Original Article

Long-term coronary artery graft patency evaluation by computed tomographic coronary angiography

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Objective: To evaluate long-term coronary graft patency post coronary artery bypass graft (CABG) surgery in coronary artery disease (CAD) patients using 64-slice coronary computed tomographic angiography (CCTA).

Methodology: In this retrospective study, a total of 11 CAD patients with history of CABG were included. All patients had CCTA at least 5 years after CABG. Patency rates for both arterial and venous grafts were calculated.

Results: Out of 11 patients with a total of 29 grafts, comprised of 9 left internal mammary artery (LIMA) grafts and 20 saphenous vein grafts (SVGs). Overall, 62.06% grafts were patent, 37.93% showed disease, including 2 (18.18 %) arterial and 9 (81.81 %) venous grafts. The patency rate for LIMA grafts was 77% and SVGs was 55%.

Conclusion: The LIMA grafts showed significantly higher long-term patency rate than SVG, 5 years after CABG. (Rawal Med J 202;45:766-770).

Keywords: Atherosclerosis, occlusion, tomography.

INTRODUCTION

Coronary artery bypass graft (CABG) surgery is the mainstream procedure for treatment of advanced coronary artery disease (CAD). The bypass grafts used in CABG can be arterial and venous.[1] Long term sequelae after CABG surgery includes disease advancement in native coronary arteries or de novo atherosclerosis in grafts leading to recurring ischemic pain and even death. Post CABG follow-up evaluation of grafted vessel is essentially warranted in symptomatic as well as asymptomatic patients as the benefits of surgery may be lost with graft failure or occlusion.[2,3]

There are multiple diagnostic techniques to assess the coronary graft health. Percutaneous Invasive coronary angiography (ICA) is the gold standard for evaluation of patency of bypass grafts and provides excellent visualization of coronary arterial tree. But this conventional technique is invasive, technically demanding, risky, time consuming and costly.[4] Therefore, for the assessment of bypass grafts, use of non-invasive alternative techniques like Computed Tomography Angiography (CTA) and Magnetic Resonance Angiography (MRA) can be convenient and offer substantial clinical and economic benefits.

Coronary MRA permits non-invasive visualization of coronary artery grafts without radiation exposure. However, its major limitations are long scan times, lower spatial resolution, operator dependency and relatively lesser availability.[5] In contrast, coronary computed tomographic angiography (CCTA) is widely available and precise imaging technique for sensitive assessment of graft patency or disease irrespective of type of graft. This technique is not only well tolerated and requires shorter duration but also can be performed on the scheduled outpatient basis.[6] These attributes make CCTA most reliable non-invasive imaging modality for evaluation of graft patency. 64-slice multi-detector CCTA yields high-quality angiograms, high temporal and spatial resolution, accurately demonstrating the anatomy of heart vessels and graft patency through three dimensional volume-rendered images.[7,8] It is especially effective in assessing bypass grafts because of their larger size, reduced motion and lower degree of calcification as compared to native coronary vessels.[9,10]

Early detection of disease in grafts via CCTA helps in implementing subsequent management plan of treatment.[11,12] The factors such as advanced age, male gender, diabetes, hypertension, dyslipidemia, family history, smoking and exercise are considered potential predicting risk factors for occlusion of

grafts.[13,14] The goal of this study was to utilize CCTA for assessment of both arterial and venous grafts, 5 years post CABG surgery, for patency and disease.

METHODOLGY

This retrospective study was carried out at Imaging Radiology department of Capital Hospital, Islamabad from September 2012 to September 2019, after formal approval from institutional ethical review board. A total of 11 CAD patients with history of CABG were included in the study. After informed consent, data were collected about the demography and potential risk factors. Arterial and venous coronary grafts were evaluated for patency and disease via 64-slice multi-detector CCTA (Toshiba, Aquilion).

