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Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Case Report

Transdiaphragmatic intercostal herniation in the setting of trauma

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ARTICLE INFO

Keywords:

Transdiaphragmatic intercostal herniation
Trauma
Motor vehicle collision
Mesh repair

ABSTRACT

Transdiaphragmatic intercostal herniation is a rare injury that can be associated with blunt trauma. Since its first documentation within the literature in 1946, there have been less than 50 cases reported. We present a case involving a 56-year old female who presented to our Trauma Center with transdiaphragmatic intercostal herniation caused by blunt trauma from a high-velocity T-bone vehicular collision. Upon presentation, she exhibited bilateral breath sounds; however, with labored breathing, chest pain, and hypoxia. The initial chest radiograph interpretation indicated the presence of “left lower lobe infiltrates”, and subsequent computed tomography imaging identified “a small lateral hernia along the left mid abdomen”. After initial resuscitation, her condition deteriorated, exhibiting respiratory distress and becoming increasingly hypercarbic, requiring intubation. Review of the imaging showed disruption of the left hemidiaphragm with intrathoracic herniation of colon and stomach through the thoracic wall between the ninth and tenth ribs. Consequently, a thoracotomy was performed in the operating room, revealing a large defect between the two ribs with disruption of the intercostal muscles and inferior displacement of rib space. Lung and omentum had herniated through the disrupted rib space and the diaphragmatic rupture was attenuated anteriorly, measuring 11x6cm. After reduction of the herniated organs, a biologic porcine mesh was placed and an intermediate complex closure of the thoracic wall hernia was performed. The patient was later extubated, recovered from her injuries with no complications and was discharged. With the low incidence of transdiaphragmatic intercostal herniation, there is no standardized surgical management. Recent literature suggests that these injuries should be managed with mesh, rather than sutures only, due to high rates of recurrence. Furthermore, diaphragmatic injuries may suffer a delay in diagnosis. Therefore, a high index of suspicion should be maintained in patients with respiratory distress following a blunt trauma, with close review of computed tomography.

Introduction

Transdiaphragmatic intercostal herniation (TDIH) of visceral contents is a rare injury associated with blunt and penetrating trauma. Although traumatic diaphragmatic rupture was first documented in the literature in 1541 [1], the first account of TDIH emerged in 1946, with fewer than 50 documented case reports to date [2]. Most cases of TDIH occur on the left side, with the colon and stomach most commonly herniating through the diaphragm and between the intercostal space [3]. We present a case of a 56 year-old female with TDIH involving the colon and stomach as a result of blunt trauma from a high-velocity T-bone vehicle collision. The patient’s initial presentation, complications of diagnosis, and surgical management are discussed.

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<https://doi.org/10.1016/j.tcr.2024.101016>

Accepted 2 April 2024

Available online 3 April 2024

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Fig. 1. (A) Initial trauma bay chest radiograph demonstrating left lower lobe infiltrates. (B) CT chest coronal view with left diaphragmatic rupture and intrathoracic as well as intercostal herniation of bowel. (C) CT chest axial view with left diaphragmatic rupture and intrathoracic as well as intercostal herniation of bowel.

Case report

A 56 year-old female presented to our Trauma Center following a high-velocity motor vehicle collision. On presentation, she had bilateral breath sounds, but also exhibited labored breathing, hypoxemia, and chest pain. The initial chest radiograph was interpreted as “left lower lobe infiltrates” and computed tomography (CT) imaging was interpreted as “a small lateral hernia along the left mid-

