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Case report

Left diaphragmatic rupture in vehicle trauma: Report of surgical treatment and complications of two consecutive cases

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Summary. *Background and aims:* Diaphragmatic ruptures are associated with blunt abdominal or thoracic trauma and often occur in car and motorbike accident with a high energy impact. *Case presentation.* We report two cases of patients victims of car and motorbike accidents that were referred to the Emergency Department of our Hospital in August and September 2017 for a politrauma. The patients were both diagnosed with a left diaphragmatic rupture with herniation of the stomach in the chest, and decomposed fractures of the ribs. One of the two patients reported a large abdominal wound with loss of substance in the site of the impact. Both patients underwent to open emergency surgery with primary repair of the phrenic rupture. The post-operative course was characterized by the occurrence of complications such as respiratory distress and emothorax for one of the patients. *Conclusion:* Traumatic rupture of the diaphragm can be associated to blunt or penetrating abdominal trauma in car and motorbike accident with a prevalence of the left-sided lesions. In patients with politrauma an associate rupture of the diaphragm should be always suspected especially in motor accident where high energy impact can generate a traumatic laceration of the respiratory muscle. The treatment of associate thoracic wall fractures to prevent weaning and respiratory distress in intubated patient should be discussed. (www.actabiomedica.it)

Key words: Diaphragmatic rupture – thoraco-abdominal trauma – motor vehicle accident

Introduction

A traumatic diaphragmatic rupture is often associated with blunt abdominal and thoracic trauma (1) and its incidence ranges from 2.5 % to 7 % (2,3). Diaphragmatic ruptures occur in car and motorbike accident with a high energy impact where direct anterior blow to the abdomen may increase intra-abdominal pressure and overcome the pressure of the musculotendinous structure (4). The side of the lesion usually directly correlates with the direction of impact (5) with a prevalence of left sided injuries (6,7) with recognized right-sided diaphragmatic occurring only between one half (8,9) to one third (6) of cases. This may be explained by a cushioning or buffering effect of the liver on the right side. Bilateral lacerations are relatively rare and occur in 1% to 2% of patients. Usually asymptomatic, traumatic rupture of the diaphragm must be suspected in politrauma with several associated life-threatening injuries (10). An high index of suspicion should guide the clinician to the diagnosis when there are no signs or symptoms directly attributable to the diaphragmatic defect. Most commonly symptoms are secondary to concomitant injuries especially to the intra-abdominal organs (11) such as herniated stomach in the thorax causing nausea, inability to swallow

or more classic signs of occlusion like abdominal distension and bloating when small bowels or colon are herniated in the pleural cavity.

Since chest X-ray could be disguised by the presence of fluid or collection of blood due to a concomitant hemothorax, multidetector CT scan in the axial and coronal sections allows a diagnosis in most cases (12,13); other methods include RMN, ultrasound and contrast studies with gastrografin® especially in the presence of herniated bowel in the thorax.

Sometimes diagnosis is made by direct vision during surgical intervention, either via laparoscopic, thoracoscopic or open approach (14,15,16) that allows for concomitant treatment of any intra-abdominal or intra-thoracic injuries, and the reduction of acutely herniated viscera.

Methods of repair differs according to surgeon's skills and experience: a minimally invasive approach trough laparoscopy or thoracoscopy is feasible in an expert setting but not suitable for most surgeons; a combined thoraco-abdominal approach is used in case of intra-abdominal and intra-thoracic bleeding (4); open repair is possible even with the use of prosthetic non absorbable inert or biological materials.

Non-absorbable interrupted sutures and running absorbable sutures are two options, with similar outcomes (17,18). In olden ruptures the use of prosthesis is frequently needed (20) where intermittent stitches on an atrophic diaphragm could expose the suture to a higher risk of dehiscence.

