

Original Research Article

Does pleurotomy for internal mammary artery harvest increase postoperative complications? A comparative study of internal mammary artery harvest with and without pleurotomy

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Received: 14 January 2021

Revised: 24 January 2021

Accepted: 25 January 2021

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ABSTRACT

Background: To assess and compare the postoperative complications in patients who are undergoing Left Internal Mammary artery harvesting for coronary artery bypass grafting surgery with pleurotomy and without pleurotomy.

Methods: The study was conducted on the patients admitted in a single unit of department of cardiothoracic surgery, NIMS, Hyderabad during the period of July 2017 to December 2017.

The study was a randomized open labelled controlled trial of two interventions. A total of 90 patients undergoing Coronary artery bypass surgery were enrolled in the study, with 60 among them having their Internal mammary harvesting done with pleurotomy and 30 undergoing the same without pleurotomy.

Results: In the non pleurotomy group, 16 (53.33%) were male and 14 (46.66%) were female. In the pleurotomy group males and females were 41 (68.33%) and 19 (31.66%) respectively. There was no statistical significance between both the groups with respect to postoperative bleeding, ICU stay, reexploration rate, duration of ventilation, PaO₂ and PCO₂ values or wound infection rates. The only difference between both the groups which showed statistical significance (0.051) was the occurrence of pleural effusion on POD 5. In the closed pleurotomy group only 2 (6.66%) patients had pleural effusion upto POD5, whereas in the open pleurotomy group 14 (23.33%) patients had pleural effusion persisting till POD5.

Conclusions: There is a higher incidence of Pleural effusion in the pleurotomy group although this did not translate into higher postop pain score, ICU/Hospital stay, wound infection rates.

Keywords: Pleurotomy, Pleural effusion, LIMA harvest

INTRODUCTION

The two commonly used conduits in CABG are Internal mammary artery (IMA) and saphenous vein graft (SVG). Although IMA is considered to be the conduit of choice, due to superior patency rates, there are some studies opposing its harvesting, due to the pleurotomy involved during the procedure. The breach in pleural integrity was

associated with altered respiratory function and postoperative pain.¹⁻³ These associated morbidities were found to increase duration of hospital stay and increasing the overall costs of the procedure.

The studies that support pleurotomy during IMA harvest justify that it would prevent cardiac tamponade if postoperative bleeding were to occur.⁴

The harvesting of IMA without pleurotomy has been reported to reduce the postoperative complications.

As there is scarcity of studies on the subjects and clear guidelines have not been evolved, we intend to conduct this study to assess and compare the postoperative pleural and cardiac complications between group of patients who are undergoing coronary artery bypass graft using IMA as one of the conduits, with and without pleurotomy.

METHODS

The study was a randomized open labelled controlled trial of two interventions. The study subjects were randomly assigned to one of the two intervention groups using computer generated random number sequence, after assigning a set of numbers to each intervention.

The participants for the study were selected from the cases admitted in a single unit of Department of Cardiothoracic Surgery, Nizam’s Institute of Medical Sciences (NIMS), Hyderabad during the period of July 2017 to December 2017 after applying the defined inclusion and exclusion criteria.

Patients with coronary artery disease, who were planned for elective coronary artery bypass grafting (CABG) surgery were included in the study. Patients undergoing emergency CABG, patients with respiratory illnesses and critical comorbidities were excluded from the study. The total subjects included in the study were 90 (30-nonpleurotomy group and 60- in the pleurotomy group). All the procedures were performed by senior consultant cardiac surgeons who were proficient in harvesting LIMA with both techniques i.e open pleura method and closed pleura method.

Ethics approval was obtained from the institute’s Ethics Committee and informed written consent was sought from all the participants.

Statistical methods

Since the proposed intervention was a surgical intervention, investigator blinding was not possible but the study participants and the statistician analysing the data were blinded for the intervention

Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables.

Independent sample t-test was used to assess statistical significance. The association between explanatory variables and categorical outcomes was assessed by cross tabulation and comparison of percentages. Chi square test was used to test statistical significance. P value<0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.

RESULTS

A total of 90 patients were included in the study. Among them, 30 (33.33%) people had closed pleural harvesting of IMA and 60 (66.67%) people had open pleura harvesting (Table 1).

Table 1: Groups in study population (n=90).

Groups	Frequency	Percentage
Closed pleura	30	33.33
Open pleura	60	66.67

The mean age of closed pleura group was 50 ± 6.48 and the open pleura group was 52.85±5.72. The mean difference 2.85 between two groups was statistically significant (p value 0.036) (Table 2).

