

9 Pus in the pleura, pericardium & lung

9.1 Pus in the pleural cavities: empyema

Pus usually reaches the pleural cavity from infection of the lung adjacent to it. This can be pneumonia, a lung abscess, or the pneumonitis that may follow an inhaled foreign body (usually in a child), or carcinoma of the bronchus (usually in a cigarette smoker or mine worker). Frequently, an empyema is tuberculous, especially in HIV disease; rarely it may follow rupture of a liver or subphrenic abscess through the diaphragm.

A common history is that a week or more before, as the patient was beginning to recover from a chest infection, improvement stopped. He now remains ill, anorexic and febrile, and is starting to lose weight, despite antibiotics. Many kinds of bacteria can be responsible, especially *streptococci*, *staphylococci*, and *E. coli*. Antibiotics are only effective in the earliest stages, and may mask the symptoms of an empyema later. The result is that empyemas can remain undetected for years and are often missed in a busy outpatient department. This is sad because you can treat them, so watch out for them, and ask your staff to do so too.

Pus in the pleural cavity, like pus anywhere else, must be removed. To begin with, it is thin, like serum; later it thickens and looks like scrambled egg. So adapt your method of removing it to its thickness. While it is still thin, aspirate it using a three-way tap or use closed drainage, as if you were draining blood from an injured chest. The surfaces of the pleura will not have stuck together at this stage, so you will have to use an underwater seal to prevent air getting into the pleural cavity and letting the lung collapse.

If the pus in the pleural cavity is left undrained, it will soon become too thick to flow down a long thin tube into a bottle. Once the empyema has reached this stage, you can improve things greatly by draining pus through an open drain. To do this, you need to remove a piece of a rib and open its bed. The surfaces of the pleura will be stuck so firmly that a pneumothorax will not ensue. In order to do this safely, *be sure to:*

- (1) Remove the piece of rib from inside its periosteum, so as not to injure the vessels and nerve which run just below it.
- (2) Place the inner end of the drainage tube at its most dependent site in the sitting position.

If pus in the pleural cavity remains even longer, it will be replaced by fibrous tissue which will be very difficult to remove: this is an extensive operation called decortication.

Children have special problems. In a child between 1-3yrs, an empyema may follow a post-measles pneumonia, or the rupture of a staphylococcal lung abscess into a pleural cavity.

The child is likely to be malnourished, anaemic, and anorexic, with a persistent cough, fever, dyspnoea, diarrhoea, and perhaps vomiting. He may be very sick indeed with a pyopneumothorax under tension. Check the HIV status, and drain the pus.

