Chapter

Pericardial Diseases: Surgery for Pericardial Effusion

Ing Xiang Soo

Abstract

Management of pericardial effusion is a common topic for cardiothoracic surgeons. From a surgeon's perspective, we would review and evaluate patients for surgical drainage. Besides discussing the frequent indications for performing pericardial window creation, we would go through the decision-making process during the perioperative management of these patients who might be critically ill. For example, regardless of whether surgery is for diagnostic or therapeutic reasons, the risks of surgery must be weighed against the benefits including the odds of quality of life across a reasonable life expectancy.

Keywords: pericardial window, surgical drainage

1. Introduction

Management of pericardial effusion is a common topic for cardiothoracic surgeons. In this chapter, we will discuss the common etiologies referred for surgical management. From a surgeon's perspective, we would review how to evaluate patients for surgical drainage, as well as the frequent indications for performing pericardial window creation. Technically, surgery is rather straightforward compared to other procedures done by cardiothoracic surgeons; however, it requires lots of decision-making experience during the perioperative management of these patients who might be critically ill. For example, regardless of whether surgery is for diagnostic or therapeutic reasons, the risks of surgery must be weighed against the benefits including the odds of quality of life across a reasonable life expectancy.

Other discussion points will include anterior thoracotomy technique vs. video-assisted thoracoscopic surgery (VATS) approach. Other technical points include identifying the phrenic nerve and removing adequate pericardial tissue anterior to the nerve to avoid risk of recurrent pericardial effusions.

2. Reasons requiring surgical drainage

2.1 Neoplastic

The common etiologies encountered in surgery for pericardial effusion can be broadly classified into neoplastic, infective, and reactive. For neoplastic causes, frequently malignant pericardial effusion can manifest after tumor involvement of the pericardium. Majority of this type of effusion will be from hematogenous

spread, whereby primary tumors of the pericardium are rare [1]. Occasionally, pericardium effusions can result from local spread of thymic malignancy and even myocardial tumor-like lymphoma. We will discuss the rationale for proceeding with therapeutic surgical drainage for this group of patients later, as this involves a careful consideration of their long-term prognosis.

2.2 Infective

Another etiology of pericardial effusions will include infectious causes. Even though rare in this day and age due to the use of antibiotics, infection of the pericardial space is a consideration in immunocompromised patients. These groups of patients can be rather septic from this deep-lying infection, especially if the source is bacterial in origin. In areas where tuberculosis is still prevalent, infection involving the pericardial cavity has been reported [2]. Treatment with the appropriate antibiotics can then be optimized when drainage has been achieved and the correct causative organism identified. The role of the surgeon here is to assist in surgical drainage for both therapeutic and diagnostic reasons. Occasionally, smaller bore drains inserted percutaneously are unable to reduce septic foci, and surgery is required for source control. However, unlike creating a permanent window for drainage into the pleural space in cases of malignant effusions, I would be less inclined to do so for infective causes. This is to avoid contaminating the pleural space with infection.

2.3 Traumatic

For trauma-induced pericardial effusion, most surgeons would suggest surgical exploration rather than conservative approach. This is because in the acute setting, most patients are unstable with multiple injuries, and they would require urgent surgery to exclude ongoing bleeding into the pericardial cavity. The resultant tamponade is rapidly fatal unless drainage and hemostasis are quickly established. Any blunt or penetrating injury in the cardiac box (bounded by both nipple lines laterally, the clavicles superiorly and the costal margin inferiorly) must be viewed with a high index of suspicion that there is myocardial injury. Opinion is divided between the left anterior thoracotomy incision and the sternotomy incision. The sternotomy approach is safer as it allows rapid access to the ascending aorta and vena cava if cardiopulmonary bypass is urgently required for repair of a heart chamber perforation. Left anterior thoracotomy avoids a bigger incision and the risk of sternal wound infection; however, if cardiopulmonary bypass is required, it may still require conversion to a sternotomy for better control. Another reason why traumatic pericardial effusion cannot be usually treated conservatively is the fact that most commonly the right ventricle is involved and this usually requires surgical repair.

