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Analysis of Coronary Artery Rotational Atherectomy: A Single Centre Study

Suresh V Patted[1], Sanjay C Porwal[2], Sameer Ambar[3], Prasad MR[4], Vasu Babu Nukavarapu[5], Vishwanath Hesarur[4], Vaibhav Patil[4], Suhasini Atharga[4]

[1]*Professor and HOD, Department of Cardiology, J N Medical College, Belagavi, Karnataka, India*

[2]*Professor, Department of Cardiology, J N Medical College, Belagavi, Karnataka, India*

[3]*Associate Professor, Department of Cardiology, J N Medical College, Belagavi, Karnataka, India*

[4]*Assistant Professor, Department of Cardiology, J N Medical College, Belagavi, Karnataka, India*

[5]*Senior Resident, Department of Cardiology, J N Medical College, Belagavi, Karnataka, India*

[*]**Corresponding author:** Suresh V Patted, Professor and HOD, Department of Cardiology, J N Medical College, Belagavi, Karnataka, India, Tel: + 91 9845683888; E-mail: drpatted@yahoo.com

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Abstract

Background: Rotational Atherectomy (RA) is a valuable tool for treating severely calcified complex coronary artery disease in the Cardiac Cath lab despite a lot of helpful techniques and devices, but this is under used now due to technique demands and non-superior outcomes. The aim of our study was to evaluate the procedural and clinical outcomes of patients with complex severely calcified lesions treated by RA in the current era.

Materials and methods: This retrospective study was conducted from February 2015 to February 2019. All consecutive patients who underwent RA for severely calcified lesions were included in the study. The angiographic and procedural parameters and clinical outcomes were analyzed.

Results: A total of 115 patients with complex, severely calcified coronary lesions who underwent RA were included in the study. Out of which 88% were male and 12% were female. The mean age at presentation was 65.6 ± 7.7 years. Most patients (83.4%) underwent RA in Left Anterior Descending artery (LAD) followed by Right Coronary Artery (RCA) (12.2%), Left Circumflex Artery (LCX) (3.5%) and Left Main (LM) (0.9%). The average length of calcium and coronary artery calcium score were 27 ± 10 mm and 3.84 ± 0.77 respectively. Eleven (9.5%) patients underwent RA for in-stent restenosis. There were two (1.74%) in-stent thrombosis, two (1.74%) patients had perforation and one (0.87%) patient had dissection. The In-hospital MACE was 3.5% and MACE at 23 months follow up was 6.09%.

Conclusion: RA in complex, severely calcified coronary lesions can achieve very low complication and low out of hospital major adverse cardiac event rates even in high-risk patients. The study results convince us to sustain and even broaden the use of this novel, but under used, device in this era.

Keywords: Rotational atherectomy; Calcium; Burr size

Introduction

Severely calcified coronary lesions, due to the rigidity, requires multiple balloon inflations at high pressures to eliminate the "waist" of the stenosis and the vessels exposed to this high inflation pressure had a significantly higher incidence of mural thrombus formation, dissection, perforation and medical necrosis [1]. The calcified lesions cannot be crossed with even the smallest available balloons sometimes and very tight lesions may resist dilatation even at the highest possible balloon pressure or may cause rupture of the balloons at low inflation pressure. Stent delivery to this type of calcified lesions may be difficult and stent expansion sub-optimal due to high resistance of the calcified plaques and may potentially lead to in-stent thrombosis. Rotational Atherectomy (RA), with its ability to differentially ablate calcified plaques, is very useful in the calcified lesions [2-4]. First case of RA was performed by Jerome Ritchie, David Auth and colleagues in 1987 [5]. Although coronary Angioplasty has evolved tremendously, RA has an established role in treatment of complex calcified coronary artery disease. Initially introduced as an alternative procedure, but now has become an adjunct procedure during coronary intervention especially in heavily calcified or fibrotic lesions [6,7]. RA debulks the lesion by physical removal of plaque, causing plaque modification and allows additional devices like stents, balloons, thereby increasing the procedural success [8]. Initially this was adopted in about 10% of all Percutaneous Coronary Interventions (PCI), and now a days used only in 3-5% of all cases. The utility of RA is limited in tortuous and angulated coronary arteries, with increased risk of vessel perforation and difficulty in delivery of the RA burr [8]. RA is underused in the present era, in view of availability, cost, procedural expertise, complications associated with it. Most studies done showed a high MACE in the hospital and out of hospital. Hence this study was undertaken to know procedural characteristics and MACE in the hospital and out of hospital.

