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Original Research Paper

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OUTCOMES OF TOTAL PERICARDIECTOMY FOR CONSTRICTIVE PERICARDITIS- A SINGLE CENTRE EXPERIENCE OF 20 YEARS

Utkarsh Sanghavi Department of Cardiovascular and Thoracic Surgery, U.N Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India

Vartika Jain Department of Cardiovascular and Thoracic Surgery, U.N Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India

Vidur Bansal* Department of Cardiovascular and Thoracic Surgery, U.N Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India *Corresponding Author

Vinay Upadhyay Department of Cardiovascular and Thoracic Surgery, U.N Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India

ABSTRACT

Background: Constrictive pericarditis (CP) consists of a spectrum of primary cardiac and noncardiac conditions. It represents a form of severe diastolic heart failure (HF) which is usually secondary to a non-compliant pericardium. Our study was designed to evaluate immediate and short term outcomes of total pericardiectomy clinically and echocardiographically. Through this study we aimed to analyze the short-term and mid-term outcomes of total pericardiectomy using death and adverse events as end points. Between January 2001 and December 2020, a total of 166 patients with constrictive pericarditis underwent total pericardiectomy at our institute. **Results:** The mean age was 30.4±13.35 years. The mean post-operative CVP was 8.73±3.06 cm of H20. Histopathological results showed tuberculous pericarditis 86(51.82%) in patients, chronic constrictive pericarditis in 76(45.78%) patients, purulent pericarditis in 2(1.20%) patients and viral pericarditis in 2(1.20%) patients. At the end of 12 months, 150(92.60%) patients were in NYHA class I and 12(7.40%) patients were in NYHA class II. **Conclusions:** In a developing country like India, tuberculosis is still the most frequent cause of CP. Total pericardiectomy with or without the use of CPB is the surgical treatment of choice and should be performed as early as possible as it is associated with a lower mortality, early normalization of hemodynamics, less postoperative low cardiac output syndrome, and better long-term survival.

KEYWORDS : Constrictive pericarditis, echocardiography, computed tomography, total pericardiectomy

BACKGROUND

Constrictive pericarditis (CP) is usually characterized by the encasement of the heart by a non-pliable rigid pericardium due to dense adhesions and fibrosis. The inflamed and/or scarred pericardium limit the diastolic filling, which leads to impaired diastolic cardiac function leading to heart failure which manifests as systemic congestion without pulmonary congestion [1]. The true prevalence of CP maybe unknown, but can be seen in 0.2–0.4% of patients following cardiac surgery. [2] Also, it can occur after pericardial trauma or inflammation due to varied etiologies. The most common etiologies in the developed world are idiopathic, postsurgical, or radiation injury whereas in developing countries like India, tuberculosis is still the most common cause.

CP was first described by Lower in 1669 [3] and Sauerbruch performed the first successful pericardiectomy in 1913 [4]. Observational studies and case reports done in the past suggest that in most instances, there is progression of symptoms and frequently, early death without surgical intervention[5]. Studies done in the past have also shown that overwhelming majority of operative survivors experience an improvement in symptoms and/or quality of life [5]. The impact of pericardial calcification (CA) on perioperative mortality and long-term outcome is still unclear. Ling et al. [6] found higher perioperative mortality for patients with CA, and in a study by Gimlette [7] CA was associated with poor postoperative outcome.

The purpose of this study is to determine the short and mid term outcomes of patients who underwent total pericardiectomy in our centre over a period of 20 years with death and adverse events as end points.

METHODS

Type of Study: Retrospective study

How Was The Sample Size Calculated: Based on existing records

Method Of Randomization: Not applicable as it is a retrospective study

Inclusion Criteria: All patients who underwent total pericardiectomy from January 2001 to December 2020

Exclusion Criteria: Patients who underwent partial pericardiectomy

Endpoints: Peri-operative death and serious adverse outcomes

Statistical Analysis: Fundamental statistical methods using Microsoft Excel® (Microsoft Inc., Washington, United States)

RESULTS

From January 2001 to December 2020, 166 patients underwent total pericardiectomy at our institute. Out of 166 patients, 110(66.26%) were males and 56(33.74%) were females. Table-1 shows the clinical characteristics and diagnostic tests of the 166 patients who underwent total pericardiectomy.

