HAWLEY H. SEILER RESIDENT AWARD PAPER

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Bilateral Internal Mammary Artery Use for Coronary Artery Bypass Grafting Remains Underutilized: A Propensity-Matched Multi-Institution Analysis

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Background. Bilateral internal mammary arterial (BIMA) grafts have repeatedly demonstrated superior outcomes compared with single IMA (SIMA) after coronary artery bypass grafting (CABG). Despite known survival benefits with BIMA use, perceived perioperative challenges often preclude BIMA use. We hypothesized that the use of BIMA remains underutilized, even in low-risk patients.

Methods. A total of 43,823 primary, isolated CABG patients in a regional Society of Thoracic Surgeons Database were evaluated. Patients were stratified by BIMA versus SIMA use. Surgical candidates considered "low risk" for BIMA use included the following: age less than 70 years; no or mild chronic lung disease; body mass index less than 30; and absence of diabetes. The BIMA patients (n = 1,333) were 1:1 propensity matched to SIMA patients (n = 1,333) and outcomes were compared.

Results. Overall, BIMA use was 3%; 24% (n = 10,327) of patients met "low-risk" criteria for BIMA use. Among "low-risk" patients, BIMA utilization was 6%. Propensity-matched comparisons revealed similar preoperative risk profiles between BIMA and SIMA patients (Predicted Risk of Mortality [PROM] 1.1% vs 1.1%, $p > 0.05$). The BIMA use was associated with longer cross-clamp time (71 vs 62 minutes, $p < 0.05$). Importantly, BIMA use was not associated with increased postoperative mortality, morbidity, or hospital length of stay (all $p > 0.05$). However, hospital readmission within 30 days was 41% greater for BIMA patients compared with SIMA patients ($p = 0.01$).

Conclusions. Bilateral IMA graft use appears to remain underutilized in the modern surgical era, even in low surgical risk patients. The BIMA use does not appear to increase the risk of postoperative morbidity, although requires longer operative times and a higher risk for readmission. Efforts to more clearly understand surgeon motivators for the use of BIMA grafting are needed.

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Coronary artery bypass grafting (CABG) remains one of the most common operations performed in the United States [1]. The left internal mammary artery to left anterior descending conduit has become standard of care for performance of CABG due to superior patency [2]. The benefits of arterial grafts include improved survival

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and freedom from myocardial infarction, improved long-term graft patency rates with lower late occlusion, and lower rates of reintervention compared with saphenous vein graft (SVG) [2–4]. These differences are largely due to the purported advantages of the inherent characteristics of the arterial endothelium of the left internal mammary artery graft [5–7]. Patients often require more than 1 bypass graft during CABG. Thus, the debate as to the optimal strategy for CABG conduit selection has evolved over the past few decades.

The use of bilateral IMA (BIMA) grafts has been evaluated to determine whether this strategy can improve outcomes for patients undergoing CABG. Prior reports have repeatedly demonstrated superior outcomes favoring BIMA use [8, 9]. Despite the documented survival benefits with BIMA grafting, perceived perioperative challenges often preclude routine BIMA utilization. These challenges include longer operating room times and concerns for higher rates of perioperative morbidity and mortality associated with increased sternal wound complications and infection [10–13]. As a result, the perceived tradeoff of improved long-term survival and graft patency with an increased potential for perioperative morbidity has resulted in low utilization of BIMA grafts in documented series [1, 14–17].

The purpose of this study was twofold: (1) to evaluate the utilization of BIMA grafts within a statewide, multi-institution cohort of CABG patients, including those from community and tertiary care programs; and (2) to evaluate the outcomes of BIMA grafting compared with SIMA use after accounting for baseline patient risk. We hypothesized that BIMA grafting during CABG within the Commonwealth of Virginia remains underutilized, even in low-risk patients.

Material and Methods

This investigation was exempt from formal Institutional Review Board review at each participating center as it represents a secondary analysis of the Virginia Cardiac Surgery Quality Initiative (VCSQI) data registry with the absence of Health Insurance Portability and Accountability Act patient identifiers and because the data are collected for quality analysis and purposes other than research.

Patients and Data Acquisition

De-identified patient records for primary, isolated CABG operations were evaluated from the VCSQI database for the study period January 1, 2001 through December 31, 2013. Study inclusion criteria included patients undergoing primary, isolated coronary artery bypass grafting operations (STS Procedure Type "CAB Only" and Incidence type "First Cardiovascular Surgery") that required 2 or greater vessel grafting. All CABG procedures represent standard surgical approaches to surgical myocardial revascularization with and without the use of cardiopulmonary bypass support. Patient preoperative risk was assessed by prevalence of patient comorbid disease, extent of coronary artery disease, operative status, and individual calculated The Society of Thoracic Surgeons Predicted Risk of Mortality (STS PROM) scores. Patients were stratified according to BIMA versus SIMA use during CABG. In addition, surgical patients considered ideal, low-risk candidates for BIMA use were identified as those with the following aggregate of preoperative characteristics: age less than 70 years; no or mild chronic lung disease; body mass index (BMI) less than 30, and absence of diabetes.

Measured Outcomes

The primary outcomes of interest included the incidence of BIMA (vs SIMA) use during CABG as well as risk-adjusted differences in perioperative outcomes as a function of BIMA use. Secondary outcomes included risk-adjusted differences in the prevalence of preoperative patient risk profiles and operation-related characteristics in order to determine the effect of BIMA use among low-risk surgical candidates. Standard STS definitions for preoperative variables, operative characteristics, and postoperative events and complications were utilized, including prolonged ventilation (>24 hours of mechanical ventilation), presence of any new onset atrial fibrillation, and renal failure (increase in serum creatinine level greater than 2.0 or a doubling (×2) of the most recent preoperative creatinine level).

Statistical Analysis

Categoric variables are expressed as group percentages, while continuous variables are expressed as either mean ± standard deviation or median [25th, 75th percentile] depending upon overall variable distribution. Descriptive, univariate statistics included either the Pearson χ^2 or Fisher exact test for categoric variables and either independent sample single factor analysis of variance for comparisons of normally distributed data or the Mann Whitney *U* test for non-normally distributed data comparisons. Calculated test statistics were utilized to derive all 2-tailed *p* values with standard statistical significance set to a *p* value less than 0.05.

To account for potential confounding effects and treatment allocation bias between study cohorts on postoperative outcomes, propensity-score matching was performed to generate a study cohort of matched BIMA and SIMA patients. Propensity scores were estimated using logistic regression modeling with likelihood for BIMA use as the response variable adjusted for the influence of baseline patient risk as assessed by STS PROM score as well as the number of bypass grafts performed during CABG. In our modeling methodology we chose to include the modeled factors as potential covariates to generate a parsimonious model that adjusted for preoperative patient risk without overestimating the model by the inclusion of too many covariates. The STS PROM scores for each patient were included as the principle factor in our models as this score has become a widely accepted measure of preoperative risk for patients undergoing CABG procedures. We did not adjust for other factors as covariates in our model that are included in the calculation of the STS PROM score so as to avoid