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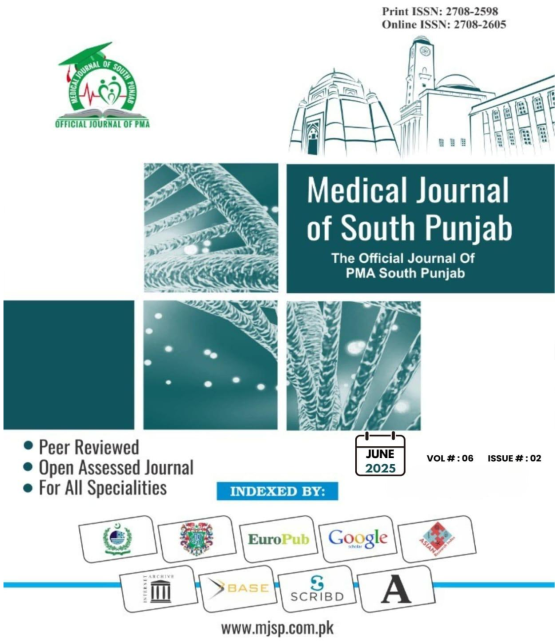

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Original Article

Increase in Vessel Luminal Diameter after Rotational Atherectomy: A study from Multan Institute of Cardiology, Pakistan

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ABSTRACT

Objective: To determine the increase in vessel luminal diameter in patients undergoing rotational atherectomy at Multan Institute of Cardiology, Pakistan.

Methods: Our study enrolled 100 patients undergoing rotational atherectomy. After recording baseline characteristics, the pre- and post-procedural minimal luminal diameters and reference vessel diameters were noted. The change in luminal diameter was recorded in terms of mean and standard deviation. We stratified the data, applied a post-stratification t-test, and considered a *p*-value of less than 0.05 to be statistically significant.

Results: The mean age was 52.20 ± 11.19 years, with a higher proportion of male patients (76.0%). Risk factors included hypertension (45.0%), smoking (40.0%), diabetes (34.0%), and hyperlipidemia (32.0%). The most frequently involved lesion was the left anterior descending artery (LAD: 55.0%), with mid-distal location (65.0%) and severe calcification (71.0%). The minimal lumen diameter (MLD) significantly increased from pre-procedure and post-procedure 0.75 ± 0.14 mm to 1.88 ± 0.22 mm ($p < 0.001$). At the same time, the mean luminal gain was 1.13±0.026 mm. The luminal gain with relation to reference diameter was 46%.

Conclusion: Rotational atherectomy can lead to significant luminal gain with remarkable procedural success.

Keywords : Rotablation; Rotational Atherectomy; Rotational Angioplasty; Luminal Diameter; Vessel Diameter

1. INTRODUCTION

Despite considerable progress in percutaneous coronary intervention (PCI) over the last four decades, severe calcification within atherosclerotic plaque remains the principal factor contributing to adverse clinical outcomes in patients. [1,2] The incidence of significant coronary calcification is increasing, linked to an aging demographic. [3,4] Significant calcifications in coronary arteries pose a major challenge to the successful implantation and expansion of stents. Intracoronary imaging is crucial for the identification, localization, and quantification of coronary calcification. [5] Planning for PCI is recommended, especially in cases where substantial calcification is expected. [6] Interventional devices intended to alter calcified lesions before balloon angioplasty and stenting are classified into two techniques: atherectomy and non-atherectomy techniques. Lesion modification options that exclude atherectomy include balloon-based procedures, such as cutting/scoring balloons, semi-compliant balloons, ultra-high-pressure balloons, and intravascular lithotripsy.

Rotational atherectomy (RA), or rotablation, was introduced three decades ago as a treatment for complex CAD characterised by severely calcified lesions. [7] In 2015, the UK had the incidence of RA procedure during PCI (3.1%), despite >20% of highly calcified coronary lesions being treated with PCI throughout Europe [5,8]. International rates range from 0.8% to 3.1%. The absence of standardised procedures, inadequately structured training, and challenges associated with procedural complexity impede the broader adoption of RA [9,10].

In a study in Pakistan, calcification was mild to moderate in 16.4% and severe in 9.6% of patients, indicating a notable presence of vascular calcification in this group [11]. The prevalence of patients who require rotablation is significantly high. However, the data regarding the rate of estimated procedures undergoing rotablation is lacking. Outcomes and characteristics of RA in our patients are expected to differ due to increased age, frailty, multiple co-morbidities, and complex lesions[12]. Additionally, numerous studies conducted on Western populations have demonstrated the effectiveness of RA in improving vascular patency and procedural success [13,14]. Nevertheless, data concerning South Asian populations, particularly from Pakistan, are scarce, despite the rising incidence of complex coronary lesions in this area [15]. This study was conducted at the Multan Institute of Cardiology, Pakistan, to evaluate the increase in vessel luminal diameter in patients undergoing RA. This evaluation is essential for understanding procedural outcomes and guiding optimal interventional strategies tailored to the local patient population.