Predominant symptoms were dyspnea, peripheral edema, abdominal distension, chest pain, palpitation, fever, cough and weight loss. At the time of admission, 120(70.29%) patients were in New York Heart Association (NYHA) functional class II, 38(22.89%) patients were in NYHA functional class III and 8(4.82%) patients were in NYHA functional class IV. The mean duration of symptoms was 22.873±20.47 months.

Table 1: Clinical Characteristics And Diagnostic Tests

Mean Age	30.4±13.35 years
Sex	
Male	110 (66.26%)
Female	56 (33.74%)
New York heart Association Functional class	
I	0

II	120 (70.29%)
III	38 (22.89%)
IV	8 (4.82%)
Mean duration of symptoms (in months)	22.873±20.47
Symptoms	
Dyspnea	144 (86.75%)
Fever	14 (8.43%)
Cough	12 (7.23%)
Chest pain	16 (9.63%)
Palpitation	16 (9.63%)
Peripheral edema	106 (63.86%)
Weight loss	10 (6.02%)
Abdominal distension	94 (56.62%)
History of heart failure	8 (4.82%)
History of Tuberculosis	60 (36.14%)
History of pericardiocentesis	28 (16.86%)
History of ascitic fluid tapping	8 (4.82%)
History of pleural tapping	24 (14.46%)
Signs	
Raised jugular venous pressure (JVP)	162 (97.59%)
Edema	68 (40.96%)
Ascites	88 (53.01%)
Hepatomegaly	34 (20.48%)
Splenomegaly	4 (2.41%)
Muffled heart sounds	18 (10.84%)
Pulsus paradoxus	10 (6.02%)
Pericardial knock	94 (56.62%)
Chest roentgenogram	
Calcification	42 (25.30%)
Pleural effusion	34 (20.48%)
Electrocardiogram	
Sinus rhythm	126 (75.90%)
Atrial fibrillation	8 (4.82%)
Atrial flutter	2 (1.20%)
Low voltage	30 (18.07%)
Echocardiography	
Pericardial thickening	132 (79.51%)
Pericardial effusion	6 (3.61%)
Respiratory variation	84 (50.60%)
Right ventricular dysfunction	6 (3.61%)
Left ventricular dysfunction	40 (24.09%)
Mitral regurgitation	2 (1.20%)
Cardiac catheterization	34 (20.48%)
Equalisation of diastolic pressure	32 (94.11%)
Dip plateau	30 (88.23%)
Computed tomography (CT scan)	144 (86.74%)
Pericardial thickening or calcification	134 (93.05%)
Pericardial effusion	4 (2.78%)
Normal	6 (4.16%)
Magnetic resonance imagining (MRI)	20 (12.04%)
Thickened pericardium	18 (90.0%)
Normal	2 (10.0%)
Mean central venous pressure (CVP) Pre-op (cm of H20)	19.94±6.08
Mean CVP Post-op (cm of H20)	8.73±3.06
Off pump	156 (93.97%)
On pump	10 (6.03%)
Mean ventilation time (in hours)	14.31±8.01

Chest roentgenograms (CXR) showed calcification in 42(25.30%) patients and pleural effusion in 34(20.48%) patients. Electrocardiogram (ECG) showed sinus rhythm in 126(75.90%) patients, atrial fibrillation in 8(4.82%) patients, atrial flutter in 2(1.20%) patients and low voltage QRS complex in 30(18.07%) patients.

Surgical Procedures

Total pericardiectomy was defined as removal of pericardium along with pericardial fat from the right phrenic to the left phrenic nerve with the superior and inferior extent being left innominate vein and the diaphragm respectively.

All patients underwent total pericardiectomy through midline sternotomy. The mean pre-operative central venous pressure (CVP) was 19.94±6.08 cm of H_20. The pericardium was freed in this order: first from the aorta and pulmonary artery, including the left ventricular outflow tract; then from the left and right ventricles and the left pulmonary vein orifices; and finally from the superior and inferior venae cava using either diathermy or by sharp dissection using scissors.

156(93.97%) patients underwent off pump total pericardiectomy. Ten (6.03%) patients underwent on pump total pericardiectomy. The mean cardio-pulmonary bypass(CPB) time was 56 minutes. Out of these 10 patients, four patients had a tear in right atrium while releasing the adhesions hence emergency CPB was established. In five patients, elective cardiopulmonary bypass was established as the pericardium was densely adhered. In one patient, there was injury to left anterior descending artery which was repaired with 8-0 polypropylene suture.

