Thoracic trauma: A comprehensive review of radiological findings

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Authors: S. A. Moreno, E. Esteban, L. Fernandez Prudencio, A. Lopez Moreno, M. Milan, S. Comellas Cruzado, C. E. Rodriguez, D. Sánchez Paré; Badajoz/ES
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Learning objectives

To illustrate with imaging the spectrum of injuries that can occur after chest trauma.

To explore what are the indications of the different imaging techniques in the study of patients with thoracic trauma.
Background

We define chest trauma as anyone occurred on the thoracic cage with involvement of this, the lung parenchyma, heart, great vessels or mediastinal structures.

Thoracic injuries are classified as open or closed depending on there is or no solution of continuity in the parietal pleura.

In our environment, the vast majority of thoracic trauma is closed, with integrity of the thoracic cage.

The most frequent causes of chest injury were falls mainly in patients older than 71 years, and traffic accidents predominantly between 31 and 55 years old patients.

Traffic accidents are the major source of blunt chest trauma representing approximately two thirds of cases.

In addition to the closed trauma, penetrating wounds by stabbing or bull horn are also an important source of thoracic injuries against the lesions of iatrogenic origin that constitute a rare entity.

The survival of these patients depends not only on the severity of the lesions, but also speed diagnosis and the quality of care they receive. It is therefore essential that imaging tests carried out are suitable, have a high diagnostic quality and made in the minimum time possible once the patient is stable.

Nowadays while the imaging test considered the gold-standard for the evaluation of the thoracic injuries is CT, chest radiograph is still the technique of choice in the initial study (screening) of thoracic pathology. Once assured the stability of the patient, an x-ray chest must be obtained.

The majority of patients with chest trauma are not capable of performing the x-ray chest standing up, so that, in the majority of cases it will be held in supine projection.

This projection has some limitations that we must know:

- The AP projection does not distinguish bone and soft tissues injuries of that are in the inside of the chest.
- It allows a bad view of the mediastinal structures.
- Air-fluid levels are not visible because the incidence of the x-ray beam is perpendicular to the ground.
• Inadequate inspiration and the magnification can produce a false impression of cardiomegaly with increase in pulmonary vessels.
• Homogeneous distribution of the flow from the vertex to the base.
• Widening of the upper mediastinum or the vascular pedicle due to increased systemic venous return to the heart.

Above these limitations, the value of the x-ray chest is incalculable in the polytraumatized patient allowing diagnosis of certainty or suspicion in many cases of bone fractures, pleural effusion, pneumothorax, subcutaneous and mediastinal emphysema, and in the majority of cases of pulmonary contusion. It also allows to diagnose high-risk vital entities and requiring immediate treatment as the tension pneumothorax.

Nevertheless the information obtained can be suboptimal for the diagnosis of large vessels or mediastinal lesions underestimated the severity and extent of chest trauma.

The sensitivity of the CT is higher in the detection of thoracic injuries. It will detect significant pathology in patients with normal chest radiograph and will reveal more extensive lesions than the displayed on the initial x-ray. Due to this fact, has increased the use of CT as additional technique, or imaging modality of choice, for patients with chest trauma.

CT is the most advantageous technique for the direct diagnosis of large vessels and mediastinal lesions, respiratory tract and diaphragm injuries, the course of penetrating trauma, and subtle pneumothorax or pleural effusion.

In addition, CT offers better resolution spatial and temporal, allowing reconstructions of high quality that are of great value in the diagnosis of severe traumatic injuries of the chest.
Findings and procedure details

The spectrum of injuries that can occur after chest trauma is wide. We classify the radiological findings depending on the anatomy of the patient. This way, we can find cases of affectation of the thoracic wall, pleural injuries, traumatic diaphragmatic hernias, parenchymal lung lesions, tracheobronquial injuries and mediastinal injuries.

1. INJURIES OF THE THORACIC WALL

We classify the injuries of the thoracic wall in soft tissue lesions and bone structure lesions.

