Türk Göğüs Kalp Damar Cerrahisi Dergisi 2014;22(1):29-34
doi: 10.5606/tgkdc.dergisi.2014.8315

Original Article / Özgün Makale

A comparison of two surgical techniques for symptomatic pericardial effusion after cardiac surgery: subxiphoid open pericardial drainage and lateral thoracotomy

Kardiyak cerrahi sonrası semptomatik perikardiyal efüzyonlu hastalarda iki cerrahi tekniğin karşılaştırılması: Subksifoid açık perikardiyal drenaj ve yan torakotomi

Garip Altıntaş, Emre Yaşar, Ersin Kadiroğulları, Muhammet Onur Hanedan, Adem İlkay Diken, Ömer Faruk Çiçek, Adnan Yalçınkaya, Gökhan Lafçı

Department of Cardiovascular Surgery, Türkiye Yüksek İhtisas Training and Research Hospital, Ankara, Turkey

Background: This study aims to compare the outcomes of the two most common surgical techniques applied in patients with symptomatic pericardial effusion following open heart surgery.

Methods: Between September 2004 and September 2012, we retrospectively analyzed the data of 14,390 patients who underwent open heart surgery in our clinic. A total of 152 patients were included and divided into two groups, according to treatment modality applied. Subxiphoid pericardial drainage was performed in 86 patients (56.6%) (group 1) and pericardial window opening via lateral thoracotomy was performed in 66 patients (43.4%) (group 2). We further analyzed the patients who underwent surgical reexploration due to symptomatic pericardial effusion via lateral thoracotomy or subxiphoid procedure. Perioperative outcomes were compared in terms of operative and 30-day in-hospital mortality.

Results: In group 2, operative technique produced a complete success (100%), whereas the success rate was 87.2% in group 1 (p<0.003). Local anesthesia was preferred in 73 patients (84.9%) in group 1 and shorter operation times were observed (p<0.001). Although four patients (4.7%) died in the operating room in group 1, there was no statistically significant difference in operative mortality between the groups (p=0.133). Technical failure in group 1 led to increased mortality rates (36.4%) (p<0001).

Conclusion: Although subxiphoid procedure can be performed rapidly with ease, technical failure is not rare and may be associated with high mortality rates.

Key words: Effusion; subxiphoid; tamponade; thoracotomy.

Amaç: Bu çalışmada açık kalp cerrahisi sonrası semptomatik perikardiyal efüzyonlu hastalarda en sık kullanılan iki cerrahi tekniğin sonuçları karşılaştırıldı.

Çalışma planı: Eylül 2004 - Eylül 2012 tarihleri arasında, kliniğimizde açık kalp cerrahisi yapılan 14.390 hastanın verileri retrospektif olarak analiz edildi. Toplam 152 hasta bu çalışmaya dahil edildi ve uygulanan tedavi yöntemine göre iki gruba ayrıldı. Subksifoid perikardial drenaj 86 hastaya (%56.6) (grup 1), yan torakotomi ile perikardiyal pencere açılması 66 hastaya (%43.4) uygulandı (grup 2). Bu hastalar içerisinde semptomatik perikardiyal efüzyon gelişmiş olan ve subksifoid perikardiyal drenaj veya yan torakotomi yöntemi ile yeniden eksplore edilen hastalar analiz edildi. Ameliyat sırası veriler, ameliyata bağlı ve 30 günlük hastane mortaliteleri açısından karşılaştırıldı.

Bulgular: Grup 2'de ameliyat tekniği tam bir başarıya ulaşmışken (%100), grup 1'de başarı oranı %87.2 idi (p<0.003). Lokal anestezi, grup 1'de 73 hastada (%84.9) tercih edildi ve ameliyat süresinin daha kısa olduğu tespit edildi (p<0.001). Grup 1'de dört hasta (%4.7) ameliyat masasında kaybedilmesine rağmen, ameliyata bağlı mortalitede gruplar arasında istatistiksel olarak anlamlı fark bulunamadı (p=0.133). Grup 1'deki teknik başarısızlığın mortalite oranında artışa yol açtığı tespit edildi (%36.4) (p<0001).

