LECTURE 5

THORACIC & ANGIO/INTERVENTION & EXTREMITIES

MDCT EVALUATION OF MEDIASTINAL TRAUMA

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Tracheal Injury

Tracheal injury occurs in from 0.35 to 1.5% of major blunt trauma cases. The cervical trachea can be injured by a direct blow, such as a karate kick, impaction against a fixed object, i.e., steering wheel, "clothesline" - type crushing against a fixed horizontal barrier, i.e. snowmobile and tree limb, or rarely from cervical spine injuries. If the tear is complete the major manifestation is marked cervical soft tissue gas. Rarely, the tracheal disruption can allow the larynx to elevate, permitting the hyoid to ascend above the top of C3, which normally never occurs. Cervical tracheal injuries are most commonly between the cricoid and thyroid cartilage and below the 4th tracheal cartilage. Injury to the larynx, esophagus, and recurrent laryngeal nerve are commonly associated from either blunt or penetrating force.

Intrathoracic tracheal injury occurs as a result of compression of the trachea against the spine, shearing forces, or possibly by sudden increased intraluminal pressure. Most injuries occur within 2.5 cm of the carina (80%) and favor the right mainstem bronchus. The hallmark of the injury is persistent, progressive, and severe pneumomediastinum unrelieved by tube thoracostomy. Fractures to ribs 1 -3 are also very commonly associated (90%) reflecting the large blunt impacts required to produce the injury. Other radiologic signs of airway disruption include interstitial air in the tracheal or mainstem bronchial wall, persistent pneumothorax, "fallen lung" sign with a dependent position of a collapsed lung, ectopic location of an endotrachael tube, and over-distension of the ET tube cuff. The ET tube balloon should not appear wider than 2.5 cm in men and 2.1 cm. in women. Distention of the ET tube > 28mm implies tracheal rupture. The diagnosis of tracheal or mainstem bronchial injury is confirmed by bronchoscopy. On occasion, the adventia of the airway may remain intact despite a complete disruption masking the typical radiologic findings caused by air leak. The mainstem bronchi can rarely rupture into the pericardium leading to pneumopericardium and potentially tamponade. The presence of air directly outlining the outside of the trachea or mainstem bronchi as seen by radiography or CT is statistically associated with injury to these structures as opposed to mediastinal air in general and should increase suspicion for airway disruption.

Esophageal disruption

Esophageal disruption is very rarely caused by trauma, with both blunt and penetrating forces accounting for 10% of such injuries. Penetrating injury is predominant with the thoracic esophagus the most common site of injury. Again, injury to the esophagus is often accompanied by injury to adjacent structures. The esophagus can be injured from compression between the sternum and spine, traction form cervical hyperextension, direct penetration by bone fragments from spine fractures, and of course direct penetration by foreign bodies both from within and without. In the setting of acute trauma, one need also consider iatrogenic injury from traumatic attempts at intubation, forced nasogastric tube placement, esophagoscopy and potentially trans-esophageal sonography. In the emergency department setting, a history of impacted foreign body should be sought. Recently reports have also appeared describing "airblast" injuries from exploding tires or inner tubes as a cause of esophageal injury. Imaging manifestations of esophageal injury include pneumomediastinum, usually more limited than from airway injury, pleural effusion, and contour change in the mediastinum that may be progressive with superimposed inflammation. Most often, in blunt trauma cases the diagnosis is not suspected unless there is also injury to the trachea or infection (mediastinitis/abscess) intervenes. The demonstration of an air column in the esophagus or gas bubbles in the nasogastric tube suggests a tracheo-esophageal communication.

When the diagnosis of injury to the esophagus is suspected or considered both contrast esophagography and endoscopy can be used. Most studies suggest that both have areas of weakness and together they offer the highest sensitivity.

Cardiac/Pericardial Injury

The heart and pericardium are also subject to both penetrating and blunt force injury, with penetrating predominating. Cardiac contusions are typically not diagnosed by imaging in the acute period and will not be considered. Pericardial tamponade can occur secondary to air or blood accumulating in the pericardial sac. Tension pneumopericardium occurs when air dissects along the pulmonary adventitia into the pericardial space and cannot egress (1-way valve effect). I have noted this most commonly in patients with a combination of severe lung contusions and high airway pressures. The pericardium becomes distended and the cardiac shadow grows progressively smaller, findings that can be seen easily by radiography and CT. CT will also show distension of venous return vessels (IVC, hepatic veins, SVC) and periportal edema. The finding demands immediate pericardiotomy for tube decompression. Detection of hemopericardium is most difficult radiographically since only a small amount of blood can produce tamponade of cardiac motion acutely without changing the cardiac shadow significantly. CT is very reliable at detecting pericardial hemorrhage and will also show evidence of tamponade as described above. Bedside sonography is very useful to quickly confirm or exclude pericardial fluid after trauma.

Pericardial rupture can occur from direct or penetrating trauma. The rent in the pericardium can allow hemiation of parts or all of the heart usually leading to tamponade. Occasionally, herniation of structures intothe pericardium can occur such as with diaphragmatic-pericardial rupture and bowel herniation. At the Shock-Trauma Center in Maryland pericardial rupture occurred in only 22 of 20,000 admission (0.11%). The majority of tears involve the left pericardium (64%).

