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Original Article

Sternal healing after bilateral internal mammary arteries use for Coronary artery bypass grafting in diabetic Patients; short-term results

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Abstract

Background: Bilateral internal mammary artery (BIMA) use may improve long-term outcomes after coronary artery bypass grafting (CABG); however, the risk of infection is high. Skeletonization of the internal mammary may decrease the risk of infection, especially in patients with diabetes. Our study aimed at evaluation of sternal healing in diabetic patients with different techniques of bilateral internal mammary artery harvesting.

Methods: This prospective randomized study included 200 diabetic patients who underwent CABG using BIMA between 2017 and 2019. We divided patients into two groups; Group A had skeletonization of both internal mammary arteries, and Group B had pedicled left mammary and skeletonized right mammary. Patients were observed for three months, post-operatively for any sternal wound problems.

Results: There was no significant difference regarding the baseline variables. Type I diabetes mellitus was present in 25% in group A (n= 24) and 13.64% in group B (n= 12) (p= 0.324). There was no difference in harvest time between groups (83 ±4 vs. 81 ±3 minutes in group A vs. B, respectively. P= 0.1). The mean number of grafts was 3± 0.5 in Group A and 3± 0.6 in Group B (p= 0.8). Postoperative drainage was 402.9 ± 174.1 ml in Group A vs. 387.2 ± 153.6 ml in Group B (p= 0.474). The duration of ICU stay did not differ significantly between groups (2± 0.7 in Group A vs. 2± 0.5 in Group B; p= 0.8). Deep sternal wound infection occurred in 4.17% in group A (n= 4) and 4.55% in group B (n= 4) (p= 0.705). Superficial wound infection occurred in eight patients in group A (8.33%) and eight patients in group B (9.1%) (p= 0.59). No patient had sternal dehiscence in group A vs. four patients in group B (4.55%) (p= 0.39).

Conclusion: We did not find differences between bilateral mammary artery harvest with skeletonization of both arteries versus skeletonization of the right mammary only on sternal healing nor wound infection in diabetic patients undergoing CABG. A larger study is recommended.

Introduction

Coronary artery bypass grafting (CABG) have superior long-term survival compared to percutaneous interventions, particularly in diabetic patients with a multi-vessel disease [1]. The left internal mammary artery (LIMA) is the gold standard conduit for myocardial

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revascularization because of the established clinical and survival benefits when compared to saphenous vein grafts [2].

LIMA has excellent long-term patency, reaching 90% after ten years. In contrast to vein grafts, where around half are occluded, and the other half is severely diseased at the same follow-up period [3]. Angiographic studies demonstrated markedly superior patency of bilateral internal mammary arteries (BIMA) compared to vein grafts, with patency rates of BIMA grafts being as high as 95% at two years and 90% at seven years [4,5].

However, BIMA harvesting is more challenging, and there are concerns that it is associated with longer operation time and increases the risk of early mortality and major morbidity impaired wound healing. Thus, BIMA grafting is only used routinely in around 10% of the CABG patients in Europe and 4% of the CABG patients in the USA [6].

Keeley first described the skeletonization of IMA in 1987, which involved the harvest of only the IMA without any surrounding tissue. Skeletonization of the IMA has been proposed as a solution to many of the problems associated with IMA harvesting [7]. Skeletonization may increase the graft flow and length, decrease sternal infection rates, and reduce pain [8].

The objective of our study was to compare sternal healing in diabetic patients with different techniques of bilateral internal mammary artery harvesting.

