LEFT-SIDED TRAUMATIC DIAPHRAGMATIC INJURIES

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Abstract

Traumatic diaphragmatic injuries may result from either penetrating or blunt trauma, usually of the lower chest or upper abdomen. The injury of the left hemidiaphragm occurs three times more frequently than does injury to the right.

The objective of this review is to present, on the base of personal experience, the mechanisms, diagnostic and therapeutic diaphragmatic injuries, the diagnostic algorithm and the management of these traumas that remains a challenge for the surgeon are presented.

key words: *left hemidiaphragm, traumatic left diaphragmatic injuries, penetrating trauma, blunt trauma*

Introduction

Traumatic diaphragmatic injuries may result from either penetrating or blunt trauma, usually of the lower chest or upper abdomen. These injuries are infrequent and they have been a diagnostic dilemma for surgeons for years. The recognition and management of these injuries remains a challenge. Further, once identified, there is some debate as well, over whether or not all diaphragm injuries require repair. Clearly, large wounds with obvious herniation of abdominal content to the thorax are not diagnostic or treatment dilemmas. However, small injuries on the right where the liver is unlikely to herniate through have been subject to some debate.

The injury of the left hemidiaphragm occurs three times more frequently than does injury to the right. **The objective** of this review is to present the mechanisms, diagnostic and therapeutic challenges in the left sided diaphragmatic injuries.

Mechanisms of left hemidiaphragmatic injuries

In general, the diaphragmatic injuries are described in penetrating as well as in blunt abdominal, thoracic, and thoraco-abdominal traumas. The three mechanisms of diaphragmatic injuries are observed.

The first one is injury of the diaphragm by transmission of force through the abdominal viscera to the diaphragm (8, 9, 10). This mechanism is typical for the cases with blunt abdominal trauma, with the left diaphragm damaged more frequently. There are two circumstances explaining why the left hemidiaphragm is affected in blunt abdominal traumas more frequently. At first, the left hemidiaphragm is unprotected, as compared to the right which is protected by the liver. The energy from the force applied to the abdomen or flank should be distributed equally in all directions throughout the abdominal visceral contents. This force is distributed to the peritoneal cavity and the left hemidiaphragm, buffered only by the less bulky stomach, spleen, and kidney, which tends to rupture with greater frequency when enough pressure is applied. On the second place, there is a theory that the left hemidiaphragm appears to be less resistant to applied pressures than does the right.

The second mechanism of diaphragmatic injury is laceration of the diaphragm by sharp object in penetrating thoracic trauma (2, 6, 7). By this mechanism, the left diaphragm again is more often injured than the right. The explanation of this fact is that in cases of attack, most attackers are right handed and therefore will be more likely to injure their victims on the left side.

The third mechanism of diaphragmatic injury is damaging of diaphragm by sharp edges of the fractured ribs in blunt thoracic traumas (1, 4, 11, 12). In situation of direct impact on the thoracic cage

with high kinetic energy, there is bending of the lower ribs (6^{th} to 10^{th}) inward against the diaphragm. Without protection of the underlying liver, the left diaphragm is also more often injured than the right by this mechanism.

The real problem in diaphragmatic injuries is herniation of the abdominal organs into the thoracic cage. Herniation through the acute rupture of the left hemidiaphragm is about 66% more common after blunt traumas than after penetrating injuries (3, 6, 13). The most commonly herniated organs through the left hemidiaphragm are stomach, spleen, small bowel, left sided colon and great omentum.

Diagnostic tests in left hemidiaphragmatic injuries

The diaphragm is rarely injured alone. There is a large number of associated abdominal and thoracic injuries in cases of diaphragmatic rupture. Because of the associated injuries, only a minority of patients present typical signs and symptoms of diaphragmatic rupture, which include respiratory distress, cardiac abnormalities, deviated trachea, and bowel sounds in the chest. Most of the patients with diaphragmatic injury present with signs and symptoms related to other organ system injuries resulting from the trauma. Moreover, hypovolemic shock is a common finding that obscures the typical symptoms of diaphragmatic injury. That is why the diagnosis of diaphragmatic injury presents a challenge for the surgeon.