THE ANATOMY OF THE PLEURAL CAVITIES

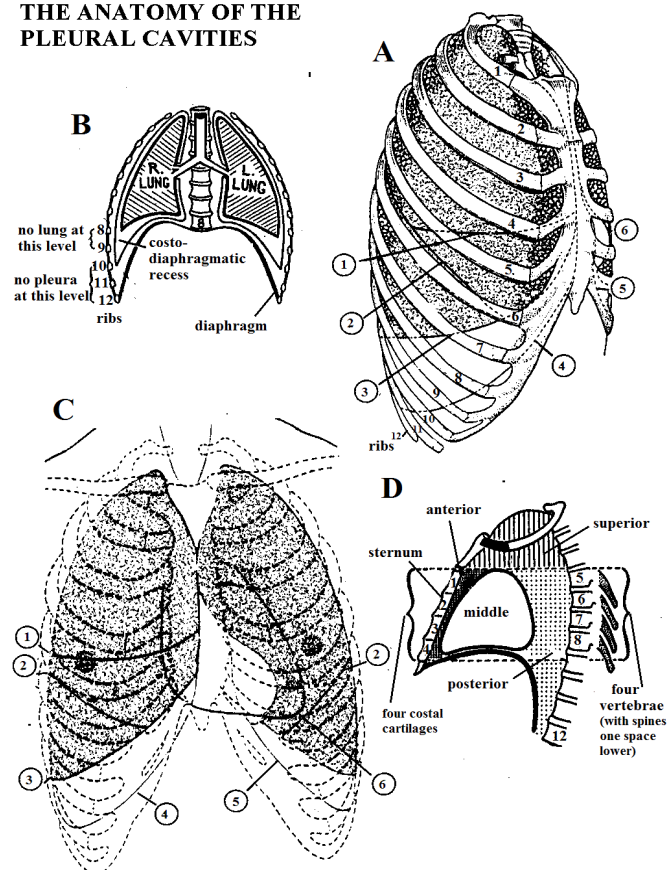


Fig. 9-1 THE ANATOMY OF THE PLEURAL CAVITIES.

A, relation of the pleurae and lungs to the chest wall. **B,** coronal section of the thorax (semischematic). **C,** ventral aspect of the thorax showing the surface projections of the heart and pleurae. **D,** subdivisions of the mediastinum, with surface markings.

N.B. The anterior mediastinum contains essentially only the thymus.

(1) horizontal fissure. (2) oblique fissure. (3) inferior border of the right lung. (4) costodiaphragmatic reflexion of the right pleura. (5) costodiaphragmatic reflexion of the left pleura. 6, cardiac border. *N.B. In lung collapse, the level of the diaphragm rises.*

A, C 9-23, from Gray's Anatomy, Churchill Livingstone. B, 6-6 & D, 6-9 from Basmajian JV. Grant's Method of Anatomy 9th ed 1975, with kind permission.

CLINICAL FEATURES. If an empyema involves the whole of the pleural cavity and contains $\geq 1L$ of pus, you should be able to diagnose it clinically. Look for limited movement of the chest on the affected side, shifting of the trachea and apex beat, dullness to percussion, reduced breath sounds and reduced vocal fremitus. Vocal resonance (the sound "99") may be high-pitched at the top of the empyema and absent over its lower part.

RADIOGRAPHS usually show a dense area at one lung base, often rising laterally towards the axilla. Take an *erect PA and a lateral view* to show the site and extent of the empyema.

N.B. A ruptured diaphragm or hiatus hernia with stomach or colon in the chest may look like a pyopneumothorax on a radiograph if there is no air visible!

ULTRASOUND is very useful and will indicate if there are septations in the pleural fluid.

ANTIBIOTICS. When an empyema is established, antibiotics are ineffective. Pus must be drained. If there is fever or malaise, treat with chloramphenicol until sensitivity tests show the need for change.

ASPIRATING A PLEURAL EFFUSION (GRADE 1.1) INDICATIONS

- (1) To confirm the diagnosis.
- (2) To remove the bulk of the fluid in the early stages while it is still thin (*i.e.* needing only one pull to fill a 10ml syringe using a 21G needle).

EQUIPMENT. A Martin's aspirator, with a 3-way tap, a 20ml syringe, LA solution and a receiver. Or, improvise the equipment.

METHOD. Preferably use the sitting position, leaning over a bed table or a pile of pillows. You may need to provide oxygen. Aspirate near the lowest point of the empyema, as defined on the PA and lateral radiographs, or by ultrasound. To establish this, aspirate several sites if necessary, so as to find the lowest site that yields pus, but remember the surface markings of the pleura. Look these up if you are not sure, and mark them on the patient's skin. Commonly, the posterior axillary line is the correct vertical line in which to aspirate. Infiltrate LA solution into the skin and subcutaneous tissues over the chosen space, down to the pleura (*it does not matter if you enter the pleura: you will do so anyway!*) and also a space above and below. Insert the needle, pierce the pleura and aspirate gently; turn the tap and discharge the fluid into a receiver. If you don't have a 3-way tap, you can attach a giving set and use an empty vacolitre of IV fluid or attach a glove.

CAUTION! Very rapid decompression of a large pleural effusion can cause acute mediastinal shift and a vasovagal attack.

If the patient becomes distressed, clamp the drain immediately!

If the effusion recurs, repeat the aspiration but if pus does not stop forming, proceed to closed drainage.

