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Delayed Sternal Closure in Cardiac Surgery

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Abstract

Background: Delayed sternal closure (DSC) has a reported incidence of 1.2%-4.2% in the adult cardiac surgical literature for indications including hemodynamic instability, marked myocardial edema, respiratory compromise, intractable bleeding, placement of assist devices, and persistent arrhythmias. The purpose of this study was to evaluate the incidence, survival, and morbidity of open chest management (OCM) patients who subsequently required DSC.

Methods: All data were collected from the Robert Wood Johnson University Hospital Cardiac Surgery Database. A total of 1261 patients who underwent cardiac surgery from January 2012 through June 2013 were analysed, evaluating postoperative morbidity and mortality, along with inciting conditions for the utilization of DSC. Chi-square and frequency analysis were performed using SAS 9.3 software (SAS Institute, NC).

Results: A total of 41/1261 (3.25%) cases resulted in DSC. Of the cases requiring DSC, 33/41 (80.5%) were men and 8/41 (19.5%) were women. Analysis revealed 11/41 (26.8%) of cases requiring delayed sternal closure were orthotopic heart transplants, 9/41(21.9%) insertion of ventricular (uni- or bi-ventricular) assist devices (VAD), 8/41 (19.5%) operations were coronary artery bypass graft (CABG), 4/41 (9.76%) were type A aortic dissection graft repairs, 2/41 (4.88%) were mitral valve repairs (MVR), 2/41 (4.88%) were aortic valve repair (AVR) combined with CABG, 2/41 (4.88%) were MVR with CABG, and 3/41 (7.32%) were other cardiac procedures. There were no incidences of superficial sternal infection or mediastinitis in the DSC cohort, while infection occurred in 3/1220 (0.25%) patients after conventional closure. Analysis of postoperative comorbidities revealed acceptable rates of postoperative stroke [2/41 (4.88%)], atrial fibrillation [6/41 (14.6%)], and renal failure [16/41 (39.0%)]. Overall mortality was 14/41 (34.2%). Reasons for planned DSC included bleeding 7/41 (17.1%), hemodynamic instability 11/41 (26.8%), elevated pulmonary artery (PA) pressures in 4/41 (9.76%), and coagulopathy in 19/41 (46.3%), while graft occlusion and valve dysfunction were not factors leading to the implementation of DSC.

Conclusion: DSC is a technique that can be readily used in patients who require OCM for various reasons following cardiac surgery. DSC does not appear to increase the risk of infectious complications. Although postoperative complications such as stroke, atrial fibrillation, and renal failure, along with an acceptable mortality rate, is reflective of the patients' morbid condition requiring OCM, DSC can be carried out with a relatively low incidence of sternal complications after cardiac surgery.

Keywords: DSC; Sternal infection; Delayed sternal closure

Introduction

Delayed sternal closure (DSC) has a reported incidence of 1.2%-4.2% in the adult cardiac surgical literature [1] for indications including hemodynamic instability, marked myocardial edema, respiratory compromise, intractable bleeding, placement of ventricular assist devices or intra-aortic balloon pumps (IABPs), and persistent arrhythmias [2]. The concept for open chest management (OCM) with the intent for delayed sternal closure was first utilized in 1975. As this technique was implemented, certain advantages became apparent, including the ability to relieve cardiac compression postoperatively, provide rapid access to control postoperative complications such as hemorrhage and arrhythmia, and to allow easy access to evacuate blood and/or clot formation in the mediastinum to prevent tamponade [3]. However, fears of mediastinal infection from prolonged open sternotomy have led many to refrain from the utilization of open chest management. The purpose of this study was to evaluate the incidence, survival, and morbidity of open chest management (OCM) patients who subsequently required DSC [4].

Materials and Methods

Patient characteristics

In this retrospective analysis, a total of 1261 patients who underwent cardiac surgery from January 2012-June 2013 were analysed. Of these patients, 41/1261 (3.25%) resulted in delayed sternal closure [5]. Men comprised 33/41 (80.5%) of the cardiac surgery patients, while 8/41 (19.5%) of the cases were women. The average age of the patient cohort was 73 ± 13, with no patients from the paediatric population [6].

Indication for OCM

OCM was performed if all attempts to achieve hemodynamic stability were unsuccessful. Ventricular function was routinely determined by transesophageal echocardiography [7]. Some patients underwent a trial of chest closure, failed, and were subsequently treated with open chest management. Other indications included bleeding, coagulopathy, cardiac edema, and arrhythmias with hemodynamic compromise.

Technique of DSC

The patients who underwent open chest management, after placement of mediastinal and/or pleural tubes, had a single lap pad placed in the mediastinum. An airtight seal was then made using Esmarch® (Innovate Medical, 836-3609) bandage covered with Ioban® (3M, 34-8701-3137-1) dressing. Patients requiring open chest management, either directly from the operating room or after opening of the chest in the surgical intensive care unit (SICU), underwent mediastinal exploration and washout every 24-48 hours until delayed sternal closure was performed. Patients were maintained on prophylactic IV antibiotic therapy. The decision and timing of sternal closure was at the discretion of the attending surgeon, influenced by improvements in hemodynamics, edema, and cardiac function [8-12].

Statistical analysis

Data were collected by a trained nurse evaluator conducting chart reviews and compiled into a secure Robert Wood Johnson University Hospital Cardiac Surgery database, with strict adherence to HIPAA confidentiality guidelines after Institutional Review Board acceptance. This database was password protected with encrypted patient identifiers, made available only to study investigators. Chi-square and frequency analysis were performed using SAS 9.3 software (SAS Institute Inc., Cary, NC). A p value of <0.05 was considered significant [13,14].

