Imaging of cardiothoracic trauma in children – enigmas, edicts and errors

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Traumatic injury still remains the No. 1 cause of death in the United States in the pediatric population. While thoracic trauma is an uncommon reason for admission of children who are victims of trauma, chest injury is a marker for higher mortality. The vast majority of injuries reported (>85%) result from blunt trauma, with motor-vehicle-related injury being the most common mechanism.

When specific organ injuries are categorized by frequency, pulmonary contusion represents the most common injury (50–90%), followed by hemo/pneumothorax (15–56%), rib fractures (20–60%) and pulmonary laceration (2–4%). Other thoracic injuries are rare, but important. This presentation will address the appearance of the common injuries, characterize the lesions that are critical to diagnose, and discuss the mistakes made in assessment of thoracic trauma.

Injuries in the pediatric population tend to differ from those in adults. These differences can be explained by anatomical and physiological distinctions. In a child, greater flexibility of the thoracic cage results in fewer rib fractures and greater compressibility of the anterior thoracic cage, resulting in more common pulmonary contusions. The increased mobility of the mediastinum in children leads to a miniscule incidence of aortic tears and diaphragmatic injury.

Pulmonary contusions represent the most common injuries in the pediatric population. Plain radiographs are much less sensitive than CT for detecting these injuries, but these injuries tend to be clinically significant only if seen

on conventional radiographs. These lesions are not limited by segmental borders, are more common in the lung bases, and uncommonly demonstrate air bronchograms. Peripheral sparing of the lung is a typical finding on CT. Although differentiation from aspiration and atelectasis is sometimes difficult, there are usually clues to point to the specific etiology of the focal alveolar pathology.

Hemothorax (HTX) and pneumothorax (PTX) might have subtle findings on the conventional portable chest radiograph. Up to one-third of PTXs are not visible on these initial radiographs. Subtle findings include a sharply defined diaphragm or an inferior lung border or cardiac border. It is important to understand that PTXs can rapidly increase in size during assisted ventilation. HTX might only demonstrate a graded or veiled opacity in the affected hemithorax on conventional portable radiographs. Mortality is high with HTX, approaching 50%. These require prompt evacuation in order to monitor blood loss and to prevent empyema and fibrothorax.

Pulmonary lacerations are much less common than contusions. On the initial portable chest radiograph they might be obscured by the adjacent parenchymal injury. Although they serve as a marker for high mortality (40–50%), care is usually supportive. There is a risk of increasing size of the laceration during the first few weeks, but most resolve within a month. These lacerations are generally seen on CT as ovoid radiolucencies, usually with a contusion.

The most critical traumatic thoracic injuries in the pediatric age group are fortunately rare. However, failure to identify these lesions can have fatal consequences for these children. This list of don't-miss lesions includes aortic laceration, tracheobronchial rupture and tension PTX. Aortic laceration is very rare, occurring in less than 0.1% of children presenting with blunt thoracic trauma. These injuries usually occur at the level of the ligamentum

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arteriosum. On the portable chest radiograph findings might be subtle and nonspecific. The findings are the same as those expected in the adult population, but the thymus can confound assessment of the mediastinum. The positive predictive value of a portable chest radiograph for aortic laceration is low, but the negative predictive value of a normal chest radiograph is very high. CT angiography is now considered the test of choice should aortic injury be suspected.

Tracheobronchial rupture should be considered in any child with a pneumothorax that does not resolve following placement of a thoracostomy tube. The vast majority of these injuries occur near the carina. Although CT might be diagnostic, the injuries are sometimes small and only

visualized on bronchoscopy. These injuries have a high mortality rate. A high index of suspicion can lead to earlier diagnosis.

Tension pneumothorax is a life-threatening complication of trauma. Findings are usually quickly recognized on conventional radiographs and treatment must be immediate, as there is a rapid resultant decrease in cardiac output.

The list of injuries at risk of going undetected includes aortic injuries, diaphragmatic rupture, thoracic spine injuries and myocardial contusion. Generally, these lesions are missed or misinterpreted because findings are subtle (especially on portable chest radiographs), the appearance of the findings is delayed, the radiographic examination is suboptimal, or artifacts simulate these lesions.