Original Article

A Comparison of Immediate Postoperative Complications in using Left Internal Mammary Artery + Vein Versus only Vein as Conduit in Patients Undergoing off-Pump Coronary Artery Bypass Grafting

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Abstract

Objective: The objective of the study is to compare the immediate postoperative cardiac complications in patients undergoing off-pump coronary artery bypass grafting (OPCABG) using mixed (arterial and venous grafts) versus only venous grafts and to compare the requirement of packed red cell units and intra-aortic balloon pump (IABP) in both the groups. **Materials and Methods:** This was an observational, analytical, prospective study. **Sample Size:** Fifty new patients were included in the study. **Inclusion/Exclusion Criteria:** Patients diagnosed with triple-vessel coronary artery disease (CAD) undergoing OPCABG with an ejection fraction (EF) of more than 30%. Patients who have undergone prior CABG, EF <30%, preexisting valvular heart disease, any evidence pulmonary hypertension, preoperative IABP, any history of neurological dysfunction, left atrium size more than 5.5 cm, and history of coagulation disorder was excluded from the study. **Results:** The most common immediate postoperative cardiac complication observed was atrial fibrillation followed by ventricular arrhythmias in both the groups. There was no statistically significant difference in complication rate between the two groups. Postoperative requirement of IABP and requirements of blood products were also similar in both the groups. **Conclusion:** Patients undergoing off-pump CABG have similar immediate postoperative complications irrespective of the type of conduit used.

Keywords: *Atrial fibrillation, blood transfusion, internal mammary artery, intra-aortic balloon pump, myocardial revascularization, off-pump coronary artery bypass grafting*

Introduction

Adam Hammer in 1876 established pathophysiology of coronary artery disease (CAD), establishing that angina was caused by interruption of coronary blood supply and that myocardial infarction occurred after the occlusion of at least one coronary artery.[1] Coronary artery bypass grafting (CABG) is a procedure where section of a blood vessel is grafted from the aorta to the coronary artery to bypass the blocked section of the coronary artery, thus improving the blood supply to the heart. In 2004, CAD was the leading cause of death in India, leading to 1.46 million deaths.[2] There is always a debate between percutaneous coronary intervention (PCI) and surgical revascularization. The surgical revascularization provides better long-term results, thus favoring CABG over PCI for revascularization.[3]

Preoperative clinical condition has also been associated with postoperative outcome and the preoperative presence of angina is a positive predictor of improved life expectancy despite impaired left ventricular (LV) function as compared to patients with heart failure symptoms and dyspnea.[4]

CABG with the use of the left internal mammary artery (LIMA) and saphenous vein grafts is the standard and widely accepted surgical approach in the treatment of CAD.[5]

Vasospasm of the arterial grafts is a serious perioperative complication and may result in IMA hypoperfusion syndrome with its high mortality.[6] Harvesting of both right and left IMAs, particularly in the diabetic patient, is associated with an increased incidence of sternal wound infections because in the process of IMA dissection, the sternal branches are sacrificed so sternal blood supply is jeopardized. CABG with the use of arterial conduits and the sequential

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anastomotic techniques has been the trend. Harvesting of bilateral mammary arteries is more time-consuming and may result in increased operative time.[7]

Morbidities such as atrial fibrillation, ventricular arrhythmias, renal dysfunction, and stroke after CABG are more common in patient with poor LV function. Intensive care unit stay and mean hospital stay are also longer in these low ejection fraction (EF) patients and contribute to postoperative morbidity and mortality.[8]

The use of IMA as a conduit has proven to be superior for its long-term patency rates, whereas saphenous vein graft being larger caliber vessel achieves superior flow dynamics in the early postoperative period.[9]

Off-pump technique has reduced the complications associated with extracorporeal circulation and heart–lung machine, thus contributes to better surgical outcome.[10]

Although many studies have demonstrated the long-term advantage of using mixed conduits (LIMA + vein) instead of only venous conduits in terms of graft patency, a very few studies have compared the incidence of postoperative cardiac complications. Our present study aims to compare the above-mentioned parameters in both the groups.

