Chapter 7

Intercostal Drain Insertion

Dr Peter Rose
Dr Cyprian Mendonca

Intercostal drains allow drainage of the pleural space in an effort to restore normal physiological function of the underlying lung. In this chapter we will discuss the applied anatomy, indications, practical procedure, contra-indications and complications. It is important to understand these to safely carry out this procedure. A chest drain is a tube inserted through the chest wall between the ribs and into the pleural cavity to allow drainage of air (pneumothorax), blood (haemothorax), fluid (pleural effusion) or pus (empyema) out of the chest. It carries a 3% early and 8% late complication rate.

Applied Anatomy

Understanding the anatomy enables avoidance of damage to neurovascular structures in the intercostal space and underlying intrathoracic, or indeed intra-abdominal structures.

The landmarks for the "safe triangle" of insertion are:

- Anterior border of latissimus dorsi posteriorly (A)
- Lateral border of pectoralis major anteriorly (B)
- A line along the 5th intercostal space/ through nipple inferiorly (C).

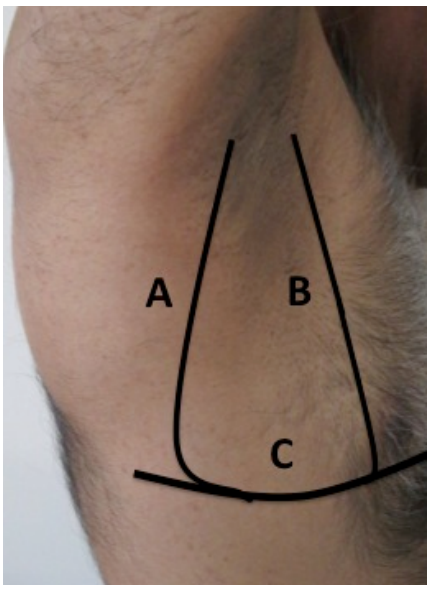

Figure 1: Anatomical land marks demonstrating the safe triangle.

Commonly intercostal drains are sited in the fifth intercostal space, anterior to the

mid-axillary line, in the safe triangle.

The intercostal space

The importance of understanding the intercostal space is primarily to comprehend the location of the neurovascular bundle and hence avoiding damaging it. Beneath the skin lies the superficial fascia. There is no deep fascia in the trunk region. There are three muscular layers; these are the external, internal and innermost intercostals. The external and internal layers are complete, whereas the innermost is poorly developed and blends with the internal layer. The neurovascular bundle comprises the posterior intercostal vein, artery and nerve from cranial to caudal (top to bottom). The vessels anastomose anteriorly with the anterior intercostal artery and vein, which are branches of the internal thoracic artery and vein. The neurovascular bundle is located between the internal and innermost intercostals in the subcostal groove.

