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RESEARCH ARTICLE

PERICARDIAL EFFUSIONS : PERICARDIOCENTESIS, IS IT THE SAFEST WAY ?

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Abstract

Pericardiocentesis is a straightforward bedside procedure that has proven to be safe in experienced centers. However, it remains an invasive procedure, and the operator must be aware of potential complications. Periprocedural ultrasound facilitates a careful evaluation of the pericardium before the procedure, enabling the selection of the safest trajectory and the assessment of complications.

Introduction:-

Pericardial effusion is defined as the accumulation of fluid in the pericardial sac, leading to an increase in intrapericardial pressure, which mainly depends on the rate of onset of the effusion (1).

In cases of cardiac tamponade, the classic clinical presentation includes Beck's triad: distension of the jugular veins, muffled heart sounds, and hypotension (2).

Two therapeutic options are available: percutaneous approach (pericardiocentesis) or surgical approach.

Pericardiocentesis is the method of choice for significant pericardial effusions, providing both diagnostic and therapeutic benefits.

Pathophysiology:

Physiology of the Pericardium:

The pericardial sac is composed of two layers that envelop the entire heart and extend around the superior and inferior vena cava, the pulmonary veins, around the ascending aorta for 5-6 cm, and around the pulmonary artery up to its bifurcation.

The layers include the visceral (or epicardial) and parietal (or fibrous) layers, which are continuous with each other through the pericardial reflection zones.

This cavity normally contains 10 to 50 mL of a clear, yellowish fluid (3).

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Hemodynamic Impact of Pericardial Effusion:
The elevation of intrapericardial pressures is directly responsible for the hemodynamic consequences of cardiac tamponade. These consequences are closely dependent on the volume, but more importantly, on the rapidity of the effusion's development, the pressure/volume relationship of the pericardial sac (distensibility), and biventricular compliance (4). Thus, a rapid accumulation of blood in the pericardium, particularly due to a cardiac rupture concurrent with a myocardial infarction, will result in a severe and rapidly fatal clinical presentation, even if the amount of intrapericardial fluid is small (150-200 mL). Conversely, a slowly developing pericardial effusion (often neoplastic) may be relatively well tolerated clinically, sometimes for several days or weeks, even in the presence of a large volume (sometimes exceeding 1 liter). Adiastole is one of the predominant circulatory abnormalities in tamponade.

When intrapericardial pressure equals left ventricular end-diastolic pressure, left ventricular filling is impaired, leading to a decrease in stroke volume. Initially, cardiac output is maintained through compensatory tachycardia secondary to increased filling pressures. However, as intrapericardial pressure continues to rise, tachycardia is no longer sufficient to compensate for the drop in stroke volume. This results in a decline in cardiac output and systemic blood pressure, leading to hypoperfusion and cardiogenic shock if effective treatment is not promptly initiated (5).

Etiologies:
Malignant and renal origins of pericardial effusions were the most common causes (6), while tuberculosis remains the most frequent cause in our setting (7). Over the past decade, the rate of iatrogenic pericardial effusions has significantly increased (8,9,10,11,12).

The rise of interventional cardiology techniques has also contributed to the increase in iatrogenic pericardial effusions, especially as these patients are often on anticoagulant or antiplatelet therapy (13,14).

Ho et al. [15] demonstrated that pericardiocentesis during a pericardial effusion secondary to cardiac catheterization can lead to more significant acute complications compared to other causes of pericardial effusion.

Viral pericarditis is the most common in industrialized countries, while bacterial pericarditis predominates in developing countries. Other etiologies include neoplastic, autoimmune, traumatic, and less commonly, drug-induced and metabolic origins (3) (Table 1).

Indications:
The clinical presentation of pericardial effusion can range from an asymptomatic patient to tamponade or even hemodynamic collapse. Before performing pericardiocentesis, the benefits and risks of this invasive procedure must be carefully evaluated. Effusions of low or moderate abundance with a treatable origin are often managed conservatively. Regardless of the extent of the effusion, pericardiocentesis is indicated in cases of hemodynamic instability or when the origin of the pericardial effusion is unknown. However, in stable hemodynamic conditions, pericardiocentesis may be delayed by 12-24 hours (table 1).