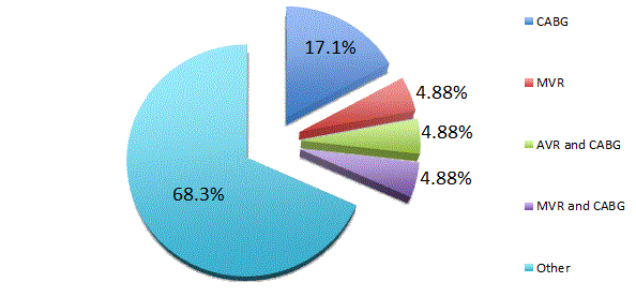

Figure 1: Types of operations utilizing delayed sternal closure.

Results

A total of 1261 patients were analysed, with 41 (3.25%) cases which resulted in delayed sternal closure. Of the cases requiring DSC, 33/41 (80.5%) were men and 8/41 (19.5%) were women. Patient demographics are displayed in Table 1. Analysis revealed 7/41 (17.1%) operations were coronary artery bypass graft (CABG), 2/41 (4.88%) were mitral valve repairs (MVR), 2/41 (4.88%) were aortic valve repair (AVR) combined with CABG, 2/41 (4.88%) were MVR with CABG, and 28/41 (68.3%) were other cardiac procedures [15,16], most of which involved the placement of ventricular assist devices (Figure 1). There were no incidences of superficial sternal infection or mediastinitis in the DSC cohort, while infection occurred in 3/1220 (0.25%) patients after conventional closure. Analysis of postoperative comorbidities revealed acceptable rates of postoperative stroke [2/41 (4.88%)], atrial fibrillation [6/41 (14.6%)], and renal failure [16/41 (39.0%)]. Overall mortality was 14/41 (34.2%) (Figure 2). Reasons for planned DSC included bleeding 7/41 (17.1%), hemodynamic instability 11/41 (26.8%) and other cardiac abnormalities in 18/41 (56.1%), while graft occlusion and valve dysfunction were not factors leading to the implementation of DSC (Figure 3).

Characteristics	Median (range) or Number of cases (%)
Men	33
Women	8
Age	73 ± 13
Operation	
CABG	17.10%
MVR	4.88%
AVR+CABG	4.88%
MVR+CABG	4.88%
Other	68.30%

Table 1: Patients with delayed sternal closure.

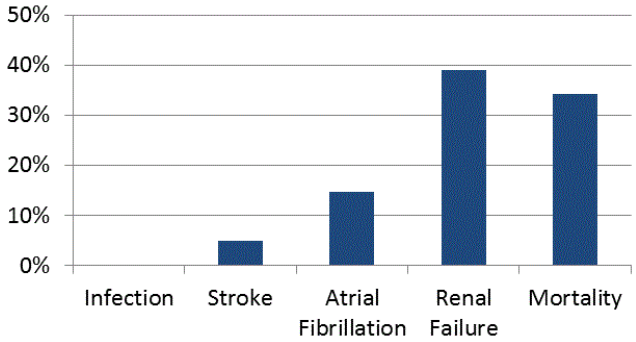

Figure 2: Postoperative complications.

Discussion

The evolution of open chest management has improved the therapeutic options in the treatment of hemodynamic instability and other difficult to manage complications during and after cardiac surgery where sternal closure would not be tolerated. In the past, however, the fear of mediastinitis and other sternal complications has limited the implementation of OCM and subsequent DSC to some capacity. Research efforts have been undertaken to justify its use, with several series describing the outcomes in the adult cardiac literature of

patients treated with open chest management and subsequent delayed sternal closure, namely those of Christenson et al. [6] with 142 patients and Furnary et al. [7] with 107 patients; however, these remain some of the largest series to date, as our experience equates with other series in the sample size. As we continue to monitor the results of OCM and DSC, however, and with the expanding use of cardiac assist devices in complex cardiac surgical cases, these institutional numbers should increase.

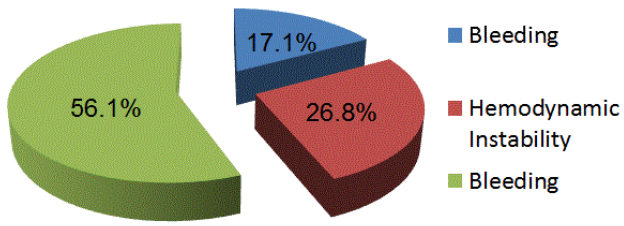

Figure 3: Reasons for planned delayed sternal closure.

Our case series incidence of 3.25% of patients undergoing delayed sternal closure falls within the reported range in the cardiac literature, with many of the indications for open chest management being similar to those described by previous reports. In the future, we hope to continue the analysis to further understand predictive factors to improve outcomes, not only to further our implementation of OCM, but also to develop our technique to provide for even better outcomes in these highly complex cardiac cases.

In conclusion, we believe delayed sternal closure is a technique that can be readily used in patients who require open chest management for various reasons following cardiac surgery. DSC does not appear to increase the risk of infectious complications. Although postoperative complications such as stroke, atrial fibrillation, and renal failure, along with an acceptable mortality rate, is reflective of the patients' morbid condition requiring OCM, DSC can be carried out with a relatively low incidence of sternal complications after cardiac surgery.

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