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Original Article

Percutaneous drainage of delayed post-cardiac surgery pericardial effusion

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Abstract

Background: Pericardial effusion and tamponade are common following valve surgery. The optimal treatment of symptomatic pericardial effusions remains controversial. The objective of this study was to present our experience in non-surgical management of delayed postoperative pericardial effusion.
Methods: This retrospective study was conducted on 64 patients who had delayed pericardial effusion after cardiac surgery from 2016 to 2020. Eight patients were excluded due to the presence of inaccessible posterior or clotted pericardial effusion and were managed surgically, and 56 patients had percutaneous drainage of the pericardial fluid and were included in the analysis.
Results: The mean age was 46.84±11.67 years (range: 22- 68 years), and 46.43% were females. The patients had coronary artery bypass grafting (n= 9), Aortic valve replacements (n= 13), Mitral valve surgery (n= 21), double valve replacements (n= 8) and combined procedures (n= 5). All patients complained of varying degrees of exertional dyspnea. There were statistically significant differences between INR in different cardiac surgeries. Mean INR following mitral valve replacement (4.72±0.63) was significantly higher than in aortic valve replacement patients (3.32±0.34; $p<0.001$) and aortic valve patients (1.76±0.24; $p<0.001$). Fifteen patients (26.78%) had a large pericardial effusion. Successful drainage was achieved in all cases. Complications were pneumothorax (n= 2, 3.57%), recurrent effusions (n= 4, 7.14%), arrhythmias (n= 7, 12.5%), myocardial punctures (n= 2, 3.57%) and no mortality was reported.
Conclusions: Percutaneous drainage of postoperative pericardial effusion under radiological guidance is generally safe. Pericardial effusion is common after mitral valve surgery, which could be related to higher INR in these patients.

KEYWORDS
Cardiac surgery; Pericardial effusion; Echo guided; Drainage; Tamponade pericardiotomy

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Introduction

Postoperative pericardial effusion following cardiac surgery is a frequent complication. There is no specific algorithm for the treatment of pericardial effusion post-cardiac surgery [1].

Pericardial effusion, in most cases, is mild and resolves spontaneously; however, 0.8-6% become clinically significant and necessitate intervention [2]. Despite the recent improvements in operative and postoperative management, late pericardial

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effusions remain a significant cause of morbidity after cardiac surgery. Pericardial effusions may delay recovery and can be life-threatening when it causes tamponade with hemodynamic compromise [3].

Postoperative pericarditis can occur as early as two weeks following surgery. Pericarditis often bears restrictive hemodynamic characteristics despite an open pericardium. The presence of blood in the pericardium may result in irritation of the serosal layer and inflammation [4].

The optimal treatment of symptomatic pericardial effusions remains controversial. The ideal treatment strategy would include complete drainage of the effusion with minimal procedural mortality [5].

Surgical pericardial drainage via reopening the subxiphoid part of the wound is technically straightforward. It offers a view of the inferior pericardial space, plus it permits drainage of blood clots in the effusion. However, general anesthesia is required with its risk, and reopening the wound could contaminate the pericardial space [6].

Although transthoracic echocardiography (TTE) is the preferred first-line modality for evaluating postoperative pericardial effusion, computed tomography of the chest (CT) often allows a thorough assessment. This technique is superior to echocardiography for accurate detection of the small amount and localization of the fluid. Characterization of the pericardial fluid by measuring attenuation values on CT images is valuable. Additionally, CT imaging enables an accurate illustration of the pericardial layers, with an assessment of thickness and composition [7]. In this study, we present our experience in non-surgical management of delayed postoperative pericardial effusion in our university hospital.

Patients and Methods:

Study design and setting:

This retrospective study was conducted from January 2016 till January 2020. We included patients presented with delayed post-cardiac surgery pericardial effusion, defined as effusion occurring after 15 days of surgery. The medical records were retrospectively reviewed for clinical presentation, surgical maneuver, imaging modalities, procedural details, and outcomes. A phone call to the patients was used to complete the missing data.

