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Original Article

Multi-Slice Computed Angiography for the Evaluation of Stent Patency after Left Main Coronary Artery Stenting

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ABSTRACT

Due to the high frequency of in-stent restenosis, repeat coronary angiography and left main percutaneous coronary intervention is recommended. But Computed Tomography Angiography is a noninvasive procedure for evaluating coronary arteries. **Objectives:** To assess the proportion of InStent restenosis in left main per-Cutaneous coronary intervention and to evaluate diagnostic efficacy of Computed Tomography Angiography in detecting In stent Restenosis. **Methods:** We assessed 263 consecutive LM PCI patients; 130 patients were chosen for this study procedure as they meet our criteria. CTA was conducted three months following the LM PCI. **Results:** The vast majority of patients (73.8 %) had PCI from LM to LAD and 16.2 % from LM to LCX. Only 10% of patients had bifurcation PCI, and all patients had DES (100%). The average period for ISR development was 125 months, with ISR rates of 32.2 % in the LM to LAD cohort and 38 % in the LM to LCX cohort. The median time between PCI and CTA was 194 days, with a mean basal heart rate of 69 ± 12 beats per minute. CTA exhibited a positive predictive value of 84.7%. **Conclusion:** CTA enables an accurate noninvasive assessment of selected patients following LM PCI. And CTA can be used as a first-line treatment instead of coronary angiography.

INTRODUCTION

It is a dictum that is well accepted in the field of clinical cardiology that substantial left main stenosis (LMS) that is medically controlled is related with an elevated risk of cardiac death that approaches 50 % [1]. There is involvement of atheroma from the distal left main (LM) into the proximal left anterior descending (LAD) artery in the majority of instances of distal left main stenosis (distal LMS). This is most likely the result of accelerated atherosclerosis occurring in a region of the distal wall of the proximal LAD those experiences minimal shear stress. Significant left main stem (LMS) is seen in between 5 and 7 % of individuals who have coronary angiograms done. In right dominant type coronary circulation, LM feeds 75%, whereas in left dominant type coronary circulation, LM supplies 100% of the myocardium. The LM may be broken down into three distinct anatomical regions: the ostium, the mid-part, and the distal section [2]. CTA, or computed tomography angiography, is a well-established noninvasive imaging method for the coronary arteries. Although a number of experiments have shown that it may be used to evaluate the patency of stents, a precise evaluation inside the lumen of the stent is made more difficult because of the blooming artefact, which is created when the metallic struts of the stent are artificially enlarged [3]. The effect of the blooming artefact on the assessment of the structures contained within the stent has a negative correlation with the diameter of the vessel. Neointimal hyperplasia can be identified on CTA in bigger-vessel coronary stents,

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including those implanted in the LM coronary artery. This demonstrates CTA's potential for identifying in-stent restenosis (ISR) in particular lesion subgroups [4]. Although coronary artery bypass graft (CABG) surgery is still recommended in patients of LM disease, the new-generation drug-eluting stents (DES) has led to an increased use of left main (PCI) in contemporary interventional cardiology [5, 6]. However, the mortality rate of LM ISR is greater; hence, thorough supervision in the form of routine angiography is required every three to six months [7]. Therefore, a noninvasive approach to identify ISR and its clinical relevance is of clinical importance in this patient subsets. This patient subset includes patients who have had a previous diagnosis of ISR. In this study, our objective was to evaluate the percentage of LM PCI patients who had ISR as well as the diagnostic performance of CTA in identifying ISR.

