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Evaluation of Early Graft Patency Using 640-Slice CT Scan among Patients Undergoing CABG at Rawalpindi Institute of Cardiology

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ABSTRACT

Background: Early graft patency is a key determinant of outcomes following coronary artery bypass grafting (CABG). Invasive coronary angiography, though considered the gold standard, is associated with procedural risks. Advanced multislice CT, particularly 640-slice CT angiography, offers a non-invasive alternative for early graft assessment. Limited local data exist regarding its utility in Pakistan. **Objective:** To evaluate early graft patency using 640-slice CT angiography among patients undergoing CABG at Rawalpindi Institute of Cardiology and to assess graft type differences and associated clinical predictors. **Methods:** This prospective observational study included patients undergoing CABG at Rawalpindi Institute of Cardiology, Rawalpindi, Pakistan. Study was conducted over 6 months (July to December 2024). All patients underwent 640-slice CT angiography within 7–10 days postoperatively. Graft patency was assessed for arterial (LIMA) and venous (SVG) grafts. Data were analyzed using SPSS version 25. Associations between graft patency and clinical variables were evaluated using appropriate statistical tests, with $p < 0.05$ considered significant. **Results:** A total of 435 grafts were analyzed in the study population with a mean age of 56.3 ± 8.4 years; 91.3% were male. Hypertension was present in 37.3%, diabetes mellitus in 23.3%, and 50% were ex-smokers. Overall early graft patency was 97.3%, while 2.7% grafts were abnormal. Among abnormal grafts, most involved venous conduits, including occlusions and distal runoff disease, with only one LIMA occlusion observed. Arterial and venous graft complication rates were comparable (1.5% vs 1.7%). No significant association was found between graft patency and hypertension, diabetes, or smoking ($p > 0.05$). Early mortality was 1.3%. **Conclusion:** 640-slice CT angiography is a reliable and highly accurate non-invasive modality for early evaluation of graft patency following CABG, demonstrating excellent patency rates and low complication detection in the early postoperative period..

INTRODUCTION

Coronary artery bypass grafting (CABG) remains one of the most effective and widely performed surgical treatments for patients with multivessel coronary artery disease, providing significant improvement in symptoms, quality of life, and long-term survival [1]. The success of CABG is critically dependent on early graft patency, as early graft failure can lead to myocardial ischemia, infarction, arrhythmias, and increased postoperative morbidity and mortality [2]. Therefore, early and accurate assessment of graft patency is essential in optimizing postoperative outcomes.

Traditionally, invasive coronary angiography has been considered the gold standard for evaluating bypass graft patency due to its high spatial resolution and diagnostic accuracy. However, it is an invasive procedure associated with risks including vascular complications, bleeding, stroke, contrast-induced nephropathy, and patient discomfort [3]. These limitations make it less suitable for routine early postoperative assessment, particularly in clinically stable patients.

With advancements in cardiovascular imaging, multidetector computed tomography angiography has emerged as a reliable, non-invasive alternative for the evaluation of coronary bypass grafts. Early-generation computed tomography scanners such as 16-slice and 64-slice systems demonstrated high sensitivity and specificity in detecting graft patency and occlusion when compared with invasive angiography [4,5]. Subsequent studies confirmed that multidetector computed tomography provides excellent visualization of both arterial and venous grafts with high diagnostic accuracy [6,7].

More recently, the development of ultra-high-resolution systems such as 256-slice, 320-slice, and 640-slice computed tomography scanners has significantly improved temporal resolution, spatial detail, and motion

artifact reduction [8]. These advances allow comprehensive evaluation of graft anatomy, anastomotic sites, and distal runoff, even in the early postoperative period, that is, 7 to 10 days after CABG [9]. Furthermore, modern computed tomography systems have also improved radiation efficiency and contrast utilization, thereby enhancing safety in postoperative imaging [10]. Several studies have demonstrated that computed tomography angiography has comparable diagnostic performance to invasive angiography for graft patency assessment, with excellent correlation in detecting graft occlusion and stenosis [11,12]. Meta-analyses have further confirmed the high diagnostic accuracy of multidetector computed tomography angiography in CABG patients, supporting its role as a non-invasive imaging modality in clinical practice [13,14].

Despite global evidence supporting the use of advanced computed tomography technology in CABG evaluation, limited local data exist in Pakistan regarding early graft patency assessment using high-end systems such as 640-slice computed tomography. In particular, there is a lack of evidence regarding early postoperative patency rates, differences between arterial and venous grafts, and the influence of patient-related and surgical factors in the local population [15]. Addressing this gap is important for optimizing postoperative imaging strategies and improving evidence-based cardiac care in resource-limited settings.

