Evaluating the Efficacy of Venous versus Arterial Grafts in CABG: A Cross-Sectional Retrospective Study

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KEYWORDS

Arterial Grafts, CABG, Retrospective

ABSTRACT

Background: Angiography of the coronary arteries is the most noninvasive advanced method of establishing graft patency post-coronary artery bypass grafting. The emergence of multi-slice computed tomography has opened a wide avenue for fast imaging around coronary angiography, with a featured scan time of 0.25 seconds, up to 32-slice detection, and multirow detector arrays, which are very important for quick evaluation.

Methods and Results: This study was a retrospective cross-sectional case series that involved 56 individual patients who underwent CABG in the Erbil Cardiac Center. Clinical and radiological evaluations were carried out to evaluate arterial and venous grafts' patency, considering the sociocultural pattern of the individual, type of conduits used, and patency in relation to multiple risk factors. The patency of arterial grafts was 84.9%, while that of venous was 61.9%. Features like hypertension, diabetes mellitus, exercise, and dietary restriction were shown to have a significantly associated vessel occlusion with a P-value of less than 0.05%.

Conclusion: The results of our study also confirm that arterial grafts have far better patency rates than saphenous vein grafts (SVG) in coronary artery bypass grafts. Contributory factors for graft occlusion are diabetes mellitus, hypertension, double antiplatelet therapy, and smoking habits. There is also suggestive evidence that dietary and exercise modification in the patient orientation program would improve the long-term outcome of patients after CABG.

1. Introduction

CABG forms an essential part of the surgical procedure to reinstate blood flow in the heart through diversion around blocked, ailing coronary arteries using either venous or arterial graft. Their patency studies will determine these grafts' success and long-term viability. Venous and arterial grafts differ in their long-term patency and flow characteristics. For example, arterial grafts, such as the internal mammary artery, commonly have superior long-term patency over venous grafts. Several studies have been able to show that occlusion rates are lower in arterial grafts, and comparatively better clinical outcomes have been witnessed over a long period of time or even a lifetime, according to one study identified in Bazylev et al [1]. Venous grafts, while effective at first, do show a decline in patency over several years [2].

CABG is the most effective treatment for symptomatic multi-vessel coronary artery disease [3]. Every year, more than 800,000 patients receive CABG worldwide [4]. Anastomosis of the left internal thoracic (mammary) artery to the left anterior descending artery is the most effective approach during the CABG procedure [4-6]. The 10-year patency rate of the left internal thoracic artery graft is 90% 25 years after the initial grafting [7]. Long-term outcomes following CABG rely appreciably on the patency of the vessels grafted to the coronary arteries. Over the years, various arterial and venous grafts have been used during CABG to achieve maximum myocardial perfusion. The great saphenous vein is often used as an aortocoronary conduit for the non-LAD coronary artery [7]. Its large caliber compared to the target coronary artery exposes it to one possible complication, that of the closure of the graft. The rate of late closure for the great saphenous vein is approximately 50% to 60% at 10 years because of vein graft atherosclerosis [7].

Modern imaging techniques have an important role in assessing graft function and patency. Among the histopathological approaches, multi-detector computed tomography has been the most preferred non-invasive diagnostic modality for imaging over conventional invasive coronary angiography [8]. Possessing the ability to provide a detailed image with a minimum radiation dose application has made this modality common; moreover, effective in portraying the patency and stenosis of the grafts of CABG, it is therefore useful for postoperative assessment.

Several vital factors determine the success of a coronary bypass graft. Bazylev et al. report that the average volumetric blood flow velocity in the grafts is affected by composite shunting, the combination of occlusion and borderline stenosis, and the diameter of the bypassed artery. In addition, studies have noted the effect of diabetes mellitus on the patency of the graft, pointing to the fact that diabetic patients show different graft disease patterns monitored by advanced imaging techniques such as multi-slice CT coronary angiography [8].

Medical therapy has historically been accepted as the standard of care in the management of advanced coronary artery disease. The long-term clinical outcome after myocardial revascularization depends on the patency of the coronary artery bypass grafts [9]. Several studies have recently revived radial artery grafts, showing excellent long-term patency [10]. RA grafts have good long-term patency and no significant difference with LITA grafts. Many authors support them due to their biological properties, adaptation to blood flow, and minimal intimal proliferation, all of which point to improved efficacy compared with saphenous vein grafts [11]. A few clinical studies support using radial arteries instead of saphenous vein conduits. Others suggest the opposite.

Many scanning protocols are routinely used in clinical settings to perform noninvasive CABG evaluations with CT. It is very important to know what the previous surgical procedure was to determine the level of the scanning in the bypass graft assessment. For example, imaging of saphenous vein graft (SVG) patency should span from the mid-ascending aorta to the inferior margin of the heart, whereas that of the internal mammary artery (IMA) graft generally includes the origin of the vessel at the subclavian artery to the cardiac apex.

