

ORIGINAL ARTICLE

EFFECT OF INTERNAL MAMMARY ARTERY HARVESTING WITH AND WITHOUT PLEUROTOMY ON RESPIRATORY COMPLICATIONS IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING

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Background: Respiratory problems are one of the major issues faced by cardiovascular surgeons, which increase morbidity and mortality among patients undergoing coronary artery bypass grafting (CABG). It is possible to harvest the left internal mammary artery (LIMA) without opening the left pleura; however this cannot be reliably achieved in all cases due to intimate anatomical relationship. This study was designed to evaluate the effect of internal mammary artery harvesting with and without pleurotomy on respiratory complications in patients undergoing coronary artery bypass grafting. **Methods:** In this observational study 90 patients who underwent coronary artery bypass surgery were included by review of records. Patients were stratified into two groups according to surgical procedures, i.e., Internal Mammary artery harvesting with pleurotomy; (WP Group) (n=45) and with extra pleural harvesting technique; (EP Group) (n=45). Inclusion criteria were elective coronary artery bypass grafting, age over 18 years, willingness to be randomly assigned, provision of informed consent. Exclusion criteria were chronic obstructive pulmonary disease (COPD) or skeletal abnormalities that caused pulmonary restriction. Only the first 30 days postoperative outcome was studied. Data was analysed using SPSS version 21. **Results:** The demographic characteristics in terms of age and gender were comparable in study groups. The preoperative clinical presentation and medical history were also found similar. The hospital stay was significantly longer in WP Group than EP Group patients (7.2 vs 6.1 days, $p<0.005$). Moreover, post-operative morbidity was more prevalent in WP group 10 (22.2%) than EP Group 3 (66%) ($p<0.03$). In WP Group more respiratory complications were observed; 2 (4.4%) patients had dry cough and atelectasis, 1 (2.2%) patient experienced pleural effusion, 3 (6.6%) had bronchospasm while 1 (2.2%) patient each had sternal dehiscence and bleeding, however, these did not differ significantly among study groups. **Conclusion:** Respiratory complications were more frequent in patients undergoing Internal Mammary artery harvesting with pleurotomy compared to those managed extra pleural harvesting.

Keywords; Coronary Artery Bypass Grafting, Left Internal Mammary Artery, pleurotomy, extra pleural, respiratory complications

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INTRODUCTION

Cardiac diseases are quite common these days and surgical procedures like coronary artery bypass grafting are done in routine.¹ Practicing cardiovascular surgeons have observed that respiratory problems are one of the major factors affecting morbidity and mortality rates among patients undergoing coronary artery bypass grafting (CABG).² Anaesthesia, poor preoperative pulmonary function, cardiopulmonary bypass, and poor surgical techniques are the most widely known reasons for respiratory complications after CABG.^{3,4} The left and Right internal mammary arteries (IMA) are the conduit of choice for myocardial revascularization although Left Internal mammary artery (LIMA) is more widely used due to its proximity to the left anterior descending artery. Compared with the saphenous vein, the LIMA has superior long term graft patency and better survival.³ Although it is

possible to harvest the LIMA without opening the left pleura, this cannot be reliably achieved in all cases due to the intimate anatomical relationship.⁵

In our centre, left pleurotomy is performed routinely prior to harvesting the LIMA in order to allow the placement of the LIMA medial to the upper lobe avoiding any undue tension on the mammary pedicle. Some surgeons prefer to open the pleural cavity during Internal Mammary Artery harvesting in order to achieve better exposure of this arterial conduit.³ The groups of surgeons who perform the procedure with pleurotomy have observed better LIMA exposure with fewer complications. On the other hand, the other group of surgeons who proceed their surgeries with intact pleura have observed lesser risk of postoperative pulmonary complications.^{4,5} The aim of this study was to assess whether or not avoiding pleurotomy would reduce postoperative respiratory complications. This study was designed to

evaluate the effect of internal mammary harvesting with and without pleurotomy on respiratory complications in patients undergoing coronary artery bypass grafting.

