Chest Drains

Introduction

The role of a chest drain is to remove air or fluid that has built up in the pleural space. By preventing the accumulation of air or fluids, we hopefully help to avoid dyspnoea and respiratory compromise.

The pleural space is the potential space that exists between the visceral and parietal pleura in the chest. The visceral pleura covers the outside of the lungs and the parietal pleura lines the inside of the chest cavity. A small amount of pleural fluid is normally present: it helps prevent friction between the body wall and the thoracic organs, and also through surface tension, ‘sticks’ the lungs to the chest wall to help them to expand as the chest wall moves outwards during inspiration. When fluid or air accumulates in the pleural space, it separates the lungs from the chest wall and puts pressure on the lungs. Both of these factors makes it difficult for the lungs to expand and fill with air, causing clinical signs of dyspnoea, tachypnoea, and poor oxygenation of the blood.

Pneumothorax

Accumulation of air in the pleural space is termed a pneumothorax. If the chest wall is intact and the air has accumulated from a leak of air inside the chest this is a closed pneumothorax—such as might happen following lung trauma from an RTA, or if air leaks from existing lung pathology such as a tumour or abscess. If the chest wall is punctured or torn, then this is termed an open pneumothorax—for example dog bites or an air gun pellet, though there may well be damage to the lungs as well.

Pleural Effusions

Fluid that accumulates in the pleural space is called a pleural effusion. The fluid is then categorised by its characteristics and its origins:

1) Transudates. Form when there is a disturbance in the colloid osmotic forces of the blood. For example if an animal had very low blood albumin levels, the low colloid osmotic force of the blood would fail to ‘draw’ fluid from the pleural space back into the blood, leading to the increased accumulation of fluid, as normal control mechanisms are lost. The patients may have ascites or subcutaneous pressure.
Modified Transudates. Disease processes that increase the pressure within vessels may lead to fluid ‘leaking’ from the tissues into the chest. Examples are lung lobe torsions where venous and lymphatic drainage from the lung lobe is occluded and fluids leak from the lobe into the pleural space. Also diaphragmatic rupture, where abdominal organs may be trapped within the chest and their drainage occluded.

Non-Septic Exudates. These have high protein levels. A common cause of this type of effusion is FIP, where a peritoneal effusion may also be present.

Septic Exudate is a septic purulent fluid where infection is active, also known as a Pyothorax, more commonly seen in cats than dogs.

Haemorrhagic effusions consist of blood from trauma, surgery, tumours, or anti-coagulant rodenticides.

Chylous effusions: due to leakage of chyle from the thoracic duct.

Thoracic neoplasia can cause effusions by different means, from haemorrhage, obstructing lymphatic drainage, or inflammation of the pleura.

Indications for Chest Drains

A chest drain is often used pre-operatively, such as in lung lobe torsion. This allows the effusion to be removed, and so reduce respiratory compromise prior to general anaesthesia.

A drain may placed post-operatively prophylactically (following a thoracotomy or a diaphragmatic rupture repair) to prevent any accumulation of blood or air and allow the healing process to monitored.

This can be a matter of the surgeon’s opinion or personal preference. Bear in mind that rapid re-expansion of previous collapsed or compressed lungs can be dangerous and potentially fatal due to lung injury and oedema. In the cases of diaphragmatic rupture repairs, some surgeons may elect to drain the chest through the repaired diaphragm using an IV catheter with syringe and 3-way tap prior to closing the abdomen rather than place a chest drain.

A chest drain may be used to cure a condition without surgery. In a closed pneumothorax following an RTA, drainage of the air from the chest until a pleural tear has healed and the air leak stopped may be all that’s required. Similarly in pyothorax in cats the drainage of the septic effusion using bi-lateral chest tubes with ongoing lavage and appropriate antibiotics is usually successful.
Drains are indicated where there is likely to be an ongoing or rapid accumulation of fluid or air. Where it is probable that repeated thoracocentesis is likely, then a drain is preferable, as once placed it is safer and more effective.

A closed pneumothorax following an RTA may be the result of a tiny pleural tear. Following thoracocentesis the pneumothorax may not recur, as the tear may heal rapidly, so a drain is not indicated.

A modified transudate forming due to congestive heart failure, may be drained by thoracocentesis and then not recur due to appropriate cardiac medication being initiated, so again a drain is not indicated.

In MOST cases where a drain is indicated, the patient should be stabilised first, using oxygen, thoracocentesis and appropriate therapy. The drain can be placed later, either under general anaesthesia, or sedation combined with local anaesthesia.