Sonuç: Subksifoid işlem hızlı ve kolay yapılsa da teknik başarısızlık nadir değildir ve yüksek mortalite oranına sahiptir.

Anahtar sözcükler: Efüzyon; subksifoid; tamponad; torakotomi.

Available online at
www.tgkdc.dergisi.org
doi: 10.5606/tgkdc.dergisi.2014.8315
QR (Quick Response) Code

Received: February 05, 2013 *Accepted:* May 16, 2013

Correspondence: Muhammet Onur Hanedan, M.D. Türkiye Yüksek İhtisas Eğitim ve Araştırma Hastanesi, Kalp ve Damar Cerrahisi Kliniği, 06100 Sıhhiye, Ankara, Turkey.
Tel: +90 505 - 799 51 55 e-mail: ohanedan@hotmail.com

Although pericardial effusion after open heart surgery is not infrequent, symptomatic pericardial effusion leading to cardiac tamponade is rare with incidence rates of between 0.2% and 1.9% having been reported in the literature.[1-3] Pericardial effusion may compromise recovery and increase the length of time in the hospital, thereby leading to higher costs. It can also be life-threatening if it results in cardiac tamponade.[4]

The management of pericardial effusion after open heart surgery is comprised of surgical and percutaneous techniques, with technological improvements having led to an increased preference for percutaneous techniques in the treatment of symptomatic pericardial effusion. Echocardiography and computed tomography (CT) are used to guide the percutaneous techniques.[1,5,6] However, especially after cardiac surgery, the surgeon may encounter a situation in which symptomatic pericardial effusion has to be dealt with surgically, with subxiphoid drainage and opening the pericardial window opening via a thoracotomy being the most common procedures.[3,7] In our study, we compared the operative and postoperative outcomes of these two surgical techniques performed for the management of pericardial effusion that led to cardiac tamponade.

PATIENTS AND METHODS

After our study was approved by the ethics committee of our institution, we retrospectively searched the records of the 14,390 patients ≥18 years old who underwent open heart surgery between September 2004 and September 2012 and included those who had undergone a reoperation due to symptomatic pericardial effusion in this study. However, those who were reoperated on for bleeding or cardiac tamponade within the first three days after the original surgery and who were good candidates for echocardiography-guided percutaneous catheter drainage were excluded. However, only 164 of these patients had undergone surgery for symptomatic pericardial effusion (1.14%). In addition, an emergency median sternotomy due to hemodynamic instability (cardiac arrest, ventricular fibrillation, etc.) had been performed on 12 patients, and these were also excluded, leaving 152 patients (85 males, 67 females; mean age 49.1±13.2 years; range 19 to 84 years) for our study. The patients were divided into two groups, with group 1 consisting of the 86 (56.6%) who had undergone subxiphoid pericardial drainage and group 2 made up of the 66 (43.4%) who had a lateral thoracotomy to open the pericardial window.

Valve surgery was performed in 78 (51.3%) of the patients as the primary surgery. In addition, aortic surgery was performed on 32 others (21.1%), and 27 (17.8%) underwent coronary artery bypass grafting (CABG). The decision of whether to perform percutaneous or surgical management in the patients was dependent on their clinical status and echocardiographic findings. Those with intense, an echo-dense fibrous content, a gross hematoma, and posteriorly located effusion after cardiac surgery underwent a reoperation. In addition, fresh frozen plasma (FFP) was administered to normalize the international normalized ratios (INRs) before surgery for those patients under warfarin therapy or those who had elevated INR levels.

We also analyzed the demographic characteristics along with the preoperative, operative, and postoperative data of groups 1 and 2 and compared the operative and 30-day mortality rates.

Echocardiographic evaluation

A diagnosis of cardiac tamponade was made based on the symptoms and echocardiographic findings. Right atrial compression, right ventricular systolic collapse, left ventricular collapse, and distension of the inferior vena cava (IVC) with blunted inspiratory response were suggestive of cardiac tamponade. Computed tomography was used to verify the diagnosis when needed.

