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Saphenous Vein Graft vs. Radial Artery Graft: Searching for the Best Second Conduit in Coronary Artery Bypass Grafting

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ADULT CARDIAC SURGERY & ANAESTHESIA

ABSTRACT

Objective: To compare early in hospital outcomes between Radial Artery (RA) graft and saphenous vein grafts (SVG) in patients undergoing Coronary Artery Bypass Graft (CABG) surgery.
Study Design: Quasi Experimental study.
Place and Duration of Study: Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi Pakistan, from Oct 2021-Nov 2024.
Methodology: Three hundred and ninety-one patients with over age of 18 years, regardless of gender who underwent isolated On-pump CABG were recruited through non probability consecutive sampling. Patients were non-randomly allocated into two groups; Group-A (LIMA+VG) and Group-B (LIMA+RA+VG). Data on demographic, preoperative, intraoperative, and postoperative characteristics was collected using a structured proforma from adult cardiac surgery database. In-hospital outcomes and post-operative complications were compared between the study groups.
Results: Out of 391 patients, 76(19.4%) were females and 315(80.6%) were males with median age of 59.00(52.00-65.01) years. Group-A and Group-B had 182(46.5%) and 209(53.5%) patients respectively. Group-A had longer ICU stay duration compared to Group-B [45.50(22.00-91.00) vs. 29.00(21.00-61.00) hours; $p<0.01$]. In patients receiving three grafts, Group-A showed significantly higher chest tube drainage than Group-B [550.00(380.00-990.00ml) vs. 400.00(250.00-650.00ml); $p=0.013$]. The OR for type of graft was 2.03 (95% CI: 0.98-4.19; $p=0.05$), manifesting the borderline but significant impact on the postoperative complications.
Conclusion: RA grafts showed potential advantages over SVG as the second conduit in CABG surgery, especially in improving early in-hospital outcomes. Our findings emphasize the potential of RA graft use and support its frequent adoption in clinical practice particularly in younger population.

Keywords: Complication, Conduit, In-hospital outcome, Radial artery, Graft patency.

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INTRODUCTION

Coronary artery disease (CAD) causes over 40% of the 900,000 cardiac-related deaths annually in the U.S.[1] Coronary artery bypass grafting (CABG) is the most common surgery and treatment of choice for patients with severe left main or triple-vessel disease, poor ventricular function, and diabetes mellitus.[2] The type of conduit used is important for CABG outcomes, with graft patency being key to long-term success.[3] Radial artery(RA) as a second conduit revealed that its use leads to reduced hospital stays due to lower harvest-site infection risk than saphenous vein grafts(SVG).[4]

The 2021 ACC/AHA guidelines (Class-I) recommend RA, as the preferred conduit for significantly stenosed, non-left anterior descending (non-LAD) vessels.3The Left Internal Mammary Artery (LIMA) and Greater Saphenous Vein are commonly used CABG conduits, with LIMA to LAD as the gold standard.[4,5] Moreover, total arterial grafting is more beneficial in both short and long-term outcomes and its use should be encouraged.[6] Several studies have shown excellent patency rates of RA grafts due to lower atherosclerosis risk.[7,8]

A total arterial revascularization strategy reduces postoperative morbidity, especially in early graft failure rate, recurrent angina, and redo-CABG surgery.[8] Previous study depicted the graft patency rates of 79.25% for RA, and 74.3% for SVG and offers better clinical and angiographic outcomes.[9-10] Studies suggested RA graft use in CABG improves early in hospital outcomes, including shorter ICU stay, hospital stay, fewer complications, and mortality.[6]

Despite the first use of a RA graft in 1973, its use as the second-choice conduit has been limited in

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Pakistan in favor of the more conventional SVG. As such, scarce information is available on the surgical outcomes and risk factors associated with RA grafts in the Pakistani population. The aim of this study is to compare early in hospital outcomes between RA graft and SVG in patients undergoing CABG surgery.

METHODOLOGY

This was Quasi experimental study conducted at Adult Cardiac Surgery Unit, armed Forces Institute of Cardiology & National Institute of Heart Diseases, Rawalpindi Pakistan, from Oct 2021-Nov 2024 after approval from Institutional Ethical Review Board (IERB) (ltr#9/2/R&D/2024/329-Dated; 25th Oct 2024). Data was collected through non probability consecutive sampling.

Sample size 412 was calculated using the G-Power calculator for two population proportions, based on the Major Adverse Cardiac Events (MACE) rates. In the RA-Group, the MACE rate,[11] was observed at 60.2%, while in the SVG-Group, it was 73.2% while keeping 80% power of study and 5% margin of error. 438 participants were recruited for the study to increase the power of study.

Inclusion Criteria: Patients over age of 18 years, regardless of gender who underwent isolated On-pump CABG were recruited

Exclusion Criteria: Patients who had an abnormal modified Allen's Test, (capillary refill >10 seconds), Chronic kidney disease, patients undergoing CABG with valve procedure and patients undergoing emergency surgery were excluded from this study.