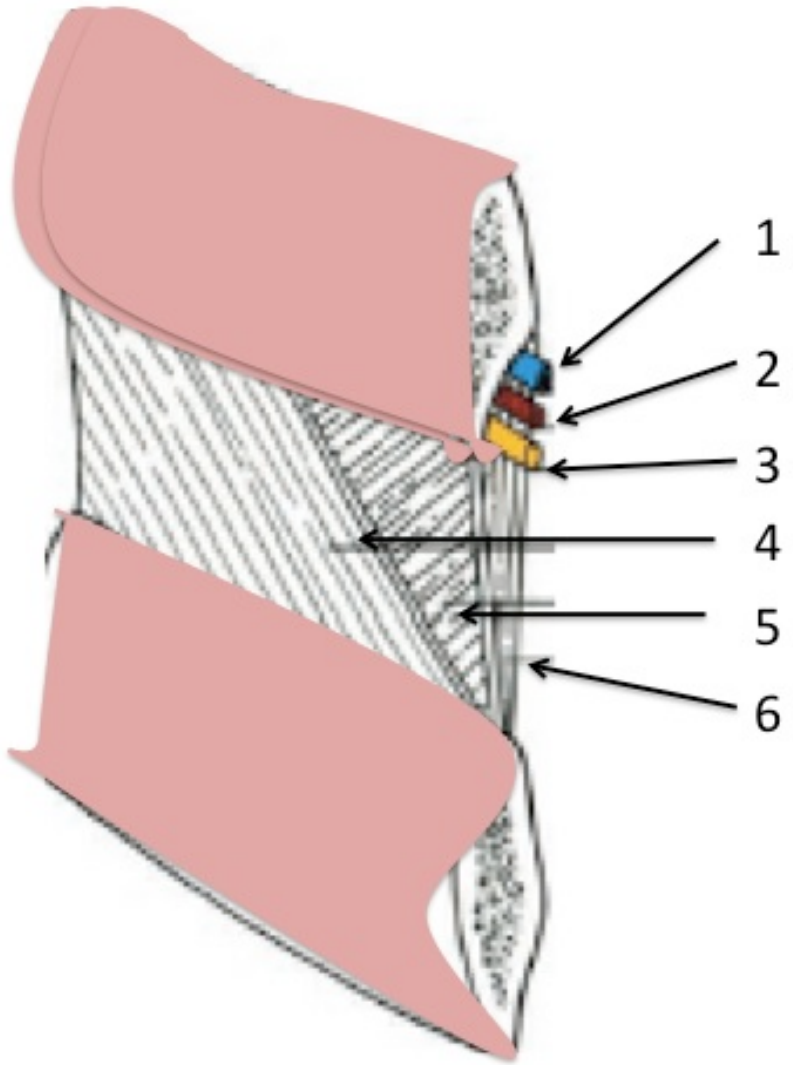

Figure 2: Anatomy of intercostal space
1. vein, 2.artery, 3.nerve. 4. External intercostal muscle, 5. Internal intercostal muscle. 6. Innermost intercostal muscle.

The deep structures

The parietal pleura lies in close proximity to the internal chest wall. There is normally a thin film of fluid between the parietal and visceral pleura; this allows free movement of the lung.

The apex of the diaphragm rises to the fifth intercostal level in the mid-clavicular line, higher on the right than the left. Inspiration causes the diaphragm to descend and flatten due to muscular contraction. In expiration the diaphragm passively rises, although in forced expiration the anterior abdominal muscles push it vertically upwards. Beneath the diaphragm on the right is the liver; the stomach and spleen are on the left. All of these structures can be damaged during chest drain insertion.

Indications for insertion of chest drain

- Pneumothorax
    - Pneumothorax in any ventilated patient (CPAP, IPPV)
    - Tension pneumothorax after needle decompression
    - Persistent or recurrent pneumothorax after simple aspiration
    - Large secondary spontaneous pneumothorax in patients over 50 years
- Malignant pleural effusion
- Empyema and complicated parapneumonic pleural effusion
- Traumatic haemopneumothorax
- Postoperative
    - Thoracotomy
    - Oesophagectomy
    - Cardiac surgery

Contraindications (or precautions)

Absolute contra-indications:

- Need for emergency thoracotomy

- Lung densely adherent to chest wall throughout hemithorax
- Patient refusal

Relative contra-indications:

- Coagulopathy
- Bullous lung disease
- Pulmonary, pleural or thoracic adhesions
- Loculated pleural effusion or empyema
- Skin infection at insertion site

Complications

Minor complication rate approaches 30%.

- Tube misplacement
    - Kinked
    - Subcutaneous
    - Horizontal – adequate for haemothorax/effusion, inadequate for pneumothorax
    - Too deep – too apical
    - Intra-abdominal – needs removal

- Tube dislodgement

- Retained pneumothorax/haemothorax/pleural effusion

- Bleeding
    - Superficial
    - Haemothorax – intercostal artery/lung parenchyma/myocardial injury
    - Haemoperitoneum – liver or splenic injury

- Organ penetration – stomach, colon, diaphragm, heart, lung

- Empyema – secondary to foreign body presence

- Re-expansion pulmonary oedema – rare complication of pneumothorax treatment. More common in tension pneumothorax and diabetics.

Clinical procedure:

Confirm patient identity

Consent: A valid consent should obtained prior to the procedure wherever possible.

However in certain scenarios patient may be semiconscious, sedated or anaesthetised when the situation of inserting chest drain arises.

The General Medical Council (GMC) guidelines for consent state that it is the responsibility of the doctor carrying out a procedure, or an appropriately trained individual with sufficient knowledge of a procedure, to explain its nature and the risks associated with it. In some circumstances the patient may not be in a position to give their consent. In this scenario the physician should act in the patients best interest and explain what has been done after the patient has retained capacity.

Ensure the availability of experienced help and skilled assistant

Position

1. In bed, slighted rotated with arm, on side to be drained, above head
2. Sitting upright, leaning over an adjacent table with a pillow
3. Lateral decubitus position

Confirm side and site using

- Chest radiograph
- Ultrasound
- Fluoroscopy
- CT guided

Image-guided techniques have a 71-86% success rate. Various sites can be selected for insertion but the safe triangle is the usual. Alternative sites include: posterior, anterior second intercostal space and suprascapular posterior drains but these should be performed by experienced operators.

The technique depends to some extent on the size (bore) of chest tube that is required. *Smaller bore tubes are inserted by a seldinger technique, whereas large tubes are inserted by blunt dissection*.

- The procedure is performed using an aseptic technique. Iodine or chlorhexidine is used to prepare the skin
- Drapes are applied to create a sterile working area.
- Local anaesthetic is infiltrated to the skin and structures down to the pleura.
- Needle aspiration to confirm air/fluid can be aspirated
- Seldinger technique involves passing a guidewire through a needle into the pleural cavity. A dilator is then passed over the guidewire to create a track pass the drain tubing over.
- Blunt dissection involves a skin incision followed by dissection into the

pleural cavity with forceps. The incision should be above and parallel to the rib and approximately the same size as the tube to be inserted. Once the parietal pleura has been breached a finger sweep is performed to ensure no lung adhesions. The forceps are then used to guide the drain into the chest cavity.

