Bilateral Skeletonized Internal Mammary Versus Single-Pedicled Internal Mammary Grafting in the Elderly

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Abstract

Background: The use of the bilateral internal mammary arteries has been reserved mainly for younger and low risk patients.

Aim: To assess the safety and efficacy of BIMA grafting in older patients (≥ 70 years).

Methods: We reviewed the records of all consecutive patients ≥ 70 years old who underwent coronary artery bypass surgery with a BIMA graft in our institute over a 2 year period. Demographic data, operative data, perioperative morbidity and mortality were recorded. Findings were compared with a matched-size group of patients who underwent CABG with a left internal mammary artery graft to left anterior descending artery.

Results: The study sample included 136 patients, of whom 68 underwent BIMA grafting and 68 LIMA grafting. Baseline demographic and clinical characteristics were similar in the two groups. There was no significant difference in operative mortality between the BIMA and LIMA groups (1.5% vs. 0%, $P = 0.3$) or in mortality during follow-up at a mean of 16 months (4.4% vs. 2.9%, $P = 0.4$, respectively). There was no difference between the groups in the incidence of perioperative complications, readmission and reintervention rates during follow-up. Significant between-group differences were noted for mean cardiopulmonary bypass time (93.2 ± 34.7 min with BIMA vs. 108.8 ± 40.7 min with LIMA, $P = 0.02$) and for red blood cell transfusion (1.9 ± 1.9 vs. 4.3 ± 2.8 packed cells/patient, $P < 0.001$).

Conclusions: The performance of mainly arterial revascularization with BIMA grafting in patients 70 years or older is as safe as LIMA grafting, with the added advantage of being a better conduit than saphenous vein graft, requiring fewer blood transfusions, and shorter cardiopulmonary bypass time.

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The use of the left internal mammary artery to bypass the left anterior descending coronary artery has become the standard of care in coronary artery bypass grafting. The advantages of LIMA grafts compared to the saphenous vein grafts include better graft patency [1], fewer subsequent adverse cardiac events [2,3], fewer subsequent revascularization interventions, and enhanced survival [4-6]. The high attrition rate of the saphenous vein graft has led to growing interest in the use of multiple arterial grafts. Several studies have investigated whether the use of the bilateral internal mammary arteries yields better results then solitary LIMA grafting. Some reported that BIMA grafts are associated with increased operative mortality [7], higher rates of sternal wound infection, higher rates of reoperation for bleeding, and prolonged postoperative ventilation [3,8]. However, the BIMA grafting technique has recently undergone a series of refinements, and today in many centers the internal mammary is usually dissected as a skeletonized vessel, and not as a pedicle, together with vein, muscle, fat and accompanying endothoracic fascia. This preserves the collateral blood supply to the sternum, leading to more rapid healing and a decreased risk of infection [9], decreased blood loss, in addition to elongation of the artery for a greater spontaneous blood flow [10]. Therefore, the results of later investigations [11-14], including a meta-analysis [15], suggest that use of the BIMA improves survival and significantly reduces the need for reintervention, without increasing perioperative mortality or morbidity. In all these studies, however, BIMA grafting was reserved mainly for younger and low risk patients.

The elderly are a continuously growing subgroup in western society, and more and more elderly patients are now being referred for CABG surgery. Use of the LIMA technique during CABG in these patients has been shown to result in better early patency and improved survival [16]. Nevertheless, the use of the BIMA method in elderly patients is not yet established. He et al. [17] reported an operative mortality of 24% in elderly patients (≥ 70 years) receiving BIMA grafts compared to 6.8% for LIMA grafts. By contrast, Galbut and colleagues [18] reported lower hospital mortality and better survival with BIMA than with LIMA grafting in the elderly. Prompted by the growing safety of BIMA grafting in the general population, the advances in surgical technique, and the poor quality of saphenous vein grafting in older patients because of varicosity, we sought to assess the efficacy of BIMA grafting in patients over 70 years old.

BIMA = bilateral internal mammary artery
CABG = coronary artery bypass graft
LIMA = left internal mammary artery

Patients and Methods

We reviewed the medical records of all consecutive patients aged ≥ 70 years who underwent CABG in our institute during the last 2

years. During this period 68 patients over age 70 underwent BIMA grafting. Patients who received a BIMA graft were compared with a matched-size group of the first consecutive 68 patients who received a solitary LIMA graft during this period. Patients who had a concomitant valve operation, aortic surgery, or repeated CABG operation were excluded.

