Effect of Pleurotomy During Internal Mammary Artery Harvest on Pulmonary Function

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Keywords: *Pleurotomy, Internal mammary artery(IMA), Pulmonary function, CABG.*

Abstract:

Background: *Pulmonary function after coronary artery bypass graft surgery using harvested Internal mammary artery(IMA) were assessed in this prospective case control Clinical study comparing two groups of Patients with or without pleurotomy.*

Method: *we conducted this Study at National Institute of Cardiovascular Diseases (NICVD), Dhaka, in the Department of Cardiovascular Surgery.A total of 60 consecutive patients undergoing CABG with use of IMA between july 2005 to June 2007 were reviewed. Study population were divided into Group A (n=30,undergone CABG with pleurotomy during IMA harvestion).Group B (n=30,undergone CABG with intactpleura during IMA harvestion).*

Results: *in lung function spirometry revealed FEV1 significantly decreased in group A than B (56.81±17.76% Vs 79.85±7.7%; p=0.035)and when FEV1correalated with inspiratory vital capacity the advantage of intact pleura were confirmed at 6^{th} postoperative day (78.02 ±12.17; B, 82.08 ±11.72 p=0.045). Vital capacity was significantly decreased in-group A than B at 3 months postoperatively (A 88.79 ± 14.38%;B 98.11±30.25%; p=0.009), but not on 6^{th} Postoperative day. Pleuropulmonary complication like atelectasis, pleural effusion insignificantly higher in groupA than B(16.7 %VS6.7%) and (10% vs. 6.7%)at 6^{th} postoperative day but not at 3months postoperatively.*

Conclusions: *These results demonstrate that pleurotomy during Internal mammary artery harvesting significantly deteriorated pulmonary function variably than intact pleura group of patients.*

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Introduction:

The internal mammary artery (IMA) is the graft of choice for myocardial revascularization owing to supirior graft patency and increased longterm survival compared with saphenous vein bypass grafting.Patients undergoing coronary artery bypass graft surgery (CABG) with the use of internal mammary artery (IMA) may require more attention to postoperative respiratory care.[1] Performance of pleurotomy to harvest IMA graft results greater chest wall and lung parenchyma trauma, greater pain, impaired ability to cough and inhale deeply. In addition IMA dissection may reduce blood supply to ipsilateral intercostals muscle, phrenic nerve injury or devascularization resulting in diaphragmatic dysfunction and ultimately atelectesis. Moreover median sternotomy incision, chest trauma, blood loss, presence of pleural chest tube contribute further deterioration of postoperative pulmonary function.[1-4] Impairment of pulmonary function after CABG is one of the most common complications in early postoperative period. Sternotomy, pain and most importantly pleurotomy with opening of pleural space during harvest of internal mammary artery (IMA) may lead to further deterioration of postoperative pulmonary function and complication. Additionally CPB may cause pathomorphologic and functional pulmonary changes called "post perfusion syndrome".[4-8] Spirometry is one of the earliest and most valuable simplest forms of pulmonary function test performed by a special device called Spirometer. It enables measurement of all lung volumes and of maximal breathing capacity or maximal voluntary ventilation.[9,10] So, the aim of the study was to compare the clinical outcome of patients after IMA harvesting resulting with or without pleurotomy by assessing pulmonary function postoperatively.

Patients and methods:

In a prospective , case-control ,clinical trial we studied 60 consecutive patients undergoing

