

Comparison of Sternal Wound Complication after Off-Pump CABG between Skeletonized and Pedicled LIMA Harvesting: A Single Centre Experience in Bangladesh

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Abstract

Background: Off-pump coronary artery bypass grafting (OPCAB) is a surgical procedure that has gained popularity due to its potential benefits over traditional coronary artery bypass grafting, including reduced morbidity and mortality. However, sternal wound complication (SWC) remains challenging following the procedure. The technique of left internal mammary artery (LIMA) harvesting has been shown to impact the incidence of SWC. This study aimed to compare the incidence of SWC between two techniques of LIMA harvesting, *i.e.*, skeletonized and pedicled. **Methods:** The study was conducted at the Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University, and included 60 patients who underwent OPCAB. The patients were divided into two groups of 30 each based on the technique of LIMA harvesting used, *i.e.*, skeletonized (group A) or pedicled (group B). The postoperative ICU care was given to each patient as per the protocol. The statistical analysis was conducted using the SPSS version 26.0 for Windows software. **Results:** The results showed that 5 (8.33%) patients developed SWC, with 1 (1.67%) patient in group A and 4 (6.66%) patients in group B. However, the occurrence of SWC was not statistically significant between the two groups ($p = 0.35$). The mean age, gender distribution, and comorbidities such as hypertension, diabetes, dyslipidemia, and anemia were also not statistically significant between the two groups. The number of smokers was statis-

tically significant between the two groups ($p = 0.03$), and the occurrence of SWC was found to be higher in smoker patients in group B ($p = 0.04$). Preoperative and postoperative parameters such as duration of operation, duration of mechanical ventilation, duration of chest drains, duration of the central venous line, and amount of postoperative mediastinal bleeding were also not statistically significant between the two groups. The distribution of wound complications, duration of ICU stays, and hospital stay between the two groups was also not statistically significant. **Conclusion:** In conclusion, this study found that the incidence of SWC was less in skeletonized LIMA harvesting than in pedicled LIMA harvesting after OPCAB. However, this finding was not statistically significant. Further studies with larger sample sizes may be needed to confirm these results and determine the appropriate technique of LIMA harvesting to decrease the incidence of SWC after OPCAB.

Keywords

Sternal Wound Complication (SWC), Off-Pump Coronary Artery Bypass Grafting (OPCAB), Left Internal Mammary Artery (LIMA), Skeletonized LIMA Harvesting, Pedicle LIMA Harvesting

1. Introduction

Coronary artery disease (CAD) is a highly prevalent cardiovascular disease caused by the narrowing of coronary arteries due to a chronic inflammatory process called atherosclerosis [1]. Bangladesh has a higher incidence of cardiovascular diseases than other South Asian countries [2]. The off-pump coronary artery bypass grafting (CABG) method is an innovative approach to treating CAD [1]. When conducting CABG, the left internal mammary artery (LIMA) is the most preferred choice among various conduits for myocardial revascularization [3]. Two established techniques exist for LIMA harvesting: skeletonized and pedicled, each with advantages and disadvantages [4] [5] [6]. The skeletonized LIMA harvesting technique involves the separation of LIMA from the surrounding tissue, including intrathoracic fascia, veins, and adipose tissue. In contrast, the pedicled LIMA harvesting technique involves the harvesting of LIMA along with the surrounding fascia, veins, and adipose tissue [7]. However, this technique may increase the risk of complications, as the blood supply of the sternum is mainly derived from the internal mammary artery (IMA), and there are fewer collateral vessels in the inferior portion of the sternum, making this area more vulnerable to complications following the IMA harvest. Experimental and clinical evidence suggests that a pedicled graft may compromise postoperative sternal blood flow, leading to a necrotic substrate favorable for bacterial growth and increasing the risk of sternal wound complications [8]. Therefore, the technique of LIMA harvesting must be carefully considered to reduce the incidence of sternal wound complications, among the most challenging complications of cardiac surgery [9]. These complications can range from sterile wound dehiscence to suppurative

mediastinitis and are classified into two types: sternal wound dehiscence and sternal wound infection, which have various subtypes [10]. This study aims to advocate the best technique of LIMA harvesting for surgeons to reduce the incidence of sternal wound complications.

