Pericardiectomy for Chronic Constrictive Pericarditis via Left Anterolateral Thoracotomy

Ujjwal K. Chowdhury, MCh, Diplomate NB,* Sandeep Seth, DM, † and Srikrishna M. Reddy, MS*

Chronic constrictive pericarditis is the end stage of a chronic inflammatory and noninflammatory process that results in a thick, fibrotic constricting, and sometimes calcific, pericardium.1-4 Modern series from the third world countries document tuberculosis in 38 to 89% of all cases of constrictive pericarditis and cases are increasing due to the emergence of drug-resistant tuberculosis in association with acquired immunodeficiency syndrome.2-9 The advent of antitubercular chemotherapy has brought down the mortality for tuberculous pericarditis from 90% to about 40%.2-9

The pathophysiologic hallmarks of constrictive pericarditis result from loss of pericardial compliance. This pericardial inflexibility results in dissociation of intrathoracic and intracardiac pressures with respiration, expiratory reduction of flow velocity in venae cavae, increased hepatic venous diastolic flow reversal, decreased transmural flow velocity, impaired diastolic filling, and heart rate.10

The literature is rife with examples of patients with constrictive pericarditis treated by pericardiectomy by either left anterolateral thoracotomy or median sternotomy.1-15 Despite the effectiveness of surgical therapy for the treatment of constrictive pericarditis, there are disparate opinions regarding the role of corticosteroids in the treatment of tuberculous pericarditis, the timing of operation, the issue of surgical approach, extent of decortication, and the requirement for cardiopulmonary bypass.1-15

The problems of perioperative diagnostic error also have not been adequately addressed in the surgical literature, despite known difficulties in differentiating patients with restrictive cardiomyopathy from those with constriction.16,17 The association of characteristic hemodynamic changes with pericardial thickness more than 3 mm is usually confirmatory. Constrictive pericarditis is generally considered to be hemodynamically significant when there are clinical features of constriction with supportive echocardiographic and hemodynamic criteria.1-17

Computed tomography and magnetic resonance imaging (MRI) are performed selectively to identify the pericardial thickness, a hallmark of the disease.18,20 In one study, MRI was found to be 88% sensitive and 100% specific, with a diagnostic accuracy of 93%.39 Patterns of left ventricular diastolic filling on radionuclide ventriculography have also been used to diagnose constriction.21,22 Generally, a combination of available diagnostic modalities, if judiciously used, may obviate the need for diagnostic exploratory thoracotomy or endomyocardial biopsy.1-22

Early pericardiectomy has been advocated after the clinical symptoms and diagnosis have been confirmed before severe constriction (and myocardial atrophy) occurs.1-15 The extent of pericardiectomy necessary for chronic constrictive pericarditis has also been debated. The terms “radical,” “total,” “extensive,” “complete,” “subtotal,” “adequate,” “near-total,” and “partial” pericardiectomy also have been variably used in the literature to describe the procedure to be performed, often without precise definition of the limits of the pericardial resection.1-15

Published reports attest to the unpredictable and variable pattern of constrictive pericarditis and lend support to radical decortication.4,11-15 We attempted to define total pericardiectomy when a patient had wide excision of the pericardium over the anterolateral and diaphragmatic surfaces of both ventricles with intact phrenic pedicles and over the great vessels including the intrapericardial portion of the vena cava–right atrial junctions.4 Failure to decorticate the anterolateral and diaphragmatic surfaces of both ventricles does lead to less than the optimal result and the term “partial pericardiectomy” probably should be reserved for such incomplete resections.4 Second, the importance of unrecognized constricting epicardial (visceral pericardial) peel was described by Harrington in 1944 and successful pericardiectomy requires decortication of the ventricular epicardium and relief of all constricting layers.23 In one study, pressure-volume loops were monitored intraoperatively during pericardiectomy for constrictive pericarditis. The intraoperative normalization of the pressure-volume loop was used as an indicator of operative success.24