Surgical technique

During the study period, the skeletonization technique was routinely used in the dissection of both internal mammary arteries, while in the LIMA group the entire pedicle was harvested. The target vessel for each internal mammary artery was chosen at the discretion of the surgeon. Cardiopulmonary bypass was used in all cases under moderate hypothermia (28°–32°) with antegrade cardioplegia.

Data collection

Perioperative data were obtained by review of the patients' hospital records. We recorded the demographic data, clinical profile, preoperative echocardiographic left ventricular function, extent of coronary artery disease, type of conduit used and corresponding target vessels, mean cardiopulmonary bypass time, mean duration of aortic cross-clamping, need for blood transfusion, duration of hospitalization, perioperative morbidity, and hospital death. Adverse events were defined as cardiac ischemia (postoperative myocardial infarction; development of new Q-waves or a new regional wall motion abnormality on echocardiography), neurological events, sternal wound infection, arrhythmia, renal failure (increase of $\geq$ 25% in serum creatinine level), and respiratory failure (need for mechanical ventilation for more than 72 hours).

Follow-up information was obtained by contacting the patients. Data included occurrence of major adverse late cardiac events, recurrent hospitalization, and repeated coronary catheterization. Patients were asked to describe their functional capacity and were ranked according to the New York Heart Association classification system. In addition, the patients were asked to express their satisfaction or dissatisfaction with the surgery.

Statistical analysis

Statistical analyses were conducted using SPSS statistical software, version 11. Continuous variables were expressed as mean ± SD. Differences between continuous variables were assessed with Student's *t*-test. Categorical variables were compared using the paired test or Fisher's exact probability test. Significance was set at $P < 0.05$. Bivariate correlations were assessed by the bivariate correlation test. Long-term event-free survival curves were estimated by the Kaplan-Meier method, and differences between curves were assessed by the log-rank test.

Results

The study cohort consisted of 136 patients, of whom 68 underwent skeletonized BIMA grafting and 68 pedicled LIMA grafting. The LIMA was directed preferentially to the left anterior descending artery.

In the BIMA group, the right internal mammary artery was directed to the left coronary system in 52 cases (76.4%) using the T-graft technique. CABG was performed on an emergent basis in 2 patients (2.9%) in the BIMA group and 6 (8.8%) in the LIMA group ($P = 0.72$). There was no difference between the groups in baseline demographic or clinical characteristics, left ventricular function, or extent of coronary disease [Table 1].

The operative and postoperative data and complications are presented in Table 2. There was no difference between the two groups in the number of grafts per patient (3.45 in the BIMA group vs. 3.43 in the LIMA group, $P = 0.9$), duration of hospitalization, or incidence of perioperative complications. Significant differences were noted in the number of saphenous vein grafts (69 BIMA group vs. 162 LIMA group, $P < 0.001$). In the BIMA group saphenous vein grafting was used mainly to the right coronary artery. The rate of total arterial revascularization was 32.3% in the BIMA group vs. 4.4% in the LIMA group ($P < 0.0001$), mean cardiopulmonary bypass time was 93.2 ± 34.7 minutes in the BIMA group vs. 108.8 ± 40.7 min in the LIMA group ($P = 0.02$), and need for transfusion was 1.9 ± 1.9 packed cells/patient in the BIMA group vs. 4.3 ± 2.8 in the LIMA group ($P < 0.001$).

The duration of follow-up was mean 16 months (range 10–36 years). During this period, three patients in the BIMA group died (4.4%), one perioperatively (within 30 days) and two later; and two patients in the LIMA group died (2.9%), both of them later ($P = 0.4$) [Figure 1]. In the case of early death, the procedure was performed on an emergent basis due to unstable angina; 9

Table 1. Baseline characteristics, risk factors and left ventricular function, extent of coronary disease in patients undergoing bilateral (BIMA) or unilateral (LIMA) internal mammary bypass surgery.