CLOSED DRAINAGE FOR A PLEURAL EFFUSION (GRADE 1.4)

Many empyemas don't resolve on aspiration alone and closed drainage is necessary. Use an Abram's needle to get a pleural biopsy for tuberculosis or melioidosis. Insert an underwater seal drain (1cm diameter for an adult, 0.5cm diameter for a child), as for a haemothorax. Instil 250,000 units of streptokinase bd for 3 days to promote fibrinolysis. Leave the drain for at least 2wks until firm adhesions have formed between the surfaces of the pleura, which will prevent the lung collapsing when you take the tube out.

The instillation of 5-10g of lipiodol before repeat radiographs is a useful way of defining the lowest point of the empyema. Beware of damage to the liver or spleen by inserting a drain too low!

If radiographs show disappearance of the empyema and re-expansion of the lung, cut the suture securing the tube, and pull it out quickly while closing the hole with a purse-string suture. Remember to follow up for diagnosis of TB.

If there is no improvement, proceed to open drainage.

EMPHYEMA THORACIS (PYOTHORAX)

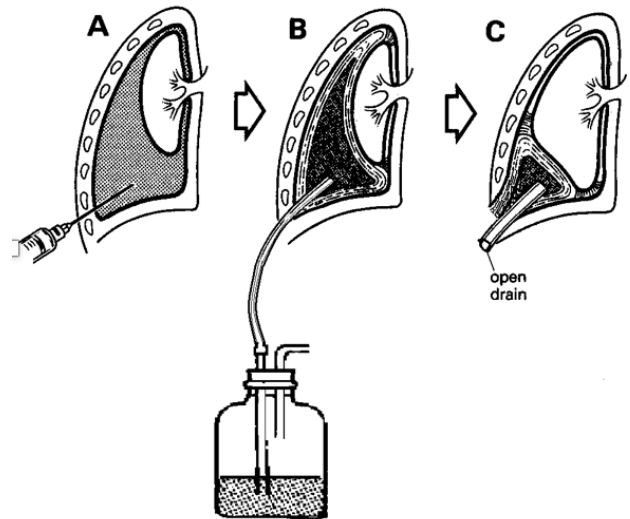


Fig. 9-2 STAGES IN THE DRAINAGE OF PUS IN THE PLEURA. A, drain a very recent pleural effusion with a syringe and needle. B, if pus recurs, use an underwater seal drain in a bottle (closed drainage). C, if pus becomes thick, resect a rib, and insert a short wide tube (open drainage). Shorten this tube as the empyema drains, and make sure it is in the bottom of the cavity.

OPEN DRAINAGE FOR AN EMPHYEMA, RESECTING A RIB: PLEUROSTOMY (GRADE 2.5)

INDICATIONS. If pus thickens, so that aspiration needs 2 or more pulls to fill a 10ml syringe using a 21G needle, or where the pus has over $\frac{1}{3}$ as sediment, or when closed drainage has failed, proceed to open drainage. The lung must have stuck to the ribs. Prove this by slowly withdrawing the tube of the underwater seal drain from the water. If the column of water does not run up towards the pleura, but stays in the tube, the pleura has stuck to the ribs, so that an underwater seal is unnecessary and open drainage can start.

If pus bulges on the chest wall (*empyema necessitatis*), almost certainly due to TB, open drainage is indicated.

RADIOGRAPHS. Examine PA and lateral chest films with the greatest care to see which rib to resect. If you cannot easily see the lowest point of an empyema, inject 10ml of oily contrast medium before you expose the films.

ANAESTHESIA. Use a combination of LA, intercostal blocks and sedation in theatre. Block the intercostal nerves at the site of your chosen incision, and also one rib above and one below it as far posteriorly as possible.

METHOD. Drain the empyema from its lowest point in the sitting position. Choose the lowest point of the empyema posteriorly. Often, the 9th rib in the posterior axillary line is the best, but it may be below this.