The European Society of Cardiology has established a scoring system to guide the indication for pericardiocentesis. This score takes into account the etiology, clinical presentation, and imaging findings (16). A score of ≥ 6 indicates urgent pericardiocentesis, while a score < 6 indicates elective pericardiocentesis.

Cardiac tamponade is a Class I indication for pericardiocentesis [17]. Diagnostic pericardiocentesis may be considered in cases of large pericardial effusion (>20 mm) (Class IIa recommendation) [17]. Relative indications for drainage based on echocardiography findings include: (a) collapse of the right atrium and/or right ventricle in diastole, or (b) development of a significant effusion within one month [18].

Contraindications :
Aortic dissection, myocardial rupture, and traumatic effusion with hemodynamic instability are contraindications to pericardiocentesis [17], warranting surgical drainage [19]. Among the relative contraindications are uncorrected coagulopathy, ongoing anticoagulant therapy, and thrombocytopenia (platelet count <50,000/mm3) [20]. Relative contraindications may be reassessed in cases of acute or symptomatic tamponade and hemodynamic instability.

Pericardiocentesis may be contraindicated in cases of inaccessible posterior collections, extensive adhesions, and purulent pericardial effusions.

Procedure:
The patient is prepared with continuous hemodynamic monitoring to detect signs of decompensation during pericardiocentesis.

The patient is positioned in the dorsal decubitus, typically in a semi-recumbent position of about 45°. An echocardiogram should be performed immediately before the procedure in the presence of the surgeon to confirm the presence of an effusion greater than 10 mm and to specify the location of the effusion.

The operator should locate the appropriate area by palpating the xiphoid process, clean a wide area of the anterior thoracic wall and upper abdomen with an antibacterial skin solution, set up sterile drapes, guide the needle, and determine the depth of penetration.

The puncture is performed under local anesthesia with 1% Xylocaine® using the Seldinger technique, and there are sterile kits available with all necessary equipment (figure 1).

Two puncture techniques are commonly used (but should always be adapted to echocardiography data and patient morphology), following local anesthesia with Xylocaine.

The operator punctures at the left xyphocostal angle with a maximum angle of 45° to the skin plane, and the needle is directed towards the left medioclavicular line. This approach directs the puncture towards the largest space between the pericardium and the anterolateral wall of the right ventricle (figure 2).

Alternatively, the operator can puncture at a 30° angle relative to the abdominal plane, passing between the xiphoid process and the left costal arch, aiming towards the medial end of the right clavicle. This approach theoretically increases the risk of right pneumothorax. The needle is advanced gradually while maintaining gentle aspiration, preferably under ultrasound guidance. If an ultrasound machine is not available, electrocardiographic monitoring is recommended to detect when the needle makes contact with the myocardium. This helps avoid the risk of blind puncture [21].

When pericardial fluid enters the syringe, if it appears bloody, it is important to check if it clots or not using the "compress test". A "bubble test" under echocardiographic control can be performed to rule out myocardial puncture, identified by the presence of contrast in the cardiac chambers. This test is conducted using a macromolecular solution mixed with a small amount of air, with the mixture passing under pressure from one syringe to the other alternately, connected by a three-way stopcock.

If necessary, the syringe is detached, a flexible metal mandrin (guide) is inserted, and then the needle is removed, leaving the mandrin in place. A small skin incision is made, and then an introducer is mounted on the mandrin, allowing for the placement of a Redon drain, or a flexible indwelling catheter (pigtail or straight) is directly mounted on the guide and inserted into the pericardial sac. The drainage device is connected to a closed low-pressure suction device or a simple bag positioned in a dependent manner.

It is possible to actively drain the pericardial sac to decompress the heart more rapidly using a 60 ml syringe mounted on a three-way stopcock connected to the drainage system, similar to what is done during ascites punctures [22,23].

In cases of left parasternal puncture (figure 3), ultrasound guidance is similar to guide the procedure and determine the intercostal space (ICS) providing the best access to the effusion (typically between the 3rd and 5th ICS). The puncture is performed at a 90° angle to the thoracic wall, away from the left edge of the sternum to avoid injury to the left internal thoracic artery. Once the effusion is reached, the rest of the procedure is equivalent to the subxiphoid puncture [22].

After completing the pericardiocentesis, echocardiographic control is necessary to confirm evacuation of the pericardial effusion. A chest X-ray should be performed to assess for pleural effusion or pneumothorax. Continuation of clinical and echocardiographic monitoring of the patient is warranted.