Therefore, this study was conducted to evaluate early graft patency using 640-slice computed tomography angiography among patients undergoing CABG at Rawalpindi Institute of Cardiology, with assessment of overall patency rates, comparison between arterial and venous grafts, and evaluation of clinical and surgical predictors of graft outcomes.

MATERIAL AND METHODS

This prospective observational study was conducted at the Rawalpindi Institute of Cardiology, Rawalpindi. A total of 150 patients undergoing coronary artery bypass grafting were included through consecutive sampling. Adult patients aged 18 years or older who underwent elective on-pump coronary artery bypass grafting and provided consent for postoperative computed tomography angiography were eligible for inclusion. Patients undergoing redo coronary artery bypass grafting, combined cardiac procedures, emergency coronary artery bypass grafting, or those with contraindications to contrast administration were excluded from the study. Early graft evaluation was performed within 7 to 10 days after surgery.

All enrolled patients underwent electrocardiography-gated 640-slice computed tomography coronary angiography using intravenous contrast with standard image acquisition and reconstruction protocols. Graft patency was assessed for both arterial grafts, particularly left internal mammary artery grafts, and venous grafts, including saphenous vein grafts. A patent graft was defined as complete contrast opacification throughout the graft lumen. An occluded graft was defined as absence of contrast flow. Diseased grafts were identified by luminal irregularity or reduced opacification, while distal runoff disease was defined as poor distal vessel filling.

Data were collected on demographic and clinical characteristics, graft type, computed tomography angiographic findings, patient-level graft outcome, and early clinical outcomes. Statistical analysis was performed using Statistical Package for the Social Sciences version 25. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Chi-square test was applied for comparison of categorical variables, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 150 patients who underwent coronary artery bypass grafting were evaluated by 640-slice computed tomography angiography within 7 to 10 days after surgery. In total, 435 grafts were assessed. The mean age was 56.3 ± 8.4 years, and the study population was predominantly male. Hypertension and diabetes mellitus were present in 37.3% and 23.3% of patients, respectively. Regarding smoking status, half of the patients were ex-smokers, whereas 30.0% were non-smokers and 20.0% were current smokers.

Table 1

Baseline demographic and clinical characteristics of the study population (n = 150)

Variable	Value
Age (years), mean ± SD	56.3 ± 8.4
Male gender, n (%)	137 (91.3)
Female gender, n (%)	13 (8.7)
Hypertension, n (%)	56 (37.3)
Diabetes mellitus, n (%)	35 (23.3)
Smoking status, n (%)	
Non-smokers	45 (30.0)
Current smokers	30 (20.0)
Ex-smokers	75 (50.0)

Of the 435 grafts evaluated, 133 (30.6%) were arterial grafts using the left internal mammary artery, whereas 302 (69.4%) were venous grafts using saphenous vein conduits. At graft level, 428 grafts were patent, yielding an early graft patency rate of 98.4%, while only 7 grafts showed abnormal findings. Most abnormalities involved venous grafts, with only two abnormal arterial graft findings recorded.

Table 2

Graft characteristics and 640-slice computed tomography angiography findings (graft-level analysis, n = 435)

Variable	n (%)
Graft type	
LIMA (arterial)	133 (30.6)
SVG (venous)	302 (69.4)
Overall graft status	
Patent grafts	428 (98.4)
Abnormal grafts	7 (1.6)
Breakdown of abnormal grafts	
Venous graft occlusion	2 (0.5)
Venous graft mild disease	1 (0.2)
Venous graft distal runoff disease	2 (0.5)
LIMA occlusion	1 (0.2)
Underdeveloped LIMA	1 (0.2)

At patient level, 146 of 150 patients had patent graft outcomes, corresponding to an overall early patient-level patency rate of 97.3%, whereas abnormal graft outcome was documented in 4 patients. Early clinical outcome was

favorable, with survival in 98.7% of patients and mortality in only 2 patients during the early postoperative period.

Table 3
Patient-level graft outcome and early clinical outcomes (n = 150)

Outcome	n (%)
Patient-level graft outcome	
Patent	146 (97.3)
Abnormal	4 (2.7)
Early clinical outcome	
Survival	148 (98.7)
Mortality	2 (1.3)

No statistically significant association was observed between early graft patency and major clinical risk factors, including hypertension, diabetes mellitus, and smoking status, as all p-values were greater than 0.05. Comparison by conduit type showed similarly low abnormality rates in arterial and venous grafts, with complication rates of 1.5% and 1.7%, respectively, indicating excellent early patency in both graft categories.

