The Heart Surgery Forum #2011-1128
15 (2), 2012 [Epub April 2012
doi: 10.1532/HSF98.20111128

Online address: http://cardenjennings.metapress.com

The Use of Posterior Pericardiotomy Technique to Prevent Postoperative Pericardial Effusion in Cardiac Surgery

Canturk Cakalagaoglu,[1] Cengiz Koksal,[1] Ayse Baysal,[2] Gokhan Alıcı,[3] Birol Ozkan,[3] Kamil Boyacioglu,[1] Mehmet Tasar,[1] Emine Banu Atasoy,[4] Hasan Erdem,[1] Ali Metin Esen,[3] Mete Alp[1]

[1]Cardiovascular Surgery Clinic, [2]Anesthesiology Clinic, [3]Cardiology Clinic, and [4]Neurology Clinic, Kartal Kosuyolu Training and Research Hospital, Istanbul, Turkey

ABSTRACT

Aim: The goal was to determine the effectiveness of the posterior pericardiotomy technique in preventing the development of early and late pericardial effusions (PEs) and to determine the role of anxiety level for the detection of late pericardial tamponade (PT).

Materials and Methods: We divided 100 patients randomly into 2 groups, the posterior pericardiotomy group (n = 50) and the control group (n = 50). All patients undergoing coronary artery bypass grafting surgery (CABG), valvular heart surgery, or combined valvular and CABG surgeries were included. The posterior pericardiotomy technique was performed in the first group of 50 patients. Evaluations completed preoperatively, postoperatively on day 1, before discharge, and on postoperative days 5 and 30 included electrocardiographic study, chest radiography, echocardiographic study, and evaluation of the patient's anxiety level. Postoperative causes of morbidity and durations of intensive care unit and hospital stays were recorded.

Results: The 2 groups were not significantly different with respect to demographic and operative data ($P > .05$). Echocardiography evaluations revealed no significant differences between the groups preoperatively; however, before discharge the control group had a significantly higher number of patients with moderate, large, and very large PEs compared with the pericardiotomy group ($P < .01$). There were 6 cases of late PT in the control group, whereas there were none in the pericardiotomy group ($P < .05$). Before discharge and on postoperative day 15, the patients in the pericardiotomy group showed significant improvement in anxiety levels ($P = .03$ and .004, respectively). No differences in postoperative complications were observed between the 2 groups.

Conclusion: Pericardiotomy is a simple, safe, and effective method for reducing the incidence of PE and late PT after cardiac surgery. It also has the potential to provide a better quality of life.

Received August 30, 2011; accepted November 14, 2011.

Correspondence: Dr. Cengiz Koksal, Kartal Kosuyolu Eğitim Araştırma Hastanesi, Kartal, Istanbul, Turkey; 90-533-7270667; fax: 90-216-4596321 (e-mail: ckoksal@hotmail.com).

INTRODUCTION

Pericardial effusion (PE) is a benign clinical finding that is frequently observed after cardiac surgery. Large PEs are more commonly reported in the early postoperative period after valve surgery or cardiac transplantation operations secondary to excessive amounts of bleeding [Pepi 1994]. In approximately 30% of patients, the insidious clinical presentation becomes evident 4 to 10 days after cardiac surgery; however, development of cardiac tamponade has been reported in only 1% of patients with PE [Bakhshandeh 2009]. The occurrence of either PE or tamponade is related to the use of anticoagulation or antiplatelet medications, such as warfarin, aspirin, and clopidogrel, after cardiac surgery [Erdil 2005]. Because postoperative PE or pericardial tamponade (PT) may present without prominent clinical signs and findings, there is a potential risk for life-threatening events. The delayed presentation of PE or PT may arise several days to weeks after the operation. In these clinical situations, early diagnosis would aid in the early treatment [Mangi 2002; Kouchoukos 2003].

In our study, our primary goal was to assess the effectiveness of the posterior pericardiotomy technique in preventing the development of early and late PEs, as well as PT. Our secondary goal was to determine the preoperative and postoperative clinical predictive parameters that are of crucial value in the early diagnosis of PE, such as rhythm disturbances, respiratory system–related dysfunctions, and psychosocial and emotional disturbances, including anxiety and restlessness.

