Outcomes of delayed sternal closure after complex aortic surgery

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Abstract

Objective: Open chest management during complex proximal aortic surgery may sometimes be necessary. Infectious complications such as mediastinitis and late aortic graft infection remain a concern. The objective of this study was to report our experience with open chest management and delayed sternal closure after complex proximal aortic surgery.

Methods: Between 1991 and 2007, 12 patients (1.2%, 12/1011) required open chest management and delayed sternal closure. Eight patients were men (67%), with a mean age of 56 years (range 28—83 years). Four cases involved redo-median sternotomy (33%) and seven cases (58%) involved acute dissection. All procedures were performed using total cardiopulmonary bypass with profound hypothermic circulatory arrest. Reasons for open chest management included hemodynamic instability, mediastinal edema, bleeding, and respiratory compromise.

Results: In-hospital mortality was 16.7% (2/12). Delayed sternal closure was achieved in 92% of patients (11/12). Mean time to closure was 3 days (range 1—9 days). Five patients (42%) required one or more mediastinal explorations prior to final closure. Mean length of stay was 51 days (range 1—186 days). Significant predictors of open chest management were pump time (p < 0.0001) and intra-operative blood transfusions (p < 0.002). Mean follow-up was 60 months (range 8—106 months). No patients developed mediastinitis or aortic graft infection during postoperative follow-up.

Conclusions: Open chest management with delayed sternal closure after complex aortic repairs may be performed with acceptable mortality. Open chest management does not appear to increase the risk of infectious complications (mediastinitis or graft infections) during complex proximal aortic replacement.

Keywords: Aortic surgery; Sternum

1. Introduction

Open chest management (OCM) remains an important strategy during major cardiovascular procedures that are complicated by bleeding, cardiac compromise, or mediastinal edema. With improved patient condition, resolution of coagulopathy and recovery from myocardial dysfunction, ultimate delayed sternal closure (DSC) is often achieved. This management regimen was first reported in 1975 [1] and has been noted to occur in 1.2—4.2% of adult cardiac procedures [2].

The use of delayed sternal closure after open chest management has predominantly been described for major cardiac procedures involving coronary artery bypass, valvular heart procedures, and ventricular assist implantations [3—7]. Although the incidence of mediastinal infection with DSC has been reported between 1 and 4%, no significant increase in the rate of mediastinitis has been observed when compared to non-open chest managed procedures [8]. Despite these reports, concerns over mediastinal infection especially in the setting of exposed aortic graft remains concerning. One report has suggested that prolonged OCM may lead to an increased risk of infection [2]. With this in consideration, outcomes regarding OCM and DSC during complex aortic surgery have not been reported. The purpose of this study was to report our experience with OCM and DSC after complex aortic procedures.

2. Materials and methods

2.1. Patient characteristics

Between January 1991 and January 2007, we performed 1011 proximal aortic procedures (aortic root, ascending,
transverse arch procedures). In 12 cases (1.2%), open chest management with delayed sternal closure was required during the perioperative period. Eight patients were men (67%), with a mean age of 56 years (range 28—83 years). Four cases involved redo-median sternotomy (33%), with two cases (17%) of acute dissection. Informed consent was obtained when possible and operative procedures were covered by general approval of the institutional review boards.

2.2. Operative procedures

The specific aortic procedures performed are listed in Table 1. A detailed description of our operative technique for proximal aortic reconstruction has been described previously [9]. All procedures were performed using total cardiopulmonary bypass with profound hypothermic circulatory arrest. Open chest management was defined as leaving the operating room without sternal closure after the primary aortic intervention. Reasons for OCM included hemodynamic instability, mediastinal edema, bleeding, and respiratory compromise. If OCM with DSC was required, then mediastinal isolation was accomplished by suturing a sheet of Esmark™ (Medline Industries, Inc., Mundelein, IL) to the skin, which was then covered using adhesive IoBan™ 2 (3M™, St. Paul, Minnesota). The sternum was held in the retracted position using either a sternal retractor or a ‘sternal stent’ constructed from a 60 cc plastic syringe.

2.3. Technique of DSC

Mediastinal exploration was performed every 24—48 h until DSC was completed. Mediastinal exploration was performed in the operating room or in the intensive care unit with sterile irrigation of mediastinal contents. Prior to DSC, mediastinal cultures were obtained, and antibiotic solution (2 g of vancomycin/l of normal saline) was used to irrigate the mediastinal contents using a Pulsavac™ wound system (Zimmer, Inc., Warsaw, Indiana). With resolution of mediastinal edema and improvement of cardiac function, the sternum was closed over chest drains. The decision to perform sternal closure was left to the discretion of the operating surgeon. If delayed closure was performed on the sixth postoperative day or later, we preferred to cover the aortic graft reconstruction with a pedicled omental flap. Patients were then placed on intravenous antibiotics until the chest drains were removed. Long-term intravenous antibiotics (6 weeks) were used if operative cultures isolated organisms.

