Open Access

Original Article

Early Post-operative Outcomes of Single versus Multiple Arterial Grafts in Coronary Artery Bypass Grafting; A Comparative Analysis

Imtiaz Ahmed Chaudhry, Nasir Ali, Sidra Afzal*, Imran Bashir

Department of Adult Cardiac Surgery, Armed Forces Institute of Cardiology/National Institute of Heart Diseases/ National University of Medical Sciences (NUMS) Rawalpindi, Pakistan, *Department of R & D, Armed Forces Institute of Cardiology/ National Institute of Heart Diseases/National University of Medical Sciences (NUMS) Rawalpindi, Pakistan

ABSTRACT

Objective: To compare early post-operative outcomes of Single versus Multiple Arterial grafts in Coronary Artery Bypass Grafting (CABG) surgery.

Study Design: Analytical Cross-sectional study.

Place and Duration of Study: Adult Cardiac Surgery, Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi Pakistan, from Jul 2022 to May 2023.

Methodology: One hundred and forty nine patients planned for elective isolated CABG (with two or more grafts) were enrolled in study using consecutive sampling. They were allocated into two groups, group A (Multiple Arterial CABG group) and group B (Conventional CABG group). Data was collected on early post-op outcomes i.e. ICU stay, ventilation time, inotropic duration, chest drainage, rhythm complications including Supraventricular Tachycardia (SVT) and mortality using a structured proforma. Chi-square and t-test were applied to make comparison between both groups. $p<0.05$ was considered statistically significant.

Results: Out of one hundred and forty nine patients, who underwent elective CABG, majority were males 124(83.2%). Mean age of the patients was 59.18±9.28 years. Seventy four (49.7%) patients underwent Multiple Arterial CABG while 75(50.3%) had conventional CABG. Mean ICU stay duration was 56.74±48.30 hours in group A while it was 67.25±73.42 hours in group B; p=0.30. Mean Chest Drainage was 622.05±505.69 ml in group A while it was 846.13±799.67 ml in group B; p=0.04. Mean ventilation time was 10.28 ± 19.88 hours in Multiple Arterial CABG group while it was 11.27 ± 29.88 hours in Conventional CABG group; p=0.81

Conclusion: The use of the Radial Artery (RA) in CABG surgery was associated with better early clinical outcomes and minimal complications when compared to conventional CABG. RA is time-tested robust graft and it should be used more frequently in CABG surgery.

Keywords: Arterial conduits, Coronary artery bypass graft, Post-operative outcomes, Radial artery.

How to Cite This Article: *Chaudhry IA, Ali N, Afzal S, Bashir I. Post-operative outcomes of Single versus Multiple Arterial Conduits in Coronary Artery Bypass Grafting; A Comparative Analysis. Pak Armed Forces Med J 2023; 73(SUPPL-3): S539-545.*
DOI: https://doi.org/10.51253/pafmj.v73iSUPPL-3.10968

INTRODUCTION

In patients with multivessel Coronary Artery Disease (CAD), Coronary Artery Bypass Graft (CABG) surgery is the preferred treatment option, and remains the gold standard for coronary revascularization.[1] Around 200,000 isolated cases of CABG are done annually in the US alone, with about 400,000 procedures performed worldwide making it the most common cardiac surgery procedure globally.[2] The choice of conduit remains a critical factor in achieving the best results for CABG surgery. Graft patency is most likely the main determinant of long-term survival.[3]

Vein and arterial conduits are used in coronary surgical revascularization with the aim of ensuring long-term patency.[3,4] Saphenous Vein Graft (SVG) as a conduit in CABG surgery was initially utilized in 1968.[4] and remains the most used conduit for revascularization because of its ease of availability, accessibility, and available length. The Left Internal Mammary Artery (LIMA) and the Greater Saphenous vein are the bypass conduits most frequently used in CABG, with the graft of LIMA to the Left Anterior Descending (LAD) artery being recognized as the gold standard.[5] Because arterial grafts are less likely to develop atherosclerosis and occlusion than venous grafts, arterial grafts may offer greater long-term patency.[3,6]

Other arterial grafts that have been used in CABG surgery over time include the Right Internal Mammary Artery (RIMA), the Radial Artery (RA) and the gastroepiploic artery.[6] RA as a bypass conduit in CABG surgery was used by Carpentier and associates in 1973 who reported the short-term outcomes of 40

