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Effect Of Skeletonization Of Internal Mammary On The Incidence Of Deep Sternal Wound Infection And Post Operative Pain In Patients Undergoing Coronary Artery Bypass Grafting

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ABSTRACT

Background: Coronary revascularization has advanced significantly since Coronary Artery Bypass Grafting (CABG) was introduced over fifty years ago, remaining the gold standard for coronary artery disease (CAD), particularly in diabetics or multivessel disease cases.

Aim: To compare the early outcome of left skeletonized mammary harvesting and pedicled left mammary harvesting in cases having CABG operation.

Patients and methods: In this non-randomized prospective clinical trial, data of 230 cases with ischemic heart disease requiring CABG who were admitted to Kasr Al-Ainy Hospitals and other affiliated hospitals, in the duration from February 2023 to August 2024, categorized into to 2 groups: Group (A): 115 cases of CABG operation with skeletonized left internal mammary artery (LIMA) harvesting. Group (B):115 cases of CABG operation with pedicled LIMA harvesting.

Result: Pain levels, measured by Visual Analog Scale (VAS) score, were significantly reduced in the skeletonized group than the pedicled group (2.08±0.48 versus. 2.97±0.36; P<0.001). Postoperative paresthesia was also less frequent in the skeletonized group (12.2% versus. 22.6%; P=0.037). Nevertheless, insignificant differences have been observed in deep sternal wound infection (2.6% versus 4.3%; P=0.722) or sternal dehiscence (2.9% versus 1.7%; P=1). ICU and hospital stay durations were similar between groups, with mean ICU stays of 2.09±0.39 and 2.18±0.59 days, and hospital stays of 6.19±0.85 and 6.32±1.06 days, respectively.

Conclusion: LIMA harvesting reduced postoperative pain, blood drainage, and paresthesia compared to the pedicled technique, enabling more anastomoses. No differences were found in wound infection, sternal dehiscence, ICU stay, or hospitalization duration.

Keywords: *Skeletonization; LIMA; CABG.*

1. INTRODUCTION

Coronary revascularization has evolved significantly since the inception of CABG over fifty years ago, with substantial advancements in diagnostic and therapeutic techniques. Coronary artery bypass grafting is the established treatment for obstructive coronary artery disease, especially in cases with multivessel disease or diabetes. It is widely acknowledged that not all coronary artery bypass grafting procedures are equivalent; the surgical technique, involving conduit selection for bypass grafts and target coronary artery selection, influences survival outcomes **(1).**

Numerous vascular structures in the body serve as conduits in CABG procedures. The right or left internal mammary artery, radial arteries, and great saphenous vein are commonly utilized as vascular structures. The left internal mammary artery (LIMA) is the most frequently utilized due to its prolonged patency, ease of implementation, and compatibility with coronary grafting **(2).**

The choice of harvesting method for the internal mammary artery has to take into account its complication profile, particularly the possibility of sternal wound infections (SWI), which is one of the most significant problems after myocardial revascularization. The pedicled method is purported to enhance sternal wound infections due to less sternal vascularization. At this point, skeletonization surfaced as a superior alternative, offering enhanced preservation of sternal microcirculation, which may serve as a protective factor against sternal wound infections **(3).**

Multiple investigations indicate that CABG surgery can result in enduring chest wall pain referred to as post CABG pain (PCP). PCP is characterized as pain at the surgical site that differs from preoperative pain and is localized pain that endures for over three months following surgery **(4).**

The goal of this investigation was to compare the early outcomes of left skeletonized mammary harvesting with pedicled left mammary harvesting in cases following CABG surgery.

2. PATIENTS AND METHODS

In this non-randomized prospective clinical trial, data of 230 cases with ischemic heart disease requiring CABG who were admitted to Kasr Al-Ainy Hospitals and other affiliated hospitals, in the duration from February 2023 to August 2024, have been included and have been categorized into 2 groups according to surgeon preference: Group (A): consists of 115 cases of CABG operation with skeletonized left internal mammary artery (LIMA) harvesting. Group (B): consists of 115 cases of CABG operation with pedicled LIMA harvesting.

Inclusion criteria: All cases with ischemic heart disease undergoing elective CABG operation with the utilization of left internal mammary, both genders, and age below 75 years.

Exclusion criteria: All cases undergoing CABG operation with bilateral mammary harvesting, emergency CABG operation, CABG operation combined with other intervention (valve replacement or aortic surgery), and redo cases.

Methods

The collected and analyzed data for all included cases included age, gender, diabetes mellitus diagnosed based on ADA criteria, hypertension defined by specific BP readings or a history of antihypertensive treatment, and smoking status, whether current or recent.