1.1 SOFT TISSUE LESIONS

Hematomas in the thickness of the subcutaneous cellular tissue are very frequent and usually without clinical significance. CT shows an increase in the density of subcutaneous fat (Figure 1).

The chest wall hematomas are collections between parietal pleura and intrathoracic fascia and may have an arterial (intercostal arteries, internal mammary artery or subclavian) or venous origin. The blood origing tend to grow rapidly, displacing organs and causing mass effect. Those venous origins are usually self-limiting and low pressure (Figure 2).

1.2 BONE STRUCTURE LESIONS

- FRACTURE RIB

Is the most frequent lesion in the thoracic injuries closed, with an incidence of 50% (Figure 3).

A single fracture rib has no clinical significance, but multiple fractures rib, fracture of the first arche or bilateral involvement, indicate severe damage with increase in morbidity and mortality and should prompt a careful search for other injuries.

Fractures of the lower ribs may be associated with diaphragmatic tears and spleen or liver injuries.
• **FLAIL CHEST**

Unstable or flail chest is defined as paradoxical movement of a segment of the chest wall, which happens when there are at least two fractures per rib (producing a free segment), in at least two ribs. The segment of chest wall that is affected, is isolated, and moves in the opposite direction to the rest of the thoracic cavity, contributing to altering respiratory mechanics. His presence is an indicator of high energy trauma and tends to be associated with massive pulmonary contusions, requiring ventilatory support in the majority of cases. (Figure 4).

• **STERNAL FRACTURES**

Sternal fractures are rare (3-8% in blunt chest trauma), and generally occur subordinate to motor vehicle accident due to seat belt or air bag trauma. They frequently involve the sternal body and/or manubrium and their presence requires complete the study by CT. Multiplanar reconstructions facilitate the diagnosis (Figure 5).

It is almost always accompanied by anterior mediastinal haemorrhage, which has a preserved fat plane with the aorta and may be associated with cardiac contusion and spinal injury.

• **STERNOCŁAVICULAR DISLOCATION**

Is rare and occurs in 1-3% of all types of dislocation.

Anterior sternoclavicular dislocation is more common and easily detectable, as it is palpable. It usually has a benign course, but it implies a high-energy trauma and may be associated with haemopneumothorax, rib fractures or pulmonary contusion.

Posterior sternoclavicular dislocation is clinically and radiographically silent and carries serious morbidity, as it is associated with injuries of the mediastinal vessels, nerves, trachea and oesophagus.

• **CLAVICULAR FRACTURES**

It is a rare finding that occurs after high-impact trauma.

It has been associated with other injuries such as: pulmonary contusion, rib fractures and arterial injuries (subclavian, axillary or brachial).

• **SCAPULA FRACTURES**
It is a rare finding (3-5%) and indicates a high-energy force trauma.

It is associated with other injuries in 35-98% of cases (hemo / pneumothorax, lung injuries, spinal injuries, brachial plexus, subclavian vessels, and they are surgical if there is joint involvement.

• VERTEBRAL FRACTURES

Dorsal vertebral fractures account for 30% of vertebral fractures and are more common at D9-D12. 62% are associated with neurological deficits.

In the chest radiograph they may go unnoticed unless there is a clear misalignment of the vertebrae or will widen the paraspinal line. The CT is the diagnostic method of choice and very useful MPR in its detection (Figure 6).

The IMR is useful for assessing spinal cord injury and traumatic disc herniations.

2. PLEURAL INJURIES

2.1 PNEUMOTHORAX

Defined like the appearance of air into the pleural cavity, pneumothorax supposes a lack in the continuity of pleura.

Behind the rib fracture, it’s the second injury in frequency, with an incidence of 30-40% in the thoracic blunt trauma.

Between causes, it’s frequent to be due to rib fractures that lacerate the lung; as well as wounds and injuries of the chest wall that allow the air entrance from outside. Also, it may be secondary to a sudden increase of intrathoracic pressure that originates an alveolar rupture or to a ruptured bleb existing at the time of impact.

Usually a simple inspired chest radiograph leads the diagnosis, where we note the visceral pleural line separates of the parietal pleura by an hyperclare airspace, without vasculature (Figure 7).

