Short term complications after bilateral internal mammary artery grafting — a retrospective study

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Abstract

Objectives: To analyze our experience of conducting Bilateral Internal Mammary Artery (BIMA) grafting, using both pedicled and free grafts for coronary revascularization, assessing the safety and efficacy of the procedure and comparing any differences observed between the two techniques of harvesting the grafts.

Methods: A retrospective cross sectional study was conducted in July 2010 in which all 48 patients undergoing bilateral internal mammary artery grafting for coronary bypass surgery at the Aga Khan University Hospital from 1996 to 2010 were reviewed and evaluated. The main outcome measures were perioperative mortality and early morbidity with particular reference to cerebrovascular accidents, sternal wound complications and re-opening for bleeding. Chi-square test was used to elicit any meaningful associations between patient characteristics and post-operative outcomes.

Results: Of the 48 patients undergoing bilateral IMA grafting, 46 were males and 2 females. The mean age was 48 ± 9.4 years. Dyslipidaemia and smoking were the most common identifiable risk factors for coronary vascular disease. Following the 40 elective and 8 emergent surgeries, there was one hospital death. The most common post-operative complications were arrhythmias and wound infection. Diabetes and obesity were not observed to be associated with an increased risk of developing surgical site infection.

Conclusions: Our study suggests that the short-term efficacy and the safety profile of bilateral IMA grafting for coronary revascularization is clinically acceptable. Long-term follow-up studies should be done to assess the cardiac event-free survival of these individuals evaluating its applicability as a routine for coronary artery bypass grafting in Pakistan.

Keywords: Complications; BIMA. (JPMA 62:745; 2012).

Introduction

Coronary artery bypass surgery (CABG) is being performed routinely worldwide as a therapeutic treatment for coronary artery disease. The technique of using saphenous vein graft (SVG) as a conduit was first introduced in 1967 followed a year later by the introduction of internal mammary artery as a viable graft.[1] Since then there have been many advancements and research over the use of the best possible conduit in terms of graft patency, decreased re-occlusion and prolonged patient survival.[2] It has been well established now that arterial grafts are superior to saphenous venous grafts (SVGs) owing to their better long-term patency, which is associated with a decrease in recurrence of angina pectoris and subsequent cardiac events. A significant difference has been reported in the 10, 15 and 20 year survival rates between the two, favouring the use of internal thoracic arteries over SVGs.[1,3] Other arteries including the radial artery, gastroepiploic artery (GEA) and inferior epigastric artery (IEA) along with the internal mammary arteries (IMA) then started being employed leading to the use of multiple arterial grafting in CABG.[4]

Increasing evidence also supports the use of bilateral IMA grafts in favour of a single IMA graft, demonstrating better patient outcome and long-term cardiac event-free survival associated with the former.[5,6] Unlike SVGs which can only be used as a free graft, the internal mammary artery gives us the option of using it as a pedicle, a skeletonized graft, or a free graft. Merits and demerits of the different possible methods of harvesting the right IMA have been reported in literature, but irrespective of whether a free or in-situ right IMA is employed, the use of both IMA has been reported to be superior to one IMA in terms of the long-term patient outcomes and survival rates.[7,8] However, despite increasing evidence of efficacy, the use of bilateral IMA grafts has not been adopted as a primary practice in most centers. This may be due to the controversy over the possibility of increased perioperative complications and early post-operative morbidity which have been observed in some centers to be associated with the procedure,[9] with other

centers demonstrating no significantly increased risk.[10] Considering the above, our study aims to analyze our initial experience of conducting BIMA grafting at a tertiary care hospital in Pakistan, using both pedicled and free grafts for coronary revascularization, assessing the safety and efficacy of the procedure and comparing any differences observed between the two techniques of harvesting the grafts.

Patients and Methods

A retrospective cross sectional study with two comparative groups (in-situ and free) was conducted in which all patients undergoing bilateral internal mammary artery grafting for coronary bypass surgery at the Aga Khan University Hospital from January 1996 to January 2010 were reviewed and evaluated. The data was collected in July- August 2010. The spread of clinical features within this group was studied with respect to the demographics, co morbid factors, underlying disease etiology and severity and compared with the outcomes, including any perioperative or early complications, assessing the safety and efficacy of the procedure.

A total of 48 BIMA surgeries were conducted at the Aga Khan Hospital in the studied time interval out of which

40 were elective and 8 were done on an emergent basis. All cases were included in the study.