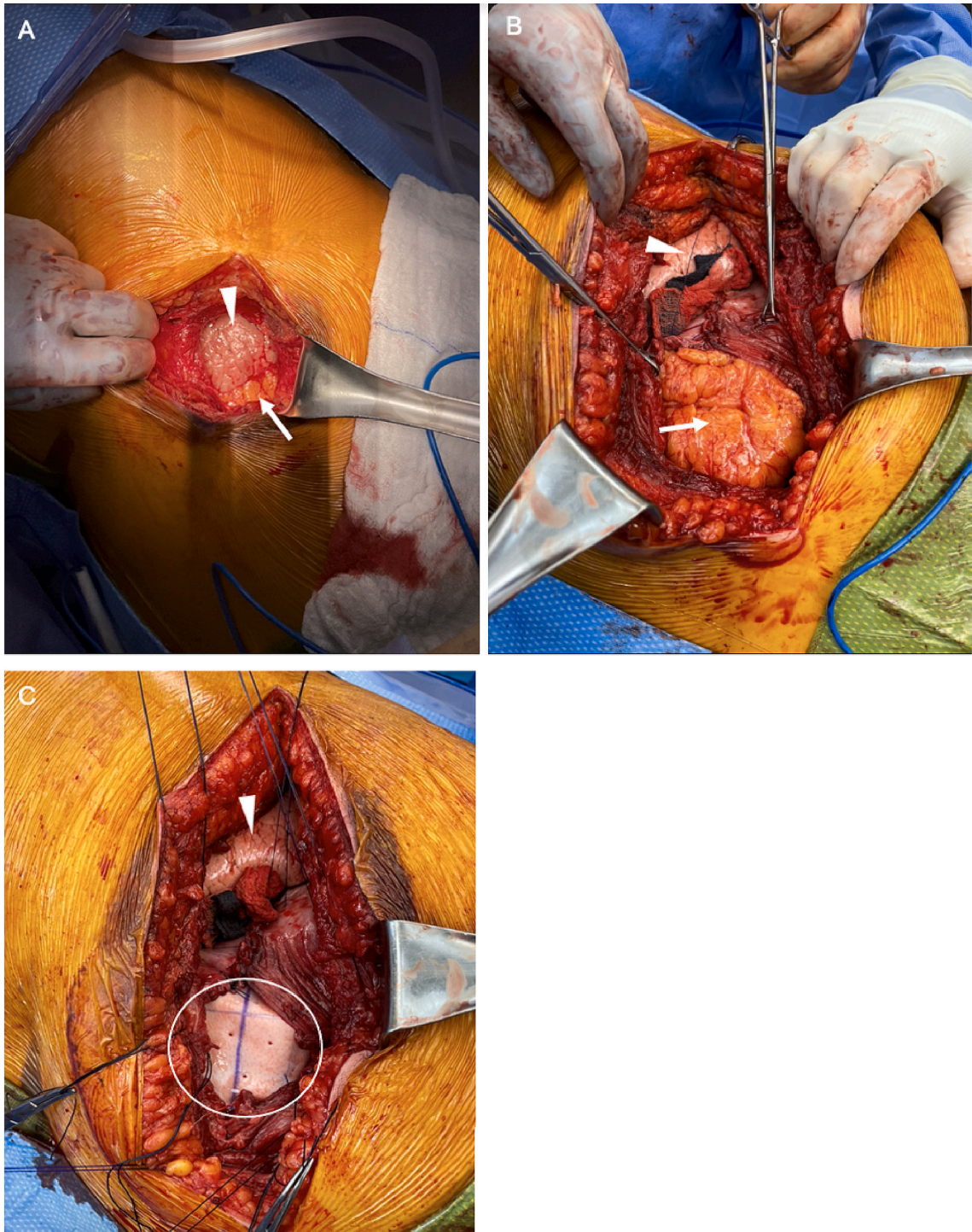


Fig. 2. (A) Intercostal herniation of lung (white arrowhead) and omentum (white arrow). (B) Intercostal herniation of lung (white arrowhead) and omentum (white arrow). (C) Intercostal herniation of lung (white arrowhead) with biologic porcine mesh (circled).

abdomen". After initial resuscitation, she progressed into respiratory distress, became increasingly hypercarbic, and was intubated. Review of the CT images revealed a disruption of the left hemidiaphragm with intrathoracic herniation of the colon and stomach through the thoracic wall between ninth and tenth ribs (Fig. 1). She was taken to the operating room for an emergent thoracotomy.

Intraoperatively, a palpable defect was identified in the intercostal space between the ninth and tenth ribs. A thoracotomy was performed through the rib space and electrocautery was used to dissect through the subcutaneous tissue, ultimately revealing a 10 cm defect between the two ribs, along with disruption of the underlying intercostal muscles and fascia. Notably, the ribs were noted to be torn away from the costochondral junction and displaced inferiorly by approximately 10 cm. The incision was then widened to provide adequate visualization of the diaphragm, allowing for the omentum to be reduced back into the intra-abdominal space. The left hemidiaphragm was noted to be lacerated and disrupted starting from the medial insertion extending laterally into the mid-diaphragm. Importantly, the spleen and omentum remained uninjured. An extensive area of attenuation was observed on the anterior aspect of the diaphragm, measuring 11 × 6 cm in size. Therefore, a 16 × 8 cm xenograft biologic mesh was selected, with 2 cm overlap, and secured in place with slow-absorbing sutures in an interrupted fashion for a tension-free repair (Fig. 2). A 7F flat drain was then placed over the mesh, passing under the diaphragm, and brought out through the abdominal wall inferior and secured with sutures. The diaphragm was then closed with figure-of-eight slow-absorbing sutures. A 28F chest tube was placed in the chest cavity under direct visualization, brought out inferiorly to the incision through the chest wall, and secured with sutures. Subsequently, intermediate complex closure of the thoracic wall hernia was performed, and the skin was approximated with staples. The patient tolerated the procedure well without any immediate complications. She was later extubated, recovered from her injuries with no complications and was discharged from the hospital.

Discussion

Traumatic diaphragmatic hernia is a rare sequelae of trauma, with an incidence of up to 1% [4,5]. The diaphragm functions as the body's primary muscle of respiration, generating negative intrathoracic pressure as it contracts. In the setting of a traumatic diaphragmatic rupture, the negative pressure gradient can draw abdominal contents through the diaphragm breach. Even rarer are instances of TDIH, where abdominal contents herniate through a diaphragm injury and traverse the intercostal space [2]. This occurs due to direct trauma or weakening of the thoracic cage with sudden change in intrathoracic pressure at a later time, resulting in separation of the intercostal muscles and herniation of abdominal contents through the intercostal space [2].