Operative techniques

The subxiphoid pericardial drainage was generally performed under local anesthesia via a 5 cm lower midline incision through the former median sternotomy incision line. Blunt dissection allowed for access to the pericardial space and facilitated the pericardial drainage, and blunt finger dissection was also used to remove adhesions and evacuate the localized hematoma. The surgery was concluded by inserting a 32F thoracostomy tube into the pericardium (Figure 1).

The left thoracotomy to open the pericardial window was performed under general anesthesia, and single-lung ventilation was achieved using double-lumen endobronchial tubes. After positioning the patient in a lateral decubitus position, the pleural space was entered between the fourth or fifth intercostal spaces, and ventilation of the left lung was interrupted. The pericardium was then incised 1-2 cm anterior to the phrenic nerve. Next, a hematoma or fluid was drained via a 5x5 cm window, and 28F or 32F thoracostomy tubes were inserted into the pericardial and pleural spaces.

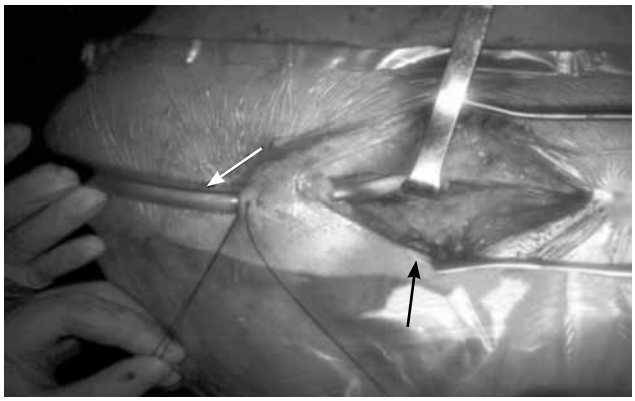

Figure 1. Operative view of the subxiphoid drainage technique. Drainage tube placed subxiphoidally (white arrow); Approximately a 5-6 centimeters of incision through skin and subcutaneous tissue in order to reach pericardial space (black arrow).

Statistical methods

The SPSS version 15.0 for Windows software program (SPSS Inc., Chicago, Il, USA) was used for the various analyses, and the results were expressed as the mean ± standard deviation (SD) for the normally distributed continuous variables and median values for the abnormally distributed continuous variables. Categorical variables were reported as numbers and percentages. In addition, comparisons between the two groups were performed with an unpaired two-tailed t-test for the normally distributed continuous variables while the Mann-Whitney U test was used for those that were abnormally distributed. Furthermore, we used Pearson's chi-square test or Fisher's exact test for the categorical variables. A p value of <0.05 was considered to be significant with a 95% confidence interval (CI).

RESULTS

The demographic characteristics of the patients who required surgical drainage are listed in Table 1, and comparisons of the demographic, operative, and postoperative results of groups 1 and 2 are shown in Table 2.

The data regarding age and gender were similar in both groups. The subxiphoid drainage was performed under local (n=73, 84.9%) or general anesthesia (n=13, 15.1%), but general anesthesia was used for all of the thoracotomy patients in group 2 (p<0.001). In addition, group 1 had significantly shorter operative times than group 2, with a median operative time of 60 minutes (range 30-400) in group 1 and 90 minutes (range 45-185) in group 2 (p<0.001).

The echocardiographic data revealed that 19 patients (22.0%) in group 1 and 14 (21.2%) in group 2 had massive effusion (swimming heart). Moreover, the pericardial effusion was located primarily anterior to the right ventricle in group 1 (n=34; 39.5%) and posterior to the left ventricle in group 2 (n=28; 42.4%).

Table 1. Demographic characteristics of the patients who underwent surgical pericardial drainage (n=152)

Characteristics	n	%	Mean±SD
Age (years)			49.1±13.2
Gender			
Male	85	55.9	
Female	67	44.1	
Operative technique			
Subxiphoid drainage	86	56.6	
Lateral thoracotomy	66	43.4	
Previous open heart surgery			
Valve*	78	51.3	
CABG	27	17.8	
Valve + CABG	4	2.6	
Aortic surgery	32	21.1	
Other‡	11	7.2	
Timing of the surgery			
Elective	43	28.3	
Urgent	59	38.8	
Emergency	50	32.9	

SD: Standard deviation; CABG: Coronaryartery bypass grafting; * Mitral, tricuspid, or aortic valve replacement/repair; ‡ Adult congenital transplant surgery.