Correspondence: Dr Imtiaz Ahmed Chaudhry, Department of Adult Cardiac Surgery, AFIC/NIHD Rawalpindi, Pakistan

grafts in 30 patients. However within a couple of years of their initial publication, they contradicted their own results due to the high incidence of graft occlusion and narrowing when compared to saphenous vein grafts on control angiography.[7] Radial artery grafts were revived in 1980s when work by Acar and associates revealed in their study that radial artery grafts initially believed to be occluded, were found to be patent for the duration of 13–18 years after CABG. With refinements in the harvesting techniques and the use of arterial vasodilators, later studies revealed the 5-year graft patency rate of the RA was 84% compared with 90% for the Left Internal Thoracic Artery (LITA).[8]

Observational studies have suggested a link between using the radial artery and better early postoperative results.[9] Some of the important early post-op outcomes after CABG surgery are ICU stay duration, ventilation time, inotropic duration, hospital stay duration, chest drainage, rhythm complications including Supraventricular Tachycardia (SVT) and mortality.[9] An arterial graft (radial artery) is the second most important vessel of the lateral left ventricular myocardium has been recommended as a class I recommendation in the 2021 AHA/ACC guidelines.[10] Limited data is available on the surgical outcomes and risk factors connected to RA grafts in our population. The aim of this study was to compare the early post-op outcomes of Single versus Multiple Arterial Grafts in Coronary Artery Bypass Grafting.

METHODOLOGY

We conducted an Analytical Cross-sectional study at Adult Cardiac Surgery Unit, Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi Pakistan, from July2022 to May 2023. After receiving approval letter from Institutional Ethical Review Board (9/2/R&D/2023/284), the study was intiated. Non-probability consecutive sampling technique was used for patient selection to collect data.

A sample size of 135 was calculated by taking the prevalence of RA graft for CABG as 9.7%,[11] at 95% Confidence level and 5% margin of error using WHO sample size calculator. However, we collected data from one hundred and forty nine patients and divided them into two groups.

Inclusion criteria: All patients of both gender who underwent primary isolated CABG with two or more grafts.

Exclusion criteria: Re-operations, concomitant or previous cardiac surgery and the absence of arterial grafting.

Data was collected after taking written informed consent from patients who met the inclusion criteria. Patients were allocated into two groups, group A n=74 (Multiple Arterial CABG group) and group B n=75 (Conventional CABG group). Data was collected using a structured proforma which included patients' demographics, preoperative, intra-operative and post-operative characteristics. Data analysis was done using Statistical Package for Social Sciences (SPSS) version 23:00 Analysis of variables were presented in the form of frequencies, percentages, mean and standard deviation (SD). Chi-square test of independence and Independent samples t-test were used to make comparison between both groups. *p*-value ≤0.05 was considered as statically significant .

Surgical Technique

In the multi-arterial group, radial artery harvesting was initially performed via a full forearm incision. Adequacy of collateral ulnar circulation was assessed preoperatively via an Allen's test. Intraoperative pulse oximetry assessment was carried out, following occlusion of the radial artery, to correlate the preoperative assessment. The non-dominant hand was used when possible. Radial artery was not utilized in patients with equivocal/inadequate ulnar collateral flow, or more than mild calcifications or atherosclerotic plaque within the radial artery. A pedicle containing the RA and the accompanying vena cometanties was dissected using electro-cautery at a low setting, the muscular branches were identified and clipped.

Following extraction of the radial artery, the proximal end was cannulated and flushed gently dilated using hydrostatic pressure with warm 'graft solution' (100 cc of lactated Ringer's solution with 2 ml Papaverine, 5000 units of Heparin and 20ml of blood).

All CABG procedures were done on cardiopulmonary bypass. Aorto-coronary grafts were constructed exclusively. Sequential grafting of the radial artery was utilized where indicated. Distal arterial anastomosis was done using Prolene 8/0 continuous suture technique, whereas the proximal anastomosis was done using Prolene 7/0 suture, over a 3.5mm punch hole in the aorta.

