Apical Approach for Pericardiocentesis

A guide to safely and successfully performing apical pericardiocentesis using continuous echocardiographic visualization for needle advancement.

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The principal goal of pericardiocentesis is to access the pericardial space and evacuate the pericardium without injury to the heart and surrounding organs. Since the first described blind pericardiocentesis by Marfan via the subxiphoid approach in 1911, advances in interventional and imaging techniques have resulted in contemporary approaches to this life-saving procedure that are much safer and more successful. With the advent of fluoroscopic, electrocardiographic, and echocardiographic guidance (especially since its introduction at the Mayo Clinic in 1979),[1] the procedure can be performed simply and safely.

WHY I DO IT

Cardiac tamponade is a life-threatening accumulation of pericardial fluid leading to compression on the heart and compromise of cardiac output. In hemodynamically unstable patients, an emergency pericardiocentesis is the cornerstone of therapy because the removal of fluid allows for normal ventricular filling and restores adequate cardiac output.[1-3] In case of pericardial effusion without hemodynamic compromise, pericardiocentesis is indicated for diagnostic purposes as well as symptomatic relief in moderate to large effusion nonresponsive to medical therapy or when tuberculous, bacterial, or neoplastic pericarditis is suspected. Pericardiocentesis may also need to be performed for chronic, large pericardial effusion (lasting > 3 months, > 20 mm on echocardiography in diastole) to prevent progression to tamponade.[3]

ANATOMIC CONSIDERATIONS

The pericardium is a double-layered, flask-shaped fibroserous sac enveloping the heart and proximal great vessels, with a potential space created between the parietal and visceral layers. Anteriorly, the pericardium is related to the sternum by the sternopericardial ligaments. The pericardium is associated laterally with the parietal pleura and inferiorly with the diaphragm. These attachments help maintain the heart's position within the thorax. Several noncardiac structures are in close relation to the pericardium and are therefore at risk for complications during interventions using apical pericardial access.[4]

HOW I DO IT

Watch It Now

Pericardiocentesis via the apical approach is classically performed under echocardiographic guidance. The echocardiographic-guided approach allows one to simultaneously define the position of the effusion, the ideal entry site, and the needle trajectory. The ideal puncture site will have no intervening organs and the minimum distance from the ultrasound probe to the maximal fluid accumulation within the pericardium (primarily apical).[2] Because ultrasound does not penetrate air, echocardiographic guidance ensures avoidance of the lung and the shortest path to reach the pericardium. There are two different methods to echocardiographic guidance: The first, as described by the Mayo Clinic, is the echocardiographic-assisted method in which the operator memorizes the optimal needle trajectory and advances the needle toward the pericardial space without continuous ultrasound visualization.[2] In the second, safer method, the needle is advanced under continuous echocardiographic visualization. This is facilitated by using a needle carrier mounted on the ultrasound transducer to ensure steady needle advancement into the pericardial space.[5]

Step 1: Patient Preparation

For safe performance of pericardiocentesis, the platelet count and coagulation profile should be checked. Packed red-cell units should be readily available before starting nonemergency procedures, especially in anemic patients. Electrocardiographic monitoring is required in an appropriate environment with resuscitation equipment. A venous line is essential for potential rapid infusion of fluids and drugs—or a central venous catheter for monitoring right atrial pressure if indicated. Continuous noninvasive arterial pressure monitoring is required to detect the presence of pulsus paradoxus and detect and rapidly correct sudden hemodynamic instability.

After reviewing the diagnostic echocardiography and checking for feasibility of the apical approach, the patient should be placed in a semireclined position at an angle of approximately 30° and slightly rotated leftward to enhance fluid collection in the inferior-anterior part of the pericardial space.

Step 2: Puncture Site and Needle Advancement

After appropriate disinfection and preparation of the operative field, a local anesthetic is administered at the anticipated puncture site. The needle insertion site is typically 1 to 2 cm lateral to the apex beat within the 5th, 6th, or 7th intercostal space. The shortest path to the pericardium (identified by echocardiography) from the apex is marked. The angle between the probe and the chest wall constitutes the optimal needle trajectory, which should be visualized in the operator's mind. Using a long, 18-gauge needle attached to a local, anesthetic-filled, 10-mL syringe, the needle is advanced over the superior border of the rib to avoid intercostal nerves and vessels. During advancement, gentle suction from the attached syringe is maintained and local anesthetic is intermittently injected to both ensure a painless procedure and clear the needle. Aspirating fluid at a needle depth shallower than anticipated can be a sign of pleural access. If no fluid is freely aspirated beyond the anticipated depth, the needle should be withdrawn and appropriate skin puncture location and needle direction reconfirmed.