	BIMA (n=68)	LIMA (n=68)	*P*
Male (%)	52 (76.5)	45 (66.2)	0.18
Age (yrs)	74.6 ± 3.8	74.5 ± 4.2	0.94
Range	70–84	70–87	
Diabetes mellitus (%)	25 (36.7)	25 (36.7)	1.0
Hypertension (%)	39 (57.4)	41 (60.3)	0.72
Renal failure*	7 (10.3)	4 (5.9)	0.34
Chronic obstructive lung disease (%)	6 (8.8)	3 (4.4)	0.49
Peripheral vascular disease (%)	14 (20.6)	12 (17.6)	0.66
Previous myocardial infarction (%)	34 (50.0)	45 (66.2)	0.08
Unstable angina preoperatively (%)	40 (58.8)	49 (72.1)	0.19
Normal LV function (%)	53 (77.9)	43 (63.2)	0.06
Mild LV dysfunction (%)	3 (4.4)	9 (13.2)	0.10
Moderate LV dysfunction (%)	12 (17.6)	15 (22.1)	0.51
Severe LV dysfunction (%)	0	1 (1.5)	0.31
Left main disease (%)	16 (23.6)	22 (32.3)	0.22
Triple-vessel disease (%)	47 (69.1)	49 (72.0)	0.85
Double-vessel disease (%)	16 (23.6)	17 (25.0)	0.84
Single-vessel disease (%)	0	2 (2.9)	0.15

Continuous variables presented as mean ± SD.

* Blood creatinine > 1.5 mg/dl

LV = left ventricular

Table 2. Operative data and postoperative course and complications in patients undergoing bilateral or unilateral internal mammary bypass surgery

	BIMA (n=68)	LIMA (n=68)	*P*
No. of grafts	3.45 ± 1.22	3.43 ± 1.17	0.91
Use of saphenous vein graft	46 (67%)	65 (96%)	<0.001
Cardiopulmonary bypass time (min)	93.2 ± 34.7	108.8 ± 40.7	0.02
Aortic cross-clamp time (min)	63.5 ± 18.8	65.0 ± 21.0	0.66
Blood transfusion*	1.9 ± 1.9	4.3 ± 2.8	< 0.001
Intensive care unit stay (days)	2.3 ± 0.7	2.8 ± 2.1	0.08
Postoperative stay (days)	5.6 ± 2.5	6.1 ± 2.4	0.19
Low output syndrome (%)	2 (2.9)	1 (1.5)	0.5
Postoperative myocardial infarction (%)	0	0	
Re-exploration for bleeding (%)	0	3 (4.4)	0.24
Deep sternal wound infection (%)	2 (2.9)	1 (1.4)	0.55
Superficial sternal wound infection (%)	2 (2.9)	3 (4.4)	0.64
Renal failure (%)	8 (11.8)	8 (11.8)	1.0
Respiratory failure (%)	4 (5.9)	2 (2.9)	0.34
Cerebrovascular events (%)	2 (2.9)	2 (2.9)	1.0
Arrhythmia (%)	4 95.9)	3 (4.4)	0.69
Atrioventricular block (%)	0	2 (2.9)	0.15

Continuous variable presented as mean ± SD

* No. of packed cells per patient

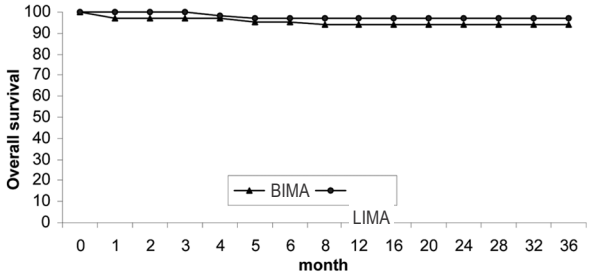

Figure 1. Kaplan-Meier survival curves of bilateral internal mammary artery (BIMA) graft versus left internal mammary artery (LIMA) graft.

days after surgery the patient died suddenly. The causes of late mortality were heart failure and multi-organ failure after sepsis in the BIMA group and sudden cardiac death and sepsis in the LIMA group.

The mean preoperative NYHA class was 2.89 ± 0.83 in the BIMA group and 3.01 ± 0.61 in the LIMA group (P = 0.31). At follow-up, the mean corresponding values were 1.3 ± 0.5 and 1.4 ± 0.6, respectively (P = 0.19) [Figure 2A, B]. Sixteen patients in the BIMA group (23.5%) required readmission, 8 (11.7%) for a cardiac cause, compared to 21 in the LIMA group (30.9%), 12 for a cardiac cause (17.6%) (P = 0.37).

