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Research Article,

"Pleurotomy during CABG on the Clinical Outcome Following Left Internal Mammary Artery (LIMA) Harvesting"

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Abstract

Background: The internal mammary artery (IMA) is the graft of choice for coronary artery bypass grafting (CABG) due to superior patency and enhanced patient survival.Pleurotomy during coronary artery bypass grafting (CABG) may cause post-operative events, mostly pulmonary complications.

Objective: To assess the impact of intact pleura during left internal mammary artery harvesting on clinical outcome.

Materials and Methods: This Cross sectional observational study was carried out in the Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from January 2019 to December 2019.101 patients who underwent Department of Cardiac Surgery, BSMMU were enrolled in this study and divided into two groups: group A (n = 48, 36 male and 12 female patients at a mean age of 56.5 ± 11.2 years) underwent routine CABG and pleurotomy and group B (n = 53, 45 male and 8 female patients at a mean age of 55.4 ± 10.3 years) had CABG with intact pleura. The patients were compared regarding their demographic data, surgical data, and postoperative events.

Results: The Incidence Of Postoperative Pericardial Effusion Was Similar Between The Groups, But The Incidence Of Postoperative Pulmonary Complications Such As Pleural Effusion (Except For Mild Pleural Effusion) On The Second (No: 10.4%, mild: 41.7%, moderate: 45.8% and severe: 2.1% in group A versus no: 42.6%, mild: 44.4%, moderate: 13%, and severe: 0 in group B) and fifth postoperative days (no: 27.1%, mild: 33.3%, moderate: 35.4%, and severe: 4.2% in group A versus no: 42.6%, mild: 44.4%, moderate: 13%, and severe: 0 in group B) was significantly lower in group B (p value < 0.001 and p value = 0.007, respectively). Also, the incidence of atelectasis (except for mild atelectasis) on the second (no: 2.1%, mild: 22.9%, moderate: 72.9%, and severe: 2.1% in group A versus no: 9.2%, mild: 59.3%, moderate: 31.5%, and severe: 0 in group B) and fifth postoperative days (no: 22.9%, mild: 39.6%, moderate: 35.4%, and severe: 2.1% in group A versus no: 39.6%, mild: 49.1%, moderate: 11.3%, and severe: 0 in group B) was significantly higher in group A (p value < 0.001 and p value = 0.004, respectively). Postoperative partial oxygen pressure and O2 saturation were similar between the groups, but partial carbon dioxide pressure was significantly lower in group A (p value = 0.017). Amount of bleeding (p value = 0.008) and duration of hospitalization (p value = 0.002) were significantly higher in group A than those in group B.

Conclusion: Our results indicate that keeping the pleura intact has beneficial effects on the respiratory function, without increasing the incidence of postoperative pericardial effusion.

Keywords: Coronary Artery Bypass; Pericardial Effusion; Pleural Effusion.

Introduction:

The internal mammary artery (IMA) is the graft of choice for coronary artery bypass grafting (CABG) due to superior patency and enhanced patient survival.[1,2] The left internal mammary artery (LIMA) is most commonly used due to its proximity to the left anterior descending artery. Although it is possible to harvest the LIMA without opening the left pleura[3], this cannot be reliably achieved in all cases due to the intimate anatomical relationship. In comparison with the saphenous vein, this artery is widely used in coronary artery bypass grafting (CABG).There are different factors which may cause respiratory complications after CABG such as anesthesia, poor preoperative pulmonary function, cardiopulmonary bypass, and poorly executed surgical techniques. In addition to these factors, some studies have shown that among the patients undergoing CABG the ones who receive internal mammary grafts exhibit marked pulmonary dysfunction.[4] Although it is possible to harvest the LIMA without opening the left pleura, this cannot be reliably achieved in all cases on account of the intimate anatomical relationship.[5] It is thought that many factors ranging from surgical technique to the preoperative medications have a role on the development of pleural effusion in postoperative early period. Primarily, there are two basic reasons for pleural effusions that occur in the period so-called perioperative period, which comprises postoperative first one-week. The first is diaphragm disorder and the second is harvesting LIMA.[6,7] Heart failure after CABG decreased cardiac output after surgery; pleural infection, pulmonary embolus, and chylothorax are among the causes of postoperative pleural effusion.[8] On the other hand, the other group of surgeons who proceed their surgeries with intact pleura may reduce the risk of postoperative pulmonary complications, pericardial effusion, and tamponade. With pleurotomy, the blood will pass through the pleural cavity, which will reduce the chance of pericardial effusion and, therefore, tamponade. However, the patients may suffer from some degrees of pleural effusion instead of pericardial effusion.