Initially, all patients received intravenous Glyceryl Trinitrate (GTN) infusion in the perioperative period, which transitioned to oral Nifedipine postoperatively in the multi-arterial group, and was maintained for three to six months post-operatively.

All patients received Aspirin, Statins, Beta-blockers and ACE inhibitors post-operatively, unless these were contraindicated by allergies or clinical circumstances.

RESULTS

Out of one hundred and forty nine patients enrolled in the study; majority were males 124(83.2%) while 25(16.8%) were females. Mean age of the patients was 59.18±9.28 years. Mean BMI, weight, and height noted were 28.72±23.73 kg/m2, 74.95±14.80kg, 166.05 ±10.85cm respectively and the mean ejection fraction was 48.30±8.23%. While assessing medical history of patients, it came to light that 77(51.7%) were diabetic, 37(24.8%) were smokers. Seventy four (49.7%) patients underwent Multiple Arterial CABG (L+Rd+VG) while 75(50.3%) with conventional CABG (L+VG).

Table-I: Demographic and baseline characteristics of patients with Multiple Arterial CABG and Conventional CABG (n=149)

Variables		Frequency (%)
Demographics		
Gender	Male	124(83.2%)
	Female	25(16.8%)
Age (years)	(Mean±SD)	59.18±9.28
Weight (kg)	(Mean±SD)	74.95±14.80
Height (cm)	(Mean±SD)	166.05±10.85
BMI (kg/m²)	(Mean±SD)	28.72±23.73
Co-morbids		
Smoking Status	Ex-Smoker >8 Weeks	31(20.8%)
	No Smoking	112(75.2%)
	Still Smoking (<8 Weeks)	6(4.0%)
Diabetes Mellitus	Yes	77(51.7%)
	No	72(48.3%)
Symptoms		
Angina Duration	<1 week	6(4.0%)
	1-6 weeks	47(31.5%)
	7-12 weeks	17(11.4%)
	3-6 months	9(6.0%)
	7-12 months	3(2.0%)
	1-5 years	4(2.7%)
	6-10 years	1(0.7%)
	Asymptomatic	62(41.6%)
Pre-operative variables		
Ejection Fraction (%) Mean ± SD		48.30±8.23
Left Main Stem Disease	≤50%	8(5.4%)
	51-70%	13(8.7%)
	>70%	24(16.1%)
	Nil	104(69.8%)
Extent of Significant CAD	SVCAD	5(3.4%)
	DVCAD	25(16.8%)
	TVCAD	114(76.5%)
	Nil	5(3.4%)
Intra-operative variables		
Procedure	CABG (Elective)	122(81.8%)
	CABG (Arterial)	27(18.1%)
Type of Grafts	Multiple Arterial CABG (L+Rd+VG)	74(49.7%)
	Conventional CABG (L+VG)	75(50.3%)
No. of grafts	1	4(2.7%)
	2	29(19.5%)
	3	68(45.6%)
	4	45 (30.2%)
	5	3(2.0%)
CPB Time (mins) Mean±SD		133.11±34.96
CX Time (mins) Mean±SD		83.83±22.50
Post-operative variables		
IABP Support	Nil	140(94.0%)
	Pre-Op	3(2.0%)
	Per-Op	4(2.7%)
	Post-Op	2(1.3%)
Inotropic Support	Mild	109(73.2%)
	Moderate	26(17.4%)
	Nil	14(9.4%)
Normal Rhythm	No	131(87.9%)
	Yes	18(12.1%)
Ventilation time (hours)	(Mean±SD)	10.78±25.36
Inotropic duration (hours)	(Mean±SD)	57.14±54.76
Chest drainage (ml)	(Mean±SD)	735.61± 678.09
CKMB (ng/ml)	(Mean±SD)	72.23±38.27
Number of RBCs perfused	(Mean±SD)	1.95±1.16
Days in Hospital (days)	(Mean±SD)	7.40±5.12
Complications		
SVT	No	133(89.3%)
	Yes	16(10.7%)
VPC	No	145(97.3%)
	Yes	4(2.7%)
Re-exploration		11(7.4%)
Outcomes		
Outcome	Alive	143(96.0%)
	Dead	6(4.0%)