This study will assess and compare the patency of the arterial versus venous grafts in patients with post-coronary artery bypass grafting. Further, it shall seek out and critically analyze the association of different factors that impinge on graft patency: both modifiable and non-modifiable risk factors such as time since surgery, age, smoking status, dietary habits, exercise, diabetes, hypertension, hyperlipidemia, and medication such as single or dual antiplatelet therapy, lipid-lowering agents, and β-blockers. This research will, therefore, try to assess the long-term predictors of graft patency maintenance post-CABG surgery. Inclusive analysis will include all the clinical risk factors that might affect the graft's longevity, like advanced age, gender, smoking habits, diabetes mellitus, hypertension, and dyslipidemia. The effect of post-operative medications, namely Aspirin, Clopidogrel, Beta-blockers, and lipid-lowering drugs, on the patency of the grafts will be evaluated. The project will also compare the CT angiography findings in these patients who underwent CABG management with the long-term graft results of these patients.

2. Methodology

Methods

It is a prospective cross-sectional study conducted in the Cardiovascular and Thoracic Surgery Department of the Erbil Cardiac Center in Erbil City, Kurdistan Regional Government of Iraq, for post-operative assessment from November 2020 to June 2022. Erbil Cardiac Center is a referral cardiac center for about 2.9 million inhabitants of Erbil Governorate and the neighboring cities of Dohouk, Sulaymaniyah, and Kirkuk, in addition to Mosul City, with a scale that reaches around 3.5 million inhabitants. We had 57 cases at the Erbil Cardiac Center, in which CABG was performed, and patients followed up after routinely visiting the hospital. Preoperative patients who showed symptoms and were considered candidates for CT coronary angiography were sent to the hospital. Patients were evaluated preoperatively using an abdominal ultrasound to evaluate vital organs and carotid Doppler to evaluate the carotid artery. Patients showing bilateral carotid artery severe stenosis were consulted by a neurologist for reassessment. A CXR was done for all patients to evaluate the pulmonary structure and the presence of any deformity in the chest and mediastinal abnormality. The CT Angio machine is PHILIPS Brilliance iCT 256, and the software was updated in 2021. Preoperative workup of the patients should include a coronary angiography showing indications of CABG; they are sent by the Department of Cardiology to the Department of cardiac surgery for revascularization. Preoperative blood

investigations were a complete blood count, renal function test, liver function, blood group and RH, thyroid function test, PT, PTT, INR, HbA1c, and lipid profile. The patients stopped taking anti-platelets 1 week before surgery; patients fasted for 10 hours before surgery.

Surgical technique

The GE anesthesia machines are utilized for the same while preparing the patient where propofol or fentanyl is used, a central venous (CV) line, arterial line, and at least two intravenous (IV) cannulas are placed. The patient is then positioned supine, and a median sternotomy is performed. The surgeon or first assistant takes down the LIMA, and sometimes the RIMA, while another assistant takes down the radial artery or SVG graft using legeclips and electrocautery for hemostasis. Heparin is given intravenously before reaching the distal third of the IMA. A pericardiotomy is now performed, and aortic and atrial cannulation is done using two purse strings for the aorta and one for the right atrium, using Prolene 5/0 sutures.

An antigrade cannula is put in the aorta, and the patient is put on the heart-lung machine. The IMA or SVG and other conduits are opened, and target coronary arteries are visualized. The aorta is detached from the pulmonary artery, and a Cross clamp is applied on the aorta to isolate the heart circulation with the rest of the body at the level of the distal ascending aorta above the level of origin of the brachiocephalic artery. The first dose of cardioplegia every 30 minutes is delivered to maintain myocardial protection. Venous return through the venous cannula is monitored for line pressure and to maintain a reasonable limit.

The patency of these targeted coronaries is checked after opening the targeted coronaries distal to the lesion, after which the conduits are anastomosed to the targeted coronaries with the help of Prolene 7/0 or 8/0 according to the size of the coronary artery. SVG grafts are completed initially, followed by IMA grafts. During the anastomosis of LIMA to LAD, rewarming is started. After all grafts are completed, the cross-clamp is removed, and the patient remains on cardiopulmonary bypass while the heart begins beating again. Proximal anastomoses of non-IMA grafts are done with the help of the side clamp in the aorta, and sites are chosen to avoid kinking and rotation of grafts. Prolene 6/0 is used in these anastomoses. After the completion of all proximal anastomoses, the side clamp must be carefully removed, and the graft positions have to be cross-checked for rotation, kinking if it has a free fall, and appropriate length to make sure that it is neither too long nor too short, which would make it less likely to be patent. The anastomoses of the distal part of the graft are brought close to the anastomoses of the conduit side and checked for any bleeding. The patient is slowly weaned from cardiopulmonary bypass by clamping the venous line and subsequent evaluation for heart contractility and blood pressure. If both are satisfactory, the venous line is clamped off, and the atrial line from the right atrium is taken and secured with Prolene 4/0.

