Update in
Anaesthesia

Thoracic trauma

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Summary

Many of the injuries that require immediate attention during resuscitation following trauma, involve the chest. This article describes a systematic approach to management of these injuries, using chest Xray and CT examples to demonstrate learning points.

CASE SCENARIOS

Scenario A

The front, unrestrained passenger of a vehicle from a road traffic accident is brought into the Emergency Department. On arrival he is in PEA (pulseless electrical activity) cardiac arrest. He has obvious bilateral chest wall injuries.

- *What are the important causes of cardiac arrest in trauma?*
- *What is the immediate management if you suspected a tension pneumothorax or a cardiac tamponade?*

Scenario B

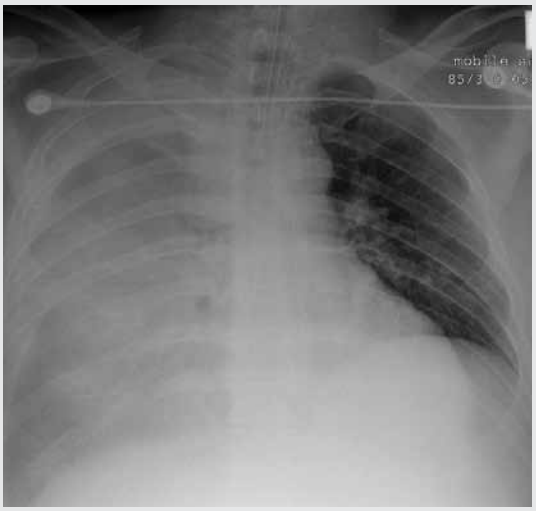
A young man presents to the Emergency Department with left sided stab wounds to his chest. His initial observations are: respiratory rate 40 per minute, saturations 88% on 15L.min^{-1} oxygen, heart rate 110 bpm, BP 102/60mmHg.

- *What is your initial approach to this injured patient?*
- *What important diagnoses do you need to consider?*

During the primary survey you find that the young man is effectively maintaining his own airway, but his chest sounds quiet on the right side and the percussion note is dull. There is reduced chest wall movement on the affected side. The trachea appears central and you think you can hear normal heart sounds. He is developing obvious respiratory distress.

- *Are you ready to progress onto the rest of the primary survey?*
- *What is the most likely diagnosis?*
- *What is your management?*

You decide to sedate, intubate and ventilate him. His chest Xray (below) shows a right haemothorax.



- *Which patients with a right haemothorax are likely to require a thoracotomy?*

Answers are found in the article.

INCIDENCE

Thoracic trauma is responsible for 25% of all trauma deaths in the UK. Many deaths occur immediately, but a significant group can be salvaged. 85-90% of patients with thoracic trauma can be managed conservatively. Surgery is needed in 10-15% of cases.

CHEST INJURIES – GENERAL APPROACH

Full ATLS protocol should be followed, with the <C>ABCDE approach to primary and secondary survey (see article on page 95). During the B phase of the primary survey, life threatening chest injuries should be identified and treated before moving on with the survey.

The life threatening chest injuries are:

- Tension pneumothorax
- Open pneumothorax
- Massive haemothorax
- Flail chest
- Cardiac tamponade.

Other injuries that should be identified during the secondary survey are :

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- Aortic injury
- Lung contusion
- Myocardial contusion
- Diaphragmatic rupture
- Tracheobronchial injury
- Oesophageal injury.

This article will focus on the diagnosis and treatment of the life threatening injuries that should be identified in the primary survey.

Tension pneumothorax (Figure 2)

A tension pneumothorax develops when air enters the pleural space. There is a valve-like effect of the ruptured pleura and air is forced in during inspiration and coughing, but unable to escape during expiration. The accumulated air becomes pressurised, collapsing the affected lung and then begins to push the mediastinum away from the affected side of the chest. As a result, the mediastinal structures are compressed and the major vessels kinked, decreasing venous return and therefore cardiac output.

Figure 2. *Chest Xray showing left tension pneumothorax, with mediastinal shift to the right side. Generally this pathology should be recognised clinically and treatment should not be delayed for Xray imaging.*

Causes of pneumothorax in trauma

- Penetrating chest trauma e.g. stab wound
- Blunt chest trauma with or without rib fractures
- Positive pressure ventilation in a patient with pre-existing simple pneumothorax (i.e. not previously under tension)
- Following insertion of a subclavian or internal jugular central venous catheter.

