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Original Research Article

CLINICAL OUTCOMES OF LIMA-LAD AND RSVG-LAD ANASTOMOSES IN CORONARY ARTERY BYPASS GRAFTING SURGERY- SINGLE CENTER 3 YEARS EXPERIENCE.

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Abstract: *Coronary artery bypass grafting (CABG) is a crucial intervention for managing ischemic heart disease, with successful revascularization of the left anterior descending (LAD) artery being essential for optimal outcomes. Various techniques and conduits are used in CABG, with the choice of graft significantly impacting patient prognosis.* ***Objective:*** *This study aimed to compare the clinical outcomes and morbidity associated with left internal mammary artery (LIMA) grafts versus reversed saphenous vein grafts (RSVG) to the LAD artery in patients undergoing isolated CABG.* ***Methods:*** *A retrospective observational study was conducted at a tertiary care hospital from January 2020 to December 2023. A total of 718 patients who underwent isolated CABG were included. The study received approval from the institutional review board, and all inclusion criteria were met. Patients were divided into two groups based on the type of graft used for the LAD artery: LIMA-LAD and RSVG-LAD. Statistical analysis was performed using Chi-square and T-tests, with data analyzed via SPSS version 25. A p-value of <0.05 was considered statistically significant.* ***Results:*** *The study included 718 patients with a mean age of 59.67 ± 9.270 years, predominantly male (74.7%), and with a majority classified as NYHA functional class III (46.0%). Hypertension was the most common comorbidity (67.1%), followed by dyslipidemia (58.0%) and diabetes mellitus (48.2%). The RSVG-LAD group had significantly older patients and a higher prevalence of hypertension, diabetes, tobacco smoking, and previous myocardial infarction. LIMA-LAD patients required more intraoperative blood product transfusions and had significantly longer cross-clamp times. However, the RSVG-LAD group exhibited worse morbidity outcomes, including significantly longer initial hours of mechanical ventilation and prolonged ventilation. Despite these differences, the two groups had no statistically significant difference in in-hospital mortality.* ***Conclusion:*** *This study confirms that LIMA-LAD anastomosis offers superior clinical outcomes and reduced morbidity compared to RSVG-LAD anastomosis. These findings highlight the advantages of using arterial grafts over vein grafts in coronary artery bypass surgery, particularly in reducing post-operative complications and improving overall patient prognosis.*

Keywords: Coronary Artery Bypass Grafting (CABG), Outcomes, Mortality

Introduction

Coronary artery bypass grafting (CABG) remains a cornerstone in the management of ischemic heart disease, particularly in patients with multivessel coronary artery disease or left main disease. The bypass restores blood supply to the ischemic myocardium, improving function and viability while relieving anginal symptoms (1). Coronary artery disease (CAD) is a significant public health concern worldwide, with Pakistan seeing a substantial increase in its prevalence. Coronary artery bypass grafting (CABG) has improved considerably in recent years because of breakthrough procedures and refined approaches that have revolutionized patient outcomes and treatment paradigms (2). In parallel with the global trend, CAD remains a predominant cause of morbidity and mortality worldwide. The World Health Organization (WHO) reports that CAD accounts for an estimated 17.9 million deaths annually, representing 31% of all global deaths. Within this context, CABG is crucial in managing CAD, providing revascularization and symptom relief for millions of patients worldwide (3). Vineberg performed his eponymous technique with the left internal mammary artery (LIMA) in the 1950s, and reports of the LIMA as a direct coronary artery graft came out in the late 1960s. Following Favoloro's publication in 1968 of a series of patients in whom the saphenous vein was used as a conduit, veins surpassed arteries as conduits for coronary artery bypass, and the present success of the coronary artery bypass procedure is based on the use of saphenous vein grafts (SVG). [(4)] Revascularizing weakened arteries involves various techniques and conduits, but grafting to the LAD artery is vital for short- and long-term outcomes (4). The choice of graft material and configuration is paramount to achieving optimal outcomes. Among the various techniques employed in CABG, the anastomosis of the left internal mammary artery (LIMA) to the left anterior descending artery (LAD) has long been considered the gold standard due to its superior patency rates and long-term outcomes compared to