2.4 Iatrogenic

Iatrogenic pericardial effusion can be caused by injury to any cardiac chamber or intra-pericardial injury to the superior vena cava. Especially if the patient is anticoagulated and symptomatic, urgent intervention is required. This may be in the form of an urgent pericardiocentesis to prevent impending cardiac tamponade [3]. If there is persistent drainage after pericardiocentesis or if it is unable to adequately decompress the pericardial cavity, emergency surgical drainage is indicated. The approach would be similar to that mentioned above, although I would recommend a sternotomy approach for better exposure and safety.

2.5 Others

Another common cause of pericardial effusion encountered by both thoracic and cardiac surgeons includes the broad group underreactive causes. This also covers the postcardiotomy pericarditis and Dressler's syndrome [4, 5]. It often occurs after cardiac surgery when the pericardium gets inflamed and produces pericardial fluid which cannot be reabsorbed fast enough. Drainage can be in the form of pericardiocentesis or open subxiphoid approach which avoids re-sternotomy. But for persistent pericardial effusions, creating a surgical window between the pericardial cavity and the pleural cavity is better suited for longer-term drainage.

I would classify unknown and idiopathic causes as underreactive. This is because despite clinical suspicion, some cases of pericardial effusion may not have a definitive diagnosis. Specimens of pericardium tissue and pericardial fluid obtained during surgery may only be labeled as inflammatory or even normal in appearance under the microscope. Hence, apart from knowing there is an inflammatory reason, the patient should be treated with other clinical inputs to achieve diagnosis. These causes which are also not exhaustive include uremic, auto-immune, drug-related and postradiation. However, despite not knowing the diagnosis, most of the time, surgical drainage is therapeutic and achieves the desired outcome of symptom relief.

3. Presurgical considerations

3.1 Indications

This is the portion that the art of medicine is needed more than the science. Being a surgeon, it would appear rather strange that I would advocate surgical drainage only if all other alternatives have been considered first. But my approach to surgical drainage of pericardial effusion is always to weigh the risks against the benefits. This is always the case in medicine and even more so in these patients who might be in extremis prior to surgery.

An ideal patient for surgical drainage would be one with good life expectancy despite advanced disease or cancer. I do not recommend surgical drainage for patients with less than 6 months of life expectancy. Surgical drainage is to improve long-term outcome and relief of symptoms in patients, so I would consider other forms of drainage for short-term belief.

3.2 Preoperative assessment

A great deal of effort is usually required to counsel the patient prior to any surgery for pericardial effusion. In fact, I take the most time to talk to this group of patients, even more than patients with other pathologies. This is because patients in this group tend to have multiple medical conditions and pro-morbidities which complicate surgery. Speaking to them and understanding their wishes and concerns is paramount. For example, if they are not affected functionally by the pericardial effusion, they may not want surgery especially if surgery is high risk and can lead to adverse outcomes which they might not accept.

The patient should not have any other contra-indications to general anesthesia. A good bedside assessment, which has been handed down from seniors, would be to check if the patient is able to lie completely flat with the head not elevated. This tells two things about the patient: firstly, the pericardial collection is not causing too much hemodynamic compromise that it is affecting venous return to the heart, and, secondly, it is to ensure there is no other pathology that

could lead to his or her symptoms. It is an unwise clinical decision to operate and drain a pericardial effusion promising full relief of symptoms, where, for example, the symptoms are actually manifested from compression of the airway due to mediastinal disease.

