

Echocardiography-guided pericardiocentesis with the apical approach

Ekokardiyografi rehberliğinde apikal yaklaşımla perikardiyosentez

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Objectives: We aimed to evaluate our experience with echocardiography-guided pericardiocentesis with the apical approach for pericardial effusions.

Study design: We evaluated 32 pericardiocentesis performed under echocardiography guidance and with the apical approach in 29 patients (15 men, 14 women; mean age of 49 years; range of 18 to 72 years). Indications were diagnostic purpose, pericardial tamponade or symptomatic pericardial effusion. Procedural success, the amount of drainage, and complications were assessed.

Results: Common causes of pericardial effusion were malignancy (n=6), postpericardiotomy syndrome (n=5), idiopathic (n=5), chronic renal disease (n=4), and myocardial infarction (n=3). The amount of drainage was 120 ml to 2,200 ml and the duration of pericardial catheter placement in the pericardial space was 24 to 144 hours. Death did not occur. Echocardiographic control showed residual effusion in the lateral wall in one case, which required repositioning of the pericardial catheter for complete removal. The procedure failed in one patient due to insufficient drainage caused by multiple septations and fibrinous fluid in the pericardial space. The success rate of the procedures was 96.9%. Four cases developed hemopneumothorax requiring tube drainage, vasovagal reaction, nonsustained ventricular tachycardia, and frequent ventricular extrasystoles, respectively. Apical puncture was repeated in two cases due to erroneous left ventricular puncture and pleural catheter placement, respectively.

Conclusion: Echocardiography-guided pericardiocentesis with the apical approach is readily performed at the bedside without the need for catheterization laboratory, with a high success rate and low complication rate. It should be considered especially in cases in which anterior pericardial collection is more prominent where it will reduce unnecessary surgical interventions.

Key words: Echocardiography; heart catheterization; pericardial effusion/therapy; pericardiocentesis/methods.

Amaç: Bu çalışmada perikart efüzyonu nedeniyle ekokardiyografi rehberliğinde apikal yaklaşımla perikardiyosentez uygulamalarımızın değerlendirilmesi amaçlandı.

Çalışma planı: Çalışmaya, tanı amacıyla veya perikardiyal tamponad ya da semptomatik perikart efüzyonu nedeniyle ekokardiyografi rehberliğinde apikal perikardiyosentez yapılan ardışık 29 hasta (15 erkek, 14 kadın; ort. yaş 49; dağılım 18-72) alındı. Toplam 32 perikardiyosentez uygulaması, işlem başarısı, boşaltılan sıvı miktarı ve komplikasyonlar yönünden değerlendirildi.

Bulgular: Perikart sıvısının sık nedenleri malignite (n=6), postperikardiyotomi sendromu (n=5), idiyopatik (n=5), kronik renal yetersizlik (n=4) ve akut miyokard enfarktüsü (n=3) idi. Boşaltılan sıvı miktarı 120 ile 2200 ml arasında değişmekte idi. Kateterin perikartta kalma süresi 24 ile 144 saat arasındaydı. İşleme bağlı mortalite olmadı. Bir hastada ekokardiyografik kontrolde lateral duvarda efüzyon kaldığı görüldü ve kateterin floroskopi altında buraya yönlendirilerek kalan sıvının tamamının boşalması sağlandı. Bir hastada perikart boşluğundan aşırı septasyon ve fibrinöz sıvı içeriğine bağlı olarak yeterli sıvı boşaltılamadığından işlem başarısız kabul edildi. Uygulanan apikal perikardiyosentez işlemlerinde başarı oranı %96.9 idi. Birer hastada sırasıyla tüp drenajı gerektiren hemopnömotoraks, vazovagal reaksiyon, devamlı olmayan ventrikül taşikardisi ve sık ventrikül erken atımları izlendi. Bir hastada sol ventrikül ponksiyonu, bir hastada kateterin plevraya yerleştirilmesi nedeniyle ponksiyon tekrarlandı.

Sonuç: Ekokardiyografi rehberliğinde perikardiyosentezde apikal yaklaşım, kateter laboratuvarına ihtiyaç duymadan yatakbahında rahatlıkla yapılabilmesi, işlem başarısının yüksek, komplikasyonların düşük olması nedeniyle ve özellikle sıvının kalbin anteriorunda biriktiği olgularda gereksiz cerrahi girişimi azaltacağından mutlaka düşünülmelidir.

Anahtar sözcükler: Ekokardiyografi; kalp kateterizasyonu; perikart efüzyonu/tedavi; perikardiyosentez/yöntem.

