Chest Tube Drainage

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Contents

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A chest drain is by definition a flexible tube that is inserted through the ribs into the pleural space.

The drains can vary in size from 6 to 40 F. Most are fenestrated to allow for a better outflow of air or fluid and contain a radio-opaque strip to identify them radiographically. The chest drain must be considered as part of a system that also includes an aspiration system to which the drain itself must be connected to allow for the collection of air or fluid. This aspiration system and its management are of equal importance to the positioning of the drain.

16.1 Indications

The pleural drain serves to create a negative pressure in the pleural cavity and the resulting re-expansion of the lung by removing air or fluid. The main indications [1] are listed in ◘ Table 16.1.

◘ **Table 16.1** Indications for chest drain placement

Pneumothorax
Pleural effusion:
• complicated parapneumonic effusion and empyema
• symptomatic malignant effusion
• benign symptomatic pleural effusion (heart failure, renal failure, cirrhosis) considering the risk–benefit ratio in frail patients
• refractory effusion (especially neoplastic) to perform pleurodesis
• haemothorax
• chylothorax
• postoperative after thoracoscopy or thoracic, cardiac and oesophageal surgery

16.2 Contraindications

There are no absolute contraindications.

There are no absolute contraindications to the placement of a drain other than the absence of a useful pleural space, for example due to the presence of secondary adhesions to previous surgery, lung infections or trauma. Relative contraindications can be the presence of coagulation pathologies or diaphragmatic hernias.

16.3 Patient Preparation

The manoeuvre must be avoided in patients on anti-coagulant therapy until the INR is <1.5.

A chest X-ray and often a chest CT scan are usually performed before placing a chest drain. But the most important change in the practice of interventional pneumology, particularly in the placement of a drain, is the general adoption of Thoracic Ultrasound (TUS). The scan (which is done in a quick and safe way at the patient's bedside or in the endoscopic room) enables us to confirm the indication for the procedure, identify the point where the drain should be placed, estimate the quantity and characteristics of the fluid, see if the pleural effusion is free or organised and prevent complications related to an incorrect manoeuvre [2].

Before the procedure, a blood clotting profile is necessary to avoid bleeding; a non-urgent manoeuvre must be avoided in patients on anti-coagulant therapy until the INR is <1.5.

Antibiotic prophylaxis should normally not be necessary, but is recommended in the case of thoracic trauma.

The patient's signed consent to perform the procedure and a venous access are also essential.

16.4 Procedure

The drain is ideally placed in the so-called 'safety triangle'.

The procedure may be subdivided into several points.

16.4.1 Positioning of the Patient and Point of Introduction of the Drain

The patient can be positioned in lateral decubitus on the side opposite the drain insertion site with the arm above the head, or in semi-supine recumbency, always with the arm above the head (◘ Fig. 16.1). This is because the drain is ideally placed in the so-called 'safety triangle' [3]. This area is located between the middle and anterior axillary lines, in the fourth or fifth intercostal space, passing over the upper edge of the lower rib

Fig. 16.1 Positioning of the patient in decubitus on the side, sitting and semi-supine

to avoid the intercostal bundle (artery, veins and nerves). The fourth intercostal space is normally at the nipple level in the male and on the inframammary line in the female. But the patient can also be positioned seated if it is decided, after TUS, that posterior access is necessary.

16.4.2 Choice of Pleural Drain

The drains are measured in French (3 French = 1 mm) and are divided into narrow drains (less than or equal to 14 French (F)) and wide drains (greater than 14 F). The narrow drains used in Italy by respiratory physicians are of two types, the Pigtail-type catheter with Seldinger technique or the Unico-type catheter with a Veress needle, while the wide drains consist of the classic Trocar (Fig. 16.2).

The use of narrow catheters has increased, favouring those positioned with the Seldinger technique.

In recent years, the use of narrow catheters has increased, favouring those positioned with the Seldinger technique. Narrow catheters have a lower risk of severe complications, are less painful for the patient and require less anaesthesia, are quicker to place and provide better patient comfort. Both pulmonologists and surgeons increasingly use these drains in patients presenting with acute symptoms secondary to pneumothorax or pleural effusion. The most frequent problem that arises with the use of small-calibre drains is the blocking of the discharge: daily washing with physiological or fibrinolytic solution is recommended. Narrow drains below 14 F are the first choice in the treatment of pneumothorax, pleural effusion and empyema. Wide drains should be used when narrower ones fail [4].