Materials and Methods:

This Cross sectional observational study was carried out in the Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from January 2019 to December 2019. 101 patients who underwent Department of Cardiac Surgery, BSMMU were enrolled in this study and divided into two groups: group A (n=48, 36 male and 12 female patients at a mean age of 56.5±11.2 years) underwent routine CABG and pleurotomy and group B (n=54, 45 male and 8 female patients at a mean age of 55.4±10.3 years) had CABG with intact pleura. The patients were compared regarding their demographic data, surgical data, and postoperative events. These patients were divided into two groups based on the surgeons methods. One surgeon performed the procedure with pleurotomy, whilst the other surgeon performed the procedure with keeping the pleura intact: Group A: the opened pleura (OP) group comprised 48 patients, and Group B: the closed pleura (CP) group was comprised of 53 patients. The cases with a history of chronic obstructive pulmonary disease, severe left ventricular dysfunction, or thoracotomy and the patients who underwent redo surgeries, emergency CABG, and re -exploration due to significant surgical bleeding were excluded from the study. In the case of incidental intraoperative pleurotomy and double mammary artery harvesting during the procedure, the patients were also excluded from our study. For the patients who had received Plavix and were candidates for percutaneous coronary intervention, Plavix administration was discontinued 72 hours before surgery. During this process, a series of chest X-ray examination was obtained: upright chest X-ray before surgery; anteroposterior chest X-ray after surgery and chest drains extraction but before the transfer of the patients from the intensive care unit (ICU) to the ward; and upright posteroanterior chest X-ray on the fifth day of admission at the cardiac surgery ward. All the chest X-rays were evaluated for the existence of any pleural effusion or infiltration and atelectasis by the same radiologist.

Statistical Analyses:

For the statistical analyses, the statistical software SPSS version 15.0 for Windows (SPSS Inc., Chicago, IL) was used. The clinical data are expressed as mean values ± standard deviation. Differences were analyzed with the paired and independent Student t-test for the values of a

scaling term and the Pearson chi square test for the nominal values. The Mann Whitney U test was employed to compare the values without a normal distribution between the two groups. Postoperative values on the second and fifth days in each group were compared using the Wilcoxon signed-ranks test. A p value < 0.05 was considered statistically significant.

Results:

There were no significant differences between the two groups of patients in our study regarding their demographic data, except for the mean value of preoperative partial carbon dioxide pressure (PCO_2), which was significantly lower in the patients in group A (Table-1).The mean duration of aortic cross-clamp time (group A: 40.9 ± 10.3 minutes vs. group B: 38.2 ± 8.1 minutes) and mean duration of cardiopulmonary bypass time (group A: 69.4 ± 15.5 minutes vs. group B: 68.4 ± 11.4 minutes) were similar between the groups (p value = 0.151, p value = 0.752, respectively). The mean number of grafts was 3.5 ± 1.0 in group A vs. 3.4 ± 0.8 in group B with no significant difference (p value = 0.577).

