

Research Article

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Minimum Nonsurgical Approach to Post-Traumatic Diaphragm Injury

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ABSTRACT

Objectives: Diaphragm injury is mostly caused by blunt or penetrating trauma. It is a rare diagnosis and therefore carries a risk of misdiagnosis or delay in diagnosis. We perform routine thoracoscopy for the treatment of patients with traumatic rib fractures in our institution. We recorded several cases of occult diaphragmatic injuries and hypothesized that these injuries may be a penetrating injury from rib fractures, as opposed to the high-velocity blunt trauma typically associated with diaphragmatic injuries.

Methods: The medical records of all patients admitted to our Şişli Etfal Hospital with rib fractures and traumatic diaphragmatic injuries between January 2012 and January 2023 were retrospectively reviewed.

Results: During the study period, 2218 patients had rib fractures and 68 of them had diaphragmatic injuries. 26 patients with traumatic diaphragmatic injuries were found to have been operated by thoracic surgeons. After the video-assisted thoracoscopic surgical evaluation of the pleural space, surgery was performed in 11 patients who were diagnosed with diaphragmatic injury intraoperatively.

Conclusions: Our patient series illustrates the diagnostic difficulties in determining the association and condition between major rib fractures and diaphragmatic injuries in trauma patients. We recommend using a thoracoscope in patients undergoing post-traumatic chest wall surgery to aid in the diagnosis of this condition.

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Introduction

Injuries to the diaphragm following blunt or penetrating thoraco-abdominal trauma are rare, but can be potentially life-threatening. These injuries are difficult to diagnose and are often overlooked despite the use of various imaging techniques. The rate of missed diagnoses using computed tomography can be up to 63% [1]. Traumatic diaphragmatic injuries are difficult to diagnose in the setting of acute trauma, but are easily treated once diagnosed. Diagnosing a traumatic diaphragmatic injury has been a dilemma that has plagued acute care surgeons for centuries [2].

The actual incidence of traumatic diaphragmatic injury (TDI) is unknown, but has been reported to be approximately 2.1% for blunt trauma and 3.4% for penetrating trauma [3]. The TDI mechanism is thought to involve increased intra-abdominal pressure predominantly secondary to blunt abdominal trauma. It is thought that this leads to rupture of the posterolateral part of the diaphragm, which is the weakest part during embryonic development [4].

Rib fractures are one of the most common traumatic injuries in patients presenting with blunt thoracic trauma. Rib fractures are also one of the most common associated injuries in patients diagnosed with TDI. The number, location, and degree of displacement of broken ribs determine the likelihood of further intra-abdominal or intrathoracic injury. In particular, lower rib fractures have been

associated with a higher probability of diaphragmatic injury in studies[5]. We hypothesize that such diaphragmatic injuries may be secondary to penetrating trauma from broken lower ribs (in the presence of increased intra-abdominal pressure). The aim of this retrospective study was to focus on this less defined subgroup of TDI patients with concomitant rib fractures. In particular, we examined clinical presentations, diagnostic methods and surgical management in our institution.

Human and animal rights and informed consent

This article does not include any animal studies performed by any of the authors. Informed consent was obtained from all individual participants included in the study. There is no identifying information in the presented work.

Methods

Medical records of all patients admitted to our hospital with traumatic diaphragmatic injury were reviewed retrospectively. Potential patients were identified by performing a query on the trauma database to identify a list of all trauma patients with rib fractures and/or diaphragmatic injuries using the appropriate procedural diagnostic codes. Once this list was obtained, we reviewed all medical records and determined the frequency of associated chest and abdominal injuries. Diagnostic methods, preoperative imaging, intraoperative findings and surgical approach are emphasized.

Results

During the study, a total of 2218 patients who presented to the emergency department with chest wall trauma were identified. 14 patients had sternal fractures and were excluded from the study. Of these, 36 patients were diagnosed with diaphragmatic injuries and operated on. The median age of these 36 patients was 35 (range 16-78 years), 29 males and 6 females. There were 21 left-sided and 14 right-sided diaphragmatic injuries.