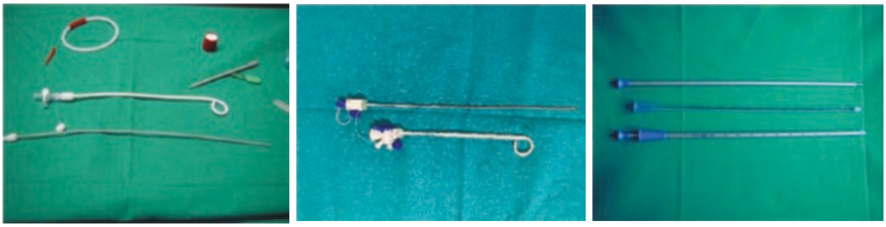

Fig. 16.2 Small-bore pig tail catheter, small-bore Unico catheter and large-bore Trocar catheter

In the case of haemothorax, for the obvious reasons linked to a high viscosity of these fluids, a wide drain is essential, of at least 28–30 F.

Narrow drains can also be left in place and managed at home in the case of relapsing malignant pleural effusion requiring frequent thoracentesis. The specifications of the narrow catheters indicate that they can be left in place for less than 2 months. If longer times are expected, it would be advisable to proceed with the placement of a tunnelled catheter.

16.4.3 Chest Drain Placement

The use of TUS is essential.

The drain is positioned in the so-called 'safety triangle'. The access point is identified through thoracic ultrasound. The use of TUS is essential, especially in complicated patients with a medical history of thoracic infections or surgery with the associated high possibility of finding adhesions or loculations. The material required for positioning a drain is indicated in Table 16.2.

During local anaesthesia, it is advisable to enter the pleural cavity with a narrow-gauge needle to check that there really is air or fluid.

- Trocar-type drain placement: for Trocar-type chest drainage, a so-called wide-bore chest tube is used. The most used gauge is 20 or 24 F. This is an 'armed' drain, made rigid by a mandrel positioned inside it in order to facilitate penetration of the chest wall and positioning within the pleural cavity. The procedure manoeuvre must be performed in sterility to avoid infections. First of all, local anaesthesia is practised (20 mL of 2% xylocaine, first on the surface, then subcutaneously) which can be associated with analgesics (NSAIDs, tramadol, morphine) and sedatives (midazolam) in case of failure to control painful symptoms. It is emphasised that, during local anaesthesia, it is advisable to enter the pleural cavity with a narrow-gauge needle to check that there really is air or fluid. A cutaneous and subcutaneous incision is then made longitudinally along the course of the

Table 16.2 Material needed to place a thoracic drain

1.	Sterile gloves and sterile gowns
2.	Antiseptic solution
3.	Sterile sheets to delimit the disinfected skin area
4.	Sterile gauze
5.	Syringes and needles (21–25 gauge)
6.	Xylocaine 2%
7.	Scalpel
8.	Suture thread
9.	Instruments for minor surgery including 'blunt tip' scissors
10.	Drains of various sizes
11.	Connection pipes, biconical valves and drainage system

ribs, of the size of the drain that will be introduced, being careful not to sink the scalpel blade too deep so as to avoid vascular injury. Immediately after, a controlled dissection through the intercostal muscles is made using blunt-tipped scissors or a Kelly clamp, creating a track extending over the top and into the intercostal space and opening up the pleural surface. At this point, the Trocar is introduced, which will be directed towards the apex of the lung in the case of pneumothorax or towards the base in the case of pleural effusion. The drain will be connected to an aspiration system. Finally, it will be necessary to fix the drainage tube to the chest wall, to avoid accidental leakage, by applying a linear suture perpendicular to the incision line. The placement of the drain should then be checked with a chest X-ray in the two views.

The dilator should not be inserted further than 1 cm.

- Small-bore drain placement with Seldinger's technique: Another type of drainage is the small-bore 'pig-tail' 14 F catheter introduced with the Seldinger technique [5]. After locating the insertion position, local anaesthetic (lidocaine 2%) should be infiltrated in the cutaneous and subcutaneous layers. During this procedure, an attempt should be made to aspirate the pleural contents with a narrow-gauge needle. If this is not possible, chest drain insertion should not continue. Once fluid or air is found, a small incision is made with a scalpel blade. The needle (supplied with the Seldinger kit) is then inserted into the intercostal space to penetrate the pleural space. Air or pleural fluid should be aspirated via the needle. The syringe is removed and the guide wire is passed through the needle; there should be no resistance and the wire should pass freely. The needle is then removed and the guide wire left in. The dilator is passed over the guide wire into the thorax. The dilator should not be inserted further than 1 cm beyond the depth from the skin to the pleural space. The dilator is then removed, ensuring that the wire is not pulled out of, or pushed further into, the thorax. The drain is inserted by sliding it over the guide wire, to approximately 12–16 cm. The guide wire and inner tube are then removed from the drain.