Table-1: Preoperative patient characteristics (N=101)

	Opened Pleura Group	Closed Pleura Group	P value
Age (y)	56.5±11.2	55.4±10.3	0.607
Sex (F/M)	12/36	8/45	0.196
Smoking	17 (35.42)	17 (32.08)	0.660
Diabetes Mellitus	15 (31.25)	20 (37.73)	0.696
Ejection Fraction (%)	45.0±8.8	43.3±8.6	0.343
PO_2 (mmHg)	106.8±84.5	117.1±97.1	0.571
O_2 saturation (%)	94.9±3.0	94.8±3.3	0.870
PCO_2 (mmHg)	36.1±5.4	38.6±4.1	0.009
Hematocrit (%)	40.3±6.3	40.9±5.3	0.612

Data are presented as mean±SD or percentage.

PO_2, Oxygen partial pressure; PCO_2, Carbon dioxide partial pressure

These two groups of patients were evaluated for postoperative complications such as pericardial effusion, pulmonary effusion, atelectasis, drainage, and transfusion. Partial oxygen pressure (PO_2), oxygen saturation (O_2 Sat), and PCo_2 were also evaluated preoperatively and early in the postoperative period as well as on the second and fifth postoperative days; the results are shown in (figures 1, 2 & 3).

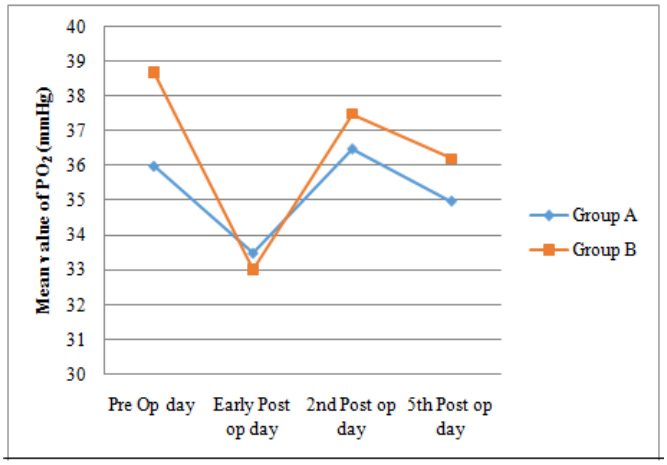

Figure1. Comparison of preoperative, early, and second and fifth postoperative days' PO_2 between Group A (opened pleura) and Group B (Closed pleura) PO_2, Partial oxygen pressure.

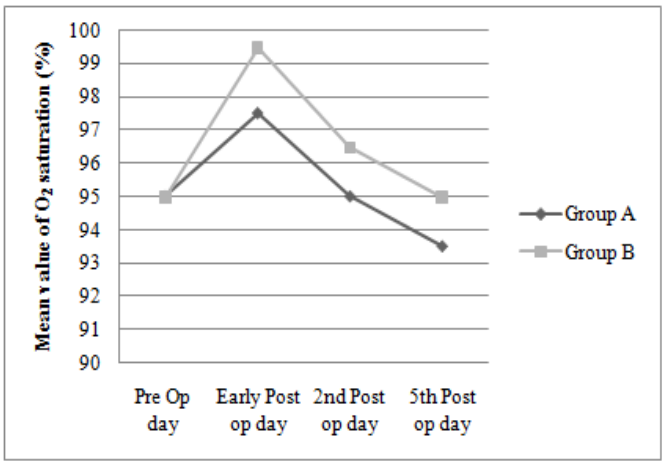

Figure 2: Comparison of preoperative early, and second and fifth postoperative days' O_2 saturation between Group A (opened pleura) and Group B (closed pleura).

