Saphenous Vein Graft Patency When Anastomosed to Distal Right Coronary Artery versus Right Posterior Descending Artery: A Comparative Study

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ABSTRACT
Background: The failure of the saphenous vein graft (SVG) is a critical flaw in coronary artery bypass grafting (CABG) that has been associated with bad cardiac outcomes such as the necessity to repeat coronary revascularization, recurrent angina, myocardial infarction, and mortality. **Objective:** To compare mid-term patency of saphenous vein graft used for revascularization of the RCA when anastomosed to Distal Right Coronary Artery (DRCA) versus Right Posterior Descending Artery (RPDA) in proximal RCA lesion in patients who underwent isolated CABG.
Patients and method: 80 patients who underwent isolated CABG with saphenous vein graft utilized for revascularization of RCA with proximal lesions were enrolled. Patients had been randomly allocated into 2 groups depending on the site of RCA anastomosis. In Group A (n=40), SVG was anastomosed to DRCA, while in Group B (n=40) SVG was anastomosed to RPDA. The postoperative multislice coronary angiography (MSCT) was used for evaluation of patency of the SVGs, and the presence of graft occlusion through mid-term follow ups. **Results:** 30 of the 80 SVGs used for RCA revascularization were found to be occluded, whereas the remaining 50 were determined to be patent. Group A had a significantly greater mean age than Group B (p<0.05); nevertheless, no statistically significant difference between the study groups was detected in terms of cardiovascular disease risk factors (p>0.05). Group A had similar patency rates (50% patent and 50% occluded), while group B had much greater patency rates (75% patent and 25% occluded, p =0.001). Moreover, the target vessel's mean diameter was substantially greater in group A (p-value=0.001).
Conclusion: The findings corroborate the hypothesis that SVG anastomosed to RPDA are more patent than those anastomosed to DRCA.
Keywords: Bypass grafting, Coronary artery disease, Graft occlusion, Shear strength.

INTRODUCTION

Coronary artery bypass grafting (CABG) still the optimal cure for revascularization of complex multivessel coronary artery disease (CAD) and has shown long-term survival advantages [1]. This is done by by-passing the stenosed segment of the coronary artery with an arterial or venous conduit, reestablishing the blood flow to the distal ischemic myocardial region [2].

CABG's vital inadequacy is failure of saphenous vein graft (SVG), which is linked to negative cardiac outcomes like the necessity for coronary revascularization repeatedly, recurrent angina, myocardial infarction, and mortality [3].

One of the most critical aspects in gaining advantage for CABG patients is graft patency. In order to achieve complete revascularization, both venous and arterial conduits are employed combined. Arterial grafts are more usually employed on the left side of the coronary system, while on the right coronary system, the venous grafts are employed. Because atherothrombosis progresses more quickly in venous conduits than in arterial ones, grafts anastomosed to the RCA have lower long-term patency rates [2,4]. The quality of the anastomosis accomplished, the quality of the target vasculature, the distal run-off as well as the ongoing atherosclerotic process are all key factors in the graft's early and long-term patency [5].

It was mentioned that, usage of an Internal Thoracic Artery (ITA) graft was proved to improve prognosis, with patency rates of 85 to 91 percent at ten years. In contrast, SVG failure rates at 12 months after surgery were reported to range between 10% and 25% [3]. From 1 to 5 years, an additional 5 to 10 % of SVGs will occlude, and from six to ten years, an additional 20 to 25 % will fail, implying that SVG patency rates at ten years are around 50 %, with only 50% of these veins are atherosclerosis-free [3,6].

The most commonly and widely used anastomotic strategy to RCA during CABG is done by using SVG where single distal anastomosis is done to any part of RCA or RPDA while proximal anastomosis is done to the ascending aorta. On the other hand, Sequential and composite grafting uses many distal anastomoses for each proximal anastomosis is rarely used for revascularizing the RCA [2,7].

There is no doubt that the SVG is a great conduit for surgeons because it is usually available at the desired length, is easily harvested without being time-consuming, supplies a limitless blood flow to the myocardium, and is associated with less risk of sternal wound infection when only one ITA is harvested [8].

