Original Article

Short-term outcomes associated with bilateral internal thoracic artery grafting

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Abstract

Background: Bilateral internal thoracic artery (BITA) grafting is associated with improved long-term survival and graft patency compared to single internal thoracic artery (SITA) graft and saphenous vein graft in coronary artery bypass grafting (CABG). However, BITA grafting may adversely affect early in hospital mortality and morbidity due to deep sternal wound infection. Hence, we carried out this study to evaluate early outcomes of BITA grafting in different configuration in our hospital and to assess safety and applicability of BITA grafting as a routine procedure.

Methods: A retrospective cross sectional study was conducted in September 2014 where all 134 patients using bilateral ITA for coronary artery bypass (CABG) at United Hospital, Dhaka, Bangladesh from January 2009 to September 2014 were included. BITA grafting were used in either in-situ or Y-graft technique. We reviewed and evaluated patients' characteristics and short-term outcomes. The short-term outcomes included in hospital mortality and major morbidities.

Results: Out of 134 patients, 129 (96%) patients were male. The mean age was 48.73 ± 8.42 yrs ranging from 28 to 72 yrs. Hypertension and smoking were the most common cardiac risk factors. There was no mortality in both BITA in-situ and BITA Y-graft groups. Most common postoperative complications were fever (26%), and arrhythmia (7.5%). Only one female patient (0.7) had sternal wound complication. Elderly, obesity and COPD were not observed to be associated with sternal wound complication.

Conclusion: Short-term outcomes of BITA grafting for CABG is excellent with no significant difference between BITA in-situ and BITA Y-graft groups.

Keywords: BITA, CABG, short-term outcomes, Y-graft.

(Bangladesh Heart Journal 2016; 31(1) : 3-9)

Introduction:

Despite advances in Percutaneous Coronary intervention (PCI), coronary artery bypass surgery (CABG) remains the best therapy for severe multivessel ischemic disease and the most commonly performed cardiac operations worldwide. [1] The gold standard for CABG is the left internal thoracic artery (LITA) to the Left Anterior Descending Artery (LAD) due to the inherent characteristics of internal mammary artery endothelium and improved run-off of the LAD territory.[2]

Ten years after CABG upto 95% of internal thoracic artery (ITA) grafts remain in pristine condition whereas around three quarters of vein grafts are blocked or severely diseased.[3] Specially, patients who received two ITA grafts had approximately 10% risk for reintervention at 10 years, those with one ITA had 20% risk and with no ITA had 30% risk for reintervention at 10 years.[4] Bilateral internal thoracic artery (BITA) grafting is associated with improved survival, better event-free life and reduced reintervention relative to CABG with single ITA grafts and saphenous vein grafts.[5] Manipulation of the diseased aorta in elderly patients is one of the major risk factors for stroke after CABG. Composite arterial grafts including BITA graft with a non-touch aortic off pump coronary artery bypass (OPCAB) technique offers major advantages in such a population who are at highest risk of stroke.[3]

Although BITA grafting appears to offer superior revascularization, it is associated with increased surgical time, increased technical challenges, increase the risk of early mortality and major morbidity, in particular

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increased rates of sternal wound complication.[1,4] In addition, patients receiving BITA grafting had higher rates of bleeding requiring postoperative mediastinal re-exploration (2.9% vs 0.6%) along with increased rates of wound complication[6]

Advantages of skeletonized ITA are increase conduit length, provides superior flow and greater graft diameter, reduces the incidence of deep sternal wound infection, less postoperative paresthesia and pain, improved graft patency.[7] Therefore, skeletonization of the ITA leaves enough of the sternal circulation intact to facilitate proper wound healing.[8]

A crucial point in bilateral ITA grafting is the proper use of the right ITA. When the right ITA is used in-situ, the right coronary system is the easiest to reach and next to proximal LCX branches. But the right ITA is best used as a graft to the LAD or the marginal branches (over or under the aorta).[9] In-situ RITA crossing midline anterior to aorta is at risk of ITA injury in redo operation. In-situ ITA graft is a better conduit as it carries its homeostatic melieu with it and so is less prone to thrombus formation.[10, 11] BITA Y configuration allows the larger number of arterial anastomoses and total revascularization of the whole myocardium in selected patients. However, Composite T or Y grafting with BITA brought back concern of a potential "steal phenomenon "of the LITA by the RITA.[10]

Considering the above, we carried out this study to review our experience of performing BITA grafting using both ITA in-situ graft and BITAY-graft technique for CABG. We also evaluated and compared short-term outcomes of BITA grafting in both configuration and assessed safety and applicability of BITA grafting as a routine procedure.