- The drain is fixed in place using silk sutures and a dressing is applied. Traditionally two sutures are applied, one stay suture and one mattress suture to close the wound after drain removal.

Equipment

The equipment required:

- Sterile gloves and gown
- Skin antiseptic solution, e.g. iodine or chlorhexidine in alcohol
- Sterile drapes
- Gauze swabs
- A selection of syringes and needles (21–25 gauge)
- Local anaesthetic, e.g. lignocaine (lidocaine) 1%
- Scalpel and blade
- Suture (e.g. "1" silk)
- Instrument for blunt dissection (e.g. curved clamp)
- Guidewire with dilators (if small tube being used)
- Chest tube
- Connecting tubing
- Closed drainage system (including sterile water if underwater seal being used)
- Dressing

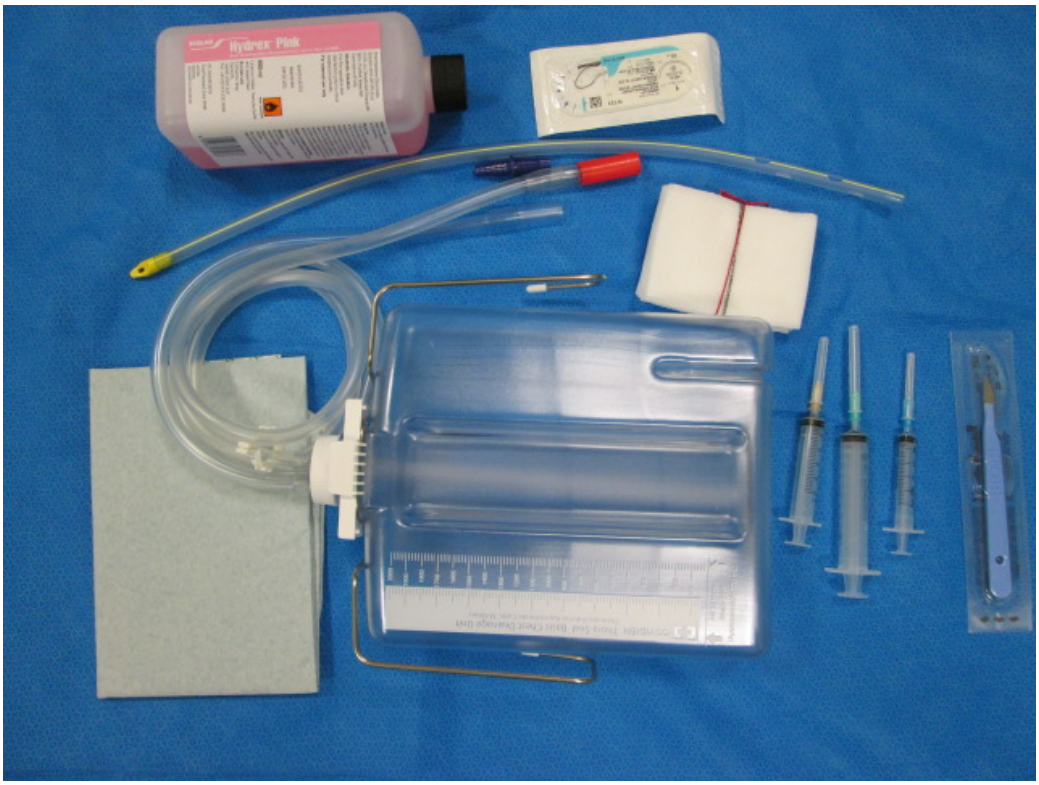

Figure 3. Equipment set up for insertion of large bore chest drain

Figure 4: Seldinger chest drain

Post procedure care

After insertion the drain must be attached to an underwater seal or flutter valve. This must be kept below the level of the patient to prevent re-entrainment. Drains inserted

for pneumothorax should not be clamped, particularly if the drain is still bubbling, as there is a risk of a tension pneumothorax developing. Large pleural effusions may need to be drained in a more controlled fashion to prevent re-expansion pulmonary oedema. Clamping is not required prior to removal of drains. A chest radiograph after insertion is helpful to clarify position of the tube within the thorax. Patients with intercostal drains in situ should be managed in an area capable and confident of managing the drain. Documentation should be kept to record details of drainage volume, bubbling and respiratory swing (movement of the fluid within the tubing during respiration). Removal of the drain depends on the indication for insertion. The drain should be removed with the patient performing a full expiration. This maximizes the positive pressure within the chest cavity and prevents a pneumothorax occurring.

Further reading

Laws D, Neville E, Duffy J (British Society Pleural Disease Group). BTS guidelines for the insertion of chest drain. Thorax 2003;58(Suppl II):ii53–ii59