Original Article

The Evaluation of Stent Patency Using Computed Angiography Following Left Main Coronary Artery Stenting

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ABSTRACT

The increased chances of in-stent restenosis have led to repeated coronary angiography and left main percutaneous coronary intervention. However, for the evaluation of coronary arteries, computed tomography angiography (CTA) is regarded as a non-invasive intervention. **Objectives:** To evaluate the proportion of in-stent restenosis in the left main PCI and to determine the diagnostic efficacy of CTA in detecting in-stent restenosis. **Methods:** We conducted this study from June 2021 to July 2022. 130 patients were chosen for the study among the 300 LM PCI patients. The CTA was conducted 3 months after the LM PCI. The data were collected and entered into the SPSS software and the descriptive analysis was conducted. **Results:** In our study, the majority of the patients (n=92, 70.8%) of the patients undergoing PCI from the LM to LAD, and the number of patients who went from LM to LCX was 19 patients (14.6%). Only 14.6% of the patients in our study had bifurcation PCI and all 130 (100%) patients had DES. The average period for the development of ISD was 11 months. **Conclusions:** CTA is quite efficient in accurately assessing the selected patients who have undergone LM PCI and CTA can be utilized as the 1" line treatment modality.

INTRODUCTION

It is a well–established known fact in the field of cardiology that patients with left main stenosis which is medically managed have an increased risk of cardio-pulmonary arrest of approximately 50% [1, 2]. In most of the cases involving distal left main stenosis, there is an atheroma contribution from the distal left main (LM) Into the proximal left anterior ascending (LAD) artery [1, 3] This is most probably the outcome of increased frequency of atherosclerosis developing in a section of the proximal LAD's distal wall that undergoes comparatively less shear stress. In about 5 to 7% of patients who have undergone coronary angiogram, a notable left main stem (LMS) is found. The LM supplies blood to about 75% of the right-sided predominant coronary circulation, whereas in the left-sided predominant coronary circulation, the LM provides all the blood to the myocardium [4]. LM can be divided into 3 definite anatomical areas: the ostium, the mid-part, and the distal section [2]. CTA is a well-known noninvasive imaging technique for coronary arteries [5-9]. Although several investigations have proven that it may be

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utilized to evaluate stent patency, a precise evaluation inside the stent lumen is made more challenging due to the susceptibility artifacts that are encountered when the metallic struts of the stent are synthetically widened. The influence of the blooming artifact on the evaluation of the structures contained within the stent exhibits a negative association with the vessel diameter [10]. The proliferation of new smooth muscle cells and connective tissue components(neo-intimal)hyperplasia can be seen in larger vessel coronary stents, inclusive of those placed in the LM coronary artery. This illustrates CTA's ability to detect in-stent restenosis(ISR)in specific lesion subtypes. Although coronary artery bypass graft (CABG) surgery is still preferable in patients with LM illness [3], the utilization of next-generation drug-eluting stents (DES) has led to greater use of left main (PCI) in modern interventional cardiology [3, 11, 12]. Nonetheless, the mortality rate of LM ISR is higher, necessitating close monitoring in the form of regular angiography every three to six months. Hence, a non–invasive method is preferred to determine ISR, and its clinical value is of major importance in medical practice in this patient sub-sets [10]. In this study, our goal was to estimate and analyze the proportion of LM PCI patients who had ISR and the diagnostic importance and accuracy of CTA to detect ISR.

METHODS

We conducted a cross-sectional study in the Cardiology unit of the Jinnah Post Graduate Medical Center (JPMC). 300 patients were found to have LM and underwent PCI from June 2021 to July 2022 out of which, only 130 patients fulfilled the inclusion criteria and were included in the study to conduct CTA to look for ISR. Ethical approval was sought from the hospital (Reference: No.F.2-81/2021-GENL/284/JPMC). The inclusion criteria included all those patients who could hold their breath for 20 seconds in the normal rhythm of the heart and have given consent. The exclusion criteria of our study included all the patients with known hypersensitivity to the radiographic contrast media, nephropathy (creatinine >1.8 mg/dl), adverse reaction to beta-blockers, Acute coronary syndrome, or BMI more than 30kg/m2. PNS granted permission for the trial and all the patients gave signed informed consent. After three months of consecutive LM PCI, CTA was performed after which 50mg metoprolol in oral–tablet form was administered 30 minutes before the scan to patients with a pulse greater than 70 bpm. 64-slice multi-slice CT scanner was used for the scan. CTA data were obtained during a single breath hold after a single large dose of 100 mL of contrast was introduced at a rate of 5 mL/s, once the contrast had reached the ascending aorta at a preset 100 HU. A detector was used to grade the 64-slice CT scan. All the data were reassembled using an inbuilt image matrix in

a CT scan to obtain a clear image of the heart. Motion artifacts were reduced using ECG and cardiac cycle synchronization to reproduce images. CTA data groups were inspected by two specialists to inspect the appearance of ISR. In the presence of LM bifurcation stenting all the three segments (LM, LAD, and LCX) are visualized separately. The stent lumen was divided into four categories: (i) patent with no obvious ISR; (ii) patent with non-obstructive ISR (50% stenosis); (iii) patent with obstructive ISR (50% stenosis); or (iv) entirely occluded. ISR was identified by consensus. The definition of consensus was given as the two CT experts accepting the same classification of in-stent restenosis. Quantitative elements are presented as mean, standard deviation, and discrete elements as frequency and percentages. The interobserver variability was calculated using kappa statistics. Positive predictive value (PPV), negative predictive value (NPV), sensitivity, and specificity are determined to evaluate CTA precision. SPSS version 25.0 has been applied for the analysis of all statistics.

