The Influence of Pericardiectomy on the Hemodynamics of Chronic Constrictive Pericarditis

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SUMMARY

Preoperative and postoperative right heart catheterizations were performed on six patients with chronic constrictive pericarditis. Before surgery the patients characteristically showed distinct elevation of right ventricular end-diastolic, pulmonary arterial and wedge pressures. During the operation, right and left ventricular pressure curves were recorded both before and after pericardial resection. Before decortication, the average values of end-diastolic pressures for the right and left ventricles were 17 and 20 mm Hg respectively. No significant changes were observed after pericardiectomy was completed. However, all patients showed excellent clinical recoveries. Postoperative catheterizations performed two to five months after operation disclosed normal intracardiac pressures.

Persistent impairment of ventricular performance in the early period after pericardiectomy must be attributed to a reversible myocardial failure.

Additional Indexing Words:

Cardiac catheterization
Intraoperative pressure measurements
Restoration of normal intracardiac pressure
Preoperative and postoperative hemodynamics
Ventricular end-diastolic pressure
Myocardial failure

THE CHARACTERISTIC clinical picture of chronic constrictive pericarditis is caused primarily by restriction of ventricular filling.[1] After pericardiectomy most patients improve clinically and their hemodynamic readings return to normal.[2-5] However some authors have found that the abnormal pressures may persist for as long as two and one-half years after operation.[6] These findings have been largely ascribed to incomplete decortication, although the possibility of irreversible myocardial changes has also been discussed.[7-9]

This paper reports the clinical features and the hemodynamic studies made preoperatively and postoperatively in six patients with chronic constrictive pericarditis who have undergone pericardial resection. Intraoperative studies measured right and left ventricular pressures prior to decortication and after pericardiectomy had been completed.

Methods

Six patients, three males and three females, ranging in age from 19 to 53 years, were studied. At the time of hospital admission, chronic constrictive pericarditis was diagnosed in all subjects on the basis of the case history, a physical examination, radiologic studies, electrocardiograms, and cardiac catheterization. This diagnosis was confirmed at surgery.

Patients were studied several days before the operation and two to five months after operation by right heart catheterization. Brachial, arterial, and mixed venous blood samples were analyzed for O_2 and CO_2 by the manometric method of van Slyke and Neill[10] and pH was determined with a Beckman pH meter. The carbon dioxide tension was calculated using the Henderson-Hasselbalch equation. Measurements were made of venae cavae, right atrium, right ventricle, pulmonary artery, wedge, and systemic artery pressures. Cardiac output was also measured, using the direct Fick method. Pressures were measured and recorded on a Statham P23Db transducer and a Sanborn direct-writing recorder.

At surgery, in order to achieve a complete decortication, either a transpleural, transsternotomy incision, or a midline sternal splitting incision was employed. In all cases both ventricles and the corresponding atrioventricular grooves were freed. Resection of the scar overlying the right atrium and the venae cavae was considered not essential and was done only if a good cleavage plane could be found. During operation, right and left intraventricular pressures were measured. The pressure curves were obtained by puncture of the heart wall with a 18-gauge thin-walled cannula with a pointed stylet and recorded on a direct-writing oscillograph utilizing a Statham P23Db transducer.

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Received April 26, 1973; revision accepted for publication June 20, 1973.

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Results

At the time of the initial examination all patients showed symptoms of dyspnea, neck vein distention when sitting, hepatomegaly, ascites, and slight ankle edema. In five of the six patients constriction had been evident for between six months to one year. One (G.M.) presented signs of congestive heart failure which pericardiectomy carried out five years earlier had failed to relieve. In all patients the chest roentgenograms showed normal cardiac size or slight cardiomegaly but in one (G.M.) dense calcification of the pericardium was present. The electrocardiograms showed universally low or slightly inverted T waves. Atrial fibrillation was recorded in the electrocardiogram of G.M.

Tuberculous etiology was suspected in two patients on the basis of histologic evidence from the pericardium. One patient showed widespread pericardial adhesions and multiple hydatid cysts. Etiology was unknown in the remaining subjects. Dense pericardial fibrosis with minimal inflammation was found in three, and the pericardium of the other showed extensive calcification, as stated above.

Table 1 summarizes the clinical data.

Blood gas levels and pH were within normal range. The cardiac index was higher postoperatively in four patients although the preoperative average for the group (3.14 liters/min/m^2) was in the normal range.