2. Materials & Method

A prospective cross-sectional study was conducted in the Department of cardiac surgery, Bangabandhu Sheikh Mujib Medical University. The study was conducted from October 2019 to September 2021. The study included all willing off-pump CABG patients, excluding those who underwent conversion to on-pump CABG, redo CABG, were hemodynamically unstable, required bilateral internal mammary harvesting, had re-open surgeries, were diagnosed with malignancy, or were undergoing chemotherapy. A total of 60 patients were selected. Under group A, 30 Patients received skeletonized LIMA; under group B 30 Patients received pedicled LIMA. LIMA harvesting techniques were randomly assigned in an alternate manner between the two groups. A semi-structured questionnaire was developed in English. After proper evaluation and optimization, all patients underwent off-pump CABG according to the Department's standard operative, anesthetic, and antibiotic protocol. Left internal mammary artery (LIMA) was harvested using two techniques. In the postoperative period, both A and B groups were monitored. Blood sugar was monitored routinely, and glycemic control was ensured. All patients were observed cautiously for the detection of sternal wound complications. A check dressing was done on the third postoperative day to assess the wound condition. Any clinical features of cellulitis were looked at (*Cellulitis* was defined as the presence of redness, swelling, the local rise of temperature, pain or tenderness over the sternal wound). In case of soaking of bandage or discharge from the wound, the swab was collected in a sterile test tube and sent for Gram's stain and microbiological culture and sensitivity test. In the presence of positive or negative culture, any clinical evidence of cellulitis, pus formation, wound dehiscence or wound infection was taken into account, and details information was noted. Thus, patients were monitored for any sternal wound complications throughout the postoperative hospital stay. This study regarded sterile wound dehiscence to suppurative mediastinitis as a sternal wound complication [11].

Statistical analyses were performed using Windows-based computer software devised with Statistical Packages for Social Sciences (SPSS-26) (SPSS Inc, Chicago, IL, USA). Descriptive and inferential statistical methods were applied to analyze data. Several inferential statistics were used, including chi-square or Fisher exact test for qualitative data and paired or unpaired t-test for quantitative data, to compare the study groups and draw conclusions from the data. The statistical significance threshold was set at 5% for all analytic tests, and a p-value of ≤ 0.05 was considered statistically significant. The current study follows the principles outlined in the Declaration of Helsinki and has been approved by the

Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University (reference number: BSMMU/2020/9294).

3. Results

The current study included 60 patients divided equally into groups (A and B). The mean age of patients in Group A was 53.17 ± 10.74 years, while in Group B, it was 54.50 ± 11.50 years. However, there was no statistically significant difference in age between the two groups ($p = 0.91$) (Table 1). Similarly, the mean BMI in Group A was 24.53 ± 1.86 ; in Group B, it was 24.66 ± 1.59 , with no significant difference between the groups ($p = 0.78$). The distribution of patients by gender also showed no statistically significant difference between the groups (Table 2). The comparison of major risk factors, including hypertension, diabetes mellitus (DM), dyslipidemia, and anemia, between the two groups, was not statistically significant ($p > 0.05$) (Table 3). However, there was a higher prevalence of smokers in Group A, which was statistically significant ($p = 0.03$).

Table 1. Comparison of age and BMI between two groups.

Age and BMI	Groups			p-value
	Group A f (%)	Group B f (%)	Total f (%)	
^a Age Group (Years)				
35 - 44	7 (63.6)	4 (36.4)	11 (100)	0.78 ^{ns}
45 - 54	12 (48.0)	13 (52.0)	25 (100)	
55 - 64	5 (45.5)	6 (54.5)	11 (100)	
65 - 75	6 (46.2)	7 (53.8)	13 (100)	
^b Age (Mean, & SD)	53.17 ± 10.74	54.50 ± 11.50	53.83 ± 11.2	0.91 ^{ns}
^b BMI (Mean, & SD)	24.53 ± 1.86	24.66 ± 1.59	-	0.78 ^{ns}

Data were analyzed using ^aChi-square test, and ^bStudent's t test (presented as mean \pm SD) was done to measure the level of significance. p value ≤ 0.05 was considered to be significant. ns = not significant. f = Frequency. BMI = Body Mass Index in Kg/m².

Table 2. Gender distribution of the patients between two groups (N = 60).

^a Gender	Group			p-value
	Group A n1 = 30 f (%)	Group B n2 = 30 f (%)	Total f (%)	
Male	27 (50.9)	26 (49.1)	53 (100)	0.69 ^{ns}
Female	3 (42.9)	4 (57.1)	7 (100)	
Total	30 (50)	30 (50)	60 (100)	

^aStatistical analysis was done by Chi-square test. N = Total number of subjects. ns = Not significant. Data were expressed as frequency (f) and percentage. p value ≤ 0.05 was considered as significant.

Table 3. Comparison of the patients according to preoperative risk factors between groups.

^a Risk factors	Group		p-value
	Group A (n1 = 30) f (%)	Group B (n2 = 30) f (%)	
Smoking	20	12	0.03 ^s
Hypertension	19	22	0.41 ^{ns}
Diabetes	14	21	0.07 ^{ns}
Dyslipidemia	16	18	0.60 ^{ns}
Anemia	4	4	1.00 ^{ns}

^aChi-square test was done to measure the level of significance. p value ≤ 0.05 was considered to be significant. n = number of patients. f = frequency. ns = not significant. s = significant.

