Chest Tubes: Generalities

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KEYWORDS

• Chest drainage • Chest tube • Air leak • Pleural effusions • Pneumothorax

KEY POINTS

- Insertion, management, and withdrawal of chest tubes is part of the routine activity of thoracic surgeons.
- The selection of the chest tube and the strategy for each of these steps is usually built on knowledge, practice, experience, and judgment.
- The indication to insert a chest tube into the pleural cavity is the presence of air or fluid within it.
- Various types and sizes of chest tubes are now commercially available.

Insertion, management, and withdrawal of chest tubes is part of the routine activity of thoracic surgeons. The selection of the chest tube and the strategy for each of these steps is usually built on knowledge, practice, experience, and judgment. The indication to insert a chest tube into the pleural cavity is the presence of air or fluid within it. The goals should be:

- To evacuate air or fluid from the pleural space
- To collapse any residual cavity in order to prevent subsequent pleural problems
- To ensure complete pulmonary reexpansion and restore respiratory mechanics

The achievement of these goals depends on:

- Viscosity of the pleural fluid and presence of debris within it
- Whether the fluid is uniloculated or multiloculated
- Size of the underlying/residual lung
- Capability of the underlying/residual lung to reexpand and occupy the pleural space
- Presence of air leaks (both alveolar or bronchopleural fistula)

HISTORY

Hippocrates was the first to drain the pleural space: he described incision, cautery, and metal tubes to drain empyemas.[1] Hunter, in the 1860s, developed a hypodermic needle and inserted it into the pleural space for drainage purposes.[2] Continuous chest tube drainage of the pleural space incorporating an underwater seal device seems to have been first performed by Playfair[3] in the 1870s in a patient with empyema unresponsive to repeated aspiration. Hewett[4] described closed tube drainage of an empyema in 1876. However, extensive use of this technique was not reported until 1917, when it was successfully used to drain postinfluenza epidemic empyemas.[5]

The use of chest tubes to drain the chest cavity after thoracic surgery procedures was reported by Lilienthal[6] in 1922; this included lobectomy for suppurative diseases. It was not until the Korean War that postoperative chest tube placement became the gold standard after major thoracic surgery procedures.[7] As a consequence, the use of closed systems became more popular than open drainage systems (rib resection with open drainage or Eloesser flap). The mortality for empyema treated with rib resection and leaving the chest open was 28%, compared with 4% for closed pleural drainage.[8]

Gotthard Bulau, a German internist, is credited as the first to design a closed water seal drainage system.[9,10] Based on these findings, closed

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pleural space drainage became the standard of care in the early twentieth century and it is part of the modern era of thoracic surgery. Chest tubes made of several different materials in different designs and sizes have been produced and have been accompanied by the development of different pleural drainage units.

AIR AND FLUID ACCUMULATION IN THE PLEURAL SPACE

Gas and fluid, when profuse, can completely fill the pleural space; in contrast, smaller amounts of fluid may collect only in selected areas based on its nature and density, the quality of the underlying lung and visceral pleura, and the presence of pleural adhesions.

Air tends to collect in the upper part of the chest. Fluids tend to accumulate in the lower part of the chest cavity, which is inferior in the sitting or standing position, or posterior with the patient supine (costophrenic and costovertebral spaces, respectively).

These variables are crucial to choose the optimal site for tube drainage both of a free pleural space and a multiloculated effusion. Particularly, the latter situation requires precise localization of chest radiograph and computed tomography (CT) scan.

INDICATIONS FOR CHEST TUBE PLACEMENT

Indications for chest tube insertion are the following:

- Pneumothorax (according to guidelines)
- Penetrating chest injuries
- Hemopneumothorax
- Recurrent symptomatic pleural effusions
- Empyema and parapneumonic effusions
- Chylothorax
- Postoperatively in thoracic and cardiac surgery
- Bronchopleural fistula

Absolute contraindications do not exist; coagulopathies and platelet defects require specific considerations on a case-by-case basis with correction of the disorder if patient stability allows it.[11] Chest tube insertion in a skin area with benign or malignant disorders should be avoided if possible.

CHEST TUBE PLACEMENT, MANAGEMENT, AND REMOVAL

The site of chest tube insertion is usually determined by the material that requires drainage and the location within the pleural space. Insertion is guided by chest radiograph or CT scan when available. Ultrasonography can also be useful, particularly in intensive care patients who cannot be moved to more sophisticated radiological equipment or when lateral projections cannot be recorded. Chest tubes can be inserted in the midaxillary line at the level of the third or fifth intercostal space. Alternatively, the second intercostal space on the midclavicular line can be chosen, particularly in cases of small apical pneumothorax. However, also in these cases, the authors prefer the fifth intercostal space on the lateral side of the chest, pushing the tube as far up as possible. Insertion of the chest tube should be preceded by local anesthesia and careful maneuvers should avoid injuring the intercostal vessels and nerve, staying as close as possible to the border of the lower rib of the space. Aspiration of air or fluid into the anesthetic syringe indicates entrance in the pleural space. Blunt dissection and finger exploration should be encouraged to avoid injuring the lung parenchyma. The chest tube should be sewn in place using heavy suture material (0 silk). Placement of an additional purse string suture at this time, under the effect of local anesthesia, helps at the time of chest tube removal. Chest radiograph after placement of thoracic drainage is mandatory. It helps to confirm the correct position of the tube; if the tube requires repositioning, this can be done with local anesthesia still active.

In difficult situations, small-bore chest tubes can be placed under CT guidance with the Seldinger technique.

At the end of a surgical procedure 1 or 2 chest tubes are placed under direct visual control. If 2 chest tubes are placed the posterior is left lower in the chest cage to drain blood, whereas the anterior is pulled up to the apex to drain air. If only 1 chest tube is inserted, this is usually located posteriorly and pulled up the apex of the chest. Additional holes are made to drain fluids from the lower part of the thoracic cavity.

The size of the chest tube should be based on the type of intrathoracic collection that requires drainage. Small-bore catheters are used with an increased frequency in cases of pneumothorax. In contrast, empyema always requires large-bore tubes because of the viscosity of pus.

Various types and sizes of tubes are currently available. The key factor in selecting the correct size of tube is the air or liquid flow rate that can be obtained through the tube. This rate is determined by the Fanning equation:

$$v = \pi^2 r^5 p / fl$$