

Impact of Intact Pleura during Left Internal Mammary Artery Harvesting on Clinical Outcome

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Abstract

Background: Pleurotomy during coronary artery bypass grafting (CABG) may cause post-operative events, mostly pulmonary complications. In this study, we evaluated the influence of pleurotomy during CABG on the clinical outcome following left internal mammary artery (LIMA) harvesting.

Methods: Between March and August 2009, 102 patients who underwent cardiac surgery 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, 46 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.

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Introduction

The left internal mammary artery (LIMA) is mostly used as the conduit of choice for myocardial revascularization. The LIMA has superior graft patency, better long-term survival, and fewer cardiac events.^{1,2} Due to these advantages 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.¹ 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.² Some surgeons prefer to open the pleural cavity during LIMA harvesting in order to achieve better exposure of this arterial conduit. The groups of surgeons who perform the procedure with pleurotomy have better LIMA exposure with fewer complications such as 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. 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.

The aim of this prospective cohort study was to investigate whether or not avoiding pleurotomy whilst harvesting the LIMA would reduce both postoperative pulmonary and cardiac complications.

Methods

After this prospective cohort study protocol was approved by the institutional review board and written informed consent was obtained from each patient, 102 patients who underwent elective CABG with LIMA graft were enrolled. The surgical operations were performed by two cardiac surgeons in Rajaie Cardiovascular, Medical and Research Center between March and August 2009.

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 54 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. However, if the patients had received Aspirin 80 mg/day as routine before admission, Aspirin would be continued before the surgical operation. In addition, for all the patients, Aspirin 325 mg/day was administered early after extubation. 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. Also, a series of arterial blood gas (ABG) analyses was performed for the patients: immediately before surgery; two hours after the transfer of the patients to the ICU and after extubation; immediately before the transfer of the patients from the ICU to the ward; and before the removal of the arterial line. These ABG analyses were also thereafter studied.

The patients were evaluated for postoperative pulmonary complications, pleural effusion, pericardial effusion, hypoxia or hypercapnia, incidence of atelectasis, ICU length of stay, duration of hospitalization, intubation time, amount of bleeding, and transfusion requirement.

Pericardial effusion was considered mild when its diameter was less than 5 mm, moderate with a diameter of 5-20 mm, and severe with a diameter more than 20 mm in echocardiographic views. The two surgeons followed up the mild and asymptomatic moderate cases and performed subxiphoid drainage for the symptomatic moderate and severe cases.

The patients with a blunt costophrenic angle in sitting or upright posteroanterior chest X-rays were considered cases with mild pleural effusion and they were followed up. Nevertheless, for the other cases with significant effusion,

based on the surgeons' decision and the estimated volume of effusion in pleural sonography, percutaneous drainage with sonographic guide was performed in the cases with less than 1000 cc of effusion and chest tube insertion was carried out in the cases with more than 1000 cc of pleural effusion.

General anesthesia was induced for all the patients. After performing median sternotomy and with the aid of electrocautery and Hemo Clips number 200, LIMA harvesting became possible.

In group A patients, the left pleura was opened with the aid of electrocautery. The LIMA was thereafter prepared via the pediculated harvesting technique. The LIMA was dissected from the first part of the subclavian artery to the first site of the internal mammary artery bifurcation. In group B, the left pleura was retracted with moisturized sponge and the pleura was kept intact. In the case of incidental pleurotomy, the patient was excluded from the study.

During the surgery, all the patients were connected to cardiopulmonary bypass. For group A patients, a retrosternal chest tube (number 32) and an intercostal (space 5-6 in mid-auxiliary line) chest tube (number 36) were inserted. For group B patients, a retrosternal chest tube (number 32) was instituted.

On the second postoperative day at the ICU, the patients were assessed for drainage. For the cases with no drainage, the chest tubes were extracted and then the patients were transferred to the ward, whereas the patients with a drainage volume more than 50 cc in the last six hours before ICU discharge or with a drainage volume of 300 cc in total were transferred to the ward with chest tubes. The chest tubes were extracted in the ward when the volume of drainage was less than 200 cc/24 hours.

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 \pm 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).

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, and 3.

