Plain chest radiographs for the diagnosis of post-traumatic diaphragmatic hernia

Exame radiográfico convencional do tórax no diagnóstico de hérnia diafragmática pós-traumática

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A B S T R A C T

Objective: To describe changes in the radiographic examination of the chest in patients with post-traumatic diaphragmatic hernia (PTDH) confirmed intra-operatively. **Methods**: Between January 1990 and August 2008 45 patients with PTDH were treated. We analyzed demographic data, cause of injury, changes in chest radiography (CXR), extent and location of the diaphragmatic lesion and herniated organs. We described the radiographic findings most frequently identified by surgeons and radiologists. **Results**: CXR was performed on 32 patients, predominantly male (27 cases, 84.4%) and the mean age was 34 years. The most common cause of injury was blunt trauma (25 cases, 78.1%). Radiographic examination of the chest showed changes suggestive of PTDH in 26 cases (81.3%). During exploratory laparotomy, left PTDH was found in 28 cases (87.5%) and right in four (12.5%). The most frequently herniated organ was the stomach. **Conclusion**: The study showed that CXR is very useful in the initial diagnostic approach to PTDH. The difficulty is that diaphragmatic injuries, particularly after penetrating trauma, may initially go unnoticed, and without changes in the CXR images, diagnosis is made difficult.

Key words: Hernia. Hernia, diaphragmatic. Hernia, diaphragmatic, traumatic. Radiography, thoracic. Diagnosis.

INTRODUCTION

The post-traumatic diaphragmatic hernia (PTDH) occurs when one or more abdominal organs or other structures, such as omentum or peritoneal fat, protrudes through the injured diaphragm. Thus, abdominal organs leave their original cavity and invade that of the thorax[1].

The injury of the diaphragm may be secondary to blunt or penetrating trauma[2,3]. Motor vehicle accidents are the most common cause of this injury, ranging between 70% and 85% of all cases[2,4].

Clinical experience has shown the highest incidence of left PTDH occurs after injuries were undiagnosed[2]. There is a study that justifies the higher incidence of left PTDH in patients admitted to hospitals as being due to the higher mortality of right PTDH at the scene[5]. Left-sided diaphragmatic injuries may manifest themselves as intra-thoracic herniation of abdominal viscera, e.g. stomach, colon, spleen and peritoneal fat[5-7]. It is noteworthy that the absence of PTDH does not rule out diaphragmatic injury, which must be repaired.

Lesions of the diaphragm, when diagnosed and treated at the time of trauma (early or acute), have mortality rates lower than 5%, and when diagnosed during complications (obstructive or late), the mortality rate increases to between 36% and 48%[7,8].

A systematic investigation based on research procedures for injury of the diaphragm is still the main determining factor for diagnosis, thus avoiding the occurrence of late PTDH. It is known that its actual incidence is greater than that found in literature[9-11].

Studies have emphasized the limitations of conventional chest radiography (CXR) in the diagnosis of diaphragmatic injury and have suggested the use of other methods, including fluoroscopy, gastrointestinal contrast, ultrasonography, computed tomography (CT scan) and

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magnetic resonance imaging to improve the diagnostic index. However, none of these methods provides near 100% accuracy[2,12].

The CXR establishes preoperative diagnosis in only one third of patients[10,11]. The elevation of the hemidiaphragm is an alteration which strongly suggests the injury, but it is not specific to PTDH, as it may be related to other problems such as atelectasis and phrenic nerve paralysis[12]. It is nevertheless the greatest-used imaging method in the initial care for trauma patients due to its availability in emergency rooms, ease of performance and requirement of little cooperation from the patient[13]. Another favorable factor is that the emergency physician can evaluate a CXR, since there is often no radiologist available. Based on radiographic changes and the mechanism of trauma, an injury to the diaphragm should be highly suspected.

To avoid the late diagnosis of PTDH, injuries to the diaphragm should be investigated as a function of a high index of suspicion (cause and mechanism of trauma), using additional different diagnostic procedures, even surgical procedures such as laparoscopy or thoracoscopy, until the diagnosis is confirmed or discarded.

