Turk Gogus Kalp Dama 2014;22(3):553-557
doi: 10.5606/tgkdc.dergisi.2014.9529

***Original Article** / Özgün Makale*

Computed tomography-guided drainage of pericardial effusion

Bilgisayarlı tomografi eşliğinde perikardiyal effüzyon drenajı

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Background: This study aims to evaluate the safety and feasibility of computed tomography (CT)-guided drainage of pericardial effusions by using a nephrostomy catheter.

Methods: We performed CT-guided drainage of pericardial effusions on 30 patients (15 males, 15 females; mean age 52±3 years; range 18 to 80 years) in our clinic between December 2005 and November 2011. Only patients who were ineligible for echocardiography-guided drainage were selected. By using the Seldinger technique, a 8 or 10F nephrostomy catheter was inserted into the pericardial space.

Results: Procedure was successful in 29 patients. In one patient, the catheter was able to be placed in the pericardial space, but the fluid was unable to be aspirated. The patient was operated. An organized hematoma was found in the pericardial space. During surgery, a small epicardial laceration was detected on the anterolateral surface of the right ventricle. Serous fluid was aspirated from 12 patients (41%), hemorrhagic fluid from 10 patients (35%), transude from seven patients (24%) and purulent fluid was aspirated from one patient (3.3%). Catheters were removed after a mean duration of 4±2 days. In two (6.6%) patients pericardial effusion recurred and successful drainage was performed by the same method. No new recurrences were observed. No procedure-related death was occurred.

Conclusion: Our study results suggest that CT-guided drainage with a nephrostomy catheter is an effective, safe and feasible procedure in patients who are ineligible for echocardiography-guided drainage. We also believe that this technique is more suitable for patients with postoperative localized pericardial effusions.

Keywords: Cardiac tamponade; pericardial effusion; pericardiocentesis.

Amaç: Bu çalışmada nefrostomi kateteri kullanılarak bilgisayarlı tomografi (BT) eşliğinde yapılan perikardiyal efüzyonların drenajının güvenliliği ve uygulanabilirliği değerlendirildi.

Çalışma planı: Aralık 2005 - Kasım 2011 tarihleri arasında kliniğimizde 30 hastada (15 erkek, 15 kadın; ort. yaş 52.3 yıl, dağılım 18-80 yıl) BT eşliğinde perikardiyal efüzyon drenajı gerçekleştirildi. Yalnızca ekokardiyografi eşliğinde yapılan drenaj için uygun olmayan hastalar seçildi. Seldinger tekniği kullanılarak 8 veya 10F nefrostomi kateteri perikard boşluğuna ilerletildi.

Bulgular: İşlem 29 hastada başarılı idi. Bir hastada kateter perikard boşluğuna yerleştirildi; ancak sıvı aspire edilemedi. Bu hasta ameliyata alındı. Perikard boşluğunda organize bir hematoma rastlandı. Ameliyat sırasında sağ ventrikülün anterolateral yüzeyinde küçük bir epikardiyal lazerasyon tespit edildi. On iki hastada (%41) seröz sıvı, 10 hastada (%35) hemorajik sıvı, yedi hastada (%24) transüd ve bir hastada (%3.3) pürülan sıvı aspire edildi. Ortalama 4±2 gün sonra kateterler çıkarıldı. İki hastada (%6.6) perikardiyal efüzyon tekrarladı ve aynı yöntemle başarılı bir şekilde drene edildi. Yeni nüksler gözlenmedi. İşleme bağlı ölüm gerçekleşmedi.

Sonuç: Çalışma sonuçlarımız ekokardiyografi eşliğinde yapılan drenaj için uygun olmayan hastalarda, nefrostomi kateteri ile BT eşliğinde yapılan drenajın etkili, güvenli ve uygun bir işlem olduğunu göstermektedir. Bununla birlikte, bu tekniğin ameliyat sonrası lokalize perikardiyal efüzyonlu hastalar için daha uygun olduğu görüşündeyiz.

Anahtar sözcükler: Kardiyak tamponad; perikardiyal efüzyon; perikardiyosentez.

