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Clinical and Echocardiographic Characteristics of Pericardial Effusion in Patients Who Underwent Echocardiographically Guided Pericardiocentesis: Yonsei Cardiovascular Center Experience, 1993-2003

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Percutaneous pericardiocentesis guided by two-dimensional echocardiography was introduced in 1983 as an alternative to electrocardiographically or fluoroscopically guided puncture for the management of pericardial effusion. The objective of this study was to investigate echocardiographically (echo)-guided pericardiocenteses performed at Yonsei Cardiovascular Center from January 1, 1993 to December 31, 2003, and also to determine whether patient profiles, etiology, and practice patterns have changed over this 11-year period. The medical records of 272 patients were examined and a follow-up survey was conducted. Patient clinical profiles, etiology, echocardiographic findings, and procedural details were determined for 2 periods: January, 1993 through December, 1997 (period 1); and January 1998 through December, 2003 (period 2). During the 11-year study period, 291 therapeutic, echo-guided pericardiocenteses with pericardial catheter drainage were performed in 272 patients. The number of pericardiocentesis in period 2 was increased compared with period 1 (191 cases vs. 100 cases). The mean age at pericardiocentesis increased from 49 $\pm$ 17 years in period 1 to 55 $\pm$ 16 years in period 2 ($p<0.05$). The procedural success rate was 99% overall with a major complication rate of 0.7% (2 cases of right ventricular free wall perforation which required emergency operation). Only one procedure-related mortality (< 30 days) was noted. Malignancy was the leading cause of a pericardial effusion requiring pericardiocentesis (45.6%). The incidence of pericardial effusion following cardiothoracic surgery and percutaneous coronary intervention procedures accounted for nearly 20% of all pericardiocenteses performed.

Echo-guided pericardiocentesis has become a safe, standard practice for clinically significant pericardial effusion, in line with the changes of patients profiles over the 11 years of the study.

Key Words: Pericardial effusion, echo-guided pericardiocentesis

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INTRODUCTION

Historically, percutaneous pericardiocentesis was performed as a blind procedure and was associated with a high complication rate.[1-5] However, the development of two-dimensional echocardiography in the 1970s allowed confirmation of the presence and localization of the fluid-filled cavity and substantially enhanced the safety of percutaneous pericardiocentesis.[6] An optimal point of needle entry can be selected to avoid contact with the heart or any vital structures. This two-dimensional echocardiographically (echo)-guided pericardiocentesis has been the procedure of choice for diagnostic and therapeutic pericardiocentesis. The experience of echo-guided pericardiocentesis at several institutes has been published.[7-12] This simple, safe and effective procedure with pericardial catheter drainage has become the standard method for relief of pericardial effusion and cardiac tamponade.

We retrospectively analyzed the data of all echo-guided pericardiocenteses performed at Yonsei Cardiovascular Center from 1993 to 2003. Patient clinical profiles, clinical outcomes, etio-

logy, echocardiographic findings, practice patterns and procedural complications related to echo-guided pericardiocentesis were investigated.

MATERIALS AND METHODS

Data collection and study population

We reviewed the medical records of all patients who underwent echo-guided percutaneous pericardiocentesis at Yonsei Cardiovascular Center between January 1, 1993, and December 31, 2003, for treatment of clinically significant pericardial effusions, defined as hemodynamically significant, symptomatic, and asymptomatic with large pericardial effusions. The study population consisted of 272 patients who underwent 291 echo-guided pericardiocenteses.

Clinical and echocardiographic data

Patients profiles, clinical outcomes, and details of pericardiocentesis were obtained from the medical records of all patients. Echocardiographic findings were retrieved from the Echocardiography Database. Outcomes of interest included procedural success and complications, incidence of repeated pericardiocentesis, etiology of pericardial effusion and practice pattern. "Overt clinical tamponade" was considered present for heart rate greater than 100 beats/min and documented evidence of systolic blood pressure less than 90 mmHg. "Echo tamponade" was defined as right atrial or ventricular diastolic collapse with significant respiratory variation of the Doppler mitral inflow velocity. Pericardial effusion was considered large for drainage amount greater than 400 ml or the size of the pericardial effusion greater than or equal to 2 cm circumferentially based on the amount of fluid between the visceral and parietal pericardium.

