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Robert Vezzetti, Peter Cosgrove, Julie Sanchez, Gael Lonergan

ABSTRACT

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Case Report: We describe a case of blunt thoracic trauma that was complicated by rib fractures and associated lung herniation, which is a rare complication of such an injury.
Imaging modalities as well as repair options are discussed.
Conclusion: Thoracic trauma in children, while rare, can be associated with significant injury. Often, associated clinical symptoms may be subtle in children, making detection difficult. Recognition of injuries associated with non-penetrating thoracic trauma is critical to ensure proper treatment and recovery in children.

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Keywords: Lung herniation, Pediatrics, Thoracic injury, VATS

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INTRODUCTION

Thoracic trauma in children is rare, accounting for 4–6% of children presenting to trauma centers [1]. This trauma mechanism, however, can be significant and is second to head injury as a cause of significant morbidity and mortality among the pediatric population [2, 3]. The majority of cases in children are due to blunt injury, although penetrating injury occurs more frequently in the adolescent population. Blunt thoracic trauma typically does not result in clinically significant injury but when present can be associated with other intrathoracic injuries, including rib fractures, pneumothorax, hemothorax, and pulmonary contusions. Infants often are exposed to thoracic trauma through motor vehicle crashes or non-accidental trauma; in school-age children, this trauma often is due to bicycle accidents, scooters, etc.

In adolescents, motor vehicle crashes or gunshot injuries predominate [2]. The data regarding the use of imaging in the pediatric patient with thoracic trauma is sparse and the method of repair of pediatric thoracic injuries is evolving.

CASE REPORT

An 11-year-old girl was brought to the pediatric emergency department after falling off of her bicycle. She was riding when she turned suddenly and, in the process of falling, her left chest struck the handlebar. On physical exam, her vitals include a heart rate 103 bpm, respiratory rate 24 bpm, blood pressure 110/70 mmHg, and an oxygen saturation of 98% on room air. She was conversing and stated that she had some left sided anterolateral chest pain. Physical examination demonstrated a small visible bruise at the anterolateral portion of the mid-left chest. There was mild palpable tenderness and she complained of pain with inspiration; breath sounds were mildly decreased on the involved side. She had no abdominal pain. At the conclusion of the physical examination she was found not to have any further injuries. Laboratory evaluation, including complete blood count, liver function tests and urinalysis were normal. Chest radiograph demonstrated rib fractures and there were also thickening of the periaortic tissues, possibly consistent with a small effusion, and the left lung base was hazy (Figure 1). These findings prompt a CT scan, demonstrating rib fractures and lung herniation. Additionally, there was a small pulmonary contusion of the affected lung (Figure 2). The pediatric trauma team was consulted and the child was taken to the operating room for repair, using video-assisted thoracoscopic repair (VATS) technique (Figures 3–5). She had an uneventful hospital course and does well.

DISCUSSION

Blunt thoracic trauma in most children typically results in pulmonary contusion [4]. The anatomic properties of the pediatric chest play a significant role in the injury sustained from this type of trauma mechanism. Principally, the pediatric thorax is more pliable, allowing for compression of the ribs, which results most commonly in contusions rather than fractures [2]. Indeed, the presence of rib fractures has been shown to be associated with other pathology, including intracranial and intra-abdominal injuries, [5] and their presence should alert the clinician to this possibility. The presence of multiple rib fractures has been shown to correlate with increasing mortality [6].

Identification of thoracic injuries in children who have sustained blunt thoracic trauma is critical to ensure a reduction in morbidity and mortality. There is a dearth of clinical decision rules for identifying thoracic injuries due to blunt chest trauma in pediatrics. One prospective study identified six clinical findings to help predict injuries: abnormal chest auscultation, low systolic blood pressure, Glasgow Coma Scale (GCS) <15, abnormal thoracic examination, elevated respiratory rate, and femur fracture [4]. Of the six criteria, abnormal chest auscultation, hypotension, and elevated respiratory rate had the highest specificity, while a GCS <15, abnormal thoracic examination, and elevated respiratory rate had the highest sensitivity [4]. Interestingly, our patient met