The pathophysiologic mechanisms underlying SVG failure are related to the time interval after surgery: (1) Acute graft thrombosis is the main cause

of acute SVG failure during the first month but may also occur later in atherosclerotic areas; (2) focal neointimal hyperplasia at anastomotic sites, in addition to thrombosis, is the underlying cause for early SVG failure occurring between 1 month and 2 years after surgery; and (3) atherosclerotic degeneration, in addition to generalized neointimal hyperplasia, is responsible for late SVG failure occurring more than 2 years after surgery [8].

Choosing a good anastomotic site is crucial during surgical revascularization of the right coronary artery (RCA) system. In many instances of distal and/or sequential main trunk disease, either the right posterior descending coronary artery (RPDA) or distal part of the right main coronary artery (DRCA) is preferred as the target vessel [9].

This study aimed at investigating the patency of saphenous vein graft when used for revascularization of the right coronary artery (RCA) when anastomosed to DRCA versus RPDA in proximal RCA lesion in patients who underwent isolated CABG.

PATIENTS AND METHOD

This is a prospective randomized controlled study in which 80 patients who underwent isolated CABG surgery from May 2019 to May 2020 whom their preoperative (pre-op) coronary angiography showed proximal RCA lesion only beside other lesions in the left system where the saphenous vein was used to re-vascularize RCA either to DRCA or RPDA were enrolled. The mean length of follow-up time was 16.7 ± 4.3 months (from 13 to 24 months).

Right posterior descending artery (PDA) was found to originate from the RCA in all of the patients, and the greater saphenous vein was utilized as an RCA graft in all of them. The diameter of both DRCA and RPDA was measured during the pre-op coronary angiography and confirmed intraoperatively by measuring the diameter of DRCA or RPDA using vascular probes of different sizes (1, 1.5, 2 mm).

The postoperative multislice computed tomography coronary angiography (MSCT-CA) was used for evaluation of the patency of the SVGs, and the presence of graft occlusion through mid-term follow ups. The mean time elapsed between CABG and MSCT-CA was from 13 to 24 months. In addition, intra-aortic balloon pump (IABP), ejection fraction (EF), and the requirement for inotrope in the postoperative (post-op) time, diameter of the target vessel, hospital discharge time, site of distal anastomosis and endarterectomy requirement were all assessed. Throughout the data collection time, a link was discovered between the patency of right coronary bypass grafts and the location of RCA distal anastomoses. Hence, the patients were divided into two groups depending on the site of RCA distal anastomoses, each of 40 patients. In Group A (n=40), the saphenous vein graft was anastomosed to the distal part of RCA, while in Group B (n=40), the saphenous vein graft was anastomosed to the right posterior descending artery, aiming at investigating if the site of the anastomosis to the RCA was a factor affecting the midterm patency of RCA bypass grafts.

Analysis of MSCT-CA:

Multi-Slice Computed Tomography Coronary Angiography (MSCT-CA) is a minimally invasive, 3D imaging modality and clinically reliable diagnostic tool to detect significant (luminal diameter > 50% stenosis in the native coronaries as well as venous and arterial grafts.

The post-op MSCT-CA data was evaluated by two readers separately. The previous surgical procedure with graft distribution were disclosed to the readers. A final decision was reached during a combined reading in cases of disagreement. The saphenous venous graft to the RCA was assessed and recorded as totally occluded, significantly stenosed (50 to 99 % luminal narrowing), or not significantly stenosed.

Ethical consent:

An approval of the study was obtained from National Heart Institute Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation and participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (χ^2) was used to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). The results were analyzed using a 95% confidence interval. P value < 0.05 was considered significant.

RESULTS

As shown in table (1), participants were divided into two groups in terms of the site of anastomosis (DRCA or RPDA). 40 patients were included in group A (DRCA), and other 40 were enrolled into group B (RPDA).

Group A showed a statistically significant higher mean age than group B, whereas non-significant differences were found between the two groups regarding sex, BMI, hypertension, metabolic disorders, hyperlipidemia, current smoking, diabetes mellitus, intervention with statin, IABP requirement, inotrope requirement after the operation, EF, endarterectomy, follow-up time, and hospital discharge time.