Procedures

Two- dimensional and Doppler echocardiographic images were obtained before percutaneous pericardiocentesis. The ideal entry site was identified as the point at which the distance from the skin to maximal fluid accumulation was minimized, with no intervening vital organs. All echo-guided pericardiocentesis procedures were supervised by experienced echocardiologists and pericardial fluid drainage with pig tail catheter was performed. The pericardial catheter was removed once the fluid was less than 20 ml over 24 hours, and/or follow-up echocardiography showing no significant residual effusion. Pericardiocentesis was considered successful if the fluid was removed, resulting in improvement of symptoms and relief from hemodynamic instability. Complications were classified as "major" if emergency operation related to the procedure was required. Minor complications were those that required only monitoring and repeated pericardiocentesis.

Statistical analysis

Descriptive statistics are presented as means ± SD or by frequency percentages

and were analyzed using SPSS for windows 10.0 by the two-sample independent t-test and/or chi-square test. A value of $p<0.05$ was considered significant.

RESULTS

Clinical and echocardiographic characteristics

A total of 291 consecutive echo-guided pericardiocenteses(158 male, 58%) were performed in 272 patients between January 1993 and December 2003. This 11-year interval was separated into two periods: January, 1993 through December, 1997 (period 1), and January, 1998 through December, 2003 (period 2). The cases of pericardiocentesis in period 2 increased compared with those in period 1 (191 cases vs. 100 cases). The mean age of all patients was 53 ± 16 years. The mean age at pericardiocentesis increased from 49 ± 17 years in period 1 to 55 ± 16 years in period 2 ($p<0.05$). The proportion of patients age 65 years or older in period 2 increased significantly compared with that in period 1 (27% vs. 12%, p=0.004). Malignancy was the leading cause of a pericardial effusion requiring therapeutic pericardiocentesis (45.6%).

Subgroup analysis of malignant pericardial effusions showed no significant differences between the two periods: lung cancer was the most common cause (64.5%), followed by breast cancer (8.8%). Contrary to other reports from western countries, tuberculosis was the second most common cause of pericardial effusion (14.7%). Most patients presented with pericardial tamponade as the first manifestation of tuberculosis. The incidence of pericardial effusion following cardiothoracic surgery was not significantly greater in period 2 than in period 1. Valve surgery (68.4%) was the most common procedure, followed by coronary artery bypass graft surgery (CABG) (15.7%). In our study, patients after valve surgery were routinely placed on oral anticoagulant therapy, while patients after CABG were placed on aspirin, with few exceptions. There were several etiologies of pericardial effusion such as chylopericardium, connective tissue disease, ischemic heart disease, complication during coronary intervention and unknown causes (Table 1). There were 16 cases of repeated pericardiocentesis after removal of pig tail catheter (8 cases in both periods 1 and 2). The most common cause of repeated pericardiocentesis was malignancy (11 patients, 69%), of which most were associated with lung cancer (8 of 11 cases, 73%). Other causes

Table 1. Clinical and Echocardiographic Characteristics of the Study Subjects

	Period		p value
	Period 1 (1/1993-12/1997)	Period 2 (1/1998-12/2003)	
Number of patients (n, %)	91 (33)	181 (66)	NA*
Male (n, %)	53 (58)	105 (58)	0.97
Mean ± SD age (yr)	49 ± 17	55 ± 16	0.017
Patients>65 yr (n, %)	11 (12)	49 (27)	0.004
Etiology of effusion (n, %)			
Malignancy	43 (47)	81 (45)	0.107
Tuberculosis	14 (16)	26 (14)	0.224
Postoperative	11 (12)	27 (15)	0.067
Coronary intervention related	6 (7)	7 (4)	0.265
Ischemic heart disease related	2 (2)	7 (4)	0.523
Infection	1 (1)	4 (2)	0.345
Connective tissue disease	1 (1)	2 (1)	0.612
Idiopathic	4 (4)	10 (6)	0.412
Others?	9 (10)	17 (9)	0.577
Hemodynamic status (n, %)			
Echo-tamponade	42 (46)	101 (55)	0.923
Clinically tamponade	12 (13)	18 (10)	0.591
Hemodynamically collapse	11 (12)	13 (8)	0.773
No tamponade physiology with large pericardial effusion	26 (29)	49 (27)	0.554
Distribution of effusion (n, %)			
Circumferential	87 (96)	168 (93)	0.234
Loculated	4 (4)	12 (6)	0.443
Not specified	0 (0)	1 (1)	0.546