MATERIAL AND METHODS

In this observational study 90 patients who underwent coronary artery bypass surgery were included by review of records conducted at the Pakistan Institute of Medical Sciences Islamabad, Bilal Hospital and Quaid-e-Azam International Hospital Islamabad from September 2010 to September 2015. Patients were stratified into two groups according to surgical procedures, i.e., Coronary Artery Bypass Graft surgery (CABG) either with Internal Mammary artery harvesting with pleurotomy; (WP Group) (n=45) or Internal Mammary artery harvesting with Extrapleural technique; (EP Group) (n=45). This was a single surgeon study conducted in different institutions with aim of analysis of data on Coronary Artery Bypass Graft surgery. Only the first 30 days postoperative outcome was studied. The medical records of patients between ages 18–80 years of both genders who underwent CABG were reviewed.

All patients underwent similar pre-operative preparations for different cardiac procedures (78% Coronary Artery Bypass grafting with pedicle Internal Mammary Artery harvesting and 22% other cardiac procedures), using standard median sternotomy. The patients data was reviewed in the two groups; the opened pleura or with pleurotomy (WP) Group and the closed pleura or extra pleura (EP) Group. In closed pleura group extra pleural harvesting of Internal Mammary artery was done. Similarly, in open pleura group Internal Mammary artery was harvested by conventional method by opening the Left pleural cavity.

All patients were assessed preoperatively by using Euro Score for standardizing the risk and expected outcome. Inclusion criteria for the patients were elective coronary artery bypass grafting, age over 18 years, willingness to be randomly assigned, provision of informed consent. Exclusion criteria for the patients were chronic obstructive pulmonary disease (COPD) or skeletal abnormalities that caused pulmonary restriction. Patients were evaluated with the aid of daily progress parameters. To monitor pleural effusion and atelectasis, chest radiography was performed as routine on day 01 before surgery, and on the 2nd, 3rd, 4th, 5th, and 7th postoperative days. Later on all the patients were followed up in outdoor clinic first weekly then after two weeks and monthly basis follow up first six month post operation. Instances of sternal dehiscence and of mediastinal drainage of any kind were recorded till 30th day postoperatively. Such cases were accepted

as mediastinitis in the event of positive serologic culture, and appropriate medical treatment was initiated. A 2nd surgery due to postoperative bleeding or mediastinitis was recorded as reoperation.

The data was entered in a computer using SPSS (Statistical Package for Social Sciences) Version 21.0 for Windows. The categorical variables were measured as frequencies and percentages while quantitative numerical variables were expressed as mean and standard deviations. The proportional responses were compared among EP and WP Groups using Pearson's chi-square test. The means were compared among the two groups using student's *t*-test. A *p*-value of ≤ 0.05 was considered statistically significant.

RESULTS

The mean age of patients was 56.4±11.0 years in extra pleura (EP) group and 57.5±11.2 years in with pleurotomy (WP) Group. Males and females were in similar proportions in the two groups. There were 33 (73.3%) males and 12(26.7%) females in Extra pleural Group and 32 (71.1%) males and 13 (28.9%) females in patients who had Internal Mammary artery with pleurotomy in WP Group.

The mean weight of patients was less 73.8±12.6 kg in EP Group as compared to 77.9±12.1 kg in WP Group $p < 0.11$. The height of patients was similar in the two groups. The preoperative physical exam and medical status was similar in the two groups, except for mean heart rate/min which was significantly higher in WP Group 75.0±12.0 as compared to EP Group patients 70.0±10.0 $p < 0.03$. In the WP Group all surgeries were done electively, however, in the EP Group 2(4.4%) patients needed emergency intervention whereas rests of the surgeries were elective 43 (95.5%). (Table-1) The operative time was longer in WP Group compared to EP Group (185.0±35. vs 180.0±30.0 minutes) respectively. Blood loss was also more in WP Group as compared to EP Group (520±350 vs 500±300 ml respectively) however *p* value was non-significant. (Table-2). The hospital stay was significantly longer in WP Group than in EP Group patients (7.2 vs 6.1 days, $p < 0.005$). Moreover, post-operative morbidity was more prevalent in WP Group 10 (22.2%) than EP Group 3 (66%) with statistically significant association $p < 0.03$. Two (4.4%) patients in the WP Group required re-opening. Two (4.4%) patients died in the WP Group whereas 1 (2.2%) patient died in EP Group. (Table-3)