**BMI=Body Mass Index; CAD=Coronary Artery Disease; SVCAD=Single Vessel Coronary Artery Disease; DVCAD=Double Vessel Coronary Artery Disease; TVCAD=Triple Vessel Coronary Artery Disease; CABG=Coronary Artery Bypass Graft; L+Rd+VG=Lima+Radial+Vein Graft; CPB=Cardiopulmonary Bypass; CX= Crossclamp Time; IABP=Intra-Aortic Balloon Pump; SVT=SupraVentricular Tachycardia; VPC=Ventricular Premature Contraction; CKMB=Creatine Kinase Myocardial Band; RBCs=Red Blood Cells*

Mean CPB time was 133.11±34.96 mins and mean CX time was 83.83±22.50 mins. Mean ventilation time was 10.78±25.36 hours and the mean inotropic duration was 57.14±54.76 hours and mean ICU stay duration of study participants was 62.07±62.33 hours. Detailed descriptive statistics of study sample are presented in Table-I.

Figure illustrates post-operative outcomes i.e., ICU stay, ventilation time, inotropic duration and Chest drainage in between Multiple Arterial CABG group and conventional CABG group.

Table-II depicted that 74(49.7%) patients underwent Multiple Arterial CABG while 75(50.3%) had conventional CABG. Mean Cardiopulmonary Bypass(CPB) time was higher in Group A as compared to Group B (135.80±31.33 mins vs 130.47±38.24 mins) respectively.

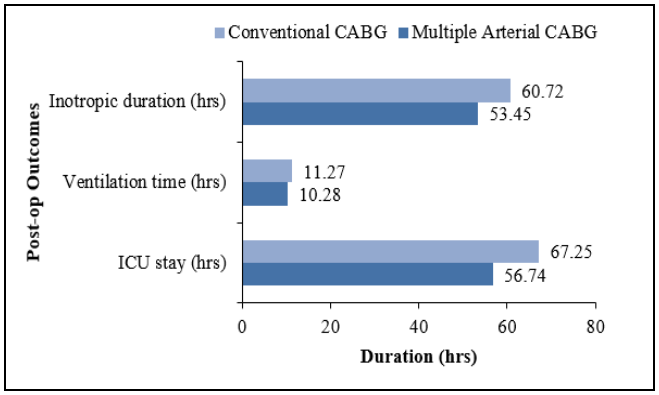

Figure: Early post-operative outcomes (n=149)

Mean Cross-clamp time(CX) was higher in Group A than Group B (83.99±19.23 min vs 83.68±25.45 min) respectively. ICU stay duration was lower in Group A than Group B (56.74±48.30 hours vs 67.25±73.42 hours; p=0.30) respectively. Mean Chest Drainage was lower in Group A as compared to Group B (622.05±505.69 ml vs 846.13±799.67 ml; *p*=0.04) respectively. Mean Hospital stay was 6.49±2.13 days in Multiple Arterial CABG group while it was 8.22±6.67 days in Conventional CABG group; *p*=0.03. CPB time, CX time, ICU stay, Ventilation time and inotropic duration did not show significant differences when compared between both groups (*p*>0.05).

Table-II: Association of Demographic and Pre/Intra/Post-Operative variables with Type of grafts used (n=149)

