

Is It True Bilateral Internal Thoracic Artery Harvest for Coronary Artery Bypass Grafting Increase the Risk of Mediastinitis?

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Abstract

Summary: The single internal thoracic artery (SITA) has been used almost exclusively as a pedicled graft. Many publications report that bilateral pedicled internal thoracic artery (ITA) grafting increases the risk of mediastinitis. Recently in order to gain the additional length, increase the number of arterial anastomoses and decrease the occurrence of deep sternal infections, there has been an increasing popularity of bilateral use of the skeletonized internal thoracic artery (ITA) for CABG. The aim of this article is to review English literature from multicenter and different cardiac surgeon's experiences regarding this fact. We used terms bilateral mammary harvesting, harvesting of bilateral mammary, mediastinitis and related keywords to search MEDLINE, other literature databases and article reference lists for English-language single versus bilateral internal mammary artery for coronary artery bypass grafting that were published from 1990 – December, 2007. Current available evidence shows that skeletonized BITA grafting carries an acceptable risk of deep sternal infection but is not recommended for repeat CABG or for patients with chronic obstructive pulmonary disease (COPD). Skeletonized BITA grafting can be safely applied in almost every patient. All cardiac surgeons should be trained efficiently in using skeletonized BITA.

INTRODUCTION

Deep sternal wound infection remains infrequent complication after coronary artery bypass grafting (CABG), and is associated with significant morbidity, mortality, prolonged hospitalization with increased cost of care. Patients with bilateral internal thoracic artery (BITA) grafts had improved freedom from myocardial infarction, recurrence of angina pectoris, percutaneous coronary angioplasty, and repeat operation [1, 2, 3]. Pedicled ITA is isolated from the chest wall together with the vein, muscle, fat, and accompanying endothoracic fascia. Using electrocautery for harvesting damages the blood supply to the sternum and this in turn impedes sternal healing and exposes the sternum to the risk of early dehiscence and infection. Most surgeons do not routinely use BITA grafting because multiple retrospective clinical studies have shown that the technique was associated with an increased risk of deep sternal infections, especially in diabetic, elderly, and obese patients [4, 5, 6].

A surgical technique was developed a decade ago in which

the ITA is dissected as a skeletonized vessel [7]. The advantage of using a skeletonized ITA is the preservation of collateral blood supply to the sternum. The skeletonized artery is gently isolated with silver clip and scissors without the use of cauterization, a factor that probably decreases collateral vessel damage. The advantages of this technique are that a skeletonized artery is distinctly longer and its spontaneous blood flow is greater than that of a pediculated ITA [8]. Clinical studies using technetium-99m methylene diphosphate bone scanning and single photon emission computed tomography provided evidence that dissecting an ITA as a pediculated graft reduced blood supply to the sternum more than harvesting an ITA as a skeletonized vessel [9, 10, 11].

METHODS

We used terms bilateral mammary harvesting, harvesting of bilateral mammary, mediastinitis and related keywords to search MEDLINE, other literature databases and article reference lists for English-language single versus bilateral internal mammary artery for coronary artery bypass grafting

that were published from 1990 – December, 2007.

DISCUSSION

Harvesting of pedicled BITAs has been associated with an increased risk of deep sternal wound infection, especially in diabetic, elderly, and obese patients [5, 6, 12]. Other risk factors for sternal complications include obesity, chronic obstructive pulmonary disease, advanced age, peripheral vascular disease, redo surgery, postoperative low-output syndrome, and reoperation for bleeding [13]. Kouchoykos et al demonstrated sternal wound infection rates of 1.9% and 6.9%, respectively, for single ITA and bilateral ITA [5]. Furthermore, in diabetic patients undergoing CABG the use of BITA has been associated with higher percentages of mediastinitis which can be as high as >10% [14, 15]. Several mechanisms may be involved in poor sternal healing in patients undergoing BITA grafting, but the main one is probably related to decrease sternal blood supply after BITA harvesting. Numerous studies have demonstrated that harvesting of pedicled BITAs causes transient almost complete devascularization of the sternum [16, 17]. A surgical technique was developed a decade ago in which the ITA is dissected as a skeletonized vessel [7]. The use of techniques for skeletonizing the ITAs during preparation, thus minimizing the decrement in sternal blood supply, may decrease the incidence of sternal complications [18]. De Paulis et al [19] prospectively collected data on patients undergoing coronary artery bypass operations with at least a single internal thoracic artery were reviewed. The last 450 patients receiving bilateral internal thoracic artery grafts were compared with 450 patients who received a single internal thoracic artery during the same period. They concluded that bilateral internal thoracic artery harvesting carries a higher risk of sternal infection than harvesting a single internal thoracic artery. Skeletonization of both internal thoracic arteries significantly decreases this risk. Peterson and collage [20] reviewed prospectively gathered data on all patients who have undergone coronary artery bypass grafting and received bilateral internal thoracic artery grafts at their institution since 1990. They compared patients with diabetes who received skeletonized (n = 79) versus conventional pedicled (n = 36) internal thoracic artery conduits. They found that Skeletonization of internal thoracic artery conduits lowers the risk of deep sternal wound infection in patients with diabetes undergoing bilateral internal thoracic artery grafting. Calafiore et al [21] reviewed prospectively one thousand one hundred forty-six patients underwent isolated myocardial revascularization