For the diagnosis of diaphragmatic injuries, the surgeon should have high index of suspicion of them just from the moment of taking the history of the trauma. Except that, the surgeon must recognize the entire spectrum of clinical presentation of diaphragmatic injuries. With the aim to recognize diaphragmatic injuries in the acute setting after trauma, the surgeon must follow diagnostic algorithm for diagnosis of this injury. This algorithm includes diagnostic tests that are presented below, with an accent to diagnosis of the left hemidiaphragm injuries.

At first, the diagnostic algorithm in diaphragmatic injuries includes history of the trauma. In left sided blunt thoracic traumas with high energy (like falls from heights, direct impacts from vehicles, crush injury) the surgeon should be alert to the possibility of left hemidiaphragm injury. In contrast, of blunt thoracic traumas, penetrating trauma in the left thoracoabdominal area immediately alerts the surgeon to the possibility of injury of the left hemidiaphragm.

On the second, the presenting symptoms of the patient with left sided diaphragmatic injury must be recognized by the surgeon. Thoracic symptomatology, including left sided chest pain, dyspnea and orthopnea are found in most of the cases. Thoracic pain with irradiation to left shoulder area (Kehr's sign) is very typical sign of left sided injury of the diaphragm. Expression of dyspnea is generally related to the volume of the left pleural space occupied by the displaced intra-abdominal viscera.

Physical finding as dullness to percussion of the left hemithorax with bowel sounds on auscultation is typical physical presentation of herniation of the abdominal organ into the left pleural cavity trough defect of the left hemidiaphragm. In some of the cases with injury of the left hemidaiphragm due to the severe thoraco-abdominal trauma, with replacement of abdominal organs into the pleural space, physical examination may establish scaphoid abdomen with localized or diffuse abdominal tenderness and guarding.

After history of the trauma and physical examination, the next step in diagnostic algorithm of diaphragmatic injuries is imagining diagnosis. The method of the first choice in imagining diagnosis is conventional chest radiograph (5, 8, 9, 10). The diagnostic accuracy of the chest X-Ray in left diaphragmatic injury is reported from 25 % to 60%. Chest X-Ray may reveal the gastric or colonic bubble and/or air-fluid levels consistent with colon or small bowel in the left thoracic cavity (fig.1). Occasionally, in acute ruptures of the left hemidiaphragm, nasogastric tube placed during the

resuscitative phase will be found in the left thoracic cavity. Other findings may include an elevated left diaphragm, fractured ribs (with or without displacement) and left hemothorax or pneumothorax.

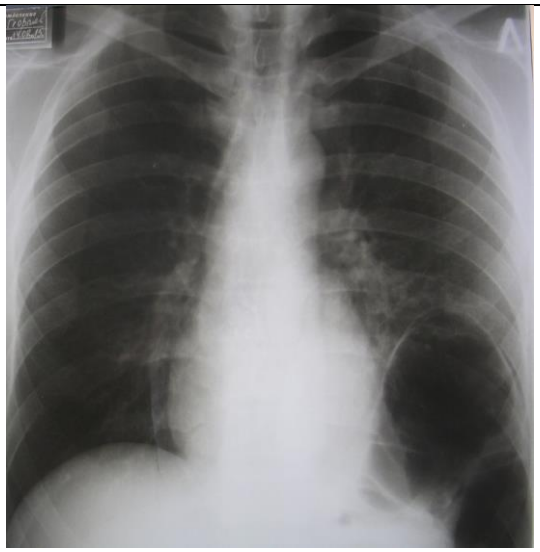

Figure 1. Chest X-Ray reveals colonic bubble in the left thoracic cavity / (the author's database).