*Department of Cardiothoracic Surgery, All India Institute of Medical Sciences, New Delhi, India.
†Department of Cardiology, All India Institute of Medical Sciences, New Delhi, India.
Address reprint requests to Ujjwal K. Chowdhury, M.Ch, Diplomate NB, Additional Professor, Department of Cardiothoracic and Vascular Surgery, All India Institute of Medical Sciences, New Delhi 110029, India. E-mail: ujjwalchow@rediffmail.com
The operative approach used by Churchill25 and later by Harrington23 is now of historical interest. The choice among median sternotomy, left anterolateral thoracotomy and bilateral anterior thoracotomy appear to be one of personal preference.1-15 Generally, the median sternotomy approach allows a more radical clearance of pericardium overlying the right atrium and veins cavae, but these areas are of little hemodynamic significance in the majority of patients.4,11-15

The disadvantages of the median sternotomy approach include the requirement of excessive manipulation of the heart to permit complete decortication of all surfaces of the left ventricle, particularly the diaphragmatic surface.5,6,11 Copeland and associates advocated median sternotomy approach in all cases of chronic constrictive pericarditis undergoing pericardiectomy because they used cardiopulmonary bypass in all cases of pericardiectomy.13

Analysis of the published literature substantiates the lack of specific physiologic and/or hemodynamic criteria that can be used in deciding an optimal approach for a given patient.1-3,5-15 In our earlier publication, we had attempted to compare two surgical approaches for pericardiectomy, clinically, echocardiographically, and hemodynamically.4 We demonstrated the operative approach for pericardiectomy, although mostly based on surgeons’ preference, the maximum benefit for constrictive pericarditis, in particular, is expected from total pericardiectomy. In our center, the median sternotomy approach was the preferred option in the following clinical subset of patients: (1) annular constrictive pericarditis; (2) calcific pericardial patch compressing the right atrium and right ventricular outflow tract; (3) extracardiac intrapericardial mass; (4) presence of a 2-mm or greater gradient between ventricular outflow tract; and (5) constriction after previous open heart surgery; and (6) recurrent constrictive pericarditis after partial pericardiectomy.4

We concur with the observations of the other investigators that cardiopulmonary bypass is not a necessary adjunct for “total” pericardiectomy and should be employed only in special circumstances, namely, (1) inadvertent damage to a cardiac chamber; (2) those who have had a previous cardiac operation, or a previous incomplete pericardiectomy; (3) presence of calcific pericardial “cocoon” encompassing all cardiac chamber; and (4) presence of a coexistent cardiac lesion that requires correction.1,11

Despite experience spanning over 50 years, there is no foolproof formula in the published literature that can be used in deciding an optimal surgical approach for a given patient.1-15 Literature documents clear anecdotal cases of pericardiectomy for constrictive pericarditis by either left anterolateral thoracotomy or median sternotomy approach.1-15 The published literature also substantiates the lack of ventricular diastolic distensibility as the primary pathophysiologic hallmark of chronic constrictive pericarditis in the majority of cases.10

Left anterolateral thoracotomy offers excellent exposure of the anterolateral and diaphragmatic aspects of the left ventricle with minimal manipulation and retraction of the heart.1,3,8,11 If necessary, the incision can be easily extended across the sternum and to the right side of the chest. Although this approach allows greater exposure and thus resection of the pericardium overlying the left ventricle, it is indeed less desirable when the right side is extensively involved.4

The literature does not specifically address the choice of surgical approach in the setting of bacterial pericarditis. In our experience, a left anterolateral thoracotomy was the preferred approach in cases of purulent pericarditis and effusive-constrictive pericarditis. Thoracotomy was the preferred option in these patients because of the presence of concomitant pyothorax and the concerns of sternal infection. It was possible to achieve total pericardiectomy in these patients because of loculations and poorly formed fibrinous adhesions, which could be easily peeled off.4

The Operation

The Incision

The left anterolateral thoracotomy is performed using a submammary incision and opening the chest through the fourth or fifth intercostal space with the patient tilted slightly to the right (Fig. 1).

