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## Complications after sternal reconstruction: a 16-y experience



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### ABSTRACT

**Background:** Unlike risk factors associated with sternotomy complications, those associated with sternal reconstruction have not been well elucidated. We sought to examine complication rates after sternal wound reconstruction and to identify perioperative risk factors associated with these complications.

**Methods:** We evaluated the records of 230 consecutive patients who underwent sternal reconstruction with muscle flaps after cardiac surgery. Patient demographics, clinical comorbidities, and operative procedure types were evaluated against two outcome variables—major complications and reconstructive failure.

**Results:** The mean age of our cohort was 62 y. Major complications (readmission, reoperation, or death) occurred in 76 patients (33%), including mortality rate of 3.5%. Obesity, chronic obstructive pulmonary disease, and type of reconstructive procedure correlated with an increased risk of major complications. Reconstructive failure occurred in 39 patients (17%) and was associated with female gender, obesity, previous coronary artery bypass graft procedure, and prior left internal mammary artery usage. Regression analyses demonstrated that obesity is independently associated with an increased risk of major complications and that women are at an increased risk of reconstructive failure. Reconstructions involving the rectus abdominis were correlated with an increased risk of major complications, but this difference was not significant in multiple regression analysis. **Conclusions:** Usual risk factors for sternal wound development after cardiac surgery include diabetes, age, obesity, tobacco use, history of stroke, bilateral left internal mammary artery harvest, and significant blood transfusion. In distinction, this study found that the risks independently associated with major complications and reconstructive failures after reconstruction of sternal wounds are limited to obesity and female gender.

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## 1. Introduction

Sternal wound infections occur at an incidence of 0.75%–4% after open cardiac operations [1–11]. Known risk factors include diabetes [1,3,6,10–12], older age [1,7,11], obesity

[3,4,6,13], tobacco use [3,4,10], history of stroke [3,10,11], harvesting of the bilateral internal mammary arteries [4,11], and significant blood transfusion requirements [4,6,10]. The use of vascularized tissue transfer for sternal reconstruction has dramatically diminished mortality rates from the historical

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level of 50% [14] down to current levels of 3%–28% [2,3,9,15–19].

Although significant data exist regarding risk factors and complications associated with open cardiac surgery, similar information for patients undergoing sternal reconstruction are limited. Estimates of complication rates after sternal wound reconstruction vary widely between 5 and 65%, and come mainly from small published series [2,9,17–19]. Furthermore, few studies have specifically examined risk factors associated with these reconstructive complications [17,20]. It is unknown if the same factors that predispose a patient to develop a sternal wound infection are similar to those which lead to failure of the reconstructive procedure. Elucidating this information would assist in informing patients, potential proactive reduction of known risk factors, and possible adjustment of the reconstructive plan.

Treatment of sternal wounds takes on many forms. For limited wounds, conservative management, including debridement, dressing changes, negative pressure therapy, antibiotics, and nutritional support, may be sufficient. However, reconstruction with vascularized flaps is often required, including patients with large soft tissue defects, sternal osteomyelitis, mediastinitis, or sepsis. Various flaps have been described for definitive management of sternal wounds. Pectoralis major muscle, pectoralis major myocutaneous, rectus abdominis muscle, and omental flaps are most often used. Comparison of outcomes between these reconstructive options continues to be limited because of the assortment of sternal defects, variable patient presentations, low case volumes, and individual surgeon preference [21]. Gaining an understanding of which reconstructive procedures have the lowest morbidity and highest success rates would also be valuable.

This study reviews the longitudinal experience of a plastic surgery section at a tertiary medical center with complex sternal wound reconstruction after open cardiac surgery. We sought to 1) examine specific complication rates after sternal wound reconstruction, 2) identify risk factors associated with these complications, and 3) compare the effect of different muscle flap procedures on postoperative complications.

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## 2. Methods

Our study was approved by the Institutional Review Board before initiation. All patients who underwent sternal reconstruction after open cardiac surgery between September 1997 and July 2012 at the University of Michigan Health System were retrospectively identified from the coding database. Only patients who underwent muscle flap closures by faculty within the Section of Plastic Surgery were included. Sternal wounds treated nonoperatively, reconstructions after noncardiac surgery procedures (e.g., pneumonectomy, tumor resection), omental flap coverage, open reduction, and internal fixation patients, and pediatric patients (aged <18 y) were excluded.

Patient demographics, preexisting comorbidities, tobacco use, plastic surgeon, microbiological data, and surgical procedure types were determined using retrospective chart review. Renal insufficiency was defined as a serum creatinine of  $\geq 1.5$  g/dL. Serum albumin was recorded and then categorized based on previously used ranges for analysis [13]. Sternal wounds

were classified as “acute onset” if the initial clinical presentation occurred within 6 wk of the index cardiac operation. All other wounds were considered to be “chronic.” Time to reconstruction was defined as the time between wound presentation and definitive reconstruction. The date of presentation for a sternal wound was based on the first clinic, emergency department, or inpatient note that documented the wound.

Cardiac surgery procedures were categorized as coronary artery bypass graft, valve repair, aortic reconstruction, or other procedures (e.g., cardiac transplant). Initial analysis of the type of reconstruction performed included distinction between pectoralis major muscle(s) only flap(s), pectoralis major myocutaneous flaps, and pectoralis major muscle flaps with the superior portion of the rectus abdominis muscles mobilized in continuity with the pectoralis. However, these flaps were ultimately combined into a single category because of similarities in the incidence of measured outcomes and lack of clear distinction in some operative reports between pectoralis muscle flaps and pectoralis myocutaneous flaps. Reconstructions were categorized as rectus muscle or pectoralis/rectus combination when an abdominal incision was required and the inferior portion of the rectus muscle was divided for flap transposition.

Primary outcome measures were major postoperative complications (requiring readmission to the hospital, a second operative procedure, or perioperative death) and reconstructive failure (persistent mediastinitis, requiring repeat surgical debridement/reconstruction, or wound care >6 wk). Patients who required rehospitalization and/or reoperation contributed one “major complication” to the total number of outcome events. Perioperative deaths were fatalities occurring either within 30 d of flap reconstruction or during the same hospitalization. Reconstructive failure was defined as persistent mediastinitis or wounds requiring repeat surgical debridements/reconstruction or long-term wound care (greater than six weeks).

Data analysis was performed using the SAS 9.3 statistical package (Cary, NC). Continuous variables of age, body mass index, serum albumin, and time to reconstruction were transformed to categorical variables at clinically relevant cutoff points. To examine the effect of individual risk factors on the rate of major complications, bivariate statistics were performed using the chi-squared test or the Fisher exact test as appropriate. *P* values of  $\leq 0.05$  were considered to be statistically significant. Multivariable logistic regression was then performed to identify predictors of major complications, while controlling for other risk factors. Independent variables were included in the multivariate analysis if  $P < 0.10$  in the bivariate analysis. Because of the limited number of outcomes of interest, addition of more variables or degrees of freedom was not possible without grossly overfitting the model.

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## 3. Results

From September 1997–July 2012, 230 patients underwent muscle flap reconstruction of a sternal wound resulting from open cardiac surgery and had reconstructive flap procedures performed by plastic surgeons at the University of Michigan Health System. Patients undergoing omental flap (1) and

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