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coronary artery bypass grafting(CABG)with internal mammary artery graft. This Study were done at National Institute of Cardiovascular Diseases and Hospital, Dhaka in the Department of Cardiovascular Surgery between July 2005 to June 2007.Study population were divided into Group A (n=30,undergone CABG with pleurotomy during IMA harvesting); Group B (n=30,undergone CABG with intact pleura during IMA harvesting). The protocol of this study was also accepted by the Academic Council, NICVD, Dhaka. Patients were explained the purpose and importance of the study and also the likely consequences. The study was conducted with signed informed consent of the participants accordingly. Patients with Elective CABG without IMA Harvesting, cerebro-vascular disease ,valvular heart disease, congenital cardiac anomalies, emergency CABG surgery, redo coronary artery bypass grafting surgery, hepatic and renal dysfunction , LVEF<40% , FEV1, FVC, and FEV1/FVC <50% of the predicted value. At 1st detail medical history were taken from each patient in preformed data sheet including age, sex, risk factors of IHD, symptoms including NYHA classification and some preoperative relevant investigation eg: chest X-ray, ECG, spirometry, echocardiography, other biochemical and heamatological investigations were done. Peroperatively, no. of graft, cross clamp time(XCT), extra-corporeal circulation time (ECCT) in min, were recorded in both pleurotomy and intact pleura group of patient during IMA harvesting. Postoperatively, mechanical ventilation time in hrs, arterial blood gas analysis(ABG) preoperatively, 1& 4 hour before and after extubation, again at 6th post operative day. Chest X-ray done postoperatively again 2nd , 6th day postoperatively(POD). Spirometry was done again on 6th postoperative day. Amount of blood loss in ml at ICU with total ICU & hospital stay in days were included. All patients were followed up postoperatively for pleuropulmonary complication like atelectesis, pleural effusion, consolidation, empyema, pneumonia , respiratory failure , reintubation, prolong mechanical ventilation; by chest X-ray & spirometry both on immediate postoperative day & again at 3 months. All these were recorded in data sheet & a master chart were prepared. Data analysis was done by standard statistical package for the social sciences (SPSS). software.The results were presented in Tables, Figures, and Diagrams etc. for significance of difference unpaired 't' test, paired t-test and chi-square test were done. A probability 'p' value (P<O.05) was considered as statistically significant.

Results:

A total of 60 patients divided in 2 groups (30 patients in each group) were included in this study. Most of the patients were between 41-60 yrs of age in group A & group B (90% vs 76.66%) and male (90% VS 93.33%). Female were(10%VS6.7%) . smoking (82% Vs 78%), hypertension (60% VS 40%)& diabetes (53.3% Vs 60%) were major risk factors in two groups having chest pain (93.3% VS 83.3%) and dyspnoea (NYHA III-50% Vs 43.4%)as main complaints. Echocardiography LVIDd, LVIDs in mm(46.5±11.6 VS 48.8±4.8),(28.7±4.5 VS 27.2±5.1),LVEF% were (50±8 VS 58±7)in both groups. On pump conventional CABG (33.3%. VS 16.7%)and OPCAB (50%VS 40%)were the main methods of surgical revascularization in vs 3.3%), Awake (3.3% Vs 6.7%) CABG.preoperatively, Mean no of graft2.2±1.3V s 1.7±0.8(p=0.001), XCT (in min) showed FEV1 94±17VS 90.5±14(p=0.001) and ECCT (in min) 189±38VS183±27 (p=0.001) in on pump CABGin both groups. Postoperative ABG analysis revealed slightly depressed respiratory function in-group A than B 1 and 4 hour before and after extubation. Higher PO2(130±25.4 VS 140±42.2), (156.4±40.4 VS 172±27.8) & (100.7±12.6 VS 115.6±21.8). (95.7±8.5 VS 105.9±10.5) mmhg, lower PCO2(34.8±5.6 VS 32.9±3.9), (35.4±3.8VS32±4.1) & (35.6±5.7 VS 33.8±5.1), (34.4±7.7 V S32.7±5.8) mmhg, under lower FIO2(45.1±4.5VS42±1.6), (48.2±4.5 VS 46.8±4.1) & (35.3±4.8 VS 33.6±5.5), (31.6±4.2 VS 28.2±3.5) were better in Group B than A & returned to similar level at 6th POD. Regarding lung function test the post operative spirometry significantly decreased in group A than B(56.81±17.76% Vs 79.85±7.7%; p=0.035) and when FEV1correalated with inspiratory vital capacity the advantage of intact pleura were confirmed at 6th postoperative day (78.02 ±12.17; B, 82.08 ±11.72 p=0.045). Vital

capacity was significantly decreased in-group A than B at 3 months postoperatively (88.79 ± 14.38%; B, 98.11± 30.25%; p=0.009), but not on 6th postoperative day. Mechanical ventilation time in hour (12.3± 7.1 vs 9.5± 3.9; p=0.041), ICU stay in days (5.6 ±3.1VS 2.3±0.6; p=0.035), amount of blood loss (A, 634.8 ±96.1; B, 471.2 ±82.1;p=0.029) and hospital stay in days (A, 8.8±3.4; B, 7.2 ±1.2; p=0.032) were significantly differing between two groups. However prolong ventilation (>24 hour)(10%Vs3.3%), reintubation (16.7%Vs10%) and death due to respiratory failure(6.7%Vs 3.3%) between two groups did not differ significantly. atelectasis and unilateral pleural effusion as revealed by chest Xray were higher (16.7 % vs. 6.7% and 10% vs. 6.7%) in group-A than group-B at 6th postoperative day, but these complications improved markedly thereafter. However there was no significant difference between two groups both at early and 3 months postoperatively.