The data collected was entered in Epi-Info and analyzed through SPSS (version 17.00). Frequencies and means, as appropriate, for the demographic data and clinical characteristics of the study population were obtained and were compared between the in-situ IMA group and the group receiving free IMA graft to ensure homogeneity. The frequencies with which each conduit was used for grafting were also calculated and tabulated. The chi-square test was used to associate different post-operative complications with the pre-operative patient characteristics and to determine if any association observed was a statistically significant one.

Results

Demographically, only 2 patients were females, representing a 4% of the total. This is in accordance with the increased incidence of males undergoing coronary bypass surgery in Pakistan.[11] The age distribution had a wide range of 29 to 74 years, the mean age being 48 ± 9.4 years. There were 11 patients less than 40 years age with7 patients being above 60 years of age (Table-1).

Table-1: Clinical Characteristics of the patient population.

	All (n = 48)	In-situ (n = 32)	Free (n = 16)	P-value
Age				
Mean age (years)	47.8 ± 9.4	49 ± 10.1	46 ± 7.6	0.28
Age $\geq$ 60 years, % (n)	14.6 (7)	15.6 (5)	12.5 (2)	0.77
Female, % (n)	4.2 (2)	6.3 (2)	0 (0)	0.31
Males, % (n)	95.8 (46)	93.8 (30)	100.0 (16)	
Height - mean (cm)	167.9 ± 5.9	167 ± 6.4	169 ± 4.2	0.51
Weight - mean (kg)	72.1 ± 10.5	73.2 ± 10.4	69.9 ± 10.7	0.33
BMI	25.6 ± 3.5	26.2 ± 3.0	24.6 ± 4.1	0.15
Diabetes, % (n)	14.6 (7)	12.4 (4)	18.8 (3)	0.56
Hypertension, %(n)	35.4 (17)	34.4 (11)	37.5 (6)	0.83
Previous MI, % (n)	45.8 (22)	50.0 (16)	37.5 (6)	0.41
Smoking, % (n)	54.1 (26)	46.9 (15)	68.8 (11)	0.15
Dyslipidaemia, % (n)	56.3 (27)	53.1 (17)	62.5 (10)	0.54
Alcohol usage, % (n)	4.2 (2)	3.1 (1)	6.3 (1)	0.61
Degree of vessel disease				
Triple, % (n)	79.2 (38)	84.4 (27)	68.8 (11)	0.11
Double, % (n)	20.8 (10)	15.6 (5)	31.2 (5)	
Ejection Fraction %	55.68	54.85	57.29	1.30
$\leq$ 0.40, n	5	3	2	0.74

Table-2: Target Coronary Artery.

	Grafts	LAD %	LCx %	OM %	DIAG %	PDA %	RCA %	Rm.Int %
In situ LIMA	48	66.7	2.1	29.2	2.1	0.0	0.0	0.0
In situ RIMA	32	43.8	6.3	0.0	0.0	3.1	34.4	12.5
Free RIMA	16	12.5	18.8	62.6	6.3	0.0	0.0	0.0
Radial artery	12	0.0	8.3	33.3	0.0	16.7	25.0	16.7
SVG	78	1.28	15.4	15.4	29.5	14.1	10.3	14.1

OM: Obtuse Marginal Artery; DIAG: Diagonal Branch; PDA: Posterior Descending Artery; Rm.Int: Ramus Intermedius Artery.

Table-3: Peri-operative mortality & morbidity and early follow-up results.

	All patients (n =48) % (n)	In-situ (n = 32) % (n)	Free (n = 16) % (n)	P-value
Hospital death	2.1 (1)	3.1 (1)	0 (0)	0.59
Morbidity:				
Perioperative MI	6.3 (3)	3.1 (1)	12.5 (2)	0.21
Bleeding from wound site				
- Reopening required	4.2 (2)	6.25 (2)	0 (0)	0.31
- Reopening not required	2.1 (1)	3.1 (1)	0 (0)	0.21
Wound infection	10.4 (5)	9.38 (3)	12.5 (2)	0.74
Sepsis	4.2 (2)	6.25 (2)	0 (0)	0.31
Fever	14.6 (7)	12.5 (4)	18.75 (3)	0.56
Arrhythmia	12.5 (6)	12.5 (4)	12.5 (2)	1.00
Pleural Effusion	2.1 (1)	3.1 (1)	0 (0)	0.48
Follow-up evaluation				
LVEF mean %	58.9	59	63	0.70

Looking at the spread of co- morbidities, dyslipidaemia with elevated cholesterol levels and smoking were the two most common identifiable risk factors for coronary vessel disease in the study group, followed by a history of previous MI and hypertension. This is in consistency with the known risk factors for coronary artery disease.