Table 2: Comparison of mean age between study groups (n=90).

Groups	Age Mean±STD	Mean difference	P value
Closed pleura	50±6.48	2.85	0.036
Open pleura	52.85±5.72		

Among people with closed pleura, 16 (53.33%) people were male and 14 (46.66%) people were female. The number of males and females was 41 (68.33%) and 19 (31.66%) in open pleura. The differences in proportion gender with group was statistically not significant (p-value 0.164) (Table 3).

Table 3: Comparison of groups with gender of study population (n=90).

Gender	Groups		Chi square	P value
	Closed pleura (n=30)	Open pleura (n=60)		
Male	16 (53.33%)	41 (68.33%)	1.938	0.164
Female	14 (46.66%)	19 (31.66%)		

In the people with closed pleura, 14 (46.66%) people had diabetes mellitus. In the people with open pleura, 23 (38.33%) people had diabetes mellitus. The difference in proportion of diabetes mellitus with group was statistically not significant (p value 0.449) (Table 4). In the people with closed pleura, 4 (13.33%) people had hyperlipidemia. In the people with open pleura, 7 (11.66%) people had hyperlipidemia. The difference in proportion of hyperlipidemia with group was statistically not significant (p-value 0.820) (Table 4). In the people with closed pleura, 17 (56.66%) people had hypertension. In the people with open pleura, 32 (53.33%) people had hypertension. The difference in proportion of hypertension with group was statistically not significant (p value 0.765) (Table 4).

Table 4: Comparison of comorbidities in the groups with of study population (n=90).

Co-morbidity groups	Diabetes mellitus		Hyperlipidaemia		Hypertension		Smoker	
	Yes	No	Yes	No	Yes	No	Yes	No
Open pleura	23 (38.33%)	37 (61.66%)	7 (11.66%)	53 (88.33%)	32 (53.33%)	28 (46.66%)	38 (63.33%)	22 (36.66%)
Closed pleura	14 (46.66%)	16 (53.33%)	4 (13.33%)	26 (86.67%)	17 (56.66%)	13 (43.33%)	16 (53.33%)	14 (46.66%)
Chi square	0.574		0.052		0.090		0.833	
P-value	0.449		0.820		0.765		0.361	

Table 5: Comparison of mean blood loss (ml) between study groups (n=90).

Groups	Blood loss (ml) Mean±STD	Mean difference	95% CI		P value
			Lower	Upper	
Closed pleura	727.73±51.38	17.13	-5.62	39.88	0.138
Open pleura	710.6±51.11				

In the people with closed pleura, 16 (53.33%) people had smoking. In the people with open pleura, 38 (63.33%) people had smoking. The difference in proportion of smoking with group was statistically not significant (p-value 0.361) (Table 4). The mean blood loss of closed pleura group was 727.73±51.38 mL and the open pleura group was 710.6 ± 51.11 mL. The mean difference 17.13 mL between two groups was statistically not significant (p value 0.138) (Table 5).

Table 6: Comparison of mean PaO₂ (mmHg), PaCO₂ (mm Hg) and SpO₂ between study groups (n=90).

Groups	Closed pleura	Open pleura
PaO ₂ (mmHg) Mean±STD	87.9±4.5	88.23±5
Mean difference	0.33	
P-value	0.759	
PaCO ₂ (mmHg) Mean±STD	34.33±1.3	34.58±1.08
Mean difference	0.25	
P-value	0.335	
O ₂ (mmHg) Mean±STD	96.17±2.04	96.03±2.21
Mean difference	0.13	
P value	0.783	

The mean PaO₂ of closed pleura group was 87.9±4.5 (mmHg) and the open pleura group was 88.23±5 (mmHg). The mean difference 0.33 (mmHg) between two groups was statistically not significant (p value 0.759) (Table 6). The mean PaCO₂ of closed pleura group was 34.33±1.3 (mmHg) and the open pleura group was 34.58±1.08 (mmHg). The mean difference 0.25 (mmHg) between two groups was statistically not significant (p value 0.335) (Table 6). The mean O₂ saturation of closed pleura group was 96.17±2.04% and the open pleura group was 96.03±2.21%. The mean difference 0.13% between two groups was statistically not significant (p value 0.783) (Table 6).