MATERIALS AND METHODS

Patients

After approval of the institutional review board, the study was conducted in a prospective, randomized case-controlled design between September 2010 and June 2011 in our cardiovascular surgery clinic. Informed consent was obtained from all patients before they underwent the procedure. We assigned 100 patients randomly into 2 groups: patients who underwent the posterior pericardiotomy technique (group 1; n = 50) and patients who did not (group 2, control group; n = 50).

The criteria for participating in the study were patients undergoing coronary artery bypass grafting (CABG) surgery, valvular heart surgery, or combined valvular heart and CABG surgeries. Exclusion criteria were as follows: a previous cardiac or thoracic operation, left-sided pleural adhesions, rhythm disturbances such as atrial fibrillation, documented depression and anxiety, hyperthyroidism, left ventricular aneurysm, renal failure (plasma creatinine >2.0 mg/dL), use of β-blockers, and inability to provide informed consent because of a neurologic or psychiatric illness.

Operative Procedure

All patients underwent a median sternotomy. Before cardiopulmonary bypass (CPB), each patient received a loading dose of heparin (3 mg/kg) and then additional heparin doses to achieve an activated clotting time >480 seconds. Arterial and venous cannulations were performed before the initiation of CPB in accordance with the surgical procedure. Induction and maintenance of anesthesia were similar for all patients and included weight-adjusted doses of fentanyl, midazolam, and rocuronium, as well as appropriate doses of sevoflurane, an inhalational anesthetic agent. Moderate hemodilution (hematocrit, 20%-26%) and moderate systemic hypothermia (28C-32°C) were used during CPB. For myocardial protection, isothermic hyperkalemic blood cardioplegia was provided via a combination of antegrade and retrograde cardioplegia. Heparin was reversed with protamine administration (3.5 mg/kg) at the end of the CPB.

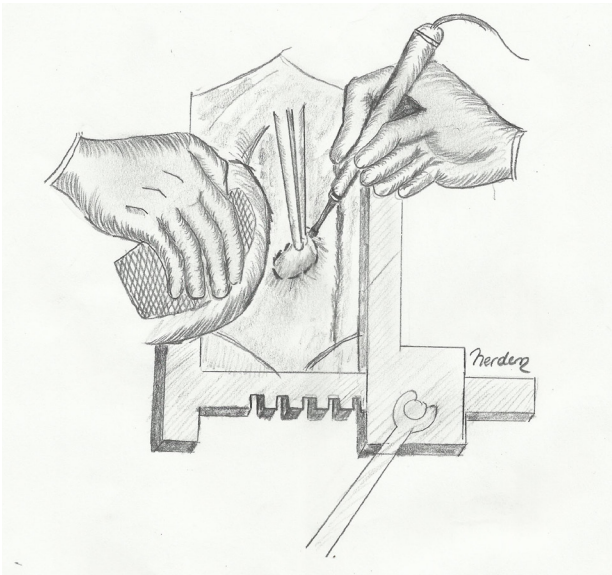

Diagram showing the posterior part of the pericardium after posterior pericardial fenestration. The heart has been lifted to expose the posterior pericardium.

The posterior pericardiotomy technique was performed in the 50 patients in group 1. In CABG surgery, this procedure was performed before removal of the aortic cross-clamp, whereas in valvular procedures or combined CABG and valvular procedures, posterior pericardiotomy was performed before valve excision. In our study, a pericardial fenestration window was opened, similarly to the surgical technique described by Erdil et al [2005]. The fenestration site was away from the phrenic nerve. The pericardial tissue was clamped and retracted upwards to allow fenestration via the use of a low-power electrocauterization instrument (Figure). In the pericardiotomy group (group 1), we placed 2 chest tubes at the end of surgery, one in the left pleural cavity and the other in the anterior mediastinum. In the control group (group 2), however, the 2 chest tubes were placed in the anterior mediastinum. In CABG patients, the left pleural space was opened while the left internal mammary artery was mobilized. Two chest tubes (one in the left pleural cavity and the other in the anterior mediastinum) were inserted, and the pericardium was left open anteriorly in both groups. Placement of a chest tube at the posterior aspect of the heart was avoided in both groups to prevent tube-induced ventricular arrhythmias. In addition, if the left side of the thorax was opened accidently, another chest drainage tube was inserted in the left side of the thoracic cavity in the valve cases. In the postoperative period, the chest tubes was removed when the amount of daily drainage was <100 mL. Whenever there was a need for pain relief, appropriate doses of nonsteroidal anti-inflammatory medications or morphine were provided.