Patients and Methods:

A retrospective cross sectional study was conducted in which all patients undergoing bilateral internal thoracic artery grafting for coronary bypass surgery only at United Hospital, Dhaka, Bangladesh from January 2009 to September 2014 were included. During this period, 134 patients underwent BITA grafting. Out of 134 patients, 111 patients received BITA Y-graft and 23 patients BITA in-situ for CABG.

Surgical technique

During the study period both left and right internal thoracic artery were harvested by skeletonization technique. One ITA was used to bypass left anterior descending artery (LAD) and second ITA was used to bypass either LCX or RCA system using in-situ or Y-graft technique according to surgeon preference based on position of targeted vessels (Figure-1 and Figure-2). All grafting were done on off pump beating heart (OPCAB).

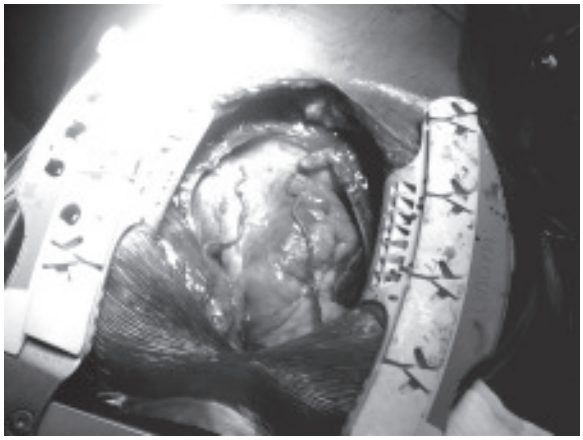

Fig.-1: *LITA and RITA in-situ*

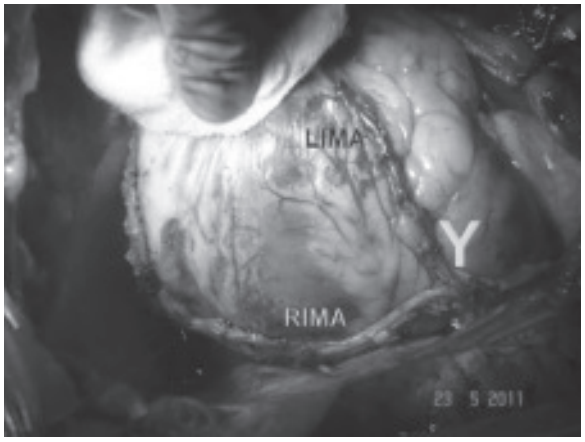

Fig.-2: *LITA/LIMA and RITA/RIMA Y graft.*

Data collection

The data were obtained by retrospective review of the patients' hospital records. The demographics, clinical profile, co-morbid factors, underlying disease pathology and severity, type of conduits used and corresponding target vessels, operation time, intensive care unit (ICU) and total hospital stay were recorded. We compared the short term outcomes as defined by the Society of Thoracic Surgeons (STS) including 30-day operative death, permanent stroke, renal dysfunction or renal failure requiring dialysis, any reoperation, prolonged ventilation (>48 hours), deep sternal wound infection, perioperative myocardial infarction, arrhythmia and fever for assessing the safety and efficacy of the procedure in both groups (insitu and Y graft group) of patients undergoing BITA grafting for CABG.

