Original Article

Management of constrictive pericarditis: a comparative study between median sternotomy and left thoracotomy

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ABSTRACT

Objective: Constrictive pericarditis (CP) requires pericardiectomy but the choice of surgical approach remains controversial. Hence we have reviewed our experience of pericardiectomy carried out for CP and compared the results of pericardiectomy performed by median sternotomy versus left thoracotomy with regard to functional outcomes.

Methodology: The study group consisted of 33 patients with CP who underwent pericardiectomy from May 1999 to January 2010 at our institution. There were 22 female and 11 male patients, ranging in age from 5 to 57 years with a mean age of 45 years. Pericardiectomy was performed via median sternotomy in 17 patients (Group A). In the remaining 16 patients (Group B), pericardiectomy was performed via a left anterolateral thoracotomy in the fifth intercostal space.

Results: During the subsequent follow-up, both groups of patients showed a similar and significant improvement in New York Heart Association (NYHA) functional class. In the group A, the mean NYHA functional class decreased from 3.3 ± 0.7 to 1.8 ± 0.5 (P = 0.0004). In group B, the mean functional class decreased from 3.2± 0.9 to 1.6 ± 0.6 (P = 0.00005). Also, both groups had a similar and significant improvement in their mean CVP. In the group A, the mean central venous pressure (CVP) decreased from 15.2±3.1 mmHg to 8.3±3.2 mmHg (P<0.005). In the group B, the mean CVP decreased from 15.1±4.9 mmHg to 7.7±2.4 mmHg (P<0.004).

Conclusion: Constrictive physiopathology is a problem primarily of the ventricles and can be alleviated by decorticating both the right and left ventricles. Therefore, CP could be relieved through the left thoracotomy or median sternotomy in most cases. However, echocardiographic findings should be considered to prefer thoracotomy or sternotomy approach.

KEY WORDS: Constrictive Pericarditis, Median Sternotomy, Thoracotomy.

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INTRODUCTION

Constrictive pericarditis (CP) is the end result of a chronic inflammatory process that leads to progressive pericardial fibrosis encasing the heart in a thickened and fibrotic pericardium with limitation of diastolic ventricular filling.[1,2] However, in atypical forms, cardiac constriction may develop with a pericardium that is normal in thickness.[3] The cause is idiopathic in the majority of cases, and in some cases, it includes acute pericarditis, infection, malignancy, radiation, rheumatoid disease, trauma, and previous cardiotomy.[4] The dense adhesions between the visceral and parietal pericardium prevent normal diastolic filling and function of the ventricles, leading to venous congestion and diminished cardiac output.[5] These hemodynamic abnormalities appear clinically as exertional dyspnea, fatigue, peripheral edema, jugular vein distention, hepatomegaly, and ascites.[6] However, its definitive diagnosis is

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difficult. Echocardiography, computed tomography and magnetic resonance imaging are useful diagnostic modalities. Additionally cardiac catheterization may be used, if required. Echocardiography remains the diagnostic modality of choice.

Although medical treatment may temporarily alleviate the symptoms of heart failure, patients with CP do not recover well without pericardiectomy.[7] Definitive management requires pericardial decortication. Also, with the current operative techniques and perioperative management, most patients with CP can undergo pericardiectomy safely and expect long-term relief of symptoms and improvement in functional class and survival.[8]

The approaches described for pericardiectomy include left anterolateral thoracotomy, median sternotomy, a U incision with the base of U lying at the sternal border and bilateral thoracotomy. Of all the approaches median sternotomy and left anterolateral thoracotomy approaches are widely used.[2] Despite experience spanning over 60 years the choice of surgical approach remains controversial. However, good results have been reported using different surgical approaches.

In this study, we have reviewed our experience of pericardiectomy carried out for CP and compared the results of pericardiectomy performed by median sternotomy versus left thoracotomy with regard to functional outcomes.

