Original Article

Early postoperative constrictive pericarditis in China: a single-center retrospective observational study

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Background: The diagnosis, treatment, and prognosis of early postoperative constrictive pericarditis (EPCP) have not been discussed in depth. The objective of this study was to devise and propose a management strategy for EPCP.

Methods: In this study, constrictive pericarditis (CP) within 6 months after cardiac surgery was defined as EPCP, and patients were divided into two groups based on intraoperative findings: a parietal thickening group and a visceral thickening group.

Results: A total of 20 patients were included in this study, and the incidence rate of recurrent pericardiectomy was 0.32% among all patients undergoing cardiovascular surgery. EPCP after valve surgery occurred in 85.0% of patients. Pleural effusion was the most common preoperative symptom, occurring in 90% of patients. Pericardial thickening occurred in the visceral layer in seven cases and in the parietal layer in 13 cases. There were no differences in comorbidities, C-reactive protein (CRP) level, or erythrocyte sedimentation rate (ESR) between the two groups. Most patients with visceral thickening (83.3%) needed cardiopulmonary bypass (CPB) assistance during surgery and had a longer hospital stay than those with parietal thickening (52.8±21.8 *vs.* 34.9±13.8 days, P=0.049). Central venous pressure (CVP) was decreased in all patients after pericardiectomy (24.9±6.96 *vs.* 8.9±2.92 cmH_2O, P<0.001), and the cardiac function improved significantly in patients with parietal thickening [New York Heart Association (NYHA) grade ≥ III accounted for 28.6% of patients]. The long-term survival rate of patients with parietal thickening was 92.3% and that of patients with visceral thickening was 57.1%, and there was no significant difference between them (P=0.056).

Conclusions: Recurrent episodes of chest tightness, pleural effusion, and elevated CVP within 6 months after cardiac surgery should be considered highly suggestive of EPCP. There are few points of difference between pericarditis with thickening of the parietal and visceral layers. After failure of conservative medical treatment, pericardiectomy results in significant improvements in cardiac function and quality of life, especially in patients with thickening of the parietal layer.

Keywords: Constrictive pericarditis (CP); cardiac surgery; management strategies

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Introduction

Constrictive pericarditis (CP) is the thickening, adhesion, and even calcification of the pericardium caused by inflammation (1). It can limit the diastolic and systolic activities of the heart and eventually cause systemic circulation disorders (2). Tuberculosis, trauma, tumor, radiation, chemotherapy, and nonspecific inflammation may all contribute to the etiopathogenesis of this condition (3,4). Cardiac surgery is an important yet relatively neglected cause of CP, and the incidence of cardiac surgery-related CP is about 0.2% to 3% (5). CP is a complex and long-term change, and CP in the early postoperative period (<6 months) is rare. The purpose of this study was to summarize the characteristics of early postoperative CP (EPCP) and propose management strategies. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1186/rc).

Methods

We conducted a single-center retrospective study of patients with EPCP who were enrolled from 2015 to 2020. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the ethics committee of Changhai Hospital (No. CHEC2022-021). Individual consent for this retrospective analysis was waived. The inclusion criteria for patients were as follows: (I) the patient was scheduled to undergo a second pericardiectomy, with the initial cardiac surgery being performed in our center [including coronary artery bypass grafting (CABG) surgery, valve replacement surgery, congenital heart disease surgery, etc.]; (II) CP was diagnosed via intraoperative findings; and (III) the interval between the two operations was less than 6 months.

Pericardiectomy was performed via a median sternotomy approach, and all patients were divided into two groups based on reoperation findings: a parietal thickening group and a visceral thickening group.

Duration of follow-up by telephone and outpatient examination ranged from 3 to 60 months, and information on survival, symptom improvement, cardiothoracic ultrasound, etc., was collected. Cardiac function was determined using the health problem-solving scale (HPSS) and the 6-minute walk test at 3 months after surgery.

Highlight box

Key findings

- Clinicians should be alert to early postoperative constrictive pericarditis (EPCP), and pericardiectomy can significantly improve symptoms (according to health problem-solving scale score and 6-minute walk test results).