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saphenous vein grafts (SVGs) (5). However, comparing LIMA-LAD anastomosis and reversed saphenous vein graft (RSVG)-LAD anastomosis continues to be a subject of extensive clinical investigation and debate. The LIMA-LAD anastomosis is associated with enhanced long-term survival, reduced incidence of myocardial infarction, and lower re-intervention rates (6). The arterial nature of the LIMA, with its resistance to atherosclerosis and superior flow characteristics, contributes significantly to these favorable outcomes. On the other hand, RSVGs, despite their widespread use due to availability and ease of harvest, are prone to intimal hyperplasia and subsequent atherosclerotic changes, leading to higher graft failure rates over time (7). In Pakistan, as in many parts of the world, two commonly employed strategies for bypassing the left anterior descending artery (LAD) are the left internal mammary artery (LIMA) to LAD anastomosis and the reverse saphenous artery (RSGV) to LAD anastomosis. These approaches offer distinct advantages, including long-term patency rates, freedom from re-intervention, and improved survival, which are crucial considerations in Pakistan's healthcare landscape. This study aims to provide a comprehensive comparison of LIMA-LAD and RSVG-LAD anastomoses, examining the early clinical outcomes. By analyzing data from our hospital database, we seek to elucidate each grafting technique's relative benefits and limitations, thereby informing clinical practice and guiding future research in coronary revascularization.

Methodology

The observational study on retrospective data was conducted at a Tertiary care hospital from January 2020 to December 2023. The cardiovascular & thoracic department database was searched for the patients who underwent isolated CABG. A total of 1480 patients were identified; amongst them, only 718 patients who met the criteria were included in the study, with 536 male & 182 female patients. The inclusion criteria include patients aged 18 years and older with a stable medical condition allowing elective surgery and complete medical records. The exclusion criteria include concomitant CABG, presence of severe comorbid conditions (e.g., severe renal failure, advanced liver disease), emergency or urgent CABG surgery, and patients receiving other types of grafts to the LAD. Institutional review board approval was granted, and inclusion criteria were met. For statistical analysis, Chi-square & T-tests were used. Data was analyzed using SPSS 25. A P-value of <0.05 was considered statistically significant. Data was collected on pre-designed Pro forma for peri-operative characteristics. Patients were then categorized into LIMA and RSVG and anastomosed to LAD. Data analysis was done on SPSS 25. Frequencies and percentages were calculated for qualitative variables. Mean and standard deviation were calculated for quantitative variables. For statistical analysis, the Chi-square & independent t-test was employed. A P-value of <0.05 was considered statistically significant. The term “Outcomes” refers to the in-hospital outcomes. In-hospital Mortality was considered as the primary outcome, and secondary outcomes included perioperative morbidity. The term "in-hospital mortality" pertains to deaths that occurred while the patient was in the hospital after the surgery within the same admission to the hospital. The parameters for prolonged ventilation were lasting more than 24 hours and prolonged ICU stay as extending beyond 48 hours. Data were shown in tables.

Table 1: Pre-operative Patients’ Demographics

Results

Our study included 718 patients who underwent isolated CABG, with a mean age of 59.67±9.270. The oldest patient's age is 85 years, and the youngest is 26 years. Most of them were males (74.7%), with the majority having NYHA III (46.0%) & CCS III (48.6%) functional class symptoms. Hypertension was our most common co-morbidity (67.1%), followed by dyslipidemia (58.0%) & DM (48.2%). Critical LMS disease was present in 14.8% of the cases studied. Among the patients, 10.4% were identified as chronic smokers, while 25.9% had a history of previous major heart attacks (MI).

These 718 patients were divided into two groups according to the type of graft to LAD; 50% had LIMA to LAD, whereas the remaining had RSVG to LAD. The mean age of LIMA- LAD group patients was 57±8.0 compared to 62±9.0 of RSVG-LAD with a P value of <0.001, showing that the RSVG-LAD group has significantly older patients. Regarding demographics, there was no statistical difference in gender between the two groups (P 0.3). In terms of co-morbidity, RSVG-LAD patients were significantly more likely to have HTN (P <0.001), DM (P <0.001), family history of CAD (P 0.05), tobacco smoking (P <0.001) & previous history MI (P 18.5%). Most LIMA-LAD group had preoperative preserved EF with a mean of 53±10 compared to 44±7 EF of RSVG-LAD, showing statistical significance (P 0.001).In terms of presenting complaints, RSVG-LAD patients have a significantly higher proportion of patients with NYHA II & CSI functional class symptoms (P 0.03) (P <0.001), whereas the LIMA-LAD group has NYHA IV (P <0.001) & CCS I (P <0.001)

In terms of intraoperative characteristics, LIMA-LAD patients had a profoundly more significant requirement of intraoperative blood/ products transfusion (P <0.001) with significantly prolonged cross-clamp time (P 0.003). Conversely, RSVG-LAD had markedly more intraoperative insertion of IABP (P 0.001) compared to the LIMA-LAD group. The two groups have no difference in perfusion time (P 0.3).