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Echocardiography-guided percutaneous pericardiocentesis, as an alternative to electrocardiography or fluoroscopy-guided procedures was first developed at the Mayo-Clinic in 1979.^[1] Echocardiography-guided pericardiocentesis had several advantages in diagnosis and treatment of pericardial effusion owing to its ease of use and significantly lower complication rates.^[1-5] Most of the procedures are performed through anterior chest wall, mostly from apical region.^[4,5]

Despite its ease of use and lower complication rates, the apical approach is not generally preferred compared to the subxiphoid approach. In addition, apical/anterior approach is often neglected although pericardial effusion is mostly seen anteriorly rather than inferiorly.^[6-9]

In this study, we aimed to evaluate our experience of the past 2 years with echocardiography-guided pericardiocentesis with the apical approach for pericardial effusions.

PATIENTS and METHODS

We evaluated 29 consecutive patients (15 men, 14 women, mean age 49 years; range 18 to 72 years) retrospectively who underwent echocardiography-guided apical pericardiocentesis in cardiology clinic between March 2006 and September 2008. Indications were; diagnostic purpose (cases with asymptomatic and diastolic >10 mm pericardial fluid), pericardial tamponade (consistent with echocardiographic and/or clinical criteria) or symptomatic pericardial effusion (cases without clinical or echocardiographic findings of cardiac tamponade). A total of 32 pericardiocentesis were evaluated with respect to procedural success, the amount of drainage, mortality and complications.

Bedside surface echocardiography-guided apical pericardiocentesis (Vivid 3, GE Vingmed Ultrasound,

Horteni Norway) was performed under local anesthesia on all patients in the coronary intensive care unit. With the assistance of two-dimensional echocardiography, the puncture site was designated as the site in which pericardial fluid mostly accumulated and which was proximal to the skin.^[10] The direction of puncture needle and echocardiographic probe was parallel during the procedure. The area of the chest wall with peak heart beat and its surrounding was described as the apical and para-apical region. The procedure was performed through the upper margin of ribs in the intercostals space. Puncture was not performed to prevent any damage to the left internal mammary artery located 4-5 cm to the left side of sternum.^[1,10]

Patients were instructed to lie supine, with the upper body elevated to a 45 degree angle. The puncture site was cleaned with povidone-iodine, covered with a sterile cloth and local anesthesia with 2% lidocaine was applied. An 18-gauge needle was placed into a 10-mm syringe filling with a 3-mL saline solution and the fluid was aspirated continuously. Simultaneously, puncture was performed under negative pressure. When pericardial fluid was aspirated, the puncture needle was retrieved after replacing a 0.038-inch J-tip guidewire. Agitated saline contrast was injected to confirm correct guidewire position in suspected cases. A 6- or 7-F Cordis sheath (Figure 1a) or multi-orifice pleural catheter (Pleuracan®, B. Braun Melsungen AG, Germany) (Figure 1b) was placed into the pericardial space over the guidewire and the guidewire was retrieved. Following insertion of the sheath, drainage was done via a pigtail catheter which was advanced into the pericardial space through the sheath. A closed system was used to drain the fluid. Samples from the drained fluid were obtained for biochemical, microbiological and cytological analyses. Samples from effusions which developed iatrogenically or following the procedure were not collec-

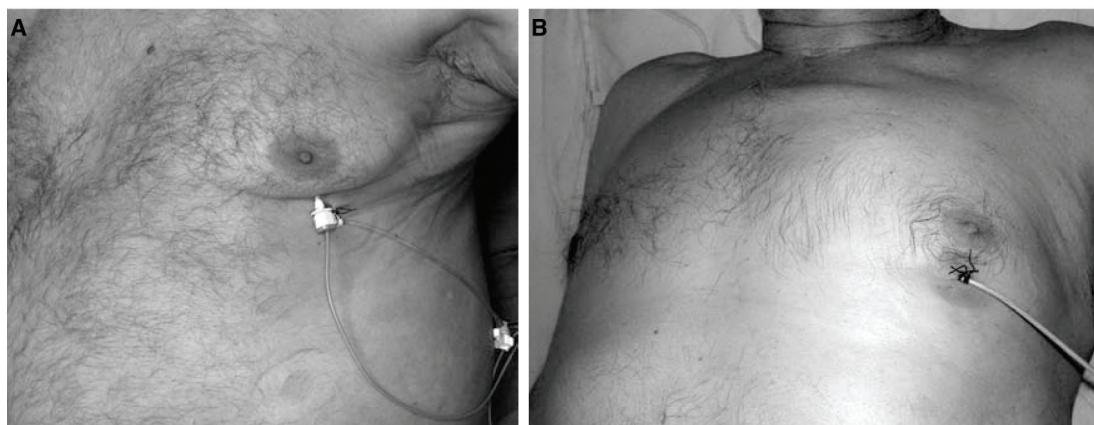


Figure 1. Sheath containing a pigtail catheter (A) and pleural catheter (B) in the apical region.