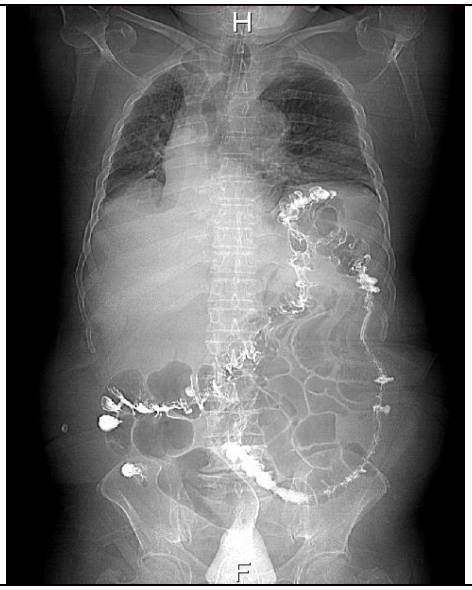

Figure 2. Contrast X-Ray reveals herniation of the colon into the left thoracic cavity / (the author's database).

Contrast studies as a rule are useful in diagnosis of chronic, long-standing herniation of intra-abdominal viscera into the left thoracic cavity (fig. 2). However, in some cases of acute phase of diaphragmatic injury (immediately after the trauma) in which the initial chest x-ray has failed to yield a diagnosis of diaphragmatic injury, contrast studies can be used to prove this pathology. Clearly, the patient must be hemodynamically stable in order to undergo these studies. An upper gastrointestinal series will often delineate the presence of the stomach within the left thoracic cavity. A barium enema, as either a single-column or a double-contrast study, will also outline a herniated colon within the left thoracic cavity.

Contrast enhancement computed tomography scan has a greater diagnostic accuracy in left diaphragmatic injury (1, 5, 8, 11, 12). This diagnostic method will reveal the herniated abdominal organ into the left pleural cavity and in some of thoracic trauma patients will differentiate herniated solid abdominal organ (most commonly spleen) from the left sided hemothorax, which is impossible with the conventional X-Ray (fig. 3).

The focused abdominal sonography for trauma (FAST) is easily performing and relatively accurate technique for evaluation of the left diaphragmatic injuries, even for establishing the herniation of abdominal organ through the diaphragmatic defect.

Video-thoracoscopy is established as an effective method of evaluating the left diaphragmatic injuries (fig. 4). This method is recommended in hemodynamically stable patients with suspicion of left diaphragmatic injury, unrevealed by the imagining methods.

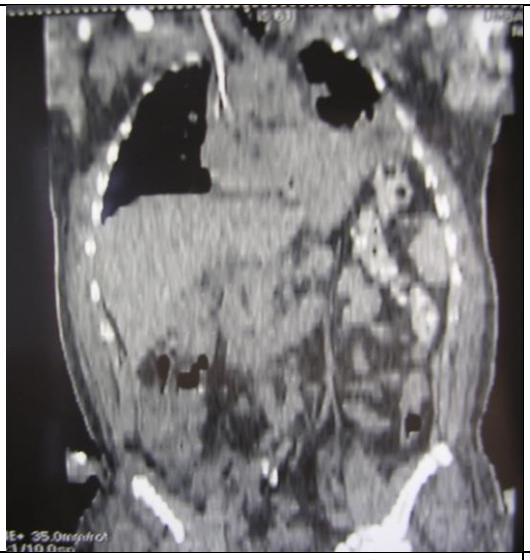

Figure 3. Contrast enhancement computed tomography reveals left diaphragmatic rupture with concomitant left hemothorax / (the author's database).

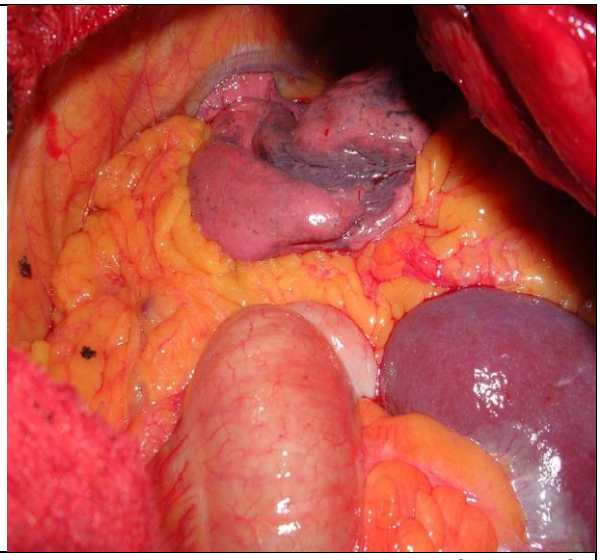

Figure 4. Video-thoracoscopy of the left plural cavity: herniation of the spleen, great omentum, left colonic flexure in a patient with traumatic left-sided injury of the diaphragm / (the author's database).