What is known and what is new?

- Pericardiectomy is an effective treatment for EPCP, especially for patients with visceral thickening.
- There was no significant difference in long-term survival rate between patients with visceral thickening and those with parietal thickening.

What is the implication, and what should change now?

- Recurrent chest tightness and pleural effusion within 6 months after cardiac surgery should be suspected to be EPCP, and failure to improve significantly with medical treatment is an indication for pericardiectomy.

Statistical analysis

Categorical variables are presented as absolute numbers and percentages. Continuous variables with a normal distribution were assessed with the Shapiro-Wilk test, and continuous variables are expressed as the mean and standard deviation or the median and interquartile range according to the distribution of variables. Differences between categorical variables were tested with the χ^2 test or the Fisher exact test, as appropriate. Differences between continuous variables were tested with Kruskal-Wallis test. All statistical analyses were performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA) for Windows. A two-sided P value <0.05 was considered to indicate a statistically significant difference.

Results

Over a period of 5 years, 20 patients were readmitted to the hospital for pericardiectomy within 6 months after initial cardiac surgery. This accounted for 0.32% of all cardiac surgeries performed at the hospital over the study period, and we list all the demographic characteristics of this patient group in *Table 1*. The mean age of the patients was 57.3±8.5 years, and 85.0% of patients were male. The initial cardiac surgery included 17 valve replacements or valvuloplasty, two CABGs, and one pericardiectomy. All patients had varying degrees of lower extremity edema or dyspnea. In addition, 90% of patients had pleural effusion, 50% had ascites, and 40% had localized pericardial

Table 1 Demographic and clinical characteristics of the patients

No.	Age (years)	Gender	BSA (m^2)	Symptom	Effusion	Pre-NYHA	Comorbidity	Primary operation	Thickening	Window (days)	CPB
1	59	Male	1.7	Edema	C	III	AF	DVR	Parietal layer	48	No
2	51	Male	1.8	Edema	P	II	None	MVR	Parietal layer	168	No
3	71	Male	1.6	Dyspnea	C + P + A	IV	CRD	CABG	Visceral layer	70	Yes
4	67	Male	1.8	Dyspnea	P + A	III	None	AVR	Visceral layer	173	Yes
5	57	Male	1.6	Dyspnea	C + P + A	III	None	MVP	Visceral layer	55	No
6	46	Male	2.1	Edema	P	III	TR	AVR	Parietal layer	159	No
7	58	Male	1.6	Edema	C + P + A	II	AF/TR	DVR	Parietal layer	179	No
8	51	Male	1.8	Dyspnea	P + A	IV	None	Pericardiectomy	Parietal layer	155	No
9	50	Male	2.0	Dyspnea	P + A	III	None	MVR + TVP	Visceral layer	141	No
10	54	Female	1.4	Edema	P	II	AF	MVP + TVP	Parietal layer	118	No
11	73	Male	1.6	Edema	C + P	III	None	MVR + TVP	Parietal layer	48	Yes
12	48	Male	1.7	Dyspnea	P	II	None	MVR	Parietal layer	168	No
13	51	Male	1.8	Edema	C + P	III	AF/TR	DVR	Visceral layer	70	Yes
14	43	Male	1.0	Edema	P	III	CRD	CABG	Visceral layer	173	Yes
15	68	Female	1.6	Dyspnea	C + P + A	IV	AF	MVR + TVP	Parietal layer	55	No
16	59	Male	1.7	Edema	P + A	II	None	AVR	Parietal layer	159	No
17	63	Male	1.6	Edema	C + A	III	None	AVR	Parietal layer	179	No
18	53	Male	1.8	Edema	P + A	I	None	MVP + TVP	Parietal layer	155	No
19	55	Male	1.8	Edema	P	IV	None	AVR	Visceral layer	141	Yes
20	69	Female	1.6	Dyspnea	P + A	III	None	MVR	Parietal layer	118	No

BSA, body surface area; pre-NYHA, preoperative New York Heart Association functional class; Window, time window from date of primary operation to date of CP (days); CP, constrictive pericarditis; CPB, cardiopulmonary bypass; C, pericardial effusion; AF, atrial fibrillation; DVR, double-valve replacement; P, pleural effusion; MVR, mitral valve replacement; A, ascites; CRD, chronic renal disease; CABG, coronary artery bypass grafting; AVR, aortic valve replacement; MVP, mitral valvuloplasty; TR, tricuspid regurgitation; TVP, tricuspid valvuloplasty.

effusion. The mean interval from the first to the second pericardiectomy was 126.6±48.2 days.

