

Chest Tube Insertion

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A chest drain is a tube inserted through the chest wall between the ribs and into the pleural cavity primarily to drain an air or fluid collection from the pleural space, and to instill medications into the pleural cavity.

Indications

1. Pneumothorax
2. Tension pneumothorax
3. Penetrating chest trauma
4. Hemothorax
5. Chylothorax
6. Empyema
7. Drainage of pleural effusion
8. Prevention of hydrothorax after cardiothoracic surgery
9. Bronchopleural fistula

Contraindication

Absolute contraindication - dense attachment of lung to chest wall throughout hemithorax

Relative contraindication

- known or suspected coagulopathy
 - avoid chest drain insertion in patients taking anticoagulants until INR < 1.5
 - correct underlying coagulopathies or platelet defects prior to chest tube insertion if possible
 - routine measurement of platelet count and prothrombin time only recommended in patients with suspected coagulopathy
 - emergent chest drain insertion may be necessary in patients with tension pneumothorax
- pulmonary bullae
- dense pleural adhesion
- loculated pleural effusion

Equipment Lists

1. 2 percent lidocaine
2. Needles and syringes for anesthetizing the skin
3. Scalpel with no 10 or 11 blade
4. Three Kelly clamps
5. Straight scissors
6. Chest tube
7. Silk suture (1 to 0)
8. Needle holder, Petroleum gauze
9. Drain sponge
10. Sterile drapes, gown and gloves
11. Mask, protective eyewear
12. Elastic tape
13. 2% Chlorhexidine or povidone iodine
14. Drainage system

Preparation

A. Antibiotic prophylaxis

Prophylactic antibiotics are **not** warranted for chest tubes placed in the setting of spontaneous pneumothorax or other non-traumatic indications

B. Tube selection

Chest tubes are available in a range of French sizes from 14 to 40 Fr (diameter in French/3 = diameter in millimeter). A 28 Fr tube will drain about 15 L/min for air but about thirty times less for liquids. Compared with a transudate or sterile exudate, the drainage of more viscous fluids (eg, pus or blood) requires a larger bore chest tube to obtain the same flow rate. These tubes can get plugged easily with blood or purulent drainage, a large tube is needed. A 32 Fr or larger tube (36 Fr for trauma) to manage hemothorax since it will allow evacuation of gelatinous clot. Due to the minimal viscosity of air, smaller tubes (≤ 24 Fr) can be placed for persistent air leak.

C. Drainage system selection

Wet or dry suction-control, closed drainage systems are typically used, and each is effective.

D. Level of suction

The typical level of suction used in the clinical setting is -20 cm of water. Commercial closed drainage systems typically allow the suction level to be adjusted between 0 and -40 cm of water. The amount of suction that should be used depends upon the indication. Suggested starting suction levels are given below:

- For spontaneous air leaks, the least amount of suction (including none) needed to maintain full expansion of the lung is appropriate. Anything more may potentiate the leak and can delay pleural healing. We suggest starting at -10 cm of water and increasing the amount of suction only as needed, as determined by chest radiograph.
- For a collapsed lung due to pneumothorax or copious pleural effusion, large differential pressure gradients should be avoided during lung reexpansion to prevent reexpansion pulmonary edema.
- When the chest tube is placed for fluid drainage, -20 cm of water is a reasonable place to start and the level of suction should be increased as indicated with the goal of achieving full lung expansion as determined by chest radiograph.