In the LIMA group, 5 patients (9.8%) underwent coronary recatheterization, of whom 3 (5.8%) required revascularization; in the BIMA group 1 patient (1.4%) underwent catheterization and revascularization (P = 0.09). Satisfaction was expressed by 64

NYHA = New York Heart Association

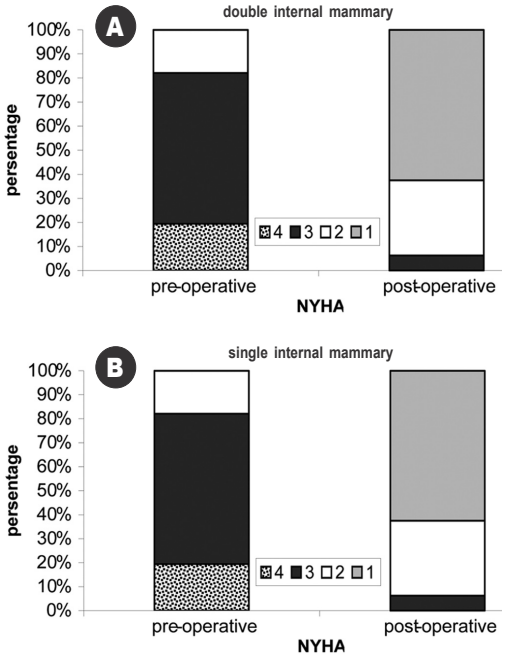

Figure 2. Mean New York Heart Association class preoperatively and at 3 years follow-up in **[A]** the BIMA group and **[B]** the LIMA group.

patients who received a BIMA graft (94.1%) and 62 with a LIMA graft (91.1%) (P = 0.5).

Discussion

Our study shows that the use of BIMA grafts in elderly patients is safe and is not associated with increased complications compared to the LIMA graft. Given the accelerated attrition of saphenous vein grafts on the one hand and the lesser use with BIMA grafts on the other, BIMA grafts have the potential benefit of longer patency.

Recent studies [11-14], including a meta-analysis [15], with long-term follow-up periods indicated that use of BIMA grafts may improve survival and significantly reduce the need for re-interventions, at no cost of higher complications; however, those studies did not focus on the elderly population and comprised only a small number of patients older than 70. He and collaborators [17] reported an operative mortality of 24% in elderly patients (≥ 70 years) who underwent BIMA grafting, but they used a pedicle conduit, unlike the skeletonized conduit used in the present study. Galbut et al. [18], in a large series, found that patients with a BIMA graft had a lower hospital mortality (3.1%) than patients with a LIMA graft (6.4%), and a better rate of late survival (mean 43 months) (69.7% vs. 60.7%). Others reported relatively low morbidity and mortality in elderly patients with BIMA grafting [19]. In our series, the perioperative mortality in the BIMA group was only 1.4%. These percentages are even lower than the 3% predicted by the Parsonnet score or the EuroSCORE perioperative mortality for patients aged ≥ 70, even with no other risk factors. In the longer term, after a mean of 16 months follow-up, total mortality was 4.4% in the BIMA group and 2.9% in the LIMA group; this difference was not

statistically significant. These low mortality rates could be related to the high percentage of preserved left ventricular function in our patients who had coronary artery disease only. The potential survival benefit of BIMA grafting could become even more apparent on longer follow-up when saphenous vein graft occlusion occurs. Given our low perioperative and short-term mortality rates, and the potential for good long-term results in our study and other studies [18,19], we suggest that the reluctance to use BIMA grafts (8% reported by the New York State Cardiac Surgery database and 4% by the Society of Thoracic Surgery) [20] should be reconsidered. It is noteworthy that perioperative death in the BIMA group in our study occurred in a patient who underwent emergency surgery. Since harvesting two skeletonized arterial graft is time-consuming, we would advise using the LIMA technique in the emergency setting. BIMA grafts are also not amenable for use in diabetic women with low ejection fraction [21] because of the risk of increased mortality, or in obese patients (body mass index > 27) [22] because of the increased risk of sternal complications.