According to the results of intraoperative findings, seven cases of pericardial thickening were finally determined to occur in the visceral layer and 13 cases in the parietal layer (*Table 2*). There was no significant difference in preoperative comorbidities between the two groups (P>0.05). Patients with a thickened visceral layer had worse cardiac function, and the New York Heart Association (NYHA) grade of all these patients was greater than III; they also had a longer operation time (288.6±51.1 *vs.* 196.2±48.0 min, P=0.001), and 83.3% of them required a cardiopulmonary bypass (CPB).

The overall mean length of hospital stay was 39.2±18.2 days, and the mean duration of intensive care unit (ICU) stay was 5.4±7.5 days. The results of the comparison between the two groups are presented intuitively in *Figure 1*. There were statistically different differences between patients with visceral thickening and those with parietal thickening in terms of length of hospital stay (52.8±21.8 *vs.* 34.9±13.8 days, P=0.049) and ICU stay (10.0±11.7 *vs.* 2.9±1.2 days, P=0.0035). However, there were no significant differences in C-reactive protein (CRP) level or erythrocyte sedimentation rate (ESR) between the two groups. The mean preoperative central venous pressure (CVP) was 24.9±6.96 cmH_2O, and the postoperative CVP

Table 2 Comparison of the data before and after pericardiectomy between the parietal thickening and visceral thickening groups

Variables	Parietal (n=13)	Visceral (n=7)	P
Gender (male)	10 (76.9)	7 (100.0)	0.521
Age (years)	57.8±8.4	56.3±9.8	0.606
BSA (m^2)	1.7±0.2	1.8±0.2	0.132
Comorbidity			>0.99
AF	4 (30.8)	1 (14.3)	
TR	2 (15.4)	1 (14.3)	
CRD	0	2 (28.6)	
CRP (mg/L)	25.9±14.7	25.9±17.2	0.382
ESR (mm/h)	27.9±17.4	19.1±5.0	0.451
Symptom			0.356
Edema	9 (69.2)	3 (42.9)	
Dyspnea	4 (30.8)	4 (57.1)	
Pre-CVP (cmH_2O)	25.4±4.2	24.0±10.8	0.937
Pre-EF	0.6±0.1	0.5±0.1	0.578
Pre-NYHA			0.090
I	1 (7.7)	0	
II	5 (38.5)	0	
III	5 (38.5)	5 (71.4)	
IV	2 (15.4)	2 (28.6)	
Pre-pericardial effusion	5 (38.5)	3 (42.9)	>0.99
Pre-pleural effusion	11 (84.6)	7 (100.0)	0.521
CPB	1 (7.7)	5 (71.4)	0.007
Operation time (min)	196.2±48.0	288.6±51.1	0.001
Blood loss (mL)	700.0±367.4	1,028.6±694.5	0.449
Drainage volume on days 1–3 (mL)	851.5±512.5	844.3±407.8	0.663
ICU stay (days)	2.9±1.2	10.0±11.7	0.004
Length of stay (days)	34.9±13.8	52.8±21.8	0.049
Post-CVP (cmH_2O)	9.4±3.2	8.0±2.4	0.377
Post-EF	0.6±0.1	0.6±0.1	0.692
Post-NYHA			0.008
I	10 (76.9)	2 (28.6)	
II	3 (23.1)	3 (42.9)	
III	0	1 (14.3)	
IV	0	1 (14.3)	
In-hospital death	0	1 (14.3)	0.350

Categorical variables are presented as absolute numbers and percentages, and continuous variables are presented as the mean ± SD. BSA, body surface area; AF, atrial fibrillation; TR, tricuspid regurgitation; CRD, chronic renal disease; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; pre, preoperative; CVP, central venous pressure; EF, ejection fraction; NYHA, New York Heart Association functional class; CPB, cardiopulmonary bypass; ICU, intensive care unit; post, postoperative; SD, standard deviation.