CAUTION! Don't make the opening too low, because the diaphragm will rise as the pus drains and block the opening. It should always be at least one space above the diaphragm. Use the sitting position, leaning forwards against the operating table. Before incising, confirm, by aspiration through more than one intercostal space, that you have chosen the correct rib to remove. Make a 9-15cm vertical incision, extending above and below the selected rib, so that you can more easily resect the rib on either side if necessary. Cut down to the rib, and incise the periosteum along its centre. Use a curved Farabeuf's rongeur to strip the periosteum with its attached intercostal muscles from the outer surface of the rib. Clean its upper and lower borders. Then use Doyen's raspator (or Farabeuf's rongeur) to remove the periosteum from its inner surface. Strip its upper and lower borders (9-3).

CAUTION!

(1) The intercostal blocks should have anaesthetized the parietal pleura adequately; if they have not, repeat the intercostal blocks and wait. If you fail to administer adequate anaesthesia, extreme pain may cause a vasovagal attack.

(2) The intercostal vessels can bleed severely if you fail to identify them, so *be sure to avoid them by keeping inside the periosteum.*

Excise a 7-10cm length of rib with an osteotome, rib shears, or a large pair of bone cutters. In HIV disease, excise an adjacent length of rib as well to make an adequate-sized hole. Make an incision in the bed of this rib through into the pleural cavity. Open it with a haemostat, explore it with your finger, and remove what semisolid pus you can with sponge holders. This will probably induce coughing. Take a biopsy of the pleura for histology. Irrigate the cavity with copious amounts of warm water, *not hydrogen peroxide.*

CAUTION!

(1) **If when you explore the cavity with your finger, you find that you have not removed the rib at the bottom of the cavity, remove the rib below.** If you don't do this, the empyema will not resolve completely.

(2) Send pus for smear and culture; it may be tuberculous, which looks different from ordinary pus, is more watery and contains particles.

Fix a wide radio-opaque tube in the empyema cavity, leaving about 2cm above the skin surface. Fix it with a suture, a safety pin and adhesive strapping to avoid it disappearing into the chest; apply a large gauze and cotton wool dressing.

POST-OPERATIVELY, encourage vigorous breathing exercises by blowing into balloons or surgical gloves. Flush the cavity daily with warm sterile water or hydrogen peroxide. Encourage sleeping on the affected side to improve drainage. Monitor the size of the cavity by introducing contrast medium and taking radiographs.

