Thoracic Trauma: Management of Tension Pneumothorax, Rib Fracture, Pulmonary Contusion

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The thoracic injury involves injury which occurs in the thoracic region of the body. The spectrum of manifestation can vary widely—from simple rib fracture to life threatening tension pneumothorax. In addition, the thorax encompasses the important organs of the body, such as the lungs and heart which may also be injured. There is a variability in the clinical manifestation based on the nature of injury, namely blunt and stab injury. The causes of the injury are most commonly motor vehicle accidents, fall in an elderly and assault. The radiographic techniques such as chest X-ray and CT scan aid in the diagnosis of the thoracic injury and its sub-clinical variety.

Definition of Thoracic Trauma

Thorax is the region of the body which is located between the neck and abdomen, and the physical injury of the thorax is referred to as thoracic injury. The thorax encompasses important organs of the body such as the heart and lungs which are enclosed in the rib cage. The spectrum of diseases which occurs because of thoracic injury can vary widely and is described in detail in this article.

Different Thoracic Injuries

Pneumothorax is defined as abnormal collection of air in the space of the pleural membrane which essentially causes disarray between the lungs and the chest wall.

Rib fracture and flail chest: One type of rib fracture is the flail chest. It is defined as the condition in which a segment of the rib has been detached from another rib and is
moving independently during the chest wall movement. Often the requirement is the fracture of three or more ribs in two or more places.

**Pulmonary contusion:** Due to the injury in the chest wall, the underlying lungs get damaged. This leads to accumulation of blood in the lungs, a condition known as pulmonary contusion.

### Epidemiology of Thoracic Injuries

Most rib fractures go unreported, and hence, the incidence of rib fracture is greater than the numbers cited in literature. Rib fracture is more difficult to occur in children than in adults due to the greater pliability of children’s ribs.

### Etiology of Thoracic Trauma

**Thoracic injury:** The reasons for thoracic injury vary widely. The common causes are motor vehicle accidents and injuries which penetrate into the thorax, aka stab injuries. In addition, a thoracic injury can also be the result of a blast associated with warfare or as a part of a civil accident.

**Pneumothorax:** Pneumothorax is the traumatic pneumothorax variant of the pneumothorax. The most common cause for development of traumatic pneumothorax is injury to the lung tissue after rib fracture.

**Rib fracture:** Rib fracture is most commonly seen after blunt injury of the chest. Other reasons include falling of the elderly onto their chest. Fracture of the first rib occurs after the violent movement of the head and neck which leads to the contraction of the scalene muscles. This, in turn, causes the chipping of the first rib at the place of insertion of the scalene muscle.

### Classification of Thoracic Injuries

**Based on the point of contact**

Based on the nature of the point of contact with the thorax, thoracic injuries can be classified into either **blunt injury** or **penetrating injury**. This classification is important as the clinical features and the management of the and penetrating injuries is different.

**Based on the injured structure**

The injuries of the thoracic region can also be classified based on the organ or structure in the thorax which is injured. This includes **cardiac injury**, **blood vessel injury**, **injury to the lungs**, **injury to the chest wall**, **injury to the airways**, **injury to the esophagus** and **diaphragmatic injury**.

**Examples of injury based on the injured structure:**

- Cardiac injury includes traumatic arrest, contusion of the myocardium, sudden fatal tamponade, pericardial contusion.
- Blood vessel injury includes injury to the thoracic aorta, dissection of the aorta (refers to splitting of the blood vessel’s wall through which blood passes).
- The airway injury includes tracheobronchial injury.
Further classification

Pulmonary injury

- The pulmonary injury can range from contusion to laceration of the pulmonary tissue.
- In addition, there is further classification based on the material which accumulates in the lung, such as pneumothorax for air, hemothorax for blood accumulation, hydropneumothorax for accumulation of both blood and air.

Chest wall injury

- The injury to the chest wall includes fractures of the rib cage with or without the sternum, fracture of the shoulder girdle, flail chest, contusion of the chest wall.
- Typical of the flail chest is the paradoxical movement in which the segment of the chest moves contrary to the normal movement of the chest wall. It is often associated with pulmonary contusion, which, in turn, leads to the infection of the pulmonary region.

Pathophysiology of Thoracic Trauma

The pathophysiology of key clinical types of thoracic injuries is described below.

**Pneumothorax:** In the case of pneumothorax, the compression of the lung by the accumulated air causes difficulty during the normal process of breathing. In case of tension pneumothorax, the compression progressively increases and hence becomes life threatening.

**Flail chest:** The fracture of multiple rib bones is referred to as flail chest. It interferes with breathing and causes ventilatory insufficiency.

**Pulmonary contusion:** The three theory, which is proposed for explaining the formation of pulmonary contusion, includes the inertial effect (shredded alveolar tissue), the implosion effect (pressure waves cause exploding of the bubble loaded alveoli) and the spalling effect (the alveoli burst as they meet the shock wave).

Symptoms of Thoracic Injuries

**Pneumothorax:** The clinical feature of pneumothorax is chest pain which is rapid in onset. It is one-sided and associated with severe difficulty in breathing.

**Rib fracture:** Rib fractures are generally symptomless, but in some cases, they represent serious injury to the internal organs of the body. The first rib fracture, although rare, is often associated with spinal injury. The location of the rib fracture is often a sign of injury to the underlying organ. Rib fractures are associated with swelling and bruising—symptoms often associated with flail chest—and pain in the chest, along with difficulty in breathing and shortness of breath.