As per study aim the post-operative respiratory complications were compared between the two interventions. In the EP Group 1 (2.2%) patient had dry cough and 2 (4.4%) experienced bronchospasm. Comparatively in WP Group more respiratory complications were observed, 2 (4.4%) patients had dry

cough and atelectasis, 1 (2.2%) patient experienced pleural effusion, 3 (6.6%) patients had bronchospasm while 1 (2.2%) patient had sternal dehiscence and bleeding, however, there was a non-significant association. (Table-4)

Table-1: Demographic characteristics and clinical presentation of patients

Characteristics	EP Group (n=45)	WP Group (n=45)	p value
Age in years (Mean±SD)	56.4±11.0	57.5±11.2	0.63
Gender			
Female	12 (26.7%)	13 (28.9%)	0.81
Male	33 (73.3%)	32 (71.1%)	
Preoperative status			
Weight mean kg	73.8±12.6	77.9±12.1	0.11
Height mean cm	163.9±9.6	164.9±6.5	0.58
Ejection Fraction mean %	35±10	35±10	1.0
Diabetes Mellitus	13 (28.8%)	16 (35.5%)	0.49
Hypertension	8 (17.7%)	12 (26.6%)	0.31
Renal Failure	2 (4.4%)	1 (2.2%)	1.0
COPD	3 (6.6%)	4 (8.8%)	1.0
Heart Rate mean/hr	70.0±10.0	75.0±12.0	0.03
Smoker	35 (77.7%)	37 (82.2%)	0.59
Surgery			
Elective	43 (95.5%)	45 (100.0%)	-
Emergency	2 (4.4%)	0	
IABP preoperative	3 (6.6%)	0	-

COPD=Chronic obstructive airways disease; IABP=Intra-aortic balloon pump

Table-2: Operative variables

Variables	EP Group (n=45)	WP Group (n=45)	p value
Cross clamp time mean min	53±25	52±20	0.83
CPB time mean min	90±25	88±23	0.69
Operative time mean min	180±30	185±35	0.46
Ventilation time mean hours	9±3	9±4	1.0
Blood loss mean ml	500±300	520±350	0.77
ICU stay mean days	3±2	3±2	1.0
Oxygen saturation mean (%)	98±2	99±1	0.003
Transfusions in OR/ICU	3±2	4±2	0.01
Haematocrit	33±3	32±4	0.18

CPB=Cardiopulmonary bypass; ICU=Intensive care unit; OR=Operation room

Table-3: Outcome variables of two study groups

Outcome variables	EP Group (n=45)	WP Group (n=45)	p value
Hospital stay in days (Mean±SD)	6.1±2.0	7.2±1.6	0.005
Morbidity	3(6.6%)	10(22.2%)	0.03
Re-opening	0	2(4.4%)	-
Re-ventilation	0	1(2.2%)	-
Mortality	1(2.2%)	2(4.4%)	1.0

Table-4: Comparison of postoperative respiratory complications between the two study groups.

Complications	EP Group (n=45)	WP Group (n=45)	p value
Dry cough	1(2.2%)	2 (4.4%)	1.0
Atelectasis	0	2 (4.4%)	-
Pleural effusion	0	1 (2.2%)	-
Bronchospasm	2 (4.4%)	3 (6.6%)	1.0
Sternal dehiscence	0	1 (2.2%)	-
Bleeding	0	1 (2.2%)	-

DISCUSSION

Respiratory problems are among the major factors affecting morbidity and mortality after coronary artery bypass grafting (CABG).^{6,7} Anaesthesia related problems, poor pulmonary function, cardiopulmonary bypass (CPB) and operative techniques are the most widely known reasons for respiratory complications after Coronary Artery Bypass Grafting. This study was aimed to find answers to the controversy and confusion of effects of intact and open pleura on respiratory outcome after Coronary Artery Bypass Grafting.

In this study age and gender of patients was similar in both extra pleura (EP) and with pleurotomy (WP) groups validating same demographics of study patients. A study by Rahim *et al* also noted majority of their cases between 41 and 60 years of age and male gender as predominant.⁵ Oz BS *et al* witnessed average age of 59.2 years in open pleura and 61.5 years in closed pleura groups and with three forth men being majority in both of their study groups.⁸ Ghavidel *et al* also observed patients having average age of 55 and 56 years and male gender in dominance.⁴ These results validate the findings of current study where CABG is mostly done in older ages and men are more prone to get operated.

