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Traumatic Diaphragmatic Injuries: A Retrospective Study Over 12 years

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Abstract

Introduction: Traumatic injury of the diaphragm is an uncommon injury, and therefore, underestimated. It can occur following any thoraco-abdominal blunt or penetrating trauma, more commonly diagnosed following penetrating injuries. The incidence of these injuries range between 0.8-15%, and has increased in the last decade. Traumatic diaphragmatic injuries are usually occult, and diagnosis is often delayed. Diaphragmatic injuries are usually a marker of serious associated injuries, which are the main reason for mortality in this group of patients.

Methods: A retrospective study for over 12 years, between January 1, 2005 and September 30, 2017 was performed at the General Surgery department and Trauma Center at Rambam Health Care Campus, Haifa, Israel. The study included patients 16 years old and above who were diagnosed with a traumatic diaphragmatic injury. Patients who arrived dead to the trauma bay were excluded from this study.

Results: During the aforementioned period, data on 87 patients with a diagnosis of traumatic diaphragmatic injury was collected. 57 of these patients (65.51%) suffered the injury following a penetrating trauma, while in the remaining 30 patients (34.48%) it was caused by a blunt trauma. Stab wounds were the most common, and represented almost 43% of all injuries. The mean age of diagnosis was 34-year-old. The diaphragmatic injury was on the left side in 65 patients (74.71%), on the right side in 19 patients (21.83%) and bilateral in 3 patients (3.44%). Most of these injuries were diagnosed during operative procedures (52 patients, 59.77%); Pre- perative diagnosis by imaging studies was achieved in 35 patients (40.22%) by CT scan (34%) or by chest x-ray (6%); Nine patients (10.34%) had delayed diagnosis (diagnosis achieved more than 24 hours following admission). Following blunt trauma, 8 out of 30 patients (26.6%) had delayed diagnosis, while only one patient out of 57 (1.7%) had a delayed diagnosis following penetrating trauma. 83 patients (95.40%) underwent surgical repair (mostly by abdominal approach), 60 patients (68.96%) were operated on using laparotomy and 10 patients (11.49%) underwent a laparoscopy. The spleen is the most common associated intra-abdominal injured organ, as it was reported in 40 patients (45.97%). Traumatic diaphragmatic injury was the only indication for operative intervention in 18 patients (20.68%).

Conclusion: Traumatic diaphragmatic injuries are uncommon, yet underestimated and often diagnosed lately, in the absence of an associated injury. Despite advances in imaging studies, diagnosis in the absence of herniation is difficult, and a high index of suspicion is warranted, especially following blunt thoraco-abdominal blunt trauma. Surgical repair is the most efficient management to prevent late complications secondary to herniated viscera.

Introduction

Traumatic diaphragmatic injuries, being a marker of serious associated injuries, were first described by Sennertus at autopsy, with gastric herniation in 1851 [1]. The first pre-mortem diagnosis made by Bowditch in 1853 [2], and the first successful repair done by Riolfi in 1886 [3]. The incidence of traumatic injury of the diaphragm range between 0.8-15% [4], and had been increasing in the last decade, especially in developed countries [5]. Following World War, I, there has been an increment in reports of strangulated diaphragmatic hernias due to undiagnosed diaphragmatic injuries,

and Carter published the first review on traumatic diaphragm injuries in 1951 [6,7]. The true incidence for these injuries is likely underestimated, especially injuries on the right side, due to missed or delayed diagnosis [8]. Traumatic diaphragmatic injuries usually occur in 0.8-5% of injured patients following blunt thoraco-abdominal trauma and in 10-15% of injured patients after penetrating thoraco-abdominal injury [9,10].

Traumatic injuries to the diaphragm can present immediately following the injury, or many years later, in an acute, latent or obstructive phase [11] Despite advances in imaging studies, in the absence of associated injuries or herniation, diagnosis is usually delayed. Computed Tomography (CT) scans miss diagnose these injuries in 12-63%. Missed or untreated diaphragmatic injury in the acute phase, can present later with strangulated diaphragmatic hernia, which has a high mortality rate of 30-60% [12,13]. This study conducted to evaluate our experience with traumatic diaphragmatic injuries at a level I trauma center.

Methods

A retrospective study over a period of 12 years, between January 1, 2005 and September 30, 2017 performed at Rambam health care campus, Haifa, Israel. Rambam health care campus is a level I trauma center and referral center for 10 other hospitals, that give medical cover for 2 million citizens. Our Trauma center admits 2400 patients older than 16 years old annually; 800 (20%) of which with an Injury Severity Scale (ISS) score of more than 16. All patients admitted with a diagnosis of traumatic diaphragmatic injury, ages 16 years and above, were included. Patients who arrived dead to the trauma bay were excluded.