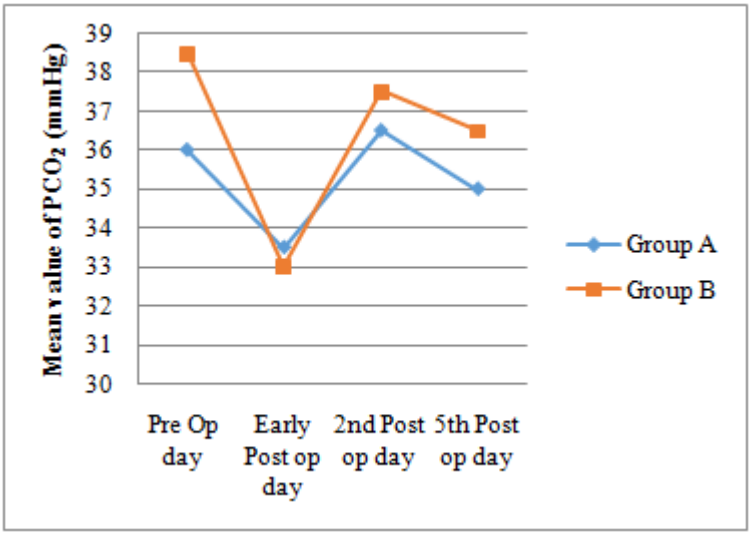

Figure 3: Demonstrates that postoperative PCO_2 was significantly lower in group A (p value = 0.017) as a result of a higher respiratory rate in these patients and significant difference among two study

Table 2: The incidence of the different degrees of respiratory complications on the second and the fifth postoperative days in Group A (opened pleura) and Group B (closed pleura) (N=101)

	Group A (n=48)	Group B (n=53)	P value
Pleural Effusion (%)			P < 0.001
No	10.4	42.6	
Mild	41.7	44.4	
Moderate	45.8	13	
Severe	2.1	0	
Atelectasis (%)			P < 0.001
No	2.1	9.3	
Mild	22.9	59.3	
Moderate	72.9	31.5	
Severe	2.1	0	

Table 3: The incidence of the different degrees of respiratory complications on the second and the fifth postoperative days in Group A (opened pleura) and Group B (closed pleura) (N=101)

	Group A (n=48)	Group B (n=53)	P = 0.007
	27.1	42.6	
Pleural Effusion (%)	33.3	44.4	
No	35.4	13	
Mild	4.2	0	
Moderate			P = 0.004
Severe	22.9	39.6	
Atelectasis (%)	39.6	49.1	
Pleural Effusion (%)	35.4	11.3	
No	2.1	0	
Mild			P = 0.007
Moderate	27.1	42.6	
Severe	33.3	44.4	

However, the duration of mechanical ventilation was similar between the two study groups: group A = 15.5 ±19.8 hours vs. group B =10.6 ± 3.4 hours (p value=0.079). Pericardial effusion did not occur in 78.6% of the patients in group A, whilst cases of mild and moderate pericardial effusion

were reported in 14.3% and 7.1% of the cases, respectively. In group B, pericardial effusion was not reported in 71.2% of the patients; however, 17.3% of the cases suffered mild and 11.5% of the patients suffered moderate pericardial effusion. These differences were not statistically significant between the two groups (p value = 0.394). The incidence of postoperative pleural effusion and the incidence of atelectasis on the second postoperative day before the transfer of the patients from the ICU to the ward and on the fifth postoperative day were evaluated and compared between the groups and the results are depicted in (Table 2, 3). The mean value of postoperative mediastinal bleeding was 565.6 ± 390.0 cc in group A and 369.4±344.5 cc in group B, there being a significant statistical difference (p value=0.008). The mean value of transfusion requirement was higher in group A (622.2±379.5 cc group A vs. 482.6 ± 255.2 cc group B); this difference, however, did not constitute statistical significance (p value = 0.126). The mean length of ICU stay was 2.5±0.9 days in group A and 2.3 ± 0.8 days in group B (p value = 0.214), and the duration of hospitalization was significantly longer in group A (7.0 ± 2.4 days) than that in group B (5.7 ±1.2 days) (p value =0.002).

