



# Pericardiectomy After Previous Bypass Grafting: Analyzing Risk and Effectiveness in this Rare Clinical Entity

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**Background.** Historically the most common causes of pericarditis necessitating pericardiectomy are infection, radiation, idiopathic causes, and inflammation. More recently, there has been a rise in iatrogenic pericardial constriction, with most cases occurring after coronary artery bypass grafting (CABG). To date, there has been no large series evaluating the incidence, presentation, and effectiveness of surgical intervention. We review our 20-year experience managing this special subset of patients.

**Methods.** From January 1993 to December 2013, 938 patients underwent pericardiectomy at our institution. We identified 98 patients who underwent pericardiectomy after previous coronary bypass grafting. Demographic information was collected along with the indication for the procedure, technical aspects of the operation, early and late morbidity and mortality, and long-term New York Heart Association (NYHA) functional class. Median age at operation was 68 years (range, 38–81 years), and 91 of the patients (93%) were men. The indication for pericardiectomy was pericardial constriction in all patients. Median preoperative left ventricular ejection fraction was 60% (range, 30%–71%) and median NYHA functional class was III (91% were class III/IV).

**Results.** The surgical approach was median sternotomy in 81 patients (83%), left thoracotomy in 16 patients (16%),

and a clamshell approach in 1 patient (1%). The extent of pericardial resection was radical in 61 patients (62%), subtotal in 27 patients (28%), and completion in 10 patients (10%). Cardiopulmonary bypass was used in 63 patients (64%) and aortic cross-clamping was used in 5 patients (5%). Concomitant coronary bypass grafting was performed in 10 patients (10%). Early mortality was seen in 3 of 98 patients (3%). The median duration of late follow-up was 3.2 years (maximum, 17.5 years), and overall 5- and 10-year survival was 62% and 41%, respectively. There were no multivariate predictors of worse outcome. The sole univariate predictor of lower overall survival was the use of cardiopulmonary bypass (hazard ratio, 1.96; 95% confidence interval, 1.03–3.7];  $p = 0.04$ ). NYHA functional class was I/II in 84% of patients at a median follow-up of 3.2 years.

**Conclusions.** The rate of early mortality for pericardiectomy after previous coronary bypass grafting is low, and the late adverse impact of cardiopulmonary bypass likely reflects increased severity of disease and technical complexity. Importantly, during late follow-up extending more than 17 years, the vast majority of patients demonstrated significant improvement in NYHA functional class.

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Although the observed cause of pericarditis has been noted to depend on several factors [1–6], with the rising volume of cardiac surgical procedures as well as catheter-based interventions, the recognition and incidence of “iatrogenic” pericarditis has become increasingly pronounced [7, 8]. Since 1982, the proportion of cases deemed attributable to previous surgical

procedures has risen significantly, whereas cases classified as idiopathic have declined to a parallel degree [5, 9–11]. The diagnosis and management of patients with constrictive pericarditis can be challenging in general, and when the cause is thought to be post-operative in nature, these challenges can often be formidable. Although some cases may be amenable to medical therapy, it is likely less helpful in these particular patients, and despite a poor understanding of which patients derive the most benefit from surgical procedures [2–4, 9, 12], pericardial resection in these patients is thought to provide the most impactful benefits [9, 11].

Cardiac operations after coronary bypass grafting (CABG) are challenging in general, and the nature of

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pericardiectomy may represent particular technical challenges related to patent grafts or ongoing native coronary artery disease. Because there are very few data analyzing risk and evaluating effectiveness in these patients, this study sought to evaluate outcomes in a large cohort of patients undergoing pericardiectomy for pericardial constriction after isolated CABG. Our goal was to evaluate early and late outcomes, as well as elucidate the factors predicting worse outcome to enable counseling of patients preoperatively and anticipate clinical outcomes postoperatively.

