Part X: Trauma

Chapter 69: Chest Injuries

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The commonest form of chest trauma in Australia is closed chest injury secondary to motor vehicle accident. Associated extrathoracic injuries, which themselves may be life-threatening, are often present.

If morbidity and mortality are to be minimized, swift assessment and resuscitation are carried out simultaneously. A team approach is necessary. The team leader must know his priorities as, in almost every case, respiratory and circulatory resuscitation will take precedence over everything else.

Initial management is directed toward detection and correction of life-threatening disorders. When these have been dealth with, a secondary assessment of the patient is made. It is during this secondary assessment that detailed radiological investigations are usually undertaken. However, the chest X-ray is an integral part of initial assessment and should be obtained as soon as possible.

Immediate Management

Obvious external bleeding is controlled. An intravenous cannula is inserted and basic circulatory resuscitation is initiated. Blood is sampled for cross-match, biochemistry and haematological tests. At the same time the respiratory and general measures listed in Table 1 are undertaken.

Table 1. *Immediate Management of Chest Trauma*

Assure patent airway, oxygenation and ventilation.
Exclude or treat:
- pneumothorax
- haemothorax
- cardiac tamponade

Assess for extrathoracic injuries.
Decompress stomach.
Provide pain relief.
Reconsider endotracheal intubation, ventilation.

1. Oxygenation

A clear airway must be assured. Oxygen is administered by face mask, and ventilation assessed. Immediate endotracheal intubation and controlled ventilation is indicated in compromised airways, severe head injuries, and gross hypoventilation and/or hypoxaemia unrelated to pneumothorax. Intubation and ventilation in the presence of tension pneumothorax carries the risk of a fatal outcome. Emergency cricothyroidotomy or tracheostomy is only rarely required when an upper respiratory tract obstruction cannot be

bypassed by translaryngeal intubation. (See Chapter 20, Acute Upper Respiratory Tract Obstruction.)

2. Pneumothorax and Haemothorax

Pneumothorax and significant haemothorax are treated if present. A 12 or 14FG intravenous cannula may be inserted percutaneously to relieve tension pneumothorax in dire emergencies. Usually, however, there is time to insert a wide bore intercostal catheter under sterile conditions. A tube directed superiorly through the second anterior intercostal space will adequately drain a pneumothorax. Insertion through the mid-axillary line at the level of the nipple or above is recommended if a more lateral position is required. If a haemothorax is to be drained, the tube should then be directed posteriorly.

3. Cardiac Tamponade

Cardiac tamponade is suspected in any patient with thoracic trauma who exhibitis a low blood pressure and raised venous pressure. In this setting, the differential diagnoses are tension pneumothorax (the most likely) and severe heart failure (usually due to gross myocardial contusion, or prolonged and inadequately treated shock).

Emergency treatment of cardiac tamponade due to pericardial effusion is aspiration of the pericardial sac, preferably under continuous ECG control. The limb leads of the ECG are attached to the patient, and the chest lead connected to the metal hub of the 16FG aspirating needle by a sterile wire. The needle with plastic cannula is advanced towards the left shoulder at a 35 degree angle to the skin from a point 2 cm below the apex of an angle formed between the xiphoid process and the left 7th costal cartilage. Aspiration is made as the needle is slowly advanced. Remarkable improvement may follow the removal of as little as 30 mL of blood. Contact with the myocardium is denoted by ST elevation on the ECG or ectopic beats. When a positive tap is obtained, the plastic cannula is left in situ for continued drainage. Subsequent thoracotomy and full exploration will usually be necessary.

In penetrating injuriesz with suspected tamponade, many centres emply prompt thoracotomy with pericardial decompression, bypassing attempts at aspiration.

4. Extrathoracic Injuries

In assessing extrathoracic trauma, head, neck and abdominal injuries, and significant concealed blood loss must be excluded. This initial rapid assessment should be made before potent analgesics are administered.

5. Gastric Decompression

Gastric distension with attendant risks of regurgitation, vomiting and aspiration, especially in patients with associated head injury, is extremely common in cases of severe chest trauma. The stomach should be decompressed by a nasogastric tube. If urgent endotracheal intubation is necessary, a rapid sequence ("crash") intubation is recommended, including the use of cricoid pressure.

