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Multiple arterial grafts in coronary artery bypass grafting, Sohag University Hospital's initial experience

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ABSTRACT

Background: Left internal mammary artery (LIMA) grafting to the left anterior descending artery (LAD) is the most crucial step in any surgical coronary revascularization. It has been proved that using LIMA during coronary artery bypass grafting (CABG) resulted in better long term results in comparison to other conduits. With accumulation of data about failure and lower patency rates of vein grafts, the concept of total arterial revascularization (TAR) and multiple arterial revascularization (MAR) has developed to offer more physiological and durable conduits for CABG patients.

Methods: This study was conducted in the Department of Cardiothoracic Surgery, Sohag University Hospital, Egypt, between January 2012 and January 2017. 104 patients who underwent CABG during the initial experience were involved. They were divided into 2 groups, group A (MAR) 46 patients, and Group B (Conventional CABG) 58 patients. Demographic data, preoperative risk factors, operative and post operative details were compared.

Results: With almost comparable preoperative demographic distribution and risk factors, results were comparable regarding post operative MI, incidence of deep sternal wound infection, number of distal anastomoses, postoperative bleeding, and the need for blood transfusion. Cross clamp time and total bypass time were slightly longer in group A than in group B with statistically significant difference.

Conclusions: Using multiple arterial grafts did not add a significant risk or time to the classic CABG. With accumulating evidence about better patency rate in arterial grafts, MAR is recommended especially in younger patients undergoing CABG.

1. Introduction

Ischemic heart disease (IHD) is the leading cause of death worldwide [1–4]. In the 1950s, cardiopulmonary bypass (CPB) machine was invented, and allowed surgeons to perform coronary revascularization [5].

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Since its innovation, coronary artery bypass grafting (CABG) remained as one of the procedures with the highest impact in the history of medicine. However, CABG future is threatened by expanding use of percutaneous intervention (PCI) and medical alternatives. Yet, CABG is constantly evolving and remains the most durable method of coronary revascularization [5,6].

In CABG the usual practice is to use Left Internal Mammary Artery (LIMA) and supplementary venous grafts as conduits to revascularize different coronary targets.

CABG is an invasive modality for treatment of IHD. On the other hand, PCI are rapidly improving, and gradually are covering areas they have never covered before. Therefore, surgeons have to offer more durable options to maintain the superiority over PCI. Theoretically, more use of arterial grafts can improve long term results. After studying different arterial conduits, the first arterial graft that can be added to the LIMA was the right internal mammary artery (RIMA) which showed characteristics almost identical to LIMA [7,8].

Some limitations slowed down the expanded use of bilateral internal mammary artery (BIMA) grafting such as; higher rate for sternal re-intervention [9], technically demanding if used as sequential free graft (Y graft or T graft), and possibly longer operative time [10]. Advantages of using BIMA grafting remained unproved for a long time [11,12] until late 1990s, when higher freedom from death [13], and cardiac-related events [14] in the case of BIMA grafting was used.

2. Patients and methods

This study was conducted in the Department of Cardiothoracic Surgery, Sohag University Hospital, Egypt, between January 2012 and January 2017. The study involved 104 patients who underwent CABG during the initial experience of the Department with CABG procedures.

Inclusion criteria: Patients who underwent elective CABG and having none of the following exclusion criteria.

Exclusion criteria: Patients with the following criteria were excluded: Impaired left ventricular function (EF less than 50%), concomitant other heart surgery (valvular … etc.), renal impairment (creatinine more than 1.5 mg/dl), significant carotid stenosis, emergency patients, previous open heart surgery, and patients who had total venous revascularization.

Each patient was subjected to: Detailed history taking, detailed clinical examination, preoperative laboratory investigations including coagulation profile, liver and renal functions, serology for HIV and hepatitis, blood picture, plain chest X-ray, complete cardiac studies (ECG, coronary angiography, and echocardiography), carotid artery Doppler (if more than 60 years, previous stroke, transient ischemic attack (TIA) or left main disease), radial artery Doppler and Allen's test (if radial artery was to be used), abdominal ultrasound, lower limb venous Doppler (if visible dilated veins) and specific investigations for any concomitant condition(s).

Patients who underwent multiple arterial CABG were named group (A) and those who underwent conventional CABG were named group (B).

The following items were studied in both groups: Risk factors (Age, sex, hypertension, diabetes, dyslipidemia, BMI and smoking), number of diseased vessels, history of myocardial infarction (MI), Left main disease, ejection fraction (EF), operative data (cross clamp time (XCT), total bypass time (TBT), number and types of conduits and grafts, number of distal anastomoses and use of sequential grafts), post operative data (bleeding in drains, postoperative MI (ECG, ECHO, and Enzymes), blood transfusion, postoperative echo data, incidence of deep sternal wound infection (DSWI), ICU stay, and hospital stay.