Patient Follow-up and Data Collection

In the postoperative period, the patients were monitored continuously via electrocardiography during the first 3 days after the operation. Continuous monitoring was subsequently reinstituted whenever an arrhythmia was suspected, eg, by the patient reporting feeling palpitations or by a change in the heart rate. Occurrences of atrial fibrillation or atrial flutter rhythm disturbances were recorded. Arrhythmias >20 minutes in duration were considered clinically significant.

Echocardiographic evaluations to detect PE or PT were performed by the same cardiologist before the operation, after the operation on day 1, before discharge, and on days 15 and 30. Our grading of PE was in accord with criteria previously discussed in the literature [Bakhshandeh 2009] (Table 1).

Table 1. Grading of Pericardial Effusion

Grade	Description
Small	<10 mm echo-free space in diastole
Medium	10 mm echo-free space in diastole
Large	20 mm echo-free space in diastole
Very large	20 mm echo-free space in diastole with compression of the heart

In the postoperative period, a chest radiograph was obtained daily in the intensive care unit (ICU) to detect any sign of phrenic nerve palsy. The chest radiographs were collected preoperatively, on postoperative days 1 through 5, and on postoperative days 15 and 30. Chest radiographs were evaluated by the same radiologist.

Emotional status was evaluated by using the Hamilton anxiety rating scale [Hamilton 1959]. The neurology specialist at our institution who carried out this evaluation was blinded to the study protocol.

Table 2. Preoperative Demographic Data of the Study Groups*

Preoperative Parameter	Pericardiotomy Group (n = 50)	Control Group (n = 50)	*P*†
Age, y‡	63.20 ± 7.67	58.82 ± 12.69	**.041**
Sex, n			.42
Male	40 (80%)	43 (86%)	
Female	10 (20%)	7 (14%)	
Diabetes mellitus, n	14 (28%)	15 (30%)	.83
Hypertension, n	34 (68%)	31 (62%)	.53
History of smoking, n	30 (60%)	36 (72%)	.21
Peripheral vascular diseases, n	10 (20%)	2 (4%)	**.01**
COPD, n	8 (16%)	16 (32%)	.06
EuroSCORE, n			.31
Low	38 (76%)	34 (68%)	
Moderate	12 (24%)	14 (28%)	
High	0 (0%)	2 (4%)	
Preoperative LVEF			.56
50%	44 (88%)	42 (84%)	
30%–50%	6 (12%)	8 (16%)	

*COPD indicates chronic obstructive pulmonary disease; LVEF, left ventricular ejection fraction.

†*P* values were obtained with the Student t test (age) and the chi-square test (other variables). Statistically significant differences ($P < .05$) are indicated in boldface.

‡Data are presented as the mean SD.

Table 3. Comparison of the Perioperative Parameters of the Study Groups*

Preoperative Parameter	Pericardiotomy Group (n = 50)	Control Group (n = 50)	*P*†
No. of CABG vessels	2.84 ± 0.88 (3)	2.51 ± 0.75 (2)	.08‡
Preoperative NYHA class	2.52 ± 0.64 (3)	2.70 ± 0.58 (3)	.17‡
Cross–clamp time, min	55.08 ± 18.88	53.22 ± 30.09	.71
CPB time, min	91.68 ± 21.69	88.04 ± 37.54	.55
Drainage, mL	568.00 ± 330.24	600.00 ± 24.27	.58
Type of operation, n			0.7§
CABG	26 (52%)	35 (70%)	
Valvular surgery	12 (24%)	11 (22%)	
CABG plus valvular surgery	12 (24%)	4 (8%)	
Use of LIMA (n = 77), n	34 (89.5%)	37 (94.9%)	.98§

*Data are presented as the mean SD (median) where indicated. CABG, coronary artery bypass graft; NYHA, New York Heart Association; CPB, cardiopulmonary bypass; LIMA, left internal mammary artery.