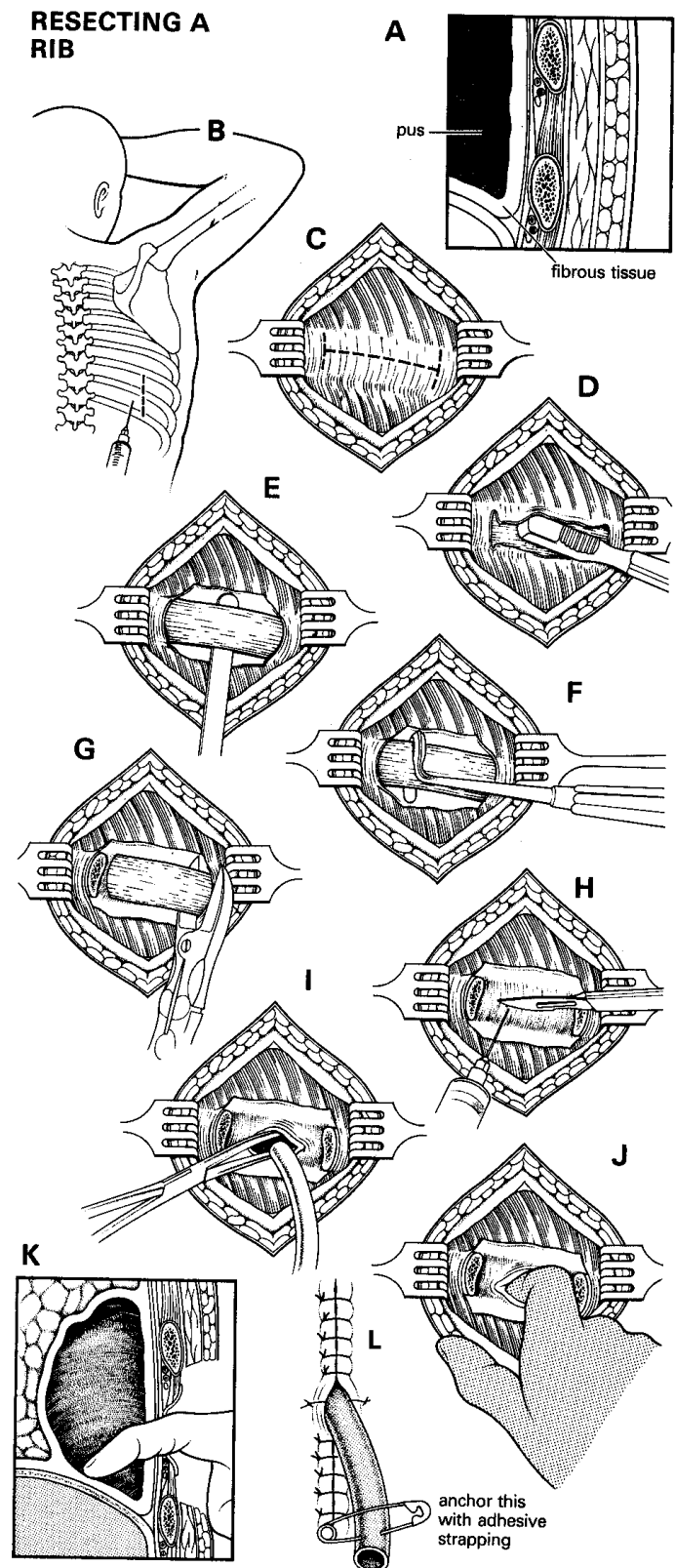


Fig. 9-3 RESECTING A RIB.

A, empyema covered with a thick layer of fibrous tissue. B, common site for draining an empyema: the 9th rib in the paravertebral line. Vary this as the occasion demands. C, incise the skin down to the periosteum. D, reflect the periosteum with Farabeuf's rongeur. E, reflect the periosteum off the inner surface of the rib. F, complete the task with Doyen's raspator. G, resect the rib. H, prepare to incise the periosteum in the bed of the rib. I, suck out the pus. J, put in a finger to break down the loculi. L, drainage tube in place.

Alternatively, measure how much sterile saline you can run into the remaining cavity.

When drainage stops or becomes <5ml/day, remove the tube. The residual sinus will heal, provided that there is no bronchopleural fistula. This can take 2 to 3 months.

CHILD WITH AN EMPYEMA. *You cannot drain a small child's pleural cavity adequately by inserting an intercostal drain between two ribs, because the drain will be nipped by the ribs or obstructed by pus. So remove 1-2cm of rib, using ketamine (LA is inadequate in children), to make a hole which is big enough for a tube. Adequate drainage will eventually achieve a cure if:*

- (1) the lung is not immobilized with thick fibrin,
- (2) there is no bronchopleural fistula, and
- (3) the empyema is localized.

Start drainage with an underwater seal drainage bottle. This will limit activity, and may cause the drain to be pulled out, but the lung will expand.

When you are confident that the lung has stuck to the ribs (see above), cut the tube short, fit it with a pin and butterfly strapping, put a colostomy bag over it to collect the pus and allow exercise. Increased activity is the best physiotherapy.

DIFFICULTIES WITH AN EMPYEMA

If air comes out with the pus, there is a BRONCHOPLEURAL FISTULA which is unlikely to close spontaneously. You can confirm this if, on coughing, pleural irrigating fluid comes up. Make sure tuberculosis is treated, if present. Once there is no more pus draining, fill the drainage bottle with 500ml sterile water and empty this into the pleural space to clean it. Drain this and repeat the process till the fluid comes out clear.

Then perform a PLEURODESIS: mix 2-5g talcum powder (or tetracycline, if there is an allergy to talc) with 50ml saline to make an opaque milky fluid which can still flow, and introduce this into the pleural space through the chest drain using a bladder syringe. If the patient feels a pleuritic pain when you do this, the inflammatory reaction may well seal the fistula. If this procedure fails, you can repeat it one or two times more. Otherwise a decortication may be needed.

