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PRIMERS IN CARDIO-ONCOLOGY

HOW TO

How to Perform Pericardiocentesis in Cancer Patients With Thrombocytopenia

A Single-Center Experience

Robin Jacob, MD,[a] Nicolas L. Palaskas, MD,[b] Juan Lopez-Mattei, MD,[b] Saamir Hassan, MD,[b] Peter Kim, MD,[b] Teodora Donisan, MD,[b] Dinu Valentin Balanescu, MD,[b] Mehmet Cilingiroglu, MD,[b] Konstantinos Marmagkiolis, MD,[b] Cezar Iliescu, MD[b]

Pericardial effusions are reported in up to 21% of patients with underlying malignancy (1), with most common being breast and lung cancer, followed by lymphoma and leukemia (2). There is a spectrum of clinical presentations that range from lack of significant symptoms to hemodynamic collapse from tamponade (3). Although surgery is the more studied technique, some patients with cancer have a prohibitive risk (4-6). Percutaneous pericardiocentesis is a minimally invasive technique that presents as a viable alternative to surgery in cancer patients who present with thrombocytopenia, a relative contraindication to pericardiocentesis (7,8).

In a retrospective study, Iliescu et al (9) evaluated cancer patients presenting with cardiac tamponade in the setting of thrombocytopenia (platelet count <100,000/uL). In this study, 43% of patients were transfused platelets before pericardiocentesis, with a median platelet count increase after transfusion of only 5,000/uL, consistent with refractoriness to platelet transfusion. It is thus of clinical importance to detail the procedural steps of a safe approach to percutaneous pericardiocentesis in patients with thrombocytopenia.

CLINICAL CASE

A 62-year-old man with a history of diabetes mellitus, hypertension, coronary artery disease (drug-eluting stent to left anterior descending artery 4 months before presentation, currently taking aspirin and clopidogrel), and malignant epithelioid mesothelioma presented to the emergency department with progressive shortness of breath and worsening chest pain.

His cancer treatment history included chemoradiation with 3 cycles of carboplatin and pemetrexed, followed by surgical left pleurectomy with decortication and partial pericardiectomy.

On arrival to the emergency center, the patient's examination revealed labored breathing, muffled heart sounds, and jugular venous distention. The patient's heart rate was 92 beats/min, blood pressure 80/60 mm Hg, temperature 36.8°C, and respiratory rate 20 breaths/min. An electrocardiogram revealed normal sinus rhythm. Laboratory evaluation revealed a white blood count of 1,700/μL, hemoglobin 7.6 g/dL, and platelet count of 91,000/μL.

Chest x-ray revealed an increased cardiac silhouette. Computed tomography (CT) of the chest revealed interval development of a large pericardial effusion (**Figure 1**). An echocardiogram revealed preserved ejection fraction with a large pericardial effusion, concerning for tamponade**.** Given the patient's thrombocytopenia, previous pulmonary surgery, and multiple comorbidities, the surgery team recommended percutaneous pericardiocentesis, which was subsequently performed.

From the [a]Department of Cardiology, McGovern Medical School at The University of Texas Health Science Center at Houston, Houston, Texas, USA; and the [b]Department of Cardiology, The University of Texas MD Anderson Cancer Center, Houston, Texas, USA.

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INITIAL ASSESSMENT OF THE CANCER PATIENT WITH PERICARDIAL EFFUSION

Cancer patients have a high prevalence of blood dyscrasias—pancytopenia (anemia, leukopenia, thrombocytopenia). In addition, a significant number of patients may be treated with direct oral anticoagulants or low-molecular-weight heparin. Bleeding complications and the lack of available blood products as a result of multiple prior transfusions with subsequent development of antibodies presents an additional challenge. If the thrombocytopenic patient (<150 K/μL) with a large pericardial effusion (>2 cm of echo-free space between the visceral and parietal pericardium in diastole) is stable, we recommend performing thromboelastography (TEG), which can help risk-stratify the patient (10). In a study with thrombocytopenic patients undergoing cardiac catheterization, a majority of cancer patients with platelet counts of <50,000/μL were hypocoagulable based on TEG. In contrast, those with counts >50,000/μL reported relatively normal TEGs. In patients with platelet count <50,000/μL, a normal TEG can reassure the operator. Although not systematically evaluated, we believe the incremental value of TEG increases as the platelet count decreases, allowing for targeted blood product replacement (fresh-frozen plasma, cryoprecipitate, platelets) if bleeding occurs.