†*P* values were obtained with the Student t test except where indicated.

‡Mann-Whitney U test.

§Chi-square test.

We also recorded postoperative causes of morbidity and the durations of ICU and hospital stays. Preoperative demographic data are presented in Table 2, and data for perioperative parameters are summarized in Table 3.

Statistical Analysis

The statistical analysis of the study was performed by NCSS (Number Cruncher Statistical System) 2007 and PASS 2008 statistical software (NCSS, Kaysville, UT, USA). Unless stated otherwise, results are presented in a descriptive fashion as a number (percentage), as the mean SD, or as the median. Qualitative or categorical variables were compared by the chi-square test or the Fisher exact test, as appropriate. Quantitative continuous variables were compared with the unpaired Student t test for variables with a normal distribution and with the nonparametric Mann-Whitney U test for variables not normally distributed. Statistical significance was assumed for *P* values <.05.

RESULTS

The mean age of the pericardiotomy group was 63.2 ± 7.67 years, whereas it was 58.82 ± 12.69 years for the control group. The distribution of the patients by sex was as follows: 40 patients (80%) in the pericardiotomy group were male, and 10 (20%) were female. There were 43 male patients (86%) and 7 female patients (14%) in the control group. The evaluation of the preoperative demographic data showed that the mean age of the group of patients who underwent pericardiotomy was significantly higher than that of the control group ($P < .05$). All other data for the 2 groups—including the incidence of diabetes mellitus, the incidence of chronic obstructive pulmonary disease, and the preoperative left ventricular ejection fraction—were not significantly different; however, the incidence of peripheral vascular disease was significantly higher in the pericardiotomy group ($P < .05$). In addition, the EuroSCORE risk scores for the 2 groups were also not statistically different ($P > .05$) (Table 2). The statistical analysis of the operative parameters, including types of surgical procedures, cross-clamp and CPB times, and the amount of drainage, showed that the 2 groups were not significantly different in these respects ($P > .05$, Table 3).

There was no statistical difference between the 2 groups with respect to ICU and hospital stay durations. No mortality was recorded. The evaluation of early and late complications revealed that no early tamponade, stroke, or mediastinitis occurred in the 2 groups during the first 10 postoperative days. No late PT was reported in the pericardiotomy group. Late PT was detected in 6 patients (12%) in the control group in the first 30 days after the operation. Renal dysfunction and low cardiac output syndrome accompanied the clinical findings of PT in 5 of these 6 patients, whereas hemodynamic deterioration in 1

patient was the only clinical finding. Of interest was that when late cardiac PT was subclassified in the 2 groups according to the type of operation, the CABG patients in the 2 groups were not significantly different, whereas the incidence of late PT was higher in the patients who underwent valve surgery or combined valve and CABG surgery in the control group, compared with the patients who underwent the same type of operations in the pericardiotomy group. When the 2 groups were compared with respect to late tamponade occurrence, the difference was significant ($P < .05$). Table 4 summarizes the comparison of the postoperative data.