Heparin effects are reversed by the administration of protamine sulfate. The remaining volume in the heart-lung machine is transfused to the patient, and the CV pressure is monitored to avoid fluid overload. Following this, the aortic cannula is taken out, and the purse string is ligated. Hemostasis is achieved; the sternum is closed using steel wire. Chest drains are placed in the patient's pericardium and pleura, and the patient is taken to the ICU to monitor abdominal blood gases (ABG) hourly, with continuous monitoring of the blood pressure by an invasive arterial pressure patient. When the drain output is negligible, and the vital signs are stable, the patient will be taken off the ventilator after complete recovery. The patient is then extubated to the ICU for one day of observation and then transferred to the surgical ward with the following medications: Aspirin, Clopidogrel, Bisoprolol, Atorvastatin, Heparin, Omeprazole, Tramadol, and Metoclopramide. Antibiotics are added on an SOS basis. The patient will be mobilized; an ECHO and CXR are done. If no collections are noted in the pericardium and pleura, the patient will have the chest drains removed. If collections are seen, the patient is encouraged to do more and more chest physiotherapy with exercise, and then a repeat CXR and ECHO will be done. The patient is allowed to leave after a few days of drain removal. If the patient is stable, they are discharged with oral medications and advised to come for a follow-up in seven days for stitch removal. The patient

is then advised to exercise, control the lipids, and observe HBA1C if diabetic. More follow-up is taken after 3 months for a year, and then after every 6 months.

Data collection and statistical analysis

Data collection was done using a predesigned questionnaire subdivided into three sections. The first part collected the patients' general information, including age, gender, and mobile number. The second section was for the collection of clinical information: past medical and drug history, smoking history, exercise, date of starting and stopping smoking, dietary restriction, drug history, aspirin, clopidogrel, beta blocker, lipid-lowering agent, drug history, and other. The third section of the questionnaire was about the surgical report and postoperative radiographic report. The patient's general information represents the mean (SD) or number (%). Clinical outcomes and the prevalence of the patency are presented in numbers and percentages. A Pearson Chi-square test was used to compare the patency prevalence and clinical outcomes between the two techniques; significance was considered at a P-value of less than 0.05. The software package for statistical analysis used was SPSS version 25.

3. Results and Discusssion

A mean of 60.88, a standard deviation of 11.96, and ages between 32-96 years were recruited for the study. Most patients fell in the 50-59 and 60-69 brackets, with the least in the 90-100 years bracket. The male-to-female ratio was 69.6:30.4. About 70% of the cases either had dietary restrictions or were smokers, followed by hyperlipidemia. Furthermore, about half of the cases had either hypertension or diabetes mellitus, as depicted in Figure (1 a,b and c).

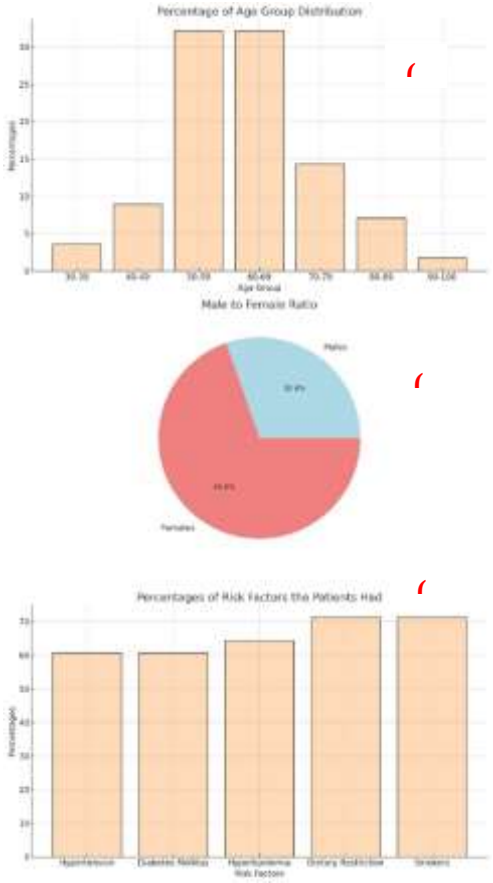


Figure 1: Distribution of the samples according to a) percentage of age group, b) male-to-female ratio, and c) percentage of risk factors the patients had.

Figure (2 a,b and c) explains the exercise practices of the sample patients prior to falling sick and their

drug usage. It also evidences the types of surgeries they undertook. Very high exercise, lipid-lowering agents, beta-blocker usage before falling sick, and a large sample with a LIMA to LAD grafting is carried out. These are valuable insights and critical to decoding patient profiles and the treatment patterns associated with CVD health.