When assessing pericardial effusion, we recommend reviewing 2 imaging modalities, the echocardiogram and chest CT, if possible:

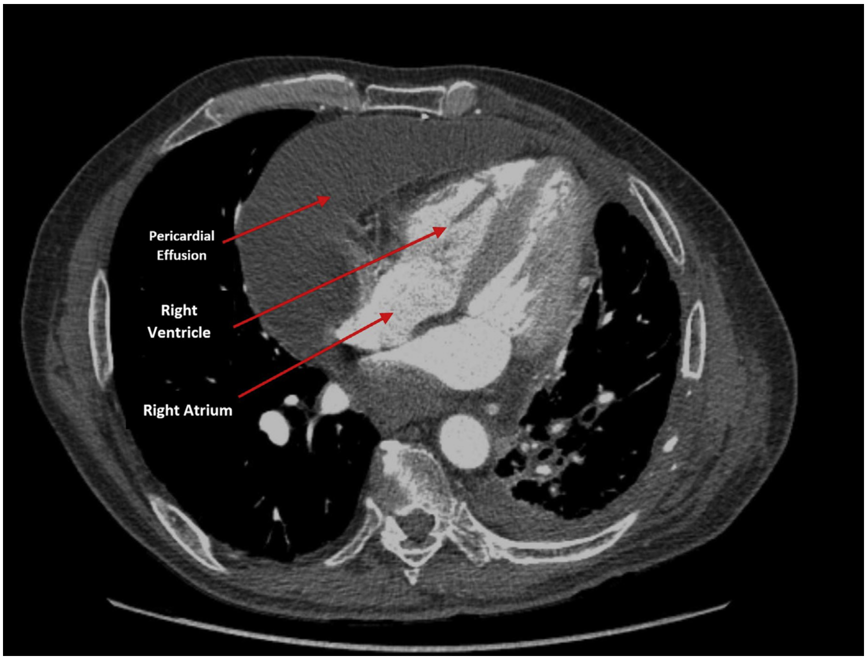
1. *Echocardiogram:* The operator will consider optimal access site the shortest distance from the skin to the pericardial fluid that is free from other structures obstructing the path of the needle (liver or lung tissue). If the subxiphoid distance from the echo probe to the pericardium exceeds 5-7 cm, we recommend scanning to assess for a lateral approach. If available, 3-dimensional echo can provide additional guidance. Patients with cancer may have distorted anatomy. Scanning the patient in a sitting position at 45°-60° is necessary to assess whether the pericardial effusion is free-floating or loculated.
2. *Chest CT:* Imaging can demonstrate an enlarged pericardium that allows for lateral access with a decreased pneumothorax risk vs a centrally positioned heart where the risk is increased. A pleural effusion can further complicate lateral access. A chest x-ray can also provide information about gastric and colonic distention.

ABBREVIATIONS AND ACRONYMS

CT = computed tomography

TEG = thromboelastography

FIGURE 1 Chest Computed Tomography



Imaging reveals large right sided pericardial effusion compressing right atrium and ventricle; **red arrows** delineate structures.

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SUBXIPHOID VS LATERAL APPROACH FOR PERICARDIOCENTESIS

Most common access sites for pericardiocentesis are the subxiphoid and lateral approaches. We favor lateral approach using the 7 cm "short" Cook micropuncture introducer set in emergent or urgent settings; if the patient is unstable, short of breath, thrombocytopenic, on anticoagulation, or has a history of abdominal surgery with scarring in subxiphoid area; or if the distance to pericardial space is more than 5-7 cm from the subxiphoid. We favor the subxiphoid approach if the distance from the echo probe to the subxiphoid space is <5 cm, the patient has a history of breast reconstructive surgery, there is the presence of chest wall scarring from radiation or tumor involvement in the chest wall, there is an apically loculated pericardial effusion, the patient had previous left lung surgery, or there are large left sided tumors with displacement of the heart to the right, as illustrated in the access site decision making algorithm (**Central Illustration**).

PERICARDIOCENTESIS IMAGING MODALITIES

In our experience, we strongly recommend having both echocardiographic and fluoroscopic guidance during the procedure if possible:

1. *Echocardiographic guidance*, with standard imaging, is helpful and sufficient in majority of the cases, especially in emergent bedside cases.
    - *Advantages*: Portable technology, establishment of the access site, and confirmation of the position of the needle in the pericardial space using agitated saline.
    - *Limitations:* Agitated saline injected through the micropuncture needle is sometimes difficult to visualize in bloody, organized effusions or in patients with poor windows caused by large body habitus. We usually aspirate some pericardial fluid in the syringe with agitated saline and reinject for better visualization.
2. *Fluoroscopic guidance*: Fluoroscopy can be used for visualization of the wire and to guide the advancement of the needle toward the "pericardial halo" or an anterior or posterior loculated pocket of fluid.
    - *Advantages:* Useful in patients with difficult anatomy and poor echocardiographic windows.
    - *Limitations:* Radiation exposure to the patient/operator and availability of a catheterization laboratory.