Inclusion and exclusion criteria:

We included adult patients with symptomatic post-cardiac surgery pericardial effusion accessible for percutaneous drainage. We excluded patients who underwent surgical exploration due to loculated effusion, presence of blood clots, inaccessible posterior collection, or failed catheter drainage. Patients with heart failure were excluded as they were medically treated. Stable patients with the proved post-pericardiotomy syndrome were managed medically by colchicine and other anti-inflammatory medications.

Ethical considerations:

We followed the declaration of Helsinki regarding studies on human subjects [8]. Approvals of the Institutional Research Board were obtained. Informed written consent was obtained from all cases after the explanation of

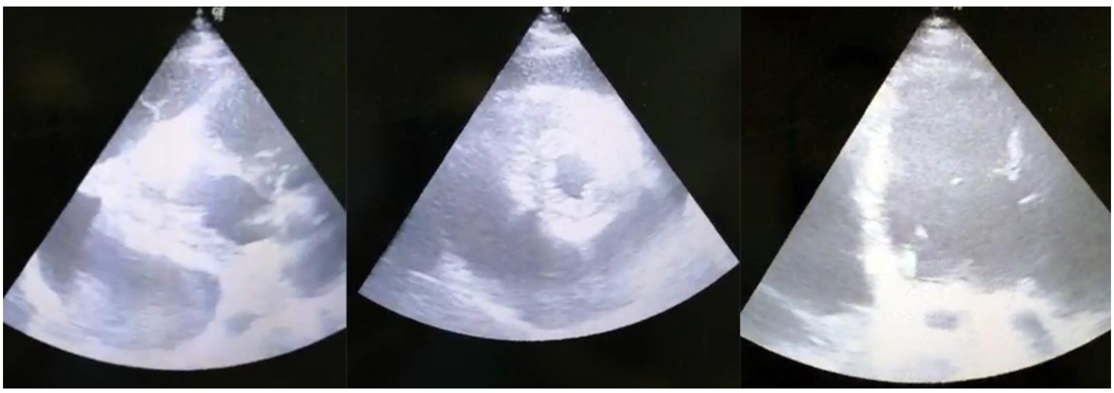

Figure 1: Transthoracic echocardiography showing massive pericardial effusion.

