The Journal of International Medical Research
2003; 31: 312 – 317

Clinical Experience with Subxiphoid Pericardiostomy in the Management of Pericardial Effusions: a Study of 240 Cases

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We aimed to assess the effectiveness of subxiphoid pericardiostomy for treating patients with pericardial effusions (PE), and its contribution to defining the aetiology of these effusions. We undertook retrospective analysis of 240 PE patients who underwent subxiphoid pericardiostomy and tube drainage between 1990 and 2000. Echocardiography classified PE as severe in 132 patients, moderate in 99, and mild in nine. The main causes of PE were uraemic, idiopathic and undefined, tuberculous and non-tuberculous pericarditis, malignancy and trauma. Peri-operative myocardial injury requiring sternotomy, and recurrent effusion requiring further surgical intervention, occurred in three and 24 patients, respectively. Histopathological examination assisted the diagnosis in 94% of patients with malignancy, and 96% with tuberculous pericarditis. Overall 30-day mortality was 1.3% and pericardial constriction, requiring pericardiectomy, developed in seven cases. In conclusion, we believe that adults and children with PE can be safely, effectively and quickly managed with subxiphoid pericardiostomy, irrespective of its aetiology.

KEY WORDS: Pericarditis; Pericardial effusion; Subxiphoid pericardiostomy; Pericardiostomy; Pericardial tube drainage; Aetiology

Introduction

Pericardial effusion (PE) is a life-threatening condition, as accumulation of fluid in the pericardial sac can lead to cardiac tamponade and fatal shock.[1,2] PE is often associated with an underlying disease or condition, and the causes can vary widely.[3,4] Pericardiocentesis performed by needle (with or without echoguidance), and various surgical procedures (including subxiphoid pericardial tube drainage, pericardial window performed through a left anterior thoracotomy, or video-assisted thoracoscopic surgery) can alleviate PE.[5] Our retrospective clinical experiences of treating PE with subxiphoid pericardiostomy are presented in this study.

Patients and methods

We reviewed the medical records of patients who underwent subxiphoid pericardiostomy to treat persistent symptomatic PE in our clinic between 1990 and 2000. Echocardiography (ECG) was used to diagnose PE and

determine the size of the effusion. A diastolic echo-free space of < 10 mm between the left ventricular posterior wall and pericardium was determined as mild PE, 10 – 20 mm as moderate, and > 20 mm as severe PE. Patients with cardiac tamponade and/or moderate to severe PE were treated by subxiphoid pericardiostomy and tube drainage.

STANDARD TREATMENT PROTOCOLS EMPLOYED

Some patients with pre-operative tuberculosis were treated with an adult four-drug regimen (isoniazid, 300 mg/day and rifampin, 600 mg/day for 12 months, streptomycin, 1 g/day for 2 months, and pyrazinamide, 2 g/day for 3 months) pre-operatively. The effusion was drained after a 3-week course of anti-tuberculosis therapy. In these, and patients diagnosed with tuberculous pericarditis, the tuberculosis therapy regimen was given for 12 months post-operatively.

The technique used for subxiphoid pericardiostomy (described previously[3]) was performed under general anaesthetic, or local anaesthesia and sedation. General anaesthesia was preferred in children and was induced with 1.5 mg/kg ketamine. Neuromuscular block was achieved with 0.1 mg/kg vecuronium, and anaesthesia maintained with 60% N_2O, 40% O_2 and 0.5 – 1.0% isoflurane. Local anaesthetic (2% lidocaine solution) was injected into the dermal and subdermal layers, and sedation and analgesia was provided by 1 mg/kg ketamine intravenously. A piece of anterior pericardium, approximately 2 – 4 cm in diameter, was excised under direct vision and submitted for histopathological analysis. The pericardial cavity was decompressed and fluid samples were collected for culture and cytological analysis. To prevent acute cardiac dilatation during decompression of the pericardial cavity, intravenous digoxin was administered and the pericardial cavity was decompressed gradually.