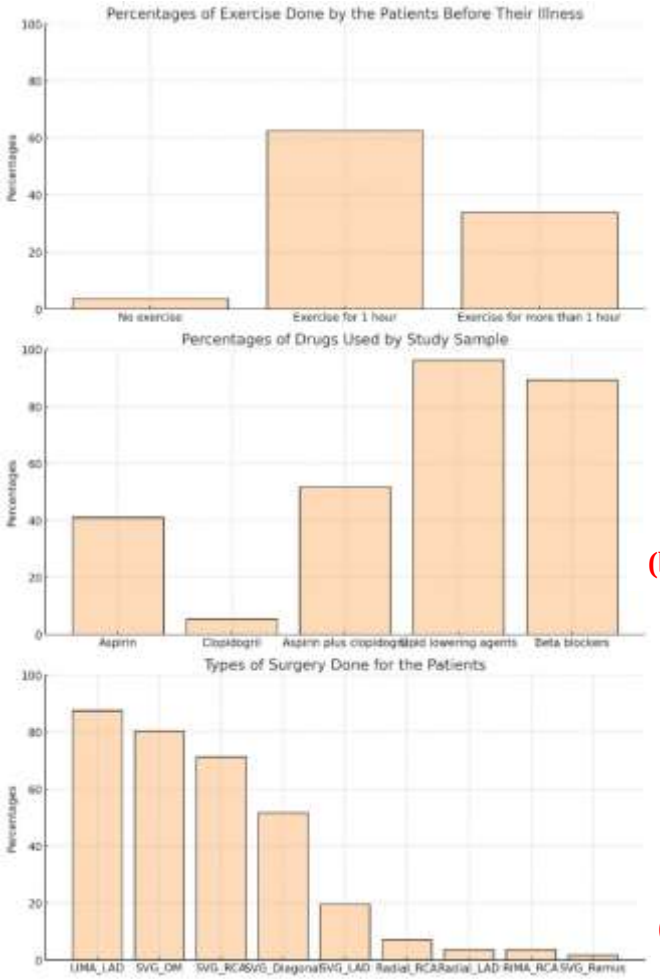


Figure 2: Comprehensive Analysis of Patient Exercise, Medication, and Surgery Practices, a) Exercise Habits Before Illness, b) Drug Usage Among the Study Sample, and c) Types of Surgery Performed.

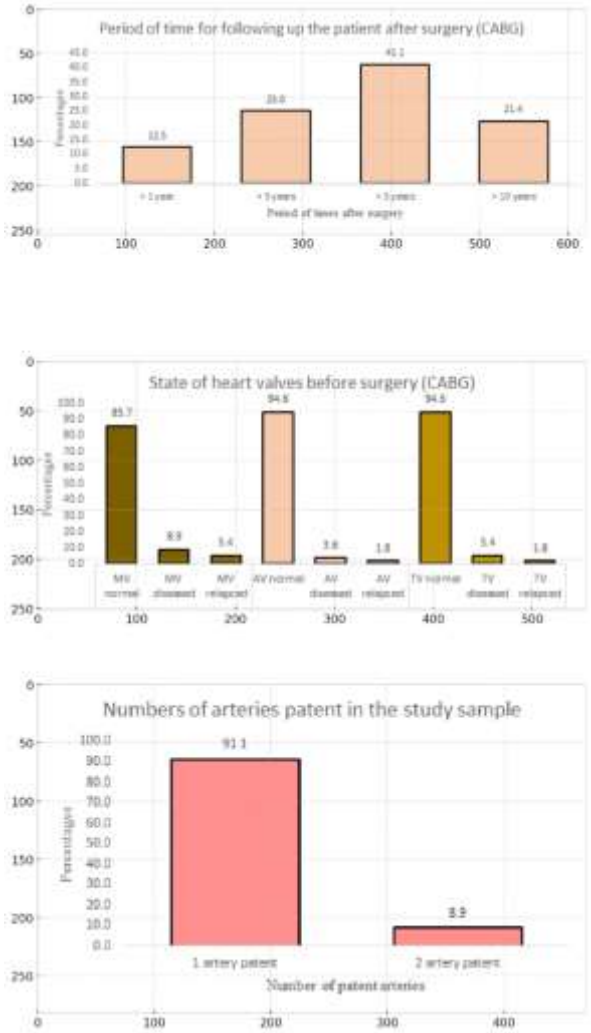
The period for following up the patient after surgery (CABG) illustrates the follow-up durations for patients undergoing Coronary Artery Bypass Grafting (CABG). The data is presented in Figure (3a).

This information shows that the care quantum concerning follow-up periods for cases post-surgery varies from one CABG patient to another and is high at extended long- and very long-term levels. Such monitoring at extended levels is required in managing patient health, ensuring that late-onset issues get caught post-surgery for better outcomes and quality of life following CABG.

Figure (3b) gives a rough balance of the condition of the heart valves in the patients before the CABG surgery. Most patients in the categories had normal aortic and tricuspid valves, while a few patients had to undergo a valve replacement or had a diseased valve. The mitral valve had a higher percentage of disease and replacements than the other valves, possibly explaining the patient's overall cardiac health.

The distribution of the number of patent arteries in the study sample as mentioned in Figure (3c). A significant majority of the patients, 91.1%, had only one patent artery. This indicates that most patients had severe artery blockage, with only one artery remaining unblocked. A smaller proportion, 8.9%,

had two patent arteries. This suggests that a minority of patients had a slightly better condition with two unblocked arteries.



(a)

(b)

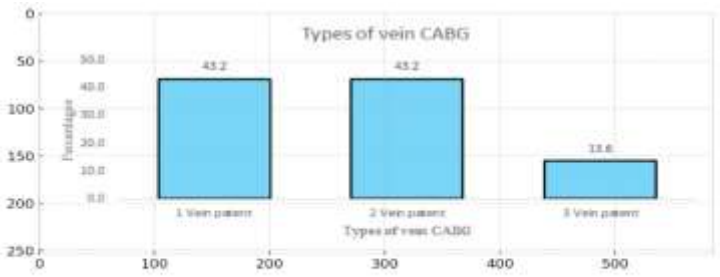
(c)

Figure 3: a) Comprehensive Analysis of Patient Exercise, Medication, Surgery Types, and Follow-Up Durations, b) Comprehensive Analysis of Patient Exercise, Medication, Surgery Types, Follow-Up Durations, and Heart Valve Conditions, c) Distribution of Patent Arteries in the Study Sample