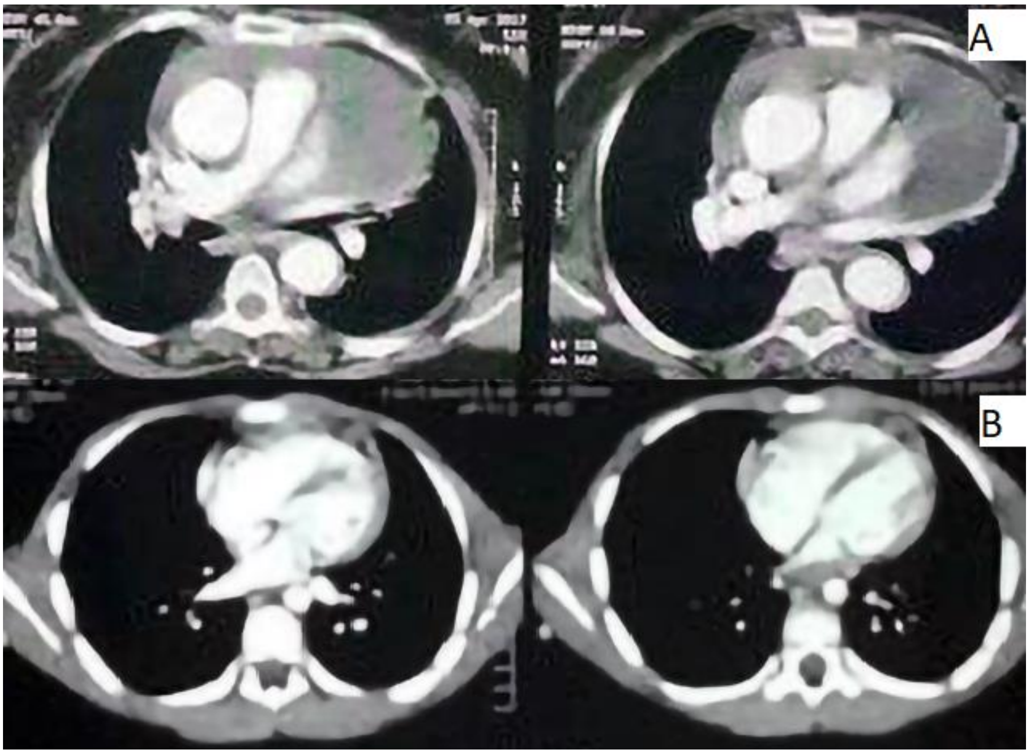

Figure 2: Multi-slice CT chest with intravenous contrast showing: Panel A: Massive circumferential pericardial effusion with access laterally and to the left in the anterior axillary line. Panel B: following complete pericardial drainage of the same patient.

the details of both percutaneous intervention and the possible need for surgical intervention with full information about possible complications. Consent to participate in the study was waived because of the retrospective nature of the research.

Surgical workup and approach:

All patients were discharged after their initial surgery with acceptable echocardiography and targeted international normalized ratio (INR). All patients had regular follow-up after one month of the procedure at the outpatient clinic.
Patients with pericardial effusion presented to the outpatient clinic or the emergency department if hemodynamically unstable.

Clinical suspicion of having pericardial collection was based on the development of dyspnea, orthopnea, palpitation, nausea, and occasionally vomiting. A thorough examination for these patients included: heart rate, blood pressure measurement, assessment of neck veins, heart sounds, edema of the lower limbs, and chest auscultation for rales. A chest X-ray was the initial test in most patients.

The final diagnosis was confirmed in all cases with echocardiography (Figure 1). CT chest with contrast was done for all stable patients with acceptable kidney function tests (Figure 2A). INR was tested routinely for all patients whether they were on warfarin therapy or not, plus other laboratory investigations included a complete blood picture (CBC), liver and renal function tests, random plasma glucose, and acute phase reactants.

Non-emergent patients with uncontrolled INR and coagulopathy were controlled before doing the invasive maneuver. Fresh frozen plasma (FFP) transfusion was sufficient. Vitamin K injection was reserved for unstable cases with warfarin toxicity. Drainage of postoperative pericardial effusion was done by percutaneous placement of an indwelling pericardial catheter. Catheter drainage was suitable for moderate to large anteriorly and anterolateral effusion (Figure 2A, Figure 3). The entirely located posterior collection was not amenable for catheter drainage. Some cases with the posterior collection but extended laterally or basally were approached but with more caution.