Available online at
www.tgkdc.dergisi.org
doi: 10.5606/tgkdc.dergisi.2014.9529
QR (Quick Response) Code

Received: November 14, 2013 *Accepted:* January 27, 2014

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Pericardial effusion may be caused by viral infections, tuberculosis (TB), rheumatic fever, renal failure, malignant diseases, or postoperative or post-traumatic leaks.[1] Drainage is needed when pericardial fluid shows hemodynamic impairment or when pericardial effusion is identified by diagnostic methods. Whether in small amounts that can develop quickly or large amounts that develop slowly, this pericardial fluid may lead to tamponade.[2] It can then be drained using different methods, but the most common technique is ultrasound-guided percutaneous drainage,[1,3] a simple procedure conducted at the patient's bedside. This is very effective in patients with diffused effusion since it is difficult to view loculated effusion in the retrocardiac space with echocardiography. However, computed tomography (CT) may be helpful in the detection of normal pericardial fluid accumulation.[4] For example, CT-fluoroscopy is used for biopsies of the mediastinum, lungs, and abdomen,[5,6] and helical CT is increasingly being used in the evaluation of cardiac pathology. Furthermore, CT is very useful for diagnosing and treating pericardial effusions,[7] and it has been reported that it can be used as a guiding method in patients with pericardial effusion.[5] However, the number of patients for whom CT has been used in this way is limited. In this article, we aim to present our experience with 30 patients who underwent CT-guided drainage of pericardial effusions using different types of catheters.

PATIENTS AND METHODS

We performed CT-guided pericardial drainage on 30 patients (15 males, 15 females; mean age 52±3 years; range 18 to 80 years) in our clinic between December 2005 and November 2011 and we used both CT and echocardiography to diagnosis and define the severity of the effusion. Mildly severe pericardial effusion was diagnosed if the distance between the left ventricular posterior wall and the pericardium during diastole was less than 10 mm. Moderately severe effusion occurred if this distance was between 10 and 20 mm, and it was deemed severe if the distance was more than 20 mm. The effusions were localized in the lateral left, lateral ventricle, posterolateral right, and right posterior atriums. Patients who were not compatible for echocardiography (echo)-guided drainage were selected for this procedure, and the remainder underwent the echo-guided or subxiphoid drainage. All of the patients were informed about the procedure preoperatively, and then we obtained their informed written consent to proceed.

The patients were assessed using helical CT, with images being acquired at 10 mm intervals from the heart apex to the aortic arch in order to define the access point for draining the pericardial effusion. After this was determined, the access point was marked on the skin. Next, a metallic needle tip was fixed to this point and the connection was confirmed with CT. Electrocardiography (ECG) was used to detect possible complications, and an isotonic solution was administered from the open intravenous vessel access. In addition, we monitored each patient's blood pressure at frequent intervals.

After being stained and disinfected, the marked area was covered with sterile covers using lidocaine 2% as the local anesthetic agent. The pericardial cavity was then accessed with a negative puncture using an 18 G needle that was fixed at the level of fluid aspiration, and the image was reacquired to confirm that the needle was in the intrapericardial area (Figure 1). Afterwards, the fluid was aspirated to evaluate its characteristics, and after verifying the presence of defibrinated blood, a 0.35 guidewire was sent through the needle into the pericardial cavity (Figure 2). The needle was removed, and we verified that the guidewire was in place. Then either an 8 or 10 F catheter, featuring a soft and pigtail-shaped tip developed for percutaneous nephrostomies (Figure 3), was advanced into the pericardial cavity through the guidewire. Next, a three-way tap was attached to the tip of the catheter, and the fluid was drained via a 50 ml injector. The catheter was then fixed and connected to the underwater drainage system. Fluid aspiration was done using the three-way tap when it was deemed necessary for the patients who had been monitored for daily drainage quantity. Finally, the catheters were withdrawn when the daily drainage amount fell below 50 ml, indicating a minimal amount of intrapericardial fluid or none at all.

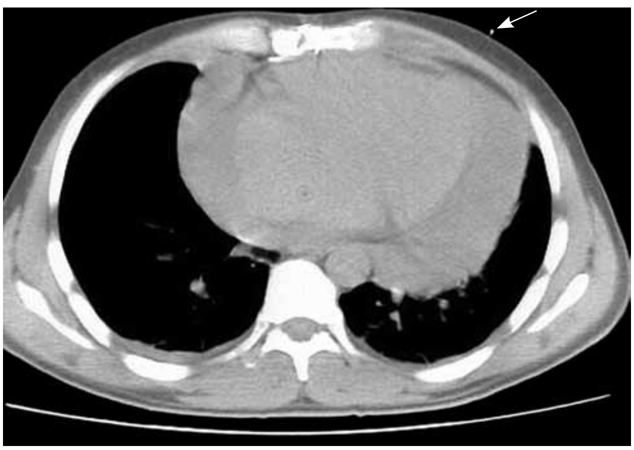

Figure 1. View of the needle in the pericardial cavity (arrow).