Preoperatively, the mean right atrial pressure was abnormally high, averaging 17 mm Hg. No gradient was observed between the right atrial and cavae pressures. The right ventricular systolic pressure, mean pulmonary artery, and wedge pressures were elevated in all cases. The average values were 42, 30, and 20 mm Hg, respectively. The pressure curves from the right ventricle showed the typical morphology with the early diastolic dip followed by a rapid rise to a plateau.

At the time of operation, pressures from the right and left ventricle were measured prior to pericardial resection and following complete pericardiectomy. The tracings registered before decortication revealed end-diastolic pressures averaging 17 and 20 mm Hg for the right and left ventricle respectively. Changes in the intraventricular pressure curves were insignificant or absent after pericardiectomy was completed (fig. 1). For the first two days after operation all patients showed values of central venous pressure similar to those found before operation. Between the second and fourth day, in all patients but one (H.C.), systemic venous pressure started to decrease steadily, and reached normal levels within four weeks after operation. One patient (H.C.) maintained high values (about 20 cm H_2O) for 15 days. Then she began to improve markedly and venous pressure returned to normal one month after operation. Postoperative cardiac catheterization performed two to five months after surgery showed satisfactory hemodynamic correction in all patients. In addition, they were free of cardiac symptoms and leading normal lives.

The results of hemodynamic studies are given in tables 2 and 3.

Discussion

It has been suggested that a long active period before operation negatively influences the achievement of a return to a normal hemodynamic state after pericardiectomy.[9] Five of our six patients had a relatively short history of constriction, having had symptoms for a year or less. One required a second operation because of failure to improve despite a previous pericardiectomy performed five years earlier. In this patient, persistence of symptoms of abnormal right heart pressures was attributed to imperfect pericardiectomy, which was confirmed at the second operation.

All patients exhibited excellent clinical recoveries when examined two to five months after surgery.

Table 1

Clinical Data

Patients	Age (yr)	Sex	Duration of illness preop.	Rhythm	Pericardial pathology
1 G.M.	47	M	6 years	AF	Fibrosis, calcification
2 E.C.	53	F	1 year	NSR	Fibrosis, no inflammation
3 J.M.	28	M	1 year	NSR	Fibrosis, no inflammation
4 H.C.	22	F	9 months	NSR	Caseation
5 M.M.	35	M	8 months	NSR	Caseation
6 Z.V.	19	F	6 months	NSR	Fibrosis, hydatid cysts

Abbreviations: AF = atrial fibrillation; NSR = sinus rhythm.