VARIABLES		Multiple Arterial CABG Group (L+Rd+VG) (n=74) Frequency (%)	Conventional CABG Group (L+VG) (n=75) Frequency (%)	*p*-value
Demographics				
Gender	Male	59(79.7%)	65(86.7%)	0.36
	Female	15(20.3%)	10(13.3%)	
Age (years) (Mean±SD)		57.51±8.47	60.82±9.79	0.03
Weight (kg) (Mean±SD)		74.59±13.46	75.30±16.11	0.77
Height (cm) (Mean±SD)		166.62±7.81	165.49±13.22	0.52
BMI (kg/m2) (Mean±SD)		26.91±4.72	30.50±33.13	0.35
Co-morbids				
Smoking status	Ex-Smoker > 8 weeks	11(14.9%)	20 (26.7%)	0.19
	No smoking	60(81.1%)	52 (69.3%)	
	Still smoking (<8 weeks)	3(4.1%)	3(4%)	
Diabetes Mellitus		37(50.0%)	40(53.3%)	0.81
	No	37(50.0%)	35 (46.7%)	
Symptoms				
Angina Duration	<1 week	4(5.4%)	2(2.7%)	0.01
	1-6 weeks	33(44.6%)	14(18.7%)	
	7-12 weeks	5(6.8%)	12(16.0%)	
	3-6 months	5(6.8%)	4(5.3%)	
	7-12 months	1(1.4%)	2(2.7%)	
	1-5 years	1(1.4%)	3(4.0%)	
	6-10 years	0(0.0%)	1(1.3%)	
	Asymptomatic	25(33.8%)	37(49.3%)	
Pre-Operative Variables				
Ejection Fraction (%) (Mean±SD)		48.96±8.16	47.64±8.30	0.33
Left Main Stem Disease	≤50%	4(5.4%)	4(5.3%)	0.36
	51-70%	7(9.5%)	6(8.0%)	
	>70%	8(10.8%)	16(21.3%)	
	Nil	55(74.3%)	49(65.3%)	
Extent of Significant CAD	SVCAD	0(0.0%)	5(6.7%)	0.08
	DVCAD	12(16.2%)	13(17.3%)	
	TVCAD	58(78.4%)	56(74.7%)	
	Nil	4(5.4%)	1(1.3%)	
Intra-Operative Variables				
Procedure	CABG (Elective)	47 (63.5%)	75 (100.0%)	<0.001
	CABG (Arterial)	27 (36.5%)	0 (0.0%)	
CPB Time (mins) (Mean±SD)		135.80 ± 31.33	130.47 ± 38.24	0.35
CX Time (mins) (Mean±SD)		83.99 ± 19.23	83.68 ± 25.45	0.93

Post-Operative Variables				
IABP support	Nil	70(94.6%)	70 (93.3%)	1.00
	Pre-op	1(1.4%)	2 (2.7%)	
	Per-op	2(2.7%)	2 (2.7%)	
	Post-op	1(1.4%)	1 (1.3%)	
Inotropic support	Mild	58(78.4%)	51 (68.0%)	0.35
	Moderate	10(13.5%)	16 (21.3%)	
	Nil	6(8.1%)	8 (10.7%)	
ICU Stay (hours) (Mean±SD)		56.74 ± 48.30	67.25±73.42	0.30
Ventilation Time (hours) (Mean±SD)		10.28 ± 19.88	11.27±29.88	0.81
Inotropes duration (hours) (Mean±SD)		53.45 ± 46.20	60.72±62.08	0.42
Chest Drainage (ml) (Mean±SD)		622.05 ± 505.69	846.13±799.67	0.04
No. of RBCs transfused (Mean±SD)		1.85 ± 1.16	2.04±1.16	0.43
CKMB (ng/ml) (Mean±SD)		69.89 ± 34.94	74.51±41.36	0.47
Hospital Stay duration (days) (Mean±SD)		6.49±2.13	8.22±6.67	0.03
Rhythm	No	67(90.5%)	64(85.3%)	0.46
	Yes	7(9.5%)	11(14.7%)	
Complications				
SVT	No	66(89.2%)	67(89.3%)	1.00
	Yes	8(10.8%)	8(10.7%)	
VPC	No	74(100.0%)	71(94.7%)	0.13
	Yes	0(0.0%)	4(5.3%)	
Re-Exploration		7 (9.5%)	4(5.3%)	0.52
Outcomes				
Outcome	Alive	70(94.6%)	73(97.3%)	0.66
	Dead	4(5.4%)	2(2.7%)	

**BMI=Body Mass Index; CAD=Coronary Artery Disease; SVCAD=Single Vessel Coronary Artery Disease; DVCAD=Double Vessel Coronary Artery Disease; TVCAD=Triple Vessel Coronary Artery Disease; CABG=Coronary Artery Bypass Graft; L+Rd+VG=LIMA+Radial+Vein Graft; CPB=Cardiopulmonary Bypass; CX=Cross-clamp Time; IABP=Intra-Aortic Balloon Pump; SVT=Supra-Ventricular Tachycardia; VPC=Ventricular Premature Contraction; CKMB=Creatine Kinase Myocardial Band; RBCs=Red Blood Cells*

Table-III: Comparison of Mean Difference of CPB/CX time Between Study Groups with Respect to number of Grafts Implanted (n=149)