using BIMAs, 304 receiving pedicled grafts (group A, October 1991 through May 1994) and 842 receiving skeletonized conduits (group B, June 1994 through June 1998). Group B had a higher incidence of patients with diabetes (223 versus 40, $p < 0.001$). Concluded that skeletonized BIMA conduits allowed them to increase the number of BIMA anastomoses per patient with a lower rate of sternal wound complications and angiographic results similar to those obtained with pedicled BIMA conduits.

The combination of current evidence in the literature and new evidence provided by Boodhwani et al [22] performed a prospective, randomized, double-blind, within-patient comparison of skeletonized and nonskeletonized ITAs in patients undergoing coronary surgery, and indicates that skeletonized harvesting of the ITA reduces pain and hypoperfusion of the sternum compared with conventional pedicle harvesting. This combined evidence confirms that skeletonized harvesting of the ITA should be indicated in diabetic patients undergoing bilateral ITA revascularization. Kai et al [14] evaluated the effects of coronary artery bypass with off-pump skeletonized bilateral internal thoracic artery grafting in patients with insulin-dependent diabetes. One hundred eighty-five consecutive patients with insulin-dependent diabetes who underwent isolated coronary artery bypass grafting with bilateral internal thoracic grafts were retrospectively compared according to surgical technique, off-pump grafting with skeletonized internal thoracic artery (n = 162) or on-pump grafting with pedicled internal thoracic artery (n = 23). Their results support the surgical management of coronary artery bypass grafting in insulin-dependent diabetics using off-pump skeletonized bilateral internal thoracic artery grafting. Hirose et al [23] in their study between June 1, 1997 and March 31, 2002, a total of 1123 consecutive patients underwent isolated CABG at Shin-Tokyo Hospital Cardiovascular Group (Shin-Tokyo Hospital and Kobari General Hospital), including 467 (41.6%) with BIMA grafting. Among them, a total of 214 patients were found to be diabetic preoperatively, and their perioperative and follow-up data were prospectively collected. Skeletonization of the IMA was performed using an ultrasonic scalpel (Harmonic Scalpel, dissecting-hook type; Ethicon Endo-Surgery, Cincinnati, OH). They found that Skeletonized BIMA grafting for diabetic patients is safe and have potential contribution for the reduction of chest wound complications. Because of the preferable results of skeletonized grafting, the frequency of BIMA grafting in their institution increased dramatically after the introduction

of the skeletonized technique [23]. Matsa et al [24] prospectively included 231 consecutive diabetic and 534 nondiabetic patients from May 1996 to April 1998, patients underwent bilateral skeletonized internal thoracic artery grafting. Mean age was 66 years. Compared with the nondiabetic group, the diabetic group comprised more women (29% vs 18%, $P = .001$), had a greater prevalence of hypertension (53% vs 44%, $P = .019$) and congestive heart failure (20% vs 14%, $P = .016$), but a lower prevalence of preoperative acute myocardial infarction (26% vs 34%, $P = .027$). Concluded that bilateral skeletonized internal thoracic artery grafting is a good surgical revascularization option in diabetic patients. Operative mortality and prevalence of sternal infection are comparable with those of nondiabetic patients. However, the risk of sternal infection in obese diabetic women is high, and for them they advocate the use of a single artery instead of bilateral internal thoracic arteries. Pevni et al [25] in their study from May 1996 to December 2001, 1518 consecutive patients underwent skeletonized BITA grafting. Of the 1175 male and 343 female patients, 659 (43.4%) were older than 70 years and 578 (38.1%) had diabetes. Concluded that BITA grafting is associated with low morbidity and good long term results. Use of skeletonized BITA is an appropriate technique for the elderly and diabetics; however, it is not recommended for repeat operations or for patients with COPD. Multiple regression analysis [24] showed chronic obstructive pulmonary disease (COPD) (OR 8.6, 95% CI 3.5–20.9), repeat operation (OR 6.7; 95% CI 1.7–26.4) and chronic renal failure (OR 3.1, 95% CI, 1.1–8.9) to be associated with increased risk of sternal infection. Follow-up (60–127 months) revealed 274 late deaths. Kaplan-Meier 10 year survival for patients younger than 65, between 65–74, and older than 75 was 84%, 77% and 66%, respectively. Cox regression analysis revealed increased overall mortality (early and late) in patients with peripheral vascular disease (RR 2.4, 95% CI 1.8–3.2), patients older than 75 years (RR 2.1, 95% CI, 1.4–3.3), repeat operations (RR 2.0, 95% CI 1.1–3.6), patients with preoperative acute myocardial infarction (RR 1.6; 95% CI 1.2–2.0, and in diabetics (RR 1.5, 95% CI 1.2–1.9). Postoperative coronary angiography performed in 252 symptomatic or ischemic patients revealed an ITA patency rate of 90.8%. Toumpoulis et al [26] raised the question of whether bilateral internal thoracic artery (BITA) harvest for coronary artery bypass grafting (CABG) increases the risk of mediastinitis (also deep sternal infection). They stated that skeletonized BITA grafting can be performed with acceptable risk in all patients including