Both skinfold and external elements (like hair tress) can simulate the visceral pleural line (Figure 8).
Pneumothorax could spread into other spaces and cause pneumomedastinum and subcutaneous emphysema (Figure 9).

Up to 30-50% of small pneumothorax may remain hidden in the supine x-ray cause the appearance of air in the anteroinferior region of hemithorax (Figure 10).

Deep costophrenic angle sign and double diaphragm sign lead to diagnosis in supine x-ray (Figure 11).

It’s important to detect small pneumothorax in patients who demand mechanical ventilation to avoid their increasing because of this treatment.

The more sensitive diagnostic test in the detection of pneumothorax is the CT because, in addition to quantify, can distinguish it from other entities such as subcutaneous emphysema and pneumomediastinum.

Almost a third of pneumothorax developed tension pneumothorax if not diagnosed or treated. Tension pneumothorax is a serious situation that is usually diagnosed clinically before performing any test image.

It is characterized by the massive entry of air into the pleural space due to injury of the lung parenchyma with unidirectional valve component. This injury allows entry but not exit air in the pleural cavity which will lead to increased intrathoracic pressure with partial or total lung and inadequate diastolic filling of the heart chambers collapse.

The cases of tension pneumothorax, open pneumothorax are immediate surgical emergency, without waiting for radiological testing.

The diagnostic signs in chest radiograph will be the collapse of the ipsilateral lung, contralateral mediastinal shift in inspiration, flattening or inversion of the diaphragm and intercostal spaces widening.

(Figure 12).

2.2 HEMOTHORAX

It’s the presence of blood in the pleural space from a vascular rupture or laceration. Hemothorax can have multiple causes, such as laceration of the intercostal vessels, lung lacerations, diaphragmatic or pleural rupture and injury of mediastinal structures.
If hemothorax has venous origin, it is usually self limited and usually does not increase in size. If the pleural effusion is between 200-300 ml can go underdiagnosed.

In the upright chest radiograph is appreciated increased density of affected hemithorax with meniscus sign that does not delete vascular contours (Figure 13).

In CT hemothorax diagnosis is easily because it has attenuation values in a range of 35 - 70 UH (reactive pleural effusion not exceeds 15uH), although they may vary depending on the time evolution of bleeding. Blood clots may reach values of up to 50 - 90UH. (Figure 14).

Ultrasound is a useful tool to differentiate between pleural effusion (anechoic) and hemothorax (with echoes inside). This technique also can provide guidance for thoracocentesis.

Massive hemothorax is the accumulation of blood in excess of 1.500 ml into the pleural space and is associated to hemodynamic instability with cardiac tamponade eventually.

It’s usually due to penetrating wounds, and secondary to injury to the heart, great vessels or large lacerations.

Symptoms and signs are similar to tension pneumothorax, but with dullness on percussion and hypovolemia always present, which can mask other signs such as jugular venous distension.

2.3 CHYLOTHORAX

Traumatic chylothorax is rare and it’s caused by rupture of the thoracic duct secondary to penetrating trauma or rupture of the proximal end of the left clavicle.

The diagnosis is made by MDCT, where we identify content in the pleural cavity with density values in the range of fat.

3. TRAUMATIC DIAPHRAGMATIC HERNIAS

Diaphragmatic ruptures are infrequents, but more commons in open injuries (where the diaphragmatic defect usually not exceed 1 cm in diameter) than in blunt trauma (where larger breaks occur), and is more common in young males.
It’s considered a marker of severe damage.

The mechanism of injury can be a sudden increase in abdominal pressure, a direct lateral impact which deforms the wall, or fragments of rib fractures that penetrate directly into the diaphragm.

The posterolateral regions are most commonly affected and the left hemidiaphragm is commonly injured (probably for the protection exerted by the liver on the right side).

As a result of diaphragmatic laceration, herniation of abdominal viscera occurs into the ribcage.

Almost 2/3 of traumatic hernias go unnoticed in the initial study due to poor radiographic findings or be obscured by pleuroparenchymal pathology associate (pleural effusion, pulmonary contusion-atelectasis, splenic contusions ...).