The amount of time between the primary surgery and the surgery for cardiac tamponade was shorter in group 1, with an average time of 16 days (range 3-150), than it was in group 2, which had an average of 24 days (range 4-120) (p<0.05).

The majority of the group 1 patients underwent emergency surgery (n=37, 43%), but this was only performed for 13 of patients (19.7%) in group 2 (p=0.002). Furthermore, the average amount of drainage was 826.87 ml in group 1 and 807.58 ml in group 2, but the total amount was not statistically significant (p=0.724).

We also compared the direct procedural complications and operative mortality rates between the two groups in our study. Four patients (4.7%) died due to procedure-related events in group 1, but there was no operative mortality in group 2. However, the difference was not statistically significant (p=0.133). In group 1, three patients suffered a right ventricular laceration and required an emergency resternotomy, and one required a resternotomy after procedural failure when the ascending aorta was injured during the median sternotomy and cardiopulmonary bypass (CPB) had to be established via femoral cannulation.

Table 2. Comparison of the demographic, perioperative, and postoperative results

	Subxiphoid drainage (n=86)					Lateral thoracotomy (n=66)					
	n	%	Mean±SD	Median	Range	n	%	Mean±SD	Median	Range	*p*
Age (years)			49.7±13.3					48.2±13.0			0.474
Females	37	43				30	45.5				0.765
Cardiac tamponade, (postoperative days)				16.0	3-150				24.0	4-120	0.015
Received local anesthesia	73	84.9				0	0				0.001
Operation time (minute)				60	30-400				90	45-185	0.001
Length of emergency surgery											
Emergency	37	43				13	19.7				0.002
Technical success rate	75	87.2				66	100				0.003
Total amount drained (ml)			826.9±359.5					807.6±261.8			0.724
Number of operative mortalities	4	4.7				0	0				0.133
30 day mortality rate	6	7				1	1.5				0.139
Length of stay in ICU (hours)				10.0	2-120				15.0	9-120	0.294
Duration of chest tube insertion (days)				3.0	1-10				3.0	2-6	0.336
Postoperative discharge (days)				5.0	3-40				5	4-10	0.729

SD: Standard deviation; ICU: Intensive care unit; p<0.05.

All four patients who died in group 1 could not be weaned from CPB.

The technical success rate was 87.2% in group 1 and 100% in group 2 (p<0.003). The subxiphoid procedure failed in 11 patients, with a right ventricle laceration being the cause in six and insufficient drainage being responsible in the other five. All of these patients were converted to a median resternotomy. Three of six patients who suffered from a right ventricle laceration and one of the five patients with insufficient drainage died during the operation. According to a subgroup analysis of group 1, the failure of the procedure was associated with statistically significant high mortality rates (36.4%; p<0.001).

Six patients (7%) died within 30 days after the surgery in group 1 while one died during this period in group 2 (1.5%); however, there was no significant difference between the groups regarding the 30-day mortality rate (p=0.139). In group 1, one patient died on postoperative day 5 because of multi organ failure, and four died because of low cardiac output subsequent to the failure of the subxiphoid procedure. Another patient died on postoperative day 12 in the intensive care unit (ICU) because of pneumonia, although the procedure was successful. In group 2, the patient died from a pulmonary embolism on postoperative day five.

The average length of time in the ICU was 10 hours for group 1 (range 2-120) and 15 hours for group 2 (range 9-120), but the difference was not statistically significant (p=0.294). Additionally, the median postoperative length of time for chest tube insertion was three days (p=0.336), and the average length time in the hospital was five days (p=0.729).