ted for analysis. Initially, fluid >1000 mL was not drained to prevent hypotensive shock due to acute right ventricular dilatation which could result from rapid fluid drainage.^[11] Following the procedure, the inside of the catheter was washed using saline to prevent possible occlusions associated with protein content of the fluid. Drainage was repeated every 4-6 hours. The success of the procedure was confirmed by echocardiography when the amount of drainage was <25 mL within 24 hours after which the catheter was retrieved from pericardial space.^[1] Chest X-rays were performed on all patients to exclude development of pneumothorax following the procedure. The procedure was found to be successful when there was relief of symptoms and when echocardiogram showed that fluid was drained completely following aspiration. Emergency surgical interventions, insertion of the needle into the cardiac spaces, arrhythmia, vasovagal reaction, hemothorax, pneumothorax associated with the procedure were considered as complication.

RESULTS

Common causes of pericardial effusion were malignancy (n=6), postpericardiotomy syndrome (n=5), idiopathic (n=5), chronic renal failure (n=4), acute myocardial infarction (n=3), tuberculosis (n=2), iatrogenic (n=1), rheumatoid arthritis (n=1), aspergillosis (n=1) and trauma (n=1).

Multi-orifice pleural catheters were used on five patients, while using coated *pigtail* pleural catheters were used on 24 patients. The amount of drainage was 120 ml to 2,200 ml and the duration of pericardial catheter in the pericardial space was 24 to 144 hours. As drainage was repeated every 4-6 hours rather than continuous free drainage and as catheters were washed using saline following every aspiration, catheter obstruction was not observed.

The 48th hour echocardiographic follow-up following catheter insertion showed a 2 cm residual effusion in the lateral wall in one patient and the remaining fluid was drained completely by directing the *pigtail* catheter in the pericardium under fluoroscopy. One of the patients underwent two pericardiocentesis, while one underwent three procedures at different times due to recurrent pericardial effusion. The procedure failed in one patient due to insufficient drainage caused by multiple septations and fibrinous fluid in the pericardial space and the patient was recommended surgical intervention. Except for this case all procedures were found to be successful. The success rate of apical pericardiocentesis was 96.9%.

Mortality did not occur due to the procedure. One patient each developed hemopneumothorax requiring tube drainage, vasovagal reaction, nonsustained ventricular tachycardia, and frequent ventricular extrasystoles. Left ventricular puncture was performed in one patient. Following echocardiographic evaluation of the puncture site after removal of the needle, the apical approach was applied. The patient was followed-up echocardiographically and hemodynamically after drainage of fluid and no complication was observed to develop.

Apical puncture was performed in one patient with postpericardiotomy syndrome and *pigtail* catheter was inserted after the sheath. Echocardiographic follow-up showed no decrease in pericardial fluid after the drainage of nearly 240 mL fluid. When agitated saline contrast was injected, it was found that catheter was positioned in the pleural cavity instead of the pericardium. Thereupon, apical puncture was repeated after re-evaluating the apical puncture site with echocardiography. The sheath and later *pigtail* catheter were inserted, when the catheter was confirmed to be in the pericardial space with agitated saline contrast and the pericardial fluid was drained. No complication developed during follow-up.

DISCUSSION

In the study, we evaluated the results of echocardiography-guided pericardiocentesis with the apical approach.

Echocardiography is a key technique in the diagnosis and determination of treatment choice of pericardial effusion. The location of pericardial fluid is clearly detected by two-dimensional echocardiography which is used as a guide during pericardiocentesis. The major advantage of echocardiography is its guidance to determine the puncture site and the direction of puncture needle. By doing so, pericardiocentesis may be performed through not only the subxiphoid, but also the apical and rarely, left/right parasternal or lateral regions.