Table 4. Comparison of the Postoperative Parameters for the Study Groups*

Preoperative Parameter	Pericardiotomy Group (n = 50)	Control Group (n = 50)	*P*
Hospital stay, d	9.58 ± 2.60 (9)	9.68 ± 3.36 (9)	.89†
Intensive care unit stay, d	2.88 ± 1.38 (3)	2.76 ± 1.90 (2)	.26†
Bleeding–related reoperation, n	1 (2%)	1 (2%)	1.00‡
Early tamponade, n	—	—	—
Late tamponade, n	0 (0%)	6 (12%)	.04‡
Development of renal failure, n	0 (0%)	5 (10%)	.06‡
Stroke, n	—	—	—
Perioperative MI, n	0 (0%)	2 (4%)	.50‡
Low cardiac output syndrome, n	4 (8%)	9 (18%)	.14‡
Postoperative SVT, n	14 (28%)	12 (24%)	.65‡
Postoperative respiratory dysfunction, n	14 (28%)	13 (26%)	.82‡
Mediastinitis, n	—	—	—

*Hospital and intensive care unit stays are expressed as the mean SD (median). MI indicates myocardial infarction; SVT, supraventricular tachycardia.

†Student *t* test.

‡Chi-square test and Fisher exact test.

§$P < .05$.

Our evaluation of the study groups according to the amounts of PEs revealed no significant differences between the groups preoperatively; however, before discharge, the control group had a significantly larger number of patients with moderate, large, and very large PEs compared with the pericardiotomy group ($P < .01$). In addition, the incidence of small and moderate PE was higher in the control group than in the pericardiotomy group on postoperative days 15 and 30 ($P < .01$, and $P < .05$, respectively). The distribution of PE amounts is summarized in Table 5. Two patients with very large PEs underwent reoperation for PT drainage on the seventh and 10th postoperative days before discharge. Four other patients were readmitted for PT drainage secondary to late PEs. Two of these patients had large PEs before discharge. The other 2 patients had moderate amounts of PE, and they presented to the hospital with late PT.

Table 5. Comparison of the Study and Control Groups according to the Amounts of Pericardial Effusion*

Pericardial Effusion	Pericardiotomy Group (n = 50)	Control Group (n = 50)	*P*†
Preoperative			—
Small	50 (100%)	50 (100%)	
Before discharge			.001
Small	50 (100%)	20 (40%)	
Moderate	0 (0%)	25 (50%)	
Large	0 (0%)	3 (6%)	
Very large	0 (0%)	2 (4%)	
Postoperative day 15 (n = 94)			.05
Small	50 (100%)	49 (91.1%)	
Moderate	0 (0%)	4 (9%)	

*Grading of pericardial effusion was done via echocardiography. Patients who underwent the late pericardial tamponade procedure on the postoperative days 15 and 30 were not included.

†Chi-square test.

The comparison of electrocardiography findings for the 2 groups before surgery revealed all patients to be in sinus rhythm. There were no significant differences between the pericardiotomy and control groups in the postoperative follow-up periods with respect to rhythm disturbances.

The chest radiographs of all patients were evaluated for the presence of atelectasis and widening of the mediastinum. On postoperative day 1, the presence of left-sided atelectasis was more prominent in the pericardiotomy group than in the control group; however, the difference was not statistically significant. Before discharge, mediastinal widening and the atelectatic areas in the lung fields were both more prominent in the control group than in the pericardiotomy group ($P < .05$). On postoperative day 30, there were no significant differences between the 2 groups with respect to atelectasis and mediastinal widening.

Table 6 shows that before their operations, all patients showed a very mild amount of anxiety according to the Hamilton anxiety rating scale. On postoperative day 1, all patients showed mild degrees of anxiety, and there were no significant differences between the groups ($P > .05$). Before discharge, the patients in the pericardiotomy group showed significant improvement in their anxiety level, and this difference was significant ($P = .03$). The level of well-being in the pericardiotomy group was also detected to be higher on postoperative day 15 ($P = .004$).

There were no deaths in this series. There were no significant differences between the 2 treatment groups in the incidences of pleural or pulmonary complications, and no phrenic nerve injury was detected in the pericardiotomy group.