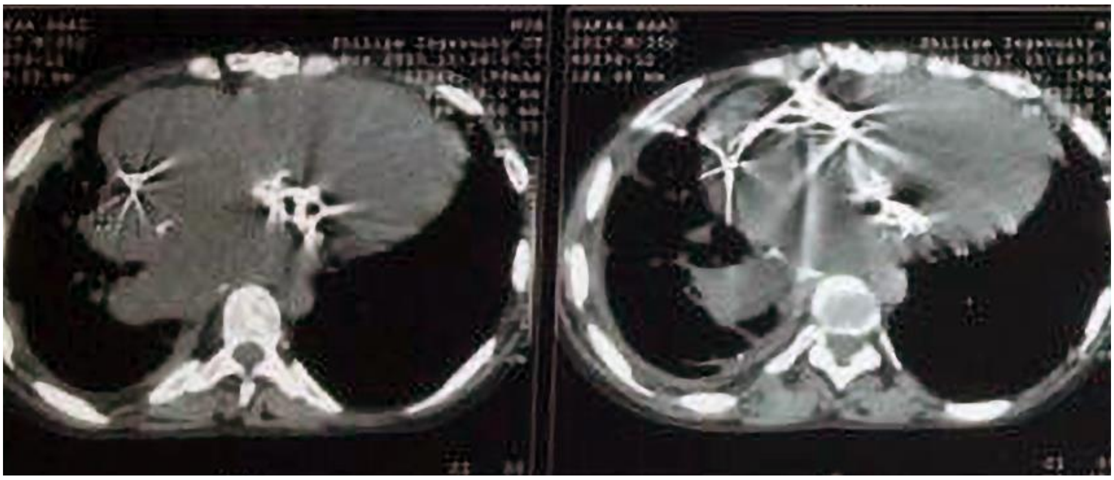

Figure 3: Multi-slice CT chest without intravenous contrast showing a pigtail inserted via a subxiphoid approach for drainage of pericardial effusion.

Indwelling catheters of sizes (7Fr- 10Fr- 12Fr) were applied using Seldinger's technique under echocardiographic guidance and prior CT assessment. The procedure was performed under full monitoring with access from the anterior chest wall, typically subcostal (Figure 3). Right or left parasternal access was used. The site of the collection was confirmed using a fine spinal needle. If the aspiration trial was proved to be hemorrhagic, cautions were done to exclude cardiac puncture by observation of electrocardiogram (ECG) changes on the monitor. Coagulation of the aspirate and rapid laboratory estimation of hemoglobin concentration in the aspirate was done and compared with the patient's hemoglobin.

Postoperative management:

Following the procedure, the cases were monitored in the cardiac surgery intensive care unit (ICU), then moved to the ward unless complications were anticipated.

The catheter was removed after cessation of drainage in a hemodynamically stable patient with echocardiographic and radiologically proven total drainage of the pericardial effusion (Figure 2B). They were discharged with close follow up in the outpatient clinic.

Study endpoints:

The primary endpoint was the success of evacuation of the pericardial effusion. The secondary endpoints were the postprocedural morbidity and mortality.

Statistical analysis:

The data were tabulated and analyzed using IBM SPSS software version 25.0 (IBM Inc., Chicago, IL, USA). Qualitative data were described using the number and percent. Continuous quantitative variables were assessed for normality; normal variables were reported as mean and standard deviation (SD). One-Way Analysis of Variance (ANOVA) to compare means of more than two groups of the INR. Tukey HSD "Honestly Significant Difference" posthoc test was used. A p-value of 0.05 or less indicates a statistically significant difference among the various groups.

Results

Sixty-four patients presented with postoperative pericardial effusion; eight patients who had surgical drainage were excluded. Fifty-six patients had percutaneous drainage and were included in the analysis. The mean age was 46.84 ± 11.671 years (ranged from 22 to 68 years). They were 30 males (53.57%), and 26 were females (46.43%). The demographic data of the study sample are presented in (Table 1). All our cases who underwent valve replacement had received mechanical valves and were on warfarin treatment.

All patients complained of exertional dyspnea and occasionally orthopnea. Additional symptoms were non-specific, including easy fatigability, palpitation, nausea, and vomiting (Table 2). INR at the time of admission ranged from 1.2 to 7 (mean± SD: 3.57 ± 1.35). The mean INR was 1.76 ±0.24 after CABG, 3.32±0.34 after aortic valve replacement (AVR), and 4.72±0.63 after mitral valve replacement (MVR).

