

Tube thoracostomy: how to insert a chest drain

Introduction

Chest drain insertion (tube thoracostomy) is an essential skill for hospital doctors dealing with certain pleural diseases. While aspiration may be appropriate in spontaneous pneumothorax and uncomplicated pleural effusions, it is often inadequate. In such cases, and for other indications (*Table 1*), it may be necessary to insert a chest drain. Traditionally, this is inserted in the pleural space percutaneously through blunt dissection and connected to a drainage device with an underwater seal. The procedure may be image-directed. Newer chest drains based on a guide-wire technique have been developed with the dual aims of safety and ease of appropriate placement.

The indications, technique and complications of tube thoracostomy will be reviewed here. The terms chest drain, chest tube and tube thoracostomy may be considered synonymous for this article.

Table 1. Indications for tube thoracostomy

Pneumothorax	Spontaneous, iatrogenic, tension
Penetrating chest trauma	
Haemothorax	
Parapneumonic effusion	If complex
Empyema	
Malignant pleural effusion	
Pleuradiesis	Recurrent malignant effusion
Chylothorax	
Bronchopleural fistula	

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Pre-procedure assessment

There are no absolute contraindications to chest drain placement. Before chest drain insertion, it is good practice to identify and correct any coagulopathy or bleeding diathesis. A recent chest X-ray should be available to the operator. The procedure should be explained to the patient and his/her consent sought. In addition to local analgesia, conscious sedation with an opioid or a benzodiazepine should be considered where the patient is haemodynamically stable. Vasovagal reactions are well described, especially in young patients. Patients given conscious sedation must be appropriately monitored from a cardiorespiratory perspective.

Technique

When the decision has been made to insert a chest tube, the operator must select the type of tube, the size of the tube, the insertion site, and the insertion technique to be used. The equipment required is listed in *Table 2*.

Procedure

The first step involves positioning the patient and choosing the insertion site. In

Table 2. Equipment for tube thoracostomy

Sterile gown and gloves
Antiseptic solution, i.e. povidine-iodine or chlorhexidine
Sterile drapes
Local anaesthetic, e.g. 1% or 2% lidocaine
Syringes and needles
Scalpel and blade
Suture, e.g. 1/0 or 2/0 silk
Forceps (round tipped) or Kelly clamp for blunt dissection
Chest drain
Closed drainage system with connecting tubing (sterile water if underwater seal used)
Guide-wire and dilators for Seldinger drains
Formal 'cut down' theatre instrument set

awake and cooperative patients, a suggested position is semi-decubitus on the bed at 45°, with the arm behind the head so as to expose the axillary area.

The drain should ideally be inserted in the 'safe triangle', which is delineated by the lateral border of the pectoralis major, the anterior border of the latissimus dorsi and a line horizontal with the nipple. Most clinicians insert the chest tube via an incision at this fourth or fifth intercostal space in the anterior axillary or mid-axillary line (Miller and Sahn, 1987). An alternative approach may be required in the presence of a loculated effusion. This will be governed by clinico-radiological assessment.

For evacuation of a pneumothorax, the second intercostal space in the mid-clavicular line has been suggested as an alternative site; however, this requires dissection through the pectoralis muscle and leaves a visible scar. In the authors' opinion, this should be considered if a small bore chest tube is indicated or if the safe triangle is not accessible.

The area of insertion is prepped with 10% povidine-iodine solution (or chlorhexidine) and draped with sterile towels. Using 1% lidocaine, a 2–3 cm area of skin and subcutaneous tissue is anaesthetized. This will allow for the development of a subcutaneous tunnel through which the chest tube will be placed to prevent air entry after the chest tube is removed. Local anaesthetic is then infiltrated above a rib to avoid the intercostal neurovascular bundle. When air or pleural fluid is aspirated (thoracocentesis), the needle is withdrawn until it ceases. Further local anaesthetic is infiltrated just above the parietal pleural, which is exquisitely painful when breached. Total infiltration of up to 30 ml 1% lidocaine is allowable.

Aspiration of air or pleural fluid confirms the appropriate site. If aspiration is not successful, then imaging should be sought. Ultrasound is the preferred form of imaging. This can be done by the bedside, allowing safe placement of the drain at the same time. If complex pleural disease is suspected, computed tomography (CT) scanning with contrast is recommended.

Chest drain size

The size of chest tube that is required varies according to the indication for its placement.

For pneumothoraces, it is increasingly accepted, without formal randomized control trial evidence, that smaller drains (8–14 F) are as effective as large bore ones. Some would advocate larger sizes (20–24 F) in ventilated patients to facilitate drainage but this is unproven. There was no evidence for a size preference in outcomes from drainage of non-malignant pleural infections in a recent multicentred randomized controlled trial (Maskell et al, 2005).