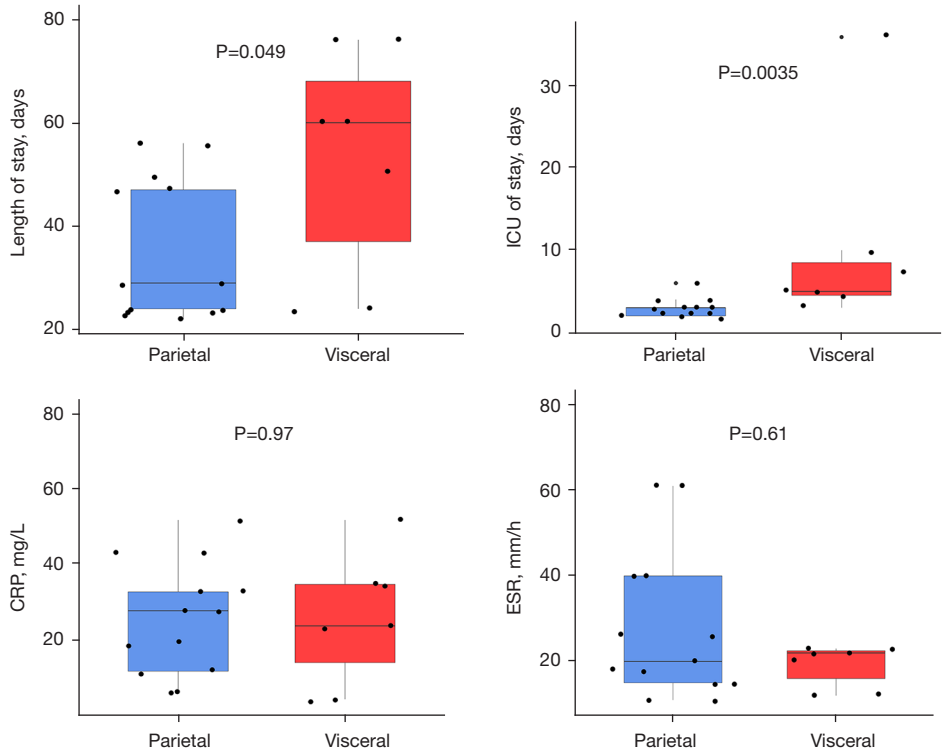

Figure 1 Comparison of length of hospital stay and inflammatory factors between the parietal thickening and visceral thickening groups. Patients with a thickened visceral layer had a longer hospital stay (P<0.05), but there was no statistical difference in CRP level or ESR between the two groups. ICU, intensive care unit; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate.

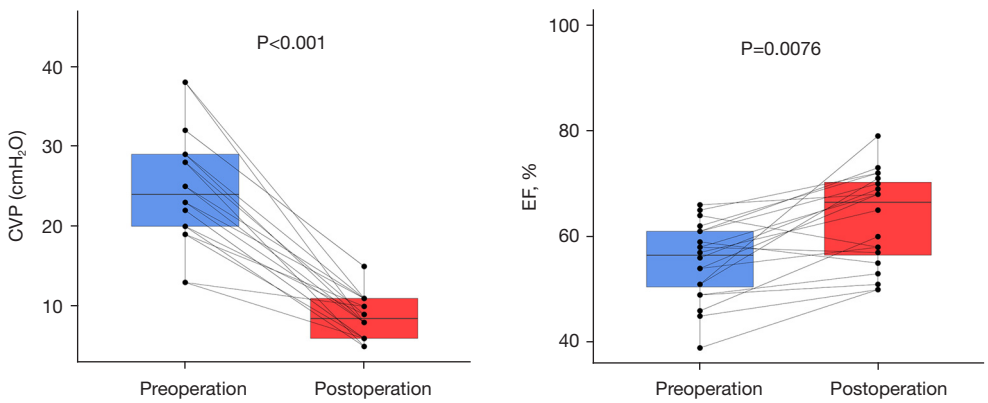

Figure 2 Changes of CVP and EF before and after surgery. The CVP and EF of the patients were significantly improved after pericardial dissection, and the difference was statistically significant. CVP, central venous pressure; EF, ejection fraction.