No. of Grafts	Type of grafts (Frequency)	CPB Time (Mean±SD)	*p*-value	CX Time (Mean±SD)	*p*-value
1	Multiple Arterial CABG (0)	-	-	-	-
	Conventional CABG (4)	58.00±10.89		39.00±8.12	
2	Multiple Arterial CABG (16)	100.93±16.69	0.68	63.06±14.62	0.66
	Conventional CABG (13)	97.15±31.64		60.53±16.32	
3	Multiple Arterial CABG (35)	134.82±19.69	0.06	84.48±13.27	0.11
	Conventional CABG (30)	125.13±20.79		78.83±15.48	
4	Multiple Arterial CABG (21)	161.42±31.09	0.98	97.09±17.73	0.09
	Conventional CABG (27)	161.22±26.84		105.70±17.44	
5	Multiple Arterial CABG (2)	162.50±16.26	0.49	105.00±2.82	0.23
	Conventional CABG (1)	183.0±0		114.00 ± 0	

Table-III compared number of grafts in each group with CPB and CX time and it didn't show any significant mean difference (p>0.05).

Table-IV compared number of grafts in each group with Chest drainage and it didn't show any significant mean difference (p>0.05).

DISCUSSION

Long-term conduit patency after CABG is the primary determinant of a procedure's success.[12-14] The results of the current study showed that using RA as a conduit in CABG resulted in generally positive outcomes.

Adoption of a new technique in surgery is a gradual process, and is met with initial skepticism, concerns about safety, needs appropriate resource allocation alongside addressing legal and ethical issues and has a steady learning curve. In current study, the early post-op outcomes of patients undergoing CABG with multi arterial grafting were compared with conventional CABG surgery outcomes in an effort to logically address these concerns.[15]

Table-IV: Comparison of Mean Differences of Chest Drainage between study Groups and Number of Grafts Used (n=149)

No. of Grafts	Type of Grafts (Frequency)	Chest Drainage (Mean±SD)	*p*-value
1	Multiple Arterial CABG (0)	-	-
	Conventional CABG (4)	230.00±110.45	
2	Multiple Arterial CABG (15)	560.00±271.21	0.38
	Conventional CABG (13)	800.30±938.29	
3	Multiple Arterial CABG (35)	618.00±615.58	0.19
	Conventional CABG (30)	871.20±931.14	
4	Multiple Arterial CABG (21)	700.47±453.00	0.17
	Conventional CABG (27)	922.96±613.87	
5	Multiple Arterial CABG (2)	335.00±205.06	0.21
	Conventional CABG (1)	1080.00±0	

Although the patients undergoing CABG with multi arterial grafting were slightly younger than the conventional CABG group (mean age 57.51±8.47 years vs 60.82±9.79 years) (p<0.03), the mean duration of hospital stay was 6.49±2.13 days in patients with Multiple Arterial CABG and it was significantly shorter than Conventional CABG group (8.22±6.67 days; p=0.03). Our findings were similar with the previous studies which demonstrated mean length of hospital stay as 8.10±2.37 days in conventional CABG group and higher age as a significant predictor of prolonged hospital stay (p<0.05).[6,16-19]

A study by Parasca,C. A *et al*, found mean aortic cross-clamp time and CPB time to be higher in arterial group when compared with venous group (62.3±24.6mins, 92.7±31.7mins vs 55.9±35.7, 87.8±35.9) respectively due to technically demanding anastomosis with arterial grafts.[20] Our study presented comparable results with mean aortic cross-clamp time and CPB time to be slightly higher in Multiple arterial CABG group than Conventional CABG group (83.99 ± 19.23mins, 135.80±31.33mins vs 83.68±25.45mins, 130.47±38.24mins) however the difference was not statistically significant (p>0.05).

