Why Did You Not Use Both Internal Thoracic Arteries?

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That is the question every cardiologist should ask if the patient he or she has referred for primary surgical coronary revascularization returns from the operating room with a single internal thoracic artery graft. There is a substantial body of evidence demonstrating that the majority of coronary bypass patients benefit more when coronary artery bypass graft (CABG) surgery is performed with both internal thoracic artery conduits rather than just one.1-4 However, only 4.4% of primary isolated CABG cases in the 2011 Society of Thoracic Surgeons National Adult Cardiac Surgery Database received bilateral internal thoracic artery (BITA) grafting.5 There are several putative reasons for this failure of adoption, but referring cardiologists and patients should demand better.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

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Why are American surgeons doing so few BITA grafts? Fundamentally, U.S. surgeons are responding to their practice environment, especially to a fear of deep sternal wound infection in an increasingly obese, diabetic population of patients. The surgeon pays a large and immediate political price for a deep sternal wound infection and receives relatively little credit for the extra years that BITA grafting adds to a patient’s life in the future. There is also a relative financial disincentive to perform BITA grafting: incremental payment for the second internal thoracic artery graft is small and considered the extra time required in the operating room. Moreover, the Centers for Medicare and Medicaid Services no longer reimburse for extra care necessary for treatment of mediastinitis after cardiac surgery, because this is now deemed a never event. Thus, surgeons, who are increasingly employed by hospitals and hospital systems, are under intense pressure to perform CABG surgery that is safe and cost-effective according to short-term metrics. Any perceived tradeoff, however small or misinformed, between the long-term benefit of BITA grafting and short-term risk of mediastinitis, may discourage adoption of BITA grafting.

Lytle et al6 from the Cleveland Clinic published the seminal study of the effect of BITA grafting on survival during 20 postoperative years in a cohort of 8123 single internal thoracic artery (SITA) and 2001 BITA patients after primary isolated CABG performed between 1971 and 1989. They identified 1152 propensity-matched pairs and followed them for a mean of 16.5 years. Survival of BITA and SITA groups at 7, 10, 15, and 20 years was 89% versus 87%, 81% versus 78%, 67% versus 58%, and 50% versus 37%, respectively (P<0.0001). Divergence of BITA and SITA hazard function curves continued to widen through 20 postoperative years. Advanced age, low ejection fraction, and noncardiac risk factors decreased overall survival, but the incremental benefit of BITA grafting persisted.

Taggart et al7 published a systematic review of studies comparing bilateral and single internal mammary arteries in The Lancet. The 7 cohort studies that met their inclusion criteria included 15,962 patients (11,269 SITA and 4,693 BITA). The BITA group had better survival than the SITA group, with a hazard ratio for death of 0.80 (95% confidence interval, 0.70–0.94). See Figure 1 below.6

Catano et al7 later posed the controversial question, “Why do UK cardiac surgeons not perform their first choice operation for coronary artery bypass graft?” By postal survey they queried United Kingdom cardiac surgeons as to what conduits they would want if they had CABG surgery performed for themselves. Forty-nine percent of respondents wanted BITA grafting or >2 arterial conduits. However, the contemporary 2001 database of the Society of Cardiothoracic Surgeons of the United Kingdom and Ireland revealed that approximately 15% of isolated primary CABG cases used >1 arterial graft. Reasons surgeons gave for not performing BITA included, in order of declining frequency, the learning curve, concern that morbidity may be higher, the procedure may take too long, mortality may be higher, and absence of proof of benefit. Nonetheless, 56% of respondents thought that at least a quarter of their patients would benefit from BITA, and 29% of surgeons believed that more than half of their patients would benefit, implying that multiple arterial grafting should not be reserved for a minority of selected cases. The observation that a learning curve was the most commonly identified barrier to multiple arterial grafts suggests that scrutiny of cardiac surgeons in the United Kingdom may play a role in clinical decision making.