Clinical features

- Respiratory distress
- Tachycardia and hypotension
- Unilateral reduced or absent air entry
- Hyper-resonance to percussion on affected side
- Decreasing lung compliance
- Tracheal deviation away from affected side
- Distended neck veins.

The last two features can be difficult to identify.

Treatment

Once the diagnosis has been made clinically, treatment must not be delayed waiting for a chest radiograph. Give high flow oxygen via a face mask.

Needle thoracocentesis is indicated and then an intercostal catheter should be inserted urgently, as definitive treatment. Needle thoracocentesis is a procedure that is associated with complications and there have been case reports of haemorrhage.

Needle thoracocentesis

1. Indicated when tension pneumothorax is clinically diagnosed (do not wait for a chest Xray).
2. Clean the skin.
3. Use at least a 16G cannula (to provide adequate length). Remove the white Luer cap and the 'flash-back' chamber on which the cap sits.
4. Advance the open cannula perpendicular to the skin in the second intercostal space, mid-clavicular line of the affected side.
5. If the pneumothorax is under pressure ('tension'), a hiss of escaping air may be heard on entry into the pleural cavity - let this air escape. Remove the needle, leaving the cannula in place.
6. Leave the cannula open to air. Avoid kinking of the cannula and do not remove the cannula until an intercostal catheter has been inserted.
7. Whether or not a pneumothorax was present, you are now obliged to insert an intercostal catheter to formally treat the pneumothorax. The cannula can safely be removed after this.

Open pneumothorax

An open pneumothorax occurs when there is an associated chest wall wound. If the defect is more than 0.75 times the diameter of the trachea then, during inspiration, air is entrained directly into the chest cavity through the wound. This occurs because the hole in the chest wall provides less resistance to flow.

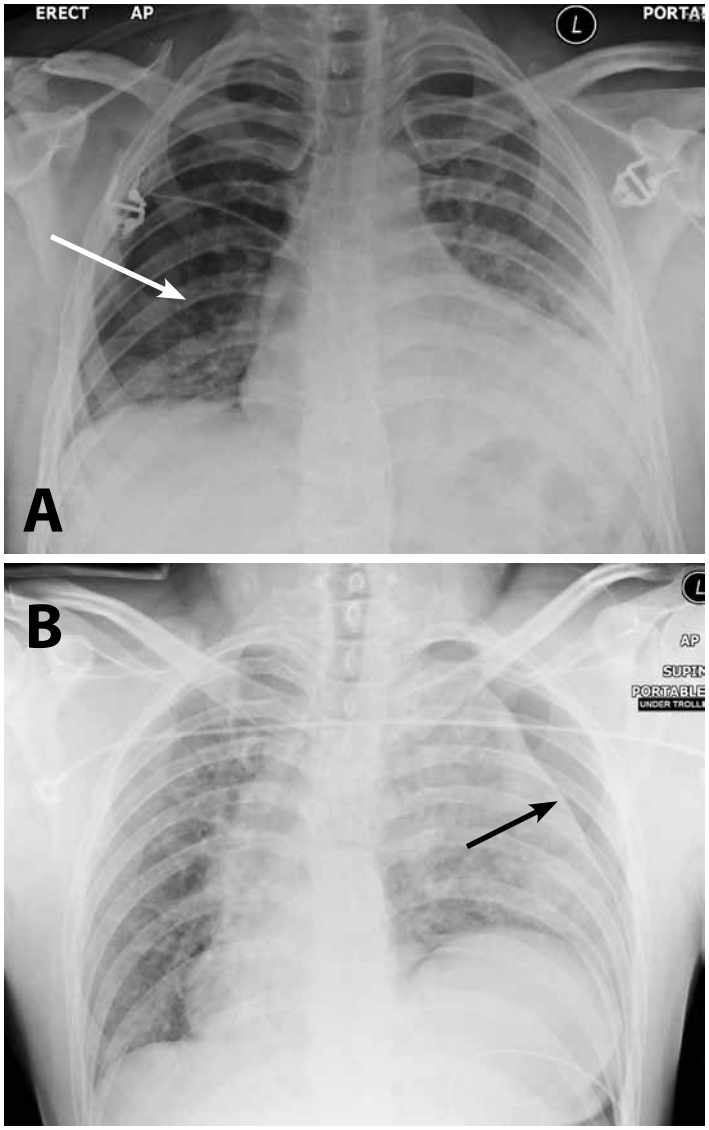

Figure 3. *A - Chest Xray of a right simple pneumothorax (lung edge is arrowed); B - left pneumothorax (arrow) with likely left diaphragmatic rupture - the mediastinum is displaced to the right and so there may be an element of tension. There is also contusion of the left lung.*