The scan parameters employed were as follows: tube voltage 120 kVp, tube current 1000 mAs, rotation time 0.4 sec and simultaneous acquisition of 64 slices per rotation with a slice thickness of 0.5 mm. The maximum field of view was increased to cover the neck during examination. The scan duration ranged from 9.12 – 15.43 seconds. For acquisition of the volume data set, patients received a total of 90 ml of 370 mg/ml concentration of non-ionic iodine contrast agent ((Inj. Ultravist) at a rate of 5.5 ml/s followed by 50 ml saline solution. The scan was performed and the images were transferred to a dedicated workstation (Vitrea®2, v3.9; Vital Images) for analysis.

Statistical Analysis: SPSS version 22 was used for analysis. Patency rates for both arterial and venous grafts were calculated. The Chi-square test was performed to find association of important potential predicting risk factors with long-term patency of grafts. $p<0.05$ was considered significant.

RESULTS

Out of 11 patients, 9 were male and 2 female. Age ranged from 57 to 75 years (mean 65.5±6.03). Out of 29 grafts, 9 were left internal mammary artery (LIMA) grafts and 20 saphenous vein grafts (SVGs). Overall, 18 (62.06 %) grafts were patent and 11 (37.93 %) showed disease. One graft to obtuse marginal artery (OM1) showed complete blockade with an intraluminal thrombus (arrow) throughout its length while the other graft to Diagonal Artery (D1) is patent with luminal contrast opacification (arrow) and no evidence of thrombosis (Fig. 1). Three-dimensional volume-rendered CT angiography image showed a left internal mammary artery graft to left anterior descending artery. The LIMA graft showed metallic artifacts in its proximal part and beaded appearance in distal part (arrow head) just above its anastomosis with LAD which represents disease (Fig. 2).

Fig. 1. Axial multidetector CT image.

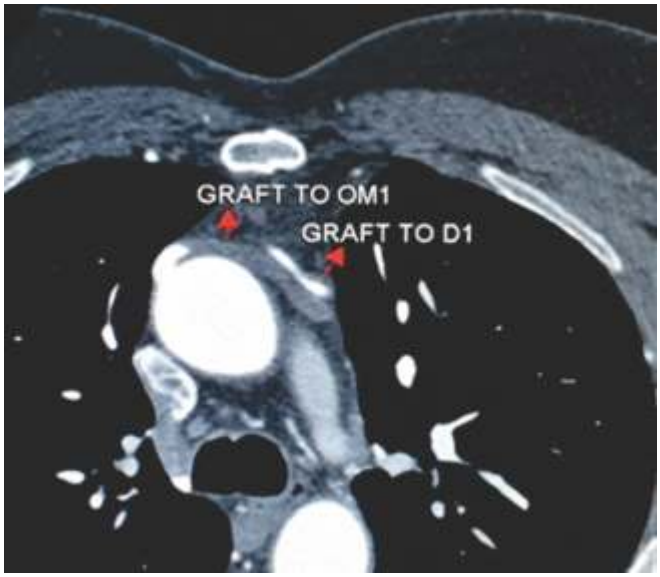

Fig. 2. Three-dimensional volume-rendered CT angiography.

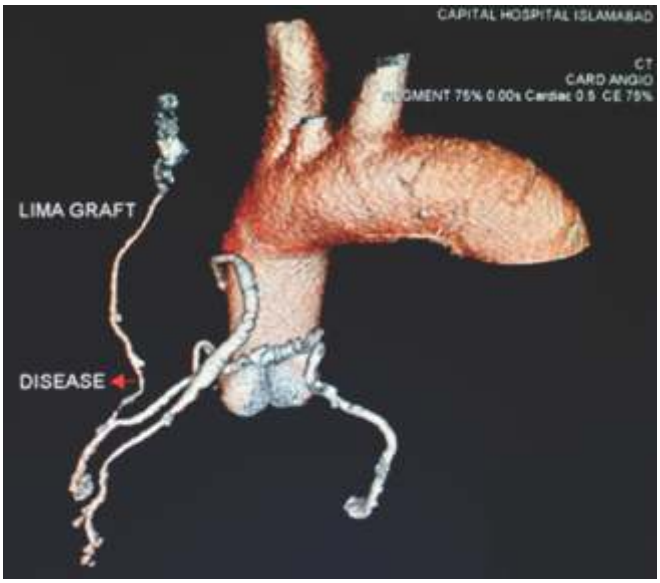

Table 1. Patency rates in coronary grafts.