†Drug related, uremia, chest trauma, and rupture of aortic dissection.
*NA=not applicable.

of repeated pericardiocentesis were tuberculous pericarditis (2 cases), uremia (1), infection (1) and invasive procedure-related (1). Pericardial window formation was performed in 6 patients for the treatment of intractable large pericardial effusion.

Overt clinical tamponade was evident in 30 patients (11%), including 24 (9%) with hemodynamic collapse. Echo-Doppler evidence of tamponade physiology was noted in 143 patients (53%), and 75 (28%) had asymptomatic large pericardial effusion without evidence of tamponade physiology. Regarding the pattern of pericardial effusion, 94 % of the effusions were circumferential, and 6 % were loculated (Table 1). Cardiac tamponade during percutaneous coronary intervention was uncommon (13 cases, 4.7%), but occasionally life-threatening due to delayed diagnosis.

Procedural success and complications

Pericardiocentesis with subcostal approach was performed in 271 (93%) patients, and apical approach through chest wall in 20 (7%). However, the number of apical approach had a tendency to increase in period 2. The fluid was serosanguineous and bloody in 30% and 69% of cases, respectively. Of the 291 percutaneous pericardiocenteses, 99% were successful in removing pericardial fluid and in relieving symptoms and hemodynamic instability without causing any complications. Technically failed pericardiocentesis was noted in a small, localized amount of pericardial effusion during emergency pericardiocentesis (3 cases). Throughout the 11-year period, a total of 2 major complications (0.7%) occurred, including the death of a 72-year-old man who did not survive an emergency operation after a right ventricular puncture that led to hemorrhagic tamponade. Minor complications such as cardiac arrhythmia, vasovagal reaction and breathing difficulties were noted in 9 patients (3%) (Table 2).

DISCUSSION

Our study reported the following. (1) The mean age at which echo-guided pericardiocentesis was performed increased over the study period, a

Table 2. Procedural Outcomes Related to Echo-guided Pericardiocentesis

	Period		*p* value
	Period 1 (1/1993-12/1997)	Period 2 (1/1998-12/2003)	
Cases of pericardiocentesis (n, %)	100 (34)	191 (66)	NA*
Procedural success (%)	99	99	0.996
Needle entry site (n, %)			
Subxiphoid	97 (97)	174 (91)	0.688
Apical	3 (3)	17 (9)	0.545
Color of effusion (n, %)			
Bloody	70 (70)	132 (69)	0.768
Serosanguineous	29 (29)	58 (30)	0.817
Chylous	1 (1)	1 (1)	NA*
Complications (n, %)			
Major†	1 (1)	1 (1)	NA*
Minor‡	4 (4)	5 (3)	0.94
Repeated pericardiocentesis (n, %)	8 (9)	8 (4)	0.92

†Major complication includes right ventricular free wall perforation.
‡Minor complications include cardiac arrhythmia, vasovagal reaction, and breathing difficulties.
*NA=not applicable.

trend that is anticipated to continue with the increasing proportion of the elderly. (2) Pericardial effusions due to malignancy and tuberculosis accounted for 47% and 15% of all pericardiocenteses respectively. (3) Pericardial effusion following cardiothoracic surgery and percutaneous coronary intervention procedures accounted for nearly 20% of all pericardiocenteses performed.

There are several modalities for the treatment of a large amount of pericardial effusion, such as percutaneous pericardiocentesis, subxiphoid surgical drainage, pericardiectomy, pericardio-pleural window, and pericardio-peritoneal window.[7,8,13-16] Among them, echo-guided pericardiocentesis is minimally invasive and effectively performed with a local anesthesia. Extended catheter drainage was incorporated into the original echo-guided pericardiocentesis procedure in an attempt to reduce recurrence.[17,18] Kopecky and his colleagues[17] first demonstrated the clinical efficacy of pericardial catheter extended drainage, after which a decrease in the selection of surgery for the management of pericardial effusions became evident. This echo-guided pericardiocentesis with extended catheter drainage has been shown to be safe and effective for managing pericardial effusions.[7,8,13] In a large series, the mortality rate was less than 1% and the major complication rate was 1.5%.[7] In the present study, only one death due to pericardiocentesis was noted (0.4%), in one patient who underwent emergency operation one day after pericardiocentesis due to perforation of the right ventricle free wall.