Theoretical concerns of inadequate chest drain hole size or number suggest larger bores (24–32 F) may be appropriate for haemothorax or penetrating chest wall injury.

If pleurodesis is being contemplated, it is advisable to use a drain of at least 12 F, with adequate holes, to allow drainage of excess talc slurry (if that is the agent of choice).

There is often concern regarding tube blockage. The use of saline or heparin flushes is suggested but unstudied. There is, on the other hand, the theoretical risk of introducing infection. Regular aspiration at the chest tube–drainage portal interface may reduce blockage.

Drain insertion

Blunt dissection technique

After local anaesthesia, a 2 cm superficial skin incision is made parallel to the intercostal space, and should be performed immediately above the rib in order to reduce the risk of neurovascular injury should the incision extend more deeply than intended. Using additional lidocaine, the periosteum of the ribs above and below the site of insertion, as well as the tissues of the intercostal space at the site of insertion and the parietal pleura, should be well infiltrated with anaesthetic.

A forceps or Kelly clamp is used for blunt dissection to the intercostal space. It should be gently advanced in the closed position until the pleura is breached and then opened to spread the parietal pleura and intercostal muscles. A finger is inserted through the tract created to ensure proper position and lack of adhesions

between the lung and pleural surface before drain insertion.

The forceps are closed onto the tip of the chest drain and used to direct the drain into the desired position. This should ideally be apically in the case of a pneumothorax and basally for an effusion.

Some chest drains are still accompanied by a metallic trocar. The latter may be retracted so that the sharp tip lies within the drain. It can then be used to position the drain. The trocar should never be used to create a tract. This obsolete technique requires significant force despite the sharp tip and has been associated with damage to essential intrathoracic structures (Symbas, 1989).

The location of the chest tube should be confirmed by the appearance of condensation within the tube with respiration, or by drained pleural fluid seen within the tube. The chest tube should be inserted with the proximal hole at least 2 cm beyond the rib margin. The position of the chest tube with all drainage holes in the pleural space should be assessed by palpation.

The drain is secured to the skin by a strong suture, i.e. 1/0 silk. If a large drain is placed, a wound closure ‘mattress’ suture should be inserted. ‘Purse string’ sutures are no longer advised as they distort the incision. This is uncomfortable and leaves unsightly scars.

The drain needs to be connected securely to a pleural drainage system with unidirectional flow. This usually is an underwater seal bottle with a side vent. The advantage of this system is that it allows pleural air loss to be observed in pneumothorax and accurate volume measurements in pleural effusions, but it requires inpatient management and restricts mobilization. Drainage bags with flutter valves and vented outlets are a more flexible alternative. Some centres use Heimlich flutter valves (one way) with a small chest drain for simple pneumothoraces.

Guide-wire (Seldinger) technique

Certain chest drains can be inserted with a Seldinger technique (e.g. Seldinger chest drain kit, Smiths Portex, Watford (Figure 1); Cook ThalQuick, Cook (UK) Ltd, Letchworth (Figure 2)) avoiding the need for blunt dissection. These were originally

designed as small bore drains (12F), but are now available in sizes up to 24F (ThalQuick).

After local anaesthesia, thoracocentesis is performed until air or fluid is aspirated confirming that the tip is lying in the desired position in the pleural cavity. A guide-wire is then passed down the hub, and proximal control is maintained thereafter. The needle is removed, a small superficial incision made and the tract enlarged with serial dilators. The drain is then passed into the pleural cavity over the guide-wire.

Safe-T-Centesis

This new catheter (Radiologic-UK Medical Ltd, Sheffield; current maximum size 8 F; Figure 3) is placed over its own rigid introducer; this has a spring-loaded covered tip that retracts to reveal a cutting edge while pressure is applied against the resistance of tissues. As soon as the pleural surface is breached, that resistance is lost and the spring-loaded covered tip hides

Figure 1. Smiths Portex Seldinger chest drain kit (12F).



Figure 2. ThalQuick chest drain kit.