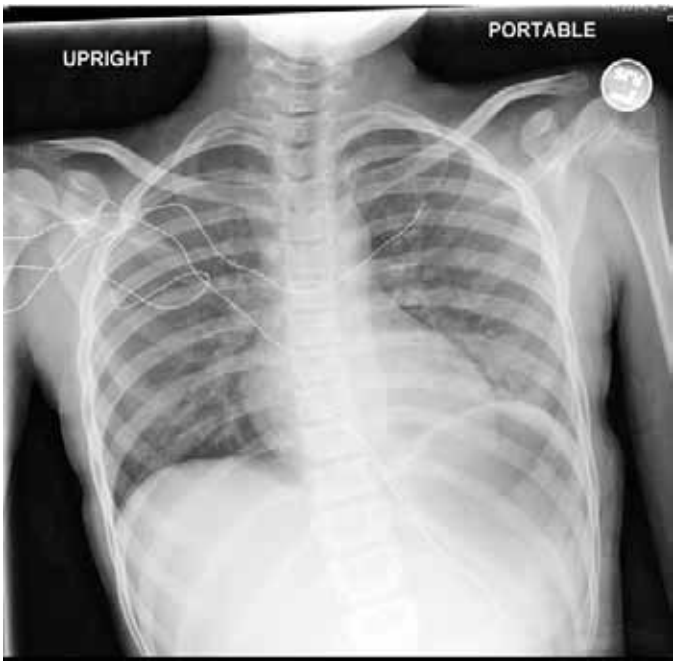

Figure 1: Chest X-ray demonstrating rib fractures and subtle left pulmonary hazziness.

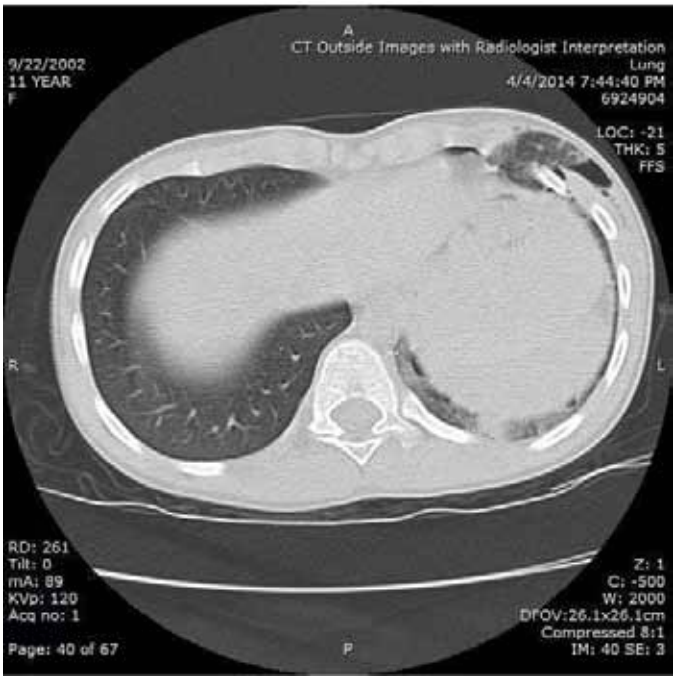

Figure 2: Chest computed tomography scan demonstrating rib fractures and lung herniation.

several of these criteria, including elevated respiratory rate, abnormal chest auscultation findings, and abnormal thoracic examination.

Plain chest radiography is a common study to obtain when evaluating children with blunt thoracic trauma. This imaging modality can identify rib fracture, pneumothorax, hemothorax, and pulmonary contusion. The identification of a pneumothorax or other findings on plain radiography and correlation to more significant thoracic injury has been studied. A multicenter retrospective cohort identified the presence of a hydrothorax and/or pneumothorax; isolated subcutaneous emphysema on CXR and off-road vehicle incidents, as statistically significant variables associated with significant thoracic injury [7]. In this study, 7 of 396 "unremarkable" chest radiographs were found to have occult pneumothoraces. Although none of these required chest tube placement, this questions a normal chest radiograph's negative predictive value. Prospective data evaluating the predictive value of chest radiographs in pediatric thoracic trauma are currently lacking.

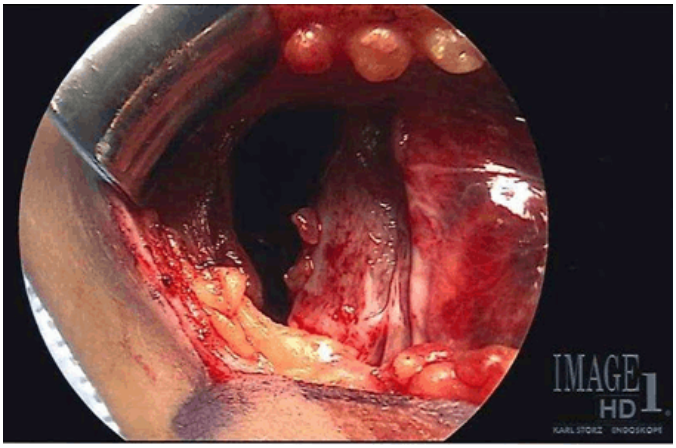

Figure 3: Operative photo of chest wall defect.