Tube Thoracostomy

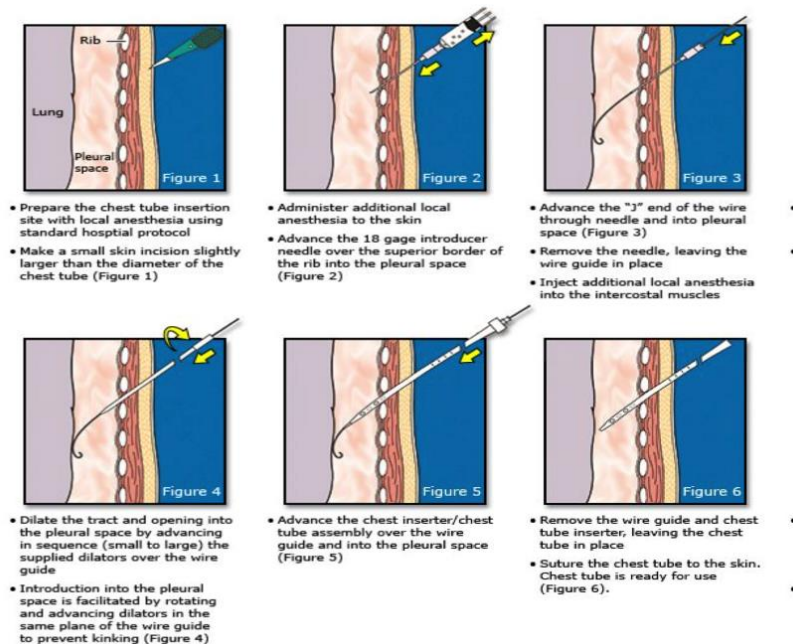
A. Standard technique

- For patients who are hemodynamically stable, attention should be paid to providing adequate pain control for this procedure with local anesthetic infiltration and the use of conscious sedation (if feasible).
- Supplemental oxygen is provided as needed.
- Place the patient in the supine position with the ipsilateral arm abducted and the elbow flexed to position the hand comfortably over the patient's head.
- Prepare the skin around the area of insertion, preferably with **chlorhexidine** or alternatively with 10 percent povidone-iodine solution. Thoracostomy tubes should be placed with full barrier precautions (gloves, gown, mask, eye protection) and, whenever possible, full body drapes.
- Using 1-2% **lidocaine**, anesthetize a 2 to 3 cm area of skin and subcutaneous tissue one intercostal space below the intercostal space that will be used to place the tube.
- Make a 1 to 2 cm incision in the skin at the site of the **lidocaine** injection parallel to the intercostal space. Anesthetize the periosteum of the rib above and the rib below the planned intercostal insertion site and include the muscular tissue of the intercostal space. The lower rib margin is avoided to prevent injury to the neurovascular bundle.
- Using a Kelly clamp, bluntly dissect and create a short subcutaneous tunnel from the incision site cephalad towards the intercostal space through which the chest tube will be inserted. Grasp the Kelly clamp with one hand controlling the handle and the other braced on the patient and holding the clamp near its tip to avoid plunging the clamp into the patient's chest.
- With the Kelly clamp in a closed position, push the clamp over the superior portion of the rib (to avoid injury to the neurovascular bundle that runs along the inferior aspect of the rib) and through the parietal pleura. Open the Kelly clamp to spread the intercostal muscles and parietal pleura.

- Insert a finger through the tract into the pleural space to confirm proper position and make sure there are no adhesions between the lung and the pleural surface.
- Clamp the chest tube at the insertion end with the Kelly clamp. With the aid of the clamp, insert the chest tube through the tract into the pleural space and direct it either apically for a pneumothorax or inferiorly and posteriorly for a pleural effusion.
- Remove the Kelly clamp and confirm that the chest tube is in the thoracic cavity by observing condensation within the tube with respiration, or drainage from the tube. Advance the chest tube until the last drainage hole is within the thoracic cavity by at least 2 cm.
- Place a suture to anchor the chest tube, loosely tying over the tube and then tying firmly around the tube to indent the tube enough to avoid dislodgement but not tight enough to obstruct the tube. (If the incision was large, an additional suture may be needed to close the incision)
- Following chest tube placement, obtain a chest radiograph to confirm tube position and assess lung expansion. Make sure that the gap in the radiopaque marker which marks the most distal chest tube drainage hole is within the pleural space
- Monitor the initial drainage from the tube. If the lung has been in a state of significant compression due to a large effusion or pneumothorax, the clinician must be aware of the possible complication of re-expansion pulmonary edema and be prepared to treat it. If a patient starts coughing while fluid is draining from a newly placed chest tube, it is reasonable to clamp the tube for a period of time before removing more fluid.

B. Sheldinger Technique

- Once the site is prepared and anesthetized, and the skin incision performed as described above for the standard technique, we proceed as follows
- Insert an introducer needle into the pleural space.
- Insert the guidewire through the introducer needle into the pleural space. The wire should pass without resistance and if this is not the case, the procedure should be abandoned. Direct the guidewire apically for a pneumothorax or inferiorly for a fluid collection. Verify guidewire position (eg, fluoroscopy).
- Pass the dilators sequentially over the guidewire to dilate the tract.
- Pass the chest tube/dilator combination into the pleural space.
- Remove the dilator and guidewire, leaving the chest tube in place.
- Suture the tube into place, dress with gauze, connect the drainage system, obtain a chest radiograph to confirm tube position and assess lung expansion, and monitor the initial drainage from the tube as described above.



Removal of chest drain

To minimize the risk of infectious complications, the tube should be removed as soon as it is safe to do so. The following criteria should be met prior to chest tube removal.

A. Pneumothorax

- The lung is fully expanded
- No visible air leak is present and air does not accumulate when suction is removed. If there is any question as to whether an air leak has resolved, a “clamp trial” can be performed. The chest tube is clamped and a chest radiograph repeated at intervals (eg, 2 hours, 6 hours, 12 hours). If air does not re-accumulate, the tube can be removed.

Opinion is divided as to whether a chest tube placed for pneumothorax in a patient receiving mechanical ventilation should remain in place as long as the patient requires mechanical ventilation even when no air leak is present.

B. Effusion

- The lung is fully expanded
- Daily fluid output is less than about 100 to 300 mL/day. The threshold is individualized depending upon the indication for the insertion and patient factors (eg, body mass)

Removal Technique

- Prior to removing the tube, it should be explained to patients that they will need to inspire deeply and hold their breath during tube removal.
- The patient should rehearse this several times prior to the actual tube removal to prevent gasping and thus causing negative intrathoracic pressure that could draw air into the chest and lead to recurrent pneumothorax.
- Holding the dressing near the chest tube insertion site with the nondominant hand, ask the patient to inspire and hold his or her breath, then remove the tube quickly with the dominant hand while simultaneously covering the insertion site with the gauze dressing.
- Tape the dressing into place, and obtain a chest radiograph immediately following chest tube removal, and 24 hours later to evaluate for recurrence of pneumothorax and/or reaccumulation of fluid.

Potential Complication

1. Injury to the heart, great vessels, or lung
2. Diaphragmatic perforation
3. Subdiaphragmatic placement of the tube
4. Open or tension pneumothorax
5. Subcutaneous emphysema
6. Unexplained or persistent air leakage
7. Hemorrhage (especially from intercostal artery injury)
8. Recurrent pneumothorax
9. Empyema
10. Lung parenchyma perforation
11. Subcutaneous placement
12. Cardiogenic shock (from chest tube compression of the right ventricle)
13. Infection

References

1. Peter Doelken, MD. Placement and management of thoracostomy tubes. UpToDate Inc. <http://www.uptodate.com> (Accessed on March 01, 2018).
2. Pleural procedures and thoracic ultrasound : British Thoracic Society pleural disease guideline 2010
3. DynaMed [Internet]. Ipswich (MA): EBSCO Information Services. 1995. Record No. 361066, Chest tube insertion; [updated 2017 Apr 26, cited 2018 Mar 01]; [about 8 screens]. Available from <http://search.ebscohost.com/login>. Registration and login required.