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Original Research Article

A comparison of left ventricular function in patients undergoing beating heart bypass surgery using mixed versus pure venous conduits

Tarun Chaudhary, Hemant Kumar Nautiyal, Aratatran Nahak*, Shantanu Sahu

Department of Surgery, Himalayan Institute of Medical Sciences, SRH University, Jolly Grant, Dehradun, India

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***Correspondence:**
Dr. Aratatran Nahak,
E-mail: an21267@gmail.com

ABSTRACT

Background: The pathophysiology of coronary artery disease was established in 1876 by Adam Hammer when he postulated that angina is caused by interruption of coronary blood supply and that myocardial infarction occurred after the occlusion of at least one coronary artery. Aims of the study were to compare the left ventricular function in patients who have undergone beating heart bypass surgery using mixed (internal mammary artery and venous conduits) versus pure Venous conduits, and to compare the incidence of postoperative complications.
Methods: It was an observational, analytical study. All patients admitted with triple vessel disease requiring CABG (n=50), with ejection fraction >30%, were subjected to either left internal mammary artery and venous conduits (group A, n=25) or only venous conduits (group B, n=25). Patient who had undergone prior surgical myocardial revascularization, preexisting valvular disease, any evidence of raised pulmonary arterial pressure more than 40/15 mmHg, operated using cardiopulmonary bypass machine, pre-operative use of Intra-Aortic Balloon Pump, any history of neurological dysfunction/Transient ischemic attack, left atrium size more than 5.5 cm were excluded from the study
Results: Improvement in left ventricular function after coronary artery bypass grafting was objectively demonstrated in both the groups. There was a statistically significant increase in mean LVEF in group B (56.16±4.13) compared to group A (51.96±5.30) at 3 months of follow up (p=0.009). The most common complication in both the groups were atrial fibrillation group A=36% (n=9), group= B 16 % (n=4), renal failure group A=12% and group B=8% and sternal wound infection. The post-operative bleeding (Drain output) in first 24 hours was similar in both the groups, 295.56 ml in group A and 265.20ml in group B (p=) with similar hospital stay (group A=9days, group B=8.5days).
Conclusions: Patients with venous conduits have better postoperative LVEF as compared to Mixed conduit with similar rate of post-operative complications.

Keywords: Left internal mammary artery, LVEF, Mixed conduits, Venous conduits

INTRODUCTION

The pathophysiology of coronary artery disease was established in 1876 by Adam Hammer when he postulated that angina is caused by interruption of coronary blood supply and that myocardial infarction occurred after the occlusion of at least one coronary artery.[1] Coronary artery disease (CAD) is predicted to be the most common cause of death globally, including India, by 2020.[2] The 2016 Heart Disease and Stroke Statistics update of the American Heart Association (AHA) has recently reported that 15.5 million persons ≥20 years of age in the USA have CHD.[3]

In India, by 2004 it was already leading cause of death, leading to 1.46 million deaths (14% out of a total of 10.3 million deaths). India is estimated to have cost 8.7 billion dollars in 2005 because of CAD, stroke, and diabetes.[4]

This epidemiological transition is attributed to recent rapid economic and social changes leading to non-communicable diseases attaining the top spot for causing death and disability, and chronic diseases contributing to an estimated 53 per cent of deaths and 44 per cent of disability-adjusted life-years lost.[5,6] Trials have shown that CABG remains the standard of care for patients with three vessels or left main coronary artery disease because CABG results in lower rates of major adverse cardiac and cerebrovascular events at one year.[7] Coronary artery bypass grafting with the use of the left internal mammary artery (LIMA) and vein grafts is the standard and widely accepted surgical approach in the treatment of coronary artery disease.[8] Vasospasm of the arterial grafts is a serious perioperative complication and may result in IMA hypoperfusion syndrome with its high mortality.[9]

The reversibility of LV dysfunction depends on factors including the presence and extent of stunned and hibernating myocardium, the surgeon's ability to completely revascularize hibernating tissue, perioperative myocardial infarction and post-operative graft complication.[10] Total arterial myocardial revascularization proved to be safe and effective and to give superior results than conventional myocardial revascularization (with left internal mammary artery on the LAD and additional saphenous vein grafts).[11] On account of better patency and post-operative survival rate, IMA has been used as the standard technique since 1980s. But recent literature shows significant downward trend of revascularization with LIMA. This was explained by the greater number of patients presenting in recent years with cardiogenic shock, severe left ventricular dysfunction, advanced age, emergency operation. Increased conduit blood flow is considered necessary in these situations and this was thought best provided by a SVG to LAD rather than LIMA.[12]