3.3 Timing of surgery and long-term outcomes

The timing of creating a surgical pericardial window also varies widely. For the first presentations of pericardial effusions, surgery may not be always necessary after initial pericardiocentesis and resolution of pericardial effusions. As patients could be treated with chemotherapy or immunotherapy for their primary disease or the causative factors modified to reduce the risk of recurrent effusions, I do not recommend surgical drainage for all first presentations. However, once the effusion recurs, this increases the subsequent times that it continues to be recurrent; hence, I do advocate creating a pericardial window for this group of patients. As all other disease, discussion with the patients' primary physician or oncologist is advised to better optimize care.

Another issue which must be discussed with the patient is the likelihood of recurrent pericardial effusion despite surgical drainage. The risk of this recurring can be up to 16% in reported cases [6]. Of course there are technical pitfalls in this. For example, my preference is for an anterior thoracotomy rather than a subxiphoid approach. The latter could be under local anesthesia which sometimes is the only option in patients who are not candidates for general anesthesia. However, it has been reported to have higher failure rates [6]. This could be due to repositioning of the diaphragm closing off the window, leading to recurrent effusions. Other authors have found no significant differences between both techniques [7]. Most authors have described a 2–3 cm size of pericardium tissue to be excised [6–11]. Despite all efforts, recurrent pericardial effusions do occur, and patients should be counseled for this. It is not uncommon to see a loculated right pericardial effusion occurring after a left pericardial-pleural window (**Figures 1** and **2**). This can be contributed by intra-pericardial adhesions or disease which progress despite medical treatment. A redo pericardial window can be done in such patients and probably in my opinion, safer and more effective via a different side than the initial approach.

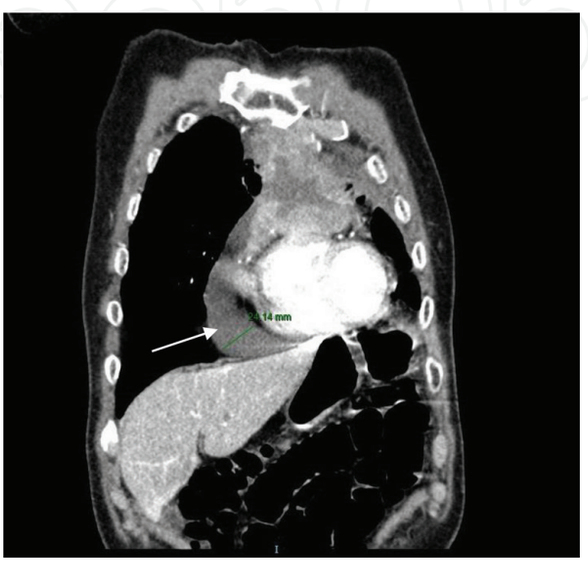

Figure 1.
Loculated right pericardial effusion (arrow). Patient had prior left pericardial-pleural window.

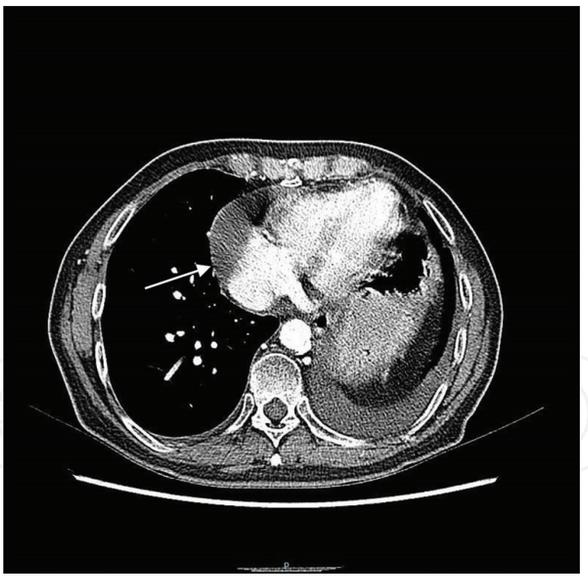

Figure 2.
Axial view of the loculated right pericardial effusion (arrow).