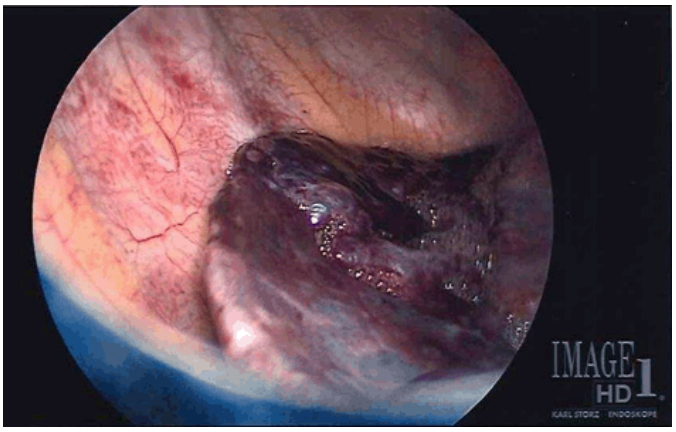

Figure 4: Operative photo of contused lung.

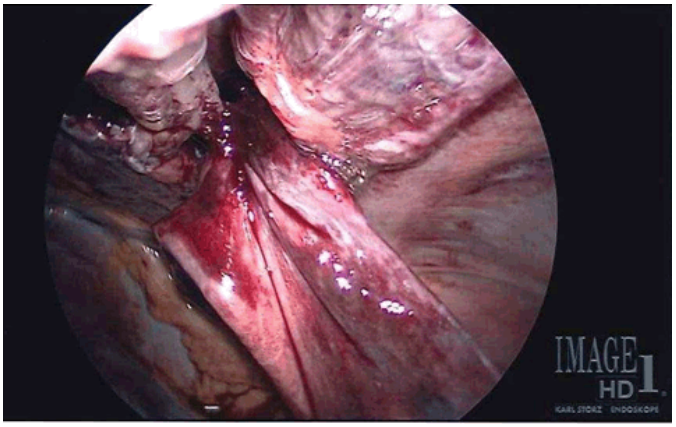

Figure 5: Operative photo of lung herniation.

The role of computed tomography (CT) imaging in pediatric blunt thoracic trauma is unclear. Smaller observational studies note that typical indications for CT imaging were thoracic injury on chest radiograph and high impact force, with few relying solely on physical examination findings. In one study, of 45 children identified at a level 1 trauma center who all had both plain radiographs and CT, 18 patients had findings on CT not seen on chest radiograph [8]. However, only six patients had a change in therapy based on CT results. Power was lacking to determine the presence of non-radiologic predictive variables that may have otherwise identified the need for thoracic CT scan . One large observational study of 235 children presenting to a level 1 Trauma Center noted that of 145 reportedly "normal" chest radiographs, the chest CT scan was abnormal in 47.6% [8]. Computed tomography scan was superior at identifying pneumothorax/hemothorax and bone/vertebral fractures when compared to portable chest radiograph. Although 47 hemothoraces or pneumothoraces were identified on CT scan only four of these required chest tube placement [9]. Whether a combination of plain radiographs and physical examination is sufficient to detect significant injury in pediatric thoracic trauma, or if CT is required, remains to be determined. In the majority of studies, CT findings did not change patient management. It would seem that in most situations plain radiography and physical examination are a reasonable first step in thoracic trauma, with CT imaging reserved for those patients with significant historical, clinical, or plain radiographic findings.

Children with lung herniation from blunt thoracic trauma require evaluation by a pediatric surgeon. The majority of children with this injury are surgically repaired. Traditionally, this is primary closure with open repair which is associated with longer hospital stays, post-operative pain/discomfort, and the potential for infection. While primary closure remains an option, Hebra et al. advocated for a GORE-TEX (Gore Medical, Flagstaff, Arizona, USA) pericardial patch mesh repair, citing shorter hospital stay and reduced postoperative pain [10]. The advent of video-assisted thoracoscopic surgery (VATS) provides a less invasive method of repair. VATS, though, may have limitations in patients with more extensive pleural disease or difficult anatomical sites not amenable to thoracoscopy. While surgical repair is the usual treatment modality and these hernias rarely

resolve on their own, they have also been described to spontaneously resolve which may support the option for clinical observation in selected patients [4]. However, the length of time to resolution is unknown and data are lacking in the pediatric population [11].

CONCLUSION

Pediatric thoracic trauma is most often associated with blunt injury. A rare complication of pediatric blunt thoracic trauma is lung herniation. Imaging options include chest radiographs and, in select patients, chest CT scanning. In most clinical settings, good quality chest radiographs are all that are indicated, with chest CT reserved for those patients with significant chest trauma, multiple injuries, or where there is a high index of suspicion for significant thoracic injury. Open, primary repair is often done, but the VATS technique is also a viable option.

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Author Contributions

Robert Vezzetti – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Peter Cosgrove – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Julie Sanchez – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Gael Lonergan – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

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