2.4. Outcome variables and statistical analysis

In-hospital mortality was death occurring during hospitalization. Data were collected from chart reviews done by a trained nurse evaluator and were entered into a dedicated Microsoft Access database. Analysis was retrospective.

Data were managed under HIPAA confidentiality guidelines in a Microsoft Access database with encrypted patient identifiers. All analyses were conducted using SAS software version 9.1.3 (SAS Institute Inc., Cary, NC) running under Microsoft Windows XP Professional. Suspected risk factors for DSC were compared between the patients described here and our larger cohort of patients without DSC (1011 – 12 = 999 comparison patients). Continuous variables were evaluated by unpaired t test with log transformation as necessary to meet normality assumptions or Wilcoxon rank-sum as appropriate. Categorical variables were evaluated using Fisher’s exact test or chi square. The null hypothesis was rejected at a nominal alpha of p < 0.05.

3. Results

In-hospital mortality was 16.7% (2/12). Of the 12 patients managed using OCM, DSC was accomplished in 11 patients (92%); one patient died prior to closure. Mean time to DSC was 3 days (range 1—9 days). Five patients (42%) required one or more mediastinal explorations prior to final closure. One patient (8%) developed respiratory failure requiring tracheostomy; one patient (8%), whose operative cultures isolated Staphylococcus aureus, received long-term (6 weeks) of postoperative intravenous antibiotics as prophylaxis for graft infection; and two patients (17%) were closed using an omental flap for aortic graft coverage. No patients developed mediastinitis or aortic graft infection during postoperative follow-up (Table 2).

Significant predictors for the need for open chest management were pump time (p < 0.0001) and intraoperative blood product transfusions (p < 0.002), (Table 3). Mean length of stay was 51 days (range 1—186 days) for those patients managed with OCM. Mean follow-up was 60 months (range 8—106 months). Subsequent aortic procedures were performed in four of these patients (33%), one patient with a descending thoracic aortic aneurysm, and three patients with thoracoabdominal aortic aneurysms. No patients developed mediastinitis or aortic graft infection during the postoperative follow-up.

4. Discussion

Although several studies have reported the use of OCM and DSC during adult cardiac procedures, there is a paucity of data regarding its use during complex proximal aortic reconstructions. Based on the results of this study and the review of previous reports on OCM for adult cardiovascular procedures, similarities exist regardless of the intended
operation. In this study, the requirement of OCM in 1.4% of our experience with proximal aortic repairs was similar to that reported in series involving other cardiac procedures, 1.2–4.2%. In addition, the indications varied little between procedures. We reported similar indications for its use (hemodynamic instability, mediastinal edema, bleeding, and non-cardiac pulmonary edema) as previously reported. Time to sternal closure averaged 3 days with all sternal closures being accomplished by 9 days. Decision to close the sternum depended on the condition of the patient, improved cardiac function, negative fluid balance, and improved pulmonary status, but was ultimately left to the subjective discretion of the operating surgeon.

Previous studies have also reported that predictors of mortality with OCM with DSC have included the use of a ventricular assist device, bleeding, dialysis use, sternal infection, delay before closure, duration of inotropes, and blood pressure. Poor functional status and advanced cardiac disease requiring longer procedural times were risk factors for the requirement of OCM with DSC. We did not identify any risks associated with the need for OCM during proximal aortic reconstruction. In this study, however, we did identify increased blood and blood product transfusions, and prolonged cardiopulmonary bypass time as significant risk factors for delayed closure.

It was reassuring that we did not observe any mediastinal or graft infections in this cohort of patients. As has been reported previously, aortic graft infection is a devastating complication associated with as high as 50% mortality. Because of the potential for increased mediastinal infection with OCM, this was one of the primary questions we wanted to address in this study. The management strategy used in this series adopted from previous reports may have been responsible for the freedom from mediastinitis and graft infection. [2] If OCM is required we recommend mediastinal isolation (Esmark™), mediastinal irrigation every 48 h, intravenous antibiotics while the chest is open, flap coverage of the graft with omentum if feasible during DSC, and long-term intravenous antibiotics if mediastinal fluid cultures are positive for bacterial growth. Although there is no evidence that pedicled omental flap graft coverage or long-term intravenous antibiotics are beneficial in preventing graft infection, we still recommend these maneuvers as the complication of aortic graft infection is so devastating.

In conclusion, OCM with DSC during proximal aortic operations is associated with excessive bleeding and coagulopathy and results in significant mortality and morbidity. If managed with aggressive mediastinal irrigation, and prudent use of intravenous antibiotics and omental flap coverage, no increase in aortic graft infections may be observed.

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References