The long-term advantages of IMA conduits in CABG procedures are widely recognized, but the immediate short term impact of IMA comparing venous grafts is not well defined. Internal mammary artery is superior for its long tern patency rates, whereas saphenous vein graft being larger caliber vessel achieves superior flow dynamics in the early post-operative period.[13] Although many studies have demonstrated the long term advantage of using mixed (Left internal Mammary artery + venous conduits) over pure venous conduits in terms of graft patency, a very few studies have compared left ventricular function, the incidence of post-operative complications and the mean duration of hospital stay in both these groups. The present study aimed to compare the above-mentioned parameters in both the groups.

METHODS

This observational analytical study included 50 patients diagnosed with triple vessel coronary artery disease requiring off pump surgical myocardial revascularization with an ejection fraction of more than 30%. Patient who had undergone prior surgical myocardial revascularization, significant impairment of left ventricular function (EF<30%), preexisting valvular disease, any evidence of raised pulmonary arterial pressure more than 40/15 mmHg, pre-operative use of intra-aortic balloon pump, history of neurological dysfunction, transient ischemic attack was not included in the study. Demographic and anthropometric indices along with relevant medical history were recorded in detail. Preoperatively apart from routine investigations, 2 D ECHO and coronary angiography were carried out in all patients. To minimize chances of subjective variability in 2 D ECHO, echocardiographic evaluation was carried out by same cardiologist in all patients. Post operatively all patients underwent 2 D ECHO before discharge and were followed up at 3 months with 2 D ECHO for left ventricular ejection fraction.

In Group A (n=25) (mixed conduits), pedicled LIMA and reverse saphaneous vein graft were used as conduits in all cases.

In Group B (n=25) (venous conduits), reverse saphaneous vein grafts only were used as conduit in all cases.

Induction of anaesthesia was carried out using standard high narcotic induction in all patients with an aim to minimize hemodynamic changes during induction of anaesthesia. CABG was done through median sternotomy using Medtronic evolution IV octopus and star fish mechanical heart stabilizer systems. Complications like atrial fibrillation, renal failure, sternal wound infection, IABP requirement and reexploration and hospital stay was recorded in both groups till 6 months. Paired t test was used to detect the significant change in LVEF at discharge, at 3 months.

RESULTS

The mean age in Group A 58.88±6.86 was comparable with the mean age in Group B 63.04±8.96 years (p value 0.079). Routine biochemical investigations were also comparable without any statistically significant difference (Table 1).

Thought the mean post-operative haemorrhage (mediastinal drain output) was more in group A (295.56±145.45ml) as compared to group B (265.20±144.60ml) but it was not statistically significance (p=0.463).

In group A 9 patients had atrial fibrillation as compared to 4 patients in group B (p =0.196). Atrial fibrillation occurred more in elderly patients with low ejection fraction and poor native coronary artery of size <1.25 mm, some reverted with amiodarone and some with beta blocker. Though optimized for raised creatinine level, 5 patients went into renal failure, 3(12%) in group A and 2 (8%) in group B, who were diabetics requiring more than 30 units of insulin per day. Sternal wound infection

occurred in diabetic's patient and one in who underwent reexploration. Intra-Aortic Balloon Pump was required in 2 patients in each group with low ejection fraction and atrial fibrillation. In all the above complications, there was no statistical difference between the two groups. The mean hospital stay of group A (8.96±3.68 days) was similar to that in group B (8.56±1.94 days) (p= 0.633).

Table 1: Illustrations of anthropometric indices, routine blood investigations, comparison of LVEF levels and mean hospital stay.

	Group A	Group B	p value
Number of patients	25	25	-
Age (years)	58.88±6.85	63.04±8.96	0.079
Male:Female	80:20	88:12	0.44
BMI (kg/m^2)	25.75±4.06	23.77±3.03	0.056
Hb (gm%)	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
Diabetics	44% (11)	28% (7)	0.239
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 3 months	51.96±5.30	56.16±4.13	0.002
Mediastinal drain output (ml)	295.56±145.45	265.20±144.60	0.463
Atrial fibrillation	36% (9)	16% (4)	0.196
Renal failure	12% (3)	8% (2)	1
Sternal wound infection	8% (2)	4% (1)	1
Hospital stay (days)	8.96±3.68	8.56±1.94	0.633
Mortality	Nil	Nil	-

Pre-operative mean LVEF was similar in both the groups (44.92±6.82) in group A and (44.28±6.76) in group B (Table 2). LVEF before discharge in both the groups was also similar, (49.72±5.78) in group A and (51.60±5.94) in group B. There was a statistically significant increased mean LVEF in group B (56.16±4.13) compared to group A (51.96 ± 5.30) at 3 months of follow up (p=0.009). It was observed that there was a significant increase in LVEF levels at discharge and 3 months in both the groups when compared to preoperative LVEF levels (p <0.001).