DISCUSSION

Although pericardial effusion is a frequent complication of open heart surgery, life-threatening cardiac tamponade is rare. Incidence rates have been reported between 0.2% and 1.9% in various studies.[1-3]

Currently, the most common treatment approaches are surgical (subxiphoid drainage or the transthoracic pericardial window technique) or percutaneous (echocardiography or guided CT) drainage techniques.[1,5,7,8] The percutaneous techniques are safe and effective for pericardial effusion as long as it does not develop following cardiac surgery.[8] Percutaneous pericardial drainage under echocardiographic guidance can easily be performed in postoperative symptomatic patients who have accessible and available fluid.[1,9] Although echocardiography is very useful for detecting and treating pericardial effusion, mediastinal gas and surgical scars may impede the view and complicate the procedure. In addition, pericardial hematomas and clot formation after open heart surgery are often loculated in nature rather than circumferential.[3,10] Therefore, if a patient has a posterior or laterally located hematoma or a minimal amount of fluid at the access site, percutaneous procedures tend to fail, resulting in higher morbidity rates.[6] For these

individuals, surgical options are more reliable. Conventional surgical drainage techniques include the subxiphoid and transthoracic pericardial window techniques. In recent years, the video-assisted pericardial window-opening technique has been developed, and it is now also considered to be a safe and successful procedure.[11,12]

Subxiphoid pericardial drainage is the most preferred conventional surgical technique. It was first described by Larrey in 1829,[13] and Fontenelle et al.[14] improved the technique. This type of surgery can be performed rapidly under local anesthesia, unlike the pericardial window-opening which requires general anesthesia and longer operation times. In our study, 84.9% of the patients in group 1 were operated on under local anesthesia, whereas all of the patients in group 2 required general anesthesia. In addition, the patients in group 1 also had shorter operation times (60 minutes vs. 90 minutes in group 2).

Blunt finger dissection can be used to release any adhesion and to evacuate a loculated hematoma or blood clot. This procedure also allows for the insertion of a chest tube into the pericardium to ensure continuous drainage. Although it is an easy and rapid procedure, inadvertent blunt finger dissection may result in graft and/or cardiac injuries, especially postoperatively in the fragile tissues. These injuries often have hazardous outcomes. In our study, cardiac injuries were seen in six of the 11 patients who were converted to a median sternotomy after the failure of the subxiphoid drainage technique, and three of the six died intraoperatively. In five patients, the subxiphoid procedure was not able to relieve the cardiac tamponade due to an inadequate amount of drainage. All of these patients were then converted to a median sternotomy, and one died intraoperatively. A high mortality rate indicates a failed procedure, and the accompanying complications can lead to catastrophic outcomes, which is a considerable disadvantage of the subxiphoid drainage technique. Four of the 11 patients (36.4%) who underwent this procedure in our study died during surgery because it was unsuccessful. Performing a thoracotomy to open the pericardial window opening avoids the adverse effects of inadvertent entry and lessens the probability of graft or cardiac injuries. In our study, there were no injuries in group 2. The similarity in operative mortality rates between the two groups in our study can possibly be attributed to the small sample size, and we hypothesize that larger group sizes may lead to a statistical difference.

The higher emergency operation rates in group 1 may mistakenly lead to the conclusion that this group had more unstable patients. However, an elaborate analysis of the causes of the operative mortality in our study revealed that only one patient in group 1 underwent emergency surgery, and the operative mortality was associated more with complications during the surgery than any patient emergencies.

Undergoing a thoracotomy to open the pericardial window has the advantage of preventing the development of cardiac tamponade caused by recurrent effusion. In these cases, the fluid accumulates in the pleural space rather than the pericardial space and can easily be evacuated percutaneously.

In our surgical practice, subxiphoid pericardial drainage is frequently used to manage late cardiac tamponade after cardiac surgery when percutaneous procedures are not suitable. The technique is simple and often life-saving, but it requires experience and caution. Inadvertent mistakes during the procedure may lead to catastrophic results. In contrast, the surgery to open the pericardial window is a safe procedure, but it is more invasive, requiring a thoracotomy under general anesthesia. The postoperative pain associated with the thoracotomy is quite uncomfortable, presenting another disadvantage. Although technological advances have made video-assisted thoracoscopy more popular,[11,12] less invasive procedures will eventually replace the more conventional surgical techniques being used today.