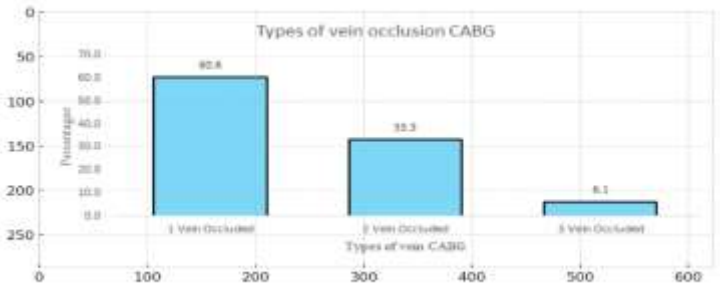
The success of vein grafts in remaining patent (unblocked) after CABG surgery is illustrated in Figure (4a). The key findings are that 43.2% of patients had one patent vein following CABG. This indicates that only one grafted vein remained unblocked for nearly half of the patients. Another 43.2% of patients had two patent veins. This shows an equal proportion of patients benefitted from two successful vein grafts, and A smaller percentage, 13.6%, had all three grafted veins patent. This suggests that achieving patency in three veins is less common.

Types of Vein Occlusion CABG" illustrates the distribution of occluded veins among patients who underwent Coronary Artery Bypass Grafting (CABG). Most patients had only one vein occluded after CABG as mentioned in Fig. (4b). This suggests that single-vein occlusion is the most common post-surgical scenario. Many patients had two veins occluded, indicating that multiple vein occlusions are also relatively common. A small percentage of patients experienced occlusion in three veins, highlighting that extensive vein occlusion is less frequent. Percentages of Occluded Vessels According to its type in the study sample," the distribution of occluded vessels in the study sample is shown. Nearly half of the patients had one vessel occluded, making it the most common scenario. Many patients had two vessels occluded, indicating that multi-vessel occlusion is also prevalent. A smaller

percentage of patients had three vessels occluded, showing that severe occlusion involving three vessels is less common. Both factors are illustrated in Figure (4c).



(a)



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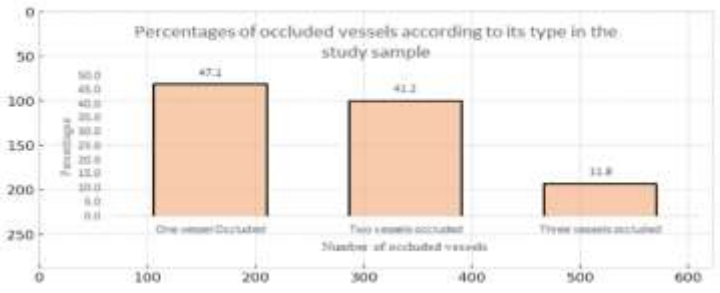

(c)

Figure 4: a) Types of veins CABG. b) Distribution of Vein Occlusions and Vessel Occlusions in CABG Patients c) percentage of occluded vessels

Figure (5) gives a full analysis of occlusion rates for CABG (Coronary Artery Bypass Graft). The first subplot relates the patency and occlusion of the different types of CABGs: LIMA_LAD, Radial_LAD, Radial_RCA, SVG grafts, and SVG_OM. The revelation is that Radial_LAD reflects high patency, amounting to 100%, while others, like SVG_OM, carry high occlusion rates, reaching 42.6%. The second subplot relates occlusion events with the number of vessels by age group. As seen in the diagram, from this age group, 50-59 stands out in the number of two-occluded vessel events and their number altogether. A third subplot relates occlusion frequencies with sex: the male category is indicative, whereas females are critical to two-vessel occlusion. First, compared to the trend in the female group, the male category is higher in cases of single occlusion (52.4%) and two-vessel occlusion (38.1%); second, the females are indicative of a significant rate of two-vessel occlusion (46.2%). In effect, the overall essence of this chart is revealing critical patterns in CABG occlusions, wherein the variance is presented in graft types, patient age groups, and difference in genders.