We thus expect to alert emergency physicians and trauma surgeons to the changes detected by this method, which is simple and available in most centers, for the diagnosis or suspicion of diaphragmatic injury in the acute phase. It is to be noted that the normal test does not exclude the presence of a PTDH.

The aim of this study is to describe the findings of CXR in patients diagnosed with PTDH confirmed intraoperatively in order to determine the most common radiographic findings.

METHODS

We evaluated the medical records of the trauma registry of the Department of Trauma Surgery at UNICAMP for prospective cases between January 1990 and August 2008.

CXR was performed on the patients in the supine position, using an anterior-posterior incidence of X-rays, either in the emergency room or in the radiology sector. Each X-ray was interpreted by at least two radiologists and two surgeons with experience in trauma surgery, and was considered positive if the findings were identified by both teams. In doubtful cases, a third expert in each area was invited to interpret the exams. All changes in CXR suggestive of acute PTDH were recorded, thoroughly reviewing the tests in which the injury was not initially diagnosed, as well as using other methods for diagnosis in these cases.

For the identification procedure, besides CXR findings, we analyzed: demographic data, trauma mechanism, extent and location of the lesion of the diaphragm and herniated organs. The severity of injury of the diaphragm was classified according to the injury scale of the American Association for Surgery of Trauma (AAST): Grade I = diaphragm contusion; Grade II = laceration less than or equal to 2 cm; Grade III = laceration greater than 2 cm and less than 10cm; Grade IV = laceration greater than 10 cm, with tissue loss less than or equal to 25cm^2 and Grade V = tissue loss greater than 25cm^2. We also described the findings in patients who underwent a CT scan and other diagnostic methods such as diagnostic peritoneal lavage (DPL) and laparoscopy.

The study procedure was approved by the Ethics Committee of the institution.

RESULTS

From January 1990 to August 2008 there were 2,593 trauma patients who underwent exploratory laparotomy. Of these, 385 (14.8%) had injury of the diaphragm. PTDH was identified in 45 cases (11.7% of diaphragmatic injuries), three of them being considered late hernias and hence excluded from the study. Of the 42 patients in whom the presence of acute PTDH was confirmed at laparotomy, CXR was performed in 32 cases, thus becoming the object of the present study. Of the 32 patients submitted to CXR the predominance was male (27 cases, 84.4%) and the ages ranged from 13 to 59 (with a mean of 34 years).

Blunt trauma was the most common cause (25 cases, 78.1%), followed by car accidents (11 cases, 44%) and pedestrian injuries (7 cases, 28%). In penetrating trauma stab wounds prevailed (5 cases, 71.4% of the penetrating traumas), followed by injury by gunshot wound (two cases, 28.6% of the penetrating traumas).

CXR alterations occurred in 26 cases (81.3%), the most common being described in table 1. Figures 1, 2 and 3 illustrate these findings.

The administration of a water-soluble contrast substance by a nasogastric tube was performed in one case, supporting the diagnosis of PTDH (Figure 4). A CT scan of the abdomen was performed on five patients, confirming the diagnosis of hernia previously suspected by CXR.

During exploratory laparotomy left PTDH was found in 28 cases (87.5%) and right in four (12.5%). In two cases, confirmation of the lesion was made by laparoscopy, followed by a laparotomy to treat the lesion. With regards to the degree of injury of the diaphragm, we observed the following: Grade II = 3 cases (9.4%); Grade III = 12 cases (37.5%); Grade IV = 12 cases (37.5%) and Grade V = 5 cases (15.6%).

The most commonly herniated organ was the stomach, which occurred in 23 patients (71.8%), followed, in descending order of occurrence, by spleen, colon, omentum, small intestine, liver and kidney.

Table 1 - Most frequent findings in the thoracic x-ray when there is suspicion of post-traumatic diaphragmatic hernia.