The pericardial cavity was examined under direct vision and/or by digital examination to detect any tumour or adhesions. Gentle digital lysis of adhesions and opening of loculations were performed as needed, to enhance satisfactory drainage. A soft chest tube was placed in the pericardial cavity, lateral to the right ventricle, after pericardiotomy for post-operative drainage. It was connected to an underwater sealed system, and was removed when fluid drainage ceased.

Patients with mild haemorrhagic effusion and cardiac tamponade, due to trauma or invasive cardiac interventions, were considered haemodynamically unstable and unsuitable for surgical subxiphoid pericardiostomy, even under local anaesthetic. These patients underwent pericardiocentesis in the intensive care unit, which provided immediate relief. Subxiphoid pericardiostomy was performed later if haemorrhagic PE persisted. Patients were followed, with physical examinations and ECG, in the outpatient clinic for at least 1 year.

STATISTICAL ANALYSIS

Numerical results are given as mean ± SD. Fisher's exact test was used to compare proportions between groups (comparison of the rates of recurrence and constriction between patient groups with uraemic pericarditis, tuberculous pericarditis and non-tuberculous bacterial pericarditis). The McNemar test was used for comparison of proportions within one group (to assess the significance of rates of recurrence and constriction in patients with tuberculous pericarditis). Statistical differences were considered significant if $P < 0.05$.

Results

The records of 240 patients were reviewed; 144 males (60%) and 96 females (40%), whose ages ranged from 6 years to 74 years (mean 37.2 years).

Mild effusion was diagnosed in nine patients (4%), moderate effusion in 99 patients (41%), and severe effusion in 132 patients (55%). The symptoms and signs in all 60 patients with cardiac tamponade were unspecific, but 51 had increased systemic venous pressures, pulsus paradoxus, and tachycardia, despite having normal blood pressure. Only nine patients had additional hypotension due to the tamponade; they were suffering from trauma and mild PE. The causes of PE in these cases were blunt injury to the thorax (two cases), and invasive cardiac interventions (seven cases). All patients with symptomatic PE obtained immediate subjective relief from pericardiostomy, which normalized pulse rate and blood pressure, and jugular venous distension simultaneously subsided. Myocardial injury, attributable to the operation, occurred in three people (1.3%), and could not be controlled by the subxiphoid approach. An immediate median sternotomy was therefore required. Myocardial injury occurred during the first pericardial excision because of severe pericardial adhesions in two patients with recurrent tuberculous pericarditis. The third patient had uraemic PE, and right atrial rupture occurred during insertion of the pericardial tube into the pericardial cavity as a result of the rough insertion of a stiff tube.

The aetiological causes of PE in this study were: uraemic pericarditis; idiopathic and undefined pericarditis; malignant processes invading the pericardium; tuberculous pericarditis; non-tuberculous bacterial pericarditis; trauma; rheumatoid arthritis (three patients); systemic lupus erythematosus (two patients); periarteritis nodosa (one patient); and hypothyroidism (one patient) (Table 1).

TABLE 1:
Aetiologic causes of pericardial effusion, and results of subxiphoid pericardiostomy in 240 patients

Causes of pericardial effusion	No of patients (% of total)	Recurrence (% of diagnostic group)	Constriction (% of diagnostic group)	Mortality 30 day/ 1 year
Uraemic pericarditis	101 (42)	16 (16)		1/0
Idiopathic and undefined pericarditis	52 (22)			2/0
Malignant processes invading the pericardium	34 (14)			0/14
Tuberculous pericarditis	25 (10)	8 (32)*	3 (12)*	
Non-tuberculous bacterial pericarditis	12 (5)		4 (33)*	
Trauma	9 (4)			
Blunt injuries to the thorax	2			
Invasive cardiac intervention	7			
Others	7 (3)			
Total	**240**	**24**	**7**	**3/14**

*Not significant.