The mean post-operative CVP was 8.73±3.06 cm of H_20. The mean ventilation time was 14.31±8.01 hours. 6(3.61%) patients had low cardiac output syndrome. One patient had involuntary movements for which neurology opinion was taken and CT brain was done which was within normal limits hence, was managed conservatively. One patient had acute renal failure for which nephrology consultation was taken and was managed medically. One patient had high intercostal drainage(ICD) which was serous in nature for which the ICD tube was kept for long time and was removed on post-operative day (POD) 22.

One patient required prolonged ventilation for 28 days in view of poor respiratory efforts needing tracheostomy which was done on POD-8.

There were two in-hospital mortalities, one due to severe right ventricular dysfunction and one due to septicemia. (Table-2)

Table 2: Post-operative Complications

Low cardiac output	6(3.61%)
Acute renal failure	1(0.60%)
Involuntary movements	1(0.60%)
High ICD drainage	1(0.60%)
Death	2(1.20%)

Histopathological examination of the excised pericardial tissue (Table 3) showed tuberculous pericarditis in 86(51.81%) patients, chronic constrictive pericarditis in 76(45.18%) patients, purulent pericarditis in 2(1.20%) patient and viral pericarditis in 2(1.20%) patient.

Echocardiography (Table 4) at discharge was normal in 144(86.74%) patients, septal bounce was present in 10(6.02%) patients, moderate mitral regurgitation (MR) in 4(2.41%) patients, moderate tricuspid regurgitation (TR) in 6(3.61%) patients. All patients were discharged with diuretics.

Table 3: Histopathological Report

Tuberculous pericarditis	86(51.81%)
Chronic constrictive pericarditis	76(45.18%)
Purulent pericarditis	2(1.20%)
Viral Pericarditis	2(1.20%)

Table 4: Echocardiography At Discharge

Normal	144(86.74%)
Septal bounce	10(6.02%)
Moderate MR	4(2.41%)
Moderate TR	6(3.61%)

Post-operatively patients were followed up at 3 months and 12

months. The mean follow up of the patients was 9.7±1.1 months.

At 3 months follow up (Table 5), 154(92.77%) patients were in NYHA class I and 8(4.82%) patients were in NYHA class II. There were two (1.20%) mortalities within three months of discharge. Two patients had moderate tricuspid regurgitation but they were in NYHA class I. They were managed conservatively and had improved on further follow-up. Two (1.20%) patients were in atrial flutter and were managed medically. Four (2.41%) patients had superficial wound infection for which they were re-admitted and were managed with regular dressings and secondary closure was done.

At 12 months follow up (Table 6), 150(90.36%) patients were in NYHA class I and 12(7.22%) patients were in NYHA class II. Six (3.61%) patients had moderate tricuspid regurgitation in NYHA class II, Two (1.20%) patients had moderate tricuspid regurgitation and mitral regurgitation in NYHA class II. All these patients were managed conservatively with regular follow-up. Two (1.20%) patients were in atrial flutter and were managed medically.

Table 5: At 3 Months Follow Up

NYHA I	154(92.77%)
NYHA II	8(4.82%)
Moderate TR	2(1.20%)
Atrial flutter	2(1.20%)
Superficial wound infection	4(2.41%)

Table 6: At 12 Months Follow Up

NYHA I	150(90.36%)
NYHA II	12(7.22%)
Moderate TR	6(3.61%)
Moderate MR and TR	2(1.20%)
Atrial flutter	2(1.20%)

DISCUSSION

Inflammatory disorders of pericardium can be acute or chronic. Acute pericarditis which accounts for 5% of admissions for noncardiac chest pain, can occur as an isolated entity or as a manifestation of an underlying systemic disease. CP can occur as a sequel after an acute process or can be idiopathic in etiology. Amongst the idiopathic causes, cardiac surgery and mediastinal radiation therapy are the most common causes of chronic pericarditis [8].