Blood transfusion after cardiac surgery is associated with increase in morbidity and length of hospital stay after CABG surgery.[19-22] Bleeding after CABG surgery can originate from multiple sources. The cardiac causes include; bleeding from cannulation sites, bleeding from proximal or distal anastomoses or bleeding from the bypass conduit itself. The non-cardiac causes involve; bleeding of the sternotomy, bleeding of the IMA-bed or bleeding into the subcutaneous tissue after SV harvesting. Radial artery pedicle contains multiple small muscular branches and has accompanying veins which are meticulously clipped at harvest.[23]

In present study, the amount of postoperative bleeding was significantly less in the multi-arterial group when compared with the conventional group (p=0.43), although the number of blood transfusions were also less in the multiarterial group and this was not statistically significant. Our findings are similar to the work of Werner, *et al*.,[22] who reported transfusion in 12.2% of all patients undergoing total arterial CABG, whereas in mixed CABG cases a significantly higher incidence of transfusions transfusion was noted (30.1%, p<0.001).

Moreover, the ventilation time, ionotropic duration, ICU stay were lesser in the multi-arterial group when compared to the conventional group. (10.28±19.88 hours; 53.45±46.20 hours; 56.74±48.30 hours vs 11.27±29.88 hours; 60.72±62.08 hours; 67.25±73.42 hours), However, they did not show statistical significance (p>0.05).

Zhang *et al.* study published in 2021, evaluated that In-hospital death was not significantly differing among study groups (MABG 1.6% vs single arterial CABG 2.2%, p= 0.78)[11] which was inconsistent to current studys' results MABG 4(5.4%) vs single arterial CABG 2(2.7%). however, the result was also not significant(p=0.66).

LIMITATIONS OF STUDY

There were few limitations in our study including; it was a single-centered study, conducted on a small sample size. Only In-hospital outcomes were under consideration, long-term outcomes have not been studied.

CONCLUSION

The use of the Radial Artery (RA) in CABG surgery is associated with better early clinical outcomes and minimal complications when compared to conventional CABG. RA is time-tested robust graft and it should be used more frequently in CABG surgery.

ACKNOWLEGDEMENT

I am deeply grateful to the R&D department for their utmost support in assisting my research project.

Conflict of Interest: None

Authors' Contribution

Following authors have made substantial contributions to the manuscript:

IAC & NA: Study design, Drafting the manuscript, Data interpretation, Critical review, Approval of the final version to be published.