Patients and Methods:
Design and patients

We conducted this randomized clinical study from January 2017 to January 2020. One hundred and eighty-four diabetic patients who had ischemic heart disease and underwent CABG using BIMAs were analyzed in this study.
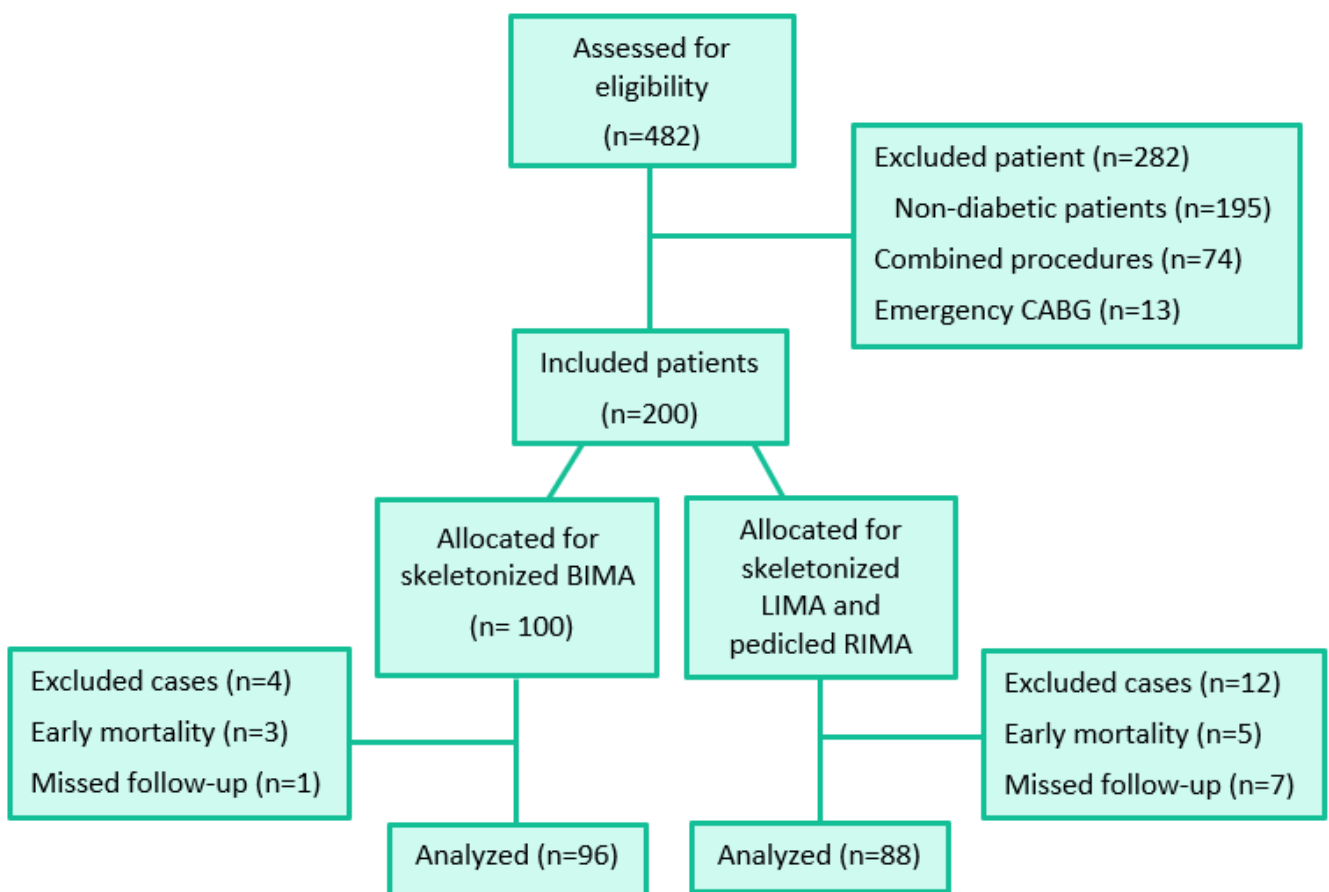

Figure 1: Flow chart of the patients allocated for the study

Patients who had associated other cardiac procedures, such as mitral valve repair or replacement, tricuspid valve repair or replacement and aortic valve replacement surgery, previous open-heart surgery, or emergency CABG were excluded. Patients who were lost for follow up were also excluded.

Patients were randomly assigned to either Group A (n=96 patients) in which we performed bilateral skeletonization of the IMA or Group B (n=88 patients) in which we used LIMA as pedicled and right internal mammary artery (RIMA) as skeletonized. The study flow chart is shown in Figure 1. Out of 482 patients who underwent CABG, 184 cases were included in our study. Each group initially had 100 patients. Four patients were excluded from group A; three patients had early mortality, and one patient was lost for follow-up. Twelve patients were excluded from group B, five patients had early mortality, and seven patients were lost for follow-up.

Data and technique:
After the routine examination and preoperative preparation of the patients, standard preparation in the operation room was done. After standard midline sternotomy was performed, both internal mammary arteries were harvested using low energy diathermy.