Case Report

Case one

In August 2017, a 65-years-old man was brought to the Emergency Department of our Hospital after a motorbike accident: a left lateral impact with another vehicle caused him to bounce out his motorbike with a consequent left sided impact on the ground. Vital signs on acceptance were GCS 15, arterial pressure 150/90 mmHg, heart rate was 98 bpm, oxygen blood saturation was 94% with supply trough a facial mask; the patient was alert and collaborative in absence of neurological findings, with preserved motor and sensitive functions. In his medical history he reported type 2 diabetes, arterial hypertension, and alcoholic habit. On physical findings the auscultation of the chest revealed decreased respiratory rumors bilaterally; his abdomen was tender to palpation, sore on the left lateral region where a loss-of-substance lesions was detected on the inspection. Bedside emergency ultrasound did not show any fluid abdominal collection or pneumothorax. The complete blood count check revealed hemoglobin 14.2 gr/dL, WBC 27 X 10 3 /microL. Blood-gas analysis reported: pH 7.34, lactate 15 mg/dL. Total body CT scan demonstrated the presence of the stomach herniated in the left pleural cavity with loss of integrity of the left diaphragm (Figure 1). The patient was diagnosed with a closed thoracic trauma with decomposed fractures of the rib from the third to the nineth, a penetrating abdominal trauma with a complete herniation of the stomach in left thorax, left parietal facial laceration and mild subarachnoid hemorrhage.

A naso-gastric and urinary catheterization were carried out and the patient was referred to the operating room.

We exposed the abdominal cavity trough a median laparotomy: we reported a 12 cm in diameter laceration of the left diaphragm with a displaced fundus of the stomach; in the left ipocondrial region a penetrating trauma caused loss of integrity of the abdominal wall (Figure 2). The stomach was healthy, and it was replaced in the abdominal cavity. The diaphragmatic and abdominal lesions were repaired with direct interrupted suture using a non-absorbable monofilament polypropylene. The visual and manual inspection of the abdominal bowels didn't reveal any visible injuries.

Two drain tubes were placed: one in the subdiaphragmatic left region, and the other in the splenic recess. The decomposed rib fractures were not surgically treated.

The ICU post-operative stay was complicated by the onset of persistent hyperpyrexia treated with large-broad antimicrobial therapy, left pleural ongoing effusion and impossible weaning. This led to the need for a temporary tracheostomy with nocturnal continue positive pressure ventilation then non-invasive ventilation trough tracheostomy.

On tenth post-operative day, a negative pressure wound therapy device was applied for the treatment

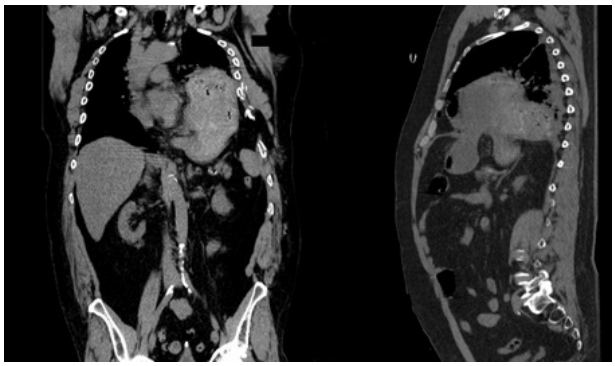

Figure 1. Case one, thoraco-abdominal contrast-enhanced CT-scan, coronal and sagittal section: dislocated stomach in the left pleural cavity

Figure 2. CT-scan, axial section: loss of integrity of the left abdominal wall with herniated bowels (left colic flexure)

of the wound in the upper left region because of the presence of loss of substance due to the penetrating trauma.

On twentieth post-operative day a brown enteric liquid was observed from the abdominal left wound; a trans-anal contrast study of the colon revealed a direct communication in an entero-cutaneous fistula (Figure 3). It is unclear if the fistula has been a late consequence of the penetrating trauma or it was exasperated by negative pressure device suction directly affixed onto the weakened abdominal fascial layer. In the impossibility to restore a normal bowel function and obtain the healing of the abdominal wound we decided to perform a segmentary colonic and cutaneous en-bloc resection followed by a side –to-side colo-colic anastomosis and reconstruction of the anterior abdominal wall with a biological mesh.

The patient was discharged 63 days after the admission with completely restored bowel function; the abdominal wound was completely healed in the absence of local signs of infection.

An abdominal CT scan obtained 10 months later revealed an uncomplicated large incisional hernia in the site of the previous trauma.