Patients were divided into two groups: Group-A (LIMA+ VG) and Group-B (LIMA+RA+VG). Data were collected from the adult cardiac surgery data base using a structured proforma covering demographic, preoperative, intraoperative, and post-operative characteristics. For in hospital outcomes, data was collected from daily progress charts/notes in ITC until the discharge of patient. For RA harvesting, a full forearm incision was used, with collateral ulnar circulation assessed preoperatively via Allen's test and confirmed intraoperatively with pulse oximetry. The non-dominant hand was preferred.

Intraoperatively the radial arteries with calcification/atherosclerosis were not harvested. The radial artery was dissected using low-setting electro-cautery, then it was flushed and gently hydro statically dilated with solution containing blood, ringers lactate, papaverine and heparin. All procedures were performed on cardiopulmonary bypass as aorto-coronary grafts. Sequential grafting was done where indicated, and standard anastomosis techniques was used. Postoperatively, Glyceryl Trinitrate was initially given intravenously, followed by oral Amlodipine in the multi-arterial group for 6 months. All patients were received Aspirin, Clopidogrel, Statins, Beta Blockers, and ACE inhibitors unless contraindicated. Flow chart as Figure-1 illustrated the entire process from enrollment of patients to the analysis of outcomes.

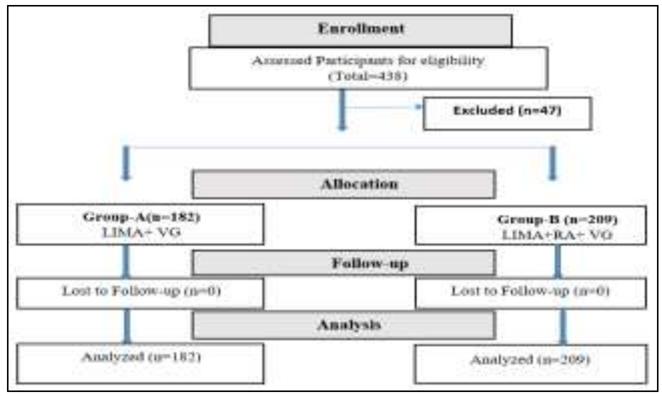

Figure-1 Patient Flow diagram

Data analysis was done using Statistical Package of Social Sciences (SPSS) version 23:00. Normality of all the continuous variables (age, weight, BMI, chest drainage, CKMB level, CPB Time, cross clamp time, EF,ICU stay, Ionotropic duration, hospital stay, ventilation time and no of blood units transfused) was explored using the Kolmogorov-Smirnov test. All these variables were not normally distributed therefore, median and interquartile were reported. Categorical variables (gender, comorbid, angina duration, symptoms, extent of CAD, number of grafts, type of grafts, inotropic support, IABP support, normal rhythm, Complications and mortality were presented as frequency & percentages. Chi-square test was used to find association between study groups for categorical variables. A Mann Whitney U test was used to compare the median differences between study groups due to non-homogenous data. A binary logistic regression model was performed to estimate both unadjusted and adjusted odds ratio for the predictors of postoperative complications. A *p*-value ≤0.05 was considered significant at 95% CI and 5%.

RESULTS

Three hundred and ninety one patients were enrolled in this study. Study analysis revealed that

Group-A patients were older and had lower BMI than Group-B patients [median (IQR); 61(55-68) years vs. 56(50-62) year, $p<0.01$; 25.80(23.88-28.69) kgm-2 vs. 26.67(23.83-30.12) kgm-2, $p<0.05$ respectively. NYHA Class-II and ASA Class-III patients were more prevalent in Group-B patients and also had a longer angina duration ($p<0.05$). Group-A had longer ICU stay duration [45.50(22-91) vs. 29(21-61) hours; $p<0.01$]. Among post-operative complication, the occurrence of SVT and VPCs in Group-A was nearly three times and five times higher than in Group-B (14.8% vs. 5.3%; 9.3% vs. 1.9% respectively; $p<0.01$). Group-A had higher mean values for inotropic duration, maximum CKMB, and ICU stay compared to Group-B as shown in Table-I.

Graft type did not significantly impact CPB or cross-clamp times, however addition of the RA graft as the second conduit contributed to lower postoperative bleeding (Table-II).

Table-III highlights the key factors associated with postoperative complications in CABG patients, with age, BMI, and NYHA class are the significant factors associated with postoperative outcomes ($p<0.05$). In this analysis patients with advanced age (median ≥62 years) experienced more SVTs, VPCs and re-exploration while high BMI value (median=29.5 kgm-2) was associated significantly with mortality.