Management of left diaphragmatic injuries.

In patients suspected of having left diaphragmatic injury, attention must be paid to the insertion of a nasogastric tube. The tube should not be forced, as herniation of the stomach into the left hemithoracic cavity may distort the esophagogastric junction therefore producing an iatrogenic laceration of the esophagus, stomach, or both (12, 13). Likewise, added caution must be taken when placing a left thoracostomy tube (due to left sided hemo-and pneumothorax). If a chest x-ray has been obtained and suspicious shadows are located in either thoracic cavity, caution must be exercised in chest insertion.

The general principle of diaphragmatic injuries is: approach to the diaphragm with its exploration, reducing and relocating of the herniated viscera in their positions within the abdominal cavity and repairing of all injuries of the diaphragm.

Proven or suspected diaphragmatic injury in abdominal trauma, original coupled with the classic findings of intra-abdominal injury mandates immediate exploratory laparotomy. The left hemidiaphragm can be inspected by applying gentle downward retraction of the spleen and greater curvature of the stomach. The central tendon of the diaphragm should also be examined, along with the esophageal hiatus (13).

Repair of acute diaphragmatic injuries in thoracic trauma can be approached via thoracotomy (fig. 5A,5B). A left sided diaphragmatic injury diagnosed by thoracoscopy in the absence of other injuries mandating laparotomy or thoracotomy can be repaired with this mini invasive approach. This requires that the trauma surgeon be skillful in thoracoscopic suturing (1, 6, 9).

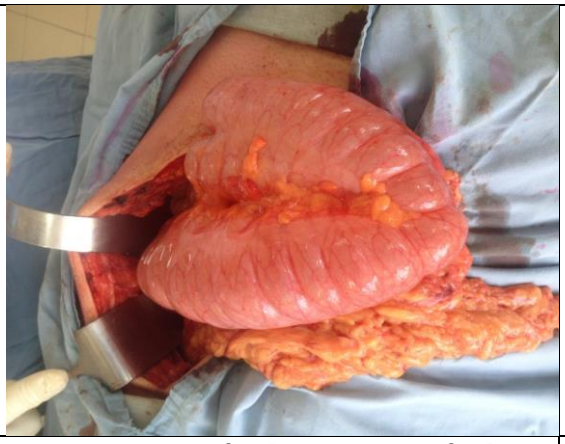

Figure 5A. Left thoracotomy finding: herniation of the left colon trough the ruptured left diaphragm / (the author's database).

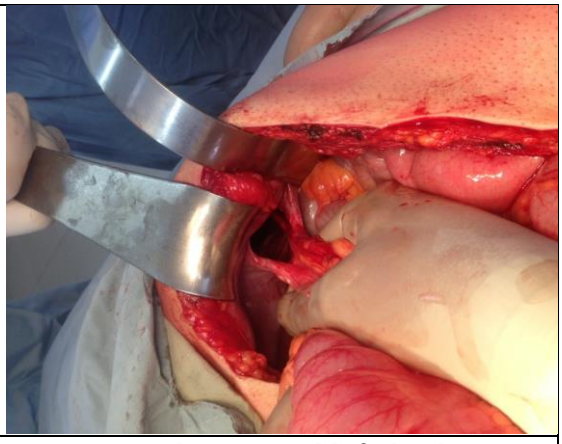

Figure 5B. The ruptured left diaphragm – presented after reducing the herniated left colon / (the author's database).

A combined left thoracotomy and laparotomy approach ensure full visualization of the left diaphragm. This approach is recommended in thoraco-abdominal trauma, especially in cases with massive diaphragmatic destruction (2, 7, 9).

Conclusion.

In conclusion, this review presents one infrequent traumatic injury in its acute stage – left sided diaphragmatic injuries. Based on personal practical experience and contemporary knowledge, the mechanisms of left sided diaphragmatic injuries, the diagnostic algorithm and the management of these traumas, challenge for the surgeon are presented.

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