The mean duration of ventilation of closed pleura group was 9.73±1.46 hours and the open pleura group was 9.75±1.41 hours. The mean difference 0.02 hours between two groups was statistically not significant (p value 0.958). The mean ICU stay of closed pleura group was 1.87±0.86 day and the open pleura group was 1.97±0.78 days. The mean difference 0.10 day between two groups was statistically not significant (p value 0.581). The mean hospital stay of closed pleura group was 6.1±0.8 days and the open pleura group was 6.13±0.81 days. The mean difference 0.03 day between two groups was statistically not significant (p value 0.854) (Table 7).

Table 7: Comparison of mean hospital stay (days) between study groups (n=90).

Groups	Hospital stay (days) Mean±STD	Mean difference	95% CI		P value
			Lower	Upper	
Closed pleura	6.1±0.8	0.03	-0.33	0.39	0.854
Open pleura	6.13±0.81				

In the people with closed pleura, 3 (10%) people had tamponade. In the people with open pleura, 2 (3.333%) people had tamponade.

The difference in proportion of tamponade with group was statistically not significant (p value 0.193) (Table 10).

In the closed pleura group none of the patients had atelectasis on post-operative day 2 and only 2 patients in open pleura group had atelectasis. In the people with closed pleura, 1 (3.333%) had post-operative day 5 atelectasis. In the people with open pleura, 7 (11.66%) people had post-operative 5 days atelectasis. The difference in proportion of post-operative 5 days atelectasis with group was statistically not significant (p value 0.190) (Table 9).

Table 8: Comparison of groups with tamponade of study population (n=90).

Tamponade	Groups		Chi square	P value
	Closed pleura (n=30)	Open pleura (n=60)		
Yes	3 (10%)	2 (3.333%)	1.694	0.193
No	27 (90%)	58 (96.66%)		

Table 9: Comparison of groups with postop. day 2 and postop. day 5 atelectasis of study population (n=90).

Post- op 2 days atelectasis	Groups		Post- op 5 days atelectasis	Groups	
	Closed pleura (n=30)	Open pleura (n=60)		Closed pleura (n=30)	Open pleura (n=60)
Yes	0 (0%)	2 (3.333%)	Yes	1 (3.333%)	7 (11.66%)
No	30 (100%)	58 (96.66%)	No	29 (96.66%)	53 (88.33%)

Table 10: Comparison of groups with postop. day 2 and postop. day 5 effusion of study population (n=90).

Post- op 2 days effusion	Groups		Post- op 5 days effusion	Groups	
	Closed pleura (n=30)	Open pleura (n=60)		Closed pleura (n=30)	Open pleura (n=60)
Yes	1 (3.333%)	5 (8.333%)	Yes	2 (6.666%)	14 (23.33%)
No	29 (96.66%)	55 (91.66%)	No	28 (93.33%)	46 (76.66%)

In the people with closed pleura, 1 (3.333%) had post-operative day 2 effusion. In the people with open pleura, 5 (8.333%) people had post-operative day 2 effusion. The difference in proportion of post-operative 2 days effusion with group was statistically not significant (p-value 0.370).

In the people with closed pleura, 2 (6.666%) people had post-operative 5 days effusion. In the people with open pleura, 14 (23.33%) people had post-operative 5 days effusion. The difference in proportion of post-operative 5 days effusion with group was statistically significant (p value 0.051) (Table 10).

DISCUSSION

Coronary artery disease and its treatment have become one of the most common health issue of the 21st century. The presence of CAD requiring intervention (percutaneous intervention/surgical) is a surrogate of suboptimal functioning of other organ systems in the body. In this context, harvesting the Internal Mammary artery by opening the pleura has been reported in some studies to impair respiratory function, increase hospital stay, need of blood transfusions, impaired wound healing. We tried to find whether there was any statistical significance in preoperative and postoperative variables, when the internal mammary artery was harvested with and without pleurotomy. Out of a total of 90 participants who were included in this study, 30 (33.3%) of them

underwent the surgery with a closed pleura and the remaining 60 (66.7%) of them with open pleura.

In the closed pleura group, 16 (53.33%) were male and 14 (46.66%) were female, whereas in the open pleura group 41 (68.33%) were male and 19 (31.66%) were female. In our study the mean age of closed pleura group was 50±6.48 and the open pleura group was 52.85±5.72. The mean difference 2.85 between two groups was found to be statistically significant (p value 0.036).