Patients in Group-A had higher rates of SVT [27/38(71.1%)] and re-exploration [9/20(45.0%)]. However, VPCs were more prevalent in patients in Group-A, (81.0% vs. 19.0%). Similarly, ventilation time, chest drainage, CKMB levels, and RBC transfusions were also significantly different across outcomes ($p<0.001$). Mortality was associated with longer ventilation times (median 64.5 hours), higher CKMB levels (median 64 IU/mL), and increased RBC

Table-I Comparison of Demographic, Comorbid, Clinical, and Perioperative Parameters Between Study Groups (n=391)

Variables		**Total=391**	**Group-A (LIMA+VG) (Total=182)**	**Group-B(LIMA+Rd+VG) (Total=209)**	***p*-value**
DEMOGRAPHICS		Median(IQR)			
Age(years)		59.00(52-65)	61(55-68)	56(50-62)	0.001
Weight(kg)		72(65-81)	71(64-79)	75(66-84)	0.009
Height(cm)		167(160-172)	166.50(160-170)	168(161-172)	0.10
BMI(kg/m2)		26.35(23.84-29.41)	25.80(23.88-28.69)	26.67(23.83-30.12)	0.04
Gender Frequency (%)	Female	76(19.40%)	42(23.10%)	34(16.30%)	0.09
	Male	315(80.60%)	140(76.90%)	175(83.70%)	
COMORBID		Frequency (%)			
DM	Yes	204(52.20%)	98(53.80%)	106(50.70%)	0.54
	No	187(47.80%	84(46.20%)	103(49.30%)	
HTN	Yes	231(59.1%)	105(57.7%)	126(60.3%)	0.60
	No	160(40.9%)	77(42.3%)	83(39.7%)	
Smoking status	Ex-smoker (>8 weeks)	88(22.5%)	49(26.9%)	39(18.7%)	0.11
	No smoking	269(68.8%)	120(65.9%)	149(71.3%)	
	Still Smoking (<8 weeks)	34(8.7%)	13(7.1%)	21(10.0%)	
Symptoms on Presentation		Frequency (%)			
Angina Duration	<1 week	39(10.0%)	18(9.90%)	21(10.0%)	0.012
	1-6 week	12(3.10%)	67(36.8%)	109(52.2%)	
	7-12 week	176(45.0%)	26(14.3%)	33(15.8%)	
	3-6 months	22(5.60%)	12(6.60%)	10(4.80%)	
	7-12 months	2(0.50%)	5(2.70%)	5(2.40%)	
	1-5 years	10(2.60%)	10(5.50%)	2(1.00%)	
	6-10 years	59(15.10%)	1(0.50%)	1(0.50%)	
	Asymptomatic	71(18.20%)	43(23.6%)	2(13.40%)	
NHYA Class	I	69(17.60%)	38(120.9%)	31(14.8%)	0.025
	II	288(73.70%)	123(67.6%)	165(78.9%)	
	III	33(8.40%)	12(5.7%)	12(5.70%)	
	IV	1(0.30%)	1(0.50%)	1(0.50%)	
ASA Class	I	246(62.90%)	119(65.4%)	127(60.8%)	0.015
	II	47(12.00%)	28(15.4%)	19(9.10%)	
	III	96(24.60%)	34(18.7%)	62(29.7%)	
	IV	1(0.30%)	1(0.50%)	0(0.00%)	
	V	1(0.30%)	0(0.00%)	1(0.50%)	
CCS Class	II	22(5.60%)	9(4.90%)	13(6.20%)	0.009
	III	256(65.50%)	105(57.7%)	151(72.2%)	
	IV	51(10.50%)	24(13.2%)	17(8.10%)	
	IVc	1(0.30%)	1(0.50%)	0(0.0%)	
	Nil	71(18.20%)	43(23.6%)	8(13.4%)	
Pre-Operative Parameters		Frequency (%)			