If the intercostal vessels bleed, encircle them with a needle and thread. Avoid tying the nerve because this is painful. If you have difficulty, transfix the vessels with a ligature, so that they are compressed against the stump of the rib which remains.

If the empyema fails to heal:

- (1) The drainage tube may be too high or too far forward.
- (2) You may have removed it too early.
- (3) You may have put it in too late.
- (4) There may be a foreign body, such as a piece of drainage tube, in the chest.
- (5) There may be a fistula between the bronchi and the pleura.
- (6) There may be tuberculosis, carcinoma, actinomycosis, or a ruptured liver abscess (15.10), which may be amoebic.

Further dependent drainage is all that is probably needed for (1), (2) or (3).

Instil 5-10ml of contrast medium, repeat the radiograph, and if necessary resect another rib.

9.2 Pus in the pericardium

Fluid sometimes accumulates in the pericardium. In sufficient quantity this may embarrass the action of the heart (cardiac tamponade) and may be fatal, so you should remove it urgently! The fluid may be blood after a cardiac injury or an effusion from many causes, either infected or sterile. Presentation with symptoms that immediately suggest a pericardial effusion is unlikely. Another initial diagnosis is likely before you observe some of the following signs:

- (1) grossly distended neck veins,
- (2) *pulsus paradoxus* (>10mm Hg fall in arterial pulse pressure on inspiration),
- (3) a large cardiac shadow on a chest radiograph.

Elsewhere in the body, you drain pus to treat an infection. In the pericardium, you are mainly draining it to overcome its mechanical effects.

Severe illness with fever and breathlessness is accompanied by signs of a low cardiac output with a poor peripheral circulation; there is a small pulse volume, tachycardia, a low normal or subnormal blood pressure, and soft heart sounds. Early on you may hear a pericardial rub, but the accumulation of fluid soon separates the pericardial surfaces and stops the rub. There are the signs and symptoms of heart failure (enlarged liver, dependent oedema or ascites), and an increased area of cardiac dullness. The severity of the signs of cardiac tamponade is related more to the rate at which fluid accumulates in the pericardium than to the volume of fluid in it. The diagnosis may be obvious, or if fluid has accumulated slowly, it may be difficult.

There are problems:

- (1) Any cause of cardiac failure may have distended the neck veins.
- (2) Although *pulsus paradoxus* strongly suggests a pericardial effusion, not all patients show it.
- (3) The radiographic finding of a large globular heart can also be due to gross cardiac enlargement without there being any fluid in the pericardium.

Ultrasound is much more reliable, and can also give you information about the thickness of the pericardium and the thickness of the fluid in the sac. It can also guide you during aspiration.

The great danger in putting a needle into the pericardial cavity to drain it is that:

- (1) You can easily penetrate the right ventricle, cause bleeding, increase the fluid in the pericardial cavity, and produce an acute fatal tamponade.
- (2) You may cause ventricular fibrillation with the tip of the needle.

Even so, in spite of these dangers, not aspirating the pericardium may be more deleterious than aspirating it, when there is tamponade.

N.B. The fluid from the pericardium may be heavily blood-stained and come out in a pulsatile manner, giving you the false impression you have entered the heart!

However with HIV, a pericardial effusion is so likely to be due to TB that *you should start treatment without aspiration*, particularly if ultrasound confirms a thickened pericardium.

RADIOGRAPHS. A *very large globular heart*, often with venous congestion. Depending on what is causing the pericarditis, you may see basal shadows in the lungs, or pneumonia obscuring the heart.

ULTRASOUND. You can easily recognize fluid around the heart. A thickened pericardium suggests a chronic process like TB, but not every case of pericardial effusion is tuberculous!

ECG. Tachycardia, usually sinus rhythm, a raised S-T segment (non-specific), an inverted T wave (late, non-specific), low voltage QRS complexes (highly suggestive).