Table-I

Lung function test (spirometric parameters)

Preoperative	Group A	Group B
FVC	3.29±1.00	3.45±1.01(p=0.83^{ns}
%FVC	99.52±26.92	98.67±32.34(p=0.33^{ns}
FEV1	2.84±0.93	2.69±0.35(p=0.90^{ns}
$\%FEV_{1FEV1/FVC}$	78.36±32.31	94.91±12.78
	80.00±16.46(p=0.92ns)	96.43±14.87(p=.97ns)

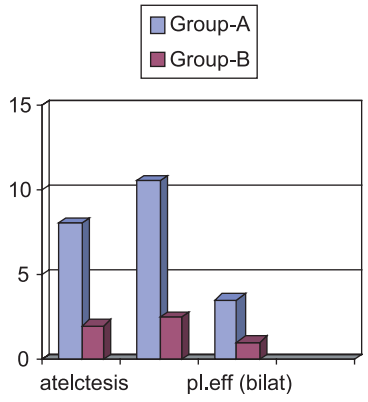

Fig-1: *Bar diagram showing pleuropulmonary complication 3months postoperatively.*

Table II

Postoperative lung function test (spirometric parameters)

6th OPD	Group A	Group B
FVC	2.57±0.66	3.04±0.53(p=0.47ns)
%FVC	73.99±15.3	78.47±12.35(p=0.43$^{ns)}$
FEV_1	1.77±0.60	2.47±0.22(p=0.045*)
$\%FEV_1$	56.81±17.76	79.85±7.7(p=0.035*)
FEV_1/ FVC	78.02±12.17	82.08±11.72 (p=0.045*)
3 month post operatively		
	Group A	Group B
FVC	2.62±0.68	3.52±0.97(p=0.045)*
%FVC	88.79±14.38	98.11±30.25 (p=0.009)*
FEV1	2.70±0.63	2.78±0.31(p=0.14$^{ns)}$
$\%FEV_1$	85.32±17.26	96.54±16.46(p=0.43ns)
FEV_1/ FVC	85.03±9.00	81.25±13.92(p=0.16ns)

Discussion:

The National Institute of Cardiovascular Diseases (NICVD), Dhaka, is performing the central role in the field of cardiovascular surgery,

The only best referral hospital at govt level for coronary artery bypass graft (CABG) operation. Regarding choices of conduit for graft in CABG undoubtedly Internal mammary artery (IMA) is superior in terms of patency, revascularization in comparison to venous and other arterial conduits. In NICVD, since its start we are using internal mammary artery most of the time, esp. Left internal mammary artery (LIMA) in more than 90% cases.[12] Altered pulmonary function is a frequently found complication after CABG surgery that is more pronounced when IMA graft are used.[12,13] The mean age was 56 ± 4.5 years in pleurotomy (during IMA harvest) and 55+_5.7 years in without pleurotomy (during IMA harvest) groups in the study of Bonacchi et al. (2001). Male /female ratio in the two groups was 153/33 and 61/21. A study by Wimmer-Greinecker et al. (1999) had a mean age of 62.3+_1.7 years in pleurotomy (during IMA harvest) and 63.5+_1.5 years in intact pleura (during IMA harvest) group and male /female ratio was 45/12 and 41/14.in this study The mean ages of pleurotomy (during IMA harvest) and without pleurotomy (during IMA harvest) group of patients were 49.0 ±6.9 years and 48.6±6.3 years respectively. Male/female ratio was 27/3 and 28/2.