Table (1): Patients' demographics and clinic information based on the site of their bypass anastomosis

Item		Group A Distal Right Coronary Artery (DRCA) n = 40	Group B Right Posterior Descending Artery (RPDA) n = 40	P-value
Sex	**Female**	11 (27.5%)	9 (22.5%)	0.719
	Male	29 (72.5%)	31 (77.5%)	
Age (years)		65.86 ± 8.64	59.89 ± 7.57	0.037
BMI (kg/m²)		29.02 ± 2.36	28.74 ± 1.85	0.802
Medical history				
Family history of coronary disease		17 (42.5%)	19 (47.5%)	0.289
Hypertension		26 (65%)	27 (67.5%)	0.647
Metabolic disorder		9 (22.5%)	12 (30%)	0.848
Hyperlipidemia		33 (82.5%)	29 (72.5%)	0.237
Current smoking		20 (50%)	15 (37.5%)	0.216
Diabetes mellitus		12 (30%)	10 (25%)	0.548
Intervention with statin		28 (70%)	25 (62.5%)	0.416
Intra-aortic balloon pump (IABP) requirement		5 (12.5%)	4 (10.0%)	0.387
Inotrope requirement		6 (15%)	5 (12.5%)	0.639
EF%		52.35 ± 7.85	53.42 ± 8.23	0.476
Endarterectomy		1 (2.5%)	0 (0.0%)	0.224
Follow-up time/months		16.89 ± 12.83	15.24 ±3.52	0.070
Hospital discharge time/days		9.35 ±12.64	8.89±3.67	0.072

In table (2) and figure (1), Group A showed a significant greater number of patients who had greater artery diameter. In group A, the rates of graft patency were found to be comparable, while in group B, patency rates were significantly greater.

Table (2): Comparison of native coronary artery characteristics and graft patency based on the bypass anastomoses site

| Item		Group A n = 40	Group B n = 40	P-value
Diameter of vessel	**1 mm**	0 (0.00%)	10 (25%)	0.001
	1.5 mm	7 (17.5%)	30 (75%)	
	2 mm	33 (82.5%)	0 (0.00%)	
Graft patency	**Occluded**	20 (50%)	10 (25%)	0.001
	Patent	20 (50%)	30 (75%)	
Endarterectomy		1 (2.5%)	0 (0.00%)	0.224
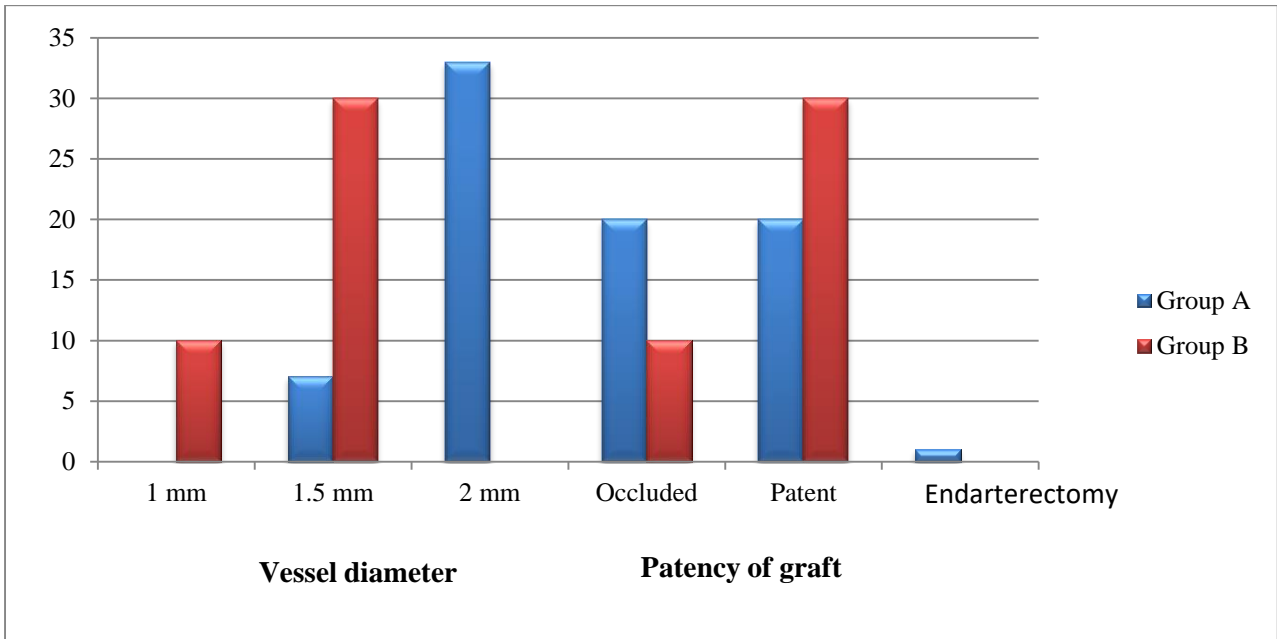
Figure (1): Comparison of native coronary artery characteristics and graft patency based on the bypass anastomoses site