Pneumopericardium

Pneumopericardium can result from penetrating trauma, following transsternal surgery or pericardial window, fistula formation between pericardium and tracheobronchial tree or gastrointestinal system, and rarely following blunt force trauma. Patients developing mediastinal emphysema from prolonged positive pressure ventilation or airway injuries, air can track along the adventitia of the pulmonary veins into the pericardial space. Following blunt traumatic rupture of the pericardium adjacent to the phrenic nerve or perforation of the pericardium by a fractured rib, pleural or mediastinal air may enter the pericardial space. Radiographically, air within the pericardial space outlines the heart and is confined superiorly by the pericardial reflections at the root of the great vessels. A small amount or air within the pericardium along the left ventricle could mimic mediastinal emphysema or a medial pneumothorax. Rarely pneumopericardium may result in cardiac tamponade from elevated intrapericardial pressuortant to recognize to prevent potential air tamponade.

Aortic and Great Vessel Injury: Salient Points

- Aortic injury occurs in approx. 0.5% of blunt trauma patients admitted to a major trauma center.
- Most injuries result from high-speed deceleration as in motor vehicular trauma, but can also occur in falls, crush injuries, and rarely direct impact to the chest.
- There are few sensitive or specific physical findings. The presence of a pulse deficit in the lower extremities is quite suggestive of traumatic aortic coarctation, seen in up to 10-20% of cases, but this finding is seldom sought clinically.
- Aortic injury accounts for 16% of deaths in motor vehicle traumas. Mortality at the scene is 85%. In hospital mortality is 30-40% in the first hour, but declines to 1-2% per hour in survivors after the first hour post-admission.
- Exsanguination is typically very abrupt due to loss of aortic tamponade. Few patients with active bleeding identified at the time of CT will survive.

- The aortic injury is most common in the proximal aortic arch at the level of the left pulmonary artery (90-95%), followed by the aortic arch, ascending aorta and peridiaphragmatic region. In an autopsy series the ascending aorta is the second most common site since most patients with this injury site will not survive to reach medical care.
- The chest radiograph is the initial imaging screening test and is usually acquired in a supine patient. If possible erect chest radiographs exposed for the mediastinum should be acquired to improve the specificity of the study. Rarely, there will be minimal or no mediastinal hemorrhage associated with aortic injury (usually minor). Thus, the mediastinal contour can rarely be normal in a patient with aortic injury.
- Any deviation from a normal mediastinal contour, i.e., a sharp aortic arch and descending aorta, clear right paratracheal region, no rightward deviation of the trachea or NG tube, and no widened left paraspinal stripe, particularly extending above the aorta, mandates further assessment.
- Contrast enhanced MDCT is an ideal definitive study for aortic injury and is usually performed in polytrauma cases. CT can reveal the quantity and distribution of mediastinal blood, but more importantly it can directly show aortic injury. With MDCT, more subtle injuries are identified than in the pre-MDCT era, allowing for less invasive treatment.
- Aortic injury by CT usually appears as a pseudoaneurysm projecting from the anterior aorta at the level of the left pulmonary artery, intimal flaps, contour irregularity, an abrupt change in aortic caliber, aortic coarctation, and intra-aortic thrombus. MDCT is revealing subtle injuries that may be managed by blood pressure control or stenting.
- Most aortic injuries manifest some or significant periaortic hematoma.
- Pitfalls in CT diagnosis include a ductus diverticulum and congenital branching anomalies, atherosclerotic disease, chronic aortic pseudoaneurysm, bronchial-intercostal diverticulum, subtle injuries, and injuries at atypical locations.
- Improved CT technology (MDCT) leads to improved accuracy.

- Currently there is little published information on proximal intrathoracic branch vessel injury, but what is recently available appears promising for these injuries as well. Demonstration of hemorrhage around the aortic branch vessel origins, contour irregularities, and intimal flaps should be sought. Often MPR and other post-processed views can be helpful in cases that are equivocal by axial CT. This is also true of equivocal cases of aortic injury.

- Our current recommendation is to perform thoracic angiography only in patients with an *equivocal CT result*, despite a good technical study and post-processing review. If there is blood *directly around the aorta or proximal great vessels*, but the study is technically acceptable and all the major vessels appear normal than *no further imaging is mandated*. This approach may be particularly appropriate for institutions with a large trauma experience.

- Some institutions perform surgical repair or stent placement based on CT results alone, but others may opt for angiographic assessment before surgery. However, an increase in time delay from injury to definitivetreatment increases risk of sudden rupture. In our center, treatment is initiated based in CT evidence of injury alone with exceptionally rare use of catheter angiography.

- Blood limited to the anterior mediastinum or posterior mediastinal blood that is centered on a spine fracture-dislocation with normal appearing vessels does not require angiography.

-The role of trans-esophageal echo (TEE) for aortic injury diagnosis has advocates, but has recently grown less attractive in many institutions. The technique requires rapid availability and technical expertise and is limited by the air-containing trachea to assess the arch region and atherosclerotic disease.

TEE might be ideal for patients taken directly to the OR after blunt trauma for hemodynamic instability.

-Intravascular ultrasonography (IVUS) is occasionally used if available for equivocal cases on MDCT. This techinique requires rapid availability of an expert in its use.

- MRI is not a primary tool in diagnosing aortic injury, but may be used as an ancillary test in patients with equivocal diagnostic results by other studies or to follow patients with aortic injury who are non-operatively managed.

- Placement of aortic stents is becoming increasingly popular. Initial MDCT reports should include information about the proximity of branch vessels to the injury, diameter of the aorta in cross section proximal and distal to the injury, the length of the injury along the long axis of the aorta, and any variants of aortic anatomy.

- Make sure there are no secondary injuries in the aorta or branch vessels. Additional injuries can change the entire management of a case.

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