Materials and Methods

The study was carried out over a period of 12 months. This is prospective, observational, analytical study. All patients attending our hospital for bypass surgery during the study period were considered as sample. During this period, 50 patients were selected for the study which fulfilled the following inclusion and exclusion criteria as follows:

Inclusion criteria

Patients diagnosed with triple-vessel CAD requiring off-pump surgical myocardial revascularization with a left ventricle EF (LVEF) of more than 30%.

Exclusion criteria

Prior cardiac surgery for myocardial revascularization, LVEF <30%, any preexisting valvular heart disease, any evidence of pulmonary hypertension, CABG with the use of cardiopulmonary bypass machine, preoperative IABP, patients with left atrium size more than 5.5 cm, or patients with a history of coagulation disorder.

All selected patients were divided into two groups alternatively to receive either mixed LIMA + veins or only veins as conduits. In the first Group A (mixed conduits group), pedicle LIMA and reverse saphenous vein were used as conduits. In Group B (venous conduits group), reverse saphenous vein only was used as conduit.

Demographic and anthropometric indices were recorded for all patients which included age, sex, and other demographic details. Preoperatively, all patients underwent routine blood and other investigations.

Antiplatelets (aspirin and clopidogrel) were stopped 3 days before surgery. Induction of anesthesia was carried out using standard high narcotic induction in all patients with an aim to minimize hemodynamic changes during induction of anesthesia as per the standard protocol of the institute. The procedure performed was off-pump CABG. All patients were given heparin after harvesting of conduits, and the same was reversed with protamine with a ratio of 1:1. At the end of surgery, pleural and mediastinal chest tubes were placed and drainage was carefully monitored and compared. Postoperatively, all patients underwent elective controlled ventilation with routine monitoring as for any cardiac surgical case. A note of certain complications was documented for study purpose which included atrial fibrillation, ventricular arrhythmias, and IABP requirement. Need for blood transfusion and actual unit transfused was noted down with a target of keeping the hemoglobin level more than 10 g% or a hematocrit above 30. The duration of ventilation was depending on clinical condition, bleeding status, and fitness criteria for extubation as per institute protocols.

Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as absolute numbers and percentage. The comparison of normally distributed continuous variables between the groups was performed using Student's *t*-test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate. $P < 0.05$ was considered statistically significant.

Results

The mean age between the two groups was 58.88 ± 6.86 (Group A) and 63.04 ± 8.96 years (Group B) ($P = 0.079$). The mean body mass index (BMI) (kg/m^2) of Group A was 25.75 ± 4.06 kg/m^2 while of Group B was 23.77 ± 3.03 kg/m^2 ($P = 0.056$) [Table 1].

There were 80% males and 20% females in Group A and 88% males and 12% females in Group B, and gender distribution was comparable ($P = 0.440$).

The prevalence of diabetes was 44% in Group A and 32% in Group B ($P = 0.556$) while that of hypertension was 24% in Group A and 28% in Group B ($P = 0.747$).

It was observed that there were 24% patients in Group A and 44% patients in Group B with NYHA Class I and II symptoms, whereas there were 76% patients in Group A and 56% patients in Group B with Class III and IV symptoms ($P = 0.136$).

It was observed that under in Group A, mean hemoglobin value was 12.18 (±1.95) gm%, whereas in Group B, it was 12.46 (±1.99) g%. Mean creatinine levels were 1.01 ± 0.30 and 0.95 ± 0.28, respectively, in both the groups. It was observed that there was no significant

Table 1: Illustrations of anthropometric indices, routine blood investigations, comparison of complications, blood loss, and blood products requirement

	Group A	Group B	*P*
Age (years)	58.88±6.85	63.04±8.96	0.079
Gender (%)			
Female	20	12	0.44
Male	80	88	0.44
BMI	25.75±4.06	23.77±3.03	0.056
Hb	12.18±1.95	12.46±1.99	0.622
TLC	8.55±2.76	9.86±3.99	0.186
Creatinine	1.01±0.30	0.95±0.28	0.450
Bilirubin	0.66±0.58	0.68±0.33	0.874
FBS	109.32±26.55	110.68±31.93	0.871
DM (%)	40	32	0.556
Hypertension (%)	24	28	0.747
Angina (Class III, IV) (%)	76	56	0.136
Preoperative LVEF	44.92±6.82	44.28±6.76	0.74
LVEF after surgery	49.72±5.78	51.60±5.94	0.262
LVEF at 6 weeks	51.96±5.30	56.16±4.13	0.002
Drain output	295.56±145.45	265.20±144.60	0.463
Atrial fibrillation (%)	36	16	0.196
Ventricular arrhythmias (%)	12	8	1
IABP requirement (%)	8	8	1
PRBC requirement	4	3.2	0.556
Mortality	Nil	Nil	-