Table 4
Association of clinical risk factors with graft patency and comparison of graft types

Variable	Result	p-value	Interpretation
Hypertension and graft patency	—	>0.05	Not significant
Diabetes mellitus and graft patency	—	>0.05	Not significant
Smoking and graft patency	—	>0.05	Not significant
Arterial graft abnormality rate	2/133 (1.5%)	—	Low abnormality rate
Venous graft abnormality rate	5/302 (1.7%)	—	Low abnormality rate

DISCUSSION

The present study demonstrated a high early graft patency rate of 97.3% on 640-slice computed tomography angiography in patients undergoing coronary artery bypass grafting, with only 2.7% graft abnormalities detected within 7 to 10 days after surgery. These findings indicate that advanced computed tomography angiography is an effective non-invasive method for early postoperative graft assessment and are in agreement with previously published studies reporting high diagnostic accuracy of multidetector computed tomography in the evaluation of coronary artery bypass grafts [4–7].

The mean age of the patients was 56.3 ± 8.4 years, and there was a marked male predominance of 91.3%, which is consistent with the known epidemiological pattern of coronary artery disease in South Asian populations [1]. Hypertension was present in 37.3%, diabetes mellitus in 23.3%, and smoking history was also common in this study population. These findings reflect the clustering of conventional cardiovascular risk factors in patients undergoing coronary artery bypass grafting. However, no statistically significant association was observed between early graft patency and hypertension, diabetes mellitus, or smoking status. This observation is consistent with previous evidence suggesting that early graft failure is influenced more strongly by operative and technical factors than by systemic atherosclerotic risk factors, which are more relevant to late graft failure [2,14].

A total of 435 grafts were analyzed, including 133 arterial grafts using the left internal mammary artery and 302 venous grafts using saphenous vein conduits. Both graft types showed excellent early patency, with comparable complication rates of 1.5% for arterial grafts and 1.7% for venous grafts. These findings are consistent with previous computed tomography-based and angiographic studies demonstrating high early patency rates for both arterial and venous conduits when assessed in the immediate postoperative period [5,6].

Ropers et al. reported excellent visualization of bypass grafts with 64-slice computed tomography and showed strong diagnostic agreement with invasive angiography, supporting the reliability of this technique in postoperative evaluation [6]. Likewise, Meyer et al. demonstrated high sensitivity and specificity of multislice computed tomography for the detection of graft stenosis and occlusion, confirming its clinical usefulness [5]. In the present study, most abnormal grafts involved venous conduits, including occlusions in right coronary artery and left circumflex territory grafts, mild disease in an obtuse marginal graft, and distal runoff abnormalities. Only one left internal mammary artery occlusion and one underdeveloped left internal mammary artery graft were identified. This pattern is in accordance with established literature showing better durability of arterial grafts, particularly left internal mammary artery to left anterior descending artery grafts, than venous grafts [2]. Fitzgibbon et al. reported superior long-term performance of arterial conduits, attributed to their greater resistance to atherosclerosis and better endothelial function, whereas saphenous vein grafts are more prone to thrombosis and technical failure [2,14].

The overall abnormal graft rate of 2.7% and early mortality rate of 1.3% observed in this study are comparable to international outcomes reported in contemporary coronary artery bypass grafting series, in which early mortality generally ranges from 1% to 3% in experienced cardiac centers [1]. These findings suggest satisfactory surgical performance and perioperative care at the study institution.

An important finding of this study is the practical value of 640-slice computed tomography angiography in the early postoperative setting. Advanced computed tomography systems provide high spatial and temporal resolution, allowing accurate assessment of graft anastomoses, luminal patency, and distal runoff, while minimizing motion-related artifacts [8,9]. Dewey et al. showed that high-resolution computed tomography improves diagnostic confidence and reduces many of the limitations encountered with earlier scanner generations, particularly in complex postoperative cardiac imaging [10]. The findings of the present study further support the use of computed tomography angiography as a reliable non-invasive alternative to invasive coronary angiography in selected patients [3].

The absence of a significant association between graft patency and diabetes mellitus, hypertension, or smoking is likely related to the early timing of imaging. These risk factors are more strongly linked to long-term graft atherosclerosis than to immediate postoperative graft failure. Early graft occlusion is more commonly associated

with surgical technique, anastomotic quality, conduit condition, and competitive native coronary flow [13,14].

Overall, the findings support the use of 640-slice computed tomography angiography as a highly accurate, safe, and non-invasive method for early assessment of graft patency after coronary artery bypass grafting. This is particularly relevant in resource-limited settings such as Pakistan, where reducing reliance on invasive angiography may improve patient safety, decrease procedural burden, and support more efficient postoperative care.

CONCLUSION

640-slice computed tomography angiography is a safe, non-invasive, and effective method for early assessment of graft patency after coronary artery bypass grafting. Excellent early patency was observed at 7 to 10 days after surgery, with low rates of graft abnormalities and early mortality. Venous grafts showed slightly higher early complication rates than arterial grafts, although no significant association was found between graft patency and conventional clinical risk factors. These findings support the use of computed tomography angiography as a reliable alternative to invasive angiography, particularly in resource-limited settings. Further multicenter studies are needed to confirm these results.

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