6. Pain Relief

Pain relief is usually obtained at this early stage with IV narcotics. This will frequently relieve respiratory distress in patients with fractures of the ribs and/or sternum.

7. Reconsideration of Mechanical Ventilatory Support

After the initial management, mechanical ventilatory support should then be reconsidered. Major indications are listed in Table 2. Ventilation should also be considered for patients with borderline respiratory distress associated with:

(a) gross obesity;
(b) significant pre-existing lung disease;
(c) severe pulmonary contusion or aspiration; and
(d) severe abdominal injuries requiring surgery.

Table 2. *Major Indications for Endotracheal Intubation and Ventilation*

Dangerous hypoxaemia and/or hypercarbia.
Significant head injury.
Gross flail segment and contusion and respiratory distress.

Specific Thoracic Injuries

Specific thoracic injuries should be systematically excluded.

1. Ruptured Aorta

A widened mediastinum should always arouse suspicion of a ruptured aorta. In one series, a mediastinal width greater than 8 cm was present in all 10 patients with ruptured thoracic aorta. Suspicion of aorta rupture in the presence of an widened mediastinum is further heightened if associated with one or more of the following:

(a) left haemothorax;
(b) depressed left main bronchus;
(c) blurred outline of the arch or descending aorta;
(d) fractured 1st rib or left apical haematoma; and
(e) displacement of the mid oesophagus to the right (easily detected when a nasogastric tube is in situ).

Aortography should then be undertaken. The classic site of traumatic rupture of the aorta is at the junction of the mobile arch and fixed descending aorta. This is immediately beyond the origin of the left subclavian artery. Rupture at this site is attributed to forward movement of the mobile arch against the tethered descending aorta in a deceleration situation (eg, motor vehicle accident). In about 10% of cases, the tear is in the ascending aorta or near the origin of the other great vessels. These tears are usually due to direct trauma. Treatment is prompt surgery and often necessitates cardiopulmonary or left atrio-femoral bypass. These techniques or local shunmts do not necessarily protect against consequent paraplegia.

2. Ruptured Diaphragm

The usual cause of a ruptured diaphragm is gross abdominal compression, and the incidence may have risen since seat belts were made compulsory. Rupture of the left diaphragm is more common. A haemo-pneumothorax is commonly misdiagnosed when the dilated stomach gives a horizontal air-fluid interface on the erect chest X-ray. A ruptured diaphragm, as an isolated injury, is often surprisingly well tolerated by the patient. Nevertheless, with a left diaphragmatic rupture, there is significant risk of gut strangulation, and surgical repair should follow basic resuscitation.

Rupture of the right diaphragm is more difficult to diagnose due to the presence of the liver. The radiographic appearance is similar to a paralysed right diaphragm. In the absence of right sided rib fractures, a small pneumothorax together with a "high right diaphragm" is suggestive evidence.

3. Disruption of Major Airways

Although signs and symptoms may vary according to the level of the rupture, the clinical picture is frequently that of respiratory distress, subcutaneous emphysema and haemoptysis. A pneumothorax, which may be under tension, is invariably present in those with ruptured bronchus. Mediastinal emphysema is commonly seen on the chest X-ray. With tracheal injuries, immediate management involves endotracheal intubation beyond the tear to ensure an adequate airway, prevent aspiration of blood, and to abate the air leak. A pneumothorax if present, must be drained. Suction to the intercostal catheter may be necessary to keep the lung expanded. After this is achieved, bronchoscopy and early primary repair is undertaken. Intubation with a double-lumen tube may be necessary if air leak from a disrupted bronchus is significant, to enable adequate ventilation of the patient as well as operative repair of the injury.

4. Massive Haemothorax

Immediate management involves insertion of a wide bore intercostal catheter and adequate resuscitation. Common causes include disruption of intercostal and/or internal mammary arteries. If the cause is massive bleeding from the aorta or major pulmonary arteries, the condition is usually fatal. Continued significant blood loss is an indication for early thoracotomy. Inadequate drainage of a haemothorax may require a thoracotomy and "decortication" at a later date. However, such decortication is rarely necessary.

5. Pulmonary Contusion

This is due to bruising of the lung and, as with any bruised tissue, becomes more oedematous over the following 48 hours. In the management, overhydration must be avoided. When associated with severe flail segments and respiratory distress, assisted ventilation is required, although this need not usually be prolonged.