The diagnosis of diaphragmatic rupture is therefore difficult and requires a high index of clinical suspicion based on mechanism of injury.

There are often liver and splenic injuries associated because their place in the border between thorax and abdomen.

Chest radiography remains the imaging method of choice, and although it has a low sensitivity and presents limitations arising from the situation of the patient (as supine position, lack of collaboration and the use of laptops), usually is the first radiological examination which is done and should be known the radiological signs suggestives of diaphragmatic rupture in order to make an early diagnosis.

More specific signs are intrathoracic herniation of abdominal viscera (Figure 15), and abnormal location of the nasogastric tube above the diaphragm.

The sensitivity of the standard CT axial ranges from 42-82%, higher for left diaphragmatic ruptures than for rights, and increases above 92% with multiplanar reconstructions, although many of the radiological signs are properly observed in the axial images.

Main findings suggestives of diaphragmatic rupture in CT are:
a) Intrathoracic herniation of abdominal content, most often the stomach and colon in the left side and the liver on the right (Figure 16).

b) Focal circumferential stenosis of herniated viscera in the place of broken diaphragm or collar sign.

c) Fallen viscera sign, which is that the herniated viscera rests on the posterior chest wall when the patient remains in supine.

d) Hung diaphragm sign, wherein the free edge of the torn hemidiaphragm curves toward the center of the abdomen instead of following its normal course parallel to the chest wall.

MRI is an alternative technique for the diagnosis of diaphragmatic rupture, but not the method of choice because of its low availability, the longer exploration, and critical clinical condition of patients.

4. PARECHYMAL LUNG LESIONS

4.1 PULMONARY CONTUSION

It’s the most common lung injury that occurs in the closed chest trauma, and becomes one of the main factors of morbidity.

Defined by the breakage of the membrane of alveolar capillar and the small vessels without clear alveolar rupture, leading to extravasation of blood into the interstitium and alveoli.

Will be manifested as interstitial thickening and / or hemorrhagic occupation of the alveoli at the point where the stroke or trauma is absorbed.

In the chest radiograph, contusions may not be visible until the first 6 hours, but can also do so early, and always are visible within the first 24 hours. Also in the first emergency x-ray, contusion is usually less than it will be after a few hours.

In case of suspected pulmonary contusion in the x-ray, is indicated performing a chest CT, since the CT details better the location and length of injuries, and because contusions may be associated with other complications such as chest wall lesions, rib fractures, hemothorax or pneumothorax.
Imaging techniques show thickening of interstitium, as well as areas more or less heterogeneous and ill-defined of consolidation or increased density in ground glass of space air, similar to pneumonia, although of predominance in the periphery and not segmental distribution, which can exceed the cisuras. The peripheral opacities typically exhibit a thin zone of surrounding subpleural lucency that is presumed to represent a rim of relatively hypovascular lung tissue that was compressed at the moment of the injury and, therefore, relatively spared of alveolar hemorrhage and edema (subpleural sparing) (Figure 17).

As result of the occupation of airway by blood, there is usually no air bronchograms.

If not complicated, are reabsorbed at 48-72 hours and completely disappear within 1-2 weeks. Persistence of airspace occupation beyond this time, suggests the development of pneumonia, aspiration or adult respiratory distress syndrome (ARDS).

4.2 PULMONARY LACERATION

Is the breaking of the alveolar wall, medial wall retraction and formation of a cavity that may contain blood (hematocele), air (neumatocele) or both.

They are usually secondary to rib fractures or penetrating injuries that pierce the lung and form a cavity.

In the chest radiograph are not usually visible at first since they are surrounded by areas of pulmonary contusion.

The CT is more sensitive to detect and assess the extent of these injuries.

They will be displayed as a thin-walled cavity, filled with air or fluid level inside (Figure 18, 19, 20).

Conservative treatment is the rule, and usually are resolved within 3-5 weeks; but in patients with mechanical ventilation or ARDS may increase in size and remain along months.