Results

During the study period, 29204 injured patients older than 16 years old were admitted. 8633 (29.56%) Patients were admitted following a thoraco-abdominal trauma. 87 out of 8633 (1%) patients had a diagnosis of diaphragmatic injury; 57 (65.51%) following penetrating injury and 30 (34.48%) following blunt trauma. The ISS score for these patients ranged between 8-57, and the mean ISS score was 27. The mean age was 34 years, with a range between 16-81 years. Patients who were younger than 16 years or had arrived dead were excluded. 74 patients were males and 13 were females (5.7:1). The penetrating injuries included 37 (42.5%) stab wounds, 12 (13.8%) gunshot wounds, 1 (1.1%) stab and gunshot wounds, 1 (1.1%) glass wounds, 3 (3.4%) shrapnel and 3 (3.4%) unknown. The blunt injuries included 22 (25.2%) motor vehicle accidents, 4 (4.6%) pedestrians hit by a car, 3 (3.4%) falls from height and 1 (1.1%) assault (Figure 1).

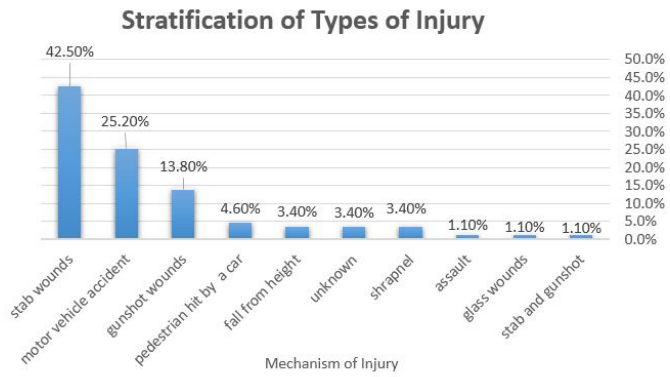

Figure 1: (Figure 1) demonstrates the different types of injuries according to their prevalence (shown as percentages).

Diaphragmatic injuries were left sided in 65 (74.71%) patients, right sided in 19 (21.83%) patients, and bilateral in 3 (3.44%) patients. Diagnoses of traumatic injuries of the diaphragm were made in most patients during operative procedures (52 patients, 59.77%). This group of patients was taken to the operating theater due to other indications. Diagnosis was achieved before surgery, by imaging studies, in 35 (40.22%) patients; 29 (33.3%) patients diagnosed by chest or abdominal Computed Tomography (CT) scan, and 6 (6.7%) patients by Chest X-Ray (CXR) (Figure 2). Nine cases (10.34%) had a delayed diagnosis of traumatic diaphragm injury; eight cases out of 30 were following blunt thoraco-abdominal trauma (26.6%), and one following penetrating injury (1.7%). The delay from the time of the injury to the time of repair ranged from 1 day to 6 months. Eight patients had laceration of the left diaphragm, and were treated by an abdominal approach, and one patient had a right diaphragmatic laceration, treated by thoracic approach.

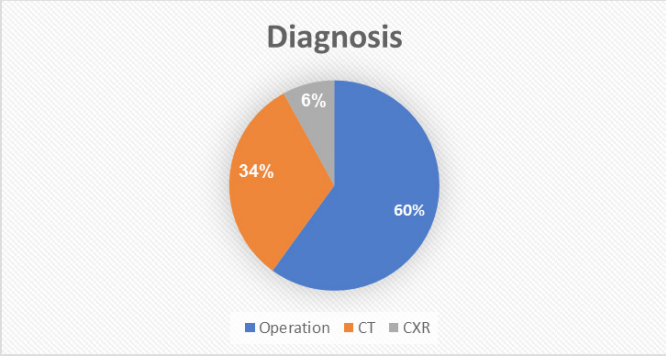

Figure 2: (Figure 2) shows the different modes of diagnosis as percentages.

In the 87 patients who were diagnosed with a diaphragmatic injury, the spleen was the most common intra-abdominal injured organ. Splenic injuries noted in 40 patients (45%). Liver injuries occurred in 32 patients (36%), stomach injuries in 14 patients (16%), small bowel injury in 9 patients (10%), large bowel injury in 13 patients (14%), pancreas injury in 3 patients (3%), and kidney injury in 4 patients (4%) (Figure 3). In 18 patients (20.68%), injury of the diaphragm was the only indication for operative intervention.