Though there were 7 diabetics in our patient population, all of them had Type 2 diabetes mellitus with their sugars under strict control.

The commonest presenting complaint was of chest pain having a high prevalence of 39 (81%), followed by shortness of breath 19 (39.6%), uneasiness 9 (18.8%), orthopnoea 3 (6.3%), palpitations 3 (6.3%) and paroxysmal nocturnal dyspnoea (PND) 1 (2.1%), respectively.

Pre-op cardiac status of the patients was assessed by pre-operative echocardiography, exercise tolerance test (ETT) and coronary angiography. The coronary angiography showed that the majority of our patients 38 (79.2%) had triple vessel disease, with 8% patients having two and 2% patients have one vessel involvement. The surgeries carried out in the latter cases were all elective. The mean left ventricular ejection fraction (LVEF) was 27 (55.7%) with only one patient having a LVEF < 35.This patient had come in an emergency to the hospital and while undergoing CABG, suffered from a perioperative cardiac arrest and expired consequently; this is the only hospital death observed in the study period.

A total of 48 surgeries were performed of which 40 were elective and 8 were done on an emergent basis. Right IMA was pedicled and used as an in-situ graft in 32 of the patients with the remaining 16 receiving RIMA as a free graft. The mean cardiopulmonary bypass time was 129 ± 38.9 minutes and the aortic cross clamp time was 69 ± 21.4 minutes. The mean minimum temperature reached was 30.4?C. A total of 186 distal anastomoses were performed in 48 patients, making it an average number of 3.9 anastomoses per patient. The target coronary vessels and anastomosed conduits are shown in Table-2. The target vessels for the in situ LIMA artery were primarily the left anterior descending artery (LAD) and the obtuse marginal arteries (OM) while those for the in situ RIMA artery included right coronary (RCA) as well as LAD and left circumflex artery (LCx).

Hospital death and perioperative morbidity, including cardiac events and wound complications were assessed. These patients were then followed up in clinics for recurrence of symptoms and the functional assessment of the cardiac contractility was made via ECHO on all those patients who could afford it to indirectly assess the patency of the grafts and hence to evaluate the efficacy of the procedure.

There was 1 hospital death (2.1%) caused due to perioperative failure of LIMA leading to cardiac arrest. As discussed above, this patient had a very low ejection fraction of 35 and was one of the emergent cases. Three other patients suffered from perioperative MI and were successfully resuscitated. Out of these, RIMA was dissected as a pedicle and applied in-situ in only one patient. Post-operatively 5 patients (10.4%) developed surgical site wound infection with 2 of them going in to sepsis. In-situ grafts had been used as conduits in both the patients developing sepsis and in 3 of the 5 developing surgical site infection. Other post- operative complications seen include re-bleeding from the incision site, arrhythmias and pleural effusion (Table-3). Of the re-bleeds, two required reopening of the wound to control the bleeding. The rates of all early morbidities in patients receiving in-situ IMA grafts were somewhat comparable, as no p-value was statistically significant, to those in which RIMA was used as a free conduit, though no bleeding from the wound site was observed in the latter group.

No trend was observed between gender, age nor any specific co-morbidity with post-op outcomes. Both gender

and age greater than 60 years were not associated with mortality (p = 0.78, 0.09), peri-operative myocardial infarction (p = 0.72, 0.34), sepsis (p = 0.79, 0.55), bleeding (p = 0.72, 0.46), arrhythmia (p = 0.59, 0.16), pleural effusion (p = 0.84, 0.68) nor wound infection (p = 0.63, 0.72). Patients with type 2 Diabetes were not associated with increased risk of wound infection (p = 0.33) or sepsis (p = 0.55). Similarly obese individuals with a BMI>30 were not associated with increased incidence of post operative wound infection (p = 0.33).

The mean length of hospital stay was 8.9 ± 5.5 days with a wide range of 1 to 23 days. Follow-up of these patients was done in clinics up till 6 months after surgery. Evaluation of the cardiac status of individuals via ETT and ECHO was only done on a few patients due to their financial constraints. The mean LVEF of the 15 ECHOs conducted was 58.9%. Clinically in the early follow-up done, no cardiac-related death was observed nor did any of the patients have to undergo a second bypass surgery.