was 8.9±2.92 cmH_2O, representing a significant difference (P<0.001) (*Figure 2*). Although there was no difference in CVP change between the two groups, patients with parietal thickening experienced better improvement in cardiac function (P=0.008) (*Figure 3*).

The follow-up time ranged from 3 to 60 months, with an average of 32.3±17.8 months. Three patients died during the follow-up period, including one case of parietal thickening and two cases of visceral thickening; the time of death for these patients was 13, 34, and 50 months after

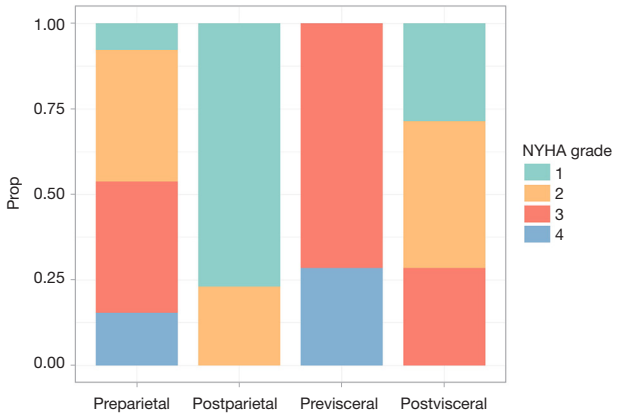

Figure 3 Changes of cardiac function grading before and after surgery. The preoperative cardiac function of patients with visceral pericardium thickening was above NYHA class III. According to HPSS score and 6-minute walk test after 3 months, the improvement of cardiac function after surgery was more obvious in patients with visceral thickening (P<0.05). Prop, proportion; NYHA, New York Heart Association; HPSS, health problem-solving scale.

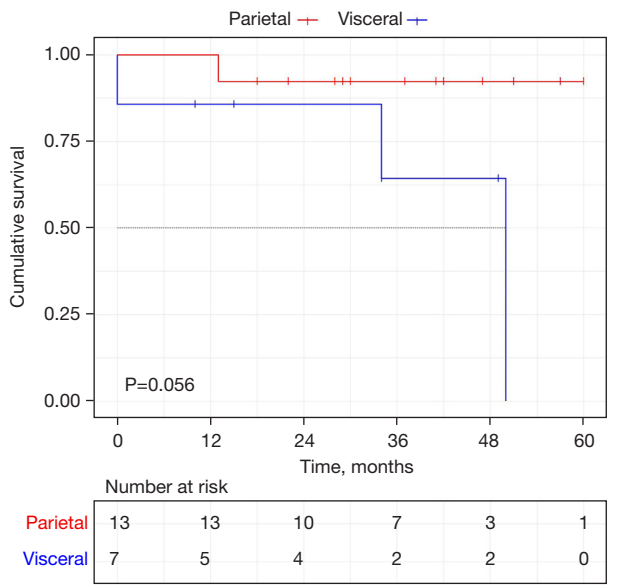

Figure 4 Comparison of survival rates between the visceral and parietal groups. The survival rate of patients with visceral layer thickening was 57.1%, and that of patients with parietal layer thickening was 92.3%, but this did not represent a significant difference (P=0.056).

pericardial dissection, respectively. Multiple treatments for pleural effusion or ascites were still possible after pericardiectomy, but there was no significant difference in survival between the two groups (*Figure 4*).

Discussion

Postoperative CP (PCP) is a nonspecific inflammation with an incidence of 0.2–3% (6). In our research, the incidence of EPCP was 0.32%, but we realize that the actual incidence rate should be higher. This is because we did not consider transient or chronic CP but only the CP that occurred within 6 months after cardiac surgery as EPCP. The purpose of having such a definition is to emphasize the characteristics and management strategies for EPCP.