Left Main Disease	<50%	34(8.70%)	19(10.43%)	15(7.2%)	0.02
	51-70%	38(9.70%)	22(12.10%)	16(7.7%)	
	>70%	50(12.80%)	30(16.50%)	20(9.6%)	
	Nil	269(68.8%)	111(61.0%)	158(75.6%)	
Extent of Significant CAD	SVCAD	3(0.80%)	3(1.60%)	0(0%)	0.05
	DVCAD	53(13.6%)	31(17.0%)	22(10.5%)	
	TVCAD	329(84.1%)	146(80.2%)	183(87.6%)	
	Nil	6(1.50%)	2(1.10%)	4(1.90%)	
EF (%) [Median(IQR)		47.00(51.00-55.00)	46.00(40.00-52.00)	48.00(43.00-55.00)	0.001
Intra-Operative Parameters		Median(IQR)			
CPB time		138.00 (116.00-155.00)	134.50 (112.00-159.00)	140.00 (121.00-155.00)	0.07
Cross Clamp time		88.00(74.00-103.00)	86.00(72.00-103.00)	90.00(76.00-103.00)	0.17
Post-Operative Parameters		Frequency (%)			
IABP Support	Pre-op	6(1.50%)	4(2.20%)	2(1.00%)	0.68
	Per-op	13(3.30%)	5(2.70%)	8(3.80%)	
	Post-op	7(1.80%)	4(2.20%)	3(1.40%)	
	Nil	365(93.4%)	169(92.9%)	196(93.8%)	
Inotropic Support	Mild	289(73.9%)	126(69.2%)	163(78.0%)	0.20
	Moderate	76(19.4%)	43(23.6%)	33(15.8%)	
	Severe	5(1.30%)	2(1.10%)	3(1.40%)	
	Nil	21(5.40%)	11(6.00%)	10(4.80%)	
		Median(IQR)			
Inotropic duration		38.00(21.00-68.00)	43.50(21.00-77.00)	26.60(20.00-59.00)	0.002
Max CKMB(IU/L)		50.00(38.00-71.00)	54.0041.00-79.00)	48.00(37.00-66.00)	0.006
ICU Stay(hours)		42.00(21.00-71.00)	45.50(22.00-91.00)	29.00(21.00-61.00)	0.002
Ventilation time(hours)		5.00(3.50-9.50)	5.00(3.50-10.50)	4.50(3.00-8.50)	0.034
Hospital Stay (days)		6.00(5.00-7. 00)	6.00(5.00-8.00)	6.00(5.00-7. 00)	0.06
		Frequency (%)			
Rhythm	No	335(85.67%)	145(79.70%)	195(93.30%)	<0.001
	Yes	56(14.32%)	37(20.30%)	14(6.70%)	
Complications		Frequency (%)			
SVT	No	353(90.3%)	155(85.2%)	198(94.7%)	0.001
	Yes	38(9.70%)	27(14.8%)	11(5.3%)	
VPCS	No	370(94.6%)	165(90.7%)	205(98.1%)	0.001
	Yes	21(5.40%)	17(9.30%)	4(1.90%)	
Rexploration	No	372(95.1%)	174(95.6%)	198(94.7%)	0.69
	Yes	19(4.90%)	8(4.40%)	11(5.30%)	
Mortality	Alive	379(96.9%)	177(97.3%)	202(96.7%)	0.73
	Dead	12(3.10%)	5(2.70%)	7(3.30%)	

LIMA+VG=LIMA+Vein Graft; L+Rd+VG=LIMA+Radial+Vein Graft; LIMA= Left Internal Mammary artery; BMI=Body Mass Index; DM= Diabetes Mellitus; HTN=hypertension ASA= American Society of Anesthesiologists CSS= Canadian Cardiovascular Society; CAD=Coronary artery disease; SVCAD=single vessel Coronary artery disease ;DVCAD=Double Vessel Coronary artery disease ; TVCAD= Triple Vessel Coronary artery disease; EF= Ejection Fraction; ICU=Intensive care unit NHYA= New York Heart Association Classification; CKMB= Creatine Kinase-Myocardial Band ;IABP=Intra-aortic Balloon Pump; CPB=Cardiopulmonary Bypass ; SVT=Supraventricular Tachycardia,; VPC=Ventricular Premature Contractions

Table II: Comparison of CPB, Aortic cross clamp time and chest drainage in terms of number and type of graft (n=391)

No. of Grafts	Type of Graft (Frequency)	CPB Time (min) Median(IQR)	*p*-value	Cross Clamp Time (min) Median(IQR)	*p*-value	Chest Drainage Median (IQR)	*p*-value
Two	L+VG (43)	90(81-112)	0.07	62(54-77)	0.30	450(280-830)	0.28
	L+Rd+VG(38)	97(91-118)		64.5(57-83)		445(320-640)	
Three	L+VG (79)	124 (116-152)	0.07	83(72-101)	0.19	550(380-990)	0.013
	L+Rd+VG (102)	134.5(122-149)		87.5(76-103)		400(250-650)	
Four	L+VG (58)	151(139-174)	0.82	99.5 (93-113)	0.75	605(390-970)	0.016
	L+Rd+VG (67)	153(142-163)		99 (92-109)		400(280-680)	
Five	L+VG (2)	183(183-183)	1.00	113 (112-114)	1.00	815(550-1080)	0.12
	L+Rd+VG (2)	169(151-187)		119 (103-135)		365(250-480)	

transfusions, reflecting more complex recovery and higher complication rates.