Table 1: Demographic data of the study sample. Data are expressed as mean and standard deviation or as a percentage and frequency

	(n= 56)
Age (years)	46.84 ± 11.67
Males	30 (53.57%)
Diabetes Mellitus	16 (28.57%)
Hypertension	27 (48.21%)
Smokers (ex or current)	12 (14.63%)
Dyslipidemia	9 (16.07%)
Ischemic Heart Disease	13 (23.21%)
Chronic Lung Disease	11 (19.64%)
Postoperative renal failure	7 (12.5%)
History of re-exploration for bleeding	3 (5.35%)
Antiplatelet agents	14 (25%)
INR	
CABG	1.76±0.24
AVR	3.32±0.34
MVR - DVR	4.72±0.63
Total	3.57±1.35
CABG	9 (16.1%)
AVR	13 (23.2%)
DVR	8 (14.3%)
MVR	16 (28.6%)
MVR and TV repair	5 (8.9%)
Combined	5 (8.9%)
Time from discharge to readmission (days)	19.39 ± 3.415

CABG: Coronary artery bypass grafting; MVR: Mitral valve replacement; TVR: Tricuspid valve repair; DVR: Double valve replacement

Posthoc comparisons indicated statistically significant differences between INR and the cardiac surgery performed (CABG vs AVR: Diff=1.5400, 95%CI=0.9652 to 2.1148, p<0.0001; CABG vs MVR: Diff=2.9400, 95%CI=2.4343 to 3.4457, p<0.001; and AVR vs MVR: Diff=1.4000, 95%CI=0.9576 to 1.8424, p<0.001).

Timing from discharge to readmission varied from 15 to 28 days with a mean of 19.39 ± 3.415 days (Table 1). The collection was large in 15 cases (26.78%) depending on the echocardiography and CT studies, which showed fluid distribution and the widest area in cm and confirmed by the quantity of the drain. The nature of the fluid was serous in 24 cases (42.9%) and serosanguineous in 32 cases (57.1%) (Table 2).

Table 2: Clinical signs, collection size, nature, and location of the pericardial collection. (Data are expressed as number and percent)

	(n= 56)
Presenting symptoms	
Asymptomatic	4 (8.04%)
Arrhythmia	13 (23.21%)
Dyspnea / orthopnea	52 (92.86%)
Hypotension	48 (85.71%)
Easy fatigue	27 (48.21%)
Fever	4 (7.14%)
Oliguria	17 (30.38%)
Chest pain	6 (10.71%)
Vomiting	8 (14.29%)
Unstable patients	12 (21.4%)
Collection size	
Moderate	41 (73.2%)
Severe	15 (26.8%)
Nature of the fluid	
Serous	24 (42.9%)
Serosanguinous	32 (57.1%)
Location	
Anterior	5 (8.9%)
Anterolateral to the left	7 (12.5%)
Anterolateral to the right	6 (10.7%)
Lateral right	12 (21.4%)
Lateral left	9 (16.1%)
Basal	10 (17.9%)
Diffuse	7 (12.5%)

Previous surgery performed was CABG (n= 9), AVR (n= 13), double aortic and mitral valve replacement (n= 8), mitral valve replacement (n= 16), mitral valve replacement and tricuspid valve repair (n= 5), combined valvular and CABG surgery (n= 5). Twelve patients presented with tamponade and were unstable. They were admitted to the ICU, stabilized firstly, and we proceeded rapidly in echo guided insertion of an indwelling catheter for drainage (Table 2).

Two patients developed pneumothorax; one required chest tube drainage for two days. The second patient had minimal pneumothorax with a stationary course over the next 24 hours and was managed conservatively (Table 3). Three patients (5.36%) needed pleural drainage and were performed immediately after the tube pericardiotomy. Four patients developed recurrent effusion and required reinsertion of the catheter. One patient with AVR returned for the third time despite controlled INR and had surgical exploration. Intraoperatively there was no active bleeding (Table 3).