The mean age and sex difference was not significant between two groups(p>0.05).6,14 In a study at NICVD, by Hossain, et al., (2004) showed that chest pain and dyspnoea were predominant symptoms in CABG patients (90% and 60%) respectively.In this study, Predominant symptoms were chest pain and dyspnoea in both groups (93.3% vs. 83.3% and 60 % vs. 50%) in pleurotomy (Group-A) and intact pleura (Group-B) group of patients' respectively.4 patients in group–A and 3 patients in group–B had obstructive pulmonary disease like Bronchial Asthma and COPD preoperatively.[7] In this study, most of the patients in both groups were in NYHA Class II and class III percentage of which were 36.6% vs. 50 % in NYHA class II and 50% vs. 43.4% in group-A (case) and group-B (control) respectively that resembled the study at NICVD by Hossain, et al., (2004).6 Regarding arterial blood gas analysis (ABG) in this study, at NICVD showed that the opened pleura negatively influenced blood arterial gas concentrations, resulting in a lower PaO2 and higher PaCO2 and FiO2 during mechanical ventilation before after extubation, which returned to similar levels (intact pleura group) only during 6th Postoperative day. However, the arterial blood gas analysis results were within the acceptable postoperative values in all patients in both groups. The analysis of the arterial blood gases revealed no significant difference in between patients undergoing IMA harvesting with intact pleura and IMA harvesting with opened pleurae. In a similar study by bonacchi et al.,(2001), Italy there were identical result only there were Less significant difference between 2 groups with addition of a 3rd group of incidentally opened pleurae (by skeletonized technique during IMA harvest).6 The most vital lung function test by spirometry like FEV1, FVC and their ratio was assessed preoperatively, at 6th POD and again after 3 months of CABG surgery in both groups of patients with or without pleurotomy. In the study by Wimmer-Greinecker et al. (1999) at Germany. The mean FEV1 (%) declined from its preoperative value of 79.4 ±1.8 to 76.0±1.6 at 6th POD but improved to 88.0±1.9 after 3 months in-group–A with opened pleurae. on the other hand, in group-B (with intact pleurae) FEV1 declined from its preoperative value 81.7 ±1.5 to 83.2±1.6 at 6th POD and recovered to 91.2±2.3 at 3 months. The decline of FEV_1 at 6th POD were significantly (p=0.020) differ between two groups although there were no difference preoperatively and 3 months after operation between two groups.14 In the study by Wimmer-Greinecker et al (1999) at Germany also showed that the mean FVC (%) in Group-A declined from its preoperative value of 100.4±2.1 to 77.4±3.0 at 6th POD and recovered to 85.1±2.1, 3 months after operation and in group-B mean FVC (%) declined from its preoperative values of 98.1±1.7 to 84.6±2.5 at 6th POD and recovered to 98.5±1.2at 3 months. The decline of FVC was not significantly differing in both groups preoperatively and at 6th postoperative day. However there was significant difference (p=0.009) of FVC at 3 months between two groups. The ratio between FEV1/FVC declined from its preoperative value of 0.958±0.020 to 0.771±0.021 at 6th post operative day and recovered to 0.876±0.025 in group-A and in group-B the ratio declines from its preoperative value of 0.972± 0.027 to 0.832± 0.020 at 6th post operative day and recovered back to 0.898± 0.022 at 3 months after operation. There were no significant difference between two groups in terms of ratio both pre operatively and 3 months after operation although the two groups significantly differ (p=0.003) at 6th postoperative day. consisted also by wheatcroft et. al (2005).[7,12-14] In this study, here at NICVD, we also did lung function test by spirometry preoperatively, at 6th postoperative day and again at 3 months after operation in all patients of both groups. The mean FEV_1 (in litre) in group-A (with pleurotomy during IMA harvest) declined from its preoperative value of 2.84 ± 0.93 L (78.36± 32.31%) to 1.77 ± 0.60 L (56.81± 17.76%)and recovered to 2.70 ± 0.63 L (85.32± 17.26%) postoperatively after 3 months. In group–B (with intact pleurae during IMA harvest) the mean FEV_1 (in Litre) declined from its preoperative value of 2.69±0.35L (80.00 ±16.46%) to 2.47± 0.22 L (79.85± 7.7%) at 6th post operative day and recovered back to 2.78±0.31L (96.54±16.46%) after 3months postoperatively. There were no difference in both groups both preoperatively and 3 months after operation but there is significant difference (p=0.04) of FEV1 values in both groups at 6th postoperative day. The mean FVC (in Litre) in group–A declined from its preoperative values of 3.29±1.0 L (99.52±26.92%)to 2.57± 0.66 L(73.99±15.3 %) at 6th postoperative day and recovered back to 2.62±0.68 L(88.79±14.38%) at 3 months after operation. In group-B the mean