When unadjusted ORs were evaluated, age, IABP support, ventilation time, inotropic duration, chest drainage, CKMB levels, number of RBC units transfused, and type of graft were significant predictors for postoperative complications in CABG patients (p<0.05). The inotropic duration with aOR of 0.99 (CI 95% 0.98-0.99; p=0.02) highlight the likelihood of post-operative complications increases with prolong duration of inotropes. The uOR for type of graft was 2.48 (95% CI: 1.47-4.17, p=0.001), indicating a significant association between graft type and post-operative outcomes. After adjustment, the OR

Table-III: Comparison of Demographic, Comorbid, Clinical, and Perioperative Parameters Across Post-operative Outcomes. (n=391)

Variables		Post-operative Outcomes				*p*-value
		SVT (Total=38)	VPCs (Total=21)	Re-exploration (Total=20)	Mortality (Total=12)	
DEMOGRAPHICS		Median (IQR)				
Age(years)		62.5(55-70)	62(55-66)	64(54.5-67)	57(55-64.5)	0.01
BMI(kg/m²)		26.10(24.40-29.40)	24.60(22.40-26.90)	24.50(21.80-29.00)	29.50(24.40-30.70)	0.04
Gender [Frequency (%)]	Female	7(18.4%)	4(19.0 %)	3(15.0%)	4(33.3%)	0.56
	Male	31(81.6%)	17(81.0%)	17(85.0%)	8(66.7%)	
COMORBIDS		Frequency (%)				
Diabetic		15(39.5%)	12(57.1%)	8(40.0%)	9(75.0%)	0.08
Hypertensive		24(63.2%)	11(52.4%)	8(40.0%)	9(75.0%)	0.41
Smoking status	Ex-smoker (≥8 weeks)	11(28.9%)	4(19.0%)	6(30.0%)	3(25.0%)	0.50
	Current Smoker (<8 weeks)	4(10.5%)	2(9.5%)	-	-	
	Non-Smoker	23(60.5%)	15(71.4%)	14(70.0%)	9(75.0%)	
SYMPTOM ON PRESENTATION		Frequency (%)				
Angina Duration	<1 week	4(10.5%)	5(23.8%)	3(15.0%)	2(16.7%)	0.20
	1-6 week	12(31.6%)	7(33.3%)	6(30.0%)	3(25.0%)	
	7-12 week	5(13.2%)	2(9.5%)	2(10.0%)	2(16.7%)	
	3-6 months	4(10.5%)	1(4.8%)	2(10.0%)	-	
	7-12 months	2(5.3%)	-	1(5.0%)	-	
	1-5 years	2(5.3%)	1(4.8%)	-	2(16.7%)	
	6-10 years	-	-	-	-	
	Asymptomatic	9(23.7%)	5(23.8%)	6(30.0%)	3(25.0%)	
NHYA Class	I	8(21.1%)	4(19.0%)	7(35.0%)	3(25.0%)	0.04
	II	24(63.2%)	16(76.2%)	12(60.0%)	6(50.0%)	
	III	5(13.2%)	1(4.8%)	1(5.0%)	2(16.7%)	
	IV	1(2.6%)	-	-	1(8.3)	
ASA Class	I	26(68.4%)	15(71.4%)	14(70.0%)	9(75.0%)	0.12
	II	5(13.2%)	2(9.5%)	2(10.0%)	1(8.3%)	
	III	7(18.4%)	3(14.3%)	4(20.0%)	2(16.7%)	
	IV	-	1(4.8%)	-	-	
CCS Class	II	1(2.6%)	1(4.8%)	-	-	0.33
	III	22(57.9)	11(52.4%)	13(65.0%)	9(75.0%)	
	IV	6(15.8)	4(19.0%)	1(5.0%)	-	
	IVc	-	-	-	-	
PRE-OPERATIVE PARAMETERS		Frequency (%)				
Left Main Disease	<50%	5(13.2%)	3(14.3%)	2(10.0%)	2(16.7%)	0.17
	51-70%	6(15.8%)	-	4(20.0%)	-	
	>70%	7(18.4%)	5(23.8%)	2(10.0%)	2(14.7%)	
Extent of Significant CAD	SVCAD	-	-	-	-	0.91
	DVCAD	6(15.8%)	2(9.5%)	4(20.0%)	-	
	TVCAD	31(81.6%)	19(90.5%)	16(80.0%)	12(100.0%)	
INTRA-OPERATIVE PARAMETERS		Frequency (%)				
Type of Graft	LIMA+VG	27(71.1%)	17(81.0%)	9(45.0%)	5(41.7%)	0.001
	LIMA+Rd+VG	11(28.9%)	4(19.0%)	11(55.0%)	7(58.3%)	
		Median(IQR)				
EF (%)		48(40-55)	40(35-47)	45.5(40-54)	44(39.5-55.5)	0.28
CPB time(minutes)		129(113-147)	141(111-183)	153(131-177.5)	151.5(37.5-178)	0.32
Cross Clamp time(minutes)		83(75-97)	96(69-112)	102(84-120.5)	98(86-110)	0.53
POST-OPERATIVE PARAMETERS		Frequency (%)]				
IABP Support [Frequency (%)]	Pre-op	1(2.6%)	1(4.8%)	2(10.0%)	3(25.0%)	<0.001
	Per-op	-	2(9.5%)	1(5.0%)	3(25.0%)	
	Post-op	3(7.9%)	3(14.3%)	1(5.0%)	-	
Inotropic Support [Frequency (%)]	Mild	23(60.5%)	12(57.1%)	14(70.0%)	3(25.0%)	<0.001
	Moderate	14(36.8%)	8(38.1%)	3(15.0%)	7(58.3%)	
	Severe	-	1(4.8%)	1(5.0%)	1(8.3%)	
		Median(IQR)				
Ventilation Time(hours)		7.8(5-19)	9(4-11)	14(7.3-34.3)	64.5(22-121.5)	<0.001
Inotropic Duration		77.5(48-140)	87(65-162)	86(46-115.5)	149.5(67.5-223)	<0.001
Chest Drainage(ml)		715(480-1000)	770(500-890)	1395(835-2150)	895(630-1280)	<0.001
CKMB(IU/ml)		57.5(48-87)	56(42-94)	50(45-74)	64(45-98)	0.002
No. of RBC units Transfused		2(1-3)	2(1-3)	3(2-4)	3(1.5-4)	<0.001