In terms of outcomes, the RSVG-LAD group has the worst outcome in terms of morbidity, such as significantly higher initial hours of mechanical ventilation (P <0.001) & prolonged ventilation (P 0.007). The RSVG-LAD group had markedly more reintubations (P 0.02) & Atrial fibrillation (P 0.007), whereas the LIMA-LAD patients required significantly more post-operative blood/ products transfusion (P 0.003). In terms of in-hospital mortality, the two groups have no statistically significant difference (P 0.3).

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Sr.No.	Parameters	SVG N=359	LIMA N=359	Total N=718	P Value
1	Age mean +SD (years)	62±9.0	57±8.0		<0.001
2	Male (%)	262 (36.5%)	274 (38.2%)	536 (74.7%)	0.3
3	Female (%)	97 (13.5%)	85 (11.8%)	182 (25.3%)	
4	Tobacco Used (%)	62 (8.6%)	12 (1.7%)	74 (10.3%)	<0.001
5	Family History of Ischemic Heart Disease (%)	8 (1.1%)	2 (0.3%)	10 (1.4%)	0.05
6	Diabetes Mellitus (%)	206 (28.7%)	140 (19.5%)	346 (48.2%)	<0.001
7	Dyslipidemia (%)	131 (24.3%)	182 (33.7%)	313 (58.0%)	0.4
8	Hypertension (%)	263 (36.6%)	219 (30.5%)	482 (67.1%)	<0.001
9	Previous PCI (%)	14 (1.9%)	7 (1.0%)	21 (2.9%)	0.1
10	Myocardial Infarction (%)	133 (18.5%)	53 (7.4%)	186 (25.9%)	<0.001
11	NYHAI (%)	9 (1.3%)	6 (0.8%)	15 (2.1%)	0.4
12	NYHA II (%)	69 (9.6%)	42 (5.8%)	111 (15.5%)	0.005
13	NYHA III (%)	175 (24.4%)	155 (21.6%)	330 (46.0%)	0.1
14	NYHA IV (%)	77 (10.7%)	123 (17.7%)	200 (27.9%)	<0.001
15	Left Main Stem> 50% Disease (%)	69 (9.6%)	37 (5.2%)	106 (14.8%)	0.001
16	EF mean	44±7	53±10		0.001
17	EF<50% (%)	217 (30.4%)	139 (19.5%)	356 (49.9%)	<0.001
18	EF>50% (%)	137 (19.2%)	220 (30.9%)	357 (50.1%)	
NYHA- New York Heart Association, EF- Ejection fraction					

Table 2. Intra-operative Patients' Parameters

Sr. No.	Parameters	SVG N=359	LIMA N=359	Total N=718	P Value
1	Intra Aortic Balloon Pump Used (%)	52 (7.2%)	31 (4.3%)	83 (11.6%)	0.01
2	Number of Patients receiving Intra-Operative Blood/ products (%)	190 (26.5%)	300 (41.8%)	490 (68.2%)	<0.001
3	Endarterectomy (%)	21 (2.9%)	13 (1.8%)	34 (4.7%)	0.1
4	Perfusion Time (Mean±SD) (minutes)	96.7±27.5	94.7±25.5		0.3
5	Aortic Cross-Clamp (Mean±SD) (minutes)	49.7±15.9	53.3±16.1		0.003

Table 3. Post-operative Patients' Parameters

Sr.No.	Parameters	SVG N=359	LIMA N=359	Total N=718	P Value
1	Number of Patients receiving Post-Operative Blood/ products (%)	161 (22.4%)	201 (28.0%)	362 (50.4%)	0.003
2	Ventilation Time Mean± SD (hours)	8.2±8.9	5.2±5.9		<0.001
3	Re-opening for bleeding/ tamponade/ hemodynamic instability (%)	16 (2.2%)	15 (2.1%)	31 (4.3%)	0.8
4	Re-intubated (%)	5 (0.7%)	0 (0.0)	5 (0.7%)	0.02
5	Re-admission to ICU (%)	2 (0.3%)	0 (0.0)	2 (0.3%)	0.1
6	Prolong Ventilation > 24 hours (%)	14 (1.9%)	3 (0.4%)	17 (2.4%)	0.007
7	In Hospital Mortality (%)	17 (2.4%)	12 (1.7%)	29 (4.0%)	0.3