Surgical Anatomy

The left lung is covered with a wet sponge and is retracted posteriorly. This approach gives good access to the left ventricle and left atrium and allows easy identification and preservation of the left phrenic nerve. Access to the right ventricle, right atrium, and veins cavae is difficult with this approach and can be achieved with certainty and safety either by extending the incision across the sternum and ligating and dividing both sets of internal thoracic vessels or by employing several technical modifications as stated below.

Using these modifications, it is possible to achieve excision of the pericardium until the right atrioventricular groove, the entire diaphragmatic pericardium, and the portion of the pericardium posterior to the phrenic nerve until the left-sided pulmonary veins.

If there is inadvertent damage to any of the cardiac chambers during pericardial resection and cardiopulmonary bypass is required to gain control, conventional arteriovenous cannulations may be impossible with this approach. Thus, it is desirable to have both groins surgically prepared and draped so that femoro-femoral bypass can be instituted, if needed.

Although the median sternotomy approach gives good access to the right ventricle, right atrium, and great vessels, including the cavo-right atrial junctions, it is impossible to excise the portion of the pericardium posterior to the phrenic nerve using this approach.

Identification and Isolation of Left Phrenic Pedicle

Two full-length longitudinal parallel incisions are employed 0.5 cm anterior and posterior to the phrenic nerve and extended until the level of the pulmonary artery is superiorly and the diaphragm is inferiorly placed. Multiple stay sutures are then placed in the pericardium to achieve adequate exposure. The length of the incisions is
Figure 1. Intraoperative views of the steps of total pericardectomy via left anterolateral thoracotomy. The chest is opened through the 4th intercostal space. n. = nerve.
Figure 2 Two full-length parallel incisions are made 0.5 cm anterior and posterior to the left phrenic nerve and extended until the level of the pulmonary artery superiorly and the diaphragm inferiorly. Multiple silk stay sutures are placed on the incised edges to achieve adequate exposure. n. = nerve.
Figure 3 Dissection of the pericardium posterior to the phrenic nerve. Posteriorly, the pericardium is gently dissected from the posterolateral surface of the left ventricle and left atrial appendage. The posterior pericardium is subsequently divided to facilitate adequate mobilization until the levels of left-sided pulmonary veins and excised. \( n \) = nerve.
deepened gradually until the epicardium (visceral pericardium) is reached (Fig. 2). The cautery is set at 8 to 10 mV during the process of dissection to avoid ventricular fibrillation. The thickened pericardium is dissected over the left ventricle, right ventricle, pulmonary artery, and aorta, in that order. Loculated pus pockets may be encountered at this or subsequent stages of the dissection. If pus is present, it is sent for culture for pyogenic and acid fast bacilli.

**Specific Useful Maneuvers to Achieve Total Pericardiectomy via Left Anterolateral Thoracotomy**

**Dissection of the Pericardium Posterior to the Phrenic Nerve**
Posteriorly, the pericardium is gently dissected from the underlying left atrium and posterolateral surface of the left ventricle. The pericardium is subsequently divided in the midline in between stay sutures to facilitate easy and adequate mobilization until the level of left-sided pulmonary veins. Thereafter, the posterior pericardium is excised (Fig. 3).

**Dissection of the Pericardium Anterior to the Phrenic Nerve**
Anteriorly, the incised pericardial edge is held in between stay sutures and is mobilized from the anterolateral surface of the right ventricle and pulmonary artery (Fig. 4).

**Mobilization and Isolation of the Left Phrenic Pedicle**
At this stage the left phrenic pedicle along with the accompanying vessels is gently dissected from the underlying left ventricle and pulmonary artery and two vascular loops are passed around the same for atraumatic traction during mobilization (Fig. 5).

**Development of a New Dissection Plane Between the Sternum and the Anterior Surface of the Pericardium**
Using cautery dissection, a new plane is made to develop within the soft tissue between the sternum and anterior surface of the pericardium to extend the area of pericardial excision. A right-angled retractor may be placed under the posterior surface of the sternum to achieve adequate mobilization of the pericardium (Fig. 6).