If they connect to the pleural cavity, could develop to bronchopleural fistulas, pneumothorax or hemopneumothorax.
4.3 PULMONARY HERNIATION

A pleura-covered lung parenchyma that extrudes through a traumatic defect of the chest wall. May increase with positive pressure ventilation and is usually associated with ribs fractures (Figure 21).

5. TRACHEOBRONQUIAL INJURY

They are rare lesions and are associated with other serious injuries, delaying their diagnosis.

Among their mechanisms of production are the increasing of intratracheal pressure when the glottis is closed at the time of trauma; shear forces between the lung, trachea and mains bronchia; and deceleration mechanisms that cause compression of the airway between the sternum and thoracic spine.

Trachea could be also damaged during intubation.

85% of the tracheal lesions occur within 2 cm of the carina.

Usually tracheal fracture is longitudinal and is located at the junction of the cartilaginous portion with membranous.

The bronchial lesions are more frequent than in the trachea, and principally in the right main bronchus at 2.5 cm or less from the carina. They are parallel to the cartilaginous rings.

CT has high sensitivity and specificity in the diagnosis of tracheobronchial rupture.

Direct CT finding is discontinuity of the tracheal or bronchial wall with air leaking around the airway (Figure 22).

Among the indirect signs, we can see the "fallen lung sign". Infrequent but pathognomonic of fracture of the main bronchus, it refers to the collapsed lung in a dependent position, hanging on the hilum only by its vascular attachments and was first described by Oh et al in 1969 and by Kumpe et al in 1970. The bronchial fracture results in the lung to fall away from the hilum, either inferiorly and laterally in an upright patient or posteriorly, as seen on CT in a supine patient.
Another indirect signs are the persistent of pneumothorax after tube thoracostomy and herniation or overdistension of an endotracheal cuff in an intubated patient

Multiplanar reconstructions are very useful because of the frequent axial location of many bronchial ruptures, and virtual bronchoscopy is a useful tool in diagnosis.

6. MEDIASTINAL INJURIES

6.1 HEART INJURIES

The heart injuries may vary from myocardial contusion to cardiac rupture.

The diagnosis of cardiac trauma requires a high clinical suspicion, and they could be associated to abnormalities in ECG or enzyme abnormalities.

Myocardial contusion is more common and usually affects the right ventricle, which is located behind the breastbone.

In CT cardiac contusion is seen as a hypo dense, non-enhancing focal area in the myocardium, contrast medium extravasation in the pericardial sac or the mediastinum, valve or coronary artery laceration injury.

Myocardial rupture is associated with 80% mortality in the place of trauma and usually affects the right atrium. The MDCT shows hemopericardium, which can lead to cardiac tamponade, with or without hemothorax, and in some cases can identify blood leakage like accumulation of contrast in anomalous situation. In cases of penetrating wounds, stab or fire weapon is possible to visualize pneumopericardium.

Hemopericardium is defined as the presence of content with the attenuation values in the range of blood, which fills and distends the pericardial cavity (Figure 23).

In pneumopericardium the air within the pericardial space outlines the heart and is limited superiorly by the pericardial reflection. A complication of air within the pericardial sac is tension pneumopericardium that can cause cardiac tamponade. Developing tension pneumopericardium has been reported to cause the cardiac silhouette to appear progressively smaller on serial conventional radiographs.
Some of indirect visible signs of cardiac injury in chest radiograph are acute pulmonary edema, cardiomegaly and Pneumopericardium

An special type of cardiac trauma is that which can occur during implantation of a pacemaker. The most serious complication is ventricular perforation with secondary hemopericardium which could originate cardiac tamponade (Figure 24).

Hemopericardium diagnosis is done by echocardiography.

As well as confirm it, MDCT allows to visualize a possible pneumopericardium and pneumothorax, in addition to delineate the electrocatheter pathway.

6.2 TRAUMATIC RUPTURE OF THE AORTA

The aortic lesion has high mortality that in the case of breakage reaches 85%.