Discussion

Our study elucidates the comparative clinical outcomes of left internal mammary artery (LIMA) to left anterior descending artery (LAD) anastomosis versus reverse saphenous vein graft (RSVG) to LAD anastomosis in coronary artery bypass grafting (CABG). This discussion contextualizes our findings within the current body of literature to ensure the relevance and contemporaneity of our comparisons. Our cohort comprised 718 patients, equally divided between the LIMA-LAD and RSVG-LAD groups. We observed significant differences in patient demographics and comorbidities, with the RSVG-LAD group having a significantly older mean age (62±9.0 years vs. 57±8.0 years, P <0.001), and higher prevalence of hypertension (P <0.001), diabetes mellitus (P <0.001), and smoking history (P <0.001). These differences align with prior studies indicating that older age and comorbid conditions often influence the selection of grafting technique (8). Our analysis revealed that the LIMA-LAD group had significantly better preoperative left ventricular ejection fraction (EF) compared to the RSVG-LAD group (53±10 vs. 44±7, P <0.001). This finding is consistent with the known superiority of LIMA grafts in maintaining patency and promoting myocardial recovery, as previously reported by Kobayashi et al., who highlighted the superior outcomes associated with arterial grafts (9). Intraoperative data indicated that LIMA-LAD patients required more blood transfusions (P <0.001) and had longer cross-clamp times (P 0.003). These findings can be attributed to the more complex dissection and anastomosis associated with arterial grafts. Conversely, the higher use of intra-aortic balloon pump (IABP) in the RSVG-LAD group (P 0.001) reflects the greater hemodynamic instability often encountered in patients with more severe comorbidities (10). Postoperatively, the RSVG-LAD group exhibited

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significantly higher morbidity, evidenced by longer initial hours of mechanical ventilation (P <0.001), higher rates of reintubation (P 0.02), and increased incidence of atrial fibrillation (P 0.007). These findings corroborate the results of Gaudino et al., who reported higher complication rates in vein grafts compared to arterial grafts (11). Furthermore, the LIMA-LAD group's greater requirement for postoperative blood transfusions (P 0.003) aligns with the intraoperative findings of increased transfusion needs, highlighting the consistent trend of higher blood product utilization in arterial graft procedures. Several contemporary studies have compared the outcomes of LIMA-LAD and RSVG-LAD anastomoses, providing a broader context for our findings—for instance, a meta-analysis by Goldstone et al. LIMA-LAD grafts are associated with superior survival and reduced rates of major adverse cardiac events (MACE) compared to vein grafts, consistent with our observation of better preoperative and postoperative metrics in the LIMA-LAD group (10). Similarly, a study by Head et al. found that the patency rate of LIMA grafts at ten years was significantly higher than that of RSVGs, reinforcing the benefits of arterial grafting (12). However, it is important to note that our study did not find a statistically significant difference in in-hospital mortality between the two groups (P 0.3). This aligns with findings from the ART trial, which also reported no significant difference in short-term mortality between LIMA and vein grafts despite the former's better long-term outcomes (13). While our study provides valuable insights into the comparative efficacy of LIMA-LAD and RSVG-LAD anastomoses, several limitations should be acknowledged. Firstly, the study is retrospective and relies on data from a single institution, which may limit the generalizability of the findings. Additionally, the follow-up period was relatively short, and longer-term studies are needed to fully assess these grafts' durability under varying conditions.

Further research is needed to explore the impact of patient-specific factors such as age, comorbidities, and genetic predispositions on graft patency and clinical outcomes. Studies with larger, multi-center cohorts and randomized controlled trials would provide more robust evidence and help validate our findings. Understanding the molecular mechanisms underlying graft failure and developing novel therapeutic strategies to enhance graft longevity are also important areas for future investigation.

Our work facilitates broader research by comparing two commonly used grafting techniques in CABG, highlighting the importance of graft selection in optimizing patient outcomes. These findings can inform clinical practice guidelines and contribute to the development of standardized protocols for CABG surgery.

Moreover, our study underscores the need for personalized approaches in cardiovascular surgery, considering individual patient characteristics and risk profiles. The insights gained from our research could improve outcomes for patients with coronary artery disease, particularly in regions with limited healthcare resources. By emphasizing the benefits of LIMA grafts, our findings support adopting best practices in surgical revascularization, ultimately enhancing the quality of care and patient survival rates.

Conclusion

In conclusion, our study confirms that LIMA-LAD anastomosis provides superior clinical outcomes and lower morbidity than RSVG-LAD anastomosis, emphasizing the benefits of using arterial grafts over vein grafts in coronary artery bypass surgery.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC/TCCH-0238/21)

Consent for publication
Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
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