Learning objectives

Identify the radiological findings on chest computed tomography scan to evaluate patients with polytrauma.

Background

Injuries to the thorax are the third most common injuries in trauma patients, next to injuries to the head and extremities. Thoracic trauma has an overall fatality rate of 10%. More than two-thirds of cases of blunt thoracic trauma are caused by motor vehicle collisions. Most of the remaining cases are the result of falls from great heights. Chest trauma include soft tissue trauma such as: soft tissue contusion, airways and intrapleural lesions like hemothorax and pneumothorax, parenchymal lung injuries like contusion and lung laceration; injuries of diaphragm and finally mediastinal lesions such as blunt cardiac and injuries of great vessels, esophagus; injuries to the bony thorax such as rib, esternal and scapula fractures. Conventional radiography is typically used for the initial imaging investigation. CT has been increasingly used for trauma. Studies have shown that CT may demonstrate significant disease in patients with normal initial radiographs. Many of these injuries are of moderate severity and rarely require surgical intervention. The majority of chest trauma requires careful surveillance to identify those patients who require operative correction.

Findings and procedure details

We did a retrospective review of CT scans in patients with polytrauma and thoracic trauma who were admitted to the emergency department of the University Clinical Hospital of Valencia between 2010 and 2014, finding multiple injuries, some of them with high morbidity and mortality.
Pneumothorax is the collection of air in the pleural space. Air may come from an injury to the lung tissue, a bronchial tear, or a chest wall injury allowing air to be sucked in from the outside. A chest X-ray is usually diagnostic, but may miss small pneumothoraces, especially with the patient supine. The presence of rib fractures on a chest X-ray should prompt a careful search for a pneumothorax. One side of the chest may appear more radiolucent than the other. This may represent an overlying pneumothorax, or alternatively an underlying haemothorax on the opposite side. A deep sulcus sign is indicative of an anterior pneumothorax. CT Scanning is more sensitive for the presence of pneumothorax than plain chest X-ray.

Haemothorax is a collection of blood in the pleural space and may be caused by blunt or penetrating trauma. Most haemothoraces are the result of rib fractures, lung parenchymal and minor venous injuries, and as such are self-limiting. Less commonly there is an arterial injury, which is more likely to require surgical repair. CT readily characterizes pleural fluid in the setting of trauma with determination of the attenuation value. Blood in the pleural space typically has an attenuation of 35-70 HU.

Pulmonary contusion is the most common lung injury from blunt chest trauma, with a prevalence of 17%-70%. Pulmonary contusion is an injury to lung parenchyma, leading to edema and blood collecting in alveolar spaces and loss of normal lung structure & function. Chest X-ray: Most significant pulmonary contusions are diagnosed on plain chest X-ray but often under-estimate the size of the contusion and tends to lag behind the clinical picture. Computed tomography (CT) is very sensitive for identification of pulmonary contusion; the typical imaging appearance consists of patchy airspace opacities or consolidations with ill-defined borders that are distributed irrespective of bronchopulmonary segmental anatomy (nonsegmental distribution). At CT, subpleural sparing (1-2 mm of clear parenchyma beneath the pleural surface) may be observed.

Pulmonary Laceration occurs when there is a disruption (tear, laceration) of the lung parenchyma, resulting in a cavity in the lung. Because of the normal pulmonary elastic recoil, lung tissues surrounding a laceration pull back from the laceration itself. This results in the laceration manifesting at CT as a round or oval cavity, instead of having the linear appearance typically seen in other solid organs. The traumatic cavity may be filled with air (traumatic pneumatocele), blood (traumatic hematocele or pulmonary hematoma), or both air and blood (traumatic hematopneumatocele).
Bronchial lacerations are more common than tracheal lacerations and are typically parallel to the cartilage rings of the bronchi. Common imaging manifestations of bronchial injuries are pneumomediastinum and pneumothorax. The latter occurs if an injury extends to the pleural space. The presence of a persistent pneumothorax, even with chest tube placement and suction, should raise concern for possible bronchial injury. When there is complete transection of a bronchus, the lung on the side of the bronchial injury may fall posterolaterally away from the hilum ("fallen lung" sign).