The production mechanism is the sudden deceleration or shear, and occurs in the anchor points of the aorta, which will remain fixed at the time of deceleration. In 90% of cases occur in aortic isthmus, just distal to the origin of the left subclavian artery. The following location is often the aortic root, in which case increases mortality by pericardial tamponade.

The great value of chest radiograph is not in diagnosing acute aortic pathology, but excludes it. A normal radiograph has a NPV of 98%.

The most frequently present finding is the periaortic hematoma.

Chest radiographic findings suggestive of aortic injury include an alteration of the normal aortic arch contour or loss of the ascending aorta line, mediastinal widening, paraspinal and paratracheal lines widening, occupation of the aortopulmonary window, tracheal or NG probe deviation to the right and descent of the left main bronchus.

The CT is considered the gold standard technique in the diagnosis of aortic pathology. It has a sensitivity of 55-100% and a specificity of 65-92%, similar to the aortography in some series.

The most common CT scan finding is the periaortic hematoma seen as increased density in the mediastinum adjacent to the aorta.
The direct signs are the intimal flap, intramural hematoma, irregular contour of the aorta, pseudoaneurysm and intravenous contrast extravasation, which indicates complete rupture of the aortic lumen (Figure 25).

The pseudoaneurysm, typically located on the anterior aspect of the proximal descending aorta, immediately distal to the aortic isthmus, indicates incomplete rupture of the aorta. It is an incomplete tear in the wall in which arterial blood is contained by the adventitia of the artery alone and is therefore quite unstable.

If CT angiography is negative for aortic injury not further testing is needed.

Conventional angiography is indicated in those patients with equivocal findings or alterations which need better evaluation. If endovascular treatment is required it can be performed in the same act.

6.3 ESOPHAGEAL RUPTURE

It is a rare injury due to the location of the esophagus in the posterior mediastinum. It is more common in penetrating chest trauma or after vigorous vomits and the most frequently affected is the cervical esophageal segment.

Conventional radiology and CT only detect indirect signs such as cervical and mediastinal emphysema, left pleural effusion or alteration of mediastinal contour by the presence of collections, mediastinitis or bleeding.

The CT can identify the presence of air bubbles adjacent to the wall of the esophagus (pneumomediastinum), mediastinitis and oral contrast leakage into the mediastinum or pleural space (Figure 26).

Esophagography would constitute the diagnostic technique of choice with 90% sensitivity for assess the integrity of the esophagus but can only be performed in stable, partners and conscious patients.

Will be use oral solution with Sodium Amidotrizoate/Meglumine Amidotrizoate as agent of contrast (barium can cause serious complications if it reaches the mediastinum) unless a fistula with airway is suspected; in this case barium is used because the hyperosmolarity of Amidotrizoate can cause severe pulmonary edema when entering in contact with the alveolar wall.
Images for this section:

![CT coronal MPR showing hematoma in subcutaneous tissue with morphology "in belt" of one patient sitting in the passenger seat.](image1)

**Fig. 1:** a. CT coronal MPR shows hematoma in subcutaneous tissue with morphology "in belt" of one patient sitting in the passenger seat. b. Subcutaneous tissue hematoma in patient with stab wounds (red arrow).

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**Fig. 2:** Hematoma in the left anterior pectoral muscle seen as increased muscle thickness and anterior mediastinal hematoma associated.

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Fig. 3: Right rib fractures. Pneumothorax and subcutaneous emphysema associate in a.

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**Fig. 4:** Flail chest. Fractures of seven contiguous arcs in left chest wall associated with fractured clavicle, pneumothorax, subcutaneous emphysema and extensive pulmonary contusions.

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Fig. 5: Transverse fracture of the sternal body with small mediastinal hematoma associated.

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Fig. 6: Sagital and coronal MPR showing fracture-dislocation of the fifth-sixth dorsal vertebra with spinal cord dysfunction.

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Fig. 7: Right pneumothorax. Airspace without vasculature

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**Fig. 8:** External element (braid hair) that simulates right pneumothorax.

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Fig. 9: Pneumothorax and subcutaneous emphysema in the right chest wall.

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**Fig. 10:** Small left pneumothorax not visualized in supine chest radiograph and confirmed in CT.