Statistical package for social sciences (IBM-SPSS), version 19 IBM- Chicago, USA was used for statistical data analysis. Data expressed as mean, standard deviation (SD), number and percentage. Mean and standard deviation were used as descriptive value for quantitative data. Student t test was used to compare the means between two groups, and one-way analysis of variance (ANOVA) test was used to compare means of more than two groups. Finally, for all these tests, the level of significance (P-value) can be explained as: No significance $P > 0.05$, Mild Significance $P < 0.05$, Moderate significance $P < 0.01$, High significance $P < 0.001$.

3. Results

46 patients had multiple arterial grafts (group A), and 58 patients had conventional CABG (group B). Group (A) patients were significantly younger than group (B) patients (48.45 Vs 60.61 years respectively) (P value < 0.001), while both groups were comparable regarding sex, body weight, and BMI (P value was 0.444, 0.346, 0.694 respectively). Hypertension, dyslipidemia, smoking and obesity showed no significant difference between both groups (p value $= 0.100$, 0.447, 0.393, 0.853 respectively) while diabetes was significantly more common in group B (p value $= 0.020$) (Table 1).

Difference between both groups regarding history of myocardial infarction (MI), left main disease, number of diseased vessels and preoperative EF were not significant (P value $= 0.906$, 0.852, 0.803 and 0.664 respectively) (Table 2).

Regarding operative details, the mean number of distal anastomoses was 2.72 ± 0.59 anastomoses per patient in group (A), and 2.61 ± 0.60 anastomoses per patient in group (B) (P value $= 0.543$). Conduits used were as follow; LIMA was grafted to LAD in all patients of group (A) and (B). In group (A) 35 patients had bilateral mammaries, Insitu RIMA in 22 and free RIMA in 13 patients, LIMA plus radial artery were used in 11 patients. Free RIMA was grafted proximally to LIMA as Y or T configuration. Radial artery was proximally connected to the ascending aorta in 7 patients and to LIMA in 4 patients (Table 3).

Table 1
Preoperative risk factors.

	Group A	Group B	P value
Mean Weight	79.66 ± 14.61 Kg	82.6 ± 6.99 Kg	0.346
Mean Body mass index	27.68	28.1	0.694
Hypertension	(44.9%)	(52.3%)	0.100
Dyslipidemia	67.3%	70.9%	0.447
Diabetes mellitus	17.4%	39.5%	0.020
Smoking	68.1%	60.7%	0.393

Table 2
Preoperative cardiac condition.

	Group A	Group B	P value
N. of diseased vessels	-32 patient had 3 vessel -14 patients 2 vessel disease	-43 patients had 3 vessel disease -15 patients 2 vessel disease	0.803
History of MI	59%	60.7%	0.906
Left main disease	22.7%	25%	0.852
Mean Preoperative EF	56.9%	58.5%	0.664

Table 3
Operative data.

	Group A	Group B	P value
Mean N. of distal anastomosis	2.72 ± 0.59	2.61 ± 0.60	0.543
Mean Cross clamp time	55.06 ± 16	44.19 ± 8.15	0.010
Mean Total bypass time	73.38 ± 22.66	60.54 ± 13.43	0.019

Table 4
Post operative data.

	Group A	Group B	P value
Mean Post operative bleeding	411.4 ± 147.1 cc	427.5 ± 227.2 cc	0.779
Mean number of transfused units	1.79 units	1.77 units	0.924
Incidence of DSWI	4.34%	3.44%	0.862
ICU stay	2.2 days	2.18 days	0.874
Hospital stay	7.4 days	7.68 days	0.733

XCT was compared between the 2 groups and the mean XCT was 55.06 ± 16 min in group (A) and 44.19 ± 8.15 min in groups (B) with statistically significant difference (t test = 2.837, P value = 0.010). The TBT was 73.38 ± 22.66 min in group A and 60.54 ± 13.43 min in group B, again, with statistically significant difference (t test = 2.552. P value = 0.019) (Table 3).

Postoperative MI was encountered in one patient in group (A) 2.17%. Patients in both groups had almost the same mean total post operative bleeding; 411.4 ± 147.1 cc in group A, and 427.5 ± 227.2 cc in group (B), with no significant difference (t test = 0.282, P value = 0.779). Packed RBCs were transfused when hemoglobin level goes below 8 g/dl. Mean number of transfused units was 1.79 units in group (A) and 1.77 in group (B), with no significant difference between the two groups (t test = 0.095, P value = 0.924).

2 patient in group (A) 4.34% and 2 patient in group (B) 3.44% had DSWI. The difference was not significant (chi square = 0.03, p value = 0.862). ICU stay and hospital stay were comparable in both groups; Mean ICU stay was 2.2 in group (A) and 2.18 in group (B), mean hospital stay was 7.4 in group (A) and 7.68 in group (B) (Table 4).

4. Discussion

The long-term success of CABG is directly related to the patency of used grafts. Internal mammary artery is resistant to atherosclerosis, therefore, it has good long term patency rate, and its use as a conduit in CABG surgery has led to improved survival and longer intervention-free periods if compared to Saphenous vein graft (SVG) alone [15].