Since its first report in the literature in 1946, two distinct presentations of TDIH have been described. The first presentation occurs gradually over a span of months to years after an initial traumatic event. In this scenario, an asymptomatic individual's regular physical activity and respirations enlarge the diaphragmatic lesion, eventually leading to respiratory symptoms [1,2,6]. The second presentation occurs immediately after or within a couple weeks of blunt or penetrating trauma when the patient has severe coughing or sneezing [6,7]. In either case, once respiratory symptoms present themselves, prompt diagnosis should be made through comprehensive history-taking, physical examination, and judicious utilization of sensitive imaging modalities. This is imperative given the potential of respiratory collapse and development of shock.

As discussed above, undiagnosed or delayed diagnosis of TDIH can lead to the rapid decompensation of a patient's respiratory status, ultimately resulting in obstructive shock [6,8]. Clinical manifestations of TDIH include respiratory distress, hypercarbia, chest pain, vomiting, and the indication of a palpable, reducible mass in the intercostal regions after trauma [1,2,8]. CT imaging is considered superior, as radiographs and ultrasounds often yield equivocal or negative results [9].

According to Macedo et al., rib cage injuries in TDIH cases most frequently occurred in two anatomical sites: the anterior and posterior portions [9]. In two of their cases, the eighth rib was fractured with subsequent widening of the 8th intercostal space [9]. In the anterior portion, the lack of external intercostal muscles can lead to injury of the costochondral junction to the sternum. The posterior portion, lacking internal intercostal muscles, is prone to injury at the rib vertebral angle [9].

The management of TDIH has varied significantly, with techniques ranging from suture repair, mesh application, rib plate fixation, and others [10]. Macedo et al. utilized a combination of mesh and sutures for their repairs, while Ioannidis used a series of suture repair and a "surgicel" pad [9]. All of Macedo's and Ioannidis' patients were safely discharged home after a brief observation period [9]. However, a high rate of recurrence of intercostal hernias has been reported with primary repair, which may suggest that the addition of mesh during repair may be prudent [2]. In our patient, we utilized a xenograft biologic graft and a series of sutures to repair the diaphragm. Suture repair was also performed to re-approximate the ribs and close the muscle and other tissue layers. The patient recovered well with no complications and was able to be discharged home after a brief stay in the hospital following extubation.

As there is no established "gold standard" for the repair of TDIH, the formulation of a unifying classification may help guide future management. In 2019, a study by Gooseman et al. proposed that costal margin injuries should be further classified and delineated based on the concept of "sequential segmental analysis" [10]. Their suggestions were rooted in anatomical considerations and the junctions between them [10]. Subtypes of costal margin injuries were categorized based on whether the costal margin, diaphragm, or intercostals exhibited rupture, each receiving distinct nomenclature. Although the study reviews different types of management utilized for each subtype, such as plate fixation, suture repair, double-mesh repair, and standard mesh repair, it did not provide a definitive consensus on surgical management of TDIH. While mesh repair remains popular, future prospective studies, systematic reviews and meta-analysis will need to be conducted in order to better define the operative algorithm for TDIH repair.

Conclusion

TDIH constitutes a rare and intricate complication of high-velocity trauma. Given its low incidence, there is currently no

standardized approach to surgical management. Recent literature suggests that TDIH should be managed with mesh, rather than sutures only, for better outcomes. Furthermore, as illustrated by our case, diaphragmatic injuries may suffer a delay in diagnosis, emphasizing the importance of maintaining a high index of suspicion in patients presenting with respiratory distress following blunt trauma, and timely imaging, specifically a CT scan, should be obtained.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical approval

University Medical Center Southern Nevada (UMC) does not require ethical approval for reporting individual cases or case series. According to the UMC Case Report IRB Guidelines, "For UMC IRB purposes, a single case report, case study, and/or case series is a retrospective analysis of one, two, or three clinical cases and generally does not meet the definition of 'research'. Therefore, a single case report does not have to be reviewed by the IRB."

Informed consent

Written informed consent was obtained from the patient for their anonymised information to be published in this article.

Guarantor

JH.

CRediT authorship contribution statement

Joshua Ho: Investigation, Writing – original draft, Writing – review & editing. **Abigail W. Cheng:** Conceptualization, Supervision, Writing – original draft, Writing – review & editing. **Noam Dadon:** Writing – original draft, Writing – review & editing. **Paul J. Chestovich:** Conceptualization, Supervision.

Declaration of competing interest

The authors declare that there are no conflicts of interest.

Acknowledgments

We would like to thank University Medical Center Southern Nevada - General Surgery Department and Kirk Kerkorian School of Medicine at UNLV for their assistance and guidance in this research.

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