Table 3: Needle entry and complications of aspiration. (Data are expressed as number and percent)

	(n= 56)
Needle entry	
Right parasternal	11 (19.6%)
Left parasternal	12 (21.4%)
Subxiphoid	33 (58.9%)
Arrhythmia	7 (12.5%)
Right internal mammary hematoma	1 (1.8%)
Pneumothorax	2 (3.6%)
Recurrence	4 (7.1%)
Exploration	1 (1.8%)
Myocardial puncture	2 (3.57%)

One patient had small opacity after full drainage; it was proved radiologically to be concealed right internal mammary vessels hematoma, about 2X3 cm with no adverse effect. Seven patients developed transient supraventricular tachycardia during needle insertion. Accidental needle puncture of the heart was reported in 2 cases and was conservatively managed. No mortality was recorded. Complete pericardial drainage was achieved in all cases

Discussion

Pericardial effusion is common after cardiac surgery and reaches its peak at the end of the first postoperative week. The risk of early cardiac tamponade is well-acknowledged, but the incidence of late cardiac tamponade is probably underestimated [9]. There is no sharp definition of timing of postoperative pericardial effusion; we considered late postoperative pericardial effusion as the effusion occurring two weeks after surgery.

We had 56 patients with significant delayed postoperative pericardial effusion presented to our institution for over four years. All CABG patients were discharged on dual anti-platelet treatment; however, none of them had significant thrombocytopenia, and thrombasthenia could not be excluded.

Subxiphoid pericardial drainage is the preferred technique because of a lower risk of complication and recurrence. In postoperative cardiac surgery, the physiopathology of the effusion is different, and there is little data about the results of both surgical and catheter drainage techniques in the literature [6].

The open approach allows the surgeon to break the loculations and place a larger tube for enhanced drainage. On the other hand, percutaneous drainage usually can be accomplished without general anesthesia. As a result of these mixed attributes, there is widespread disagreement among surgeons about the ideal procedure for PE drainage [5].

Palmer and coworkers [2] reported 83% of patients had sanguineous or serosanguineous PE, and the remaining had clear serous fluid. We reported 32 cases of serosanguineous collection and 24 cases of serous effusion.

We have 16 cases of mitral valve replacement plus 5 cases of mitral valve replacement and tricuspid valve repair; both collectively represent 37.5% of cases. The intended higher levels of INR (2.5-3.5) may be an explanation of this high percentage. The mean INR in mitral valve replacement cases was 4.7.

For patients who had hemorrhagic effusions and high INR values, the pathophysiology of effusions in these patients is proposed that high peaks in INR values causing prolonged oozing into the pericardial cavity is the commonly accepted theory. Wong and Pugsley postulated that congestion of the liver owing to right heart failure or tamponade physiology might be the triggering factor for high INR values in these patients. In our study, there was a significant relationship between the degree of INR and the occurrence of hemorrhagic effusion. Still, this relationship is not clear enough, and we had cases of CABG who were not on warfarin therapy and developed hemorrhagic effusion.

Early postoperative liver dysfunction secondary to cardiopulmonary bypass may result in bouts of INR elevation shortly after patient discharge. At that time, the process of oozing of bloody exudate within the pericardium will start, and once started, it will irritate the pericardium even after regaining hepatic function and normal range of INR.

Chest X-ray was the initial investigation in all patients, and the diagnosis was confirmed with echocardiography, which gave details about the presence of the effusion, its size, site, and nature. All stable patients were re-evaluated with a CT chest with contrast, which accurately estimated the site of the fluid and the nearest point for needle insertion, also the vulnerability of the pleura to the puncture. CT imaging helped to choose the most appropriate point for trial aspiration using a small-caliber syringe initially to confirm site accessibility and then proceed with Seldinger's technique for insertion of the catheter safely.

The subxiphoid approach for catheter insertion seemed the best being away from both lungs and the mammary vessels; there is the only risk of right ventricular injury. Thirty-three patients (58.9%) were drained through a catheter inserted through the subxiphoid approach, while 12 patients (21.4%) were done via the left parasternal approach and the remaining 11 patients (19.6%) were done via the right parasternal approach. Jaussad and coworkers performed the postoperative pericardial effusion catheter drainage by subxiphoid puncture (91.9%) or left parasternal puncture (8.1%).