decreased to 2.03 (95% CI: 0.98-4.19, p=0.05), depicts that the type of graft may still impact outcomes, although the significance is borderline. (Table-IV)

DISCUSSION

This study demonstrated comparable but improved in-hospital outcomes in patients who received RA graft as the second conduit. The radial artery is an important, but underused, conduit in CABG. It could be harvested and used exactly like an SVG, was not linked with any increased perioperative morbidity or mortality, had far better long-term patency, and was associated with superior long-term survival than SVG.[12] Previous study had shown that RA grafts were related with lower risk of in-hospital mortality, reduced mechanical ventilation time, fewer comorbidities, and shorter length of stay (LOS)1. Consistent with literaure, the RA-Group experienced lower postoperative complications, reduced mechanical ventilation times, and shorter ICU stays, while overall hospital stay and in-hospital mortality rates were comparable (p<0.001).

Table -IV Predictors of Post-operative Complications (n=391)

Covariates	95% CI for uOR	p-value	95% CI for aOR	p-value
Age (years)	0.96(0.93-0.98)	0.004	0.99(0.95-1.03)	0.70
BMI (kg/m^2)	1.04(0.98-1.10)	0.12	-	-
NYHA	1.16(0.71-1.89)	0.55	-	-
IABP Support	0.31(0.18-0.52)	<0.001	0.62(0.34-1.11)	0.11
Inotropic Support	0.73(0.48-1.09)	0.12	-	-
Ventilation Time(hours)	0.95(0.94-0.97)	<0.001	0.98(0.97-1.00)	0.23
Inotropic Duration(hours)	0.97(0.97-0.98)	<0.001	0.99(0.98-0.99)	0.02
Chest Drainage(ml)	0.99(0.99-0.99)	<0.001	1.0(0.99-1.00)	0.83
CKMB(IU/ml)	0.99(0.98-0.99)	0.011	0.99(0.98-1.00)	0.58
No. of RBCs Transfused	0.54(0.41-0.72)	<0.001	0.79(0.57-1.08)	0.14
Type of Graft	2.48(1.47-4.17)	0.001	2.03(0.98-4.19)	0.05

Post-operative Complications=Supraventricular Tachycardia, Ventricular Premature Contractions, Re-exploration & Mortality; uOR= unadjusted Odds Ratio; aOR= adjusted Odds Ratio; BMI=Body Mass Index; NHYA= New York Heart Association Classification; CKMB= Creatine Kinase-Myocardial Band ;IABP=Intra-aortic Balloon Pump;RBCs= Red Blood Cells

Current study reported that RA group had a higher mortality rate than the SVG group (p=0.73), but the difference was not statistically significant. These findings were consistent with a study conducted by Gaudino *et al*.[13] which also found no significant difference in mortality (p>0.05). Similarly, Tatoulis *et al*.[12] observed fewer MACE and lower rates of reoperation, recurrent angina, and myocardial infarction (MI) in RA grafting.

In this study, ventilation times were slightly shorter in the RA group compared to the SVG group (5 vs. 4.5 hours; p=0.034), and the length of hospital stay was similar (6 days for both groups; p>0.05). These findings aligned with study carried out by Jawitz *et al*., who also reported shorter ICU stays (median 23 vs. 26 hours, p=0.002) in RA group but comparable hospital stays (median 6 days for both groups; p=0.858).[14] Achouh *et al*., reported the significant association of CKMB with type of graft (p=0.018) as shown in current study (p<0.05).[2] Local or global myocardial ischemia can result in myocardial necrosis, leading to elevated CK-MB levels. Moreover, elevated CK-MB may serve as a significant predictor of graft occlusion.[15,16]

A study of randomized studies comparing RA with SVG as a second conduit, indicated that RA had a considerably lower rate of MI and recurrent revascularization and consequently a improved patency rate at the 5 years follow-up.[17] Arterial grafts produce Nitric Oxide(NO) which causes vasodilation and inhibits platelet aggregation and the development of atherosclerosis.[18] Several studies have mentioned a favorable impact of the RA grafting strategy in CABG survival compared to the standard Saphenous Vein approach for multi-vessel coronary revascularization.[19] Yunus *et al*.[7] reported perioperative MI and postoperative mortality rates of 1.19%, whereas our study observed rates of 4.1% for both perioperative MI and overall mortality.