2. METHODOLOGY

Following institutional ethical approval (ERB# 122, dated April 9, 2024), a descriptive study was conducted at the Cardiology Department of CPEIC, Multan, from April 10, 2024, to April 10, 2025. One hundred patients were enrolled, as the minimum sample size required was 85, calculated using the WHO calculator, with an absolute precision of 10% and a 33% increase in luminal diameter. Patients 18 years and older, undergoing elective PCI with rotational atherectomy for severely calcified coronary lesions, having de novo coronary artery disease (CAD) with significant stenosis (>70%) in at least one major epicardial vessel, lesions considered undilatable or high resistance to balloon angioplasty, requiring plaque modification, reference vessel diameter between 2.5 mm and 4.0 mm, and those who are unwilling or not ideal candidates for CABG were included in the study. Patients with severe left ventricular dysfunction (LVEF <30%), unprotected left primary disease requiring atherectomy, severe renal impairment (eGFR <30 mL/min/1.73 m^2) or on dialysis, active bleeding or contraindications to antiplatelet therapy, severe allergy to contrast media or medications used during PCI, Pregnancy or lactation, and in-stent restenosis (ISR) requiring repeat RA were excluded from the study.

After obtaining informed written consent, the study included a minimum of 100 patients who fulfilled the inclusion criteria. Baseline characteristics, including age, gender, DM, HTN, smoking, hyperlipidemia, culprit vessel, lesion location, and lesion calcification severity, were noted. The minimal luminal diameter (MLD) and reference vessel diameter were measured before the procedure using quantitative coronary angiography (QCA) or intravascular imaging. After coronary catheter engagement and lesion wiring according to standard protocol, a Rotablator system (Boston Scientific) was used during the RA procedure. The burr size was selected based on the lesion and vessel size, usually ranging between 1.25 mm and 1.75 mm. Rotational speed was maintained between 140,000 and 180,000 rpm. Multiple short burr runs were performed, each lasting no more than 20 seconds, with adequate flushing between passes to minimise complications. Adjunctive therapies, such as cutting balloons or non-compliant balloon angioplasty, were used when necessary to optimize lesion preparation. Stenting was performed according to the standard protocol, and post-dilatation was documented. Procedural parameters such as fluoroscopy time and contrast volume were documented. Post-procedure, the final MLD was measured to assess luminal gain. Angiographic success was defined as achieving TIMI grade 3 flow with residual stenosis <30%. Complications such as coronary dissection, perforation, slow flow/no-reflow, bleeding, or periprocedural myocardial infarction were monitored and recorded.

Data was analysed using SPSS v.26. Qualitative variables, such as gender, DM, HTN, smoker, hyperlipidemia, culprit vessel, lesion location (proximal/mid/distal), lesion calcification (diffuse/non-diffuse), and procedural success, were measured in frequency and percentages. Quantitative variables, including age, minimal luminal diameter (pre- and post-procedure), minimum reference vessel diameter (pre- and post-procedure), and TIMI flow grade (pre- and post-procedure), were measured in terms of mean and standard deviation. The luminal gain was recorded in terms of mean, standard deviation, and percentage, using the formula: [(post-MLD − Pre-MLD)/ mean pre RVD]. Pre- and post-MLD, RVD were compared, and a p-value of ≤ 0.05 was considered statistically significant.

3. RESULTS

The study included 100 patients who met the inclusion criteria. The mean age was 52.20 ± 11.19 years. There were more male (76.0%) patients. Baseline comorbidities included hypertension (45.0%), smoking (40.0%), diabetes (34.0%), and hyperlipidemia (32.0%). Lesions most frequently involved the left anterior descending artery (LAD: 55.0%), followed by the right coronary artery (RCA: 29.0%), with mid-distal location (65.0%) and severe calcification (71.0%). Procedural parameters included a mean lesion length of 22.29 ± 5.22 mm, burr size of 1.58 ± 0.22 mm, and rotational speed of $178{,}323\pm6{,}867.63$ RPM. (Table. I). The mean proximal reference diameter decreased from pre-procedure and post-procedure 2.58 ± 0.35 mm to 2.39 ± 0.11 mm ($p < 0.001$). The minimal lumen diameter (MLD) significantly increased from pre-procedure and post-procedure 0.75 ± 0.14 mm to 1.88 ± 0.22 mm ($p < 0.001$). The distal reference diameter decreased from pre-procedure and post-procedure 2.30 ± 0.32 mm to 2.01 ± 0.56 mm ($p < 0.001$). (Table. II). Procedural success was observed as (96.0%). (Figure. I). At the same time, the mean luminal gain was 1.13 ± 0.026 mm. The luminal gain with relation to reference diameter was 46%.