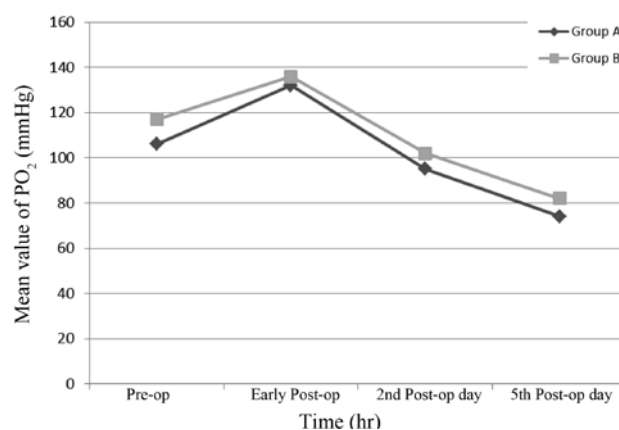


Figure 1. Comparison of preoperative, early, and second and fifth postoperative days' PO_2 between Group A (opened pleura) and Group B (Closed pleura)
 PO_2 , Partial oxygen pressure

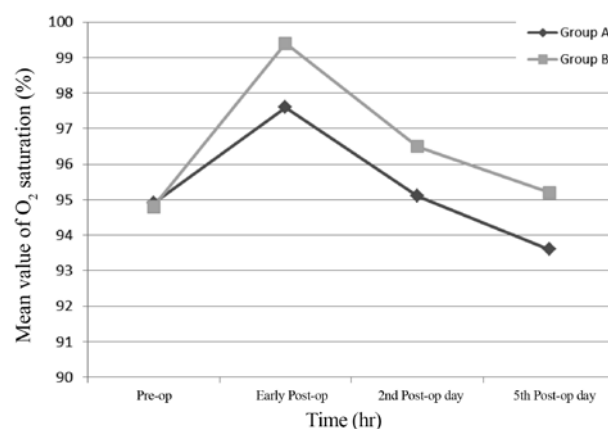


Figure 2. Comparison of preoperative early, and second and fifth postoperative days' O_2 saturation between Group A (opened pleura) and Group B (closed pleura)

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 groups regarding the mean value of PCO_2 before surgery. 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). There were no cases of massive pericardial effusion and tamponade in our study. Maintaining intact pleura increased the incidence of mild pericardial effusion, but it exerted no effect on causing a significant amount of pericardial effusion requiring intervention.

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. 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).

During our study, no ventilator-acquired pneumonia was reported.

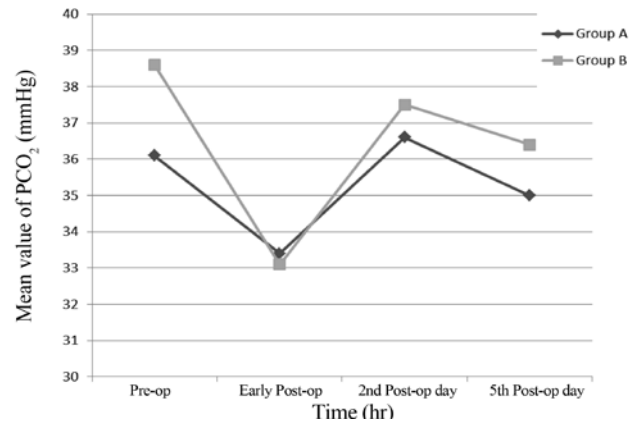


Figure 3. Comparison of preoperative early, and second and fifth postoperative days' PCO₂ between Group A (opened pleura) and Group B (closed pleura) PCO₂, Carbon dioxide partial pressure

Table 1. Preoperative patient characteristics*

	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	8/46	0.196
Smoking	18 (37.5)	18 (33.3)	0.660
Diabetes Mellitus	16 (33.3)	20 (37)	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

PO₂, Oxygen partial pressure; PCO₂, Carbon dioxide partial pressure

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)

	Second Post-Operative Day			Fifth Post-Operative Day		
	Group A (n=48)	Group B (n=54)	P value	Group A (n=48)	Group B (n=54)	P value
Pleural Effusion (%)			P < 0.001			P = 0.007
No	10.4	42.6		27.1	42.6	
Mild	41.7	44.4		33.3	44.4	
Moderate	45.8	13		35.4	13	
Severe	2.1	0		4.2	0	
Atelectasis (%)			P < 0.001			P = 0.004
No	2.1	9.3		22.9	39.6	
Mild	22.9	59.3		39.6	49.1	
Moderate	72.9	31.5		35.4	11.3	
Severe	2.1	0		2.1	0	

Discussion

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. Group A patients had pleurotomy and group B patients had their LIMA harvested without pleurotomy. 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. As a result, maintaining the pleura intact could reduce the incidence of postoperative respiratory complications in this group of patients.

Guizilini et al.³ 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%). 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. This difference, however, was not statistically significant. None of the patients in our study suffered tamponade. Bonacchi M and colleagues⁴ 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 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. In contrast, the Rolla G et al. study⁵ 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. Lim et al.,² Atay Y et al.,⁶ and Oz BS et al.⁷ 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 colleagues⁸ 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. 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.

In our series of patients, pleurotomy during surgery did not cause serious respiratory distress. Be that as it may, a higher incidence of atelectasis, pleural effusion, and some degrees of gas exchange impairment in our pleurotomy patients increased their length of hospital stay in comparison with our cases without pleurotomy. 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,⁶ 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.⁷ 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.

Conclusion

Our study 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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