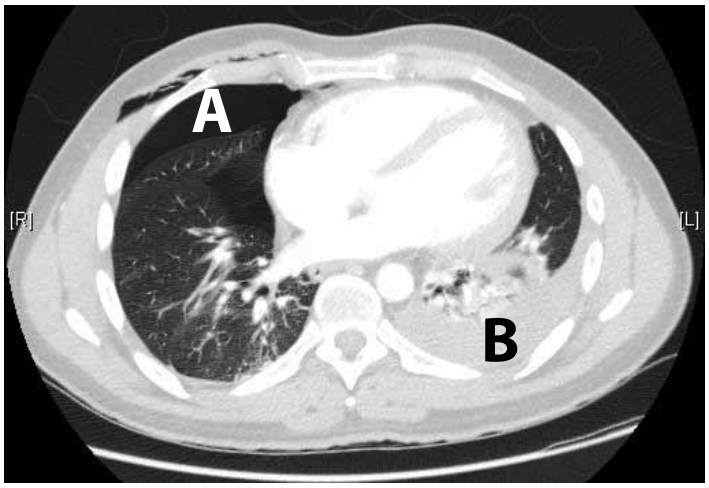

Figure 4. *Chest CT scan of showing a right pneumothorax (A) and left haemothorax (B).*

Clinical features

The features are those of simple pneumothorax (reduced air entry, resonant percussion note and decreased expansion), but in addition you may hear a 'sucking chest wound', as air enters the thoracic cavity during inspiration.

Treatment

1. 100% oxygen via a face mask.
2. Intubation and positive pressure ventilation is indicated when oxygenation or ventilation is inadequate.
3. Insertion of an intercostal catheter.
4. Many patients will require thoracotomy.
5. If definitive closure is delayed, a dressing can be applied to the wound and taped on 3 sides, leaving the 4th side free. An Asherman chest seal can also be used. Both act as a flap valve, allowing air to escape from the pneumothorax in expiration but not to enter during inspiration.

Massive haemothorax (Figure 5)

This is defined as blood loss of greater than 1500ml in one hemithorax. It can be associated with either blunt or penetrating chest injuries. Signs of hypovolaemic shock are often present. Management of the haemothorax and the blood loss need to occur simultaneously.

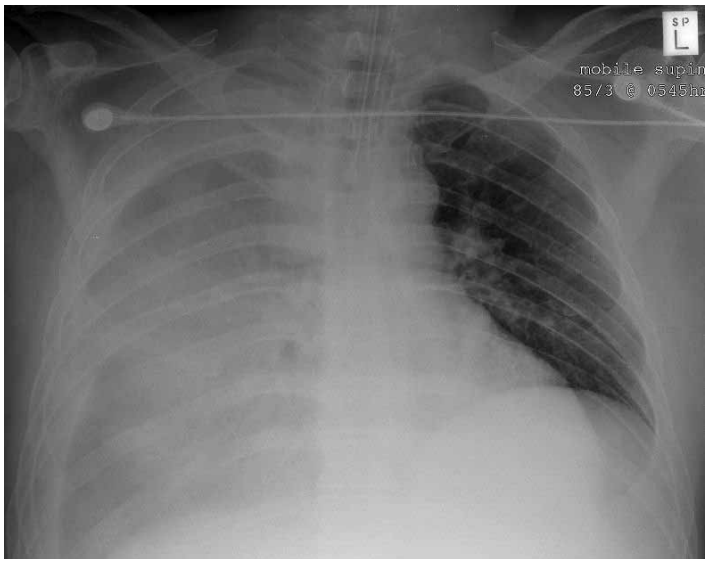

Figure 5. *Right haemothorax.*

Causes

- Rib fractures
- Intercostal vessel injuries
- Lung parenchymal venous injuries
- Arterial injury - less common.

Clinical features

- Evidence of overlying blunt or penetrating chest wall injury
- Reduced chest wall movement

- Quiet or absent breath sounds
- Dullness to percussion
- Tracheal deviation - rarely.