4. Surgical technique

4.1 Anterior thoracotomy approach

I believe for surgical approach to pericardial effusion that simple is better and the best is the enemy of the good. Like many other surgical techniques, different approaches have been described to get to the same end point. My suggested surgical approach is summarized in **Figure 3**. Left anterior thoracotomy is most commonly done in my surgical practice and it is outlined below.

As mentioned earlier, whenever possible I advocate percutaneous drainage of the pericardial effusion before bringing the patient to the operating theater. This will reduce the risk of cardiovascular collapse upon initiation of general anesthesia. Often, nonsurgical colleagues or even the patient will ask the need for surgery if the

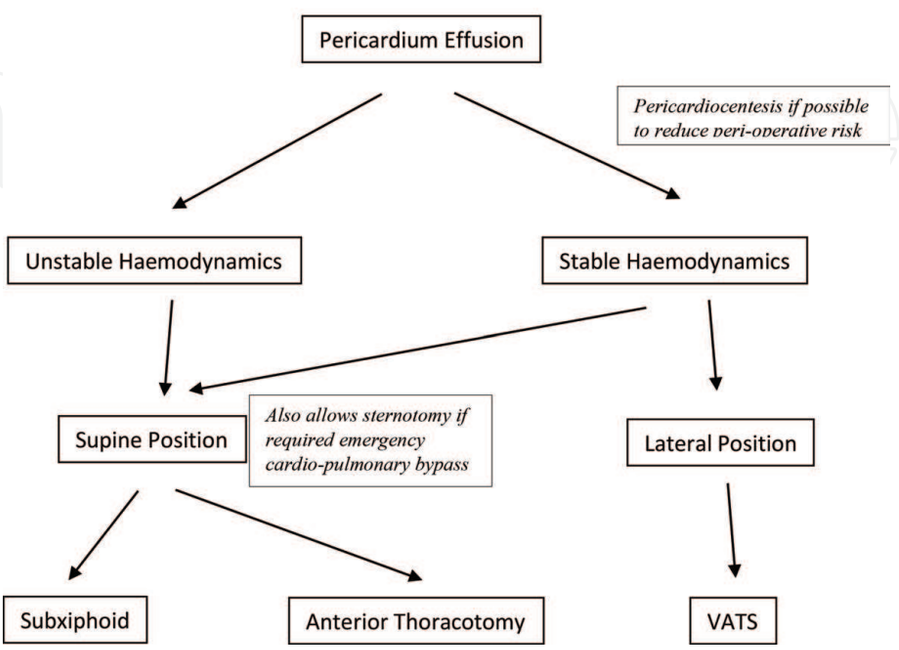

Figure 3.
Suggested flowchart for surgical approach.

effusion has been already drained. The answer is simple; creation of a surgical window is to bring about long-term benefits by reducing the risk of recurrent effusions.

The patient is positioned supine before general anesthesia via a single-lumen endotracheal tube. This approach has several advantages. Firstly, in sick and unstable patients, there is no need to turn to lateral decubitus position compared to lateral thoracotomy or VATS approaches. Conversion to midline sternotomy is also easier if required in emergency situation. Subsequently, this incision is also optimal if ascending aorta and superior vena cava cannulations are needed for crash cardiopulmonary bypass. There is always the risk of injury to the heart during surgery that requires the bypass circuit for repair. If the patient is unwell, communication with the anesthesia team is paramount. It takes an experienced anesthesiologist to intubate a patient who cannot lie flat and who requires only a little more sedation to collapse. I frequently ensure the surgical team and scrub team are ready to proceed with crash incision if required prior to onset of anesthesia.