Table 6. Comparison of the Psychosocial and Emotional Status of the Study Groups by the Hamilton Anxiety Rating Scale*

Anxiety Status	Pericardiotomy Group (n = 50), n	Control Group (n = 50), n	*P*†
Preoperative			—
Very mild	50 (100%)	50 (100%)	
Postoperative day 1			.74
Very mild	6 (12%)	4 (8%)	
Mild	38 (76%)	41 (82%)	
Moderate	6 (12%)	5 (10%)	
Before discharge			.03
Very mild	36 (72%)	23 (46%)	
Mild	14 (28%)	23 (46%)	
Moderate	0 (0%)	2 (4%)	
Severe	0 (0%)	2 (4%)	
Postpoerative day 15 (n = 94)			.004
Very mild	50 (100%)	35 (80%)	
Mild	0 (0%)	6 (13%)	
Moderate	0 (0%)	3 (7%)	
Postoperative day 30 (n = 94)			—
Very mild	50 (100%)	44 (100%)	

*Patients who underwent a late pericardial tamponade procedure on postoperative days 15 and 30 were not included.

†Chi-square test. *P* values <.05 are statistically significant.

DISCUSSION

Postoperative PE, a common complication following cardiac surgery, has a potential to increase morbidity and mortality. Although to our point of view there is a simple and easy method for its prevention [Mulay 1995; Erdil 2005], the optimal treatment for postoperative PE remains controversial [Georghiou 2009]. There are numerous reports on the role of the posterior pericardiotomy technique in preventing postoperative PE, but its usefulness is still debated [Georghiou 2009]. Our main goal in this study was to show that the posterior pericardiotomy technique is an effective method for preventing the occurrence of postoperative PEs after cardiac surgery. Mulay et al [1995] reported an incidence of PE after the posterior pericardiotomy technique of 8%. Another study demonstrated that most PEs resolve spontaneously but that the incidence of developing cardiac tamponade can be between 1% and as high as 31%. These results show that this postoperative complication has a potential for increased morbidity and mortality [Alkhulaifi 1996; Jeffrey 2002; Erdil 2005].

The pericardial fluid collected in a gap in front of the heart usually is easily drained via a chest drain; however, because pericardial adhesions are frequently observed between the inferior and posterior surfaces of the heart and the diaphragm, they may create an enclosed gap that makes drainage difficult [Erdil 2005]. The use of our pericardiotomy technique enables better drainage of the pericardial fluid and prevents the formation of effusion or tamponade. In our study, none of the patients in the pericardiotomy group developed early tamponade, whereas late PT was seen in 6 patients in the control group ($P < .05$). It is obvious that postoperative PE and late PT after cardiac surgery are more likely to be encountered in patients who require anticoagulation therapy in the postoperative period. Among the 6 patients who had late PT in the control group, 1 patient had undergone CABG, and 5 patients had undergone valve operations or combined valve and CABG operations. Our results support the idea that patients who require postoperative anticoagulation therapy probably have a higher risk of late PT occurrence. The posterior pericardiotomy technique thus is a very valuable technique for preventing postoperative late PT in patients who undergo valve surgery or valve-plus-CABG operations.

Previous reports have demonstrated that patients with PE have a higher prevalence of supraventricular arrhythmias [Angelini 1987; Bryan 1990]. Mulay and associates [Mulay 1995] demonstrated reductions in both PE and related supraventricular arrhythmias in a posterior pericardiotomy group, compared with a control group. A relationship between ventricular arrhythmias and the posterior pericardiotomy technique has been discussed in the literature; however, a final decision on this topic has not been made [DeValeria 1991; Mulay 1995; Farsak 2002; Ekim 2006; Bakhshandeh 2009]. Controversial data on this issue exists because any relationship between a surgical technique to prevent PE and the development of arrhythmias has not been demonstrated in a randomized clinical trial; most of the data have been presented as case series. In our study group, there was a statistically significant increase in supraventricular arrhythmias on the first day compared with the control group ($P < .05$). During the follow-up period, however, there were no significant differences between the 2 groups with respect to rhythm disturbances ($P > .05$). We performed a randomized controlled study with 50 patients in each group, and we compared the pericardiotomy and control groups and obtained reliable data that support our premise that our surgical technique does not cause supraventricular or ventricular arrhythmias. The 2 groups were not significantly different with respect to the incidence of such electrocardiographic changes ($P > .05$).