Treatment

1. High flow oxygen.
2. Chest drain insertion (placed anteriorly is there is an associated pneumothorax).
3. Good IV access to allow simultaneous volume replacement
4. Thoracotomy is indicated in some patients with a massive haemothorax. Indications include:
    - immediate drainage of >1500ml of blood from one hemithorax or
    - ongoing bleeding of >250ml.h^{-1}
    - continuing requirement for blood transfusion.

Flail chest

A flail chest occurs when two or more ribs are fractured in two or more places. This results in a section of the chest wall which is able to move independently. The flail segment moves inwards during inspiration and outwards in expiration. The segment can be lateral or anterior depending on the location of the rib fractures. Flail chest can be associated with a significant lung injury underlying the fractures.

Clinical features

1. Severe chest wall pain
2. Paradoxical chest wall movement (if the patient is able to splint their chest wall due to severe pain this may not be obvious)
3. Hypoxia (from inadequate ventilation or underlying lung contusion)
4. Crepitus or palpable rib fractures
5. Rib fractures on chest Xray.

Management

1. High flow oxygen
2. Analgesia to allow adequate ventilation. Consider insertion of an epidural or paravertebral catheter, if local expertise and equipment allow.
3. Endotracheal intubation and IPPV may be needed in some cases.

Cardiac tamponade

In trauma, this is an accumulation of blood in the pericardium. It normally results from a left sided penetrating injury but can also occur in blunt trauma. As blood accumulates the ventricles cannot completely fill or contract. This leads to haemodynamic instability and PEA cardiac arrest. Presentation may be similar to a left sided tension pneumothorax.

Clinical features

1. Faint heart sounds
2. Distended neck veins
3. Hypotension
4. PEA cardiac arrest.

Management

1. If cardiac tamponade is suspected, it can be diagnosed using FAST (focused assessment sonogram in trauma) or pericardiocentesis.

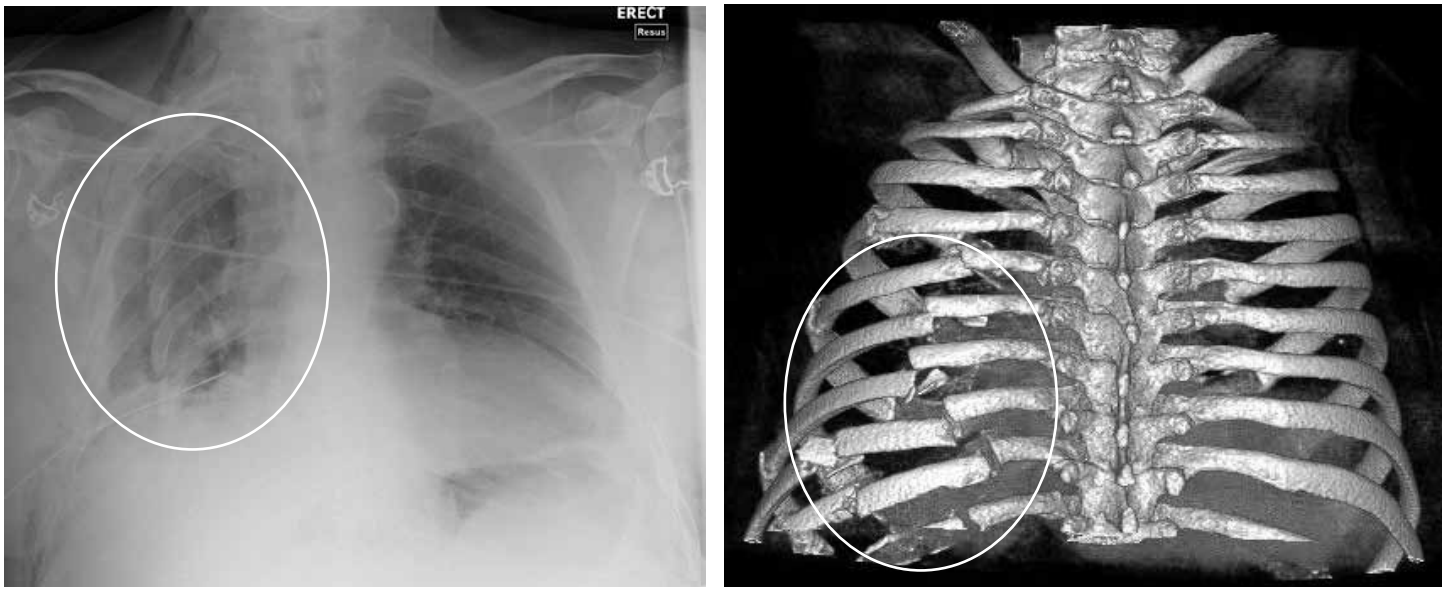

Figure 6. *Flail chest resulting from multiple displaced rib fractures in two different patients, shown on A - plain chest Xray; B - 3D reconstruction of CT scan.*

2. In addition, pericardiocentesis can be used to treat cardiac tamponade by aspirating blood from the pericardial sac.
3. Definitive treatment is cardiothoracic surgery.