STEP-BY-STEP PERICARDIOCENTESIS PROCEDURE DESCRIPTION

1. LOCAL ANESTHESIA. Inject lidocaine 1% at the area of access.

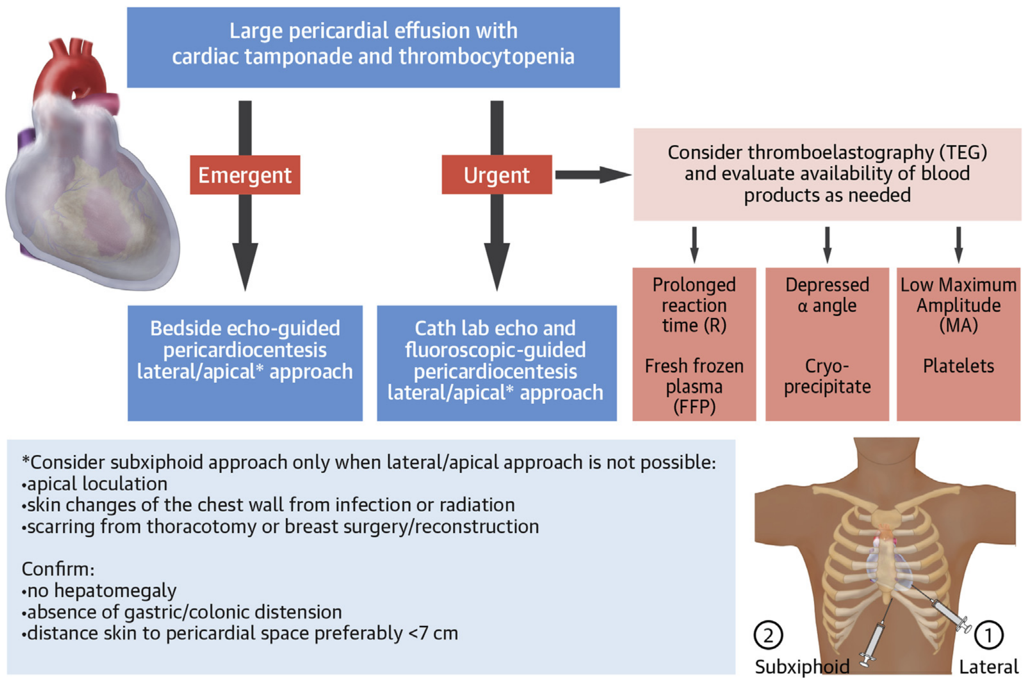
2. ACCESS OF THE PERICARDIAL SPACE. Prior to attempting access, there are several things to keep in mind. We usually use a needle connected to a 5-mL syringe with lidocaine. Body habitus determines the space the needle has to travel to reach the pericardial fluid, but we usually add 2 cm to the distance from the echo probe to the pericardial space. For any value above 7 cm, we use the long micropuncture needle. While advancing the needle, we aspirate as well as gently inject lidocaine to confirm needle patency. The micropuncture needle is extremely sharp, and touching the ribs can be equivalent to a small bone biopsy with obliteration of the needle lumen. For the long micropuncture needle, fluoroscopy can be helpful. For the lateral approach, we always use the short micropuncture kit with a needle advanced tangential to the upper edge of the ribs. Use of biplane fluoroscopic imaging may be helpful for visualization.

3. CONFIRMATION OF THE INTRAPERICARDIAL POSITION. If the initial aspiration fluid is serous, we secure the space with a micropuncture wire and confirm positioning with fluoroscopy. We then advance the micropuncture dilator, through which we inject agitated saline under echocardiographic guidance to confirm position. Agitated saline can help determine whether any perforation of the ventricles or atria occurred.

When the fluid is hemorrhagic, confirmation with agitated saline before advancing the micropuncture dilator is mandatory, as well as evaluation of the hemorrhagic fluid on a 4 × 4 dry gauze to make sure that it does not coagulate. The most challenging cases are when the pericardial fluid is hemorrhagic and when echocardiographic confirmation is not possible. In this situation, fluoroscopy and lack of premature ventricular complexes or cardiac arrhythmias may help confirm position. In our experience, it is helpful to change the angle of the x-ray C-arm and manipulate the wire to confirm absence of ectopy.

4. PIGTAIL ADVANCEMENT. Advancing the pigtail in the patient in the subxiphoid approach should be done under fluoroscopy guidance. This is the step where the 5-F Cook pigtail catheter with its tapered dilator/insert makes a difference. This catheter advances with ease, whereas larger-sized catheters are very challenging to advance, requiring additional dilatation and sometimes more supportive wires. In

CENTRAL ILLUSTRATION Access Site Algorithm



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Algorithm to help guide the approach for pericardiocentesis in thrombocytopenic cancer patients.

patients with thickened pericardium from tumor infiltration or after radiotherapy, advancing the catheter may be challenging. Additional sedation and gradual dilatation are keys to success.