METHODS

Between October 2021 and January 2022, we assessed 263 consecutive patients who had LM PCI for inclusion in a protocol to do CTA to search for ISR. All patients in sinus rhythm who could hold their breath for 20 seconds were eligible. Patients with contrast allergy, renal dysfunction (creatinine > 1.8 mg/dL), poor rate control or contraindication to beta-blockers, obesity (body mass index > 30 kg/m2), and acute coronary syndrome (ACS) at the time of selection were excluded from the trial. The Armed Forces Institute of Cardiology's institutional review board authorized the study (ID# 31/1/R&D/2022/146), and all participants provided written informed permission in accordance with the Helsinki Declaration. After three months of LM PCI, CTA was done, and patients with a heartbeat of more than 70 times per minute were given 50 mg of metoprolol in tablet 30 minutes before the scan. All scans were conducted on a 64-slice multi slice CT scanner. After administering a bolus of 100 mL of contrast at 5 mL/s, CTA data were collected during a single breath hold once the contrast reached the ascending aorta at a predetermined 100 HU. The 64-slice CT was calibrated with detector. All data were rebuilt with a 630*512-pixel field of view image matrix and a crisp heart view. Motor artefacts were reduced using cardiac cycle optimization and ECG gated image reconstruction. Two expert scientists examined CTA data sets for the presence of ISR. In the case of LM bifurcation stenting, all three segments (LM, LAD, and LCX) were seen independently. The stent lumen was classified as (i) patent with no apparent ISR, (ii) patent with non-obstructive ISR (<50 % stenosis), (iii) patent with obstructive ISR (≥50 % stenosis), or (iv) fully blocked. Consensus was used to diagnose ISR. Consensus was defined as both the CT experts agreeing to the same classification of in-stent restenosis. Subjects were considered to be positive for ISR with either patent with obstructive ISR (≥50 % stenosis), or fully blocked vessel. Angiography was taken as gold standard. Continuous variables were displayed as mean and standard deviation (SD), whereas categorical data were displayed as frequency and percentages. Kappa statistics was used to determine interobserver variability. The accuracy of CTA was assessed by positive predictive value (PPV), negative predictive value (NPV), sensitivity, and specificity by forming 2x2 table. All the data were analyzed using SPSS version 25.0.

RESULTS

According to the exclusion criteria, 133 of the 263 eligible patients were excluded from this research. On traditional angiography, 74 patients had ISR, 24 had an insufficient scan, and 35 experienced tachycardia that did not respond to rate-limiting medications. The remaining 130 people were chosen as the research population. Table 1 summarizes the baseline and procedure characteristics. The median time between PCI and CTA was 194 days, with a mean basal heart rate of 69 ± 12 beats per minute. Seventy patients were given extra beta blockers, resulting in a pre-scan heart rate of 57 ± 12 bpm on average. The vast majority of patients (73.8 %) had PCI from LM to LAD and 16.2 % from LM to LCX. Only 10% of patients had bifurcation PCI, and all patients had DES (100 %). The average period for ISR development was 125 months, with ISR rates of 32.2 % in the LM to LAD cohort and 38 % in the LM to LCX cohort, separately from the total population size (Table 1).

Variable	Patients (n = 130)
Age (years)	61 ± 12
Males	74 (56.9%)
BMI	27 ± 5
Comorbidities	
DM	47 (36.2%)
HTN	27 (20.8%)
CKD	1 (0.8%)
Dyslipidemia	30 (23.1%)
Smoking	17 (13.1%)
Prior MI	22 (16.9%)
Prior CABG	6 (4.6%)
Prior PCI	20 (15.4%)
Heart rate	69 ± 12
Stent location	
LM to LAD	96 (73.8%)
LM to LCX	21 (16.2%)
Bifurcation dual stent	13 (10%)
ISR time (months)	12 ± 5
ISR rate for vessel (angiography findings)	
LM to LAD	31 (23.8%)
LM to LXC	8 (6.2%)

Table 1: Baseline and procedural characteristics

Table 2 summarizes the diagnostic accuracy of CTA. Seven individuals tested false positive for neointimal hyperplasia. CTA had 100 % sensitivity and negative predictive value for

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detecting ISR, while specificity was 92.3 % and positive predictive value was 84.7 %. Kappa statistics were used to determine interobserver variability, which revealed Substantial interobserver agreement for detecting ISR (k-value 0.79).