Pericardiocentesis with the apical approach is an important modality to be considered when a small amount of fluid in the contiguous right atrial and right ventricular free wall cannot be reached by subxiphoid puncture, but in cases with effusion principally in the contiguous left ventricular apex, and fluid accumulation anterolaterally or posterolaterally in the left ventricle (Figure 2). In addition, the apical approach reduces the demand for surgical intervention in patients with limited effusion.^[1,10,12]

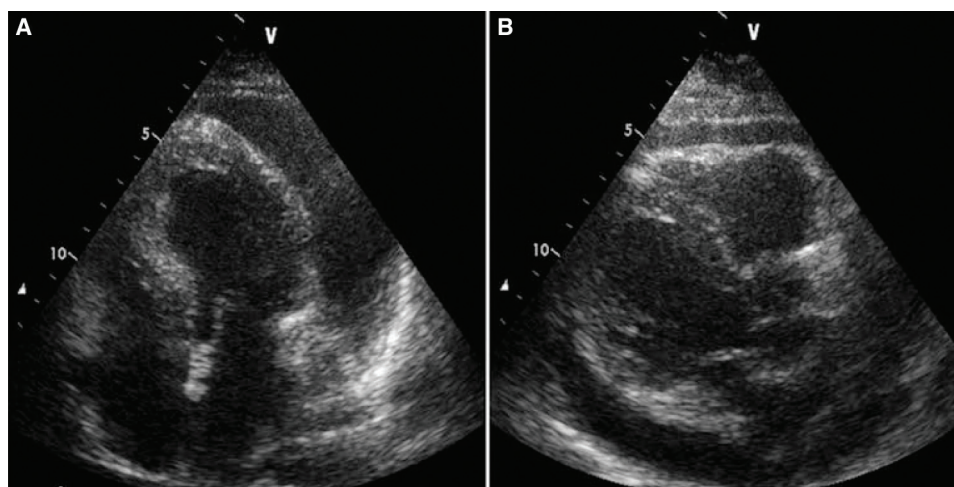


Figure 2. Long axial image of apical 4-space (A) and parasternal (B) pericardial effusion showing more fluid in left ventricular lateral, less fluid in anterior right ventricle, more convenient with pericardiocentesis with the apical approach.

Tsang et al.^[4] who published the largest case series in the literature selected the apical (64%), subxiphoid (21%) and other sites of the chest wall (15%) for puncture. The authors also found the rates of postoperative pericardiocentesis in one of their other studies to be 71% with the apical approach, 12% with the subxiphoid approach and 17% through the other sites of the chest wall.^[5] On the other hand, Cho et al.^[9] performed 93% of the procedures with the subxiphoid approach and 7% through the chest wall. Studies performed in Turkey on pericardiocentesis have demonstrated that the subxiphoid approach is generally preferred.^[7,13] Kabukcu et al.^[7] performed all procedures on 50 patients with the subxiphoid approach. Ozkan et al.^[13] also performed all procedures with the subxiphoid approach under echocardiography.

Apical approach may be advantageous particularly in obese patients compared to the subxiphoid approach as the distance between pericardium and skin is shorter. This is because the distance which the needle should take to reach the fluid is longer with the subxiphoid approach and the needle has to pass in front of the liver capsula.^[1] With the apical approach, no lung tissue is found at the site selected by two-dimensional echocardiography, and does not interrupt the puncture, since air would not transfer ultrasound waves.^[1,10] The right ventricle and right atrium shrink in size during diastole as a result of greater intrapericardial pressure over intracardiac pressure; the opposite of this is true during systole as excessive activity is observed in the pericardium.^[14] In such situations, regardless of the amount of the fluid in the contiguous right ventricle, the risk of injury to the chamber is greater with the subxiphoid approach. Moreover,

the direction of the puncture needle is positioned toward right ventricle. On the other hand, the amount of bleeding occurring during removal of the needle will be greater than with the left ventricle when the needle is advanced to the right ventricle, since the right ventricular wall thickness is 1/3-4 of the left ventricular thickness and there is a greater risk of conversion of stable effusion into tamponade.^[8,15] In addition, there is a risk of injury to the right atrium as well as right ventricle with the subxiphoid approach, and only the left ventricle is at risk with the apical approach. As seen in one of our patients, the risk of complications including rupture and bleeding when the needle is retrieved is lower with the apical approach due to a thicker wall, even when puncture is performed on left ventricle accidentally. The likelihood of injury to the left atrium is very low since it is far from the procedure area and also because of a rare development of effusion in the contiguous left atrium as only a small portion of the left atrium is covered by the pericardium.^[12]

Advancing of the sheath over the guidewire following adequate dilatation is another critical factor. As a result possible breakage of the sheath which may occur while advancing the sheath over the guidewire can be prevented.

Consequently, echocardiography-guided pericardiocentesis with the apical approach should be considered in suitable cases as it is readily performed at the bedside without the need for catheterization laboratory, with a high success rate and fewer complications. The apical approach should not be disregarded especially in cases where there is anterior pericardial collection as it will reduce unnecessary surgical interventions.

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