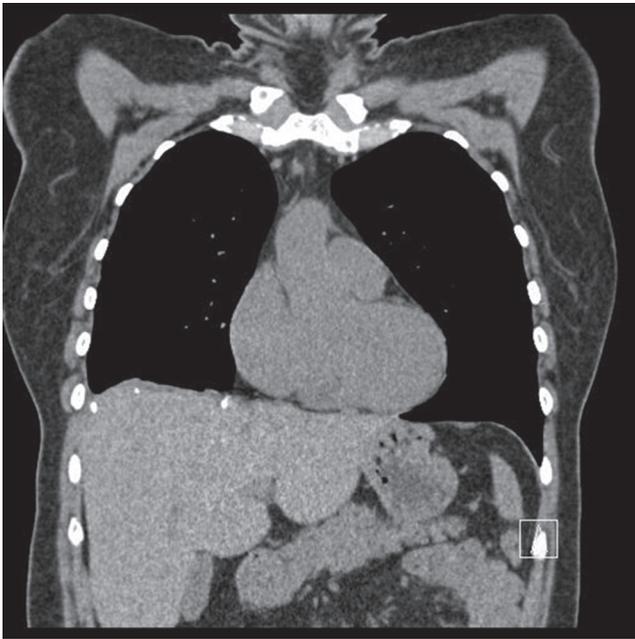


Fig. 3 Postoperative Thoraco-Abdominal CT Scan. Coronal section. Thoraco-Abdominal CT-scan showing no recurrence and diaphragmatic spontaneous hyperdensities as metallic staples.

be advertised that respiratory and abdominal symptoms due to delayed DR may occur even within years' interval. Finally, patients who survive high-velocity traumas should have a long-term follow-up in order to avoid life-threatening complications of undetected delayed DR's.

Although surgery is unanimously considered the only treatment of DR, the most appropriate approach still remains debated. Whereas an abdominal approach is usually suggested for left-sided DR, thoracic (or thorascopic) approach is highly recommended for right-sided DR,¹¹⁾ since it may be supposed to be superior in performing intrathoracic adhesiolysis and diaphragmatic repair, as the presence of the liver may interfere with a transabdominal approach.

In the reported case, laparoscopy allowed a good visualization of the diaphragmatic defect and its repair, indeed. In our opinion, few technical points should be accounted for the successful laparoscopic repair in this case, and need to be highlighted. First, the role of a 30°-laparoscope should be considered pivotal for an adequate vision in such a narrow, curve space, between the liver and the diaphragm, and beyond, in the thorax. Second, a separate ventilation of lungs should be preferred, as letting the right lung voluntarily collapse may be useful at some stage of the procedure. Third, a low pneumoperitoneum pressure (10 mmHg–12 mmHg) should be used: in fact, since no hernial sac is present and abdomen and right

thorax de facto communicate, a high-pressure right pneumothorax should be avoided, since it may be supposed to compress mediastinal organs or push them towards the left side. Fourth, in order to visualize the diaphragmatic defect and to adequately place and fixate the prosthesis, a complete right liver mobilisation by right triangular and round ligaments' division until reaching the right aspect of the Vena Cava should be pursued.

By respecting such principles, we were able to avoid the supposed main drawbacks of laparoscopic approach (difficult identification of the defect and stitching), and successfully accomplishing the mesh repair, which was time-consuming but not technically demanding. On the contrary, we took advantage of pros of laparoscopy, which are the easy reduction of herniated organs inside the abdomen and prosthesis placement in its ideal position (below the diaphragm), where intra-abdominal pressure may be supposed to stick the mesh against the diaphragm rather than far from it. Finally, although in the present case no adhesions were present among herniated and intrathoracic organs, we believe that adhesiolysis should not have been a difficult task to accomplish laparoscopically: in fact, in our opinion, intrathoracic adhesions should have been easily divided after an adequate exposure by means of the 30° laparoscope, the further reduction of pneumoperitoneum pressure and the gentle traction of herniated organs towards the abdomen.

In conclusion, DR is an often misdiagnosed affection, usually associated to ambiguous respiratory symptoms. CT-scan is the best mean of diagnosis and should not be postponed in the presence of respiratory symptoms in a patient with a history of high-velocity trauma. The laparoscopic repair of DR is a viable option, even on the right-side and in presence of herniated colon and liver.

Disclosure Statement

The authors have no conflict of interest to declare.

References

- 1) Boulanger BR, Milzman DP, Rosati C, et al. A comparison of right and left blunt traumatic diaphragmatic rupture. *J Trauma* 1993; **35**: 255-60.
- 2) Matsevych OY. Blunt diaphragmatic rupture: four year's experience. *Hernia* 2008; **12**: 73-8.
- 3) Shah R, Sabanathan S, Mearns AJ, et al. Traumatic rupture of diaphragm. *Ann Thorac Surg* 1995; **60**: 1444-9.

- 4) Sirbu H, Busch T, Spillner J, et al. Late bilateral diaphragmatic rupture: challenging diagnostic and surgical repair. *Hernia* 2005; **9**: 90-2.
- 5) Rashid F, Chakrabarty MM, Singh R, et al. A review on delayed presentation of diaphragmatic rupture. *World J Emerg Surg* 2009; **4**: 32.
- 6) Ilgenfritz FM, Stewart DE. Blunt trauma of the diaphragm: a 15-county, private hospital experience. *Am Surg* 1992; **58**: 334-8; discussion 338-9.
- 7) Voeller GR, Reisser JR, Fabian TC, et al. Blunt diaphragm injuries. A five-year experience. *Am Surg* 1990; **56**: 28-31.
- 8) Mintz Y, Easter DW, Izhar U, et al. Minimally invasive procedures for diagnosis of traumatic right diaphragmatic tears: a method for correct diagnosis in selected patients. *Am Surg* 2007; **73**: 388-92.
- 9) Puffer P, Gaebler M. [Traumatic diaphragmatic rupture in a forensic medicine autopsy sample]. *Beitr Gerichtl Med* 1991; **49**: 149-52.
- 10) Christie DB, Chapman J, Wynne JL, et al. Delayed right-sided diaphragmatic rupture and chronic herniation of unusual abdominal contents. *J Am Coll Surg* 2007; **204**: 176.
- 11) Seth D. Force. *Difficult Decisions in Thoracic Surgery: An Evidence-Based Approach, Management of Acute Diaphragmatic Rupture: Thoracotomy Versus Laparotomy*. London, Springer London, 2007; pp 379-84.