FVC (in Litre) declined from its preoperative values of 3.45±1.01L (98.67± 32.34%) to 3.04±0.53 L (78.47±12.35%) and recovered back to 3.52±0.97L (98.11±30.25%). There were no significant difference of FVC between two groups preoperatively and at 6th postoperative day but there is significant difference (p=0.04) of FVC between two groups postoperatively at 3 months. The mean ratio of FEV1/FVC (%) declined from its preoperative values of 94.91± 12.72,96.43± 14.87 to 78.02 ±12.17,82.08 ±11.72 at 6th postoperative day in group-A and group-B respectively and recovered back to 85.03± 9.00 and 81.25± 13.92 in group-A and group-B respectively. There were no significant difference of FEV1/FVC ratio between two groups preoperatively and 3 months after operation yet the ratio significantly differ (p=0.045) at 6th postoperative day in both groups of patients . Post operative findings at ICU in the study by Bonacchi et al., (2001) at Italy showed that Mechanical ventilation time in hours and prolonged ventilation (>24 hr) in hours in Group-A and Group-B patients were 6.2 ±2.9 vs. 5.4±1.2 hr and 16(9%) patient vs. 1(1.25%) patient respectively. Reintubation incidence was 15(8.4%) vs. 2(2.5%) in group-A and group-B respectively. Mortality due to respiratory failure was 7 (3.7%) vs. 2 (2.4%) in group-A and group-B patients. 6 In a study by wimmer-Greinecker etal.,1999 in Germany revealed postoperative blood loss at ICU in first 12 hours were significantly higher in Group -A than in group-B patients (608 ±58 ml vs. 470 ±48 ml p=0.027). In a study at NICVD by Hossain et al.,(2004) revealed that in CABG patients mean ICU stay were ranges from 3.8-6.1 days with ±0.16 days and the mean hospital stay were ranges from 9.14-15.36 days with ± 0.37-0.83 days.6,9,14 Post operative complications as revealed by postoperative chest X ray in the study by Bonacchi et al., (2001) at Italy showed that atelectasis, unilateral pleural effusion and pnuemothorax were higher in group-A than group-B patients as shown by 20.7 % vs. 7.5%, 29 % vs. 13.4% and 13.4% vs. 6% respectively. In another study by Wimmer-Greinecker et al.(1999) at Germany revealed that atelectesis and pleural effusions were significantly higher in group-A than in group-B patients (42.1% vs. 20% p=0.015 and 52.6% vs. 23.6 % p=0.002) at 6th post operative day. However no significant difference were observed between two groups postoperatively after 3 months. [12,13] In this study, chest x ray were done preoperatively, at 6th postoperative day and at 3 months in addition to routine chest x ray immediately after operation on arrival to ICU to detect pulmonary and other complications. Preoperatively, only 3 patient in group-A and 2 patient in group-B revealed abnormal chest x Ray (like patchy opacity in Rt -B but no significant difference were found between two groups neither in early upper lung field, COPD etc). In early post operative day especially in patients with prolonged mechanical ventilation we saw that atelectesis were more in group-A than in group-B (16.7% vs. 6.7%) some of these patient along with others subsequently developed pnuemothorax and pleural effusion on 6th post operative days which also showed more in favor of group–A than group-B (10% vs. 6.7 % , unilateral pleural effusion 20% vs. 13.3% and bilateral pleural effusion 6.7% vs. 3.3%).Equal number of patients in both group developed empyema, wound infection, wound dehiscence and unstable sternum. However though these complications were more in group-A than grouppostoperative period(6th POD) nor at 3 months postoperatively.This is a clinical casecontrol study report for the first time from a tertiary level lone government cardiac institute and hospital of Bangladesh that determined the influence of pleurotomy during IMA harvest on postoperative pulmonary function after CABG surgery. Pleural effusion and atelectesis which were higher in group-A patients contribute to reduced lung volume may be associated with significantly decreased postoperative forced expiratory volume in 1 second (FEV1) and FEV1/FVC ratio. Increased intrapulmonary shunting and increase postoperative pain owing to more extensive surgical trauma in patients with pleurotomy during LIMA harvesting causes marked reduction although not significant reduction in FVC in early 6th post operative day. However significant reduction of FVC were seen in group-A than group-B patients 3 months postoperatively occurred due to opening of pleural space leads to extensive adhesions of the lung, resulting in pulmonary restriction and decreased FVC in long term. More multicentric study in developing nation needed to confirm our findings.

Study limitation:

1. Sample size was only 60 sixty and number of female patient was very few in comparison to male patients. More number of patients, more female patients and more multicentre studies at national level required for a definitive conclusion.

2. Pain due to inadequate postoperative analgesics and poor chest physiotherapy, technical and mechanical defect, patient effort cooperation is the key factor in spirometry.

Conclusions:

This may be concluded that the pleural integrity has beneficial effects on the respiratory functional status after CABG using IMA.A meticulous and more delicate IMA harvesting approach keeping pleura intact, reduces the postoperative morbidity regarding the pulmonary functional status, and as a consequence, reduces the hospital costs.

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