The distribution of MSCT-CA findings among the different venous grafts included in this study are shown in table (3) and figure (2). Group B showed a significantly higher patency rate than group A.

Table 3: MSCT-CA findings of venous grafts

Group	Group A n = 40	Group B n = 40	P-value
Patent	20 (50.0%)	30 (75%)	0.001
Significant stenosis (≥50)	5 (12.5%)	0 (0.0%)	
Occlusion	15 (37.5%)	10 (25%)	0.001
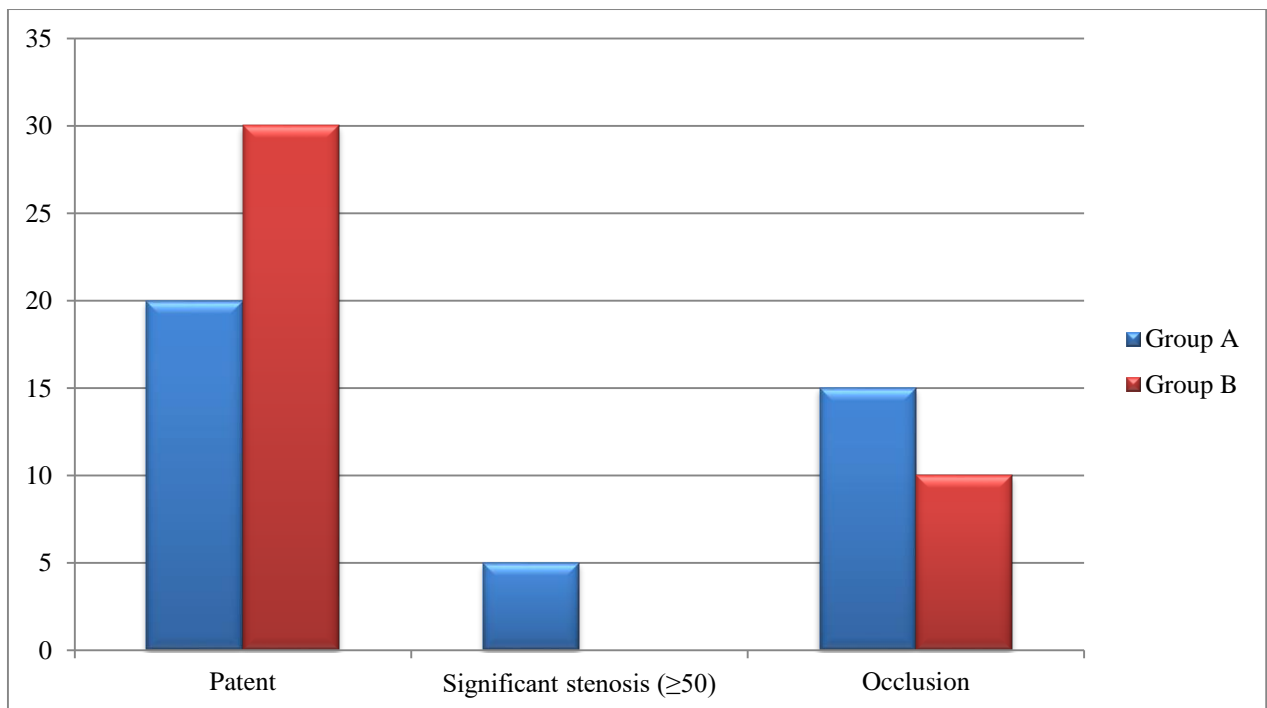
Figure (2): MSCT-CA findings of venous grafts

DISCUSSION

The main goals of CABG surgery are to improve quality of life and prevent problems that may arise throughout the chronic course of CAD [10]. Grafts occlusion is one of the most serious issues among the CABG surgery [11]. Over the last two decades, graft occlusion has gotten a lot of attention, especially in patients who are about to have CABG with SVGs [12].