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Fig. 11: Left anterior pneumothorax in supine chest radiographic. The deep costophrenic angle sign (red arrow) and double diaphragm sign (*) lead to the diagnosis.

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**Fig. 12:** Right tension pneumothorax. Collapse of the ipsilateral lung, contralateral mediastinal shift, flattening or inversion of the diaphragm and widening of the intercostal spaces.

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**Fig. 13**: Left massive hemothorax. Increased density in left hemithorax with obliteration of the cost and cardiophrenic sinus and meniscus sign (red arrow). Contralateral mediastinal displacement.

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**Fig. 14:** Left pleural laceration by rib fracture (red arrow) with hemothorax (clots) seen as hiperdense material in the pleural space.

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Fig. 15: Portable chest radiograph. Left diaphragmatic rupture with passage of abdominal contents into the chest cavity (*) .

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Fig. 16: Post-traumatic right diaphragmatic rupture in children 6 years old. Herniation of the right hepatic lobe through the diaphragmatic defect with the collar or hour glass sign visible.

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**Fig. 17:** Increased density glass opacities in both upper lobes with subpleural spar in a patient with history of chest trauma. Compatible with pulmonary contusion.

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**Fig. 18:** Gunshot chest trauma. Left pulmonary laceration that draws the path of the projectile.

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**Fig. 19:** Pulmonary laceration with linear morphology in middle lobe (red arrow in a) by gun fire (red arrow in b).

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Fig. 20: Pulmonary laceration in right inferior lobule with small neumatocele (left). Pulmonary laceration due to penetrating injury by bull horn with entrance on anterior chest wall (right image).

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Fig. 21: Lung herniation secondary to injury by bull horn (red arrow).

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**Fig. 22:** Right posterolateral tracheal rupture at the junction of the membranous and cartilaginous portion.

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Fig. 23: Hemopericardium and left hemothorax.

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Fig. 24: Chest radiograph shows electocatheter pacemaker malpositioned surpassing the cardiac silhouette. CT confirms perforation of the ventricular wall.

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Fig. 25: Aortic rupture with pseudoaneurysm and associate hemothorax (left). Aortic rupture with active extravasation of contrast and mediastinal hematoma, pneumomediastinum and extensive subcutaneous emphysema (right image).

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Fig. 26: Spontaneous esophageal rupture in 54 year old male. Pneumomediastinum (red arrow) and subcutaneous emphysema (arrow head) on chest radiograph. CT shows extensive posterior pneumomediastinum dissecting the periesophageal fat plane, indirect sign of esophageal rupture

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Conclusion

The spectrum of images in the chest trauma is wide, and the radiologist should be familiar with them for a quickly and successful diagnosis.

The imaging technique considered as gold standard for the evaluation of these patients is the computed tomography. The CT detects significant pathology in patients with normal chest radiograph and it may disclose more extensive injuries than those displayed in the initial x-ray chest.

Nowadays although no clinical decision rule is available concerning the indication for chest radiograph in trauma patients, it should be obtained in the first survey.

The chest radiograph can diagnoses serious pathology such as tension pneumothorax and mediastinal abnormalities suggestive of acute aortic o heart lesions, and is useful in the evaluation of the position of chest tubes.

However, the severity of pulmonary contusions does not correlate very well with the chest radiograph, and in patients with a normal x-ray chest but with a suspicion of mediastinum traversing injury, a CT is advocated for the evaluation of heart, pericardium, and great vessels.

CT angiography is considered the diagnostic method of choice in the aortic injury.

For the evaluation of heart and pericardial sac CT can be replaced by ultrasound.

The evaluation of oesophageal injury can be realized by esophagogram using a water-soluble contrast agent, and complementary esophagoscopy should be performed.

The trachea and bronchial tree can be evaluated by CT and bronchoscopy.
References


5.- Chen JD, Shanmuganathan K., Mirvis SE et al. Using CT to diagnose tracheal rupture AJR 2001; 176:1273-80.


9.- Cerón J., Peñalver J.C., Padilla J. et al. Rotura diafragmática