(**Table 3**). However, the percentage of preoperative risk factors for sternal wound complications among the study population is shown in **Figure 1**. Among diabetic patients, sternal wound complications were not statistically significant between Group A and Group B ($p = 1.00$) (**Table 4**). Similarly, the infection rate among non-diabetic patients was not statistically significant between the two groups ($p = 0.12$) (**Table 4**). Among the study population, 8.33% of patients (5 out of 60) developed sternal wound complications, with 20% in Group A and 80% in Group B. However, this difference was not statistically significant ($p = 0.35$) (**Table 5**). The organisms identified in infected wounds between the groups are presented in **Figure 2**. Overall, the study findings indicate no significant differences in age, BMI, gender distribution, major risk factors, and occurrence of sternal wound complications between Group A and Group B, except for a higher prevalence of smokers in Group A.

4. Discussion

Sternal wound complication (SWC) is a significant concern in cardiac surgery as it increases morbidity, mortality, and cost. This study compared the outcomes of postoperative wound complications after off-pump coronary artery bypass grafting (OPCAB) between two groups with the different left internal mammary artery (LIMA) harvesting techniques.

Five of the 60 patients in this study developed SWC (8.33%), with 1.67% in group A and 6.66% in group B. Out of 30 patients in group A, 1 (3.33%) had a sternal wound complication, while 4 (13.33%) had wound complications in group B. However, the occurrence of SWC between Group A and Group B was not statistically significant ($p = 0.35$). These findings are consistent with a study by Peterson *et al.*, where the overall incidence of SWC was similar between the two groups (4.8% and 4.2%, respectively) and not statistically significant. However, the occurrence of SWC in our study was higher than in Peterson's study, indicating that the development of SWC is multifactorial and independent of the

Table 4. Occurrence of sternal wound complication in diabetic and non-diabetic patients.

^a Attributes	Group			p-value
	Group A f (%)	Group B f (%)	Total f (%)	
Diabetic	1 (33)	2 (66.7)	3 (100)	1.00 ^{ns}
Non-diabetic	0 (0)	2 (100)	2 (100)	0.12 ^{ns}

^aFisher’s exact test was done to measure the level of significance. $p \leq 0.05$ was considered to be significant. f = number of diabetic patients. ns = not significant.

Table 5. Comparison according to types of sternal wound complication between two groups.

^a Wound Complication types	Group			p-value
	Group A f (%)	Group B f (%)	Total f (%)	
Superficial Sternal Wound Infection (SSWI)	1 (33.3)	2 (66.7)	3 (100)	1.00 ^{ns}
Deep Sternal Wound Infection (DSWI)	0 (0)	1 (100)	1 (100)	0.49 ^{ns}
Sterile Sternal Wound Dehiscence (SSWD)	0 (0)	1 (100)	1 (100)	0.49 ^{ns}
Mediastinitis	0 (0)	0 (0)	0 (0)	-

^aFisher’s exact test was done to measure the level of significance. $p \leq 0.05$ was considered to be significant. f = frequency. ns = not significant. b = No statistic is computed because mediastinitis is a constant.

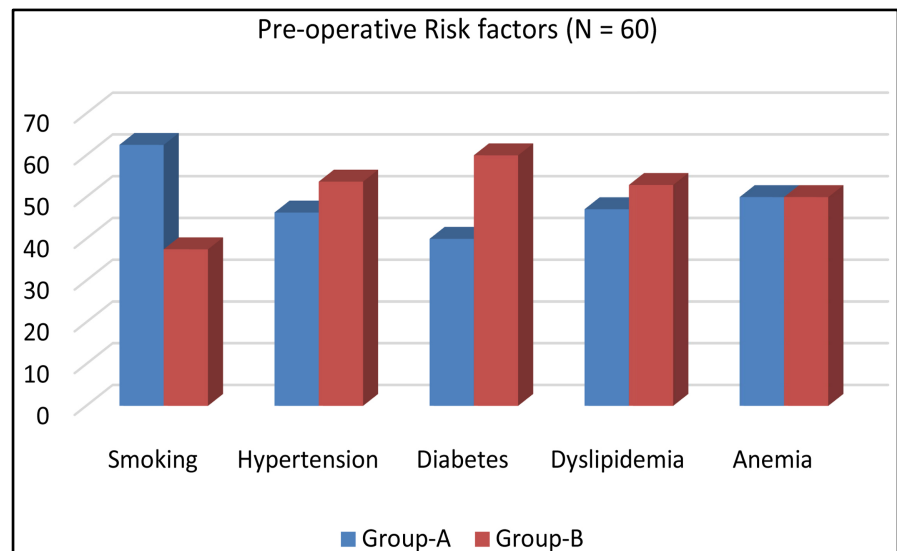


Figure 1. Showing pre-operative risk factors of sternal wound complications among the study population.