This study showed that age is considered a risk factor that might be concerned with the graft occlusion mechanism, death risk and morbidity following CABG operation. The mean age of patients in group A was significantly higher than patients in group B in patients who underwent CABG, and hence, it affected the patency rates in the 2 groups. This was in line with **Gaudino et al.** [13] and **Kusu-Orkar et al.** [14] who stated that age is one of the preoperative factors that is strongly correlated to mortality and morbidity rates post CABG.

There are further risk issues that are believed to be implicated in the occlusion mechanism of the graft as well as the risk of death and morbidity following CABG surgery included sex, BMI, family history of coronary artery diseases, hypertension, metabolic disorder, hyperlipidemia, smoking, diabetes mellitus, intervention with statin, IABP requirement, Inotrope requirement, EF, endarterectomy, and timing of hospital release are all factors to consider. None of these variables were significantly different across groups, and their impacts on the patency of graft were non-significant.

Although hyperlipidemia was found in 82.5% of participants in group A and 72.5% of cases in group B, there was no significant difference between the study groups, in addition there were no significant difference in statin use between the two groups, hyperlipidemia, intervention with statin, and patency of graft have been linked where most of the patients with occluded grafts had hyperlipidemia and were taking statins. Despite the fact that hyperlipidemia is a known factor in graft atherosclerosis [15,16], the influence of hyperlipidemia on patency of grafts could not be confirmed within this study. These results were in agreement with the study by **Aksut et al.** [17] in Turkey who found that 79.5% of patients with SVG anastomosed to DRCA and 68.8% of patients with SVG anastomosed to RPDA had hyperlipidemia, and with non-significant difference between the two groups, and also non-significant difference was detected among those groups in terms of statin usage as antihyperlipidemic drug.

Although the presence of hypertension, diabetes mellitus, and female gender in the present study are also factors that impact mortality and morbidity [18,19], there were no significant differences in these parameters between the occluded and patent groups, and their possible impacts on graft patency

could not be confirmed. These results were in agreement with **Aksut et al.** [17].

The target coronary artery's diameter and flow run-off have long been known to affect graft patency [20]. In the present study, group A, whom SVG was anastomosed to DRCA showed a significantly greater vessel diameter average than group B, whom SVG was anastomosed to RPDA, showing a greater patency rate among group B (75%) than group A (50%). Group A included all patients with 2 mm target vascular diameter; only 50% were patent, while 50% of these grafts were occluded. Out of the 80 patients enrolled in this study, 37 patients had 1.5 mm target vessel diameter and group A included 7 of those patients, whereas, group B included 30 patient. The 33 patients whom vessels diameter was 2 mm were found in group A.

These findings were in line with the **Aksut et al.** [17] who found that the average target vessel diameter in group of patients with SVG anastomosed to DRCA was considerably greater than those with anastomosis to RPDA. All cases with a target vascular diameter of (1 mm) were in group B where 75% of those grafts were patent while 25% were occluded.

When comparing SVGs patency anastomosed distally to the DRCA to those anastomosed to RPDA, the present study found that those anastomosed to RPDA had higher long-term patency rates. Patency rate of graft in group A is comparable to that of occluded graft (fifty percent were patent and fifty percent were occluded), while patent grafts rate was significantly greater in group B (patent 75%, and occluded 25%). Similar findings were shown by the study of **Aksut et al.** [17]. The result of this study contradicts what was stated in previous studies that patients with a target coronary artery diameter greater than 2 mm had higher long-term patency rate of saphenous venous conduits, compared to other patients with a target coronary artery diameter smaller than 2 mm [21].

CONCLUSION

The findings of this study corroborate the hypothesis that anastomosing venous bypass grafts distally to RPDA shows more patency rates than those anastomosed to DRCA. The grafts anastomosed to the DRCA occluded faster than grafts anastomosed to RPDA because low shear stress hastens the progression of atherosclerosis that is especially pronounced at bifurcation places.

RECOMMENDATIONS

For achieving more long-term patency in CABG, it is recommended to anastomose SVG to RPDA in proximal RCA lesion for revascularization of RCA if feasible.

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