Although the mechanism of injury of rib fractures is usually blunt traumatic injury, there was radiological evidence of rib fracture in 6 patients presenting with penetrating stab wounds to the thorax (and therefore included in our study). The remaining patients all had blunt traumatic injuries to the thorax (and in some cases, the abdomen), and the majority had either had a motor vehicle accident or had a mechanical fall. All patients were admitted through trauma. After video-assisted thoracoscopic surgery (VATS) evaluation of the pleural space, intraoperative surgery was performed in 11 of our patients with diaphragm injury. A summary of the clinical features of these patients is given in Table 1.

Table 1: Baseline patient characteristics

Characteristic	Value
No. of patients	11
Sex	
Male	11
Female	0
Age (yr)	28 (21–41)
Side	
Left	7
Right	4
Mechanism of trauma	
Motor vehicle accident	6
Blunt: mechanical fall	3
Blunt: assault	0
Penetrating	2
Mortality	0

All patients were admitted to the emergency department due to trauma. A computed tomography (CT) scan was performed as part of their initial investigation. Diaphragmatic injury was detected in only 5 patients who underwent VATS diaphragm repair at the initial CT scan. The remainder were diagnosed intraoperatively while performing internal fixation of rib fractures within the chest cavity/wall. The injury was on the left side in 7 patients and on the right side in 4 patients. A description of the associated injuries is given in table 2

Table 2: Associated injuries in patients with concomitant chest wall and diaphragmatic injuries

Associated injuries	No. (%)
Splenic rupture	2
Pelvic fracture	1
Pulmonary contusion	5
Liver laceration	3
Spinal fracture	1
Kidney laceration	2

Thoracoscopic diaphragm repair technique in the acute setting

Routine thoracoscopy has been performed for the last two years in the surgical treatment of rib fractures in our center. We use a 10 mm port placed on the rear underarm line at approximately finger level. The lungs, diaphragm, and other structures are evaluated for injury. Using a separate muscle sparing incision approximately 4-5 cm in size, rib fractures are stabilized by placing a plate and screw on the outer surface of the ribs in the submuscular space. If there is evidence of diaphragmatic injury, repair is performed immediately. Diaphragmatic lacerations vary in size from 2 to 5 cm. depending on the severity of the rib displacement. Repair of the diaphragm is done using pre-placed ports for thoracoscopy. Repair is performed using individual 0-silk sutures. No thoracotomy is performed at any point for the procedure.

The transabdominal approach for diaphragm repair in the acute setting is usually through a laparotomy incision secondary to intra-abdominal injuries associated with blunt trauma.

Transthoracic repair of the diaphragm is traditionally reserved for chronic diaphragmatic injuries and is typically done through a thoracotomy. However, video-assisted thoracoscopic surgery (VATS) is an option. In the chronic setting, patients will often have significantly greater adhesions associated with the initial injury, requiring extensive decortication to free the lungs from the diaphragm. In the chronic setting, the diaphragm defect tends to scar and retract at the margins, which may also adhere to underlying intra-abdominal organs requiring extensive dissection. Chronic diaphragmatic lacerations are often difficult to repair primarily because of retraction and may require a patch to repair.

Discussion

In our series, we identified a patient who was operated on with VATS as a result of a diaphragmatic injury who applied to our facility in the last 2 years. We tested our theory that diaphragmatic injuries may be more closely related to chest trauma, as opposed to what was previously described as abdominal injury. We are aware that our facility sees a disproportionately higher number of blunt trauma patients than penetrating trauma. We also recognize that many diaphragmatic injuries can have significant intra-abdominal disasters leading to patient death prior to diagnosis and treatment.

Most of our patients were diagnosed during thoracoscopy as opposed to preoperative imaging. No diagnosis of diaphragmatic trauma or suspicion of diaphragmatic trauma was detected in the preoperative imaging of the patients in the intraoperative diagnosis group.

Transthoracic treatment of traumatic diaphragmatic injuries has traditionally been reserved for delayed or chronic diaphragmatic injuries. Diaphragmatic injuries in the acute state have traditionally been treated using a transabdominal approach. We have seen excellent results in our patient population using a thoracoscopic approach in the surgical treatment of acute and chronic diaphragmatic injuries.

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