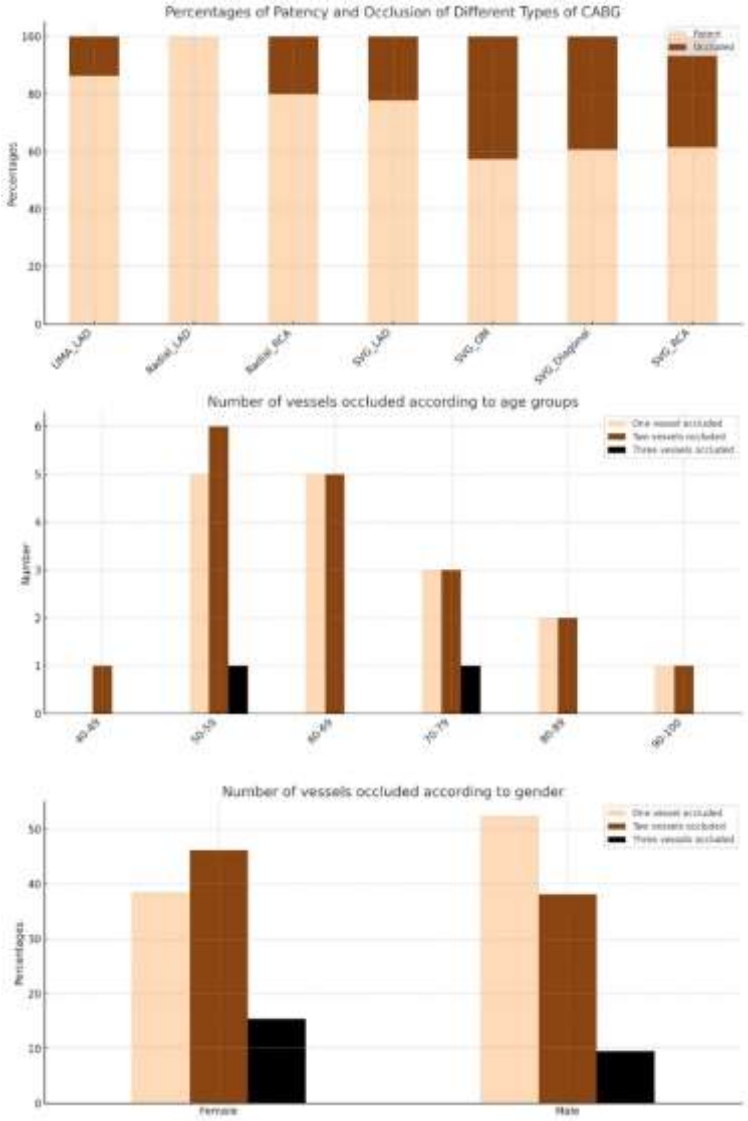

Figure 5: Comprehensive Analysis of CABG Occlusion Rates by Graft Type, Age Group, and Gender

Most occlusions occurred in ages 50-59 and 60-69, the rates being 66.7% and 72.2%, respectively, while the least occlusions were in age groups 40-49 and 90-100. However, different age groups and vessel occlusions showed no statistical association, as illustrated in Table 1. Additionally, more occlusions occurred in the male group; however, because males were more common than females, the association with vessel occlusion was not significant.

Generally, hypertension DM, exercise, diet restriction, and vessel occlusion are strongly associated with Table (1). Out of four, only diet restriction was significantly associated with arterial occlusion in Table (1) with $P < 0.05$.

On the other hand, regarding the risk factors related to vein occlusion, a high statistical value indicating a significant association with venous occlusion occurred among hypertensive, diabetes mellitus, exercised, and dietary restriction individuals, whereas smoking and hyperlipidemia showed no statistically significant association, as shown in Table 2.

Anti-platelet therapy, single or double, was not significantly associated with arterial occlusion. Either single or double anti-platelet therapy was highly significantly associated with venous occlusion. This information is given in Table 3, where double anti-platelet therapy was more significant than single

anti-platelet therapy.

Table 1: Comparison of Risk Factors and Their Associations with Vessels and Arterial Occlusion

Risk Factors	**Status**	**Vessels Occlusion (No)**	**Vessels Occlusion (Yes)**	**Vessels Occlusion (Total)**	**Vessels Occlusion (P value)**	**Arterial Occlusion (No)**	**Arterial Occlusion (Yes)**	**Arterial Occlusion (Total)**	**Arterial Occlusion (P value)**
Hypertensive	No	13	9	22	0.024	18	4	22	0.698
Hypertensive	Yes	9	25	34		30	4	34	
DM	No	15	7	22	< 0.001	20	2	22	0.46
DM	Yes	7	27	34		28	6	34	
Hyperlipidemia	No	8	12	20	0.935	16	4	20	0.437
Hyperlipidemia	Yes	14	22	36		32	4	36	
Smoking	Smokers	4	13	17	0.111	13	4	17	0.228
Smoking	Nonsmoker	18	21	39		35	4	39	
Exercise	No	8	29	37	< 0.001	30	7	37	0.243
Exercise	For 1 hour	14	5	19		18	1	19	
Dietary restriction	No	1	15	16	0.001	10	6	16	0.005
Dietary restriction	Yes	21	19	40		38	2	40	

Table 2: Risk factors and their association with venous occlusion

		Occluded Vein			
Risk factors	Status	No	Yes	Total	P value
Hypertensive	No	14	8	22	0.006
		63.6%	36.4%	100.0%	
	Yes	9	25	34	
		26.5%	73.5%	100.0%	
DM	No	15	7	22	0.001
		68.2%	31.8%	100.0%	
	Yes	8	26	34	
		23.5%	76.5%	100.0%	
Hyperlipidemia	No	8	12	20	0.903
		40.0%	60.0%	100.0%	
	Yes	15	21	36	
		41.7%	58.3%	100.0%	
Smoking	Smokers	5	12	17	0.242
		29.4%	70.6%	100.0%	
	Nonsmoker	18	21	39	
		46.2%	53.8%	100.0%	
Exercise	No	9	28	37	< 0.001
		24.3%	75.7%	100.0%	
	For 1 hour	14	5	19	
		73.7%	26.3%	100.0%	
Diatary _ restriction	No	2	14	16	0.006
		12.5%	87.5%	100.0%	
	Yes	21	19	40	
		52.5%	47.5%	100.0%	

Table 3: Comparison of Anti-Platelet Therapy and Its Association with Arterial and Venous Occlusion

