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Pericardiocentesis

URL: https://www.jove.com/science-education/10236

Overview

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The heart lies within the pericardium, a relatively inelastic fibrous sac. The pericardium has some compliance to stretch when fluid is slowly introduced into the pericardial space. However, rapid accumulation overwhelms pericardial ability to accommodate extra fluid. Once a critical volume is reached, intrapericardial pressure increases dramatically, compressing the right ventricle and eventually impeding the volume that enters the left ventricle. When these chambers cannot fill in diastole, stroke volume and cardiac output are diminished, leading to cardiac tamponade, a life-threatening compression of the cardiac chambers by a pericardial effusion. Unless the pressure is relieved by aspiration of pericardial fluid (pericardiocentesis), cardiac arrest is imminent.

Cardiac tamponadeis a critical emergency that can carry high morbidity and mortality. Patients may present in extremis, without much time to make the diagnosis and perform life-saving treatments. Causes of this condition are broken into traumatic and non-traumatic categories, with different treatment algorithms. Stab and gunshot wounds are the primary cause of traumatic tamponade, but it may occur from blunt trauma associated with sternal or rib fractures as well as shearing of vessels from rapid deceleration injuries. Non-traumatic causes include rupture of the aortic base from ascending aortic dissection, myocardial rupture of the ventricle following myocardial infarction, spontaneous bleeding from thrombolytic or anticoagulant medication, and effusions created by infection or cancer.

Slowly growing chronic effusions are usually not life-threatening, even large ones. The pericardium has gradually stretched to incorporate liters of fluid in some cases. These may be treated with elective pericardiocentesis under fluoroscopic guidance, or a pericardial window. However, transition into tamponade physiology with a patient in extremis requires urgent pericardiocentesis, even with a small amount of fluid. Tamponade presents a challenge to diagnose, as its symptoms and physical findings are often nonspecific, common to a number of diseases. An electrocardiogram (ECG or EKG) may show electrical alternans, and a chest xray may show an enlarged "water bottle" cardiac silhouette.

Procedure

1. Physical exam and preparation for the procedure

1. On reviewing vital signs, make note of tachycardia, hypotension, a narrow pulse pressure, or pulsus paradoxus (paradoxic pulse), which is a decrease in systolic blood pressure more than 12 mmHg during inspiration.
2. Perform a quick general inspection, looking for evidence of critical tamponade. This includes diaphoresis, agitation, distended neck veins, an inability to lie flat, tachypnea, inability to speak full sentences, or cyanosis.
3. Auscultate the chest wall, paying particular attention to tachycardia, muffled heart sounds, or a displaced point of maximal impulse. The historical findings of Beck's triad for acute tamponade (which include distended neck veins, hypotension, and muffled heart sounds) are not very sensitive and tend to occur shortly before cardiac arrest.
4. Physical examination findings, especially in earlier disease, are nonspecific-making diagnosis of tamponade challenging. If available, bedside echocardiography may be performed to aid diagnosis, assessing for significant pericardial fluid compressing the RV free wall in diastole.
5. For an obtunded patient, stabilize the patient while preparing for the procedure. As patients are pre-load dependent due to compression of the right ventricle, start intravenous (IV) fluid boluses. Intubation may be necessary, but keep in mind that it increases positive pressure in the thorax, which may place further strain on the heart wall. Vasopressors may be required to support blood pressure.

2. Pericardiocentesis

There are several approaches to performing an emergent pericardiocentesis, and several methods depending on equipment available. This video will discuss aspects of the primary and traditional subxiphoid approach. A pericardiocentesis may be performed blind, with EKG guidance, or under ultrasound guidance. In a hospital emergency department setting, the latter two are the most common to avoid complications that can arise from the procedure.

1. Equipment needed for the procedure: 10 mL syringe, 25-gauge needle, 1% lidocaine, 7.5 cm or 12.5 cm long 18-gauge spinal needle, 20-60 cc syringe, alligator clip cable, guide wire, dilator, 8 French pigtail catheter, tape, gauze, EKG machine separate from the cardiac monitor
2. Position the patient with the chest elevated at a 45˚ angle.
3. Ensure cardiac monitoring and IV fluid support; administer supplemental oxygen with nasal cannula or a non-rebreather mask.
4. Place the equipment on a sterile tray.
5. Identify the xiphoid process and prepare a sterile field, applying betadine liberally over the subxiphoid and epigastric area, laying sterile drapes at the outskirts of the field.
6. Don sterile gloves.
7. Anesthetize the skin over the anticipated insertion site and through the proposed route of needle entry using 1% lidocaine or 0.5% bupivacaine injected with the 10 mL syringe and 25-gauge needle.
8. Connect the hub of the spinal needle to the 60 mL syringe.
9. Attach any of V precordial EKG electrodes located on the patient's chest to the hub of the spinal needle using the cable with alligator clips at both ends.