Discussion

Bilateral internal mammary grafting has been demonstrated to be associated with improved long-term survival and graft patency when compared with both single IMA grafting and with the use of venous grafts alone.[1-3] A mean 15% increase in the 20 year survival has been observed in such patients.[12] On the molecular level too, it has been observed that there is an enhanced release of endothelial-derived relaxing factor (NO) from the IMA as compared to venous grafts.[13] NO directly regulates blood flow and inhibits platelet function and indirectly allows lesser neutrophil adhesion to the endothelium which coincides with increased short and long-term vessel patency.[14,15] However, some cardiothoracic surgeons have reservations about the routine use of bilateral IMA for coronary revascularization in with concerns that BIMA grafting is a relatively complicated procedure requiring better surgical skills, takes longer to perform, and may adversely affect early in-hospital mortality and morbidity, in particular deep sternal wound infections.[9] Some studies report BIMA as a risk factor for sternal complications with increased rates observed as compared to single IMA graft;[9] most however report no increased risk in perioperative death or morbidity conferred.[16] Hence, we carried out this study to evaluate the early outcomes observed in our hospital to assess the safety and applicability of BIMA grafting as a routine procedure in a tertiary care population in Pakistan.

In bilateral IMA grafting, the right IMA has been flexibly used as an in-situ or free graft in combination with an in situ left IMA. An in-situ right IMA can be used by anastomosing it with the left anterior descending coronary artery (LAD) and its diagonal branch along the front of the ascending aorta or to the obtuse marginal artery through the transverse sinus.[17] A free right IMA, on the other hand can be used as a composite graft or aorto-coronary bypass graft, allowing for multiple sequential anastomoses. Advocates for both the methods are found in literature.[18] It has been hypothesized that the in-situ IMA graft is a better conduit as it carries its homeostatic milieu with it and so is less prone to thrombus formation.[2] However, identical patency rates have been observed in early and 1-year angiographic studies done for both the grafts and the 5 year patency rates of the two have been shown to be comparable.[7] In our study, most (66.7%) of the RIMA grafts were used in-situ, being dissected as a pedicle from the parent artery with only a few free RIMA grafts employed. Though our sample size is inadequate to comment on the outcomes, grossly both the groups showed comparable rates of perioperative outcomes and early efficacy, with no p-value being statistically significant.

Though there is no definitive criterion for the selection of patients suitable to undergo BIMA grafting, a few considerations may be made when deciding to undertake the procedure. BIMA grafting has traditionally been performed in younger patients having a greater life expectancy and a study conducted in Laval Hospital, Canada showed that the cardiac-related survival benefit of using a second IMA when compared to single IMA decreases gradually with age, the cut off being 60 years.[19] This matches the trend of relatively younger patients (mean age 48 years) having undergone BIMA grafting at our hospital. Another important criterion relative to the use of arterial conduits is the functional status of the left ventricle. Significantly impaired left ventricular function is associated with limited life expectancy while the real benefit of doing BIMA grafting is an increase in the 20 year survival period.[20] In our study population, only one patient had LVEF ≤ 35, consistent with above.

Literature suggests diabetes as a risk factor for postoperative mediastinal wound infection and a hence a possible relative contraindication for doing bilateral IMA mobilization in these patients.[21] However with good surgical technique and strict post-operative diabetes control, the procedure can be safely conducted even in diabetics. In our study, none of the 7 diabetic patients who underwent the procedure had any sternal complications or fever as a systemic manifestation of inflammation (p = 0.33). Similarly, obesity is also considered an independent risk factor for mediastinitis.[22] A study in Melbourne showed an odds ratio of 2.4 between individuals having a BMI >30 and having post-operative deep sternal wound infection after coronary bypass surgery irrespective of the conduits used.[23] In our study, of the 48 patients, 3 individuals had a BMI > 30 and none of those developed sepsis or wound infection after surgery (p =0.33).

The assessment of the safety of the procedure has usually been compared in literature with the results of using unilateral IMA for grafting. In these studies hospital deaths have been reported to be $\leq$ 1% and the most common complication observed is arrhythmias, followed by sternal infections and perioperative MI. In our study, the only hospital death observed was of an emergent case with a particularly diminished LVEF of $\leq$ 35 while the trend of complications was similar as that of previous studies with arrhythmias and wound infections being the more observed ones. Though there is lack of association observed between diabetes and/or obesity and the development of wound complications, our data suggests a positive association of sternal infections with total cardiopulmonary bypass time, with 4 of the 5 infections observed in patients being operated for over 150 minutes .Increased operating time has been identified as an independent risk factor for post-operative surgical site infections and sepsis.[24]

Conclusion

The short-term efficacy and the safety profile of bilateral IMA grafting for coronary revascularization seems clinically acceptable even for diabetic or obese individuals who may have been considered relatively contraindicated for the procedure. A long-term follow-up should be done to assess the cardiac event-free survival of these individuals evaluating the long-term implication of the procedure and hence its applicability as a routine for coronary artery bypass grafting in Pakistan.

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