Hb: Hemoglobin, BMI: Body mass index, TLC: Total lymphocyte count, LVEF: Left ventricle ejection fraction, IABP: Intra-aortic balloon pump, PRBC: Packed red blood cell, DM: Diabetes mellitus, FBS: Fasting blood glucose

difference in routine investigations between the two groups.

The mean drain output (blood loss) in the first 24 h of Group A was 295.56 ± 145.45 ml while that of Group B was 265.20 ± 144.60 ml, although the drain output was more in Group A, the difference was not statistically significant between the two groups (P = 0.463).

The most common complication in both the groups was atrial fibrillation (AF) with the incidence of 36% in Group A and 16% in Group B (P = 0.196). It was followed by ventricular arrhythmias (12% and 8%, respectively, with P = 1.000). The most common ventricular arrhythmias seen were ventricular premature beats, bigeminy rhythm, or nonsustained short runs of ventricular tachycardia. Most of these were treated with correction of electrolytes and occasional bolus dose of IV lignocaine. Reexploration was done in one case in Group A who was on antiplatelets for acute chest pain, while there was no incidence of reexploration in Group B. IABP was required in two patients in each group with low EF and AF and they recovered eventually. Requirement of packed red blood cell units was also similar in both the groups. It was observed that there was no mortality in either group.

Discussion

In 1910, Alexis Carrel was the first to describe CABG procedure.[11] Goetz R in 1960 first reported CABG using the IMA in humans. From 1962 to 1967, human CABG using autogenous saphenous vein grafts was performed by cardiac surgical groups by, namely, Sabiston D (1962), Garrett H (1964), Kahn D (1966), and Favaloro R (1967) and many more. Thoracoscopic harvesting of the LIMA was reported in 1998 by Duhaylongsod *et al*.[12] and in the present scenario, more and more surgeons are moving toward minimally invasive and robotic surgical approaches.[13]

Similar results were observed by Edwards *et al*. Majority of patients in their study were in age group of 50–70 years. Their study had 79% male and 21% female patients in mixed group whereas 69% males and 31% females in venous group.[14] In a study conducted by Jegaden *et al*., the average age in LIMA group was 66 years and in venous group was 68 years.[15] The mean age in their study in both the groups was higher as compared to our study, probably because higher prevalence of CAD in Indian population and also at a younger age. In patients <70 years, the incidence of CAD-related deaths in India is 50%, whereas only 22% in Western countries.[16]

The mean BMI (kg/m^2) of Group A was 25.75 ± 4.06 kg/m^2 while of Group B was 23.77 ± 3.03 kg/m^2 (P = 0.056), representing similar characteristics of patients in both groups, similar observation was in the studies conducted by Jegaden *et al*.[15] and Mehsood *et al*.[17] with no difference in BMI in both the groups.

In our study, the prevalence of diabetes was 44% and 28% and the prevalence of hypertension was 24% and 48% in Group A and B, respectively, (P = 0.239 and 0.077, respectively). Edwards *et al*. noticed the prevalence of diabetes were 22.02% patients in LIMA group and 20.25% patients in non-LIMA group. About 48.70% were hypertensive in mixed group and 45.45% were hypertensive in venous group.[14]

The prevalence of diabetes and hypertension was 24.7% and 50.7%, respectively, in IMA and venous groups (P = 0.99) in study conducted by Jegaden *et al*.[15] These findings are in contrast to the results of our study.

Mehsood *et al*. in his study observed that there were 26% diabetic patients in both mixed and venous groups (P = 1.000) and there were 50% hypertensives in mixed group and 34% hypertensives in venous group (P = 0.105).[17] This observation is in contrast with our study where we observed that number of hypertensives were more in venous group.