Operative Data:

Mammary harvesting was performed using either the skeletonized or pedicled technique for the LIMA, with additional saphenous vein grafts commonly utilized and radial artery grafts in some cases. The procedure was conducted via full median sternotomy with the case in a supine position. After opening the pericardium, off-pump cases underwent stabilization, while on-pump cases had aorto-common atrial cannulation for cardiopulmonary bypass. A cardioplegia cannula was introduced in the ascending aorta for warm antegrade cardioplegia and aortic root venting. Once total bypass was reached, an aortic cross-clamp was applied, and myocardial protection has been achieved with intermittent warm blood antegrade cardioplegia. Distal anastomoses have been performed at identified target sites using continuous polypropylene sutures. In on-pump cases, after completing all distal anastomoses, the aortic cross-clamp has been removed, allowing the heart to regain contractility, followed by proximal anastomoses using an aortic side occlusion clamp. Some surgeons preferred performing T or Y anastomoses on LIMA before the distal anastomoses. Weaning from cardiopulmonary bypass was guided by hemodynamic stability, with supportive drug therapy or intra-aortic balloon pump insertion as needed. Chest tubes have been placed in the left pleural cavity and anterior mediastinum, while the pericardium was left open anteriorly to avoid mechanical irritation. Finally, heparin was reversed with protamine sulfate at a 1:1 ratio.

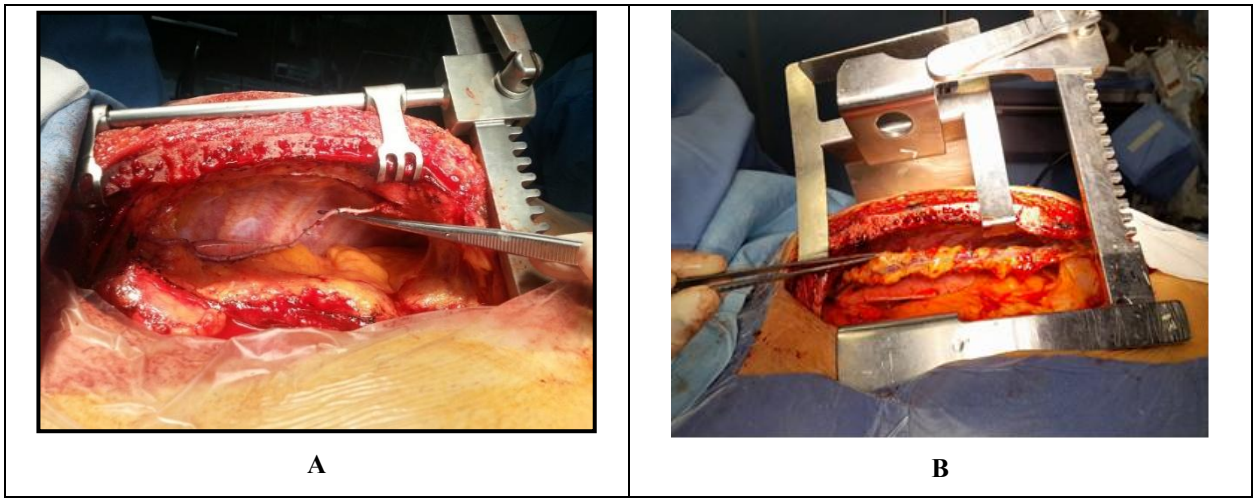

Figure (1): (A): LIMA after skeletonized harvesting. (copyrights preserved). (B): LIMA after pedicled harvesting (copyrights preserved)

Post-operative Data: Postoperatively, deep sternal wound infection, sternal dehiscence, paresthesia, pain severity (VAS), and bleeding (24-hour chest drainage) have been recorded. All cases have been transferred to the intensive care unit on mechanical ventilation with continuous monitoring of vitals, urine output, and chest drainage. Blood gases were assessed every 2 hours for 24 hours, then every 8 hours for 48 hours. A 12-lead ECG was performed upon ICU admission and every 12 hours. In cases of ischemia with rising cardiac enzymes or graft thrombosis, reoperation was done. Routine labs (CBC, liver/kidney function, coagulation) were conducted. Cases were weaned from ventilation and inotropes based on clinical stability and extubated once fully awake. After ensuring hemodynamic stability and chest drain removal, they were transferred to the ward for continued care. Discharge was granted to stable cases with no signs of sepsis, a stable sternum, and clean wounds.

Ethical Considerations

An informed written consent has been acquired from every case. Prior to the investigation start, all cases were informed about the potential risks of the surgery, including bleeding, myocardial infarction, and infection. The investigation has been permitted by the Ethical Medical Committee of Cairo University under code MD-89-2023.