Statistical analysis

The data collected were entered in Epi-Info and analyzed through SPSS (version 16.00). Results are expressed as Frequencies and means, as appropriate, for the demographic data and clinical characteristics of the study

population. Statistical analysis comparing two groups with the unpaired 2-tailed t test for the means or ÷^{2}test for categorical variables. The frequencies with which each conduit was used for grafting were also calculated and tabulated. Significance was set at p <0.05. 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:

134 patients were selected for the study, out of them 111 (82.84%) patients had BITA Y-grafting and rest 23 (17.16%) patients had BITA in-situ grafting. Male were 129 (96.27%) and 5 (3.73%) female patients. Patients had a wide range of age from 28 to 72 years with the mean age being 48.73 ±8.42 years. There were 13 (9.7%) patients being more than 60 yrs of age. 55 (41.02%) patients were overweight (BMI =25-30kg/m^2), and three (2.27%) patients were obese (BMI >30kg/m^2). Among the cardiac risk factors, Hypertension (70.1%) and Smoking (56%) were most common followed by Diabetes (41.81%). 8 (6.0%) chronic kidney disease, 5(3.7%) calcified aorta and 5 (3.7%) chronic obstructive pulmonary disease (COPD) present in these patients. Majority (64.3%) of patients had triple vessel disease (TVD) and 17.8% patients had TVD-LM. 5 (3.9%) patients had low LVEF(less than 40 %.) (Table-1).

Right internal thoracic artery (RITA) was harvested and used as an in-situ graft in 23 patients and remaining 111 patients received RITA as Y-graft with LITA. The target vessels for the in-situ LITA were mainly Left anterior descending artery (LAD),then Ramus intermedius (RI) and Obtuse marginal (OM) arteries while those for the in-situ RITA artery included Right coronary artery (RCA) as well as LAD. Average no. of 3.48±1.12 and 3.72±.93 distal anastomoses per patient done in in-situ and Y-graft group respectively and no. of arterial graft per patient was 2.22±.518 and 2.33±.61 in in-situ and Y-graft group respectively. Average operative time was 5.03±1.05 hours and 4.87±1.14 hours in BITA Y graft and BITA in-situ group respectively. Mean ICU stay was 3.04±1.38 days with range of 1 to 12 days and 3.48±1.50 days with range of 2 to 8 days in BITA Y graft and BITA in-situ group respectively. Average total hospital stay was relatively more in BITA in-situ group than BITA Y graft. (Table-2)

Hospital mortality and perioperative morbidity were reviewed. There was no in hospital mortality in both groups. However, 4 (3.6%) patients developed perioperative MI with raised cardiac enzymes ,as type 5 MI define raised cardiac biomarker >10×99th percentile upper reference level (URL) during the first 48 h following CABG, 5 (4.5%) patients required re-opening for excessive postoperative bleeding and 1 (0.9%) patient developed respiratory complication (ARDS) that needed prolonged ventilatory support. In BITA Y-graft group, 1 (0.9%) female patient developed sternal wound complication with unstable sternum after discharge. She needed re-admission for sternal wound management. She had history of recent MI, diabetes and prolonged preoperative hospital stay (7 days) but hold normal body weight (BMI 24 kg/m^2). 1 (4.3%) patient required IABP support peroperatively and postoperatively needed prolonged artificial ventilation and developed acute kidney injury (AKI) that improved with conservative treatment in BITA in-situ group. Other postoperative complications including arrhythmia (7.5%) and fever (26%) observed in both groups that increased ICU stay and total hospital stay (Table-3).

Table-I

Preoperative characteristics of patients underwent CABG with BITA grafting.

Finding	All patients(n=134)	BITAYgraft(n=111)	BITA in-situ graft(n=23)	p-value
Male	129 (96.27)	106 (95.5)	23 (100)	.300
Female	5(3.73)	5(4.5)	0(0)	
Mean age in yrs	48.73 ± 8.42	48.29 ± 8.57	50.87 ± 7.44	.182
>60 yrs n (%)	13(9.7)	11(9.9)	2(8.7)	
BMI>30 n (%)	3 (2.27)	2(1 .9)	1(4.36)	
Hypertension n (%)	94(70.1)	80(72.1)	14(60.9)	.285
Smoking n (%)	75(56)	60(54.1)	15(65.2)	.326
Diabetes n (%)	56(41.8)	50(45.0)	6(26.1)	.093
CKD n (%)	8(6.0)	6(5.4)	2(8.7)	.544
COPD/asthma (%)	5(3.7)	4(3.6)	1(4.3)	.864
Calcified Aorta n(%)	5(3.7)	3(2.7)	2(8.7)	
EF <40%	5(3.9)	2(1.8)	3(15.8)	
TVD	87(64.9)	71(64)	16(69.6)	