In the present study, malignancy was the leading cause of pericardial effusion requiring therapeutic pericardiocentesis, followed, notably, by tuberculosis. This can be ascribed to the fact that Korea has an exclusively high incidence of pulmonary tuberculosis, compared to that of the western world. However, recently the number of postoperative pericardial effusion requiring pericardiocentesis has a tendency to increase. This likely reflects the increased number of surgical procedures performed for cardiovascular diseases over the years. The development of pericardial effusion after cardiac surgery have been reported in several previous studies.[19-25] The estimated incidence of pericardial effusion after open heart surgery has been reported to be 4.7-85%,[21,23] depending on the methodology used for its detection. The possible correlation between anticoagulant treatment and pericardial effusion had been suggested in earlier reports.[24,25] However, Malouf et al.[21] reported that anticoagulated patients had a similar overall incidence of effusion and a similar incidence of small or moderate effusion, but a higher incidence of large effusion, compared to non-anticoagulated patients undergoing open heart surgery. No particular type of cardiac surgery was associated with an increased incidence of pericardial effusion.[23] In our study, all patients after valve surgery were routinely placed on oral anticoagulant therapy, while most of patients after CABG were placed on aspirin. However, a higher incidence of large pericardial effusion was not noted in patients undergoing valve surgery, compared to non-valve surgery including CABG (92% vs. 66%, p=0.067). This may be attributed to the fact that the anti-inflammatory action of aspirin may theoretically prevent formation or facilitate reabsorption of effusion, thus minimizing differences between the two groups. All of the patients developed pericardial effusion and/or tamponade 7 days or more after surgery, which suggested formation of pericardial effusion as a manifestation of the postpericardiotomy syndrome. Cardiac tamponade is a rare but life-threatening complication of percutaneous coronary intervention.[20-24] A relatively small blood volume within the pericardial space may cause severe hemodynamic instability and death, even with early diagnosis and prompt treatment. The rapidity of the pericardial accumulation of blood as a result of coronary artery rupture is associated with these hemodynamic features.

The procedural success rate was 98.9% in the first puncture in our study, confirming that echo-guided pericardiocentesis is an effective method. Recently, several large recent studies[7,8] have supported this fact, with success rates of 97-100%. Throughout the 11-year period, only two major complications (0.7%) occurred in our study. There was one death associated with puncture. Other techniques such as blind or electrocardiographically and fluoroscopically guided puncture are associated with a documented complication rate that is higher, both in mortality and morbidity.[1-4] In the present study, the recurrence rates of

pericardial effusion were significantly lower than those of previous study without extended catheter drainage.[2]

Echo-guided pericardiocentesis can be performed by subxiphoid and chest wall approaches. In the present study, the subxiphoid approach was performed in most patients (93%). However, the chest wall approach may be more beneficial because the pericardial fluid is closest to the transducer in the apical view.[26,27]

There were several limitations in our study. This retrospective study had inherent biases and, furthermore, we could not analyze several data due to inaccurate medical recordings. In addition, we only included patients with pericardial effusion who underwent echo-guided pericardiocentesis. Surgical treatments such as pericardiectomy, surgical pericardial window and percutaneous balloon pericardial window were not included in this study.

Over an 11-year period, the proportion of patients age 65 years or older who underwent echo-guided pericardiocentesis increased significantly, consistent with the increasing proportion of the elderly. The number of echo-guided pericardiocenteses with extended catheter drainage increased over the years. Malignancy was a leading cause of pericardial effusion underwent echo-guided pericardiocentesis. Since pericardial fluid is closest to the approach, pericardiocentesis with apical approach is increasing.

Echo-guided pericardiocentesis with extended catheter drainage is safe and effective for the initial treatment of effusions that are symptomatic, large, or have evidence of cardiac tamponade.

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