**Pulmonary contusion:** This injury presents with chest pain, along with coughing of blood. The patient experiences difficulty in breathing along with reduction in cardiac output. Another symptom includes decreased breath sound during auscultation.

**Progression and special forms:** The rate of progression and deterioration of penetration injury is worse when compared to blunt injury. Overall, penetrating injury has
a better prognosis in terms of recovery once treatment is undertaken. Blunt injury has slower recovery when compared to that of penetrating injury.

Diagnosis of Thoracic Injuries

The diagnosis of blunt injury requires the assistance of radiological techniques such as ultrasonography and CT scan of the chest. In many cases, penetrating injury can be diagnosed simply by clinical examination and medical history.

Pneumothorax:
- In most cases of pneumothorax, the diagnosis can be established by simple clinical examination. At that time, the physician might notice a dampening of the breathing sounds due to the decrease in transmission of lung sounds through the collection of air. The physician can also notice a decrease in vocal resonance and vocal fremitus. The percussion of the chest wall results in hyper resonant vibrations.
- Additional radiological examination, such as chest X-Ray and CT Scan, can be done to confirm the diagnosis. In the chest X-Ray of Pneumothorax, the shift of the mediastinum to the opposite side of the pneumothorax could be noted.

Rib fracture and pulmonary contusion:
- The X-ray and CT scan can be used for confirming the rib fracture and pulmonary contusion diagnosis, though the clinical feature will be sufficient in many cases. These are mainly required for complicated cases.

Differential diagnosis

The history of the trauma generally trends the diagnosis of the condition towards thoracic injury. The differential diagnosis lies in various types among chest injuries. These include pneumothorax, hemothorax, hydro pneumothorax, pulmonary contusion.

A chest tube drainage along with radiological examination will help in deciding the diagnosis. The other differential diagnosis includes rib fractures by causes other than thoracic injury, such as metastasis of the bones of the rib and genetic condition affecting the rib.

Management of Thoracic Injuries

General management
- In many cases arises the need of conservative management. This includes fluid management along with oxygen saturation maintenance.
- Pain management forms an integral part of the therapy. Opioids are avoided to the best possible extent due to the fear of respiratory depression.
- Intravenous antibiotics, such as piperacillin tazobactam, are given for chest injuries infection and can be culture based or empirical. The carbapenem are used in case of resistant organism to primary antibiotics. The combination of inhaled and intravenous colistin is used in cases where the ET aspirate has shown gram negative bacteria Acinetobacter baumannii resistant to imipenem and all other antibiotic medications and is sensitive only to colistin.
- Penetrating injury is managed conservatively in most cases using a chest
drainage tube. The management is mainly based on the symptom of presentation and may warrant screening of the mediastinal organs and undertaking laparoscopic or thoracoscopic surgery as the specific case requires.

Management of the special forms of injuries

Pneumothorax:

- The management of Pneumothorax depends on the amount of air which is collected in the pleural cavity. In case of small collection, it would resolve spontaneously, but in case of large pneumothorax, the air needs to be removed with the help of a syringe or a test tube.

Rib fracture and flail chest:

- Mild rib fracture is usually cured without treatment, though it requires bed rest in some cases. Flail chest, on the other hand, requires aggressive treatment which includes pain management using intercostal blocks, positive pressure ventilation and placing the patient in comfortable position.
- Physiotherapy forms the core in the management of flail chest patients. It includes therapy for the prevention of infection and therapy for prevention of the atrophy of the chest wall muscles. In some cases of rib fracture, internal fixation is required for best treatment results. The various options include anterior locking plate, U-plate and sanches plates.

Pulmonary contusion:

- The conservative management is the only thing required in many cases of pulmonary contusion. This includes ventilation management and fluid level maintenance. In cases where oxygen saturation is compromised, however, the patient is required to get assisted mechanical ventilation.

Complications of Thoracic Injuries

Pneumothorax: In the case of Pneumothorax, when the movement of air through the valve becomes one-sided, a condition develops known as tension pneumothorax. It is characterized by abnormal collection of air which grows with respiration. Tension Pneumothorax has a greater risk of developing in traumatic patients on mechanical ventilation. This is an medical emergency which requires immediate medical attention.

Rib fracture: Rib fractures have a better prognosis and they are, usually, not dangerous. Still, they can result in complications such as hemothorax, pneumothorax, respiratory tract infection and in some cases, hypoxemia. The risk factor for the development of respiratory infection following a rib fracture increases in older individuals.

Pulmonary contusion: Pulmonary contusion can result in death, and the mortality rate is from 15 to 40 percent. Complications also may occur, such as chest infection, pneumonia and ARDS, in cases of pulmonary contusion.

Prevention of Thoracic Injuries

Primary prevention: The primary prevention lies in avoiding thoracic injury. This includes better protection during motor vehicle driving, extra care in preventing falls in
the elderly, prevention of assault in society.

**Secondary prevention:** The secondary prevention consists of inhibiting the development of tension pneumothorax after the initial development of pneumothorax.

The better and modern safety features in the motor vehicles, such as airbags, prevent the pulmonary contusion occurrence to a great extent.

**References**


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