However, most of patients referred for CABG now have more than 1 diseased coronary artery and require multiple grafts. SVGs have been frequently used as a conduit for CABG. Unfortunately, they are prone to intimal hyperplasia, arteriosclerosis, and stenotic lesions. In one study [16], about 80%–90% of SVGs were patent 1 year after surgery. Between 1 and 5 years postoperatively, SVG occlusion occurred at a rate of 1%–2% per year, and between 6 and 10 years post operatively, occlusion rate was 4%–5% per year. By 10 years, only 60% of SVGs were patent, of those, only half were free of stenosis.

Many studies were addressed to determine the particular age group at which patients get the benefit of arterial revascularization. In one study, survival benefits were reported till the age of 60 [17], in another study survival benefits persisted even after the age of 75 [18]. In this study, multiple arterial grafts were used in patients younger than 60 years (unless contraindicated). The mean age in group (A) was 48.45 years, while in group (B) the mean age was 60.61 years.

Regarding gender, some studies reported higher mortality in female patients undergoing CABG [19], while others didn't notice any significant difference [20]. In Sohag University Hospital, female patients were far less frequent than male patients. The number of females referred for CABG was less than males. 37 out of 46 patients in group (A) were males and 48 out of 58 patients in group (B) were males. No difference was noticed in morbidity or mortality between males and females in either group.

DSWI in diabetic patients undergoing CABG is a well known complication. The use of BIMA is attributed to a significant decline in the arterial flow to the sternum [21]. Many studies [22–24] have been addressed to determine the involved risk factors, most of studies reported higher risk of DSWI in diabetic patients with BIMA harvesting, some reported less incidence of DSWI in cases where HbA1c is blow 7% [25]. Although the number of patients involved in our study was limited, we had encountered DSWI in two non diabetic patients who underwent BIMA CABG, and in two diabetic patients in group (B). Looking to the small number of patients in this study, it is not wise to conclude about the relationship between the use of BIMA, diabetes, and DSWI.

Radial artery was used only in 11 patients; none of them had significant complications.

During planning for surgery, multiple arterial grafts strategy was considered in patients younger than 55 years, the priority was to BIMA, if the patient was having BMI less than 30, not diabetic or diabetic with HbA1c less than 7%, BIMA was the choice. Non of BIMA patients were diabetic. Skeletonized harvesting was used in all BIMA harvesting, 29 patients had both mammaries skeletonized, while in the remaining 6, only 1 mammary was skeletonized and the other one was pedicled. If BIMA was contraindicated, radial artery was considered, provided that Allen's test confirmed sufficient ulnar flow, and the target vessel had a tight lesion. If both were not suitable, venous grafts were used. Out of the 58 patients who had conventional CABG, 17 were younger than 55 years old, and 6 were younger than 50 years old.

Prolonged XCT is a well known risk factor for death and other complications in patients undergoing open heart surgery [26–29]. Surgeons tend to avoid using arterial grafts because of a general conviction that it will take a longer time and longer XCT. Dorman et al., in 2012 [30] compared between BIMA and LIMA, and they noticed a slightly longer XCT in patients who received BIMA than those who received LIMA alone (74.8 ± 24.1 min Vs 68.5 ± 23.9 min). Another study from Mayo clinic in 2012 [31], the used methodology and patient population was almost the same as this study, they divided their patients into 2 groups: one was called LIMA/SV group (n: 7435) and the other group was called MultiArt group (n:1187), as regard XCT they reported similar XCT in both groups (50 ± 19 min), while, bypass time was only 10 min longer in the LIMA/SV group than in the MultiArt group (85 ± 31 and 75 ± 30 min, respectively). Results in this work were consistent with Dorman et al.; group (A) showed longer XCT: 55.06 ± 16 min in group (A) and 44.19 ± 8.15 in group (B). It has to be considered that they were doing more distal anastomoses (3.2 ± 0.9 in SIMA VS 3.4 ± 0.9 in BIMA respectively), while in our study mean number of distal anastomoses was 2.72 ± 0.59 anastomoses per patient in group (A) and 2.61 ± 0.60 anastomoses per patient in group (B). Looking to the previously mentioned survival benefits, 10 more minutes in XCT can be justified.

One of the important fears about using BIMA is postoperative bleeding. Walkes et al. [32] didn't notice a significant difference regarding postoperative bleeding. On the other hand, an earlier study conducted by Gansera et al. [23] noticed a higher rate of resternotomy for post operative bleeding. In this work, no significant difference was noticed regarding post operative bleeding (411.4 ± 147.1 cc in group A and 427.5 ± 227.2 cc in group B), nor, packed RBCs transfusion (mean number of transfused units was 1.79 units in group A and 1.77 in group B).

5. Conclusions

Using RIMA or Radial artery as a second graft may increase XCT, but not to the extent that prevent surgeon from using it especially with the accumulating evidence about their long term benefits. Blood loss and the need for blood transfusion in patients who received multiple arterial grafts were not different from those who received LIMA and venous grafts.

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