METHODOLOGY

The study group consisted of 33 patients with CP who underwent pericardiectomy from May 1999 to January 2010 at our institution. There were 22 female and 11 male patients, ranging in age from 5 to 57 years with a mean age of 45 years. The decision for the surgical approach was dependent on the surgeon's preference & echocardiographical findings.

Three patients had undergone subxiphoid drainage one month, three months and one year, respectively before the decortication. Also, one patient had undergone right thoracotomy, pleural decortication and pleuropericardial window 15 days before the pericardiectomy via median sternotomy. Patients requiring additional surgical procedures (mitral valve replacement or coronary artery bypass surgery) were excluded from the study.

Pericardiectomy was performed via median sternotomy in 17 patients (Group A). After sternotomy, the pericardium was inspected and palpated to determine a relatively soft and uncalcified area. The thymus and pleural reflection was mobilized laterally to obtain a wide width of pericardium. The pericardium was decorticated 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 caval veins. During these steps, the thickened pericardium was carefully incised using cautery (under 40 mV) until the epicardial fat tissue was located. This underlying fat tissue often bulges through the incision. The incision was extended and cleavage plane between the pericardium and epicardium was established. This plane is almost avascular and superficial to the visceral pericardium. When calcified plaques penetrating the myocardium were found, we left behind islands of calcified pericardium. Both pleural spaces were entered to optimize the visualization of the right and left phrenic nerves. To prevent damage to phrenic nerves, the entire anterior pericardium was decorticated within 2-3 cm of the phrenic nerves, and then completed the dissection of the pericardium from the diaphragm. Cardiopulmonary bypass (CPB) was kept on standby.

Pericardiectomy was performed via a left anterolateral thoracotomy in the remaining 16 patients (Group B). The left anterolateral thoracotomy was performed through the fifth intercostals space with the patient tilted slightly to the right. The left lung was covered with wed sponge and was retracted posteriorly. The left phrenic nerve was identified and the pericardium freed from the diaphragm and the sternum. Then, two full-length longitudinal parallel incisions were performed anterior and posterior to the left phrenic nerve. Multiple stay sutures were then placed on the incised edges to achieve adequate exposure for decortication. The pericardium was decorticated from the underlying myocardium with sharp dissection over the left ventricle, right ventricle, pulmonary artery and aorta. Finally decortication was achieved along with pulmonary veins, and anteriorly as far as possible on the right atrium.

Patients with tuberculosis pericarditis were given anti-tuberculosis therapy for at least two months before the pericardiectomy and full course was completed during the follow-up period. Patients with normal renal function were administered oral angiotensin-converting enzyme inhibitors before weaning from inotropic agents. All specimens sent for histological and microbiological analyses.

The data are expressed as the mean ± the standard deviation from the mean. Students t test or χ^2 was used for statistical analysis and a P value of less than or equal to 0.05 was accepted as being statistically significant.

RESULTS

The most frequent complaints were exertional dyspnea in 31 patients, fatigue in 22, chest pain in 13, palpitation in 10 and fever in 8 (Table-I). In 11 patients, auscultation revealed a pericardial knock sound. Physical examination further revealed jugular venous distention in 32 patients, ascites in 16 patients, peripheral edema in 14 patients, and hepatomegaly in 13 patients. Laboratory results showed hypoproteinemia and hypoalbuminemia in all patients. The median duration of symptoms was 10 (range 2-45) months.

Diagnosis was confirmed by echocardiography in 31 patients. Cardiac catheterization and magnetic resonance imaging were performed in the remaining two patients. Pericardial calcification was found in 16 patients. The cause of the CP was tuberculosis in 12 patients, idiopathic etiology in 12, rheumatic fever in two, uremia in one, and infection in six (streptococcus four, staphylococcus 2).

In median sternotomy group, non-fatal intraoperative complications affected two patients; intraoperative bleeding occurred in one patient due to laceration of the superior caval vein and in one due to laceration of right ventricle. They were successfully repaired without CPB.