SA & IB: Manuscript writing, Data analysis, Proof reading, Critical review

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. Dimagli A, Soletti Jr G, Harik L, Perezgrovas Olaria R, Cancelli G, An KR, et al., Angiographic Outcomes for Arterial and Venous Conduits Used in CABG. Journal of Clinical Medicine. 2023 Mar 3;12(5):2022. doi:10.3390/jcm12052022
2. Melly L, Torregrossa G, Lee T, Jansens JL, Puskas JD. Fifty years of coronary artery bypass grafting. Journal of thoracic disease. 2018 Mar;10(3):1960. doi: 10.21037/jtd.2018.02.43
3. 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. doi:10.1016/j.jacbts.2020.11.015
4. Cao C, Manganas C, Horton M, Bannon P, Munkholm-Larsen S, Ang SC, et al., Angiographic outcomes of radial artery versus saphenous vein in coronary artery bypass graft surgery: a metaanalysis of randomized controlled trials. J Thoracic Cardiovascul Surg 2013; 146(2): 255-261. doi:10.1016/j.jtcvs.2012.07.014
5. 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. Seminars Thoracic Cardiovascular Surg 2017; 29(3): 273-280 doi:10.1053/j.semtcvs.2017.05.018
6. Martins RS, Masood L, Kazi M, Gillani M, Sadiq A, Inam H, et al., Radial artery coronary bypass grafting: Surgical outcomes of an unexplored innovation in a developing country. J Pak Med Associa 2022; 72(2): S106.
7. Carpentier A, Guermonprez MD, Deloche A. The aorta to coronary radial artery bypass graft. A technique avoiding pathological changes in the graft. Annals Thoracic Surg 1973; 16(2): 1-5.
8. Schwann TA, Habib RH, Wallace A, Shahian DM, O'Brien S, Jacobs JP, et al., Operative outcomes of multiple-arterial versus single-arterial coronary bypass grafting. Annals Thoracic Surg 2018; 105(4): 1109-1119. doi:10.1016/j.athoracsur.2017.10.058
9. 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. InSeminars Thoracic Cardiovascular Surg 2017; 29(3): 273-280). WB Saunders. doi:10.1053/j.semtcvs.2017.05.018
10. Chan J, Dimagli A, Dong T, Fudulu DP, Sinha S, Angelini GD. Trend and factors associated with multiple arterial revascularization in coronary artery bypass grafting in the UK. European J Cardio-Thoracic Surg 2022; 62(2): ezac284. doi:10.1093/ejcts/ezac284
11. Zhang H, Chen W, Zhao Y, Guan L, Yu M, Wang R, et al., Multiple arterial conduits for multi-vessel coronary artery bypass grafting in patients with mild to moderate left ventricular systolic dysfunction: a multicenter retrospective study. J Cardio Surg 2021; 16(1): 1-0. doi: 10.21203/rs.3.rs-49935/v1
12. Favaloro RG. Saphenous vein autograft replacement of severe segmental coronary artery occlusion: operative technique. Annals Thoracic Surg 1968; 5(4): 334-339. doi:10.1016/S0003-4975(10)66351-5
13. Gaudino M, Benedetto U, Fremes S, Ballman K, Biondi-Zoccai G, Sedrakyan A, et al., Association of radial artery graft vs saphenous vein graft with long-term cardiovascular outcomes among patients undergoing coronary artery bypass grafting: a systematic review and meta-analysis. Jama 2020; 324(2): 179-187. doi:10.1001/jama.2020.8228
14. Gaudino M, Rahouma M, Abouarab A, Leonard J, Kamel M, Di Franco A, et al., Radial artery versus saphenous vein as the second conduit for coronary artery bypass surgery: a meta-analysis. The Journal of thoracic and cardiovascular surgery. 2019; 157(5): 1819-1825. doi:10.1016/j.jtcvs.2018.08.123
15. Gaudino M, Audisio K, Di Franco A, Alexander JH, Kurlansky P, Boening A, et al., Radial artery versus saphenous vein versus right internal thoracic artery for coronary artery bypass grafting. European J Cardio-Thoracic Surg 2022; 62(1): ezac345. doi:10.1093/ejcts/ezac345
16. Jannati M, Navaei MR, Ronizi LG. A comparative review of the outcomes of using arterial versus venous conduits in coronary artery bypass graft (CABG). J Family Med Pri Care 2019; 8(9): 2768. doi: 10.4103/jfmpc.jfmpc_367_19
17. Zhu P, Chen A, Wang Z, Ye X, Zhou M, Liu J, et al.,. Long-term outcomes of multiple and single arterial off-pump coronary artery bypass grafting. J Thoracic Disease 2019; 11(3): 909. doi: 10.21037/jtd.2019.01.101
18. Curtis JJ, Stoney WS, Alford WC Jr, Burrus GR, Thomas CS Jr. Intimal hyperplasia: A cause of radial artery aortocoronary bypass graft failure. Ann Thorac Surg 1975; 20(1): 628– 635.
19. Acar C, Jebara VA, Portoghese M, Beyssen B, Pagny JY, Grare P, et al. Revival of the radial artery for coronary artery bypass grafting. Annals Thoracic Surg 1992; 54(4): 652-660. doi:10.1016/0003-4975(92)91007-V
20. Parasca CA, Head SJ, Mohr FW, Mack MJ, Morice MC, Holmes Jr DR, et al., The impact of a second arterial graft on 5-year outcomes after coronary artery bypass grafting in the Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery Trial and Registry. J Thoracic Cardiovascular Surg 2015; 150(3): 597-606. doi: 10.1016/j.jtcvs.2015.05.010
21. Crawford TC, Magruder JT. Less Is More: Results of a Statewide Analysis of the Impact of Blood Transfusion on Coronary Artery Bypass Grafting Outcomes. Ann Thorac Surg 2017, Available at: doi:10.1016/0003-4975(92)91007-V
22. Werner RS, Lipps C, Waldhans S, Künzli A. Blood consumption in total arterial coronary artery bypass grafting. J Cardiothorac Surg 2020; 15(1): 23-28. doi: 10.1186/s13019-020-1053-1. PMID: 31952527; PMCID: PMC6969432.)
23. Goldstone AB, Chiu P, Baiocchi M, Wang H, Lingala B, Boyd JH, et al., Second arterial versus venous conduits for multivessel coronary artery bypass surgery in California. Circulation. 2018; 137(16): 1698-707. doi: 10.1161/Circulationaha.117.030959