Although there is concern for pericardial decompression syndrome when initial drainage exceeds 500 mL, when fluid is hemorrhagic there is an increased risk of clotting due the small-sized catheters and we favor a more complete drainage of the pericardial space.

5. CATHETER SECUREMENT. The catheter is secured with 2 sets of sutures 180° apart as the patient is encouraged to ambulate. We typically keep the drain for 3-5 days open to gravity to promote scarring of the pericardial space and prevent recurrence (7). In our experience, recurrence rates for pericardial effusion are low when using longer periods of drainage (10%) compared with shorter drainage duration (23%) (7).

6. POST-OP FOLLOW-UP. Radiographic imaging is appropriate to evaluate for pneumothorax. The drain and bag should be placed below the patient's heart.

7. CATHETER REMOVAL. At our institution, the catheter remains in place until the patient has <50 mL pericardial drainage in 24 hours. Catheter removal is standard, with the patient performing Valsalva maneuver by bearing down. If initial insertion of the catheter is challenging, that should be reported to the team that removes the catheter, as there is a small risk of fracturing the small 5-F pigtail catheter at the time of removal.

CASE FOLLOW-UP

Cardiology was consulted, and the patient underwent successful pericardiocentesis using the subxiphoid approach, given the prior history of lung surgery, in the catheterization laboratory using echocardiography and fluoroscopy guidance. A total of 1 L of hemorrhagic fluid was removed positive for malignant mesothelioma cells. A 5-F drain was left in place and was removed after 1 week. He was discharged home with 2-week follow-up with cardiology.

CONCLUSIONS

In our experience, pericardiocentesis in thrombocytopenic patients involves operator expertise in both the subxiphoid and lateral approaches, with a low

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threshold to use a lateral approach. We favor use of the micropuncture kit to minimize possible cardiac injury. In thrombocytopenic patients, waiting for the platelet transfusion may not change the overall risk, but could lead to procedural delay and deterioration of the patient condition. With this meticulous approach, pericardiocentesis in thrombocytopenic patients can be executed safely.

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ADDRESS FOR CORRESPONDENCE: Dr Cezar Iliescu, Department of Cardiology, The University of Texas MD Anderson Cancer Center, 1400 Pressler Street, Unit 1451, Houston, Texas 77030, USA. E-mail: ciliescu@mdanderson.org. Twitter: @onco_cardiology, @cezar_iliescu.

REFERENCES

1. Jama GM, Scarci M, Bowden J, et al. Palliative treatment for symptomatic malignant pericardial effusion. *Interact Cardiovasc Thorac Surg*. 2014;19:1019–1026.

2. Petrofsky M. Management of pericardial effusion. *J Adv Pract Oncol*. 2014;5(4):281–289.

3. Kim SH, Kwak M, Park S. Clinical characteristics of malignant pericardial effusion associated with recurrence and survival. *Cancer Res Treat*. 2010;42:210–216.

4. Vaitkus P, Hermann H, LeWinter M. Treatment of malignant pericardial effusion. *JAMA*. 1994;272:59–64.

5. Apodaca-Cruz A, Villarreal-Garza C, Torres-Avila B, et al. Effectiveness and prognosis of initial pericardiocentesis in the primary management of malignant pericardial effusion. *Interact Cardiovasc Thorac Surg*. 2010;11:154–161.

6. Saltzman A, Paz Y, Rene A. Comparison of surgical pericardial drainage with percutaneous drainage with percutaneous catheter drainage for pericardial effusion. *J Invasive Cardiol*. 2012;24:590–593.

7. Haddad DE, Iliescu C, Yusuf SW, et al. Outcomes of cancer patients undergoing percutaneous pericardiocentesis for pericardial effusion. *J Am Coll Cardiol*. 2015;66:1119–1128.

8. Maisch B, Seferovic P, Ristic A. Guidelines on the diagnosis and management of pericardial diseases executive summary: The Task Force on the Diagnosis and Management of Pericardial Disease of the European Society of Cardiology. *Eur Heart J*. 2004;25:587–610.

9. Iliescu C, Khair T, Marmagkiolis K, et al. Echocardiography and fluoroscopy-guided pericardiocentesis for cancer patients with cardiac tamponade and thrombocytopenia. *J Am Coll Cardiol*. 2016;68(7):771–773.

10. Agha AM, Gill C, Balanescu DV, et al. Identifying hemostatic threshold in cancer patients undergoing coronary angiography based on platelet count and thromboelastography. *Front Cardiovasc Med*. 2020;7:9.

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