Type	Occluded Artery (No)	Occluded Artery (Yes)	Occluded Artery (Total)	Occluded Artery (P value)	Occluded Vein (No)	Occluded Vein (Yes)	Occluded Vein (Total)	Occluded Vein (P value)
Single antiplatelet	20	3	23	1*	6	17	23	0.035
Double antiplatelet	25	4	29	1*	16	13	29	0.035
Total	45	7	52	1*	22	30	52	0.035

*Fisher's exact test

Discussion

The study comprised 56 patients of both sexes, whose average age was 32–96 years and the male-to-female ratio 69.6:30.4. The conducted statistical analysis did not reveal any meaningful relationship between sex and the patency of the grafts following CABG. No statistically meaningful difference between the two groups of patients was found in this paper's study in relation to stenosis with occlusion of the grafts [12].

The most common surgeries performed are LIMA to LAD, SVG to OM, and SVG to ramus intermedies. The patency rate for arterial grafts is 84.9% in 53 arterial grafts, and 126 venous grafts was performed, giving venous graft patency of 61.9%.

A study by the Turkish Society of Cardiology in 2018 quoted graft patency rates varying by vessel type and coronary territory. Overall graft patency varied from 90.16% for grafts from the left internal thoracic artery to 74.3% for SVGs [13]. However, in a 10-year follow-up, Kaplan–Meier curve analysis showed the following: the increase in crude survival of bilateral internal thoracic artery grafts compared with a single internal thoracic artery graft was significant (67.0% ± 2.5% in single internal thoracic artery graft vs [14]. 56.0% ± 3.4% vs. in bilateral internal thoracic artery graft, $P < .016$). The actual survival estimates for propensity score-matched patients evidenced better survival in bilateral internal thoracic artery grafts compared with single internal thoracic artery grafts at the end of the follow-up (66.0% ± 5.3% vs 53.0% ± 3.9%), hazard ratio = 0.64; 95% confidence interval, 0.44-0.94; $P = .022$ univariable Cox Model and multivariable analysis hazard ratio = 0.66; 95% confidence interval, 0.45-0.97; $P = .036$).

The incidence of postoperative complications was similar in the two groups: in the single and bilateral internal thoracic artery groups [15]. Further, findings after propensity matching of 24 factors for comparison of data from the Western Denmark Heart Registry on vein grafts and free arterial grafts suggested that the need for repeated revascularization and all-cause mortality needs to be similar for the respective grafts even in a follow-up to 10 years later [16].

It was found that DM had a significant relationship with graft occlusion. A significantly higher number of graft failures was seen in DM patients than in non-DM patients. 75.6% of vein occlusions were related to DM, compared to only 38.1% in non-DM patients (P value = 0.001). Also, the relationship between DM and arterial graft occlusions was 17.6% compared to 9.1% of non-DM patients (P value = 0.45). In a study in Bangladesh, it was observed that the mortality rate of a diabetic patient following CABG surgery was somewhat higher than that of a non-diabetic patient of the same kind [17]. Even postoperative complications were slightly higher, but none of them was markedly higher in the diabetic cohort. This suggested that very hard perioperative glycemic control may aid in the reduction of mortality and morbidity of diabetic patients receiving CABG. The finding infers that compared to the nondiabetics, CABG in the diabetics moderately increases the risk of death or complications. Other studies have shown that the outcomes of CABG in patients with type 1 and type 2 DM are significantly worse than in patients without DM. For example, a study in Catharina Hospital, Eindhoven, The

Netherlands, from January 1998 to December 2007 [18].

Patients on double antiplatelet therapy showed a lower incidence of graft occlusion in SVG grafting compared to those on single antiplatelet therapy. The network meta-analysis results suggest an added benefit of adding ticagrelor or clopidogrel onto aspirin in reducing saphenous vein graft failures in patients post-CABG. Postoperative dual antiplatelet therapy should be personalized for the patient by balancing the safety/efficacy profile of the drug intervention against important patient-related outcomes [19]. Another meta-analysis also supported the above conclusions when it showed that the rates of SVG occlusions were significantly reduced with the use of DAPT; however, these were offset by a significantly increased rate of major bleeding, while the rate of cerebrovascular mortality was decreased when compared to single antiplatelet therapy [20].

Smoking has a dramatic effect on the results of patients undergoing coronary artery bypass grafting (CABG), especially graft patency, and patient morbidity and mortality. Numerous studies have shown the negative impact of smoking on both venous and arterial grafts. The following are the rates of such incidents among smokers compared to non-smokers: occlusion of grafts—almost twofold in relation to the arterial ones [21]. On the one hand, smoking habits post-CABG remain to be an important issue in China, where the prevalence of smoking has been retained at a high level in post-CABG patients. Continuous smoking is related to higher mortality and morbidity, higher respiratory complications, and a longer length of ICU stay [22]. Smoking also relates to an increased out-of-hospital risk of death after four years of CABG [23].

Smoking cessation, however, has been shown to significantly improve prognosis among patients following CABG. It reduces both morbidity and mortality, which otherwise enhances the long-term outcomes of this surgery. Therefore, it is a good effort to enhance the therapeutic benefit to be derived from CABG [21]. Furthermore, the bad influence of smoking goes far beyond this, up to the patency of the graft and survival. Some studies showed that smoking greatly increases the risk for postoperative wound complications, like wound disruption and surgical site infections. That higher risk underlines the need for smoking intervention to be a regular part of postoperative CABG patient care [24].