Step 3: Pericardial Access and Confirmation

As the needle descends into the pericardial sac, partial entry with the needle on suction may lead to intermittent aspiration into the syringe during expiration. This is partly due to patient respiration and heartbeat-related pericardial sac motion. Advancing the needle another 1 to 2 mm allows for free aspiration. Observing slow but continuous aspiration of fluid during inspiration and expiration implies a good, secure needle position for inserting the guidewire into the pericardial space. This is done with continuous or intermittent echocardiographic visualization of the needle tip, which allows for confirmation of the guidewire's entrance in the pericardial space.

Close inspection of the aspirated fluid after confirmation of guidewire position is important. Obtaining a bloody aspirate may indicate hemorrhagic pericardial effusion, but myocardial puncture needs to be ruled out. Other signs of cardiac puncture include needle movement with each heartbeat, premature ventricular complexes, blood briskly dripping from the needle lumen, flailing wire movements during systole, and wire tracking along the pulmonary artery or aorta on fluoroscopy.

Once the guidewire position is confirmed in the pericardial space, a skin incision is made at the needle puncture site to allow for easier sheath insertion. The 18-gauge needle is then removed with the insertion of a 6-F sheath over the guidewire, and the guidewire and sheath introducer are subsequently removed. Aspirating from the sheath side port and transducing a nonventricular pressure confirms accurate positioning of the sheath. A Micropuncture kit (Cook Medical) can minimize the potential need for surgical repair in case of ventricular puncture.[6] If there is still doubt regarding the needle or sheath position, the catheter position within the pericardial space can be confirmed by injecting agitated saline through the needle, sheath, or catheter. Microbubbles observed in the pericardial space on echo confirm a correct position. Alternatively, radiocontrast can be injected. In this case, opacification of the pericardial space on fluoroscopy will confirm a correct position.

Step 4: Pericardial Fluid Drainage

The last step is introducing a 0.035-inch guidewire into the pericardial space under fluoroscopic guidance. The guidewire can be observed by following the outer cardiac border and crossing midline. A drainage catheter is then advanced over the wire (eg, 6-F pigtail). After the guidewire is removed, the catheter is connected to a drainage bag via a three-way tap to facilitate fluid aspiration with a syringe. When no more fluid can be aspirated, confirmation of pericardial effusion resolution with echocardiography can be performed, and if needed, the drainage catheter can be secured in situ with stitches and sterile dressing. Chest radiography is mandatory after pericardiocentesis to exclude a pneumothorax. Typically, the drainage catheter and sheath are removed after 24 to 72 hours once the drainage is < 25 to 30 mL. This lowers the risk of recurrent tamponade (if it was the initial indication).

MATERIALS

The following materials should be used:

- Echocardiography with a cardiac probe
- Sterile probe cover and sterile echo gel
- 16- to 18-gauge Pot needle (Kimal)
- 6- to 8-F dilator, introducer sheath, and guidewire
- 0.035-inch J-tipped guidewire
- Drainage catheter: 6- to 8-F pigtail angiography catheter or a specific pericardial drainage set
- Disposable flushing system to maintain patency of the catheter[7]

COMPLICATIONS

The rate of major complications reported in large observational studies for echocardiographic-guided or fluoroscopic pericardiocentesis is 0.3% to 3.9%, and the rate of minor complications is 0.4% to 20%.[5,8,9]

The most anticipated complications with the apical echo-guided approach include death, cardiac chamber injury (namely left or right ventricular wall perforation), laceration of the coronary arteries or intercostal vessels, pneumothorax requiring chest tube placement, pneumopericardium, ventricular arrhythmias, and pericardial decompression syndrome. Myocardial and coronary puncture may be silent initially and present with delayed hemopericardium or intrapericardial thrombus.

CONCLUSION

Apical echocardiographic-guided pericardiocentesis is a simple but important contemporary skill to acquire. It is safe and provides successful pericardial access for this essential, life-saving procedure. ■

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