6. Myocardial Contusion

Myocardial contusion is common in blunt chest trauma and may result in arrhythmias and cardiac failure. Both of these complications should be managed as in myocardial infarction. A standard 12 lead ECG may show a variety of abnormalities ranging from non-specific T wave changes to pathological Q waves. Abnormalities can also be demonstrated by myocardial nuclear scanning (not normally undertaken in the acutely injured patient). Serious damage to virtually every cardiac structure has, at some time, been reported. Cardiac injuries such as rupture of the ventricular free wall, interventricular septum, valvular apparatus, and disruption of major coronary arteries have usually been associated with penetrating injuries. However, many such complications have also been reported in non-penetrating chest trauma.

7. Systemic Air Embolism

This is more commonly seen in penetrating injuries and is immediately life-threatening. Though uncommon, it is probablyunderdiagnosed as it is unlikely to be proven at conventional autopsy. Air embolism is caused by a broncho-pulmonary vein fistula. It is suspected in the chest injured patient if:

(a) focal neurological signs exist in the absence of head injury;

(b) circulatory collapse immediately follows the institution of intermittent positive pressure ventilation (IPPV) in the absence of tension pneumothorax; and

(c) froth is obtained when arterial blood is sampled from a collapsed patient.

8. Oesophageal Perforation

Though usually due to penetrating injury, it can occur rarely with closed chest trauma. The patient may complain of retrosternal pain and difficulty in swallowing, and exhibit haematemesis and cervical emphysema. A chest X-ray may show mediastinal emphysema, widened mediastinum, pneumothorax, hydrothorax or hydropneumothorax. If suspected, a gastrografin swallow and/or endoscopy is performed. Treatment is immediate surgical repair. A gastrostomy and feeding jejunostomy are usually performed at the same time.

Management of a Flail Chest

The management of a flail chest remains unresolved. The concept of Pedulluft (the to and fro movement of air between the flail and non-affected sides of the thorax) has been shown to be incorrect. With a flail chest, overall ventilation may be reduced, but it is distributed to both lungs because the mediastinal shift equalizes the pleural pressures. Nevertheless, there is poor expansion in contused, low compliant lung areas, impairment of coughing and serious reduction in overall ventilation in gross cases. Moreover, gross mediastinal shifts may impair systemic circulation. While several basic approaches to managing a flail chest have emerged (Table 3), the ultimate choice of approach is determined by the severity of the chest injury, associated injuries and the method of pain relief.

Table 3. *Management of a Flail Segment*

Conservative
Assisted ventilation
    (a) Continuous positive airway pressure (CPAP)
    (b) Intermittent mandatory ventilation (IMV)
Controlled ventilation ± PEEP
    (a) Conventional IPPV
    (b) Independent lung ventilation
Surgical stabilization ± above measures.

1. Conservative Therapy

Conservative treatment involves oxygen by mask, adequate pain relief, and physiotherapy. It is the treatment required in a mild injury (ie, an isolated thoracic injury with fractured ribs, but without significant flail or disturbed blood gases). Similarly, it may be employed in the patients with a moderate injury (ie, a significant flail but with adequate blood gases and the ability to cough). "Prophylactic" ventilation in both of these groups has been deemed inappropriate, with possible disadvantages of barotrauma, infection, tracheostomy complications, and prolongation of hospitalization.

2. Mechanical Ventilatory Support

However, in a severe injury, ie, a gross flail segment with gross pulmonary contusion ± aspiration, and in a patient with associated head injury, endotracheal intubation and assisted ventilation is necessary. The early use of intermittent mandatory ventilation (IMV) has been claimed to result in a shorter duration of assisted ventilation. As with conservative therapy, increased residual deformity may well be the price for unrestrained used of this technique. Continuous positive airway pressure (CPAP) alone has not been fully evaluated. Independent lung ventilation, a technique of selectively ventilating each lung separately, using a double lumen tube, may be used to treat a unilateral pulmonary contusion and/or flail. (See Chapter 22, Mechanical Ventilatory Support.)