Statistical Analysis:

Information has been encoded and input utilizing the Statistical Package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, New York, United States of America). Information has been summarized utilizing the mean and standard deviation for quantitative parameters and frequencies (case numbers) together with relative frequencies (percentages) for categorical variables. Group comparisons have been conducted utilizing an unpaired t-test. The Chi-square (χ^2) test has been conducted to compare categorical data. The exact test has been utilized when the expected frequency was below 5. P-values below 0.05 have been deemed statistically significant.

3. RESULTS

Table (1): Comparison among investigated groups with regard to baseline characteristics

		Group A (Skeletonized)	Group B (Pedicled)	P value
Age (years) Mean±SD		60.90±9.33	60.70±9.54	0.867
Gender Count (%)	**Female**	13 (11.3%)	13 (11.3%)	1
	Male	102 (88.7%)	102 (88.7%)	

P-values below 0.05 have been considered statistically significant, SD: standard deviation.No significant distinction was reported among the investigated groups with regard to age or gender. The mean age was 60.90±9.33 and 60.70±9.54 years in the skeletonized and pedicled groups, respectively. Male % was 88.7% in both groups (Table 1).

Table (2): Comparison among investigated groups with regard to intraoperative details

	Group A (Skeletonized)	Group B (Pedicled)	P value
	Mean±SD	Mean±SD	
Number of anastomosis done by mammary	1.50±0.52	1.00±0.00	**< 0.001***

P-values less than 0.05 have been considered statistically significant, SD: standard deviation.

The number of anastomoses done by the LIMA in the skeletonized group was significantly greater when compared to the pedicled group (1.50±0.52 vs. 1.00±0.00; P-value below 0.001) (Table 2).

Table (3): Comparison among investigated groups with regard to postoperative details

	Group A (Skeletonized)	Group B (Pedicled)	P value
	Mean±SD	Mean±SD	
Pain VAS score	2.08±0.48	2.97±0.36	**< 0.001***
Drainage in first 24 hours (cc)	213.48±104.76	265.30±168.08	**0.006***

VAS: Visual Analogue Scale.

Pain detected by VAS score among cases in the skeletonized group was significantly reduced when compared to the pedicled group (2.08 ± 0.48 vs. 2.97 ± 0.36; P-value below 0.001) (Table 3).

Table (4): Comparison among investigated groups with regard to postoperative complications

		Group A (Skeletonized)	Group B (Pedicled)	P value
		Count (%)	Count (%)	
Deep sternal wound infection	**Yes**	3 (2.6%)	5 (4.3%)	0.722
	No	112 (97.4%)	110 (95.7%)	
Parathesia	**Yes**	14 (12.2%)	26 (22.6%)	**0.037***
	No	101 (87.8%)	89 (77.4%)	
Sternal dehiscence	**Yes**	1 (0.9%)	2 (1.7%)	1
	No	114 (99.1%)	113 (98.3%)	

Cases in Skeletonized group had significantly reduced frequency of postoperative parathesia when compared to Pedicled group (12.2% vs 22.6%; P=0.037). While insignificant distinction has been reported among investigated groups with regard to incidences of postoperative deep sternal wound infection (2.6% vs 4.3% in Skeletonized and Pedicled groups respectively; P=0.722) or postoperative sternal dehiscence (2.9% vs 1.7% in Skeletonized and Pedicled groups respectively; P=1) (Table 4).

Table (5): Comparison among investigated groups with regard to ICU and hospital stay

	Group A (Skeletonized)	Group B (Pedicled)	P value
	Mean±SD	Mean±SD	
ICU stay (days)	2.09±0.39	2.18±0.59	0.146
Hospital stay (days)	6.19±0.85	6.32±1.06	0.303

ICU: intensive care unit.

Insignificant distinction was reported among investigated groups with regard to duration of ICU stay or duration of hospital

stay. Mean duration of intensive care unit stay was 2.09 ± 0.39 and 2.18 ± 0.59 days in Skeletonized and Pedicled groups respectively. Mean duration of hospital stay was 6.19 ± 0.85 and 6.32 ± 1.06 days in Skeletonized and Pedicled groups correspondingly (Table 5).

4. DISCUSSION

CABG surgery is regarded as the fundamental treatment for multi-vessel severe CAD. Various grafts and conduits have been utilized, and many investigations have been conducted to enhance operative results. **(5).**

Our study compared the early outcomes of skeletonized versus pedicled LIMA harvesting in cases having CABG. Data from 230 cases of ischemic heart disease who were admitted to Kasr Al-Ainy Hospitals and other affiliated hospitals were analyzed. Cases were divided based on the surgeon's preference: Group A (115 cases) underwent CABG with skeletonized LIMA harvesting, while Group B (115 cases) had CABG with pedicled LIMA harvesting.

In our investigation, it was shown that an insignificant distinction has been reported among the investigated groups with regard to age or gender. The mean age was 60.90±9.33 and 60.70±9.54 years in the skeletonized and pedicled groups, correspondingly. The male % was 88.7% in both groups.