Case two

The second patient was a 47-year-old man, a car driver, with no safety belt, victim of car crash with frontal impact on the steering wheel. He reported closed thoracic trauma with several rib fractures, left pneumothorax and diaphragmatic rupture (Figure 4). On the acceptance at the Emergency Department, he was alert and responsive, with GCS 15; blood values were normal, the patient was dyspnoeic with the request of high oxygen flow, blood oxygen saturation was 78%, blood pressure 90/60 mmHg, hearth rate 125 bpm. Bedside fast ultrasound examination of the thorax documented the absence of pulmonary sliding sign and a pleural particle effusion; a contrast-enhanced CT scan of the abdomen and thorax confirmed a left diaphgramatic rupture (figure 4) and gastric displacement in the pleural cavity. In this case the placement of a nasogastric tube was helpful to partially relief the symptom related to lung and mediastinal compression by the herniated stomach.

The patient underwent to emergent laparotomy: after reducing the herniated stomach into the abdomen, left phrenic rupture was repaired directly with non-absorbable interrupted sutures using polypropylene. The spleen and the other abdominal viscera were undamaged. Two drainages were placed: a left thoracic tube and a drain in the upper left abdominal quadrant.

The post-operative course was dramatic with the occurrence of massive haemothorax (Figure 5) in first post-operative day (1500 mL/5 h blood effusion trough the pleuric drainage) that required a second emergency intervention: a thoracoscopic exploration

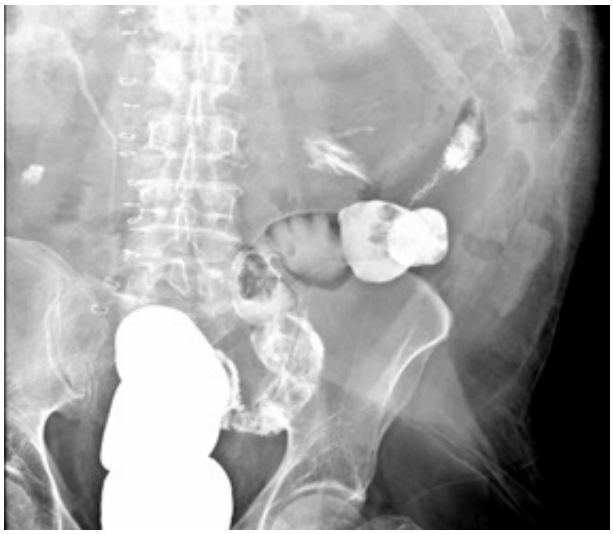

Figure 3. Colo-cutaneous fistula in the left upper abdominal region displayed after the trans-anal retrograde injection of opaque enema

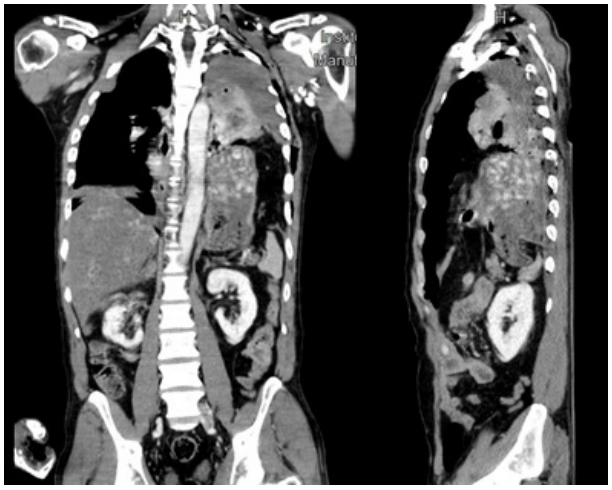

Figure 4. Case two, a pleural effusion is clearly visible surrounding the left collapsed lung and the herniated stomach

of the left pleural cavity revealed a large hematoma of the anterior chest wall and several pulmonary contusions of the inferior left lobe which was dissected, but the origin of blood spillage remained unclear. Three left thoracic drainages were left in place.

The patient was discharged on 37th post-operative day from intensive care unit and he was transferred to a rehabilitation facility for a complete functional and respiratory recovery that he finally achieved after a month.