Histopathological examination of the pericardial specimen, fluid, or both, was positive for malignant cells in 32 (94%) of the 34 patients with PE due to malignant processes invading the pericardium. Examination of the pericardial fluid alone failed to diagnose the cause of PE in 12 patients as malignant processes invading the pericardium, but histopathological examination of the pericardial specimen revealed the diagnosis in all 12. Of the 32 patients, 15 had lung cancer, eight had lymphoma, five had breast cancer, three had leukaemia, and one had malign thymoma. Histopathological examination of the pericardial fluid and specimen did not reveal any malignant cells in two patients with pre-operatively confirmed lung cancer. Cytological examination of fluid and pericardial specimens taken during surgery identified the aetiology of PE in 22 (88%) of the 25 patients with tuberculous pericarditis. In the remaining three patients, both cytology and biopsy failed to make a diagnosis.

The micro-organisms identified in cultures of pericardial fluid from patients with infectious pericarditis were: *Mycobacterium tuberculosis* (n = 21), pneumococcus species (n = 4); *Streptococcus viridane* (n = 3); *Haemophilus influenzae* (n = 3); and staphylococcus (n = 2). Only 12 of the 25 patients with tuberculous pericarditis had a pre-operative diagnosis of tuberculosis, with a positive purified protein derivative skin test, positive chest X-ray, or acid resistance bacilli in bronchial secretions.

Drainage volume during the operation was 150 – 4500 ml (mean 696 ± 32 ml), and average drainage volume during the post-operative period was 298 ± 7 ml. The highest drainage volume was obtained from a patient with uraemia, and the lowest from a patient who developed a ruptured right coronary artery during angioplasty and stent implantation. Fluid was transudate in 117 patients (49%), haemorrhagic in 79 (33%), exudate in 32 (13%) and purulent in 12 patients (5%).

Wound infection occurred in 12 patients (5%). Patients were hospitalized for 4 – 30 days (mean 6.3 days), and the overall 30-day mortality rate was 1.3% (Table 1). Low cardiac output was the cause of death in the two patients who died in the post-operative period. They died despite inotropic support (dobutamine, 5 µg/kg per min, and epinephrine, 3 – 5 µg/min) and resuscitative measures. The third patient had inoperable ischaemic heart disease and congestive cardiac failure, and died from multi-organ failure.

Recurrence of PE, requiring further surgical intervention, occurred post-operatively in 24 patients (10%) with uraemic or tuberculous pericarditis, between day 20 and day 30 (Table 1). The recurrence rate was higher in patients with tuberculous than uraemic pericarditis, but the difference was not significant. Subxiphoid tube drainage and pleuropericardial window were performed on all patients with recurrent effusion, using an oblique epigastrium incision originating in the left sternocostal angle. Effusion did not recur following this procedure.

All surviving patients were followed for at least 1 year. During this period, 14 patients with malignancy died. Constrictive pericarditis requiring pericardiectomy (by median sternotomy) developed in seven of the 223 surviving patients (Table 1), who were originally diagnosed with tuberculous or non-tuberculous bacterial pericarditis. Constrictive pericarditis occurred in three out of eight patients with recurrent tuberculous pericarditis.

Discussion

Pericardial effusion is often related to an underlying condition such as uraemia,

malignancy (lung, breast and ovarian carcinoma, leukaemia and lymphoma), infection (frequently viral), autoimmune disorders and myocardial infarction. In some reports, uraemic pericarditis is a less-frequent cause of pericarditis,[3,4] but in our cases, it is the most common cause. Our hospital admits the majority of patients with renal failure as it has the biggest dialysis centre in the region. As a result of economic problems, most of these cases are not well controlled, resulting in the high frequency of uraemic PE seen in our study.

Presentation of the PE can range from a minimally symptomatic PE to a state of complete cardiovascular decompensation. Pericardial disease is a common entity, but pericardial tamponade is often considered to be an unusual presenting feature. Previous studies reported tamponade in 44% of patients.[5] Cardiac tamponade occurred in 25% of our patients.