The left anterior thoracotomy incision is made at left fourth intercostal space. This is done by surface marking the left fifth rib. I would also utilize any recent computed tomography (CT) scan of the thorax to help guide the incision over the pericardium (**Figure 4**). The incision is centered over the mid-clavicular line and extends either side to about a total of 4–5 cm in length. This is just below the nipple line in males, but care is required to avoid incision thru breast tissue in females. The incision is deepened pass the intercostal muscles, staying close and on top of the inferior fifth rib to avoid injury to any intercostal vessels. Another pitfall is to extend too medially, where the internal mammary vessels run about 1 cm from the lateral sternal margin (**Figure 4**). If done correctly, the pleural cavity is breached first, with the surface of the pericardium seen after (**Figure 5**). If the incision is too low, pericardial fat could be obscuring the actual pericardium tissue. This fat would need to be removed for adequate exposure. Further exposure could be also improved by using a sponge-stick to gently retract the lung laterally again from the pericardium.

Before incision of the pericardium, proper communication with the anesthesia team is important. Frequently, a drop in blood pressure can be encountered on drainage of the pericardial effusion. This is attributed to inadequate venous return

Figure 4.
CT used to plan incision at left fourth intercostal space (white line), inferior to the nipple. Take a note of the location of left internal mammary artery, about 1 cm from the lateral sternal edge (arrow).

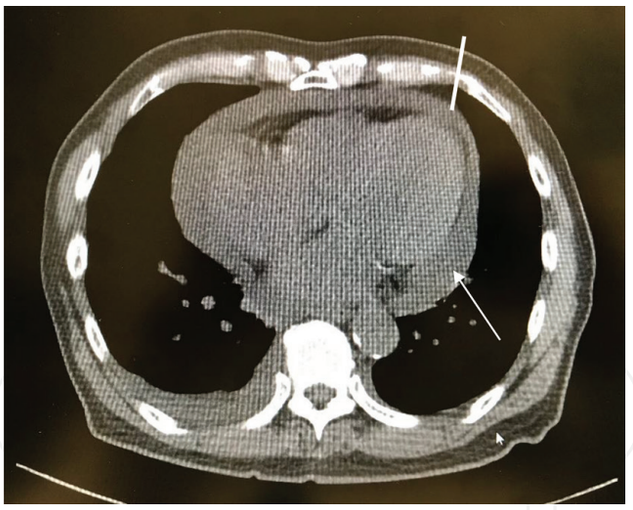

Figure 5.
Circumferential pericardial effusion (arrow) in noncontrast scan. Following the direction of the white line, left pleural cavity is breached first before the pericardium is seen.

to the patient's re-expanded heart chambers; hence, fluids should be prepared prior to drainage. Occasionally, blood-stained pericardial fluid is seen from a malignant process. If this occurs, caution is required. I suggest waiting to ensure no further hemodynamic compromise occurs before extension of the incision. Injury of the myocardium can mimic this, and even experienced surgeons can get into trouble via injury to the heart chambers.

Once the pericardial cavity is drained, I would usually excise the pericardium approximately to 3–4 cm diameter. It should be extended as laterally as possible. I believe that a bigger-sized incision and going more lateral reduces the risk of spontaneous closure of the window. A surgical pitfall is to injure the phrenic nerve which runs on the lateral pericardial surface. To avoid this, the tough pericardial tissue can be grasped and retracted towards the ceiling while the lung is retracted laterally. This is usually enough to identify the phrenic nerve and to avoid it. From this approach the pericardium can only be opened anterior to the phrenic nerve. A left-sided approach is better suited if the effusion is circumferential as minimal retraction of the lung is required to reach the pericardium (**Figure 6**). For right anterior thoracotomy, I would reserve this for redo-window creation or when there is a loculated effusion that is only accessible from the right. From the right, more of the lung is in the way before the pericardium can be seen. This may require lung isolation or even periods of intermittent apnoea from the anesthesia team for optimal visualization.