Postoperative complications were arrhythmia in 6 patients, atelectasia in 5, low cardiac output in 2, wound infection in one, and acute renal failure in one (Table-II). During the subsequent follow-up, both groups of patients showed a similar and significant improvement in New York Heart Association (NYHA) functional class. In the group A, the mean NYHA functional class decreased from 3.1 ± 0.7 to 1.8 ± 0.5 (P = 0.0004). In group B, the mean functional class decreased from 3.2± 0.9 to 1.6 ± 0.6 (P = 0.00005). Although both groups had a significant improvement in their functional condition, the degree of improvement was not significant between the both groups (P=0.62). Both groups had a similar and significant improvement in their mean central venous pressures (CVP). In the group A, the mean (CVP) decreased from 15.2±3.1 mmHg to 8.3±3.2 mmHg (P<0.005). In the group B, the mean CVP decreased from 15.1±4.8 mmHg to 7.7±2.4 mmHg (P<0.004).

Table-I: Preoperative symptoms and signs of CP.

Symptoms or Signs	*N*	*%*
Exertional dyspnea	31	94
Fatigue	22	66.6
Chest pain	13	39.4
Palpitation	10	30.3
Fever	8	24.2
Jugular vein distension	32	97
Ascites	16	48.5
Hepatomegaly	13	39.4
Cardiomegaly	12	36.3
Peripheral edema	14	42.4
Pericardial knock sound	11	33.3
Friction rub	6	18
Icterus	2	6.1

Histopathology: The histological examination was focally abnormal consistent with constrictive pericarditis in all cases including two cases with normal pericardial thickness. During a median follow-up of 2.6 years, there was one late death due to progressive congestive heart failure 22 months after pericardiectomy.

DISCUSSION

The description of CP designated as concretio cordis dates back more than 300 years.[3] The clinical table of CP was first described in 1842 by Cheever. He reported that the dangerous symptoms arose chiefly from the compression of muscle tissue by sticky material that surrounded the heart.[9] In 1898 DeLorme conceived the idea that pericardial resection for constrictive pericarditis might be feasible. Then, Churchill performed the first successful pericardiectomy in 1928. Subsequently several different operative techniques and approaches have been described.[1]

During decortication monitoring of intracardiac pressures have no prognostic value because further recovery of myocardial failure may occur late after pericardiectomy.[8] Therefore, in this series we have not used monitoring of intracardiac pressures during operation.

Table-II: Postoperative complications.

Postoperative complications	*Group 1*	*Group 2*	*Total*
Arrhythmia	3	3	6
Atelectasia	3	2	5
Low cardiac output	1	1	2
Wound infection	1	0	1
Acute renal failure	1	0	1
Total	9	6	15

The two most frequently used surgical approaches for the pericardiectomy are median sternotomy and left anterolateral thoracotomy. Tiruvoipati et al[2] were able to achieve a good functional result with adequate pericardiectomy through either of the two approaches.

The median sternotomy incision enables exploration of the left ventricle and right part of the heart and direct vision of the great vessels,[9] and sternotomy allows extensive pericardial decortication using CPB. In the event of inadvertent excessive bleeding, the patient could easily be connected to CPB.[10] Miller et al[11] suggested that all cases of CP should be approached through a median sternotomy with CPB on standby. Copeland et al[12] first reported the use of CPB for pericardiectomy. Taminaga et al[13] reported that pericardiectomy using CPB was a safe method for removing calcified pericardium. CPB aids in the surgical dissection by emptying the ventricular cavities to define clearly the appropriate plane of dissection, and facilitates the management of inadvertent iatrogenic heart injury.[1] In this series, we have not used CPB. We believe that its routine use during pericardiectomy is not indicated. It should be employed only in special circumstances.[10] In patients with CP caused by mediastinal irradiation, CPB is necessary because of severe attachments.[9]

From an anatomical perspective, while access to the mediastinum through a median sternotomy offers more radical exposure of the heart,[14] its only drawback is that it does not give good exposure of the left ventricle when the heart is large.[15] On the other hand, the left anterolateral thoracotomy offers excellent exposure of the anterolateral and inferior aspects of the left ventricle with minimal manipulation and retraction of the heart. Almost the entire pericardium as far as the left side of the inferior vena cava, except for a small part covering the right atrium, can be removed through a left thoracotomy.[5] Additionally, left anterolateral thoracotomy should be suggested for purulent pericarditis to avoid sternal infection.[10,16] We have preferred left thoracotomy incision in the setting of purulent pericarditis.