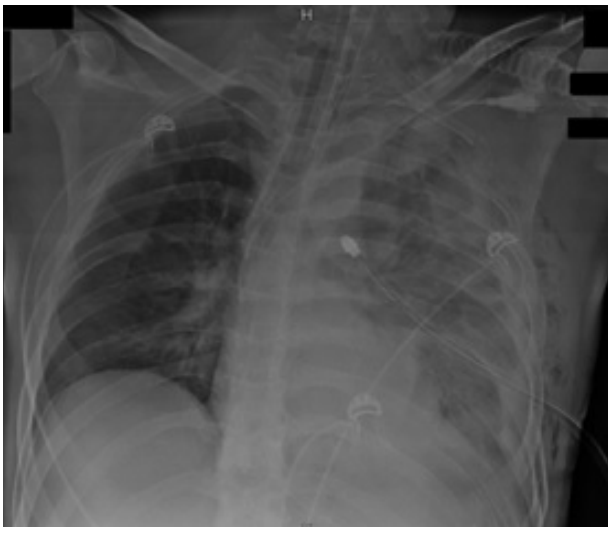

Figure 5. Post-operative day 1 after diaphragm reparation, chest X-ray shows the fluid collection occupying the left pleural cavity and collapsing the lung

Discussion and Conclusion

Diaphragmatic traumatic rupture is usually associated with high-speed abdominal trauma and it must be always suspected since it is a potentially lethal clinical condition; other etiologies of diaphragmatic ruptures are congenital postero-lateral hernia (Bochdalek).

A high index of suspicion is crucial for an early diagnosis.

A delayed or missed diagnosis causes high mortality in this type of trauma (23) up to 37% in a series depending on the presence of associated penetrating and blunt injuries. Many patients present with concomitant life-threating injuries such as haemothorax, haemopericardium, splenic or hepatic lacerations (21). Irreversible shock and head injury are most likely causes of intra-operative or early post-operative deaths, whereas sepsis and multisystem organ failure predominate as late causes of death (24).

Diaphragm is an anatomical structure uneasy to explore with conventional tools and its laceration could be only suspected indirectly through sign and symptoms caused by herniated bowel. To date chest X-ray has been replaced by CT scan due to a higher sensitivity in detecting diaphragmatic rupture, since it is often associated with other abdominal or thoracic injuries.

Missed diagnosis could result in enlargement of the diaphragm laceration: patient experience abdominal or chest pain, with possible strangulation, perforation of the herniated organs and signs of lung compressions such as dyspnea, pleural effusion and consequent infections (7).

Laparotomy provides the best way for diaphragmatic repair; it allows for concomitant treatment of any intra-abdominal injuries, and the reduction of acutely herniated bowel is easily undertaken with this approach (4).

In haemodinamically stable patients, combined VATS and open surgery is both a diagnostic and therapeutic tool for definitive management of diaphragmatic lacerations.

The post-operative morbidity includes complications like suture-line dehiscence, hemi diaphragmatic paralysis secondary to iatrogenic phrenic nerve injuries, respiratory insufficiency, empyemas and subphrenic abscess (18).

For patients in whom delayed rupture is diagnosed, the abdominal approach does not allow to take down the firm adhesions between intrathoracic structures and herniated viscera. As a consequence, a thoracic open or minimally invasive approach with intrathoracic dissection and subsequent diaphragmatic repair is the approach of choice.

In case of penetrating abdominal trauma with diaphragmatic injury the gradient due to positive abdominal pressure across the defect progressively enlarges the tear and the herniation of abdominal bowels could occur over several months. In this case minimally invasive procedure such as laparoscopy or thoracoscopy could provide direct visualization of the defect, always being cautious because laparoscopic exploration undertaken on a patient with a diaphragmatic undiagnosed rupture can lead to an iatrogenic tension pneumothorax.

In politrauma the associated rib decomposed fractures should be possibly treated to prevent the onset of respiratory distress related to the painful inspiratory movement, but the timing and type of this surgery is still controversial.

In case of older rupture delayed repair becomes difficult mainly because of adhesions and atrophy of the diaphragm.

Lastly, laparoscopic and thoracoscopic approach are feasible in expert hands and in the stable patient while exploratorive laparotomy is mandatory in haemodinamically unstable patients.

In the presence of a traumatic diaphragmatic rupture not associated to life-threatening injuries, the timing of repair should be discussed to determine whether deferred surgery provides the best outcome.

List of abbreviations: CT: computed tomography; GCS: Glasgow's Coma Scale; ICU: intensive care unit; NPWT: negative pressure wound therapy; ECF: entero-cutaneous fistula; SSI: surgical site infection; VATS: video-assisted thoracoscopic surgery

Conflict of interest: The authors declare that they have no competing interests.