Variable	All patients
True negative	84 (64.6 %)
True positive	39(30 %)
False negative	0 (0 %)
False positive	7(5.3 %)
Sensitivity (%)	100 %
Specificity (%)	92.3 %
Positive predictive value (%)	84.7 %
Negative predictive value (%)	100 %

Table 2: Diagnostic accuracy of CTA to detect ISR

DISCUSSION

The use of CTA in repeat follow-up and identification of ISR is the best-case scenario for LM PCI for a variety of reasons. First, stent implantation is greater in the LM and proximal LAD/LCX due to their larger diameters; second, the proximal LAD generally runs in a scan direction in the axial plane; and third, this region of the coronary tree is reasonably shielded from motion artefact. Modern technology and technological breakthroughs in z-resolution, quick tube rotations, and stent-specific filters have considerably enhanced CTA's ability to measure coronary stent patency [8]. The current study indicated that CTA may be used to quantify ISR in LM PCI. The approach is completely reliable for identifying the presence or absence of ISR. However, a few false negative findings (n=7) were recorded. The most apparent reason is the huge amount of metal at and around the ostium of major arteries, involving up to three layers of struts crushed in bifurcation PCIs [9]. This is a source of big artefact on CTA. To the best of our knowledge, this is Pakistan's first research demonstrating the importance of CTA in identifying ISR in LM PCI. A few studies like Papadopoulou *et al.,* and Poon *et al.,* have shown that CTA has a good accuracy in quantifying the degree of coronary artery stenosis in untreated coronary arteries [10-12]. Similarly, this Mauri *et al.,* described the measurement of ISR using LM stents. However, metal-related blooming abnormalities were found, which can compromise stent lumen vision. LM PCI has fewer patients because a significant degree of ISR had limited its growth as a main revascularization technique until recently. However, the use of DES has lowered ISR rates and improved long-term clinical outcomes [13]. However, ISR continues to occur in the LM and can result in a potentially fatal myocardial infarction [14]. The high radiation dose is a general limitation of the CTA technique; however, new developments such as dual source CT scans allow for significantly lower patient radiation via ECG-gated pulsing [15]. Another application of CTA in LM disease is the use of FFR-CT, for which the evidence has gone beyond validation, by allowing for fewer referrals to ICA. Furthermore, individuals with moderate stenosis and FFR-CT > 0.80 had positive clinical results [16]. In our study, there was no difference between males and females when LM illness was assessed by CTA. Although more research is needed to elucidate possible mechanisms for the link between nonobstructive LM plaque and adverse outcomes in women. Women have highly smaller coronary arterial diameter than men, which has been linked to worst results in women after coronary revascularization and may also increase thrombotic occlusion [17].The ISCHEMIA (International Study of Comparative Health Effectiveness with Medical and Invasive Approaches) study overcame concerns that randomization during ICA would discourage health persons from randomizing patients in the catheterization laboratory who knew they had a high anatomic burden of disease. The use of CTA to address these problems was based on the close relationship between CTA and ICA, and role of CCTA as a tool for improving angiography suite utilization [18-21]. According to the findings of Kumar *et al.,* study, the presence of left main, proximal left anterior descending artery stenosis, was related with an increased risk of cardiovascular events as compared to fever widespread coronary artery disease (CAD). However, this finding barely approached the borderline of being significant. Coronary CTA analyze many patients with negative outcomes with CAD than ICA, which is similar with our result that coronary CTA had a worse specificity when ICA was the reference technique [22]. When compared to ICA, coronary CTA has the potential to identify a greater atherosclerotic load. It may be suggested that this change in procedure would have altered the evaluation of CAD expansion, therefore it would result in conflicting results. Data from the Israeli Survey indicated substantial increase CAD in [23].

CONCLUSIONS

With adequate heart rate management, CTA provides for an accurate noninvasive examination of selected patients following LM stenting. The existence of LM ISR may be practically ruled out by a negative CTA, and as a result, coronary computed tomography angiography (CTA) may be a preffered imaging modality alternative to coronary angiogram.

Conflicts of Interest

The author declares no conflict of interest.

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