In the current study 45 patients each underwent Coronary Artery Bypass Grafting and Internal Mammary artery harvesting with and without pleurotomy, the cross clamp time, CPB, ventilation, ICU stay and oxygen saturation were similar in both study groups. However, operative time and blood loss were greater in the patients with pleurotomy compared to those managed extra pleural. Similarly, hospital stay was longer in patients with pleurotomy than extra pleural management. In this study morbidity and mortality were greater in pleurotomy group compared to those with extra pleural, even morbidity was observed to be associated significantly ($p<0.03$). A similar finding was reported by Iyem *et al* who observed cross clamp time, CPB time and ventilation time similar in both open pleura and closed pleura groups, however, they found greater blood loss and longer hospital stay in open pleura group³ which is quite comparable to our findings. Oz *et al* also noted a similar result regarding cross clamp time, CPB time and ventilation. Moreover, they also noted more bleeding and longer hospital stay in open pleura group.⁸ This shows that our results are in accordance with previous reports regarding outcome of extra pleura harvesting.

In the current study it was noted that 2 (4.4%) patients required re-opening in the pleurotomy group whereas none in the extra pleural group experienced re-opening. Variable reports of re-

opening after CABG have been witnessed.^{9,10} Bonacchi *et al* also reported that incidence of re-exploration following pericardial effusion and bleeding was same in patients managed with intact pleura and those with open pleura.⁶ Ghavidel *et al* concluded that by employing a more delicate surgical technique and spending more time on CABG procedures for harvesting without pleurotomy may reduce the risk of postoperative complications, especially, those requiring re-exploration.⁴

In the current our study respiratory complication were more common in patients who were managed with pleurotomy, though not statistically so significantly observed were noted as; dry cough (4.4%), atelectasis (4.4%), pleural effusion (2.2%), bronchospasm (6.6%), sternal dehiscence (2.2%) and bleeding (2.2%). One (2.2%) patient had dry cough in extra pleura group and 2 (4.4%) had bronchospasm. A previous study by Noera *et al* reported that atelectasis, pleural effusion and bleeding was seen in open pleura group and sternal infection was also found in 3 of their cases in open pleura group compared to none in the closed pleura group.¹¹ Iyem and colleagues found atelectasis in 23% of their patients who underwent open pleura compared to 7% in closed pleura group; similarly they observed pleural effusion in 13% open pleura and 6% in closed pleura group on 7th postoperative day.³ Peng *et al* showed that 41% of their open pleura patients had pleural effusion on 6th postoperative day.¹² Many previous studies have demonstrated that loss of pleural integrity decreases lung capacity.^{13,14} It may be due to incidence of postoperative pain associated with pleural effusion or atelectasis¹⁵ or to traction applied during IMA harvesting¹⁶.

We observed that 2.2% patients had sternal dehiscence, this is quite common complication in patients undergoing CABG. Many previous studies have reported sternal infection in 0.8% to 2.4% patients.^{17,18}

There are many advantages of the current study; firstly this was a comparative interventional study which has merits of strong research methodology. Secondly, heart diseases are common in Pakistan and these are equally rising in both developed and under developed countries, interventions to facilitate these patients are crucial, moreover, improvement in the existing management strategies would also go a long way.

CONCLUSION

Respiratory complications were more prevalent in patients undergoing Coronary Artery Bypass Grafting with pleurotomy compared to those managed by extra pleural technique. The response to the interventions and its outcome was not that different among groups

except for high morbidity experienced by with pleurotomy group and also few patients required re-opening in this study group. Despite the fact that variable responses have been seen in this study, extra pleura harvesting is superior in terms of respiratory functional compliance post operatively. However, more studies on larger scale and with rigorous research methodologies are mandated before generalization of the findings of current study.

AUTHOR'S CONTRIBUTION

JI: Primary operating surgeon. FK: Senior Member of cardiac surgery team helped and supervised in data collection. SA: Compiled all Data and article writing. ARA: Reviewed the article and did Statistical analysis of the Data.

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