The mean cardiopulmonary bypass time was significantly lower in the BIMA group than the LIMA group. The shorter cardiopulmonary bypass time in the BIMA group is probably associated with the need to perform fewer proximal anastomoses when using BIMA grafts compared to saphenous vein graft. Saphenous vein grafting requires distal anastomosis on the arrested heart and proximal anastomosis on cardiopulmonary bypass, whereas *in situ* right internal mammary artery requiring only one distal anastomosis and free right internal mammary was used mainly as a T-graft from LIMA performed before cardiac arrest. This, we believe, may be one of the explanations for the difference between the two groups. Another interesting finding of our study was the significant difference in blood transfusion requirement. One possible explanation is the shorter cardiopulmonary bypass time for BIMA grafting, which lowers the cardiopulmonary bypass risk of impaired coagulation and platelet function. Another explanation may be the fact that in the BIMA group the skeletonzied technique was routinely used in the dissection of both internal mammary arteries, while in the LIMA group the entire pedicle was used. Possibly, the fact that the single mammary group required significantly more blood transfusions suggests that this population was at greater risk than the bilateral group. This factor is important because blood transfusions, particularly in patients undergoing CABG, increase the risk of infection [23] and prolong hospital stay [24].

In terms of morbidity, mediastinitis is the most worrying potential complication of BIMA grafts, particularly in obese diabetic patients. Previous studies [11,17] reported an increased risk of sternal infection with BIMA grafts, particularly in the elderly. Our study does not support these findings. We noted no difference between the two groups in sternal wound infections even though one-third of our patients were diabetic.

We assume that dissection of the internal mammary artery with preservation of the collateral blood supply to the sternum allowed for more rapid healing and decreased the risk of infection [10]. There was no difference between our two groups in postoperative recovery – in terms of intensive care unit and hospital stay, low output syndrome, myocardial infarction, renal failure, respiratory failure, arrhythmia, or cerebrovascular events.

Physicians are becoming increasingly aware of the importance of patients' quality of life after surgery. In the present study, a significant percentage of patients in both groups reported enhanced functional improvement and were satisfied with the surgical procedure.

Conclusions

The performance of mainly predominant revascularization with BIMA grafting in patients aged 70 years or more is at least as safe as LIMA grafting, with the added advantage of a lesser need for blood transfusions and lower cardiopulmonary bypass time. BIMA grafts improve survival in younger patients. In our study the follow-up period was short, but BIMA grafting in the elderly has a potential benefit in the long-term, when failures of degenerative saphenous vein grafts of the elderly will become apparent.

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Capsule

Genome of *Trichomonas vaginalis*

Trichomonas vaginalis is a common but often neglected sexually transmitted pathogen that colonizes the urogenital tract in men and women. Carlton et al. describe its genome, which at 160 megabases is significantly larger than any other parasitic protest known so far, and which provides insight into the parabasilids, which lack mitochodria and peroxisomes and instead bear organelles called hydrogenosomes. The highly repetitive nature of this genome, which expands its genome size and hence cell volume, might provide the parasite with a selective advantage for the phagocytosis of bacteria and host epithelial cells.

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Eitan Israeli

Capsule

Risk of suicide during treatment with antidepressants

Rubino et al compared the risk of suicide in adults using the antidepressant venlafaxine compared with citalopram, fluoxetine, and dothiepin. The study group included 219,088 patients, aged 18–89 years, who were prescribed venlafaxine, citalopram, fluoxetine, or dothiepin from 1995 to 2005. Venlafaxine users had a higher burden of risk factors for suicide, including previous suicide attempts and proxies for severe depression or depression that was difficult to treat. In the analysis for completed suicides, unadjusted and adjusted hazard ratios for venlafaxine compared with citalopram were 2.44 (95% confidence interval 1.12–5.31) and 1.70 (0.76–3.80), for venlafaxine compared with fluoxetine 2.85 (1.37–5.94) and 1.63 (0.74–3.59), and for venlafaxine compared with dothiepin 2.54 (1.07–6.02) and 1.31 (0.53–3.25). Compared with other study drugs, venlafaxine was also associated with an increased risk of attempted suicide, but adjustment for measured confounders substantially reduced the hazard ratios. The authors conclude that venlafaxine use was consistently associated with higher risk of suicide compared with citalopram, fluoxetine, and dothiepin. Venlafaxine users had a higher burden of suicide risk factors, however, and adjustment for measured confounders substantially reduced the excess risks. Since the secondary data used in this analysis allowed only indirect and partial measurements of potential confounders, it is possible that residual confounding explains much, if not all, of the observed excess risk.

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