Table 2: Comparison of change in LVEF between the groups.

	Group A (n=25)			Group B (n=25)			P value (Mean change between Group A and Group B)
	Mean ± SD	Mean change from Baseline ± SD	p value	Mean±SD	Mean change from baseline ± SD	p value	
Preoperative LVEF	44.92±6.82	-	-	44.28±6.76	-	-	-
LVEF at discharge	49.72±5.78	4.80± 4.84	<0.001	51.60±5.94	7.32±8.90	<0.001	0.222
LVEF at 3 months	51.96±5.30	7.04± 5.19	<0.001	56.16±4.13	11.88±7.22	<0.001	0.009

DISCUSSION

After initial description of CABG by Alexis Carrel in 1910, cardiac surgery became more feasible in the late 1930s with the development of the heart-lung machine by Dr John Gibbon which enabled cardiopulmonary bypass.[14,15] Continuous effort by Murray G, Goetz R, Kolessov V, Sabiston D, Duhaylongsod et al and many more established CABG as cornerstone of treatment for advanced coronary artery disease.[5,16] Since Green et al introduction of the internal mammary artery (IMA) as a conduit for coronary bypass surgery (CABG), there have

been numerous reports comparing the IMA to venous conduits.[17] These studies have shown improved long-term patency and survival with IMA use. However, the short-term effects of IMA use as a conduit for CABG have only recently been evaluated.[18] The choice of conduit has been shown to influence postoperative morbidity and mortality in routine CABG experiences. The recent trends in CABG procedure have clearly favoured the use of arterial conduits, not only to perfuse the LAD in normal left ventricular function but also in patients with impaired left ventricular function.[19]

Jegaden et al, however, recently reported on potential unfavourable effects of extensive use of arterial grafts as compared to more conventional surgical management (LIMA plus vein grafts) to revascularize patients affected by impaired LV function, documenting increased rate of perioperative complications and no benefit as far as survival was concerned. They found significant increase in post-operative LV function in venous group.[20] Similar results were also shown in a study by Choudhary AK et al where they demonstrated that at 3 months LV function with total venous conduits had more improvement as compared to mixed conduits.[21]

In a study conducted by Edward FH et al majority of patients were in 50-70 years age group with 74% males and 26% females, while in study by Jegadan et al observed mean age of 67 years with 18% females.[20,22] In our study mean age was 60 years, with 84% males and 16% females. Lower age group in our study reflects that CHD affects Indians with greater frequency and at a younger age than counterparts in developed countries, as well as many other developing countries. Similar findings were noted by Gaziano TA, that 50% of CHD-related deaths in India occur in people <70 years of age, whereas only 22% of CHD-related deaths in Western countries occur in this age group.[23]

The mean BMI (kg/m^2) in present study of group A patients was 25.75 kg/m2 while of group B was 23.77 kg/m^2 (p= 0.056) which is like studies conducted by Mehsood DK et al with BMI of 25.86 and 25.63 in mixed and venous group respectively and Jegaden O et al 27.8 and 26.6 kg/m^2 respectively in both the groups.[20,24] There were 56% patients in present study who smokers and 44% were alcohol consumers in group A whereas in group B there were 36% and 28% patient respectively who smokes and alcohol (p=0.156 and 0.239 respectively). While 49.66% were smokers in LIMA group and 33.26% in venous group by study conducted by Edwards FH et al (p value <0.005).[22]

The prevalence of Diabetes in our study was 44% in group A and 28% in group B which is higher as compared to prevalence in various studies conducted (LIMA group 22-26% and non-LIMA group 22-50%).[20,22,24] Percentage of patients with hypertension in our study (36%) is similar to the studies conducted by Edwards FH, Jegaden O, Mehsood DK et al (46%, 50%, 42% respectively).[20,22,24] The mean of preoperative LVEF in present study is 44.92±6.82 in A group and 44.28±6.76 in group B while at discharge it is 49.72±5.78in group A and 51.60±5.94 in group B. There was no significant difference in mean preoperative LVEF and LVEF at discharge between the groups (p=0.74, 0.262 respectively). When repeat 2 D ECHO was done at 3 months follow up there was statistically significant difference between LVEF in two groups, group A=51.96±5.30, in group B=56.16±4.13 (p=0.009).