16.4.4 Indwelling Pleural Catheters (IPCs)

Indwelling pleural catheters are used with increasing frequency in the treatment of malignant pleural effusion [6]. The catheter is tunnelled under the skin to the pleural space. The main function of the IPC is that it can remain in place for a much longer period of time compared to normal drainage. The expected benefit is the management of the patient at home, thus avoiding repeated thoracentesis and entailing the reduction of hospitalisation times. Their use can also be extended to chronic benign effusions such as hepatic hydrothorax and inflammatory pleuritis.

The expected benefit is the management of the patient at home.

IPCs are placed under local anaesthesia and are then managed at home by trained caregivers, who will have to remove the fluid using special vacuum bottles.

There are some negative aspects: first of all the high costs, then the risk of pleural cavity infections, malfunctioning, the formation of a loculated pleural collection and the risk of metastasis along the path of the catheter.

16.5 Drainage Systems

The chest drain should be connected to a drainage system that incorporates a valve mechanism to prevent air or fluid from entering the pleural cavity..

- *Heimlich valve*. The simplest system is that of the Heimlich valve (◘ Fig. 16.3). It consists of a cylinder of plastic material measuring a few centimetres in length, with an opening on each of the two bases. Inside the cylinder, there is a collapsible rubber tube connected to one of the openings. This opening must be connected to the drain, and the other opening must be left open. The use of the Heimlich valve, however, is limited to pneumothorax, as the presence

Fig. 16.3 Heimlich valve, Bulau-type water valve, Redax-type collection system

The most commonly used drainage system is the Bulau bottle-type water valve

of fluid material, disturbing the clearance of the valves, can affect their functioning.

- *Bulau valve*. The most commonly used drainage system is the Bulau bottle-type water valve (Fig. 16.3). The system consists of a bottle equipped with a screw cap through which two tubes are inserted: the longer tube reaches the bottom of the bottle, and the short tube ends just under the cap. The Bulau valve must contain physiological solution or sterile water so that the long tube is immersed in it for at least 2 cm. The long tube connects to the patient drain. The shorter tube, not immersed in the fluid, must allow the air to escape and must be left open or connected to the aspiration system. The increase in intrapleural pressure in the expiratory phase enables the escape of air or fluid from the pleural cavity. In the event of a pleural effusion, fluid accumulates in the bottle. In the case of pneumothorax, the air, after being 'bubbled' through the sterile water that acts as a valve and which is contained in the Bulau valve, comes out through the short tube (the open one).
- *Redax*. When large quantities of fluid come out of the pleural cavity, it is advisable to use a two-bottle system, one bottle serving to collect the fluid while the other serves as a water valve. A single closed system called Redax (Fig. 16.3) can also be used, which combines both the water valve and the container for collecting the fluid in the same box.
- *Pleur Evac*. This is a very handy single-use system that can function as a three-bottle system. The first column on the right corresponds to the collection bottle, the second column to the water valve, and the third column to the pressure control bottle. It is a system used above all by surgeons in post-operative care.

16.6 Negative Pressure Aspiration

Negative pressure aspiration at levels of 10 to 20 cm H_2O can be applied to the drainage system. The application of negative pressure is necessary above all in two situations: in the case of pneumothorax with substantial leaks or after pleurodesis. After pleurodesis with talc, an aspiration with negative pressure of at least 10 to 20 cm H_2O must be applied. The patient has to stay in bed connected to the aspirator continuously for the first 24 h, crucial for the success of the pleurodesis [7].

16.7 Removal of Drain

The drain should be removed when drained fluid is less than 200 mL/day, at resolution of pneumothorax, or if drainage fails. After the drain has been removed, the cutaneous passage is closed with stitches or Steri Strips and then medicated with gauze.

The drain should be removed when drained fluid is less than 200 mL/day.

16.8 Complications

Complications include pain, bleeding, superficial site infection, deep infection of the pleural cavity (empyema), accidental removal of the tube, clogging of the drain, pulmonary re-expansion oedema, placement in the incorrect anatomic position with secondary trauma of abdominal organs such as the spleen or liver, and trauma of the diaphragm or of intrathoracic organs such as the aorta or heart. With the use of a small-bore Seldinger drain, the incidence of placement in the incorrect anatomic position and organ injury will hopefully be reduced. On the other hand, given the persistence of complications in the various cases described above and the widespread availability of ultrasound equipment, it is recommended that you always use a US scan to place a thoracic drain, reducing the incidence of complications [8].

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