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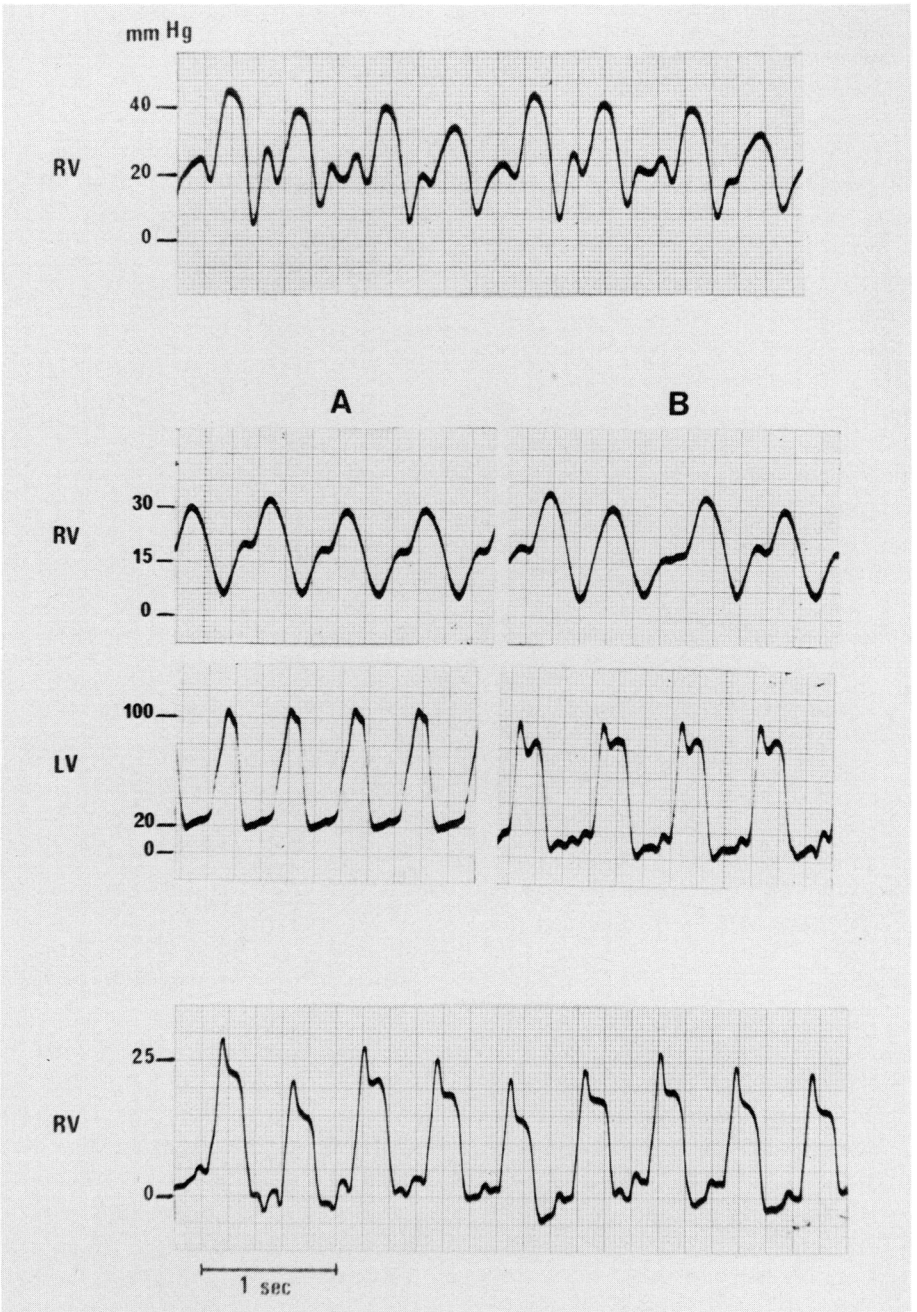

Figure 1

Case 5: (Top) Preoperative pressure tracing from the right ventricle (RV) showing the typical pattern of constriction. (Middle) Intraoperative pressure tracings. Note the absence of gross changes in end-diastolic pressures from the right and left ventricle (LV), before decortication (A) and after pericardiectomy (B). (Bottom) Pressure tracing from the right ventricle obtained three months after operation shows a normal pattern.

Right heart catheterizations demonstrated completely normal intracardiac pressures. It seems reasonable, therefore, to believe that imperfect decortication of the ventricles and atrioventricular grooves is the most important factor in the long-term persistence of constriction.[2, 11]

The electrocardiograms after pericardiectomy became normal or near normal in two patients (M.M. and Z.V.) whereas in the remaining four the abnormalities persisted postoperatively. This indi-

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Table 2

Cardiac Catheterization Data

Patient		SaO_2 %	$PaCO_2$ mm Hg	pH	Cardiac index (liters/min/m²)	Pressures (mm Hg) RA	RV Systolic	RV End-diastolic	PA	PA wedge
1	A	94	35	7.41	2.68	(21)	52	23	50/30 (38)	(26)
	B	95	40	7.39	3.42	(4)	32	4	30/12 (18)	(10)
2	A	95	28	7.44	3.26	(14)	40	15	40/25 (30)	(21)
	B	95	40	7.40	3.63	(2)	28	3	25/10 (15)	(8)
3	A	95	34	7.42	3.51	(16)	42	16	40/25 (31)	(20)
	B	96	41	7.41	3.21	(2)	25	3	25/10 (15)	(7)
4	A	94	38	7.41	3.76	(15)	35	17	35/19 (24)	(16)
	B	95	39	7.40	3.64	(2)	23	3	21/7 (13)	(5)
5	A	96	42	7.38	2.87	(18)	40	19	40/24 (29)	(19)
	B	95	38	7.41	3.57	(2)	25	3	23/8 (12)	(6)
6	A	94	41	7.39	2.80	(19)	48	20	46/28 (33)	(23)
	B	97	41	7.38	2.85	(1)	21	2	20/7 (11)	(5)
Mean	A	94	36		3.14	(17)	42	18	(30)	(20)
SD		±0.8	± 5		±0.43	± 2	± 6	± 2	± 4	± 3
Mean	B	95	39		3.37	(2)	25	3	(14)	(6)
SD		± 1	±1		±0.33	±0.9	± 3	±0.6	± 2	± 1