Our study showed that skeletonization of LIMA can allow for more anastomoses than pediceled technique for a significantly greater number of anastomoses when compared to pedicaled technique group (1.50±0.52 versus 1.00±0.00; P-value below 0.001).

Agreeing with our investigation, **Di Mauro et al. (6)** carried out an investigation on 175 cases who had pedicled internal mammary artery harvesting and 175 cases who underwent skeletonized internal mammary artery harvesting. They reported that the skeletonized internal mammary arteries group had a greater average number of arterial anastomoses (3.1 ± 0.8 versus 2.7 ± 0.8, P-value below 0.001) and internal mammary artery anastomoses (2.5 ± 0.3 versus 2.1 ± 0.3, P-value below 0.001).

In contrast, **Sazzad et al. (7)** investigated sixty consecutive cases who had CABG, in which the left IMA has been anastomosed to the left anterior descending artery (LAD). In thirty consecutive left IMAs, they have been harvested as a pedicle (Control Group), and another thirty consecutive left IMAs were harvested as skeletonized grafts (Experimental Group). That can be explained, as they excluded cases with Y or T grafts from their study, as it interfered with the angiographic results, which was the main aim of their study.

In our study, pain detected by VAS score among cases in the skeletonized group was significantly reduced when compared to the pedicled group (2.08±0.48 versus 2.97±0.36; P-value below 0.001).

Supporting our finding, **Bawany et al., (8)** included 50 cases who have been assessed for their pain at one and three months postoperatively using Visual Analogue Scale (VAS). They reported that the pedicled group had significantly greater scores measured at both one- and three-month intervals (P-value below 0.0001).

Sakic et al., (9) carried out a case-control investigation of 418 CABG cases receiving BITA, and observed an association among a reduction of sternal wound complication and skeletonized ITA compared to pedicled ITA (P = 0.001).

In discordance with our study **Shaheen et al., (10)** conducted an investigation involving fifty cases that had isolated coronary artery bypass grafting with either skeletonized internal thoracic artery (twenty-five cases) or pedicled internal thoracic artery (twenty-five cases). Insignificant distinction has been observed among the pedicled technique and the skeletonized method for postoperative drainage within the first twenty-four hours.

Our investigation showed insignificant distinction has been reported among investigated groups with regard to incidences of postoperative deep sternal wound infection (2.6% vs 4.3% in Skeletonized and Pedicled groups respectively; P=0.722) or postoperative sternal dehiscence (2.9% vs 1.7% in Skeletonized and Pedicled groups respectively; P=1).

In line with our investigation, **Ahmed et al., (11)** observed insignificant distinction among the two groups with regard to postoperative sternal dehiscence and sternal wound infection at three months monitoring.

Also, the results of **Kusu-Orkar et al., (12)** Meta-analysis revealed insignificant distinction among the skeletonized and pedicled groups with regard to sternal wound infection rates.

Moreover, **Sazzad et al., (7)** study showed that there was similar frequency of superficial wound complications among the groups.

Furthermore, an investigation involving 2056 cases by **Benedetto et al., (13)** found that skeletonized single internal mammary artery harvesting didn't confer additional advantages over pedicled single internal mammary artery harvesting concerning the possibility of sternal wound complications, and it has been related to bilateral internal mammary artery harvesting.

In the present study showed that, insignificant distinction among investigated groups with regard to duration of intensive care unit stay or duration of hospital stay. Mean duration of intensive care unit stay was 2.09±0.39 and 2.18±0.59 days in

Skeletonized and Pedicled groups respectively. Mean duration of hospital study was 6.19±0.85 and 6.32±1.06 days in Skeletonized and Pedicled groups respectively.

Similarly, **Ahmed et al. (11), Kamel et al. (14), and Sazzad et al. (7)** found an insignificant distinction among the two groups with regard to the intensive care unit stay.

5. LIMITATION

Our study has short follow up compare the outcome of left skeletonized mammary harvesting and pedicled left mammary harvesting in cases undergoing CABG operation.

6. CONCLUSION

Our study found that skeletonized LIMA harvesting significantly reduced postoperative pain, blood drainage, and incidence of paresthesia compared to the pedicled technique. It also allowed for a higher number of anastomoses using the left internal mammary artery. Nevertheless, an insignificant distinction has been observed among both techniques regarding deep sternal wound infection, sternal dehiscence, ICU stay, or overall hospitalization duration.

7. RECOMMENDATION

Further large-scale prospective studies with longer monitoring are needed to compare skeletonized versus pedicled LIMA harvesting in CABG. Skeletonized LIMA harvesting is encouraged as it significantly reduces postoperative pain, paresthesia, and blood drainage while allowing for more anastomoses.

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