CONCLUSIONS

This article has described five immediately life threatening chest injuries, that can be identified in the primary survey. Other chest injuries may be diagnosed during the secondary survey, as a result of further examination and imaging. These include ruptured diaphragm, oesophageal rupture, ruptured bronchus and pulmonary contusion.

FURTHER READING

1. Advanced Trauma Life Support for Doctors, American College of Surgeons Committee on Trauma, Student Course Manual 7th Edition.
2. Advanced Paediatric Life Support – The Practical Approach 4th Edition, Advanced Life support Group.

Guideline for management of massive blood loss due to trauma

1

1. Activate hospital **trauma team** PRIOR to patient arrival
2. Team should have a **designated trauma team leader** and at least a general surgeon and anesthesiologist
3. Receive the patient in the **emergency room** (warm environment)
4. Give **oxygen**
5. **Primary survey** <C> A (cervical spine protection) BC
6. Establish **IV access**
7. Send blood for a **group and save** (type and screen) AND crossmatch 4 units of red cells Ensure specimens accurately labelled and hand deliver it to the blood bank
8. **Start fluid resuscitation** prior to further transport (Failure to respond to crystalloid and blood dictates the need for immediate definitive intervention)
9. **Assess injuries** and **prioritise** treatment (aortic injury, head injury)
10. **Ensure availability of specialists** based on injuries (neurosurgeon, thoracic surgeon obstetrician)
11. **Alert clinical lab, blood bank, haematologist**

Bleeding uncontrolled

2

Early surgical intervention to stop bleeding

Transfer patient to theatre (operating room or interventional radiology suite)

Bleeding stopped

7

Stabilise patient

Transfer to ICU/HDU

Monitor for continued bleeding and shock

Secondary survey and attend to other injuries

Ongoing bleeding

(but surgical bleeding addressed)

Maintain tissue perfusion and oxygenation

Restore circulating volume

- Warm IV fluids (crystalloid)
- Avoid excessive haemodilution & hypertension
- If available consider hypertonic saline, plasma expanders or albumin

Concealed blood loss is usually underestimated

Monitor for complications of massive transfusion

- coagulopathy
- lung injury

3

Maintain Hb > 8g.dl^{-1}

Assess urgency of transfusion

Urgent (blood group unknown)

- **Women of reproductive age** transfuse 2 units group O Rh-ve
- **Older women and men** transfuse O positive units

As time permits (when blood group known)

- Transfuse ABO specific uncrossmatched units
- Fully crossmatched blood

Use blood warmer or rapid infusion device if flow rate is > 50ml.kg.hr^{-1} in adults

Employ cell salvage to minimise allogenic blood use

Further serological crossmatch not required after 1 blood volume replacement

4

Coagulopathy

Keep patient warm (>35°C)

Send specimens to lab

- Full blood count, prothrombin time, APTT, fibrinogen, biochemical profile, arterial blood gases

Anticipate need to give blood products

- FFP: 12-15ml.kg^{-1} after 1-1.5x blood volume replacement
- Platelets: after 2x blood volume replacement
- Cryoprecipitate: 5 packs
- Antifibrinolytics

Maintain

- PT & APTT < 1.5 x normal
- Platelets > 75 x 10^{9}.L^{-1}
- Fibrinogen > 1.0 g.L^{-1}

Antifibrinolytics

Results of coagulation tests may be affected by colloid infusion

5

Avoid DIC

Mortality id high

Treat underlying cause

- Shock
- Hypothermia
- Acidosis

Keep ionized Ca^{+} >1.13mmol.L^{-1}

Repeat pre-exisiting coagulopathy in patients with end stage:

- Cardiac failure
- Hepatic failure
- Renal failure

Consider drug effect in those on anticoagulants

6

Figure 1. *Guideline for management of massive blood loss.*