In the current edition of Circulation, Dorman et al8 report their retrospective single-center study of propensity-matched cohorts of diabetic patients who underwent CABG with either SITA (n=414) or BITA (n=414), followed for a mean of 8.9 and maximum of 30.1 years. There was no difference in operative mortality, sternal wound infection, or 30-day morbidity between groups. Median survival was significantly enhanced in the BITA versus SITA group (13.1 versus 9.8 years; P=0.001). BITA grafting was associated with improved late survival on Cox regression analysis (P=0.003). Of course, the present study has the limitations of all retrospective analyses; complex statistical techniques were used to minimize the bias in preoperative patient selection but cannot substitute for a prospective randomized study.
These results are similar to ours at Emory University, showing that BITA grafting is associated with significantly improved long-term survival, even among diabetic patients.\(^9\) In the Emory study, 3527 consecutive isolated CABG cases (812 BITA and 2715 SITA) were studied with propensity-adjusted logistic and Cox regression models to estimate the effect of BITA on short-term outcomes and long-term survival for diabetic and non-diabetic patients. There was no significant difference in 30-day rates of death, stroke, or myocardial infarction between non-diabetic patients who had BITA versus SITA or between diabetic patients who had BITA versus SITA. BITA grafting conferred a 35% reduction of death (95% confidence interval, 12–52%; \(P=0.006\)) in the long-term hazard of death equally for nondiabetic and diabetic patients \((P=0.93)\). Deep sternal wound infection was more common among diabetic than among non-diabetic patients \((1.5\% \text{ versus 0.7\%})\) but was similar within non-diabetic \((1.0\% \text{ versus 0.6\%})\) and diabetic patients \((1.7\% \text{ versus 1.5\%})\) who had BITA versus SITA. Overall, BITA and SITA patients had similar rates of deep sternal wound infection \((1.2\% \text{ versus 1.0\%})\). After rigorous statistical adjustment for other risk factors, we found that the use of BITA provided a statistically significant overall survival advantage at 8 years compared with the use of SITA alone, not only in the non-diabetic population but also in patients with diabetes mellitus.

Figure 2 shows Kaplan-Meier survival estimates for 9 years of follow-up among subgroups, revealing a survival benefit with bilateral internal thoracic artery (BITA) grafting in diabetic and non-diabetic patients compared with single internal thoracic artery (SITA) grafting. Reproduced from Puskas et al\(^9\) with permission from the publisher. © 2012, Elsevier.

Some early studies questioned the benefit of BITA in patients with diabetes mellitus.\(^11\) However, more recent reports have shown better outcomes with BITA use in diabetic patients at early follow-up,\(^13,14\) although superficial and deep wound infection remained a concern.\(^15,16\) Recent data have shown that the incidence of superficial or deep wound infection after BITA use is \(\approx 2\% \text{ to 3\%}\) and is not different from that in patients who receive routine isolated CABG with SITA grafting.\(^17\) However, Matsa et al\(^18\) found a 10-fold increase in deep sternal wound infection when BITAs were used in obese, diabetic women and advocated against the use of BITA in this cohort. We believe that avoiding the use of a second internal thoracic artery in diabetic, morbidly obese women with preoperative glycosylated hemoglobin levels \(>7.5\%\) may help decrease the incidence of deep sternal wound infection.\(^10\)

The Arterial Revascularization Trial,\(^19\) the only large prospective randomized trial of BITA versus SITA grafting ever undertaken, has recently completed enrollment with a primary end point of survival at 10-year follow-up. At 28 hospitals in 7 countries, 3102 patients having isolated primary CABG were randomly assigned to SITA \((n=1554)\) or BITA \((n=1548)\). Approximately 40% of cases were performed off pump; 23.7% of the patients had diabetes mellitus. Mortality at 30 days \((1.2\% \text{ SITA versus 1.2\% BITA})\) and at 1 year \((2.3\% \text{ SITA versus 2.5\% BITA})\) were similar between groups. The rates of stroke, myocardial infarction, and repeat revascularization were all \(\leq 2\%\) at 1 year and similar between the 2 groups. Sternal wound reconstruction was required in 0.6% and 1.9% of the SITA and BITA groups, respectively, a difference that was statistically significant \((\text{risk ratio}, 3.24 \text{ [95\% confidence interval, 1.54–6.83]})\). These results suggest that the use of BITA grafts is feasible on a routine basis. The added operative time needed to harvest BITA grafts in the Arterial Revascularization Trial was an average of 23 minutes. This definitive trial will finally settle the issue of whether there is an unequivocally compelling evidence base for BITA grafting.
The recent 2011 report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines for use in CABG operations recommends the use of a second internal mammary artery (class IIa) to graft the left circumflex or right coronary artery (when critically stenosed and perfusing viable left ventricular myocardium), citing current evidence of improved survival and decreased reintervention.\(^8\) The guidelines do not offer specific recommendations for the choice of conduits in patients with diabetes mellitus.

As 5-year results from the Synergy Between Percutaneous Coronary Intervention and Cardiac Surgery (SYNTAX) and Future Revascularization Evaluation in Patients with Diabetes Mellitus; Optimal Management of Multivessel Disease (FREEDOM) trials confirm that CABG is the preferred therapy for complex multivessel coronary artery disease, especially among patients with diabetes mellitus, it becomes increasingly important that state-of-the-art CABG be performed widely and routinely. Short-term metrics of quality in CABG surgery should include BITA grafting; present metrics and incentives favor SITA. Federal agencies and private insurers should incentivize broad adoption of BITA grafting and act to reverse the present unintended consequence of discouraging BITA grafting by having labeled postoperative mediastinitis a never event.

Dorman et al correctly conclude that, “Given the documented benefits of CABG in diabetic patients with extensive coronary artery disease, BITA grafting is the procedure of choice in those patients in whom the operation is technically feasible.”\(^8\)

**Disclosures**

None.

**References**

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