Paresenthesis (%), Mean± standard deviation

CKD-Chronic Kidney Disease, COPD-Chronic Obstructive Pulmonary Disease, EF-Ejection Fraction, TVD-Triple vessel disease,

Table-II

Distribution of patients by peroperative and postoperative findings in both groups

Findings	All patients (n=134)	BITA Y-graft(n=111)	BITA in-situ graft(n=23)	p-value
Total Graft no.	3.68±.97	3.72±.93	3.48±1.12	.277
No. of arterial graft	2.31± 0.59	2.33±0.61	2.22±0.518	.396
No of venous graft	1.37±0.954	1.39±0.946	1.26±1.01	.752
Operative time	5±1.06 hours	5.03±1.o5 hours	4.87±1.14 hours	.522
ICU stay	3.11±1.41 days	3.04±1.38 days	3.48±1.50 days	.26
Total Hospital stay	9.9±1.78 days	9.86±2.71 days	10.09±1.99 days	.43

Mean± standard deviation
ICU-Intensive Care Unit

Table-III

Distribution of patients by major morbidity

Morbidity	All patients (n=134)	BITA Y-graft (n=111)	BITA in-situ graft (n=23)	p-value
Perioperative MI	4(3.0)	4(3.6)	0(0.0)	.355
Re-opening for Bleeding	5(4.0)	5(4.5)	0(0.0)	.300
Prolong ventilation	2(1.5)	1(0.9)	1(4.3)	.215
Respiratory complication	1(0.7)	1(0.9)	0(0.0)	.648
Renal failure	1(0.7)	0(0.0)	1(4.3)	.027
Stroke	0(0.0)	0(0.0)	0(0.0)	
Arrhythmia	10(7.5)	9(8.1)	1(4.3)	.532
Fever	35(26.1)	29(26.1)	6(26.08)	.997
SWI	1(0.7)	1(0.9)	0(0.0)	.677
Re-admission	1(0.7)	1(0.9)	0(0.0)	.648

Paresenthesis (%)
MI- Myocardial Infarction, SWI-Sternal wound infection

The chi-square test was used to associate different post-operative complications with the pre-operative patient characteristics. Both female sex (p<0.014) and age greater than 60 years (p<0.025) were associated with sternal wound infection (SWI), but diabetes (p=0.236), obesity (p=0.949), COPD (p=0.843), smoking (p=0.258), and CKD (p=0.800) were not associated with SWI.

Discussion

The use of the internal thoracic artery (ITA) as a conduit for CABG has changed greatly since its initial introduction in the 1950s and 1960s. Bilateral internal thoracic grafting (BITA) has been demonstrated to be associated with improved long-term survival and graft patency when compared with both single ITA grafting and with the use of venous grafts alone.[12] A mean 15% increase in the 20 year survival has been observed in such patients.[13] On the molecular level, it has been observed that there is an enhanced release of endothelial derived relaxing factor nitric oxide (NO) from the ITA as compared to venous grafts.[14] NO directly regulates blood flow and inhibits platelet function and indirectly allows lesser neutrophil adhesion to the endothelium that coincides with increased short and long-term vessel patency.[15-17] However, some cardiothoracic surgeons have reservations about the routine use of BITA due to procedure requiring better surgical skills, takes longer time to perform, and may adversely affect early in-hospital mortality and morbidity, in particular due to deep sternal wound infections.[6] Most however have reported no increased risk in perioperative death or morbidity conferred.[18] Hence, we carried out this study to evaluate the early outcomes observed in our hospital to assess the safety and applicability of BITA grafting as a routine procedure in a tertiary care Hospital in Bangladesh.