Our secondary goal in this study was to evaluate the occurrence of anxiety in patients who gradually develop PE in the early postoperative period. For this reason, we investigated the relationship between the amount of PE and anxiety status. Although all patients showed mild degrees of anxiety on postoperative day 1, before discharge, and on postoperative day 15, the patients in the pericardiotomy group showed significant improvement in anxiety level ($P > .05$, $P = .03$, and $P = .004$, respectively). In the light of our results, changes in anxiety status in cardiac surgery patients in the early postoperative period due to a low cardiac output state may be early predictors of late PT.

We conclude that pericardiotomy (also known as posterior pericardial fenestration) is a simple, safe, and effective

method for reducing the incidence of PE and late PT, especially for patients require anticoagulation in the postoperative period after cardiac surgery. In that sense, this simple method reduces morbidity as it reduces the rehospitalization rate, provides a better quality of health care for the patient, and improves the quality of life.

REFERENCES

Alkhulaifi AM, Speechly-Dick ME, Swanton RH, Pattison V, Pugsley WB. 1996. The incidence of significant pericardial effusion and tamponade following major aortic surgery. J Cardiovasc Surg 37:385-9.

Angelini GD, Penny WI, El-Ghamary F. 1987. The incidence and significance of early pericardial effusion after open heart surgery. Eur J Cardiothorac Surg 1:165-8.

Bakhshandeh AR, Salehi M, Radmehr H, Sattarzadeh R, Nasr AR, Sadeghpour AH. 2009. Postoperative pericardial effusion and posterior pericardiotomy related. Asian Cardiovasc Thorac Ann 17:477-9.

Bryan AI, Angelini GD. 1990. Pericardial effusion after open heart surgery. Thorax 45:655-6.

DeValeria PA, Baumgartner WA, Casale AS, et al. 1991. Current indications, risks, and outcome after pericardiectomy. Ann Thorac Surg 52:219-24.

Ekim H, Kutay V, Hazar A, Akbayrak H, Başel H, Tuncer M. 2006. Effects of posterior pericardiotomy on the incidence of pericardial effusion and atrial fibrillation after coronary revascularization. Med Sci Monit 12:CR431-4.

Erdil N, Nisanodlu V, Kosar F, Akgul F, Cihan HB, Battaloglu B. 2005. Effect of posterior pericardiotomy on early and late pericardial effusion after valve replacement. J Card Surg 20:257-60.

Farsak B, Gunaydin S, Tokmakoglu H, Kandemir O, Yorgancioglu C, Zorlutuna Y. 2002. Posterior pericardiotomy reduces the incidence of supra-ventricular arrhythmias and pericardial effusion after coronary artery bypass grafting. Eur J Cardiothorac Surg 22:278-81.

Georghiou GP, Porat E, Fuks A, Vidne BA, Saute M. 2009. Video-assisted pericardial fenestration for effusions after cardiac surgery. Asian Cardiovasc Thorac Ann 17:480-2.

Hamilton M. 1959. The assessment of anxiety status by rating. Br J Med Psychol 32:50-5.

Jeffrey TK, Nibal AH, Natesa GP. 2002. Postoperative cardiac tamponade in the modern surgical era. Ann Thorac Surg 74:1148-53.

Kouchoukos NT, Blackstone EH, Doty DB. 2003. Postoperative care. In: Kouchoukos NT, Blackstone EH, Doty DB, Hanley FL, Karp RB. Kirklin/Barratt-Boyes cardiac surgery. 3rd ed. Philadelphia, Pa: Elsevier. p 230-42.

Mangi AA, Palacios IF, Torchiana DF. 2002. Catheter pericardiocentesis for delayed tamponade after cardiac valve operation. Ann Thorac Surg 73:1479-83.

Mulay A, Kirk AJB, Angelini GD, Wishheart JD, Hutter JA. 1995. Posterior pericardiotomy reduces the incidence of supraventricular arrhythmias following coronary artery bypass surgery. Eur Cardiothorac Surg 9:150-2.

Pepi M, Muratori M, Barbier P, et al. 1994. Pericardial effusion after cardiac surgery: incidence, site, size, and hemodynamic consequences. Br Heart J 72:327-31.