Injuries of the Esophagus: Blunt trauma to the esophagus is extremely rare, since this structure is well protected in the mediastinum. Most esophageal injuries occur from penetrating trauma. CT findings may suggest the diagnosis of traumatic esophageal perforation (the presence of pneumomediastinum, mediastinitis, hydropneumothorax, or leakage of orally administered contrast material into the mediastinum or pleural space).

Injuries of the Heart: Blunt cardiac injuries may range from contusion to frank rupture of the heart. Imaging manifestations of blunt cardiac injury include hemopericardium, contrast material extravasation into the pericardial sac or mediastinum, pneumopericardium, displacement of the heart due to cardiac herniation, and abnormal bowel gas in the chest due to diaphragmatic pericardial tear.

Blunt aortic injury: Up to 15% of all deaths following motor vehicle collisions are due to injury to the thoracic aorta. Many of these patients are dead at scene from complete aortic transection. Patients who survive to the emergency department usually have small tears or partial-thickness tears of the aortic wall with pseudoaneurysm formation. Most blunt aortic injuries occur in the proximal thoracic aorta, although any portion of the aorta is at risk. The proximal descending aorta, where the relatively mobile aortic arch can move against the fixed descending aorta (ligamentum arteriosum), is at greatest risk from the shearing forces of sudden deceleration. Other postulated mechanisms for aortic injury are compression between the sternum and the spine, and sudden increases in intra-luminal aortic pressure at the moment of impact. The Chest X-ray: it is still used as the primary screening study, but has a low sensitivity, but a 98% negative predictive value if normal, it is one of the standard adjuncts to the primary survey in blunt trauma patients. All are related to the identification of mediastinal haemorrhage and haematoma, the indicators of blunt aortic injury include an abnormal mediastinum or widened mediastinum, but it does not constitute the aortic injury itself. CT: The sensitivity of modern CT scanners is reported at 97-100%, with a negative predictive value of 100% and specificity of 83-99%. Most blunt aortic injuries are at the proximal descending aorta and are visible on axial CT as a pseudoaneurysm bulging anteriorly or antero-medially at the level of the left pulmonary
artery. This is associated with mediastinal haemorrhage (non-enhancing) that is a result of surrounding contusion and venous injury, rather than from the aorta itself. The trachea and oesophagus may be displaced to the right. An intimal flap may be seen.

Injuries of the Diaphragm: Blunt injuries to the diaphragm are uncommon, with a prevalence of 0.16%-5% in blunt trauma patients. Injuries are caused by a sudden increase in intraabdominal or intrathoracic pressure against a fixed diaphragm. The right hemidiaphragm is less frequently injured than the left, which may be explained by the greater strength of the right hemidiaphragm and the protective effect of the liver. Injuries to the diaphragm pose a risk of visceral organ herniation through the defect, which can occur acutely at the time of injury or be delayed. Visceral organ herniation may result in organ incarceration, strangulation, or perforation. The type of herniated contents depends on the size and location of the injury. The liver, small bowel, or large bowel may herniate through a right-sided diaphragmatic defect; the stomach, small bowel, large bowel, or spleen may herniate through a left-sided defect. Rare locations of traumatic diaphragmatic herniation include the pericardium and the esophageal hiatus. Imaging manifestations of diaphragmatic injury depend on the side of injury (left or right hemidiaphragm), the presence of herniated abdominal viscera, and concomitant pleural or pulmonary injuries. Multidetector CT with coronal and sagittal reformation can show even a small diaphragmatic discontinuity and help identify any herniated viscera. Other CT signs of diaphragmatic injury include the "collar" sign, the "dependent viscera" sign, diaphragmatic thickening, and peridiaphragmatic contrast material extravasation. The collar sign is produced by a waistlike constriction of herniated viscera at the site of herniation. The dependent viscera sign results from the abdominal viscera falling dependently against the posterior chest wall through the diaphragmatic tear. CT has an overall sensitivity in the diagnosis of blunt diaphragmatic rupture of 70%-100%.