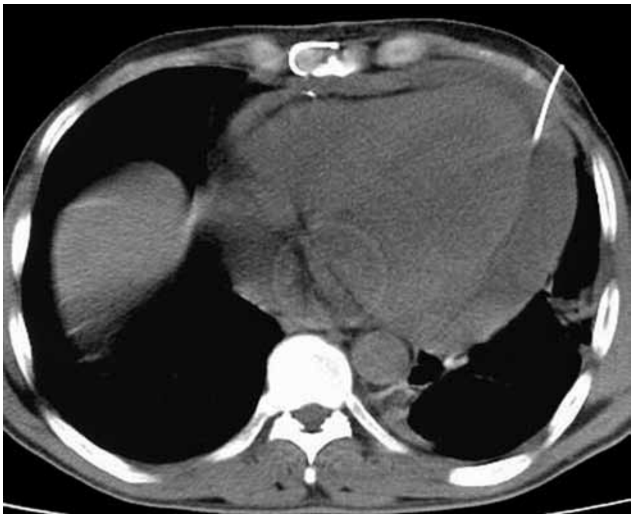
Figure 2. View of the pericardial cavity via the guidewire.


Figure 3. The nephrostomy catheter used in our study.

RESULTS

All of the CT-guided interventions were technically successful (n=30), and sufficient fluid was aspirated in 29 of the cases. However, after the puncture was made in one patient, no fluid was aspirated after introducing the catheter. The catheters were left intact for a mean of 4±2 days, and they had to be reinserted in two patients due to recurrence after they had been removed. In addition, 29 of the 30 procedures were performed without any complication, but a subxiphoid tube pericardiostomy was carried out with local anesthesia in one patient because of a complication in the hemopericardium due to epicardial injury. To correct the problem, the pericardial window was opened, and the hematoma was discharged via a mini thoracotomy under general anesthesia. An organized hematoma was also considered to be a possibility in the patient who could not be aspirated, even though access had been established to the intrapericardial area, but this was later ruled out. In addition, serous fluid was aspirated from 12 patients (41%) while hemorrhagic fluid was removed from 10 others (35%), transudate was aspirated from seven more (24%), and purulent fluid was taken from one of the study participants. The mean quantity of the aspirated fluids was 920±225 ml (range; 50-1500 ml). The smallest amount of drainage was obtained from a patient with chronic renal failure, and the largest amount came from a patient with idiopathic pericarditis.

The fluid cytology reports were negative for two patients who underwent the procedure due to malignancy. In one case in which pericardial effusion developed because of bacterial infection, the fluid cultures were also negative, and the results of the cytology reports were benign. In addition, two cases who underwent pericardial effusion due to uremia were reported as having reactive mesothelial cell hyperplasia. Fluid samples for the cytological examinations were not drawn from the patients who underwent open heart surgery, and all of the other cases were benign. Furthermore, catheter drainage was repeated via the same method in two patients (6.6%). Recurrence developed after the removal of the catheter but was not observed again in these patients. No mortality occurred due to the surgery, but one patient, who developed liver failure due to fulminant hepatitis that resulted in pericardial effusion, died three days after the drainage procedure. Furthermore, one patient who underwent mitral valve replacement (MVR) surgery died in the reanimation clinic due to cerebral bleeding related to a coumadin overdose.