PCP is more common in men and those with higher right ventricular pressure, and it has occurred in a few cases with pericardial calcification (7,8). For EPCP in our study, we also found that the incidence was higher in men than in women. It should be noted that women have a higher risk of certain cardiovascular diseases and consume more medical resources (9,10). Due to the small sample size of our study, the relationship between pericarditis and sex still needs to be further explored even after removal of other confounding factors. In previous reports, the time span from surgery to the appearance of PCP varied from 3 weeks to 54 months (11). Based on the available evidence and reported clinical cases, it is almost impossible to predict the occurrence of PCP and difficult to account for differences in time intervals.

Valve surgery and CABG are the main causes of PCP, which have different proportions across different studies (12). It is widely acknowledged that CABG surgery may lead to effusion in the early stage of antiplatelet operation. Under normal left ventricular ejection fraction (LVEF), there is constant intense friction between the pericardium and the beating heart, which may lead to pericardial damage and even pericarditis (13). However, according to the results of this study, valvular surgery accounted for 85.0% of EPCP cases. The reason may be the large amount of valve operation in our center and the patient's own rheumatoid factors (14). Moreover, aspirin is more likely to be administered after CABG as an anti-inflammatory drug for the treatment of pericarditis (15). Other explanations include inadequate drainage, postpericardiotomy syndrome, release of pro-inflammatory factors (tumor necrosis factor-α and interleukin), and transforming growth factor-β (TGF-β) when patients are subjected to CPB (16,17).

The diagnosis of EPCP requires a consideration of patient history, symptoms, and imaging findings (18). The symptoms of recurrent chest tightness, pain, and fever in the early days after cardiac surgery cannot be explained by other common causes. Echocardiography is the most commonly