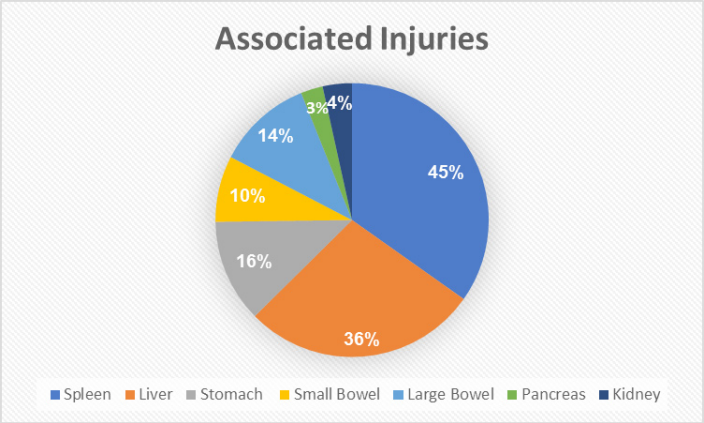

Figure 3: (Figure 3) demonstrates the associated injuries as a percentage.

Discussion

Traumatic injuries of the diaphragm, especially following blunt trauma, are usually subtle on its initial presentation, and are difficult to diagnose due to the complexity of the associated injuries. There are no specific data to estimate the precise incidence of diaphragmatic injuries following blunt trauma. Most of the retrospective studies suggest an overall incidence of less than 1% following blunt trauma to the torso [14,15]. According to Gelman et al, 66% of patients with a blunt diaphragmatic injury were assessed inaccurately on initial clinical presentation [16], whereas according to Amber et al, only 12% of patients with diaphragmatic injury following blunt trauma were missed on initial evaluation [17]. As mentioned before, in our study, about 26% of patients who suffered blunt diaphragmatic injury were assessed inaccurately, and diagnosed more than 24 hours following admission. Patients with an isolated diaphragmatic injury are usually missed on initial presentation due to the absence of clinical or radiographic evidence of injury. According to McCune et al, patients with a diaphragmatic injury diagnosed on initial presentation had an average of 2.5 additional significant organ injuries, while patients diagnosed in late setting had less associated injuries [14]. The use of different imaging studies to diagnose blunt diaphragmatic injury is a controversial issue [15], and most of these studies including CT scan, Magnetic Resonance Imaging (MRI), Ultrasound Scan (US), CXR and others have a low sensitivity in detection of these injuries [16,17]. In our review, most patients were diagnosed during operative procedures (59.77%), whereas imaging studies were diagnostic in 40%, mostly by CT scan (34%). 9 patients (10.34%) had missed diagnosis on initial presentation. 8 patients out of the 30 cases following blunt injury (26.6%) had a delayed diagnosis. 7 patients out of the 8 had no indication for immediate surgical exploration on admission, and suffered mainly thoracic injury with rib fractures and pneumothorax were the most common, thus; treated non-operatively. The first patient out of the nine aforementioned initially misdiagnosed cases was admitted following motor vehicle accident. Total body CT scan revealed multiple left rib fractures, left pneumothorax and a stable pelvic fracture. He was admitted for monitoring, observation and treatment with analgesics. On the second day of admission, he complained of left chest pain, shortness of breath, nausea and coffee ground vomiting. A CXR revealed left diaphragm rupture, with stomach herniation into the left hemi-thorax (Figure 4). The patient was explored by an abdominal approach through a midline incision, reduction of the stomach to the abdominal cavity, and primary repair of the diaphragmatic laceration done. No other intra-abdominal organ injury found.

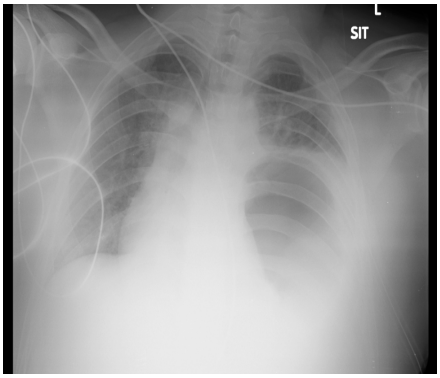

Figure 4: Chest X-ray showing stomach herniation to the left hemithorax.