Bonacchi et al. in their study found the mean age to be 56±4.5 years in the pleurotomy group and 55±5.7 years in non pleurotomy groups.⁵ The male /female ratio in the two groups were 153/33 and 61/21 respectively. Similarly, Greinecker et al in their study found the mean age to be 62.3±1.7 years in pleurotomy group and 63.5±1.5 years in non pleurotomy group with a male /female ratio was 45/12 and 41/14 in both the groups respectively.⁶

Although, a statistical significance was found between both the groups, which we can only attribute it to chance, where the closed pleura group were younger than the open pleura group. However, we found that the mean age of patients undergoing CABG in our study to be lower compared to previous studies. The presence of comorbidities (diabetes mellitus, hyperlipidemia, hypertension, and smoking) in both the groups was not significant statistically, as was found in other studies.

The mean blood loss in our study in the closed pleura group was 727.73 ± 51.38 ml and the open pleura group was 710.6 ± 51.11 ml. The mean difference was statistically not significant (p-value 0.138). This was completely in contrast to other studies by Goksin et al., Wimmer et al. and Iskesen et al.⁶⁻⁸ These studies have reported a higher amount of blood loss and transfusion requirements among the group with open pleura. They have stated that, leaving the pleura intact during CABG would reduce the blood loss significantly. This could be due to the availability of better instruments and improved understanding of the postoperative pathophysiology of CABG and better anaesthetic and ICU care.

In our study, on postoperative day 2, 2 patients (3.33%) out of the 60 patients in the open pleura group developed atelectasis and none of the patients in the closed pleura group developed it. On the 5th postoperative day 7 patients in the open pleura group and 1 patient in the closed pleura group developed atelectasis but was statistically not significant.

Further in our study, we found no statistically significant difference in the occurrence of pleural effusion on the 2nd day between both the groups (open pleura vs closed pleura; 8.33% vs. 3.33%) but when we compared the same on the 5th day there was statistical significance (p value=0.05). The patients in the open pleura group (23.33%) had higher incidence of pleural effusion than the closed pleura group (6.66%).

Rolla et al., and Lim et al. have also reported statistically significant incidence of pleuropulmonary complications in the open pleura group compared to closed pleura group.^{9,10} Similarly the incidence of elevated hemi diaphragm reported by Rolla et al. on 6th postoperative day was not different in the two groups (18.5 vs. 14%), similar to the results obtained in our current study (3.33% vs. 0%).⁹

Goksin et al., in their study of 72 patients found the incidence of postoperative pleural effusion to be significantly (0.029) lower in group closed pleura group (15.2%) than open pleura group (30.5%).⁷ Other pulmonary complications such as prolonged ventilation, reintubation, pneumothorax, atelectasis, diaphragmatic paralysis were similar in both groups. Lim et al in their prospective study of 26 patients that left pleurotomy was found to increase the rate of atelectasis. However, this was not associated with an adverse clinical outcome.¹⁰

Paracha et al concluded that the pleural integrity during IMA harvesting decreases pleural effusion and recommended the intact pleural technique of IMA harvesting.¹² In the closed pleura group, 3 patients (10%) and 2 patients (3.33%) developed cardiac tamponade. However the difference between the groups was statistically not significant (p value=0.19).

Ali et al in their study involving 280 patients found that pleural effusion occurred more often in the patients who had opening of the pleura (20% versus 5%), however, none of the patients required tapping.¹³ They also reported that 5 patients in the closed pleura group had postoperative bleeding with cardiac tamponade, whereas 6 patients in the open pleura group had postoperative bleeding without cardiac tamponade. This difference was statistically significant. Paracha et al. in their study on 62 patients, partial oxygen pressure (PaO₂), partial carbon dioxide pressure (PaCO₂), oxygen (O₂) saturation did not significantly differ in both the groups.¹² This was similar to our results.

Guizilini et al. in their study have reported that there was a significant drop in PaO₂, for both groups (p<0.001), but the intact pleura group maintained higher values than the opened pleura group ($76.5 \pm 9.1\%$ versus $85.3 \pm 5.8\%$, p<0.001). This differed from the results obtained in our study, where there was no significant difference between the groups (closed pleura - 87.9 ± 4.5 vs. open pleura - 88.23 ± 5). The mean PaCO₂ values in both the groups in Guizilini et al study did not show statistically significant difference (closed pleura- 42.9 ± 7.8 and open pleura - 42.9 ± 4.6 , p value=1.0).¹⁴ We also did not find statistically significant difference to those of our study (closed - 34.33 ± 1.3 ; open 34.58 ± 1.08 , p value=0.33).