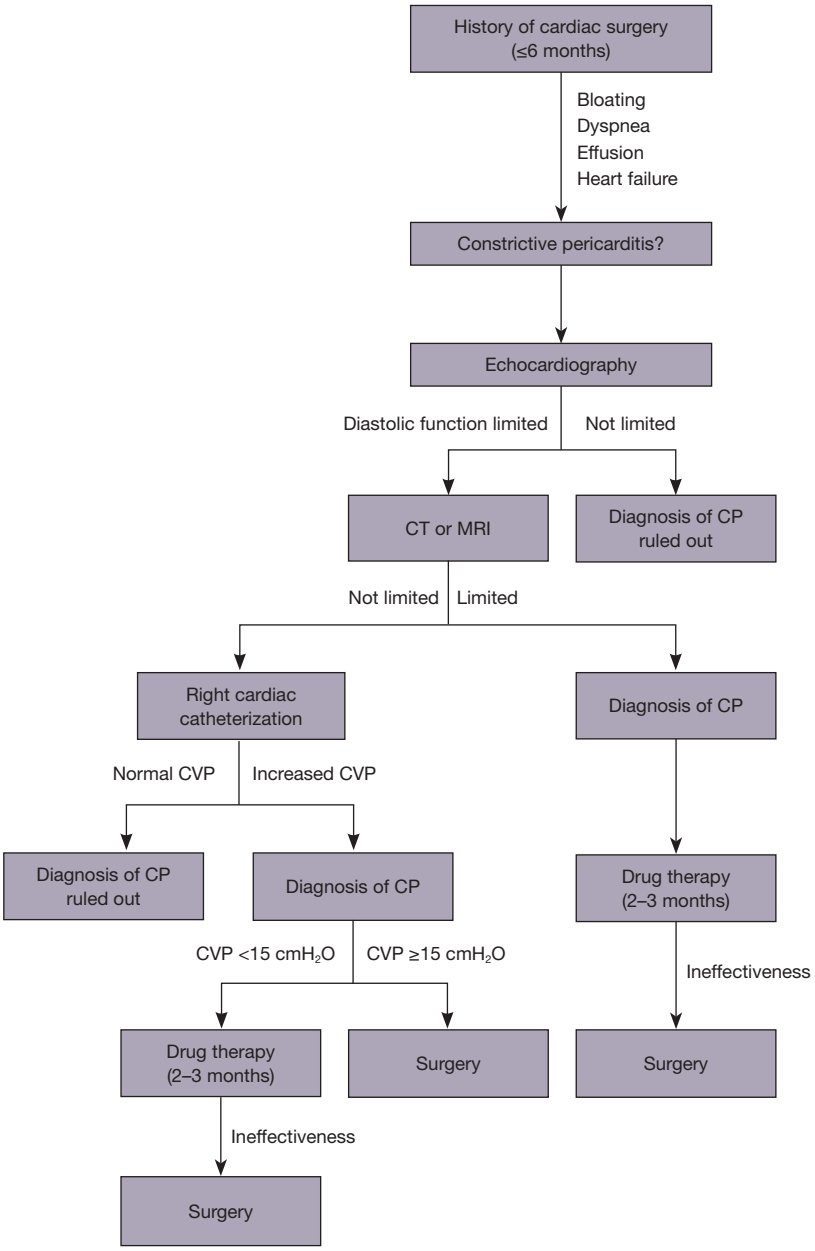

Figure 5 The management strategy of EPCP. CT, computed tomography; MRI, magnetic resonance imaging; CP, constrictive pericarditis; CVP, central venous pressure; EPCP, early postoperative constrictive pericarditis.

used method for diagnosing CP (19). It should be remembered that severe tricuspid regurgitation after cardiac surgery can also lead to the appearance of clinical symptoms similar to CP, so echocardiography has an important role in distinguishing between these two conditions. Moreover, EPCP is usually accompanied by abnormal elevation of CVP, and brain natriuretic peptide (BNP) level and proBNP level also have reference significance for the identification of etiology.

We present an EPCP management strategy here, which is expressed visually in *Figure 5*. More attention should be paid to EPCP to strengthen the understanding of the etiological mechanism and to explore specific diagnostic means (for example, specific inflammatory factors labeled by radionuclides or isotopes). The relevant guidelines state that chronic permanent CP should be treated with

pericardiectomy, but it is difficult to define chronic or even permanent in this context; thus, there is no consensus regarding the further surgical indications for CP (20). In our view, pleural effusion, dyspnea, and persistently elevated CVP after 2 to 3 months of anti-inflammatory trials with nonsteroidal anti-inflammatory drugs, colchicine, or corticosteroids should be fully considered as indicators for surgery.

The recommended surgical approach is one involving an incision directly into the sternum in order to remove a sufficient extent of the pericardium, especially at the right atrium and vena cava (21). However, no comparison has been made between this approach and one using small incisions for precise excision. In the present study, a second pericardiectomy was performed in a male patient 155 days after the initial pericardiectomy. The reason for this was that the layers of pericardium were not accurately identified during the operation and the calcified lesion was not completely removed. Therefore, it is important to be familiar with the anatomical layer of the pericardium and complete release, which is related to the surgeon's understanding of pericarditis and operating techniques.

In our study, there were no differences in CVP, ejection fraction (EF), ESR, or CRP between the two groups of EPCP. According to our results, cardiac function can be significantly improved after pericardiectomy, and NYHA grade IV patients can undergo surgery despite high surgical risk. It should be noted that some patients still had repeated pleural effusion or ascites, or even CP, after pericardiectomy, but this should not necessarily be interpreted as treatment failure. Diastolic parameters were normal in most patients during long-term follow-up.

Conclusions

EPCP should be considered when unexplained chest distress, third space effusion, and elevated CVP levels occur repeatedly within 6 months after cardiac surgery. Clinicians should not hesitate to completely remove the pericardium through median thoracotomy in patients who do not respond to anti-inflammatory therapy. Patients with thickened parietal and visceral layers will benefit from this, but the former may experience greater benefit.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1186/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1186/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1186/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of Changhai Hospital (No. CHEC2022-021) and individual consent for this retrospective analysis was waived.

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