The second patient, who had a delayed diagnosis, was admitted after motor vehicle accident. Total body CT scan on admission showed a left pneumo/hem thorax, multiple left rib fractures, grade 2 spleen laceration without contrast blush and a stable pelvic fracture. Chest tube insertion drained a small amount of blood. The patient was admitted for observation. 5 days following admission, patient complained of severe left chest pain, shortness of breath and palpitation. Chest CT-Angiography (CTA) showed a left diaphragmatic rupture with omentum herniating to the left hemi thorax. The patient underwent an exploratory laparotomy, during which reduction of the herniated omentum to the abdominal cavity and primary repair of diaphragm laceration were done. The third patient was admitted following a fall from a

height, with a left thoraco-abdominal injury. CT scan on admission revealed left pneumothorax and multiple rib fractures. The patient treated by tube thoracostomy and painkillers, and discharged home after 5 days. Six months later he was admitted with a large bowel obstruction due to an incarcerated left diaphragmatic hernia (Figure 5). Abdominal exploration revealed large bowel obstruction, with severe dilation of the proximal bowel and ischemic cecum. Reduction of the large bowel to the abdominal cavity, along with right hemicolectomy and primary repair of the diaphragmatic hernia were done.

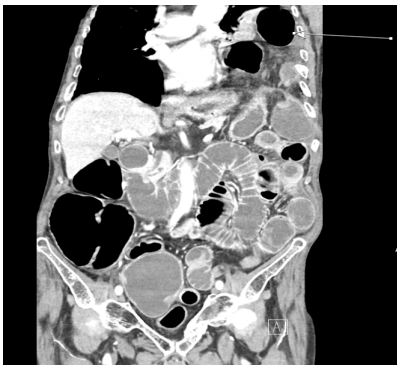

Figure 5: Coronal chest and abdominal CT scan revealing incarcerated left diaphragmatic hernia encasing transverse colon (arrow).

The fourth case of delayed diaphragmatic injury was of a pedestrian who was hit by a motor vehicle. Total body CT scan on admission showed right hemo/pneumothorax, multiple rib fractures and mild subarachnoid hemorrhage. The patient treated by chest tube and analgesics. A week following admission, patient developed severe respiratory distress. A repeat chest CT scan revealed right diaphragmatic rupture with liver herniation into the right hemi thorax (Figure 6). The patient underwent a right thoracotomy with primary repair of diaphragm laceration. The fifth patient was admitted after a motor vehicle accident. On admission patient was unstable and Focused Assessment Sonography for Trauma (FAST) showed a large amount of hem peritoneum and the patient underwent an exploratory laparotomy and a damage control surgery including splenectomy. On a second look laparotomy, she was diagnosed with left diaphragmatic laceration, treated by primary repair. The sixth patient admitted was a pedestrian hit by a motor vehicle. Total body CT scan revealed mild subarachnoid hemorrhage, right pneumothorax, right lung contusion, pneumomediastinum, grade 1 splenic laceration and a suspicion for left diaphragmatic laceration without herniation. A diagnostic laparoscopy was negative for diaphragm laceration. On post-operative day 6, due to chest pain and shortness of breath, patient underwent chest CT scan, which showed left diaphragm laceration with stomach herniation. Primary repair with an abdominal approach by laparotomy was done.

Figure 6: Axial chest CT scan showing liver herniation into the right heithorax.

The seventh patient was admitted following a stab wound to the left chest. Chest and abdominal CT scan on admission revealed left hem thorax and grade 2 splenic laceration without contrast blush or free intra-abdominal fluid. The patient was treated by left chest tube insertion and admitted for observation. Due to continuous drainage of clotted blood from the chest tube, the patient was explored by thoracoscopy, which showed laceration of the left diaphragm. Primary repair was done. The eighth patient was admitted following a motor vehicle accident. Imaging studies on admission revealed left pneumothorax, left multiple rib fractures, vertebral artery dissection and lumbar vertebrae fracture. She was treated by chest tube insertion. 6 days following admission, due to severe abdominal pain, a repeat abdominal CT scan showed free intra-abdominal fluid and free intra-abdominal air bubbles. An exploratory laparotomy revealed laceration of small bowel and left diaphragmatic laceration. Segmental resection of the small bowel, along with primary repair of diaphragmatic laceration were done.

The ninth patient was admitted following a motor vehicle accident. CXR showed left two rib fractures. He was treated by analgesics and discharged home. Due to left chest pain, a chest CT scan 3 months later showed a left diaphragmatic injury with herniation of the greater omentum to the left hemthorax. On elective diagnostic laparoscopy, left diaphragmatic defect on the lateral aspect was noted with omental herniation. Primary repair of the defect was done.

Conclusion

Traumatic injuries of the diaphragm, especially following blunt thoraco-abdominal injuries, are rare, yet underestimated, thus a high index of suspicion is warranted. Imaging studies have a low sensitivity in detecting these injuries in the acute setting, especially in the absence of herniation or associated injuries as an indication for operative intervention. When diagnosed, surgical repair by an abdominal or thoracic approach is the gold standard management to prevent late complications such as herniation.

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