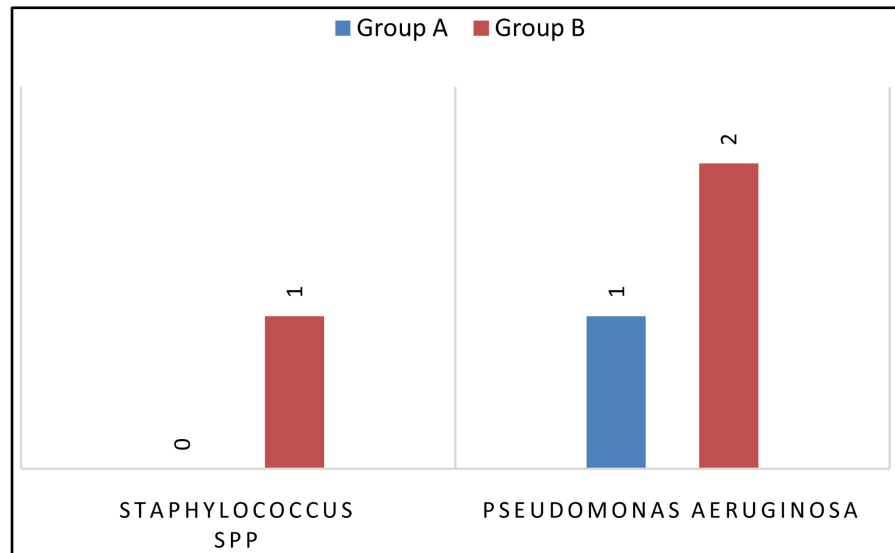


Figure 2. Organisms identified in infected wound between the groups.

harvesting technique. Factors such as patient selection, clipping branch vessels, and using a harmonic scalpel may contribute to the differences between the findings [12].

Among the patients with SWC, the most common pathogen identified was *Pseudomonas*, found in 3 (60%) patients, while *Staphylococcus* was cultured in 1 (20%). This finding differs from Oakley *et al.*, who reported *Staphylococcus* as the most common organism isolated in 70% of cases studied [10].

This study examined the association between diabetes and sternal wound complications (SWC) after off-pump coronary artery bypass grafting (OPCAB). Although the literature describes a well-established association between diabetes and SWC, our findings did not reveal a significant relationship. These results align with the study conducted by Furnary *et al.*, who demonstrated the positive impact of strict glucose level control on SWC in this patient population [13].

Furthermore, we explored the association between SWC and other comorbidities in both groups, such as hypertension, dyslipidemia, and anemia. Statistical analysis showed that these comorbidities were not statistically significant concerning SWC ($p = 1.00$, $p = 0.60$, and $p = 1.00$, respectively). However, other studies, including those conducted by Chen *et al.* (2012) and Lola *et al.* (2011), have suggested a significant association between diabetes and other comorbidities with the development of postoperative wound complications [14] [15]. Okonta *et al.* reported diabetes mellitus as the most common risk factor. However, this finding does not align with the present study, suggesting that a larger population may be needed to conclude that diabetes is a risk factor for wound complications [16]. Interestingly, in our study, SWC was more prevalent in smokers in group B, which was statistically significant ($p = 0.04$). Some studies that did not assess smoking or define smoking variables may have underestimated the connection between smoking and SWC, which contradicts the ab-

ovementioned finding. Additionally, some studies show no significant relationship [17].

5. Conclusion

The occurrence of sternal wound complications was observed to be lower in patients undergoing skeletonized left internal mammary artery (LIMA) harvesting compared to pedicled LIMA harvesting during off-pump coronary bypass grafting (OPCAB) in this study. However, it is important to note that this finding did not reach statistical significance. Therefore, we emphasize the need for a large-scale prospective study to definitively determine the role of LIMA skeletonization in reducing the incidence of sternal wound complications during OPCAB.

6. Limitations of the Study

This study was conducted at a single center in Bangladesh, involving a small population of patients, and the study was limited to a short duration. It is important to note that the sample size was insufficient to achieve statistically significant results. Additionally, the sampling method employed was not randomized, which may introduce potential biases. Furthermore, the follow-up period for the patients was relatively short. As a result, caution should be exercised in generalizing the findings of this study to a broader population of patients undergoing off-pump coronary artery bypass grafting.

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Authors' Contributions

The first author of this study played a pivotal role in conceiving and designing the research, collecting data from the hospital, conducting data analysis, and preparing the manuscript. All authors collaborated in the interpretation of the findings and unanimously approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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