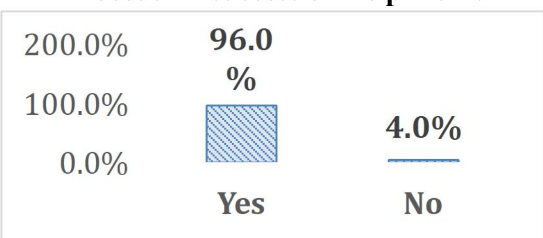
Table-I: Demographics, baseline, and lesion characteristics of the patients

Characteristics	N (%)	Mean ± S.D
Demographics characteristics		
Age (years)		52.20±11.19
≤40	23 (23.0)	
>40	77 (77.0)	
Gender		
Male	76 (76.0)	
Female	24 (24.0)	
Baseline characteristics		
Diabetes	34 (34.0)	
Hypertension	45 (45.0)	
Smoking	40 (40.0)	
Hyperlipidemia	32 (32.0)	
Lesion characteristics		
Culprit vessel		
LAD	55 (55.0)	
RCA	29 (29.0)	
LCX	9 (9.0)	
LM to LAD/LCX	7 (7.0)	
Lesion location		
Mid-distal	65 (65.0)	
Osteo-proximal	35 (35.0)	
Calcification		
Mild to moderate	29 (29.0)	
Severe	71 (71.0)	
Lesion length (mm)		22.29±5.22
Burr Size (mm)		1.58±0.22
Rotation Per Minute		178323±6867.63

Table-II: Comparison of Pre-procedure and post-procedure vessel diameters

Variable	Pre-procedure (Mean ± S.D)	Post-procedure (Mean ± S.D)	Mean difference	t-test value	p-value
Proximal reference (mm)	2.58±0.35	2.39±0.11	-0.19	5.32	<0.001
MLD (mm)	0.75±0.14	1.88±0.22	1.13	-40.79	<0.001
Distal reference (mm)	2.30±0.32	2.01±0.56	-0.29	4.11	<0.001

Figure-I
Procedural success of the patients



4. DISCUSSION

Atherectomy techniques, like rotational and orbital methods, utilize a rapidly spinning burr to modify calcified plaques. RA is performed in various conditions, encompassing high-risk patients and complex anatomical structures. The device utilizes a diamond-encrusted elliptical burr to ablate calcified plaque, rotating at speeds ranging from 140,000 to 180,000 rpm via a helical drive shaft. This has progressed to a calcified lesion, utilizing a specialized guidewire. A single burr passage generally suffices to refine the arterial lumen and eliminate intravascular calcium rings, thus aiding the passage and dilation of balloons for stent implantation.

In our study, the mean age of the population undergoing rota ablation was 52.20 ± 11.19 years. Most patients were male (76.0%). Risk factors included hypertension (45.0%), smoking (40.0%), diabetes (34.0%), and hyperlipidemia (32.0%). In most studies, the mean age of the population is around 69-75 years, [16,17,] which is older than ours, indicating changes in calcified lesions at an early age, likely due to an increase in diabetes. [18] A separate study indicated that systolic blood pressure (BP) ≥ 140 mmHg, extended lesion length, acute angulation, elevated initial burr-to-artery ratio, and the use of beta blockers were adverse prognostic indicators in patients undergoing RA[19].

In our study, the lesions most commonly undergoing RA were LAD (55%), with mid-distal location (65.0%) and severe calcification (71.0%). Procedural parameters included a mean lesion length of 22.29±5.22 mm, burr size of 1.58±0.22 mm, and rotational speed of 178,323±6,867.63 RPM. These findings were consistent with a study by Chen et al., in which the LAD was involved in 57% of patients. The mid-distal location was observed in 60% of cases, and heavy calcification was present in 80% of the population. In >50% patients, burr size of 1.5

used [20]. Another study reported 73% of heavy calcifications in RA patients [21]. Procedural success was observed as (96.0%). At the same time, the mean luminal gain was 1.13±0.026 mm (46%). The procedural success rate of the CTO-vessel undergoing RA was 93%, as reported by Ayoub et al. [22] The procedural success was 97% in a study by Khan et al. [12]. The luminal gain in ISR patients undergoing RA was 41.3% in a survey conducted by Sayegh et al [23]. At the same time, the luminal gain was 1.34 mm, as reported by Farhat et al. [24] Our study has a few limitations, including being a single-center study with a relatively small sample size. Moreover, it was just a descriptive study with no MACES on follow-up. Further studies with a like comparison of Rota-ablation efficacy at different speeds, burr sizes, and measurement of vessel size using advanced modalities like IVUS are recommended.

5. CONCLUSION

Our study concludes that rotational atherectomy can result in significant luminal gain of up to 46% and remarkable procedural success of up to 96%. This study demonstrates that RA significantly increases the vessel luminal diameter, facilitating optimal stent delivery and expansion. The findings from our study validated the procedural efficacy and safety of RA in the local population, supporting its use in complex percutaneous coronary interventions (PCIs).

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