TAPPING THE PERICARDIUM

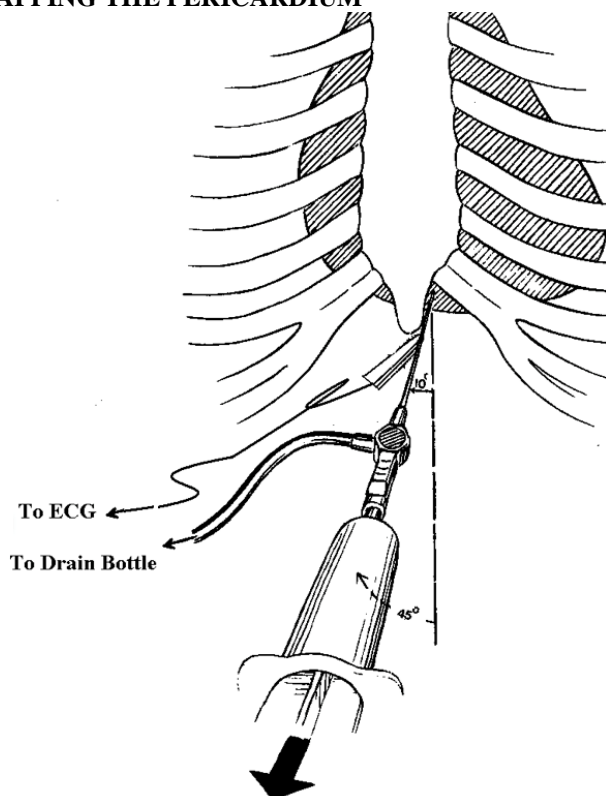


Fig. 9-4 ASPIRATING THE PERICARDIUM.

Insert the needle, attached to an ECG lead, in the epigastrum immediately to the left of the xiphisternum. With the patient propped up 45° , incline the needle horizontally and direct it 10° towards the left. In this way, if it does puncture the heart, it is more likely to meet the thicker left ventricle than the thinner right auricle.

DIFFERENTIAL DIAGNOSIS OF PERICARDIAL EFFUSION leading to tamponade is, in probable order of frequency:

Suggesting tuberculosis: a history of cough, bloody sputum, weight loss and chronic malaise, known HIV infection.

Suggesting malignancy: blood-stained fluid aspirated: *e.g.* Kaposi sarcoma.

Suggesting viral myocarditis: an influenza-like illness with generalized muscle pains. Early, you may hear a pericardial friction rub. Fluid may be blood-stained.

Suggesting a pyogenic bacterial cause: some other site of infection, such as pneumonia, meningitis, or measles with secondary staphylococcal infection. Often, there is some obvious site of infection, but not always.

Other causes of pericardial effusion that might cause tamponade include: uraemia, malignant deposits (only if they bleed seriously), collagen diseases, and the rupture of an amoebic abscess into the pericardium (rare).

These are some causes of a large heart *without* fluid in the pericardial cavity:

Suggesting rheumatic heart disease (common): valvular lesions; these are usually easily diagnosed by hearing heart murmurs.

Suggesting cardiomyopathy: an enlarged heart clinically and radiologically. The cardiac outline may be globular and closely simulate fluid in the pericardium; HIV status is often +ve.

Suggesting endomyocardial fibrosis (EMF): bilateral atrioventricular incompetence is usual with eosinophilia.

PREPARATION

Prepare as you would a theatre case using GA. Find two assistants, one to watch the ECG or the pulse, and ready to resuscitate if necessary, and another to fetch anything more that might be needed for resuscitation. Have the full resuscitation equipment available: laryngoscope, tracheal tubes, a sucker, oxygen, and an anaesthetic machine or an Ambu bag. Perform an ECG while you are aspirating, or, failing this, ask someone to feel the pulse continuously. Place the patient sitting comfortably at 45° ; be sure to have IV access.

EQUIPMENT. A 16G (or 12G for thick pus) long cannula, a 3-way tap, and a 20 or 50ml syringe.