Rib fractures: The most common skeletal injury in blunt chest trauma is rib fracture, which occurs in approximately 50% of patients. Fractures of the first through third ribs are considered to be high-energy trauma, these fractures may be associated with brachial plexus injury or subclavian vascular injuries. Fractures of the lower three ribs may be associated with liver, spleen, and kidney injuries and, less frequently, with lung injuries. Flail chest is a traumatic condition in which there are three or more contiguous ribs with fractures in two or more places. These fractures create a flail segment that can move paradoxically relative to the remainder of the chest during respiration in a spontaneously ventilating patient. Chest X-ray: The antero-posterior chest radiograph will identify most significant chest wall injuries, but will not identify all rib fractures. Lateral or anterior rib fractures will often be missed on the initial plain film. Computed Tomography: it provides very little further clinical information and is not indicated for the initial evaluation of chest wall injuries.
**Sternal fractures** are best demonstrated at CT on multiplanar reformatted images, especially sagittal images. On occasion, a fracture line may be difficult to detect at axial CT, and the clue to the diagnosis may be the presence of anterior mediastinal hemorrhage.

**Fractures of the scapula** are uncommon. Significant force may be required to fracture a scapula, whether a direct blow to the scapula or an indirect axial force transmitted through the humerus. They are associated with other injuries including pneumothorax, hemothorax, pulmonary injuries, and spinal injuries. CT with multiplanar and volumetric reformation can provide additional information regarding intraarticular extension of the fractures.

**Images for this section:**
**Fig. 1:** Polytrauma in a 57-years-old man. Left figure, Three-dimensional coronal reconstruction and Right figure, transverse section the chest CT scan, illustrating intrathoracic herniation of the stomach through a left diaphragmatic rupture, pulmonary contusion in the left upper lobe, left rib fractures, subcutaneous emphysema, and splenic laceration.
**Fig. 2:** Polytrauma in a 37-years-old man. Transverse section the chest CT scan shows a cavity with fluid-air level surrounded by ground-glass opacity in the right lung consistent with lung laceration, hemopneumothorax and subcutaneous emphysema.
Fig. 3: Polytrauma in a 35-years-old man. Thoracic CT shows right pneumothorax, right rib fracture and atelectatic lung.
Fig. 4: Polytrauma in a 36-years-old man. Computed axial tomography shows bilateral pulmonary contusions, left rib fracture and subcutaneous emphysema.
Fig. 5: Polytrauma in a 69-years-old man. Left figure, thoracic axial CT at bone window, shows a right rib fracture (yellow arrow), vertebral fracture (red arrow) and right pleural effusion. Right figure, thoracic coronal CT at window bone, shows a right scapula fracture (yellow arrow), fracture through of the T8 vertebral body (red arrow) and right pleural effusion.
Fig. 6: Polytrauma in a 28-years-old woman. CT-scan shows an aortic rupture extending from the isthmus (yellow narrow) to the descending thoracic aortic (red narrow), intramural hematoma (*) and hemothorax.
Fig. 7: Polytrauma in a 69-years-old man. CT-scan shows a right hemothorax (pleural effusion with relatively high attenuation). The patient had multiple rib fractures (not shown).
Fig. 8: Polytrauma in a 23-years-old woman. CT-scan shows, a sternal fracture affecting the body of the sternum (yellow arrow).
Conclusion

It is important to diagnose the thoracic injuries, including chest wall, lung, different structures of the mediastinum and diaphragm, in patients with polytrauma and make an appropriate and early management, because this type of trauma can have a high morbidity and mortality.

Personal information

References