## Patients and Methods

The Mayo Foundation Institutional Review Board approved this study, and all patients or their families gave written informed consent. Demographic and other patient-related data were obtained from Mayo Clinic medical records and our prospective clinical database. Follow-up information was obtained from subsequent clinic visits, written correspondence from local physicians, and mailed questionnaires to patients or families. Early operative mortality was defined as death occurring within 30 days of operation or any time during the index hospitalization. Late mortality was defined as death occurring after index hospitalization dismissal and during the follow-up period.

### Patients

From January 1993 to December 2013, 938 patients underwent pericardiectomy at our institution. To establish a homogeneous population to analyze the impact of isolated pericardiectomy, patients who had undergone previous chest irradiation or who had malignancy and concomitant valvular or coronary procedures were excluded. We identified 521 patients who underwent pericardiectomy with or without CABG; of these patients, 98 had undergone previous CABG.

### Preoperative Data

Median age at operation was 68 years (range, 18–84 years), and 91 patients (93%) were men. The indication for pericardiectomy was pericardial constriction in all patients and was diagnosed with a combination of echocardiography and hemodynamic catheterization. All patients had undergone previous CABG; 88 patients (90%) had undergone 1 previous operation and 10 (10%) patients had 2 prior operations. Previous bypass grafting included 7 patients (7%) with 2 grafts, 33 patients (34%) with 3 grafts, and 58 patients (59%) with 4 grafts. Ten patients (10%) had previous pericardial resection of varying degrees. New York Heart Association (NYHA) functional class at the time of operation was III/IV in 77% of patients. Median preoperative left ventricular ejection fraction was 60% (range, 30%–71%). Other preoperative comorbid conditions are presented in [Table 1](#).

### Statistical Analysis

Continuous data were expressed as median value with a range (minimum to maximum) and included preoperative

*Table 1. Preoperative Clinical Characteristics Present in the Study Cohort*

Variable	No.	%
Diabetes	43	44
Hypertension	60	61
COPD	11	11
PVD	6	6
Dyslipidemia	20	20
Cerebrovascular disease	7	7
Previous MI	7	7
Renal insufficiency	12	12

COPD = chronic obstructive pulmonary disease; MI = myocardial infarction; PVD = peripheral vascular disease.

left ventricular ejection fraction and age at operation. These 2 variables were not normally distributed, and nonparametric analyses were performed. Data between 2 groups were compared using the  $\chi^2$  test for categorical variables. A backward stepwise Cox regression analysis was used to identify perioperative variables independently affecting outcomes. Variables to be included in the univariate analysis were selected a priori according to comorbidities thought to represent clinical importance from the literature and our clinical knowledge, including sex, preoperative atrial fibrillation, age ( $\Delta 10$  years), left ventricular ejection fraction ( $-\Delta 10\%$ ), use of cardiopulmonary bypass, concomitant CABG, number of previous bypass grafts, surgical approach, diabetes, hypertension, chronic obstructive pulmonary disease, peripheral vascular disease, previous myocardial infarction, renal insufficiency, congestive heart failure, and extent of resection. A parsimonious model was then identified using stepwise selection with the criteria for inclusion in the final model being an alpha level of less than 0.05. Kaplan-Meier survival analysis was used to evaluate time-related outcomes and produce plots, which were subsequently compared with the log-rank test. Statistical significance was considered at a *p* value less than 0.05.

## Results

### Operative Data

All patients underwent pericardiectomy. Concomitant CABG was performed in 10 patients for native coronary artery disease; there were no injuries to patent coronary bypass grafts during pericardiectomy. Six patients received 1 bypass graft, 2 patients received 2 grafts, and 2 patients received 3 grafts. Five patients had concomitant noncardiac procedures, including lung decortication in 4 patients and lung biopsy in 1 patient. Cardiopulmonary bypass was used in 63 of 98 patients (64%), and aortic cross-clamping was performed in 5 patients (5%). The median cardiopulmonary bypass time was 69 minutes (range, 19–213 minutes). Pericardiectomy was approached by median sternotomy in 81 of 98 patients (83%), by left thoracotomy in 16 of 98 patients (16%), and with a clamshell approach in 1 patient (1%). A radical resection, defined as removal of anterior, inferior, and left

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