In our study present study, there was no statistically significant difference (p value 0.958) between the open pleura group (9.75 ± 1.41) and closed pleura group (9.73 ± 1.46) for the duration of mechanical ventilation, which was in contrast to the results of the study done by Sanad et al.¹⁵ They had reported a significantly lower duration of mechanical ventilation in the closed pleura group (10.58 ± 9.06) compared to open pleura group (14.22 ± 10.17 hours) and this difference was found to be statistically significant (p <0.001). Ozkara et al. and Atay et al. also reported a significant decrease in the duration of mechanical ventilation in the closed pleura group.^{16,17}

Our current study have showed no significant difference in post-operative pain between the two groups 4 (3.75 to 5) vs. 4.5 (4 to 6), p value=0.28). Postoperative pain results from a study by Sanad et al had shown a statistical significance difference in the median score between both groups (p=0.007).¹⁵ Similarly Gullu et al and Oz et al have reported the pain to be higher among the open pleura group.^{18,19}

In this present study, there was no significant difference between the groups (open pleura and intact pleura) for the duration of ventilation (9.75 ± 1.41 vs. 9.73 ± 1.46 , p value=0.95) which was in contrast to the results in a study by Sanad et al. where they have reported a significantly lower duration of mechanical ventilation in group of closed pleura (10.58 ± 9.06 versus 14.22 ± 10.17 hours; p<0.001).¹⁵ The results by Ozkara et al. and Atay et al. also differed from our study.^{16,17} These studies showed lesser duration of mechanical ventilation.

Our current study have showed no statistically significant (p value=0.28) difference in post-operative pain score between the two groups-open 4 (3.75 to 5) and closed 4.5 (4 to 6). But Sanad et al. their study had shown a statistical significance difference in the median pain score between both groups (p = 0.007).¹⁵ Similarly Gullu et al. and Oz et al have reported the pain to be higher among the open pleura group.^{18,19} Our patients probably had lesser pain in both the groups probably due to better pain management and lesser use of electric cautery.

The mean duration of ICU stay in the closed pleura group was 1.87±0.86 days and in the open pleura group it was 1.97±0.78. This difference was not significant statistically. Similarly the mean duration of hospital stay between closed pleura ((6.1±0.8) and open pleura (6.13±0.81) group did not show any statistical difference. Iqbal et al. in their study involving 90 patients found that the patients in the open pleura group stayed had a significantly longer (p value<0.005) compared to closed pleura group but the ICU stay was comparable.²⁰

Sayegh et al. in their study “Should the integrity of the pleura during internal mammary artery harvesting be preserved?”, discussed different studies on IMA harvesting. Among the studies that the authors compared, most of them dealt with investigating the radiographic changes, pulmonary function tests, ventilation time and also clinical consequences, such as bleeding, the need for blood transfusion, pain scores and the length of hospital stay. Eighteen articles were found, of which 6 were prospective randomized, controlled trials and 12 were cohort studies. These studies showed favourable outcomes for parameters like pleural effusion (15 studies), atelectasis (11 studies), pulmonary function tests (9 studies), arterial blood gases (5 studies), postoperative pain (6 studies), tamponade (2 studies), ventilation time (12 studies), blood loss (9 studies), transfusion (4 studies), intensive care unit stay (5 studies) and hospital stay (12 studies) in the intact pleura group. The findings of the authors suggest that preservation of pleural integrity seemed to contribute to decreased pulmonary complications and improved clinical outcome.²¹

Although our study had few patients we still found that the incidence of pleural effusion was significantly higher in the open pleura group compared to the closed pleura group. The study was not powered enough due to small sample size. Further the economic impact due to the postoperative complications has not been a part of this study.

There is a need to conduct further large scale, randomized controlled trials on the subject to scientifically assess the safety and economic efficacy of harvesting Internal Mammary artery with or without pleurotomy to further support development of evidence informed guidelines on the subject.

CONCLUSION

The incidence of CAD requiring surgery is involving younger population. The incidence of postoperative pleuroparenchymal complications, especially postoperative pleural effusion is higher in the open pleura group. To understand better the influence of open pleurotomy on postoperative outcomes a larger study involving multiple centres is required.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Palanki SSG, Kummari M, Dontineni P, Malempati AR, Bomma K. Does pleurotomy for internal mammary artery harvest increase postoperative complications? A comparative study of internal mammary artery harvest with and without pleurotomy. *Int J Res Med Sci* 2021;9:406-12.