The LIMA was harvested first after opening the pleura, using the skeletonized technique in Group (A) and pedicled technique in Group (B). The RIMA was harvested using the skeletonized technique in both groups.

Operative variables, including harvesting time, number of grafts, operation time, total bypass time, and units of blood transfused, were collected before the patient was transferred to the Intensive Care Unit (ICU).

Study outcomes:
We compared both groups regarding the ICU stay, total drainage, and the need for blood product transfusion. The follow-up included wound assessment, which was done daily until discharge for the detection of any infection or dehiscence. The outpatient follow-up continued for three months, chest computed tomography (CT) was done for detection of sternal dehiscence.

Statistical analysis:
Results were collected, tabulated, and statistically analyzed using the statistical package of social sciences, version 20 (SPSS Inc. released 2011, IBM SPSS statistics for windows, version 20.0; IBM Corp., Armonk, New York, USA). Continuous data were expressed as mean ± standard deviation (SD) and were compared with the Student t-test. The distribution of qualitative variables across groups was analyzed with Chi-square test or Fischer exact test as appropriate. All comparisons were bilateral, and a p-value <0.05 was the limit of statistical significance.

Table 1:preoperative characteristics and comorbidities

	Studied groups		P-value
	Group A (n = 96)	Group B (n= 88)	
Age (years)			
mean ± SD	55.3 ± 4.8	44.55 ±10.68	0.779
Range	47 – 63	49 – 61	
Sex (Male) n (%)	84 (87.5%)	84 (95.45%)	0.598
BMI (kg/m2)	31.34 ±0.21	30.86 ±0.33	0.634
Smoking n (%)	80 (83.33%)	72 (81.82%)	0.944
COPD n (%)	12 (12.5%)	8 (9.1%)	0.611
CKD n (%)	20 (20.83%)	12 (13.64%)	0.898
DM (type I)	24 (25%)	12 (13.64%)	0.324

BMI; body mass index, COPD: chronic obstructive pulmonary disease, CKD: chronic kidney disease, DM; diabetes mellitus.

Results

Preoperative data:

Both groups were comparable regarding the demographic data and preoperative risk factors; smoking, chronic obstructive pulmonary disease (COPD), and chronic kidney disease (CKD) with no statistically significant difference, as shown in Table 1. Our study included diabetic patients, type I DM was present in 24 patients (25%) in Group A and 12 patients (13.64%) in Group B (p= 0.324).

Operative data:

There was no statistically significant difference between both groups regarding total operative time, harvesting time, cross-clamp time, and the number of grafts, as shown in (Table 2).

Postoperative data:

Regarding the postoperative parameters, ICU stays, amount of drainage, blood units transfused, and the need for reoperation, there was no statistically significant difference between both groups, as shown in (Table 3).

Wound infection

Postoperative follow-up of the wound, including superficial or deep infection and sterile sternal dehiscence, showed no statistically significant difference between both groups, as shown in (Table 4). While wound debridement was done for eight patients in each group, rewiring was done four times in group A.

Discussion

Almost 95% of the CABG patients receive a single internal mammary artery graft with excellent long-term patency compared to other conduits [3]. The superior clinical outcome associated with a LIMA graft encouraged several groups to investigate the use of bilateral internal mammary arteries (BIMA) with reports of even better clinical outcomes [9]. Angiographic studies demonstrate markedly superior patency of BIMA grafts compared with vein grafts, with patency rates of BIMA grafts being as high as 90% seven years [10,11].

Despite that, BIMA harvesting is more challenging, and there are concerns about the infection rates after BIMA use. Therefore, BIMA is not widely used worldwide [6,12]. Proposed benefits of skeletonization include increased flow and length, decreased sternal infection rates, and reduced pain. However, these assertions are supported primarily by nonrandomized, observational studies. Not surprisingly, there is considerable debate about the optimal harvesting technique for the IMA [8].

In our study, both groups were comparable regarding cross-clamp and total operative time despite harvesting time was longer in Group A with no significant difference. The number of grafts ranged from 2-4 grafts in both groups with a mean of 3 grafts.