Graft	Total Number	Graft Patent	Graft Diseased	Patency rates n (%)
Arterial Grafts				
LIMA → LAD	6	5	1	83.3%
LIMA → OM	1	1	0	100%
LIMA → DIAGONAL	2	1	1	50%
All Arterial Grafts	9	7	2	77.77%
Venous Grafts				
SVGs → OM	7	4	3	57.14%
SVGs → RCA	5	3	2	60%
SVGs → LAD	4	2	2	50%
SVGs → DIAGONAL	3	1	2	33.33%
SVGs → POSTERIOR DESCENDING	1	1	0	100%
All Venous Grafts	20	11	9	55%
All Arterial and Venous Grafts	29	18	11	62%

Table 2. Potential patient-specific predictors of long-term diseased graft by univariate analysis.

Variable	No. of patients	Graft diseased (n = 11)	P-value
Age (years)			
≤60 years	3	3	0.632
≥60 years	8	8	
Gender			
Male	9	10	0.081
Female	2	1	
Diabetes			
Yes	5	4	0.361
No	6	7	
Hypertension			
Yes	8	9	0.206
No	3	2	
Dyslipidemia			
Yes	6	7	0.361
No	5	4	
Smoking			
Yes	4	4	0.497
No	7	7	
Exercise			
Yes	2	1	0.081
No	9	10	
Family History			
Yes	6	6	0.231
No	5	5	
LVEF			
≤60	4	5	0.497
≥60	7	6	

The 18 patent grafts included 7 (38.8%) arterial and 11 (61.1%) venous grafts. Out of 11 diseased grafts, 2 (18.18 %) were arterial and 9 (81.81 %) were venous grafts. Out of 9 LIMA grafts, 7 were patent and out of 20 SVGs, 11 were patent. The patency rate for LIMA grafts was 77% and SVGs was 55% (Table 1). The P-value of all potential risk factors as calculated by Chi-square test of association was >0.05, indicating they did not significantly predict the long-term patency of coronary grafts (Table 2).

DISCUSSION

The major findings of our study were that long-term patency of LIMA grafts was significantly higher than SVGs. The selection of graft nature (arterial or venous) is crucial for long term success of CABG.[16] Arterial grafts are a favorable choice considering their long-term patency compared with venous bypass grafts. The arterial grafts are smaller in caliber but they have better compliance to high pressure arterial environment in the coronary arteries leading to decreased incidence of atheroma formation.

In comparison venous grafts, specifically SVGs, are larger in size and they have lesser adaptability to high pressure hence these are more prone for neointimal hyperplasia and atherosclerotic changes. Nonetheless, SVGs are more readily available therefore they are more widely used.[17] Overall, arterial grafts had better long-term outcomes so use of arterial conduits should be promoted to improve the overall long-term survival of grafts and patients after CABG.[18]

A study also showed that 64 slice MDCT can be used for the post CABG follow up evaluation of venous and arterial grafts.[19] The two studies conducted by Barbero et al and Monem et al justified the role of MDCT coronary angiography as a non-invasive alternative to ICA for follow up of coronary bypass graft with sensitivity of 99%, 100% and specificity of 99% and 97.1%, respectively.[20,21]

Monem et al also concluded CT as an accurate imaging technique for coronary angiography with diagnostic accuracy of 97.4%.[20] Eisenberg et al reported the potential gatekeeper role of CTA as it

can correctly identify the graft failures and avoid the need for ICA. CTA can provide information that impact clinical decision making and aids to selectively choose patients likely to benefit from potential intervention.[22]

CONCLUSION

Post CABG long term status of bypass graft can be precisely evaluated by coronary computed tomography angiography. The LIMA grafts showed significantly higher long-term patency rate than SVGs, 5 years after CABG.

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Critical revision of the article for important intellectual content: Shazia Yusuf, Shazia Zeb
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