Jegaden *et al*. and Mehsood *et al*. in their studies observed that mean blood loss was significantly more in those patients where LIMA was harvested as conduit.[15,17-19]

Choudhary *et al*. and Sethi *et al*. also observed similar results in their studies. These are in contrast to our results as there was no significant difference in chest tube drainage between the two groups. LIMA harvesting leaves a raw bed under the chest wall that has the potential to bleed after the chest is closed, and furthermore, there are chances of bleeding from intercostal branches of the LIMA.

The most common complication in our study in both the groups was AF with the incidence of 36% in Group A and 16% in Group B (P = 0.196). There was no statistically significant difference in the incidence of AF between the two groups. The AF was reverted with amiodarone and/or with beta-blocker.

For the incidence of AF, our results were comparable to those observed by Choudhary *et al*. and Hwang *et al*. They also conducted a comparative study to find the difference in the incidence of postoperative AF in patients operated using either arterial or venous conduits and found the incidence of AF ranged from 14% to 36% in both the groups. They found that there was no difference between the two groups.[18,20]

Mariscalco *et al*. published an observational study of 1878 consecutive participants undergoing CABG and found that postoperative AF was the most common adverse events that occurred in 20%–50% of the patients. They noted that post-CABG AF was associated with a fourfold increased risk of disabling cerebrovascular accident and threefold increased risk of cardiac-related death.[21] We also had the similar observation that the incidence of AF was more in elderly age group patients with low EF in both the groups.

Ergünes *et al*. also reported that morbidities such as postoperative AF were more common among patients with low EF.[22]

In our study, ventricular arrhythmias were noted in 12%–8% of cases in Groups A and B, respectively. Similar results were noted in a study by Skorpil *et al*., as they also found ventricular arrhythmia incidence of 5%.[23]

Mehsood *et al.* noticed higher rate of ventricular arrhythmias in venous group, that is, 18% compared to LIMA group 14%.[17]

The incidence of reexploration in our study was 4% in Group A whereas no reexploration was done in Group B. Jegaden *et al*., Karthik *et al*., and Hwang *et al*. in their studies found that the incidence of reexploration was similar in both the groups (around 2%–4%).[15,20,24] Results obtained in our study were comparable with these studies. Edwards *et al*. and Cosgrove *et al*. also reported similar observations.[14,25]

In contrast, Choudhary *et al*. and Mehsood *et al*. concluded that SVG group had lesser incidence of bleeding, blood transfusion, and less frequent reexploration as compared to IMA group.[17,18]

Bleeding after CABG surgery is a concern to all practicing cardiac surgeons. Some surgeons believe that taking down the LIMA leaves a raw bed under the chest wall that has the potential to bleed after the chest is closed. In addition, there is the possibility of bleeding from intercostal branches of the LIMA itself. The chance of bleeding increases if patient is on platelet inhibitors.[26]

In our study, IABP was required in two patients (8%) in each group who had low EF and AF (they recovered eventually following IABP placement).

Edwards *et al*. and Choudhary *et al*. in their study observed that IABP requirement was 5.53%–12.9% in LIMA group and 10.18%–17.2% in venous group.[14,18] Results obtained in our study were comparable with their study. Karthik *et al*. observed that in patients undergoing CABG, the IABP support postoperatively was required in 2.4% patients in LIMA group and 2.2% in non-LIMA group.[24] In contrast to their study, IABP requirement in our study was higher. Jegaden *et al*. in their study also observed that there was no difference in IABP requirement in arterial or venous group.[15]

In a study conducted by Topkara *et al*., patients were stratified into four groups according to EF. They concluded that requirement of IABP and LV assist device (during or after surgery) was significantly higher in patients with low EF. In our study also, we found that postoperative requirement of IABP was more in patients with low EF in both the groups.[27]

Conclusion

We conclude that the most common immediate postoperative cardiac complication was AF followed by ventricular arrhythmias in both the groups. There was no statistically significant difference between the complications compared. Postoperative requirement of IABP and requirements of blood products were also similar in both the groups. Further studies with long-term follow-up are required to confirm the above findings.

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Conflicts of interest

There are no conflicts of interest.

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