JACC: CASE REPORTS VOL. 5, 2023

EDITORIAL COMMENT

Removing the Blindfold

Echo-Guidance for Pericardiocentesis*

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Echocardiographic guidance should be considered the modality of choice for pericardiocentesis in current clinical practice, which can be safely performed despite the presence of coagulopathy in the hands of expert operators. In this issue of *JACC: Case Reports*, Farooq and Iyer[1] present the case of a patient who underwent emergent pericardiocentesis, which was complicated by hepatic artery laceration and hemorrhagic shock. This case illustrates several key points for those managing patients with acute tamponade.

A percutaneous approach to management of pericardial effusions and tamponade allows for the rapid drainage of pericardial fluid and avoidance of general anesthetic and surgery. Over a century ago, Marfan described a subcostal anatomic landmark-guided approach that was universally adopted and is still frequently used to this day.[2] The operator typically accesses the skin directly beneath the costal margin to the left of the midline and advances the needle in a direction toward the left shoulder at an angle approximately 30° to the skin.[2] The goal is to access the pericardial space through a plane that is posterior to the ribs but anterior to the liver. Access to the pericardial space is confirmed through aspiration of fluid, manometry upon accessing fluid, electrocardiographic monitoring of the pericardial needle, or injection of iodinated contrast with imaging on fluoroscopy. The location of the instilled contrast or an advanced J-wire on fluoroscopic imaging allows the confirmation of a pericardial rather than intravascular location. However, regardless of technique used to confirm a pericardial location, with this technique, the course from skin to pericardial space is entirely blind and open to risk of damage to other structures. Specifically, the organ most likely to be inadvertently accessed is the anterior lobe of the liver. Seen in this case, shared by Farooq and Iyer,[1] the patient underwent successful access of the pericardial space through a blind subcostal approach with confirmation of pericardial access via fluoroscopic imaging.[1] However, it is noted that this access was achieved through a course that went through the left lobe of the liver with subsequent evidence of nearby associated liver laceration, bleeding, and hemoperitoneum.[1]

Echocardiography allows the proceduralist to visualize the structures between the skin and the pericardial space, thus allowing the avoidance of inadvertent damage to other organs. Cardiovascular ultrasound is widely available and not only allows for visualization of surrounding structures but opens many other potential sites for pericardial access. When echo guidance is used for pericardiocentesis, a subcostal location is rarely the chosen site for access. Access should be obtained at a site with the shortest distance between the skin and the pericardial space, where the pericardial fluid collection is largest, and there are no intervening structures. This thereby minimizes the risk of damage to adjacent structures and cardiac perforation. In more than 90% of cases, access is achieved through an intercostal chest wall approach whether para-apically or from the left or right parasternal windows rather than subcostal route (**Figures 1 and 2**).

Ultrasound imaging with a standard phased-array cardiac probe clearly defines the cardiac chambers and the size and location of pericardial fluid. Imaging of lung tissue has a characteristic appearance with air leading to significant beam reflectance and artifact. Hence, direct visualization of a clear path to

*Editorials published *JACC: Case Reports* reflect the views of the authors and do not necessarily represent the views of the *JACC: Case Reports* or the American College of Cardiology.

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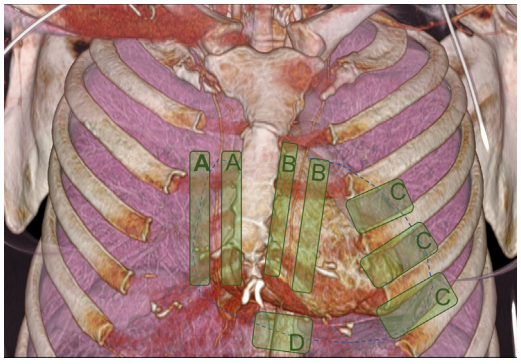
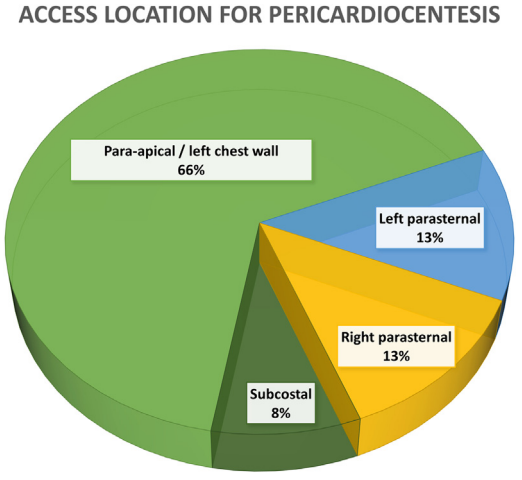
ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2022.101699

FIGURE 1 Locations for Echo-Guided Pericardiocentesis Access



A representative computed tomographic scan of a patient highlights possible access locations and their proximity to anatomical landmarks and surrounding structures. Access to pericardial space anterior to the right atrium from the left parasternal approach **(A)** or anterior or lateral to the right ventricle from the left parasternal area **(B).** Care is taken to avoid the internal thoracic vessels that course down the anterior chest between 6- and 20-mm lateral to either side of the sternal edge. Access from the left chest allows pericardial access in proximity to the left ventricular apex or free wall **(C)**. A subcostal site allows access to the inferior pericardium and is in proximity to the distal thoracic vessels and the left lobe of the liver **(D)**.