Study done by Stefan C Bertog et al [5] concluded that the etiology of CP has an important impact on long-term survival. Their results proved the survival was excellent in the idiopathic and miscellaneous subgroups whereas in patients with postsurgical CP, survival was inferior to that of patients with idiopathic CP, but significantly better than that of patients with post-radiation constriction. Apart from etiology, the other independent predictors of overall survival included LV systolic dysfunction, age, creatinine, PAP and serum sodium. By using these parameters, it is possible to assess the outcomes after pericardiectomy for CP. Pericardial calcification was not an independent predictor of survival in this study [5].

Impairment of ventricular diastolic filling is the only important hemodynamic abnormality in patients with CP, although the constrictive effect of CP affects all four cardiac chambers and the intrapericardial portions of the cava and pulmonary veins. These two factors offer a plausible explanation for the pleural effusion, low stroke volume, edema, ascites, and engorged neck veins [9].

Tuberculosis is a proven cause for CP in developing countries and in our study 43(51.82%) patients had proven tuberculosis according to the histopathological findings. The disease most commonly occurred more frequently in third and fourth decade of life in our series similar to that reported by Bashi et al [9] and Levine [10]. In our study, the male to female ratio was 1.96:1 which is in variance with the ratio of 1:3 reported by Wood and 1:1 reported by Gupta and is similar to Bashi et al [9].

The diagnosis of CP remains a challenge and is achieved by echocardiography, computed tomography, magnetic resonance imaging, and cardiac catheterization. Pericardial thickness greater than 3 mm is usually confirmatory of a diagnosis of CP[11]. In our study, all the patients underwent echocardiography as the primary tool for diagnosis. All patients further underwent either a CT scan or MRI to confirm the diagnosis. Cardiac catheterization was only done in patients with heart failure.

CP after open-heart surgery was reported first in 1972 by Kendall [12]. The different approaches for pericardiectomy include left anterior thoracotomy, bilateral thoracotomy and median sternotomy. Median sternotomy was the surgical approach in all patients because it is safe, provides good exposure of the right atrium and the venae cava and enables satisfactory clearance of the diseased pericardium with minimal cardiac manipulation [13]. The mean pre-operative CVP in our patients was 19.94±6.08 cm of H_2O which reduced to 8.73±3.06 cm of H_2O post-operatively ($p<0.05$). In a study by Nilgun Bozbuga et al, the mean central venous pressure reduced from 14.0 ± 4.2 to 7.4 ± 2.1 mmHg ($P<0.004$) [14].

In some cases of CCP surgery, the importance of CPB is evident. If there is a calcific and thickened pericardial fragment without a cleavage plane, it can be left in place, can be waffle procedure [16] can be used; but if the surgeon wants to excise the thickened part, CPB can be established [13]. Also, if there is injury to the myocardium the use of CPB is evident.

In our study, there was one immediate post-operative mortality in view of severe right ventricular dysfunction one due to septicemia whereas one mortality within 90 days. At the end of 12 months all our patients were in NYHA class I or II. Hence total pericardiectomy is the surgical treatment of choice. Reoperations for recurrent constrictive pericarditis after partial pericardiectomy are common [15]. In a study by Chowdhury et al, 9 patients who underwent partial pericardiectomy required reoperation for recurrent symptoms, and 1 died of low cardiac output in the immediate postoperative period. In our study, no patients required re-operations and six patients had low cardiac output in the immediate post-operative period which was managed with inotropic supports and diuretics.

CONCLUSIONS

Tuberculous pericarditis is still the most frequent cause of CP in developing country like India, requiring total pericardiectomy. Echocardiography is the most common technique used to identify a physiologic pattern of restriction/constriction and CT is the most reliable technique to document a thickened or calcified pericardium. Total pericardiectomy via median sternotomy with or without the use of CPB is the surgical treatment of choice and should be performed as early as possible as it is associated with lower mortality, early normalization of hemodynamics, less postoperative low-output syndrome and better long-term survival.

List Of Abbreviations

CP: Constrictive pericarditis
CCP: Chronic constrictive pericarditis
CA: Pericardial calcification
HF: Heart failure
NYHA: New York Heart Association
JVP: Jugular venous pressure
CT: Computed tomography
MRI: Magnetic resonance imagining
CXR: Chest roentgenogram

ECG: Electrocardiography
CPB: Cardio-pulmonary bypass
CVP: Central venous pressure
ICD: Intercostal drainage
POD: Post-operative day
MR: Mitral regurgitation
TR: Tricuspid regurgitation

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