4.2 Video-assisted thoracoscopic surgery (VATS) approach

If the patient is stable enough for lung isolation via double-lumen endotracheal tube or a bronchial blocker, VATS approach can be utilized. The benefits of VATS and other minimally invasive approaches have been described at length by many authors [5, 6, 9–11]. Visualization is definitely better through a camera; the entire pericardium can be visualized once the lung is isolated well. The phrenic nerve which is the lateral limit of excision can be accurately identified and preserved. Another benefit of VATS includes a less painful incision during the perioperative period, which will reduce the amount of opioids given and hence reduces their side effects. However, this effect is less pronounced compared to my preference for the anterior thoracotomy incision, which is not that painful as there is minimal spreading of ribs. The patient could be positioned either supine or lateral position for VATS, depending on the surgeon's preference. I prefer the supine approach as

Figure 6.
Healed scar from the left anterior thoracotomy incision (arrow).

mentioned earlier; it is easier to convert to sternotomy if required. However, most surgeons would avoid sternotomy if possible, as it brings about more pain with a bigger scar as well as higher risk of infection to both the superficial tissue and sternum. The greater the surgical trauma, the longer healing requires before adjuvant treatment like chemotherapy or radiotherapy could be initiated.

4.3 Variation in anesthesia methods

Another variation of technique involves the consideration between general anesthesia and local anesthesia. General anesthesia remains the most common way of anesthesia for patients; it involves intubation and protection of airway under muscle paralysis, sedation and amnesia. But for patients who have hemodynamic compromise from pending cardiac tamponade due to a significant acute pericardial effusion, general anesthesia remains very high risk. In fact this group of patients is frequently the American Society of Anesthesiologists (ASA) class V, the highest-risk class. Many a surgeon have been demoralized after losing patients on the operating table, after this group of patients collapse upon giving the slightly amount of medication that could lower the vascular tone and reduce the blood pressures. Local anesthesia has been advocated to be safer in these patients, but often not practical as few patients could tolerate the pain of an anterior thoracotomy incision even with the best local infiltration. Mentioned later below, a subxiphoid incision could be more tolerable with this, and some surgeons have been successful with it. A new method in the middle ground could be non-intubated general anesthesia. This has been successful in reported VATS surgery [12]. Without muscle paralysis and using a laryngeal mask airway to continue spontaneous-assisted ventilation, this resulting loss of vascular tone could be reduced and perhaps reduce the risk of anesthesia. But the surgeon must also realize and cope with the increased muscle tone and continued ventilation of the lungs. Exposure needs to be ensured as the lung cannot be isolated in this setting.

4.4 Alternatives including subxiphoid approach

A subxiphoid approach (**Figure 7**) is usually less painful than VATS. The reason is that being in midline, less respiratory muscles are incised. It is also the preferred approach for patients who had recent sternotomy and subsequently presents with a

Figure 7.
Healed scar from the subxiphoid incision (arrow).

pericardial effusion. In this group of patients, rather than to redo sternotomy, only the inferior portion of the scar needs to be reopened for access to the pericardial cavity. The sternum and wires used to oppose the bone during the initial sternotomy do not require any further manipulation from this approach. This type of effusion, if related to bleeding postsurgery, usually does not recur frequently or long term; hence, this approach is simple and effective. A subxiphoid incision can be also used to create a pericardial-peritoneum window. This method, when paired with a pleuroperitoneal shunt, has been described to have comparable results to other methods [13]. The proposed shunt pumps fluid actively into the peritoneum cavity, and this can possibly reduce accumulation rates by preventing omentum from occluding the pathway from the pericardium to the peritoneum. Authors have been successful with this with only local anesthesia; hence, this alternative is useful for patients who are at high risk with general anesthesia.

5. Summary

Surgical approach to pericardial effusion involves many a thought process. Different patients require different approaches for the best results. Decision-making should be made with the patient's best interest and wishes. It is rewarding indeed when patients get symptomatic relief and are able to return to their function postsurgery.

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Author details

Ing Xiang Soo
Department of Cardiothoracic Surgery, National Heart Centre Singapore, Singapore

*Address all correspondence to: soo.ing.xiang@singhealth.com.sg

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