FIGURE 2 Frequency of Access Locations for Echo-Guided Pericardiocentesis



In review of the last 1,000 pericardiocentesis procedures performed at the Mayo Clinic Rochester, most patients had access from the left chest in proximity to the left ventricular apex or free wall. The remainder were approached anterior to the right atrium from the left parasternal approach or anterior or lateral to the right ventricle from the left parasternal area. Only 8% had drainage from a subcostal access site.

pericardial fluid eliminates the presence of intervening aerated lung and the risk of pneumothorax. The important structures to avoid while accessing the pericardium from the chest wall are the thoracic vessels. An entry location superior to a rib border avoids injury to the costal vessels. The proceduralist using parasternal access, whether to the right of the sternum (anterior to the right atrium) or the left parasternal space (anterior or lateral to the right ventricle), also needs to be mindful of the internal thoracic vessels (previously called the internal mammary vessels). These vessels reliably course down the anterior chest between 6- and 20-mm lateral to the sternal edge (**Figure 1**). A chosen access site immediately adjacent to the sternal edge or more than 20 mm lateral to the sternal edge allows avoidance of inadvertent vascular damage. The location of these vessels can be directly visualized in most patients with a linear imaging probe. Using ultrasound imaging, and following these anatomical principles, allows a range of pericardial access possibilities that invariably allow a shortened distance to the pericardial fluid and a greater pocket of fluid between the access site and the underlying cardiac chamber. In addition, abdominal structures such as the liver are avoided.

In our practice, we use echo-guidance for all pericardiocentesis procedures. For acute tamponade related to procedural perforation that occurs in the catheterization or electrophysiologic laboratory, echo is used to guide access in the procedural room. For all other cases, we find pericardiocentesis is best performed with a patient on a cart or, if in an intensive care unit, in their hospital bed with their head raised 30° to 60° rather than flat. This allows optimal patient comfort and ease of access. As tolerated by hemodynamics, the use of combined local anesthesia and intravenous moderate sedation affords patient comfort and a controlled environment for rapid and effective drainage of pericardial fluid. Details of our procedural steps are described elsewhere.[3-6]

Acute perforation leading to hemopericardium, as occurred in the case of Farooq and Iyer,[1] is an increasingly common occurrence because invasive cardiovascular care becomes progressively complex. Echocardiography affords a portable and rapid mechanism for diagnosis and should also be used to guide pericardial access in all patients undergoing pericardiocentesis. In a recent review of over 400 patients who underwent percutaneous management of hemopericardium related to cardiac perforation,

the majority presented emergently, were effectively managed by echo-guided pericardiocentesis with the majority accessed from an intercostal approach.[4]

Finally, we cannot minimize the value of experience. Pericardiocentesis guided by echocardiography was first described in our practice 40 years ago.[7] Since then we have performed the procedure in thousands of patients with modest procedural modifications over time, with between 150 and 250 procedures performed at our institution annually. The high success rate of pericardiocentesis with a low rate of complications likely reflects our standard approach to the procedure and postprocedural management, our routine use of echo guidance, and also the experience of the operator. We have a dedicated team of echocardiologists who provide 24/7 emergency coverage for the management of pericardial effusions and tamponade. All have accumulated significant experience under the mentorship of one individual, Lawrence J. Sinak, MD, with an individual experience of more than 2,000 procedures. Although this experience likely affords an ability to drain effusions that are particularly challenging and small, most importantly, the procedural successes come from strict adherence to our standard protocol and the routine use of cardiovascular ultrasound.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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REFERENCES

1. Farooq W, Iyer V. Hemoperitoneum, hepatic laceration, and hepatic artery pseudoaneurysm as a complication of emergent pericardiocentesis. *J Am Coll Cardiol Case Rep*. 2023;5:101686.

2. Kilpatrick ZM, Chapman CB. On pericardiocentesis. *Am J Cardiol*. 1965;16:722–728.

3. Lekhakul A, Assawakawintip C, Fenstad ER, et al. Safety and outcome of percutaneous drainage of pericardial effusions in patients with cancer. *Am J Cardiol*. 2018;122:1091–1094.

4. Lekhakul A, Fenstad ER, Assawakawintip C, et al. Incidence and management of hemopericardium: Impact of changing trends in invasive cardiology. *Mayo Clin Proc*. 2018;93(8):1086–1095.

5. Ryu AJ, Kane GC, Pislaru SV, et al. Bleeding complications of ultrasound-guided pericardiocentesis in the presence of coagulopathy or thrombocytopenia. *J Am Soc Echocardiogr*. 2020;33:399–401.

6. Luis SA, Kane GC, Luis CR, Oh JK, Sinak LJ. Overview of optimal techniques for pericardiocentesis in contemporary practice. *Curr Cardiol Reports*. 2020;22:60.

7. Callahan JA, Seward JB, Tajik AJ, et al. Pericardiocentesis assisted by two-dimensional echocardiography. *J Thorac Cardiovasc Surg*. 1983;85(6):877–879.

KEY WORDS perforation, pericardial effusion, tamponade