This difference in LVEF corresponded in less breathlessness and chest discomfort on exertion. Similar results were observed in a retrospective and prospective study done by Choudhary AK et al based on the conduits used, patients were divided into 3 groups. 24 patients who had only arterial grafts, 98 patients who had only LIMA plus vein grafts and 62 patients who had only vein grafts. Patients were followed up every 3 months. LV function with total venous grafts had more improvement as compared to mixed conduits.[21] Similarly Jegaden O et al found significant improvement in LV function in venous group as compared to arterial group. Multivariate analysis in their study showed that the surgical technique used and the preoperative LVEF were independent prognostic factors of the postoperative myocardial outcome, with a significant positive impact of the vein use on the postoperative myocardial function recovery.[20]

Tyras DH et al found that graft flows were consistently higher at operation with the SVG, but patency rates at each interval were significantly higher with the IMA. But in contrast to our observations they observed that maintenance and restoration of normal left ventricular function was more common in IMA patients (mixed group).[25]

When comparing post-operative haemorrhage (drain output) in first 24 hours, various studies found significant more post-operative haemorrhage (drain output) in patients where LIMA was harvested as conduits. It is said that LIMA harvesting leaves a raw bed under the chest wall that has the potential to bleed after the chest is closed, also there are chances of bleeding from intercostal branches of the LIMA.[20,21,24,26] Though the bleeding in first 24 hours in group A and group B in our study is more (only one patient requiring reexploration) than the above studies. The difference in not statistically significant.

The most common complication in our study in both the groups was atrial fibrillation with incidence of 36% in group A and 16% in group B (p=0.196). There was no significant difference in incidence of atrial fibrillation between the two groups. Atrial fibrillation occurred more in elderly patients with low ejection fraction and poor native coronary artery of size <1.25 mm. Similarly, Skorpil J and Mariscalco G et al found post-operative atrial fibrillation ranging from 20% to 50%.[27,28] It has been found in various studies that there are multiple

conditions which predisposes patients to postoperative AF. These included the presence of peripheral artery disease, COPD, concomitant valvular heart disease, previous cardiac surgery, preoperative AF and pericarditis. Male gender and advanced age were also the risk factors for AF. In present study, also we observed that the incidence of AF was more in elderly age group patients with low ejection fraction in both the groups.

Another important postoperative complication in post CABG patient is Renal failure which was 12% in group A and 8% in group B (p =1.000). Similar incidence of acute renal failure of 10.2% in mixed group and 8.2% in venous group was observed in study by Choudhary AK.[21] Topkara VK et al and many others in their studies noticed that the incidence of renal failure is higher in low ejection fraction group. Other conditions predisposing to renal failure included preexisting renal dysfunction, decreased cardiac output, as in CHF or shock, insulin dependent diabetes and concomitant peripheral artery disease. We found that incidence of acute renal failure was more in diabetics that were insulin dependent, requiring more that 30 units per day and with low ejection fraction.[29-31]

Though no incidence of post-operative CVA was reported in our study. Incidence of post-operative CVA ranges from 0.9% to 2.4% in LIMA group and 0.9% to 1.9% in venous group with statistically significant difference.[22,32,33] Later studies by Ergunes K, Topkara VK et al had shown that postoperative stroke were more common among patients with low ejection fraction rather than type of conduit used.[29,31]

We observed no mortality in either groups till the follow up of 3 months. Studies have shown that there was no difference in hospital mortality in LIMA and non LIMA group as Topkara VK et al concluded that in-hospital mortality was not dependent on type of conduit used rather it depends on the preoperative ejection fraction.[24,29,32,34] The mean hospital stay of group A was 8.96 days while that of group B was 8.56 days in our study, similar to the results of Choudhary AK, and Mehsood DK et al in their study.[21,24]

CONCLUSION

The degree of increment in LVEF, in venous conduits at short term (3 months), was statistically more compared to the increment in mixed conduits with similar rate of morbidity and hospital stay. Patients with low preoperative LVEF can be subjected to all venous conduits for better post-operative LVEF, but further randomised studies with long term follow up are required.

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