Although CABG surgery represents more than fifty percent of all our surgical cases, only nine patients (16%) were included in this study. It is obvious that most cases of early postoperative re-exploration for bleeding are CABG cases, but they rarely present with delayed pericardial effusion. It may be the elevated INR related to warfarin therapy is the actual cause of delayed PE. Additionally, the widely opened left pleura in most of our cases probably guarded against pericardial collection; instead, they developed left pleural effusion.

None of our cases were re-operative surgery; the presence of adhesions may explain this. Recurrent pericardial effusion occurred in 4 patients (7.1); three of them had percutaneous drainage, while the 4th one had serosanguineous effusion and was explored surgically. Palmer and associates [2] reported three of 36 patients (8%) had recurrent effusions; one of them was heart transplantation with signs of rejection, and the other was Dressler syndrome.

Seven cases suffered from procedural related arrhythmias. All of these were supraventricular tachycardia, occurred during needle entry. They were self-limiting and subsided once the needle was withdrawn. No subsequent myocardial laceration with active bleeding was reported. In cases of significant lateral effusion, the process of catheter insertion through the intercostal space was straightforward. It resulted in minor complications; stationary 2X3 cm right internal mammary vessels hematoma and two patients had a pneumothorax.

Ashikhina and coworkers [10] studied a large group of 327 patients and found that pericardial effusion occurred in 1.5% of patients and the independent risk factors for effusion were larger body surface area, hypertension, immunosuppression, renal failure, pulmonary thromboembolism, prolonged cardiopulmonary bypass and cardiac operation other than coronary artery bypass grafting. Previous cardiac operations were associated with a lower risk of effusion, and echocardiography-guided pericardiocentesis is effective and safe in these patients [11 – 13]. Ashikhina and collaborators [10] and Hernandez and colleagues [11] described non-coronary artery surgery as a risk factor for delayed postoperative PE plus full pre or postoperative anticoagulation, need for RBC transfusion, and surgical reintervention in the first 48 h following surgery [11, 14, 15].

We had no procedure-related mortality. Jaussad and coworkers [6] reported no mortality among their 197 patients. Kolek and Brat [16] found that initial echo-guided pericardiocentesis was therapeutically effective in 98.6% of cases, and the rate of major complications was 1%. There was no mortality related to the procedure, and 18 patients (8.7%) required repeated pericardiocentesis due to recurrent effusion, while 15 patients (7.2%) required surgery due to recurrent effusion or failed maneuver.

Nour-Eldin and coworkers [17] included 128 consecutive patients complicated with pericardial effusion or hemopericardium after cardiac surgery in 8 years. The medical indication for therapeutic pericardiocentesis in all patients was hemodynamic instability. The treatment criteria for intervention were evidence of pericardial tamponade with ejection fraction <50%. Pericardiocentesis and placement of a percutaneous pericardial drain were technically successful in all patients. Directly after pericardiocentesis, there was a significant improvement of the ejection fraction to 40-55%. The drainage was applied anteriorly (periventricular) in 39 of 128 (30.5%), retro-ventricular in 33 of 128 (25.8%), and infra-cardiac in 56 of 128 (43.8%). The recurrence rate of pericardial effusion after the removal of drains was 4.7% (67/128). Complete drainage was achieved in retro-ventricular and infra-cardiac positioning of the catheter. Recorded complications included minimal asymptomatic pneumothorax and pneumomediastinum 2.3% (3/128) and sinus tachycardia 3.9% (5/128). This comes in agreement with our results and success rate.

Study limitations

The study comprises results from one referral center. The sample did not test the effect of different anticoagulants or antiplatelets. Our sample did not include cases with ascending aortic replacement. A larger sample and longer follow up are needed.

Conclusion

Percutaneous drainage of postoperative pericardial effusion under radiological guidance is generally safe. Pericardial effusion is common after mitral valve surgery, which could be related to higher target INR in these patients.

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