Our study had several limitations, including the retrospective design and the small sample size, especially in group 2. Therefore, future studies that involve larger numbers of patients may provide more statistically relevant information regarding the differences in mortality rates. Another issue was that the procedures were performed by different surgeons. Since complications are directly related to a surgeon's experience, it would have been better if all of the operations had been performed by the same surgeon.

Immediate decompression of the heart after the development of cardiac tamponade following open heart surgery is crucial. The ideal technique should be quick, safe, and simple. Surgical options, such as subxiphoid drainage, are preferable in cases with postoperative pericardial effusion, but surgical incompetence and/or inattentiveness can have devastating results. When taking into account the catastrophic outcomes that stemmed from the technical failure in group 1 in our study, it became

apparent that proper patient selection is vital. In addition, the surgeon should know when to abandon the procedure and convert to an alternative technique to avoid lethal complications.

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.

REFERENCES

1. Ashikhmina EA, Schaff HV, Sinak LJ, Li Z, Dearani JA, Suri RM, et al. Pericardial effusion after cardiac surgery: risk factors, patient profiles, and contemporary management. Ann Thorac Surg 2010;89:112-8.
2. Kuvin JT, Harati NA, Pandian NG, Bojar RM, Khabbaz KR. Postoperative cardiac tamponade in the modern surgical era. Ann Thorac Surg 2002;74:1148-53.
3. Pepi M, Muratori M, Barbier P, Doria E, Arena V, Berti M, et al. Pericardial effusion after cardiac surgery: incidence, site, size, and haemodynamic consequences. Br Heart J 1994;72:327-31.
4. Price S, Prout J, Jaggar SI, Gibson DG, Pepper JR. 'Tamponade' following cardiac surgery: terminology and echocardiography may both mislead. Eur J Cardiothorac Surg 2004;26:1156-60.
5. Pompilio G, Filippini S, Agrifoglio M, Merati E, Lauri G, Salis S, et al. Determinants of pericardial drainage for cardiac tamponade following cardiac surgery. Eur J Cardiothorac Surg 2011;39:e107-13.
6. Palmer SL, Kelly PD, Schenkel FA, Barr ML. CT-guided tube pericardiostomy: a safe and effective technique in the management of postsurgical pericardial effusion. AJR Am J Roentgenol 2009;193:W314-20.
7. Moores DW, Allen KB, Faber LP, Dziuban SW, Gillman DJ, Warren WH, et al. Subxiphoid pericardial drainage for pericardial tamponade. J Thorac Cardiovasc Surg 1995;109:546-51.
8. McDonald JM, Meyers BF, Guthrie TJ, Battafarano RJ, Cooper JD, Patterson GA. Comparison of open subxiphoid pericardial drainage with percutaneous catheter drainage for symptomatic pericardial effusion. Ann Thorac Surg 2003;76:811-5.
9. Tsang TS, Barnes ME, Hayes SN, Freeman WK, Dearani JA, Butler SL, et al. Clinical and echocardiographic characteristics of significant pericardial effusions following cardiothoracic surgery and outcomes of echo-guided pericardiocentesis for management: Mayo Clinic experience, 1979-1998. Chest 1999;116:322-31.
10. ten Tusscher BL, Groeneveld JA, Kamp O, Jansen EK, Beishuizen A, Girbes AR. Predicting outcome of rethoracotomy for suspected pericardial tamponade following cardio-thoracic surgery in the intensive care unit. J Cardiothorac Surg 2011;6:79.
11. O'Brien PK, Kucharczuk JC, Marshall MB, Friedberg JS, Chen Z, Kaiser LR, et al. Comparative study of subxiphoid versus video-thoracoscopic pericardial "window". Ann Thorac Surg 2005;80:2013-9.
12. Georghiou GP, Porat E, Fuks A, Vidne BA, Saute M. Video-assisted pericardial fenestration for effusions after cardiac surgery. Asian Cardiovasc Thorac Ann 2009;17:480-2.
13. Larrey DJ. New surgical procedure to open the pericardium and determine the cause of fluid in its cavity. Clin Chir 1829;36:303.
14. Fontenelle LJ, Cuello L, Dooley BN. Subxiphoid pericardial window. Am J Surg 1970;120:679-80.