Schwann *et al*.[20] mentioned that using the RA after LIMA instead of the SVG provided a longer survival advantage for diabetic patients undergoing CABG, reinforcing the preference for arterial grafts in this population. The utilization of the RA as the second conduit was related with a shorter postoperative LOS, likely due to low risk of harvest-site infection compared to the SVG group-5, as supported by our findings. Cohen *et al*., reported that RA-Group had a significantly shorter ICU stay (p=0.0002), although the similar hospital stay duration was observed between the groups (SVG: 8 days, RA: 8 days; p=0.32). Similarly, this study observed a longer ICU stay in the SVG group compared to the RA group (p=0.002), while the overall hospital stay remained insignificantly different [SVG: 6 [5–7] days, RA: 6 [5–8] days; p=0.06] among study groups. Logistic regression analysis further demonstrated that RA grafting provided protection against early mortality and morbidity.[21] Consistent with these findings, current study emphasized that RA grafts resulted in improved early in-hospital outcomes

This study is crucial as it provides valuable insights into the comparative effectiveness of RA and SVG as grafts in CABG. By assessing postoperative outcomes, it highlights the superior in-hospital outcomes associated with RA grafting. Moreover, the study drew attention to the protective role of RA grafting against early mortality and morbidity while asserting its potential as a preferable second conduit after LIMA grafting. These findings contribute to optimizing conduit selection in CABG, ultimately improving patient outcomes and surgical success. As much of our Pakistani population undergoing CABG fall in a younger age bracket and RA grafts provide superior long-term patency rates and the potential to enhance long-term survival, RA grafts should be utilized more frequently in clinical practice.

Our findings, combined with prior research work have suggested that RA grafting is superior to SVG for CABG and serves as a comparable second conduit after LIMA grafting. RA grafting had shown better in-hospital outcomes, including fewer complications, reduced ICU stays, and lower mortality rates. These results support the preference for RA grafts in CABG procedures.

LIMITATIONS OF STUDY

This was single centered study, which may confine the generalizability of the findings, and the short follow-up duration, as it only assessed early in-hospital outcomes until the discharge after surgery. Additionally, the study did not focus on long-term graft patency, which are essential for comprehensively analyzing the efficacy of RA grafting.

CONCLUSION

Study demonstrated that RA grafts showed potential advantages over SVG as the second conduit in CABG, particularly in improving early in-hospital outcomes. Our findings underscore the potential of radial artery use and support its frequent adoption in clinical practice especially in the younger patients.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