ASPIRATION (GRADE 2.3)

Infiltrate with lidocaine 2%. Attach the V-lead of the ECG to the cannula and insert this in the epigastrum immediately to the left of the xiphisternum. With the patient propped up at 45° , push the needle horizontally and direct it 10° towards the left (9-4). (*In this way, if it does prick the heart, it is more likely to meet the thicker left ventricle than the thinner right auricle.*)

If you can, aspirate under ultrasound guidance. Advance the needle slowly 1-2cm, aspirating frequently until fluid is withdrawn into the syringe. If the needle touches the heart, a sudden ST elevation will appear on the ECG monitor, and you will feel it knock against the needle.

Withdraw it a little and remove the needle, leaving the plastic cannula to drain the fluid. Repeat the ultrasound, if possible, to check if you have succeeded in draining all the fluid, or if it has re-accumulated.

CAUTION! If there is a sudden deterioration with absence of a pulse:

- (1) Immediately remove the cannula.
- (2) Clear the airway and ventilate with the Ambu bag.
- (3) Start external cardiac massage at a rate of 30 beats to 1 ventilation.
- (4) Administer 1mg adrenaline IV (and flush it through with saline) if there is no trace on ECG, or 50-100mg (2.5-5ml 2%) lidocaine IV if there is ventricular tachycardia (VT) or ventricular fibrillation (VF), or 0.3mg atropine IV if there is bradycardia. Continue cardiac massage. (*A defibrillator is useful, if available, for VT and VF.*)

If a normal heart trace does not return, administer further doses of drugs as required, and add 50ml 8.4% sodium bicarbonate. *Only when the situation is under control should you intubate and ventilate the patient mechanically.*

PERICARDIAL DRAINAGE (PERICARDIAL WINDOW) (GRADE 2.5)

If you aspirate pus, and it recurs, proceed to open drainage. Make a 4-5cm incision on the left side of the xiphisternum; incise the *linea alba* and proceed upwards in the extraperitoneal plane until you reach the pericardium. Put two stay sutures through the pericardium and lift this off the heart; then cautiously incise the pericardium, enlarge the hole and insert a Ch16 balloon catheter for thin pus and a Ch22 one for thick pus. Flush this with saline. Leave this draining for 2-6wks into a bag: no underwater seal is needed. If you leave the drain in long, it may erode the friable myocardium with disastrous results!

These patients have low cardiac output and usually need diuretics; dysrhythmias are common and often need IV lidocaine.

N.B. Recurrence of pyopericardium is common, especially if the pus is thick and looks like scrambled egg! Open drainage is simple and effective, but even then the pus may re-accumulate. In this situation a partial pericardiectomy through a left lateral thoracotomy, avoiding the phrenic nerve, is advisable, and is probably more effective, if you can arrange it.

9.3 Pus in the lung

Pus can collect in the substance of the lung as a result of:

- (1) aspiration of vomit, especially after getting drunk or during anaesthesia,
- (2) aspiration of pus, *e.g.* from a retropharyngeal abscess,
- (3) inhalation of a foreign body, especially organic, such as a peanut,
- (4) lateral spread from pneumonia, especially from *Staphylococcus aureus* or *Klebsiella pneumoniae* if multiple or *Streptococcus pneumoniae* if solitary in a lower lobe,
- (5) lung contusion,
- (6) bronchial obstruction by carcinoma,
- (7) an infected pulmonary embolus,
- (8) haematogenous spread especially in HIV.

Presentation is with coughing up copious amounts of foul sputum; there may be finger clubbing, and radiographs show a cavity with a fluid level. This may look like a tuberculous cavity if small, and a pyopneumothorax if large.

Pus, like everywhere else, must be removed, but *not* usually by incision. Postural drainage at physiotherapy is the most important treatment (11-24); use antibiotics to prevent spread of infection into the rest of the lungs. Drainage, however, may not be successful if the bronchus is blocked by a foreign body or carcinoma: it may be possible by bronchoscopy (29.14) to remove the former and biopsy the latter.

If there is a large lung cavity, especially peripherally placed, you can drain it through a rib resection (9-3) using a chest tube.

N.B. However, some lung abscesses, especially in children, need to be removed by pulmonary lobectomy.