Abbreviations: A = preoperative; B = postoperative; SaO_2 = arterial oxygen saturation; $PaCO_2$ = arterial carbon dioxide tension; RA = right atrium; RV = right ventricle; PA = pulmonary artery. Figures in parentheses indicate mean pressure.

cates that changes in the electrocardiogram after decortication have no prognostic significance.[2, 11]

It is well known that major hemodynamic alterations in chronic constrictive pericarditis result from the decreased compliance of both ventricles due to generalized pericardial compression.[1] In our cases, no pressure gradient between the venae cavae and right atrium was found and no constricting peel at this site was demonstrated during operation. These findings support the negligible role of caval constriction in the majority of these cases, as previously suggested.[2] Elevation of both pulmonary artery and wedge pressures was present in all patients. These findings provided physiologic evidence for involvement of the left ventricle in the constricting process. Intraoperative recordings of right and left ventricular pressures prior to decortication conclusively confirmed the previous hemodynamic studies; the studies suggested that a significant constriction was present over both ventricles.

We are not aware of recent reports describing the ventricular pressure curves at operation. In 1951, Hansen, Eskildsen, and Götzsche,[12] who reported the pressure curves from both ventricles obtained in one patient during thoracotomy, failed to demonstrate significant changes in the typical constriction pattern after an adequate pericardiectomy. Right and left ventricular pressures were measured in the six patients reported here and were found to be similar both before and after decortication. Two months or more after operation normal intracardiac pressures were found by catheterization, a finding which showed that pericardiectomy was successful.

In the light of these findings it seems clear that a reversible phenomenon caused the persistence of abnormal end-diastolic ventricular pressures found immediately after decortication. It is quite conceivable that the abnormal ventricular compliance

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Table 3

Intraoperative pressure measurements

Patient		Pressures (mm Hg) RV Systolic	RV End-diastolic	LV Systolic	LV End-diastolic
1	A	47	23	108	26
	B	39	21	100	24
2	A	38	16	150	18
	B	35	15	125	16
3	A	38	15	120	18
	B	30	15	125	17
4	A	25	15	92	14
	B	25	15	90	14
5	A	30	16	105	24
	B	30	16	100	20
6	A	30	18	120	20
	B	28	16	110	19
Mean	A	34	17	115	20
SD		± 7	± 3	± 19	± 4
Mean	B	31	16	108	18
SD		± 5	± 2	± 14	± 3

Abbreviations: RV = right ventricle; LV = left ventricle; A = before decortication; B = after pericardiectomy was completed.

could be a reflection of myocardial alterations.[6, 8, 13] In this regard, anatomic studies have demonstrated the presence of myocardial atrophy in cases of constrictive pericarditis.[14] These findings were attributed to partial ventricular immobilization resulting from long-standing pericardial constriction[9] and also could be the result of an inflammatory process extended into the myocardium.[6, 9] However, the relationship between those myocardial alterations observed on autopsy specimens and the variable delay in the achievement of a normal hemodynamic state after a complete pericardiectomy remains obscure. In this connection, the series reported by Fitzpatrick et al.[2] shows that two patients who were studied early in the postoperative course (two weeks and two months respectively) had definite abnormal pressures whereas, by contrast, one patient catheterized six weeks after surgery had normal hemodynamics. In our patients this myocardial factor impairing the diastolic function of the ventricles appeared to become inoperative soon after operation. In fact, rapid clinical improvement and a return to normal venous pressure within four weeks after pericardiectomy occurred in the six patients. On the other hand, the results of this study argue against the value of monitoring intracardiac pressures during decortication to assess the achievement of a complete pericardial resection, a procedure other authors have recommended.[2] In fact, the reversible myocardial failure that continued following pericardiectomy prevented the detection of any significant intraoperative pressure changes.

Acknowledgment

The author wishes to express his appreciation to Drs. E. Schieppati, R. Leyro-Díaz and M. Kaplan for performing the surgical operations; and to Drs. D. Vicario and E. Zuffardi for their help in the hemodynamic studies.

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