DISCUSSION

In humans, the pericardial fluid (normal level 15-50 ml) enables the heart to function in a friction-free environment.[1,3] Since the content of this fluid is similar to that of plasma, it is considered to be an ultrafiltrate of plasma, with almost the same concentrations being found in many of the molecules.[2,4]

Pericardial effusion, the accumulation of fluid between the leaves of the pericardium, is seen in one out of every 10 patients in routine echocardiography controls.[5] In addition to the presence of conditions that lead to acute pericarditis, pericardial effusion may also be seen in the clinical manifestations of congestive heart failure, hypothyroidism, malignancy, and renal failure. The fluid may be transudative, exudative, purulent, hemorrhagic, or chylous, depending on the etiology. Slow-developing large effusions, which may be asymptomatic, and small amounts of effusion, which can develop quickly, may lead to tamponade.[6]

Patients may or may not have symptoms depending on the amount of fluid, the time it took for it to accumulation, and the physical features of the pericardium.[6] Intrapericardial pressure increases when the fluid starts to accumulate in the pericardial cavity, leading to the ventricle filling pressures becoming equal. This results in a marked decrease in the diastolic volume of the ventricles. Even a sudden accumulation of 100-200 ml fluid can prevent the expansion of the pericardium and possibly cause acute tamponade. When this happens, the right atrium fills first, the left atrium is blocked, and heart tamponade begins. If the intrapericardial pressure is equal to or exceeds the left diastolic pressure, the ventricular volume decreases, and the stroke volume and cardiac output fall. Although compensated by reflex tachycardia, the intrapericardial pressure continues to increase and the systemic arterial pressure decreases. This leads to the impairment of perfusion in the vital organs and, subsequently, subendocardial ischemia.[6]

Because symptomatic pericardial effusion has various causes, it is treated with different procedures, including pericardiocentesis, CT- or ECHO-guided catheter drainage, a subxiphoid tube pericardiostomy, and the opening of a pericardiopleural window via a subxiphoid or anterior mini thoracotomy, with the best choice being made on the basis of clinical findings and the medical history of the patient. For this reason, optimal treatment options are controversial.[7,8] The ideal procedure must be readily performed, result in minimal morbidity and mortality, and provide complete and permanent drainage as well as enough material for histological, cytological, and microbiological examinations to determine the cause of the effusion while also hopefully not causing a recurrence.[9] In general, in pericardial effusion related to malignancy, the treatment method should be chosen according to the clinical picture of the patient. This is especially important since a recurrence occurs in between 50 and 70% of patients who undergo this type of effusion.[9,10] Intrapericardial treatment methods are available, but there are no randomized studies to demonstrate their reliability.

Computed tomography-guided drainage of pericardial effusions was successfully performed in 96% of our cases (n=28), and CT-guided drainage has been proven to be reliable even when pigtail catheters are used for diagnostic purposes. Furthermore, Bruning et al.[11] described the use of CT-fluoroscopy and pericardial drainage. These catheters are rigid and breakable; therefore, we preferred using the nephrostomy catheter since it is soft and unbreakable. To our knowledge, this is the first report to discuss pericardial drainage using CT-guidance that featured this type of catheter. In addition, CT-guidance has been primarily recommended for quick and easy drainage of pleural effusions.[12]

In a large series by Cox et al.[13] that included patients who underwent CT-guided drainage for pericardial effusion, a complication rate of between 2 and 42% was noted. However, in our patient group, we had only one unsuccessful attempt at effusion and one subacute complication that required surgical intervention. Bungay et al.[14] reported in their study that most of the patients who underwent CT-guided drainage for pericardial effusion had a pneumothorax, which was monitored on CT and drained in the same session. In order to acquire a helical image, patients must be exposed to pre- and postprocedural radiation, and they are also exposed to radiation during CT guidance. Katada et al.[15] determined that patients are exposed to a radiation level of 70cGy during an abdominal intervention, and we assumed that this level would be either lower or at the same level during pericardial intervention. The same authors also reported that the amount of radiation exposure to the researcher can be reduced if the puncture is done via a fluoroscopy.

In this study, CT-guided drainage required an operation for an epicardial laceration. If previous CT-guided treatment and sonographic approaches had been unsuccessful, open surgical drainage would have been necessary. Under these conditions and considering the pre-selection criteria, CT-guided drainage was associated with relatively few unsuccessful attempts and complications, and our previous experience with this procedure led to a decrease in the elapsed surgical time.

Conclusion

To our knowledge, this is the first known report on CT-guided puncture and drainage of pericardial effusions using nephrostomy catheters and we believe that our data indicates it is a viable method, especially in cases involving postoperative pericardial effusions. In addition, this method provides more patient comfort and negates the need for collecting tissue samples for diagnostic purposes.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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