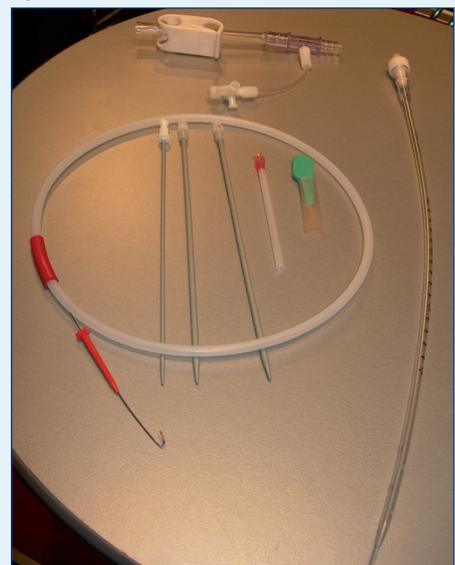




Figure 3. Safe-T-Centesis (6,8F) catheter.

the cutting edge, thus protecting any underlying structures from damage. A marker at the proximal end of the introducer changes from red to white signifying loss of resistance. Thoracocentesis is achieved at this moment, as confirmed by the aspiration of air or fluid in the attached syringe. The pleural drain is fed over the introducer, which is then removed. The chest drain is secured and connected to a drain device.

This procedure is potentially safer than other described techniques, and possibly quicker. However, its applicability is currently limited to drainage of simple effusions because of the very small chest drain sizes.

Uresil Tru-close thoracic vent

This device for the treatment of a simple pneumothorax is a small unit that fits firmly to the patient and allows early ambulation, without the need for an underwater seal. The thoracic vent uses a kink-resistant catheter and a signal diaphragm to facilitate insertion and monitoring resolution of the pneumothorax. Hence, it is akin to thoracocentesis using a Venflon, attached to a small one-way valve compartment. As the relative negative pressure of the pleural space is breached, the signal diaphragm moves, confirming placement. The introducing trocar is removed and the unit secured to the skin until further movements of the diaphragm cease. This suggests resolution of the underlying pneumothorax, which should be confirmed by imaging before removal.

Management of the drain

A chest X-ray needs to be performed after the procedure to ensure satisfactory position of the drain. In the case of a large pleural effusion, it is wise to control drainage in order to prevent re-expansion pulmonary oedema. This rare but potentially serious complication may occur depending on the extent and duration of the underly-

ing collapsed lung. It has been suggested that the tube should be clamped for up to 1 hour after draining 1 litre.

There is no need to clamp drains for pneumothoraces unless raising the drainage container above the level of percutaneous drain insertion.

The use of suction has been suggested in cases of non-resolving pneumothorax and following chemical pleurodesis. This should be done via an underwater seal using a high volume/low pressure system (e.g. Vernon-Thompson pump) until full drainage is complete. Pressures between 10 and 20 kPa are appropriate.

Removal of the chest drain

Chest tubes should be removed when the original indication for placement is no longer present or the tube becomes non-functional. The exact timing is dependent on the clinical progress.

Opinion is divided as to whether a chest tube placed for pneumothorax in a patient continuing to require mechanical ventilation may be removed if no air leak is present. Although somewhat controversial in patients with pneumothorax, many clinicians favour clamping the chest tube for 4–6 hours before removal in order to identify a persistent air leak.

In preparation for removal, the suture anchoring the chest tube to the skin is cut, and a gauze dressing is available. Following inspiration, the patient performs a valsalva manoeuvre and the tube is removed with simultaneous covering of the insertion site with the gauze dressing. The mattress suture inserted previously is tied to close the wound.

Complications

Complications of chest tube placement, excluding recurrent pneumothorax, are infrequent. Chest tube malposition is the

most common complication of tube thoracostomy (Baldt et al, 1995). A CT scan should be obtained if either a patient's plain films or clinical course is consistent with chest tube malposition.

Other reported complications include insertion site infection, empyema, lung parenchyma perforation, diaphragmatic perforation, subcutaneous placement, perforation of the right ventricle, right atrium, and abdominal organs (spleen, liver, stomach, colon), cardiogenic shock from chest tube compression of the right ventricle, mediastinal perforation and bleeding from intercostal artery injury. Re-expansion pulmonary oedema has been described. Treatment is supportive.

There appears to be no role for the use of prophylactic antibiotics for chest tube insertion or while the chest tube is in place.

Further information regarding national/international guidelines on the indications for tube thoracostomy may be obtained from societies such as the British Thoracic Society (http://thorax.bmjournals.com/cgi/content/full/58/suppl_2/ii53) and the American College of Chest Physicians (www.chestnet.org). **BJHM**

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KEY POINTS

- Preparation of the patient position, site, equipment and analgesia are crucial.
- Size and number of drainage pores on a chest tube may facilitate drainage of empyema and haemothorax.
- A 'non-swinging' chest tube is either misplaced, blocked, connected to suction or has achieved its role.
- Newer equipment may facilitate 'tailoring' to specific indications.