Various effective drainage techniques are available, but no one technique is optimal for all patients and circumstances.[5 – 10] Ideal management should ensure complete and permanent drainage, provide sufficient histological, cytological, and microbiological specimens for diagnostic study, and be performed with minimal discomfort and risk to the patient. Subxiphoid pericardiostomy can be performed under local anaesthesia and allows direct visualization, biopsy, and exploration of the pericardium and pericardial cavity. Video-assisted transthoracic pericardial drainage has been touted as effective for preventing effusion recurrence through a large pericardial resection with the creation of a 'pericardial window'. It requires, however, general anaesthesia and single-lung ventilation; procedures that are difficult in critically ill patients.[5] Pericardiocentesis was performed as a temporary procedure on nine of our 240 patients. All had life-threatening haemodynamic instability due to trauma, and subsequently underwent subxiphoid pericardiostomy. Pericardiocentesis was not used electively as a diagnostic and therapeutic modality for several reasons. First, its safety was considered. Despite several reports of high success and low complication rates with echo-guided pericardiocentesis,[7,8] we think these figures are valid only for the most experienced cardiologists. Secondly, pericardiocentesis should be performed primarily on patients with haemodynamic instability. Thirdly, it has incomplete diagnostic effectiveness in patients with tuberculous pericarditis and malignant processes invading the pericardium, because a pericardial biopsy specimen cannot be taken. As a result, although pericardiocentesis may provide temporary relief to patients with symptoms and signs of cardiac tamponade, it is not adequate for definitive therapy.

Allen *et al.*[7] reported a series of 117 patients with cardiac tamponade resulting from PE. The mortality rate in 94 patients who underwent subxiphoid pericardiostomy was 0%, complication rate 1.1% (1/94), and recurrence rate was 1.1% (1/94). Conversely, in 23 patients with PE who underwent echo-guided percutaneous catheter drainage performed by a cardiologist, the mortality rate was 4.3% (1/23), complication rate 17% (4/23), and recurrence rate 32% (7/22). These authors stated that percutaneous catheter drainage, while less invasive, is associated with increased morbidity, mortality and effusion recurrence rates.[8,9] In a series of 63 patients with cardiac tamponade undergoing primer pericardiocentesis, Bastian *et al.*[8] reported a success rate of 81% and recurrence rate of 19%. In a similar study, Vayre *et al.*[9] reported a major complication incidence of 10%, and emergency surgical

drainage was required for a failed procedure in 4% of patients. Late surgical drainage was required for persistence or recurrence of the effusion in 15% of patients. Pericardiocentesis or percutaneous tube drainage may be a useful temporary treatment for patients with acute tamponade.[6–9] Biopsy was able to define the aetiology in only four (as tuberculosis in two and neoplasias in two) out of 38 (11%) patients with PE described by Fernandes *et al*.[10] In our series of 240 patients, histopathological examination of surgical pericardial specimens defined the aetiology in 23% of patients. Moreover, the diagnosis of 27% of those with tuberculous pericarditis or malignant processes invading the pericardium was possible after pericardial biopsy alone. We believe that pericardiostomy may be useful for establishing the aetiology of PE, especially in patients with tuberculous PE or malignancy. Viral pericarditis probably caused PE in some of our 52 patients with idiopathic and undefined pericarditis, due to the fact that viral cultures are not undertaken in our microbiology laboratory. The number of patients with constriction in our study was too small for statistical evaluation, but rates of recurrent effusion and constriction are higher in patients with tuberculous and other bacterial pericarditis. For this reason, we recommend close follow-up of these patients after the first episode. We believe that subxiphoid pericardiostomy is a safe and effective technique for treatment, diagnosis and establishing the aetiology of PE, especially in patients with tuberculous and malignant processes invading the pericardium.

• Received for publication 9 January 2002 • Accepted subject to revision 13 February 2002
• Revised accepted 24 March 2003

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