**Selecting the Correct Chest Drain.**

**Materials-**

Most commercial drains are either made from PVC or silicone. The aim of using these materials is that they give a drain that is flexible and comfortable, but does not collapse when negative pressure is applied. They usually have between 3 and 6 side holes. In an emergency, a drain can be fashioned from a drip set, but when doing so, or if adding additional holes to a tube, be careful to make the holes less than a third of the tube diameter, or the drain may either kink or break off within the animal.

**Trochar or Non Trochar-**

Some drains come ready prepared with a metal stylet or trochar to allow placement through the chest wall. Non-trochar drains tend to be placed using curved artery forceps to push them through the intercostals muscles.

**Size-**

It is usually recommended that the tube diameter should be the same as the diameter of the main stem bronchus of the patient. This means a 14-16 Fr for a cat up to a 26-36 Fr for a giant dog.

**Thoracocentesis**

**EQUIPMENT:**

Butterfly needle or IV catheter
Performing thoracocentesis to remove a pleural effusion from a cat. Oxygen supplementation is provided by flow-by.

Thoracocentesis is often referred to as “both diagnostic and therapeutic”, meaning that it allows a sample to be collected to determine what kind of fluid is present, but also relieves the respiratory distress of the animal by removing the fluid and so allows lung expansion.

Thoracocentesis is usually performed at the 7th or 8th intercostal space with the animal in sternal recumbency. Usually the animal is conscious, local anaesthetic can be introduced if required. Sedation or general anaesthesia is rarely necessary unless the animal is struggling.
A wide area around the intended site (always tap both sides) is clipped and aseptically prepared. A butterfly needle with an incorporated extension set, or an intravenous catheter with a separate extension set is used, connected to a syringe via a 3-way tap. The extension set allows the animal some movement without dislodging the needle. The needle is inserted at 45 degrees to the chest wall with the bevel facing the lung to try and minimise trauma. If it has been possible to obtain a dorso-ventral radiograph of the chest before thoracocentesis, this may give a better idea of how high to place the needle:

1) Air present; the needle is inserted in the dorsal third of the chest
2) Effusion present; drainage is more efficient in the ventral third.
3) If there is a mixture of air and fluid, drain from the middle

If you apply suction to the syringe as soon as the needle enters the skin, the change in resistance on the plunger as the needle enters the pleural space, as well as the ‘feel’ of its progress, usually makes it obvious once the chest is entered.

Both sides of the chest should be drained, and radiographs taken afterwards to assess how efficient the drainage has been and whether a cause of the effusion is now obvious.

**Placing a Chest Drain**

**EQUIPMENT:**

- Appropriate chest drain
- Surgical kit
- Drape
- Suture material
- Clamp and 3-way tap.
- Syringe.

Chest drains are best placed with the animal under general anaesthetic, or, heavy sedation combined with local anaesthetic. Before placing a chest drain, the patient should always be stabilised to reduce the risks of the anaesthetic.

If the patient is cooperative it is usually possible to clip a large area of the required side of the chest and surgically prepare it with the patient in sternal recumbency and being pre-oxygenated. You can then anaesthetise and intubate the patient, rolling them into lateral recumbency prior to placing the drain.
Placing a chest drain with a troche in a dog.

When placing a drain with a trochar, a skin incision is made in the dorsal third of the chest over the tenth intercostal space. Pre-measure the drain from the skin incision to the level of the 2nd rib. The trochar and drain are introduced into the incision and tunnelled subcutaneously in a craniocaudal direction, until the tip of the trochar lies over the 7th intercostal space. (The aim of the tunnel is to prevent air tracking from the atmosphere to the chest). The trochar handle is elevated so that it is perpendicular to the chest wall, and the heel of the hand used to firmly push the trochar through the intercostal muscles, whilst the other hand grips the trochar tightly 2 cm from the tip to prevent it penetrating too far into the chest. Once into the chest, the trochar is withdrawn slightly so the tip doesn’t cause damage, the handle is lowered again, and the trochar is advanced a few centimeters in a cranioventral direction. The drain is then pushed off the trochar and advanced to a pre-measured level.

The tube must be clamped before the stylet is fully removed. The drain is connected to a 3 way tap with bungs, or a collection system. The drain is then attached to the body wall using a Chinese fingertrap suture or a commercial fixation device.

If placing a drain without a trochar, the procedure is the same, but the tip of the drain is gripped using long curved artery forceps, and the tip of the forceps is forced through the intercostal muscles into the chest.