In a recent development, a microimaging fiber (0.9 mm in diameter) has been integrated into a triple-lumen catheter for visual sputum suction [29]. Leveraging its small diameter advantage, this microimaging fiber could potentially be inserted into an 18 G needle to provide guidance during pericardiocentesis. X. Liu et al described their experience using this video-assisted system in a model of pericardial effusion (PE) [30].

Surgical drainage may be indicated in cases of recurrences, following unsuccessful pericardiocentesis, when echocardiographic characteristics do not support pericardial puncture (such as posterior effusions, excessive pericardial adhesions, or a loculated effusion), or in cases of clearly coagulated hemopericardium [24].

Alternative approaches for draining posterior effusions include transesophageal, transpleural, or transbronchial pericardial puncture, but there is limited experience with these methods [25,26].

Complications :
Over the past decade, the rate of complications following echoguided pericardiocentesis has decreased.

The most frequent complications include cardiac arrhythmias, myocardial laceration, pneumothorax, and coronary vessel injury.

Pericardial decompression syndrome is a rare complication characterized by acute paradoxical global heart failure and pulmonary edema following rapid drainage of a large volume of pericardial fluid. It is believed that this can be avoided by draining an initial volume not exceeding 1000 ml and evacuating the remaining fluid more slowly using a catheter left in place [27,28]. A deterioration in hemodynamic status after initial improvement following pericardial drainage may be caused by pneumopericardium.

Other complications associated with pericardiocentesis include inadvertent peritoneal puncture, liver or gastric injuries, puncture of the internal mammary artery, diaphragmatic injuries, and death [22,23].

Conclusion:-

Any pericardial effusion accompanied by hemodynamic instability should be managed as pericardial tamponade, necessitating prompt recognition and intervention.

Pericardiocentesis stands as an efficacious intervention for promptly managing critical pericardial effusion and pericardial tamponade. Despite complications being infrequent in proficient hands, it's important to recognize that pericardiocentesis carries inherent risks. However, pericardiocentesis remains the least invasive technique in cases of pericardial effusion.

Table 1:- Indications for Pericardiocentesis, Using a Global Scoring System.

Step 1 : etiology		**Step 2 : clinical presentation**		**Step 3 : imaging**	
Neoplasic pathology	2	Dyspnea / Tachypnea	1	Cardiomegaly on chest X-ray	1
Tuberculosis	2	Orthopnea without rales	3	Electrical alternans on EKG	0,5
Recent radiotherapy	1	Hypotension	0.5	Microvoltage on EKG	1
Recent viral infection	1	Progressive sinus tachycardia	1	Circumferential effusion (> 2 cm in diastole)	3
		Oliguria	1	Moderate effusion (1-2 cm)	1
				Small effusion (< 1 cm), no trauma	-1
Épanchement Recurrent effusion, previously punctured	1	Pulsus paradoxus > 10mmHg	2	Right atrial collapse > 1/3 of cardiac cycle	1
Chronic renal impairment	1	Pericardial chest pain	0.5	Inferior vena cava > 2.5 cm, < 50% inspiratory collapse	1
Immunodeficiency	1	Pericardial friction rub	0.5	Right ventricular collapse	1.5

Hypo/hyperthyroidism	-1	Rapid worsening of symptoms	2	Left atrial collapse	1.5
Autoimmune systemic disease	-1	Slow progression	-1	Respiratory variations in mitral/tricuspid flows	2
				"Swinging heart" appearance	1

A score of 6 or higher suggests that urgent pericardiocentesis is warranted. Regardless of the score, urgent surgical management should be considered in cases of type A aortic dissection, rupture of the free wall of the left ventricle, severe chest trauma, or uncontrollable iatrogenic hemopericardium by percutaneous means.