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References

1. Clarke DL, Greatorex B, Oosthizen GV, Muckart DJ: The spectrum of diaphragmatic injury in a busy metropolitan surgical service. Injury 2009,40:932–937.
2. Matsevych OY: Blunt diaphragmatic rupture: four years' experience. Hernia 2008, 12(1):73–78.
3. Jin YL, Young HS, Jin BY, Seung JK, Jung HC, Joong SK. Right-sided diaphragmatic rupture in a poly traumatized patient. Ann Surg Treat and Res 2017; 3: 342-345.
4. Scharff JR, Naunheim KS. Traumatic diaphragmatic injuries. Thorac Surg Clin2007;17:81-5.
5. Kearney PA, Rouhana SW, Burney RE. Blunt rupture of the diaphragm: mechanism, diagnosis, and treatment. Ann Emerg Med 1989;18: 1326-30
6. Shah R, Sabanathan S, Mearns AJ, Choudhury AK: Traumatic rupture of diaphragm. Ann Thorac Surg 1995, 60(5):1444–1449.
7. Turhan K, Makay O, Cakan A, Samancilar O, Firat O, Icoz G: Traumaticdiaphragmatic rupture: look to see. Eur J Cardiothorac Surg 2008,33:1082–1085.
8. Estrera AS, Landay MJ, McClelland RN. Blunt traumatic rupture of the right hemidiaphragm: experience in 12 patients. Ann Thorac Surg 1985;39: 525–30.
9. Williams M, Carlin AM, Tyburski JG, et al. Predictors of mortality in patients with traumatic diaphragmatic rupture

and associated thoracic and/ or abdominal injuries. Am Surg 2004;70:157–62.
10. Thiam O, Konate I, Gueye ML, ToureAO, Seck M, Cisse M, et al. Traumatic diaphragmatic injuries: epidemiological, diagnostic and therapeutic aspects. Springerplus 2016;5:1614.
11. Rosati C. Acute traumatic injury of the diaphragm. Chest Surg Clin N Am 1998;8:371–9.
12. Sliker CW. Imaging of diaphragm injuries. Radiol Clin North Am 2006;44:199–211.
13. Marts B, Durham R, Shapiro M, et al. Computed tomography in the diagnosis of blunt thoracic injury. Am J Surg 1994;168:688–92.
14. Friese RS, Coln CE, Gentilello LM. Laparoscopy is sufficient to exclude occult diaphragm injury after penetrating abdominal trauma. J Trauma 2005;58: 789–92.
15. Lowdermilk GA, Naunheim KS. Thoracoscopic evaluation and treatment of thoracic trauma. Surg Clin N Am 2000;80:1535–42.
16. D'Souza N, Bruce JL, Clarke Dl, Laing GL; Laparoscopy for Occult Leftsided Diaphragm Injury Following Penetrating Thoracoabdominal Trauma is Both Diagnostic and Therapeutic. Surg Laparosc Endosc Percutan Tech 2016; 26: 5-8.
17. Guth AA, Pachter HL, Kim U. Pitfalls in the diagnosis of blunt diaphragmatic injury. 1995;170: 5-9.
18. Sankalp Dwivedi, Pankaj Banode, Pankaj Gharde, Manisha Bhatt, and Sudhakar Ratanlal Johrapurkar. Treating traumatic injuries of the diaphragm. J Emerg Trauma Shock. 2010 Apr-Jun; 3(2): 173–176
19. Atoini F, Traibi H, Elkaoui F, Elouieraiachi M, Elhammoumi K, Sair E, Kabiri H. Les lésions diaphragmatiques post-traumatiques droites méconnues : une revue de six cas. Missed right post-traumatic diaphragmatic injuries: A review of six cases. Revue de Pneumologie Clinique; 2012; 68: 185-193.
20. Duzgun AP, Ozmen MM, Saylam B, Coskun F: Factors influencing mortality in traumatic ruptures of diaphragm. Ulus Travma Acil Cerrahi Derg 2008,14(2):132–138.
21. James R. Scharff, MD, Keith S. Naunheim. Traumatic Diaphragmatic Injuries Thorac Surg Clin 2007, 17:81–85.
22. Marts B, Durham R, Shapiro M, et al. Computed tomography in the diagnosis of blunt thoracic injury. Am J Surg 1994;168:688–92.
23. Sliker CW. Imaging of diaphragm injuries. Radiol Clin North Am 2006;44:199–211.ry. Am J Surg 1994;168:688–92.
24. Tai NR, Boffard KD, authors. Thoracic trauma: principles of early management. Trauma. 2003;5: 123–36.

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