**Division of the Anterior Pericardium in Two Halves**
The anterior portion of the pericardium similarly is divided into two halves in between stay sutures and the thickened pericardium including epicardium is dissected off the pulmonary artery and right ventricle, until the right atrioventricular groove (Fig. 7).

**Development of a New Cleavage Plane Between the Diaphragmatic Pericardium and Diaphragm**
Inferiorly, a cleavage plane is made to develop between the diaphragm and thickened pericardium all along its length. Subsequently, the diaphragmatic surface of the right ventricle including the left ventricular apex is completely freed.
from the underlying pericardial adhesions (Fig. 8). Special care is taken to avoid prolonged hypotension during the process of dissection. After the cardiac chambers are freed off the underlying adhesions, the entire width of diaphragmatic pericardium is excised in toto.

All constricting epicardial layer is peeled off from the cardiac chambers and great vessels (Fig. 9).

**Conclusions**

Between 1985 and 2004, 395 (276 males) patients underwent pericardiectomy for constrictive pericarditis. In 300 (75.9%) patients, pericardiectomy was performed through a median sternotomy; in 95 (24.1%) pericardiectomy was performed through a left anterolateral thoracotomy. The detailed clinical, echocardiographic, and hemodynamic evaluation of the two surgical approaches was published in our previous publication.4

We demonstrated that total pericardiectomy is associated with lower perioperative and late mortality and confers significant long-term advantage by providing superior hemodynamics that appear to be independent of the etiology of constrictive pericarditis.9

Since our last publication, between January 2005 and September 2007 an additional 40 patients underwent pericardiectomy for constrictive pericarditis either via median sternotomy (n = 15) or via left anterolateral thoracotomy (n = 25).

In an attempt to perform total pericardiectomy via left anterolateral thoracotomy, we have introduced several technical modifications of pericardial excision as enumerated above. Using these modifications, it was possible to achieve total pericardiectomy via left anterolateral thoracotomy, particularly removing the constricting pericardium over the anterolateral, diaphragmatic surfaces of left ventricle and the anterior and diaphragmatic surfaces of the right ventricle until the right atrioventricular groove.

Although the surgical approach for pericardiectomy is based on surgeon preference, left anterolateral thoracotomy is the preferred and noncontroversial approach in the setting of purulent pericarditis and effusive constrictive pericarditis.4 It is possible to achieve total pericardiectomy in these patients because of loculations and poorly formed fibrinous adhesions that can be easily peeled off. Median sternotomy approach with or without cardiopulmonary bypass may be specifically suited for constrictive pericarditis with calcific patches, pericardial masses, reoperations, and calcific pericardial “cocoon” and for those with predominant right-sided and annular involvement.4

---

**Figure 5** The left phrenic pedicle containing the phrenic nerve and accompanying vessels is gently dissected from the underlying left ventricle and pulmonary artery and two vascular loops are passed around it for atraumatic traction.
Using cautery dissection, a new plane is developed between the posterior surface of the sternum and anterior surface of the pericardium to extend the area of pericardial excision. APF = anterior pericardial flap; RV = right ventricle.
Figure 7 The anterior pericardial flap is divided into two halves between stay sutures and the thickened pericardium, including the epicardium, is excised until the right atrioventricular groove. APF = anterior pericardial flap; D = diaphragm; DP = diaphragmatic pericardium; RV = right ventricle.
Figure 8 Using cautery, a new cleavage plane is made to develop between the diaphragm and thickened diaphragmatic pericardium all along its length. The diaphragmatic surface of the right ventricle including the left ventricular apex is completely freed from pericardial adhesions. Subsequently, the entire width of diaphragmatic pericardium is excised in toto. APF = anterior pericardial flap; D = diaphragm; DP = diaphragmatic pericardium; RV = right ventricle; LV = left ventricle.
Figure 9 Intraoperative pictures of the decorticated heart with an intact phrenic pedicle. LAA = left atrial appendage; LV = left ventricle; n. = nerve; PA = pulmonary artery; RV = right ventricle. (Color version of figure is available online at http://www.optechtcs.com.)
References