Radiographic findings	Nº of cases (%)
Elevation of pulmonary base	27 (84.3%)
Fractures of inferior ribs	15 (46.8%)
Alveolar consolidation	15 (46.8%)
Subcutaneous emphysema	13 (40.6%)
Shifting of the mediastinum and trachea to the right	13 (40.6%)
Pneumothorax	8 (25%)
Opacification of the costophrenic sinus	5 (15.6%)

Figure 1 - *Image of intrathoracic bowel loops, pneumothorax and subcutaneous emphysema. Mediastinal shift to the right. Alveolar consolidation on the left (contusion/atelectasis). Chest tube on the left.*

Figure 2 - *Elevation of the base of the hemithorax and pneumothorax on the right. Alveolar consolidation on the right (contusion/atelectasis).*

DISCUSSION

The first report of PTDH was made by Snnertus in 1541, describing the late herniation of the stomach through the diaphragmatic injury of a patient[2,3]. The PTDH is delayed when the diagnosis is performed one week after the time of injury[7,8].

It is difficult to accurately establish the incidence of traumatic diaphragmatic injury, with an estimated incidence of 3% of such injuries following abdominal trauma[9-11]. In this study of 2,593 laparotomies performed on trauma patients, diaphragmatic injury was confirmed in 385 patients, with PTDH being diagnosed in 1.7% of laparotomies.

Figure 3 - *Elevation of the base of the left hemithorax. Gastric tube with distal end in intrathoracic stomach.*

Figure 4 - *Presence of a nasogastric tube, with one end in the stomach, in left intrathoracic position. There are pneumothorax and alveolar consolidations on the left.*

In literature, for victims with penetrating injuries in the thoracic and/or abdominal region, the incidence of injury to the diaphragm varies between 10 and 15%, while in closed traumas it ranges from 0.8 to 7% [2,13]. However, the incidence of PTDH is greater in closed traumas, as it involves more energy dissipation and therefore the damage to the diaphragm is of greater extent. Clinical experience shows that diaphragmatic lesions by penetrating trauma are usually of small extent, less than 2.5 cm, or no more than grade III AAST classification, whereas blunt trauma usually causes injuries of grade IV or V[2]. In the present study there was a predominance of PTDH caused by blunt trauma (78.1%) and grade III and IV lesions.

The incidence of left side PTDH was significantly greater (75%). This confirms data from literature on the prevalence of a left diaphragm injury in hospitalized patients, while autopsied victims display predominance on the right [5]. Aun *et al.* [5] observed a significantly higher incidence of diaphragmatic lacerations on the right in the autopsy group (49.6% of 146 cases identified in 12,276 autopsies) compared to the hospitalized group (14.4% of 97 operated cases).

Preoperative diagnosis of traumatic injuries to the diaphragm is difficult [13]. In asymptomatic patients, the lesion may not be diagnosed because the physical examination, imaging studies and the diagnostic peritoneal lavage (DPL) can have false-negative results in more than 30% of cases and, when positive, usually do not determine the side or severity of lesions[14,15,16].

The clinical findings of the acute phase PTDH are nonspecific, as by that time the herniation of abdominal viscera may not cause discomfort or radiographic changes. The gastrointestinal and cardio respiratory symptoms become prominent only in the late or obstructive phases. Therefore, the absence of clinical signs in the acute phase does not exclude the possibility of PTDH [7,13,15].

A review of literature demonstrates that CXR suggests the diagnosis of less than 40% of cases of diaphragmatic injury, despite it being the mostly requested imaging method after the initial occurrence of a trauma [9-11,13,17].

The described changes which suggest diaphragmatic injury in penetrating trauma are: hemothorax, pneumothorax, elevated hemidiaphragm or the presence of the projectile fragments close to the diaphragm. In blunt trauma the changes are: elevation of the diaphragm and the presence of bowel or stomach in the chest cavity [2].

In our study, the rate of change in the radiographic examination, when PTDH was suspected, was 81.3% (26 cases) and hemidiaphragm elevation was the most common finding (84.2%). We emphasize that the suspicion is based highly on the kinematic mechanism of injury and physical examination.

