How to Do it

Chest Drain Insertion
Indications and Techniques

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Introduction

The ability to insert a chest drain safely and painlessly is an important core skill for physicians. This article describes techniques for insertion of larger bore trochar and cannula type chest drains as well as the more recent Seldinger guide-wire type drains. The indications for chest drain insertion will also be reviewed.

Indications For Inter-costal Chest Drainage

1. Pneumothorax

a). Not all pneumothoraces require insertion of a chest drain. Primary spontaneous pneumothorax (ie in those under the age of 50 and without underlying lung disease) is usually initially treated by simple aspiration. Patients with underlying lung disease and traumatic pneumothoraces usually require inter-costal tube drainage.

b). Tension pneumothorax (ie clinical evidence of cardiovascular compromise due to compression of mediastinal structures) should always be treated with a chest drain after initial relief with a small bore cannula or needle.

c). Ventilated patients, because the positive airway pressure will force air into the pleural cavity and quickly produce a tension pneumothorax.

d). Persistent or recurrent pneumothorax after simple aspiration has failed.

In general, small-bore catheters (10-16F) are to be preferred. Many respiratory physicians use a small drain initially. Only when it becomes clear that the leak exceeds the capacity is a large bore drain considered. Persistent pneumothorax often needs thoracic surgical involvement and at that stage a large chest drain is often inserted.

2. Pleural Fluid

a). Malignant Pleural Effusion

Symptomatic pleural effusions can be relieved quickly and conveniently by insertion of an inter-costal drain. If the cause of the effusion is unknown then samples should be collected for cytology, microbiology (including Acid Fast Bacilli) and biochemistry, pH, protein and LDH. The procedure can be combined with pleural biopsy if needed. Where the diagnosis of malignancy is already known, placing an inter-costal drain allows chemical pleurodesis to be performed later. From the patients' point of view, smaller chest drains (10-16 French) are more comfortable and should be used in preference.

b). Traumatic Haemothorax.

Although there are no controlled trial data, it is agreed by most respiratory physicians and thoracic surgeons that blood in the pleural cavity should be drained using a large bore tube (28-36F). Small tubes are easily blocked by blood clots. If this happens then further bleeding may not become evident until cardiovascular collapse occurs. Infection of retained blood in the pleural cavity is another important reason for wanting to ensure complete drainage.

c). Pleural Empyema

Once the diagnosis of pleural infection is made, drainage of the fluid and appropriate antibiotic treatment must be started without delay. There is a heated controversy over what size drain should be used to drain pleural empyema. Broadly thoracic surgeons prefer the use of large tubes (>28F), whereas many respiratory physicians are moving towards the use of smaller drains (10-16F). There are no randomised controlled studies in this area to guide practice, however a number of small studies have shown small drains to be as effective as large ones and much better tolerated by patients.

d). Pneumonectomy Space

Never drain a post pneumonectomy space except after full discussion with thoracic surgeons.

Technique of Chest Drain Insertion

Before embarking on the procedure, ask yourself whether the patient needs it done. Look at the chest X-ray and examine the patient to confirm the side that is to be intubated. In patients with advanced COPD ask yourself if the appearances could be due to a bulla. If in doubt look at old X-rays and ask for help from a radiologist. If this does not resolve the issue then CT scanning can be diagnostic.

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Clearly it is important to confirm that there is an effusion to be drained before proceeding. Often the chest X-ray appearances are clear cut, however there are some pitfalls that need to be remembered. Cancer in one of the main bronchi may cause distal lung collapse and an opaque hemi-thorax. Mediastinal shift towards the opaque hemithorax indicates that the underlying lung is collapsed and pleural fluid is minimal and unlikely to be contributing to symptoms. Intercostal drainage is contraindicated in this situation. If in doubt an ultrasound examination and preferably a respiratory opinion should be sought.

Malignant mesothelioma is an increasingly common problem - by 2020 it is expected to account for 10% of intrathoracic cancers. As it advances the tumour forms a rind like mass around the lung. This characteristic can mimic an effusion radiographically. Before attempting chest drainage, ultrasound should be used to confirm the presence of fluid. Mesothelioma readily seeds in drain or needle tracks and therefore unnecessary intubation of the pleural cavity (even with a small cannula) must be avoided.

a) Consent

Explain the procedure to the patient and obtain their consent.

b) Pre-medication

Many patients find the thought of chest drain insertion frightening and the procedure may be painful. Pre-medication with an anxiolytic (eg midazolam) immediately before the procedure or an opiate (eg oromorph or pethidine) an hour before should be considered. Opiates may also afford some analgesia post procedure.

c) Patient position and site of insertion

The most commonly used position is with the patient lying at 45^0 with their arm raised behind the head to expose the axillary area. The procedure can also be performed with the patient lying on their side with the side of the lesion uppermost (lateral Decubitus position). This position allows better access to the axillary area and makes it easier to maintain a sterile operating field.

The chest drain is usually inserted in the mid axillary line, 5^{th} to 6^{th} intercostal space, within the safe area between the free lateral edges of latissimus dorsi and pectoralis major. Other positions, which may also be used are the posterior chest wall in a site selected by percussion or guided by ultrasound, or the second intercostal space mid clavicular line anteriorly (for pneumothorax). Clearly a different patient position would have to be used in these cases.

d) Aseptic Technique

This is critical, as the drain may have to stay in the pleural space for several days and secondary infection of the wound or pleural space is a real risk. An alcohol based iodine skin preparation should be used and allowed to dry on the skin before proceeding. There is good evidence that appropriate prophylactic antibiotics should be given in the presence of penetrating chest trauma. There is no evidence to recommend prophylactic antibiotics in other situations.