The number of incidences of saphenous vein graft (SVG) occlusion among hypertensive patients is significantly greater than their non-hypertensive counterparts. About two-thirds of hypertensive patients experience SVG occlusion, while only a third of the non-hypertensive patients do. However, this difference is not apparent in occlusion in arterial grafts, which is not significantly different between hypertensive and non-hypertensive patients. Hypertension has been established as a very important risk factor among patients with coronary artery disease (CAD) who have undergone coronary artery bypass grafting (CABG). One study among the patients quoted by PubMed (2007) has supported the notion that hypertension is a very potent prognostic indicator of the early and late clinical outcomes in patients who have undergone CABG [25, 26].

Although most agree on the negative influences of hypertension on SVG graft patency, the overall clinical outcome after CABG in hypertensive patients is still debatable. There is also a school of thought that a better long-term left ventricular function and post-CABG outcome is seen in hypertensive individuals as compared with normotensive persons. In contrast to situations like diabetes mellitus, this negative influence on the outcome of CABG is clear and less controversial. Discussion in progress also annotates the fact that the management of hypertensive patients undergoing CABG is complex, and the individual treatment strategies are required to be tailored compulsively for the optimal outcome of the patient [27, 28].

As shown in some studies, the occlusion of saphenous vein graft (SVG) was significantly higher in those patients who did not exercise once they underwent CABG. Their results proved that SVG happened three times more in patients who did not exercise than in those who did. Negative long-term consequences happened due to the non-availability of patient education and rehabilitation, which, in fact, ascertains the need for cardiac rehabilitation to be made a part of care for them. Importance of exercise lies as an important link to ensure better graft patency and reduces incidence of SVGD. This

is because exercise has a favorable effect on vascular health and the virility of neck vessels [28, 29].

Cardiac exercise-based rehabilitation programs reduce the heart rate recovery time in post-CABG patients and improve autonomic function, leading to better cardiovascular health in the long term. However, it is really interesting that the exercise done at home has an equivalent effect to that done by the outpatients under the formal program. This important finding supports promoting and enhancing physical activity in all patients following CABG to ensure good recovery and outcome during long-term follow-up. Improvements in SVG graft patency and the health of patients due to the exercise attest to the importance of post-operative rehabilitation for CAD patients [30, 31].

4. Conclusion and future scope

The study of 56 patients showed no statistical correlation of sex to graft patency post-CABG (average age 32–96, 69.6% male-to-female ratio 30.4%). The most orthodox surgeries performed were LIMA to LAD, SVG to OM, and SVG to ramus intermediates, with the patency rate for arterial being 84.9% and for the venous grafts 61.9%. Comparison with data from the Turkish Society of Cardiology showed varying patency rates between the different types of vessels, with left internal thoracic artery grafts having the highest patency of 90.16%. The study showed that the survival rate of bilateral internal thoracic artery grafts was significantly better than that of a single internal thoracic artery graft; therefore, a bilateral internal thoracic artery graft would have an advantage in long-term follow-up. Postoperative complications were quite similar in both groups, only to point out that the type of graft might play a critical role in survival regardless of immediate postoperative results. The study also describes diabetes mellitus as a potent factor for the occlusion of grafts to have a higher rate of occlusion of veins in diabetic patients than in non-diabetic patients. This, therefore, calls for strict control of glycemia in the perioperative period with diabetic patients undergoing CABG for a decrease in mortality and morbidity.

Patients receiving DAPT had a reduced incidence of graft occlusion but an increased risk of major bleeding. Knowing this fact lays the foundation for the personalized application of DAPT concerning the individual risk profile to enhance graft patency. Depicts that the smoking habit leads to negative influences on the patency of the graft and patient care outcomes post CABG, as the number of occluded grafts and complications for the smoker showed growth. Abandoning smoking has led or shall lead to having a significant impact on the prognosis, so much so that it was apparent in the patient's post-CABG care. Hypertension was associated with SVG occlusion, an important risk factor, although its role in arterial grafts is not well defined. The management of hypertensive patients still remains complex because revascularization in CABG is always performed on an individualized basis in terms of strategies for the best outcome.

Lastly, it was shown that physical activity, in the context of a cardiac rehabilitation program, is crucial in enhancing graft patency and patient survival after CABG. Regular physical activity, whether performed at home or in supervised sessions, has been shown to enhance cardiovascular health and lower the frequency of SVG occlusion. This view concurs with another that showed that the patency and outcomes of the graft following CABG are also multifactorial in nature. Very important in these parameters are a type of mismatch of the grafts, the presence of diabetes, anti-platelet therapy, smoking, hypertension, and exercise rehabilitation. Therefore, treatment and lifestyle interventions shall be tailored to individual characteristics for better long-term outcomes among CABG patients.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical statement

This study protocol will be submitted to the Health Ethics Committee at the College of Medicine, Hawler Medical University. The confidentiality of the patient's personal files is maintained at all stages of this study. The patients also have the option of refusing to participate in the study. Patients have the right to know the purpose of the study.

Data availability

No data was used for the research described in the article.

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