A nasogastric or orogastric tube can help CXR because, as the stomach is the organ most commonly herniated, the distal end of the tube can be located in the thoracic cavity [7].

A chest radiograph, after introduction of contrast by nasogastric or orogastric tube, increases the sensitivity of the test to levels above 50% [2,3,12]. In 3.1% of the cases studied, a contrast examination was performed, since the first CXR brought doubts about the presence of PTDH.

As for late hernias, the diagnosis can be aided by the changes found in CXR, since there is less difficulty in defining the presence of intrathoracic bowel loops.

Multi-detector computerized tomography (CT) helps in the diagnosis of diaphragmatic injury, though the presence of hemoperitoneum, atelectasis and pneumothorax may compromise the evaluation.[2,12,13,18]. In this study, CT was performed in five patients and confirmed the diagnosis of PTDH already suspected from the CXR in 100% of cases.

While MRI has limited use, it can be used for diagnosis. However, it can display artifacts during the exam, thereby assisting in forming the diagnosis [2,19].

The use of ultrasound for the diagnosis of the lesion of the diaphragm has been reported, but the method is limited by subcutaneous emphysema, the chest wall, the thickness of the abdominal wall and the presence of gas in the stomach [12.20].

During exploratory laparotomy, 28 cases of left PTDH were found (87.5%) and four of right PTDH (12.5%). According to literature, diaphragmatic injury of the right side results mainly from blunt trauma and, despite protection from the liver, has a higher severity and mortality rate due to the need for a greater energy magnitude in order to determine the injury [2,5,12]. Another important aspect that influences the lethality of right PTDH is the presence

of associated severe injuries, e.g. hepatic trauma or severe vascular injury (inferior vena cava or portal vein).

In most published studies, the organ mostly herniated was the stomach, which was concurred by this study, occurring in 23 cases (71.8%), followed in decreasing frequency, by the following organs: spleen, colon, small intestine, liver and kidney.

Despite advances in imaging methods, CXR is still useful in the diagnosis or suspicion of PTDH. It is an easy, inexpensive and universally available exam, even in the early-on care of a trauma patient. The presence of hemidiaphragm elevation, with or without identification of the bowel or stomach herniated into the chest cavity, must be regarded as a highly suspicious sign of diaphragmatic injury. In contrast, a normal examination does not exclude this injury. In cases of persistent clinical suspicions, other diagnostic procedures should be performed to confirm or refute the diagnosis in the acute phase.

RESUMO

Objetivo: *Descrever as alterações do exame radiográfico de tórax em pacientes com diagnóstico de hérnia diafragmática pós-traumática (HDPT) confirmado no intraoperatório.* ***Métodos:*** *No período entre janeiro de 1990 e agosto de 2008 foram tratados 45 pacientes com HDPT. Foram analisados dados demográficos, mecanismo de trauma, alterações na radiografia convencional de tórax (Rtx), extensão e localização da lesão do diafragma e órgãos herniados. Foram descritos os achados radiográficos mais frequentes identificados por assistentes da cirurgia e da radiologia.* ***Resultados****: A Rtx foi realizada em 32 pacientes, com predomínio do sexo masculino (27 casos - 84,4%) e a média das idades foi 34 anos. O mecanismo de trauma mais frequente foi o contuso (25 casos - 78,1%). O exame radiográfico de tórax apresentava alterações sugestivas de HDPT em 26 casos (81,3%). Na laparatomia exploradora constatou-se HDPT à esquerda em 28 casos (87,5%) e à direita em 4 (12,5%). O órgão herniado mais frequente foi o estômago.* ***Conclusão:*** *O estudo mostrou que o Rtx é muito útil na pesquisa inicial no diagnóstico de HDPT. A dificuldade é que as lesões de diafragma, principalmente após trauma penetrante, podem passar inicialmente despercebidas, sem alterações nesse método de imagem, tornando o diagnóstico difícil.*

Descritores: *Hérnia. Hérnia diafragmática. Hérnia diafragmática traumática. Radiografia torácica. Diagnóstico.*

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