Although left thoracotomy permits easier and more complete left ventricular pericardiectomy, but is less safer when severe calcifications involve the right ventricle and atrium. The main drawbacks of the left thoracotomy approach are limitations in visualization and safe performance of radical pericardiectomy at the right atrium and the vena cava and difficulty in controlling bleeding at these sites.[5] However, fatal bleeding caused by a tear in the right atrium or the caval veins during operation performed by left anterolateral thoracotomy has been reported but is not encountered commonly.[2] Also, avoiding excessive surgical efforts to decorticate them may prevent excessive bleeding[14] Furthermore, these inadvertent tears could be repaired, if occurred. Also, femoral cannulation can be achieved, if required.

Although constrictive effect of CP affects all four cardiac chambers and the intrapericardial portion of the cavae and pulmonary veins, the only important hemodynamic abnormality that is consistent is impairment of ventricular diastolic filling.[5] Also, Viola[17] suggested that resection of the pericardium overlying the right atrium and the great veins are not essential. Therefore, the right atrium and great veins are freed only if a good cleavage plane is found, for complete decortication of the right atrium and great veins is not necessary for therapeutic success.[15]

The variety of patient's presentations can make comparisons between study populations difficult.[18] The identification of variables that may help predict a patient's long-term prognosis may also help surgeons select which patients will benefit most from operative intervention.[18] Left thoracotomy permits easier and wider access to the left ventricle,[14] but is less safe when severe calcifications involve the right ventricle and atrium.[5]

Approximately 18% of patients had normal pericardial thickness in spite of surgically and histopathologically proven CP, confirming that CP can occur in patients with normal pericardial thickness and that pericardiectomy should not be denied on the basis of normal pericardial thickness when all other features indicate constriction.[19] Indeed, two CP patients (6.6%) had normal pericardial thickness in this series.

Myocardial atrophy after prolonged constriction, residual constriction or a concomitant myocardial fibrosis can lead to prolonged cardiac failure in spite of successful pericardiectomy.[20] Also, constrictive epicardial sclerosis has been incriminated as a causative factor of delayed recovery or persistent hemodynamic abnormalities after pericardiectomy.[10]

In this study, despite total pericardiectomy, one patient (median sternotomy group) died due to persistent hemodynamic abnormalities 22 months after operation. We think that his persistent hemodynamic abnormalities after operation were due to myocardial fibrosis and atrophy. Therefore, when the diagnosis of CP is confirmed, pericardiectomy should be performed early in an effect to prevent myocardial fibrosis and atrophy, because long periods of myocardial compression may contribute to remodeling

of the ventricles with fibrous invasion of the myocardium and atrophy of myocardial fibers. These chronic changes prevent positive impact of decortication.

CONCLUSION

Constrictive physiopathology is a problem primarily of the ventricles and can be alleviated by decorticating both the right and left ventricles (biventricular pericardiectomy).[21] Therefore, we suggest that CP could be relieved through the left thoracotomy or median sternotomy in most cases. However, echocardiographic findings should be considered to prefer thoracotomy or sternotomy approach, as was done in this series. In calcified cases involving the anterolateral and inferior aspects of the left ventricle, left thoracotomy may be preferred. Also, left thoracotomy may be preferred in the setting of purulent pericarditis to avoid sternal infection. Conversely, in calcified cases involving the right ventricle and atrium, median sternotomy should be preferred.

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