3. Surgery

There is revived interest in surgical stabilization of the chest wall. Advantage claimed are either a shorter period of assisted ventilation being required or a shorter hospital stay. Internal surgical stabilization undoubtedly reduces deformity, and a stable chest wall will help a patient to cope with an underlying lung problem. However, except for a broken sternum, rupture of the diaphragm, and in the course of an otherwise necessary thoracotomy, the case for surgical repair has yet to be established.

Complications

Following resuscitation and initial management, complications may follow which usually require treatment.

1. Sputum Retention

Adequate pain relief is the major determinant of whether sputum retention will occur in the spontaneously breathing chest injured patient as efficient coughing must be maintained. Similarly, assisted ventilation may be avoided in many moderately injured cases if the method of pain relief is carefully selected and significant respiratory depression is avoided. Options (see also Chapter 48, Pain Relief in Intensive Care) include:

(a) intravenous narcotics given by frequent small dose intermittently or by continuous infusion;

(b) entonox inhalation during physiotherapy;

(c) intercostal nerve block either:

(i) multiple individual nerve blocks (repeated as necessary) or

(ii) single large volume (eg, 20 mL 0.5% bupivacaine) into one intercostap space (uni- or bilaterally), spreading to block nerves above and below the site injected.

(iii) intrapleural bupivacaine (0.25-0.5%) via uni- or bilaterally placed intercostal catheters. Epidural catheters have been used for this purpose. Either intermittent or continuous infusion of bupivacaine may be employed.

(d) conventional epidural analgesia using agents such as bupivacaine; and

(e) epidural or spinal opioids.

For ventilated patients adequate humidification and frequent endotracheal and endobronchial suctioning must be employed. Frequent change in position is important. In ventilated patients, analgesic techniques producing respiratory depression are not a problem except during weaning or if IMV is used.

2. Bronchospasm

Bronchospasm suggests aspiration and is treated conventionally.

3. Tension Pneumothorax

The possibility of a late tension pneumothorax is ever present, especially if the patient is being ventilated with IPPV and positive end expiratory pressure (PEEP).

4. Acute Respiratory Failure

This is commonly seen in these patients. Causes include aspiration, pulmonary contusion, previous shock with delayed resuscitation, and fat embolism. If a classical adult respiratory distress syndrome (ARDS) occurs late after injury, then the most common cause is sepsis. However, humoral factors may play a role in the massively injured. Supportive treatment is instituted and, where possible, the underlying cause is treated. (See Chapter 25, Adult Respiratory Distress Syndrome.)

5. Infection

Sepsis remains a major cause of death in patients with severe chest and other injuries. The source of such infection is invariably endogenous, mainly coming from bacteria colonising the patient oropharynx and alimentary tract.

This has led to the use of parenteral antibiotic prophylaxis (eg, cefotaxime) active against community bacteria (eg, *S pneumoniae, H influenzae, B catarrhalis, S aureus,* or *E coli*) from the time of admission for 4 days. At the same time, oral and intragastric non-absorbable combinations of polymycin E, tobramycin and amphotericin B are administered, to prevent colonization and infection by *enterobacteria, pseudomonas* and fungi such as *candida.*

6. Thromboembolism

Preventative measures include frequent movement, full length leg stockings, avoidance of pressure on limbs, and low dose heparin (5000 units bd or tds) subcutaneously.

7. Inadequate Nutrition

Gastric atony and stasis are common. In many cases adequate enteral feeding is possible by appropriate posturing (eg, positioning on right side during feeding). In others, especially those with associated abdominal trauma, parenteral nutrition is necessary.

8. Coagulopathies

Prompt resuscitation, control of haemorrhage, and possibly, use of blood filters for massive blood transfusion help in this regard.

Prognosis

Reported mortality rates in chest injured patients vary greatly, often reflecting the severity of the chest injury and the extent of extrathoracic injuries. In one Australian series, of 1119 patients with chest and other injuries, the overall mortality rate was 5.3%. The 3 commonest causes of death were respiratory tract sepsis (35.6%), severe head injury (33.9%) and exsanguination (18.6%). Mortality rate was 37.5% for patients over 60 years of age who had respiratory failure, and for all age groups requiring mechanical ventilation, was 22.8%. Trunkey reported a 16% mortality in patients with isolated pulmonary contusion. When combined with a significant flail chest, the mortality rose to 42%.