10. Start continuous recording of a rhythm strip from this lead. If the tip of the needle touches the epicardium during insertion, a current of injury pattern that looks like a wide-complex premature ventricular contraction with an ST segment elevation will be seen. This is a signal to withdraw the needle until the pattern disappears to prevent laceration of the myocardium.
11. Insert the needle 1 cm below the xiphoid process and towards the left xiphocostal angle.
12. Aim towards the left shoulder and continue slowly introducing the needle at a 30° to the skin. Remember that the heart is an anterior structure, and deeper angles more than 30° may damage organs behind the heart.
13. While cautiously advancing the needle, continuously aspirate and monitor the EKG for any changes, watching for fluid return.
14. Once fluid is seen to enter the syringe, stop needle advancement. Patients may complain of sharp chest pain when the pericardium is pierced, as it is a sensitive structure.
15. If there is no fluid return, withdraw the needle and redirect in a deeper trajectory. If there is still no fluid aspirated, withdraw again and redirect in the same angle but aimed more towards the midline of the body. Continue this process, which may require eventual aim towards the right shoulder, until fluid is aspirated.
16. With one hand, stabilize the base of the needle to prevent further needle entry. If the patient is in extremis, aspirate as much fluid as possible at this point. Removal of 30-50 mL of fluid can result in clinical improvement.
17. Once aspiration is finished, untwist the syringe from the needle.
18. Thread the guide wire into the spinal needle and into the pericardium.
19. Remove the needle, leaving the guide wire in the pericardium.
20. Advance the dilator over the wire and dilate the subcutaneous tissue, then remove the dilator still leaving the guide wire in place.
21. Advance the pigtail catheter over the wire and into the pericardium.
22. Remove pericardial fluid by aspiration through the catheter.
23. When finished aspirating, place the stopcock at the end of the catheter.
24. Secure the catheter against the skin using gauze and tape, then suture the free end of the catheter to the skin. If repeat drainages are required, the stopcock may be turned open to allow further aspiration.
25. If a pigtail catheter kit is not available once a significant amount of fluid is aspirated from the pericardium through the spinal needle, remove the needle and place a bandage over the insertion site.
26. Reassess the patient for improvement, and obtain a chest x-ray to rule out pneumothorax or pneumopericardium caused by the procedure.

Summary

Tamponade should always rank highly in the diagnoses for undifferentiated shock, particularly in patients with prior cardiac disease, suspected aortic dissection, a history of malignancy, or anticoagulant use. Traumatic tamponade must be considered in both penetrating and blunt trauma scenarios, with temporizing pericardiocentesis performed in deteriorating patients while setting up for thoracotomy. High suspicion, clinical vigilance, understanding of tamponade physiology, and prompt action will help to avoid the deadly effects of this process.

In this modern age when imaging guidance is more prevalent, complications from deep or inappropriate needle insertion may be prevented. Patients requiring emergent pericardiocentesis often cannot sustain the time required to obtain fluoroscopy-guided or computed tomography (CT)-guided pericardiocentesis. However, bedside ultrasound is immediately available in many emergency departments and is a necessary adjunct to performing procedure. Needle entry into pericardial fluid can be viewed in real time, as well as real time aspiration. Placement in the appropriate location can be rapidly confirmed using agitated saline. Absence of pneumothorax or hemothorax can be rapidly assessed. Real time viewing also allows a better approach plan, providing more operator comfort in performing apical or parasternal approaches and thus improving success.

Pericardiocentesis has some complications that may become major. These include cardiac puncture or coronary vessel laceration, liver or stomach laceration, pneumothorax, hemothorax, pneumoperitoneum, pneumopericardium, suppurative pericarditis, and pulmonary edema due to sudden venous return to the left ventricle. Serious dysrhythmias are not common and may be vagal mediated. This may be prevented by giving atropine prior to the procedure. Failure of pericardiocentesis to yield fluid may be considered a complication, and is much more common in the blind approach.