RESULTS

130 patients were enrolled in our study. Table 1 presents the demographic variables and procedure characteristics. The median time of 191 days was set between PCI and CTA, along with the mean basal heart which was set as 71 ± 9 beats per minute. 65 patients had to exceed extra beta blockers, resulting in a pre-scan heart rate of 52±11 bpm on average. A large number of patients were found to have PCI from LM to LAD (70.8%) followed by 14.6% of the patients who had PCI from LM to LCX. 14.6% of the patients had bifurcation PCI, and DES was found in all patients (100 %). The average period for the development ISR was 12 ± 2 months as shown in Table 1.

Table 1: The baseline demographic features and the procedural characteristics.

Variables	Categories	Results (%)
Age (years) (Mean ± SD)		58.2 ± 14
Gender	Male	81 (62.3%)
	female	49 (37.7%)
BMI	>25	79 (60.7%)
	<25	51 (39.2%)
Comorbidities	Hypertension	73 (56.1%)
	Chronic kidney disease	25 (19.2%)
	Diabetes Mellitus	82 (63%)
	Prior MI	21 (16.2%)
	Prior PCI	11 (8.5%)
	Dyslipidemia	39 (30%)
	Prior CABG	13 (10%)
Heart rate (Mean ± SD)		71 ± 9
Smoking	Yes	78 (60%)
Stent location	LM to LCX	19 (14.6%)
	LM to LAD	92 (70.8%)
	ISR time (months)	12 ± 2

	Bifurcation dual stent	19 (14.6%)
ISR rate of vessel (angiography)	LM to LCX	9 (6.9%)
	LM to LAD	37 (28.4%)

Table 2 presented the diagnostic accuracy of CTA. 5 (3.8%) patients were reported to be false positive for neointimal hyperplasia. A 100 % sensitivity was reported with CTA and the negative predictive value (NPV) for detecting ISR as compared to the 93.1% specificity and 85.2% positive predictive value (PPV).

Table 2: The diagnostic accuracy of CTA in detecting ISR

Variables	Results
True positive	41 (31.5%)
True negative	86 (66.1%)
False positive	5 (3.8%)
False-negative	0 (0%)
Sensitivity (%)	100%
Specificity (%)	93.1%
Negative predictive value (NPV) (%)	100%
Positive predictive value (PPV) (%)	85.2%

DISCUSSION

For these reasons, the use of CTA in repeat follow-up and ISR identification is excellent for LM PCI. Due to their bigger diameters, the proximal LAD/LCX and LM have higher stent insertion rates. Additionally, this region of the coronary tree is somewhat shielded from motion artifacts. The proximal LAD frequently travels in an axial plane scan direction. Other technological and scientific advancements, such as rapid tube rotations, stent-specific filters, and z-resolution, have significantly improved CTA's ability to assess coronary stent patency [13]. The current study suggests that CTA can be used to evaluate LM PCI ISR. When determining if ISR is present or not, the method is 100 percent accurate. However, only seven false negative findings (n=7) were discovered [14]. The most obvious explanation is the massive amount of metal found at and near the ostium of major arteries, including up to three layers of struts crushed during bifurcation PCIs [15]. In our study, the false negative finding was 0%. This study showed good specificity and sensitivity for the detection of severe in-stent stenosis for the evaluable stents. Each instance's diagnosis of the patient's severe in-stent stenosis was accurate. Therefore, even if 16-slice MSCT is currently unable to detect modest in-stent hyperplasia, our findings suggest that it can be used to subjectively evaluate coronary stents. A major predictor of stent patency is the presence of contrast enhancement in the conduit distal to the stent, whereas the almost complete absence of distal run-off strongly supports severe stenosis or complete stent obstruction. Numerous studies, including those by Papadopoulou et al., and Poon et al., have shown that CTA is reliable for estimating the severity of coronary artery stenosis in coronary arteries

without treatment [16, 17]. Mauri et al., provided a similar explanation of how to assess ISR with LM stents [18]. However, aberrations in metal-related blooming were found, which might make the stent lumen less visible. LM PCI has fewer patients as a result of a significant quantity of ISR restricting its expansion as a primary revascularization technique until recently. However, DES medication has improved long-term clinical outcomes and decreased ISR rates [19]. In our investigation, CTA did not distinguish between males and females when LM illness was found. To better understand the mechanisms behind the link between nonobstructive LM plaque and worse outcomes in females, more research is necessary. Women's myocardial revascularization outcomes have been linked to poorer outcomes, which may also raise the risk of thrombotic occlusion because their coronary arteries are significantly smaller than that of men [20].

CONCLUSIONS

Based on the findings of our study, we conclude that the CTA is quite efficient in accurately assessing the selected patients who have undergone LM PCI and CTA can be utilized as the 1" line treatment modality.

Authors Contribution

Conceptualization: MN, RA
Methodology: AZ, HU, SK
Formal analysis: NJ, AA
Writing-review and editing: MS, NA, RA, AA
All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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