higher risk group such as diabetics. Skeletonized harvesting [27] of the ITA together with a better glucose control in diabetic patients may significantly reduce the incidence of mediastinitis, and if ITA is used bilaterally, should always take in the full skeletonized technique in obese and diabetic patients. Skeletonized harvesting of the ITA can be performed either with small scissors and hemoclips or with an ultrasonic Harmonic scalpel [19, 28]. Higami et al [28] reported that the Harmonic scalpel causes minimal charring and thermal injury to the surrounding tissues of the ITA. Bonacchi et al [29] in a retrospective study between January 1997 and July 2003, 552 consecutive patients underwent grafting of the circumflex artery with a skeletonised in situ RIMA routed through the transverse sinus. The inclusion criterion was the presence of an angiographically graftable branch of the circumflex artery (size > 1.5 mm). Surgeons chose skeletonised IMAs according to their own preference and the patient's stability. Diabetes, female sex, old age, and chronic obstructive pulmonary disease were not considered contraindications for use of both IMAs. Concluded that Patients who received bilateral IMA grafts for left coronary system revascularisation had improved early and late outcomes and decreased risk of death, reoperation, and angioplasty. Taggart [30] reviews evidence for the routine use of bilateral internal mammary artery (BIMA) grafts in CABG patients. In their routine practice they use bilateral skeletonised IMA in all patients, including diabetics, unless they are significantly obese or likely to require prolonged ventilation. Diabetic patients are those with potentially most to gain from BIMA grafts as they often have more severe, diffuse, and distal disease. Appropriate patient selection and modification of the IMA harvesting technique can significantly reduce the risk of impaired wound healing in these patients [30]. BIMA grafts are not contraindicated in diabetes, per se, unless the patient is significantly obese [24] or has significant chronic lung disease [31]. Using photon emission computed tomography Cohen and colleagues demonstrated that the skeletonisation technique results in superior sternal blood flow preservation [11]. Several groups have reported that skeletonisation of IMA grafts significantly reduces risk of wound healing in all patients [21, 32]. Endo et al [33] report on 1131 patients undergoing bypass surgery (443 receiving BITA grafts) who were followed for a median postoperative interval of 6 years. After using Cox regression analyses to identify variables that had a significant impact on outcomes in a multivariate setting, they concluded that, compared with SITA grafting, the BITA strategy decreased the likelihood of reoperation

and decreased the risk of cardiac death for patients with an ejection fraction >40% and for patients with left main stenoses. In addition to concluding that BITA grafting produced some improved outcomes, they further noted that the full benefit of BITA grafting might not be appreciated during their relatively short follow-up interval. They are right on both counts [34]. Considerable data now exist that confirm and extend their observations concerning the benefit of BITA grafts. The largest patient cohort followed for the longest postoperative interval was the subject of a recent retrospective, nonrandomized study from the Cleveland Clinic Foundation; it involved 10 124 patients (2001 receiving BITA grafts) who were followed for a mean postoperative interval of 10 years[1]. Multiple statistical strategies were used for risk adjustment, including propensity matching and parsimonious and nonparsimonious risk factor models. All comparisons demonstrated better survival rates and fewer reinterventions (reoperation or percutaneous transluminal coronary angioplasty [PTCA]) for patients receiving BITA grafts compared with those receiving only a SITA graft. The survival and reoperation hazard function (percent reoperation per year) curves for propensity-matched SITA and BITA patients for 12 postoperative years; a higher survival rate and fewer reoperations are shown for the BITA group, and an increasing benefit of BITA grafting is seen with increasing follow-up interval.

CONCLUSIONS

The current available evidence shows that careful skeletonized harvesting of the internal thoracic artery (ITA) offers many advantages with an acceptable risk of complications compared to pedicled harvesting of the ITA. Skeletonized BITA grafting can be performed with acceptable risk in all patients including higher risk group such as diabetics, but is not recommended for repeat CABG or for patients with COPD. We agree with the authors that all cardiac surgeons should be trained efficiently with regard to skeletonized harvesting of the BITA.

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