e) Local anaesthesia

A skin bleb is raised with an orange needle and the skin infiltrated in an area to include the site of suture insertion. Deeper layers are then infiltrated with a green needle. The pleural area should be infiltrated with care to ensure adequate anaesthesia of the somatic nerve fibres. Up to 3mg/kg of lignocaine may be used safely. It is most convenient to use a 1% solution as this gives good anaesthesia with minimal risk of toxicity. Aspiration of fluid (for pleural effusion) or air (for pneumothorax) confirms that you are in the pleural space and that it is safe to proceed. Occasionally in obese subjects a longer spinal needle is needed to reach the pleura. If fluid or air are not aspirated then you should not go further but seek radiological help in locating the best site to insert the drain.

f) Drain Insertion

A chest drain is ***placed*** and never forced into the pleural cavity. Significant force should never be used as there is a real risk of trauma to the major structures in the thorax. Correct technique will avoid the need to use force. The sharp tipped trochar of the Argyl catheter must never be used to create a path for the chest drain.

g) Blunt Dissection and Large Drain Insertion

This technique is used to insert larger bore tubes or where a Seldinger system is not available. After anaesthesia, an incision in the skin is made just large enough to make a tight fit around the tube. A pair of blunt ended forceps, is used to make a path to the pleura by opening and closing them to separate the tissues until the pleura is reached. If a large drain is to be inserted then it may be possible to push a finger into the cavity to check that the tube can be inserted safely. With smaller tubes this is not possible. However, a hiss of air entering and leaving the pleura with respiration or fluid leaking out confirms that you are in the correct position. The tube can now be placed. The trochar should be withdrawn 2-3cm from the end to ensure that the sharp end does not protrude. In this way the trochar can be used to stiffen the tube and allow it to be directed as required. If air is to be drained then the tube should be directed apically. If fluid, then the drain should be directed basally. Some physicians advocate complete removal of the trochar. The tube then has to be advanced into the pleural cavity using a pair of forceps with the tip in one of the side holes of the drain.

h) Securing the drain

The drain must be secured to prevent it from "falling out." The most convenient method is as follows. A strong non-absorbable material (eg 1 silk) is used to close one edge of the wound using a mattress suture. The free ends of the suture are then tied to form another non slip knot

0.5 cm above the skin. In this way an 'O' is formed. The free ends are then tied to the drain. In this way the drain can be removed later without disturbing the skin closure suture. Check that the drain is secure by pulling on it. Another suture can be left at the other end of the wound, to be tied after the drain is removed. "Purse string" sutures must not be used. They are uncomfortable and lead to scarring.

A small dressing should can be applied to the drain. Large wads of sleek dressing and tape should be avoided as they trap moisture and may predispose to infection. An "omental tag" (see Figure 1) of adhesive dressing tape can help to support the tube and protect it further against being pulled out.

Figure 1. Chest drain secured with omental tag.

Small and medium bore tube insertion (8-24F)

These are available as kits, which contain the necessary equipment to insert a drain. The skin and subcutaneous tissues are anaesthetised as described above. A larger bore needle is then used to reach the pleural space. Aspiration of air or fluid confirms that the pleural space has been reached. A guide-wire is then passed through the needle. The needle is removed and a series of dilators are passed over the guide-wire until the track is large enough to admit the drain. The drain is then sited and secured with a suture and tape.

Connection and drainage

Larger tubes are connected to traditional underwater seal systems. These have stood the test of time and are ideal for managing many inpatients. They are rather cumbersome, but it is easy to observe fluid "swinging" in the tube (this confirms that the tube is in the pleural space and patent). Bubbling indicates continued air leakage. A number of novel drainage systems are available, some of which do not include an underwater seal. They are suitable for draining fluid and have the advantage of being smaller and more portable. Flutter valves for drainage of pneumothoraces can be connected to the smaller tubes, making it possible to treat patients with pneumothorax as outpatients.

A bubbling drain should never be clamped, as there is a risk of causing a tension pneumothorax. Some physicians and surgeons clamp a swinging non-bubbling tube for a period and X-ray the patient before removing it. This allows small leaks, which would otherwise be missed, to be detected. This should only be done on wards where patients can be closely observed and where the medical and nursing staff are aware of the dangers of tension pneumothorax. If the patient becomes breathless or if subcutaneous emphysema develops the tube must be unclamped immediately.

Rapid drainage of pleural fluid can be uncomfortable and potentially dangerous. The rapid shift in pleural pressures and re-expansion of the previously collapsed lung can cause so called re-expansion pulmonary oedema, a potentially fatal complication. As a rule of thumb no more than 1-1.5 litre of fluid should be allowed to drain before the tube is clamped. If the patient starts to cough or complains of chest pain before this point is reached then drainage must be stopped as this may indicate significant mediastinal shift or the onset of re-expansion pulmonary oedema. Drainage can be resumed a few hours later.

i) Analgesia

Adequate analgesia should be prescribed after the procedure.

j) Suction

This is an area where there is little evidence and much disagreement amongst physicians. Different units have different policies on when to use suction. It is advocated in the treatment of persistent (>24 hours) pneumothorax, however there is little evidence to guide practice. If suction is used it must be a high volume low pressure system. The Vernon Thompson pump is one such system, but wall suction adaptors which allow high volume low pressure suction (less than 20cm water pressure) are also available.

k) Tube Removal

If a tube is not draining and no longer swinging or bubbling then it is either blocked or has fallen out of the pleural cavity. If it cannot be restored to function by flushing then it should be removed as it presents a portal for infection.

When a tube is to be removed the patient should be asked to perform a Valsalva manoeuvre (to increase pleural pressure and prevent air entering the pleural cavity) and the tube is withdrawn quickly. An assistant then ties the previously placed suture to close the hole. Smaller drains may not require this. Analgesia or sedation can be administered if required.

Further Reading

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