Table 2: Operative data

	Studied groups		P-value
	Group A (n= 96)	Group B (n = 88)	
Harvesting time (min)			
Mean ± SD	83 ± 4	81 ± 3	0.1
Range	78-90	70-88	
Cross-clamp time (min)			
Mean ± SD	47.8 ± 11.1	46.5 ± 12.4	0.719
Range	32 – 70	28 – 72	
Total operative time (min)			
Mean ± SD	191±28	181±25	0.627
Range	170-240	150-225	
Grafts			
Mean ± SD	3 ± 0.6	3 ± 0.5	0.810
Range	2 – 4	2 – 4	

Table 3: Post-operative data

	Studied groups		P-value
	Group A (n = 96)	Group B (n= 88)	
ICU stay (days)			
mean ± SD	2 ± 0.7	2 ± 0.5	0.821
Range	1 – 4	1 – 4	
Drainage (ml)			
mean ± SD	402.9 ± 174.1	387.2 ± 153.6	0.474
Range	210 – 900	250 – 860	
Blood transfusion			
mean ± SD	1.9 ± 0.6	1.6 ± 0.6	0.183
Range	1 – 3	1 – 3	
Reoperation n (%)	8 (8.33%)	4 (4.55%)	0.884
ICU: intensive care unit			

Our operative data were comparable to a study by Elnaggar and colleagues [13] conducted to study the use of BIMA, either skeletonized or pedicled. Less reoperation was needed; 8.33% for group A and 4.55% for group B, while being higher in Elnaggar and colleagues [13] with 12% need for re-sternotomy in BIMA group, which might be justified by the higher drainage in their study group.

Another study by Rubens and collaborators [14] showed that reoperation was required in 2.82% after skeletonized BIMA harvest and 2.06% for the pedicled BIMA technique, which is much less than our results. This ratio might explain fewer wound complications, superficial and deep sternal wound infection, than our study.

Rubens and coworkers [14] had no significant difference between both groups in superficial and deep sternal wound infections. Superficial wound infection was 3.4% vs. 3.8% in skeletonized and pedicled BIMA groups. In comparison, the deep infection was 2.5% vs. 2.4% in skeletonized and pedicled BIMA groups, respectively, while superficial sternal wound infection was 8.33% in group A and 9.1% in group B and deep sternal wound infection was 4.17% in group A and 4.55%in group B.

Therefore, reoperation for bleeding might be related to an increased rate of sternal wound complications. This can be avoided by meticulous hemostasis, especially with direct control of IMA branches in skeletonized technique with less raw area in the chest wall.

The wound infection was managed by frequent dressing and proper antibiotics after microbiological tests. The vacuum-assisted dressing was used for deep sternal infections after surgical debridement.

Thus, it seemed justifiable that the skeletonization technique gives the advantage of bilateral mammary revascularization and limits sternal ischemia by maintaining substantial blood flow through collaterals from preserved

Table 4: Comparison of wound infection between group A and group B

		Studied groups		P-value
		Group A (n = 96)	Group B (n = 88)	
Infection n (%)	Superficial	8 (8.33%)	8 (9.1%)	0.586
	Deep	4 (4.17%)	4 (4.55%)	0.705
Sterile dehiscence n (%)		0	4 (4.55%)	0.386
Debridement n (%)		8 (8.33%)	8 (9.1%)	0.586
Rewiring n (%)		4 (4.17%)	0	0.436

intercostal and sternal branches, which is confirmed by Filho and coworkers [15] who assessed sternal perfusion with scintigraphy.

The risk of sternal wound infection limits the routine use of BIMA. However, there is an arterial network around IMA, which, if not damaged, wound maintain adequate sternal perfusion after the BIMA harvest [16,17]. Diabetic patients are at higher risk of sternal wound infections. In a recent meta-analysis, there was no difference in deep sternal wound infection between skeletonized BIMA and LIMA harvest. On the other hand, the pedicled technique showed an increased risk of infection because of the acute sternal ischemia [16].

Study limitations
The study is limited by the sample size and a low number of events, and more extensive research is required to confirm the results. The study included diabetic patients only, and the results cannot be generalized to all patients. The study presents a single-center experience.

Conclusion
We did not find differences between bilateral mammary artery harvest with skeletonization of both arteries versus skeletonization of the right mammary only on sternal healing nor wound infection in diabetic patients undergoing CABG. A larger study is recommended.

Conflict of interest: Authors declare no conflict of interest.

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