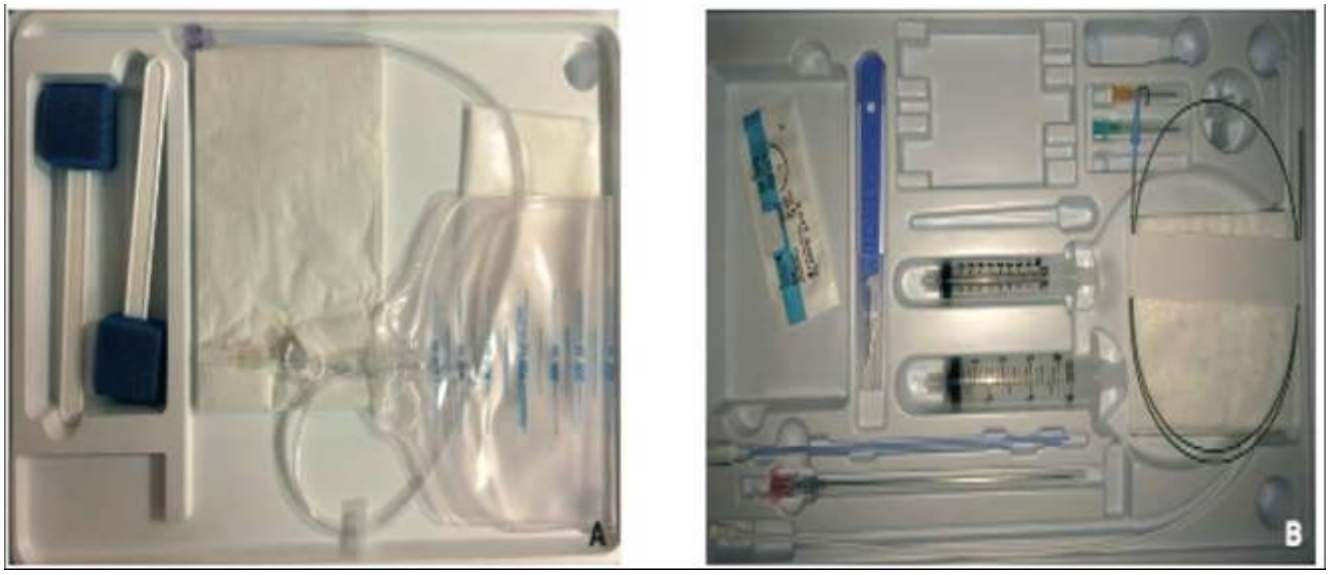

Figure 1:- Pericardial puncture kit.

Figure 2:- Pericardiocentesis via subxiphoid approach.

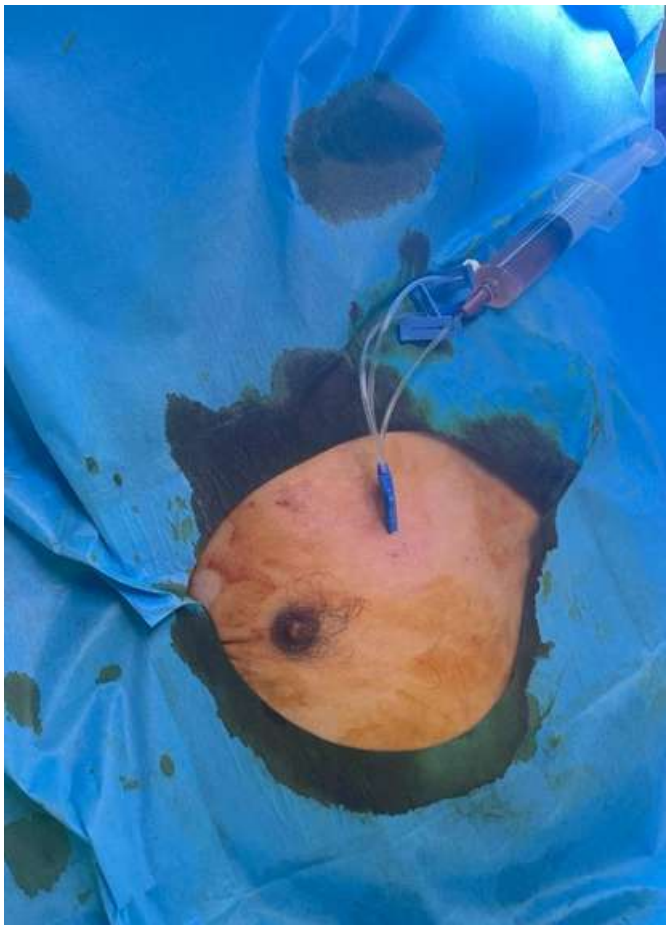

Figure 3:- Pericardiocentesis via left parasternal approach.

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