IAC & NAK: Study Design and Concept, Data acquisition, data analysis, critical review, Drafting the Manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Le NK, Mallick S, Chervu N, Butterfield J, Joachim K, Charland N, et al. Clinical and financial outcomes associated with the utilization of right internal mammary artery versus radial artery in multivessel coronary artery bypass grafting. Surgery 2024 https://doi.org/10.1016/j.surg.2024.04.011
2. Abromaitiene V, Greisen J, Kimose HH, Karaliunaite Z, Jakobsen CJ. Comparison of free arterial and saphenous vein grafting in outcomes after coronary bypass surgery. Scand. Cardiovasc. J 2022; 56(1): 42-47. https://doi.org/10.1080/14017431.2022.2060525
3. Moya-Mendez ME, DeLaura I, Thornton SW, Williams AR, Zwischenberger BA. Quality improvement initiative to increase radial artery usage as a second arterial conduit in coronary artery bypass grafting. Ann Thorac Cardiovasc Surg 2024 ;38(5): ivae068. https://doi.org/10.1093/icvts/ivae068
4. Gharibeh L, Ferrari G, Ouimet M, Grau JB. Conduits' biology regulates the outcomes of coronary artery bypass grafting. Basic to Translational Science 2021; 6(4): 388-396. https://doi.org/10.1016/j.jacbts.2020.11.015
5. Martins RS, Masood L, Kazi M, Gillani M, Sadiq A, Inam H, Fatimi S et al. Radial artery coronary bypass grafting: Surgical outcomes of an unexplored innovation in a developing country. J Pak Med Assoc 2022; 72(2): S106. https://doi.org/10.47391/JPMA.AKU-22
6. Schwann TA, Tatoulis J, Puskas J, Bonnell M, Taggart D, Kurlansky P, et al., Worldwide trends in multi-arterial coronary artery bypass grafting surgery 2004-2014: a tale of 2 continents. J Thorac Cardiovasc Surg 2017; 29(3): 273-280. https://doi.org/10.1053/j.semtcvs.2017.05.018
7. Yunus A, Banna HU, Naveed T. Early Results of Radial Artery as A Second Conduit in Coronary Artery Bypass Grafting in a Developing Country. Pak.J. Med. Health sci 2013; 17: 19-27
8. Momin A, Ranjan R, Valencia O, Jacques A, Lim P, Fluck D, et al Long Term Survival Benefits of Different Conduits Used in Coronary Artery Bypass Graft Surgery-A Single Institutional Practice Over 20 Years. J. Multidiscip. Health 2024 :1505-1512. https://doi.org/10.2147/JMDH.S461567
9. Tinica G, Chistol RO, Enache M, Leon Constantin MM, Ciocoiu M, et al. Long-term graft patency after coronary artery bypass grafting: Effects of morphological and pathophysiological factors. Anatol. J. Cardiol 2018; 20(5). https://doi.org/10.14744/AnatolJCardiol.2018.51447
10. Dimagli A, Soletti Jr G, Harik L, Perezgrovas Olaria R, Cancelli G, et al Angiographic outcomes for arterial and venous conduits used in CABG. J. Clin. Med 2023; 12(5): 2022. https://doi.org/10.3390/jcm12052022
11. Hamilton GW, Raman J, Moten S, Matalanis G, Rosalion A, Dimagli A, et al. Radial artery vs. internal thoracic artery or saphenous vein grafts: 15-year results of the RAPCO trials. Eur Heart J 2023; 44(26): 2406-2408. https://doi.org/10.1093/eurheartj/ehad108

12. Tatoulis J, Schwann TA. Long term outcomes of radial artery grafting in patients undergoing coronary artery bypass surgery. Ann. Cardiothorac. Surg 2018; 7(5): 636.
https://doi.org/10.21037/acs.2018.05.11
13. Gaudino M, Benedetto U, Fremes S, Biondi-Zoccai G, Sedrakyan A, Puskas JD, A et al. Radial-artery or saphenous-vein grafts in coronary-artery bypass surgery. NEJM 2018; 378(22): 2069-2070.
https://doi.org/10.1056/NEJMoa1716026
14. Jawitz OK, Cox ML, Ranney D, Williams JB, Mulder H, Gaudino MF, et al.. Outcomes following revascularization with radial artery bypass grafts: Insights from the PREVENT-IV trial. Am Heart J 2020; 228: 91-97.
https://doi.org/10.1016/j.ahj.2020.08.001
15. Achouh P, Isselmou KO, Boutekadjirt R, D'Alessandro C, Pagny JY, Fouquet R et al.. Reappraisal of a 20-year experience with the radial artery as a conduit for coronary bypass grafting. Eur J Cardio thorac Surg 2012; 41(1): 87-92.
https://doi.org/10.1016/j.ejcts.2011.05.027
16. Overgaard CB, Dzavík V. Inotropes and vasopressors: review of physiology and clinical use in cardiovascular disease. Circ 2008; 118(10): 1047-1056.
https://doi.org/10.1161/CIRCULATIONAHA.107.728840
17. Jasarevic M, Krueger O, Strathmann J, Jasarevic M, Shehada SE, Piotrowski JA, et al. Multiple Arterial Grafting During Coronary Artery Bypass Graft Surgery in Diabetic and Non-Diabetic Patients: A Short-and Long-Term Analysis at a Single Center J Clin Med 2024; 13(23): 7082.
https://doi.org/10.3390/jcm13237082
18. Tatoulis J. The radial artery: An important component of multiarterial coronary surgery and considerations for its optimal harvest. JTCVS techniques 2021; 5: 46-55.
https://doi.org/10.1016/j.xjtc.2020.10.042
19. He GW, Liu ZG. Comparison of nitric oxide release and endothelium-derived hyperpolarizing factor-mediated hyperpolarization between human radial and internal mammary arteries. Circ 2001; 104: I-344.
https://doi.org/10.1161/hc37t1.094930
20. Schwann TA, Al-Shaar L, Engoren M, Habib RH. Late effects of radial artery vs saphenous vein grafting for multivessel coronary bypass surgery in diabetics: a propensity-matched analysis. Eur J Cardio thorac Surg 2013; 44(4): 701-710.
https://doi.org/10.1093/ejcts/ezt061
21. Cohen G, Tamariz MG, Sever JY, Liaghati N, Guru V, Christakis GT, et al. The radial artery versus the saphenous vein graft in contemporary CABG: a case-matched study. Ann Thorac Surg. 2001; 71(1): 180-186.
https://doi.org/10.1016/S0003-4975(00)02285-2

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