In our study most of patients was male (96.27%) and mean age was 48.73 ±8.42 years range from 28 to 72

years. BITA grafting has traditionally been performed in younger patients having a greater life expectancy. The trend of relatively younger patients (mean age 48 years), and male (96%) having undergone BITA grafting at our hospital matches with other studies[19]. Thirteen (9.7%) patients were more than 60 yrs of age in this study. Elderly patients can be benefited from arterial grafts.[20, 21] Elderly patients have sub-optimal venous conduit due to varicosities and calcification, [22] prone to early occlusion. In our study, elderly patients had showed early return to normal life without complication. In our study population, most of patients (80%) had good Left ventricular ejection fraction (LVEF) and 5 (3.7%) patients had LVEF less than 40%. Most of study showed that an important criterion related to the use of arterial conduits is the functional status of the left ventricle. Patients received BITA also had a slightly better mean EF (0.55 *vs*. 0.52) than those who only received a LITA.[2] Significantly impaired left ventricular function is associated with limited life expectancy, on the other hand increase in the 20-year survival period is observed in patients with BITA grafting. [23]

In the study patients, 56(41.81%) patients had diabetes and 53 (39.6%) patients were dyslipidaemic. Literature suggests diabetes as a risk factor for postoperative mediastinal wound infection and hence a possible relative contraindication for doing bilateral ITA grafting in these patients.[24] However, in diabetic patients, increased use of skeletonized harvesting techniques when performing a BITA grafting along with other infection prevention strategies have shown a reduction in deep sternal wound infection (DSWI) comparable to that seen in LITA patients.[2] In our study, higher incidence of DSWI was found in diabetic patients (1 of 56; 1.8%) than in non-diabetic patients (0 of 78; 0%) but this difference was not significant (p=0.236). In this study 75(56%) patients were smoker, 55(41%) patients overweight and 3 patients obese (BMI > 30) and five (3.7%) patients had COPD. Obesity is considered an independent risk factor for mediastinitis.[25]. In our study, none of obese and COPD patients developed wound infection postoperatively.

BITA grafting is associated with increased early morbidity and mortality,[26,27] specifically the occurrence of deep sternal wound infection (DSWI) and the well-documented increased risk of death that accompanies it. DSWI has been reported to occur in as low as 0.3% and as high as 14% of BITA procedures and is thought to be a result of the decreased sternal perfusion exacerbated by bilateral versus unilateral harvest of the ITA.[2] Skeletonization of the ITA leaves enough of the sternal circulation intact to facilitate proper wound healing. In our study all ITA were harveseted by skeletonization technique, therefore sternal wound complication was minimum (0.7%).

The assessment of the safety of the procedure has usually been compared in literature with the results of using unilateral ITA for grafting. In our study there was no mortality But 4(3.6%) patients developed perioperative MI, 5(4.5%) patients required re-opening, 1(0.9%) patient needed prolonged ventilatory support, and 1(0.9%) female patient developed sternal wound complication in BITA Y-graft group. 1(4.3%) patient developed acute renal failure and required prolonged ventilation in BITA in-situ group. These morbidities in this study were less than other study.[28] In our study all ITA were harvested by Skeletonization technique, therefore sternal wound complication was minimum (0.7%). However, there is lack of association observed among diabetes, COPD, obesity and the development of wound complications.

In the study 134 patients were selected, out of them 111 (82.84%) patients had BITA Y-grafting and rest 23 (17.16%) patients had BITA in-situ grafting. In bilateral ITA grafting, the right ITA has been flexibly used as an in-situ or free graft in combination with an in situ left ITA. An in-situ right ITA 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.[9] A free right ITA, on the other hand can be used as a composite graft allowing for multiple sequential anastomoses. Advocates for both the methods are found in literature.[29,30] However, identical patency rates have been observed in early, 1-year and the 5-year. Traditionally, inferior rates of RITA patency versus LITA patency have been documented regardless of choice of graft site[31] and demonstrated no difference in patients receiving an *in situ* RITA to the left or right coronary system.[32] A prospective study revealed that excellent patency rates were achieved using both BITA configuration with no significant difference in terms of MACCE or ITA patency.[10] In our study, most of the RITA grafts(82.8%) were used as a composite Y graft with in-situ LITA and only a few in-situ RITA grafts (17.16%) employed. However, there is no definitive criterion for the selection of patients suitable to undergo BITA grafting. But there was no significant different in short-term outcomes in both configurations. Therefore, excellent short-term outcomes and safety of BITA grafting found in this study and BITA bypass grafting may become a first-line option for patients receiving revascularization. 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.

Conclusion:

The short-term outcomes and the safety profile of bilateral ITA grafting in both in-situ and Y graft technique for CABG seems clinically acceptable even for diabetic or obese individuals. 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.

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