Discussion:

In our study, LIMA was harvested and left pleural space was opened in all patients. The LIMA is mostly used as the conduit of choice for myocardial revascularization. The LIMA has more advantages than does the saphenous vein, and that is why the former is widely utilized in CABG procedures. LIMA harvesting was performed via two main different techniques due to the surgeons' preferences in our study. In our study the mean duration of aortic cross-clamp time (group A: 40.9 ± 10.3 minutes vs. group B: 38.2 ± 8.1 minutes) and mean duration of cardiopulmonary bypass time (group A: 69.4 ± 15.5 minutes vs. group B: 68.4 ± 11.4 minutes) were similar between the groups (p value = 0.151, p value = 0.752, respectively). The mean number of grafts was 3.5 ± 1.0 in group A vs. 3.4 ± 0.8 in group B with no significant difference (p value = 0.577). Group A patients had pleurotomy and group B patients had their LIMA harvested without pleurotomy. As a result, maintaining the pleura intact could reduce the incidence of postoperative respiratory complications in this group of patients.Guiziliniet al.[9]demonstrated that the decrease in PO_2 occurred in both groups in their study; however, the decline in the open pleura group (23.4%) was significantly higher than that in the intact pleura group (14.7%). Pleurotomy confers a better exposure of the LIMA and thus lower incidence rates of postoperative pericardial effusion and tamponade. In contrast, postoperative pulmonary complications are liable to occur more frequently via pleurotomy. Another aspect of this matter is that most of the patients who require CABG tend to be smokers and thus already suffer from some degrees of pulmonary diseases. In our study, although PO_2 and O_2 Sat were lower in group A patients than those in group B patients, these differences were not statistically important. On the other hand, PCo_2 levels were significantly lower in group A; this may have been in consequence of a higher respiratory rate in these patients, which may be secondary to some degrees of gas exchange impairment. In the present study, the incidence of postoperative pericardial effusion was higher in the group of patients with intact pleura than that in the cases with open pleura. In the current study, the incidence of pleural effusion and atelectasis (except for mild cases) on the second and fifth postoperative days were significantly higher in group A than in group B, and there were severe cases of both postoperative pleural effusion and atelectasis in group A patients. This difference, however, was not statistically significant. None of the patients in our study suffered tamponade. Bonacchi M and colleagues[10] also concluded in their study that the incidence of re-exploration following pericardial effusion and bleeding was statistically the same between the patients undergoing LIMA harvesting with intact pleura and the cases undergoing LIMA harvesting via opened pleura. In contrast, the Rolla G et al. study[11] demonstrated that the incidence of pulmonary atelectasis and postoperative pleural effusion on the second and sixth postoperative days was not different between the patients undergoing CABG with LIMA harvesting via pleurotomy and the patients undergoing CABG with LIMA harvesting without pleurotomy. In contrast to the above-mentioned study, in our study, the length of ICU stay as well as intubation period was similar between our two groups of patients but admission time was significantly higher in group A than in group B.Another

outcome of this study was that the mean value of transfusion requirement in group A patients was higher than that in group B patients but with no significant difference. Still, there was a significant difference in the mean value of drainage requirement between our two study groups. The same results were demonstrated in the study of Atay Y and colleagues,[12] in which the mean values of postoperative blood loss and blood transfusion requirement were significantly higher in the group with open pleura. Also, the study of Oz BS et al.[13]revealed that postoperative bleeding and the duration of hospital stay were markedly higher in the open pleura group than those in the closed pleura group, which is similar to the findings in our study.In our study, the number of patients who were studied was limited and our data evaluations were only based on the patients' physical examinations, chest X-rays, and ABG analyses. Lim et al.[5]Atay Y et al.[12]and Oz BS et al.[13] achieved results that chime in with those of our study inasmuch as they concluded that the incidence of atelectasis and pleural effusion was significantly higher in patients with open pleura than in the patients with intact pleura. The study of Wheateroft and colleagues,[14] revealed that all the patients with significant deterioration in pulmonary function tests who underwent CABG via pleurotomy sustained an increased rate of atelectasis and pleural effusion, although there was no impact on the clinical outcome or length of hospital stay.

Conclusion:

In concluded, revealed that by employing more delicate surgical techniques and spending more time on CABG procedures with the aim of harvesting LIMA without pleurotomy, we may reduce the risk of postoperative complications that usually require re-exploration such as pleural effusion, atelectasis, and bleeding as well as pericardial effusion and tamponade.

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