It is important the positioning of the tube is confirmed. Radiographs should always be taken. Both lateral and dorso-ventral views are required. It is vital that the positioning of the tube is checked to make sure it will drain efficiently, it will be as comfortable as possible for the patient, and that obvious complications can be
avoided. Often, commercial drains have a radio-opaque marker strip along the tube with the last drainage hole cut into the strip to allow placement to be checked.

A drain that is kinked is often uncomfortable for the animal, irritant to the pleura, and will not drain efficiently from all of its drain holes.

**Chest Drain Management**

To make use of a chest drain, it is usually necessary to apply negative pressure to suck out the air or fluid from the pleural space. This pressure may be applied intermittently, or continuously.

Intermittent thoracic drainage is most commonly used. This tends to be performed using a syringe connected to a 3 way tap on the end of the drain. This should be performed with care. Remember to always have 2 points of closure on the drain - normally a gate clamp and the 3 way tap. How often this drainage is performed depends on how rapidly air or fluid is building up, but usually every 1 to 4 hours. Do not apply more than 3-5ml of negative pressure to the drain to avoid damage to the pleura. Make sure drainage is carried out in a sterile fashion, scrubbing up and wearing sterile gloves, and keep the ends of the bungs removed from the 3 way tap sterile.

Continuous drainage is used where the air or fluid is accumulating so rapidly that intermittent drainage is not enough to prevent respiratory compromise. This is most safely provided by using an underwater seal connected to a suction device. Commercially available systems consist of a collection chamber, a water trap and a suction control chamber. The aim of these systems is to prevent air being sucked back into the chest if the suction should fail, and also to prevent excessive suction from damaging the intra-thoracic structures. Where continuous drainage is used, the patient must be constantly monitored.

In an ongoing pneumothorax, an alternative to negative pressure drainage is the use of a Heimlich valve. Heimlich valves function as a one way valve; once attached to a chest drain they allow positive pressure to push air out from the chest. The size of Heimlich valve needs to be matched to the size of the animal, small animals will not have enough expiratory effort to push air through a large valve.

The dressing at the drain site must be changed daily, again in a sterile manner, and a chest bandage or stockingette dressing applied to prevent the animal interfering with the drain.

Close observation and monitoring of the patients is paramount. Changes in cardiovascular parameters or respiratory rates may give an early warning that all is
not well. Patient interference with the drain or failure in the drainage system could lead to life threatening pneumothorax.

Prevention of hospital-acquired infection is important. Sterile handling of the drain and syringes when draining the chest and redressing the site are essential.

Analgesia is an important consideration. Often these are post-operative cases that have had thoracic surgery and sternotomies. An animal that is in a lot of pain from its chest wall will not breathe efficiently and so gas exchange is compromised. Make use of multi-modal analgesia. Opioids and non steroidal anti-inflammatory drugs can be used systemically. Local analgesia can be important as well. Intercostal nerve blocks can be used for the pain of intercostal thoracotomy incisions, and local anaesthetics can be applied via the chest drain to help with the pain of sternotomy incisions and discomfort from the drain itself. Bupivicaine is the local anaesthetic of choice for these methods.

The positioning of the animal is important. As with all critical patients, we need to ensure that while they are recumbent we reduce the risk of decubital ulcers and other problems. Respiratory function is usually maximised by having the patient in sternal recumbancy, but in cases of median sternotomy this may not be comfortable, especially in thin skinned or lean animals where the sternotomy has been closed with wire, so ensure plenty of padding along the ventrum in a dressing, and a well cushioned bed. Where an effusion is being drained, drainage is often maximised with the animal in sternal recumbency. In a pneumothorax, most air will be drained with the animal in lateral recumbancy with the drain uppermost.

**Complications**

As mentioned previously pneumothorax is a risk, either due to patient interference, or problems with the drain: such as leaks around the tube subcutaneously or connectors coming undone.

Cellulitis or subcutaneous oedema can occur at the site of drain placement and along the subcutaneous tunnel. Ascending infection is a risk which increases with the length of time the drain is present.

Rarely, the drain can cause irritation leading to pleural effusion, cardiac dysrhythmias, phrenic nerve irritation and Horners syndrome.

**Drain Removal**

The drain is removed when no more air is being removed, or when fluid production is minimal. The presence of the drain itself provokes some inflammation and so some fluid production. When the output of the drain falls to between 2 and 4 ml of fluid per
kg of patient per day it is safe to assume that this is due to the drain, and so remove it.

Ideally, at removal, the tip of the drain should be cut off with sterile scissors and sent for culture and sensitivity. Any evidence of infection can then be treated with an appropriate antibiotic.