Materials and Methods

This single center retrospective study was done in KLE'S Dr.Prabhakar kore hospital and Medical Research Centre from

February 2015 to February 2019. A total of 6489 coronary angioplasties were done during this period and out of which 115 patients underwent RA. From February 2015 to February 2019, all consecutive patients who required RA treatment for severely calcified lesions of coronary artery were included in the study. The angiographic characteristics of the target coronary lesions in the coronary angiogram were obtained by reviewing session cine thoroughly. The coronary artery disease vessel numbers were defined as the number of major coronary vessels that had a 70% or greater stenotic diameter. Coronary artery calcification was defined as readily apparent radio-opacities within the vascular wall before contrast medium injection. The coronary artery calcium score in the target lesion is measured by cine-fluoroscopy at the time of diagnostic coronary angiography.

The angiographic scoring system is as follows: 0 is none; 1 is blocky or spotty calcification; 2 is linear calcification compromising one side of the arterial lumen; 3 is linear calcification found unidirectionally compromising both sides of the arterial lumen; 4 is linear calcification found bi-directionally compromising both sides of the arterial lumen; and 5 is blanket/circumferential and dense calcification [9]. All PCIs were performed by experienced cardiologists using standard practice at our Cath lab. Patients were pretreated with aspirin and clopidogrel/ticagrelor/prasugrel. Heparin was administered to maintain an activated clotting time (ACT) of > 300 seconds. Rotablation procedure was started with a 1.25 or 1.5 mm burr at a speed of 1,50,000 to 2,00,000 rpm. The PCI was then followed with the balloon dilatation and drug eluting stent (DES) implantation. Dual antiplatelet therapy was continued for all patients for at least 12 months after DES implantation. In hospital MACEs were defined as cardiac tamponade, myocardial infarction, in-stent thrombosis, target vessel reintervention, and death. Patients were followed up for any out of hospital MACE defined as cardiac death, non-cardiac death, and stent thrombosis and target vessel revascularization. Descriptive statistical analysis was done using SPSS software.

Results

During the study period, a total of 115 (1.77% of all PCIs) patients underwent rotablation. The baseline demographics of all patients were shown in Table 1. The mean age at presentation was 65.6 ± 7.7 years. 88% were males and 12% were females. Most of the patients (71%) are above the age of 60 years. Maximum number of patients is between the age group of 61 to 70 years (49%). The minimum age in the study group was 49 years, maximum age was 85 years. In males the minimum age was 49 years and in females minimum age was 53 years. Fifty-six (48.7%) patients had diabetes mellitus and 67 (58.2%) patients had systemic hypertension in the study population. Three (2.6%) patients had chronic kidney disease, three (2.6%) patients had peripheral vascular disease, fifteen (13%) patients had prior Myocardial Infarction, six (5.2%) patients had prior cerebral vascular accident. Eighteen (15.6%) patients underwent prior PCI; four (3.4%) patients underwent prior coronary artery bypass graft (CABG). Sixteen (13.9%) patients presented with treadmill test (TMT) positive status, fifty-six (48.7%) patients presented with unstable angina, five (4.35%) patients presented with non st-segment elevation myocardial infarction (NSTEMI), thirty-eight (33%) patients presented with st-segment elevation myocardial infarction (STEMI).

The angiographic and procedural characteristics are shown in Table 2. Forty-one (35.6%) patients have single vessel disease, forty-nine (42.6%) patients had double vessel disease, twenty-five (21.8%) patients had triple vessel disease. Left anterior descending artery was involved in 95.6%, Left circumflex artery was involved in 29.5% of the patients, right coronary artery was involved in 49.5%, and ramus was involved in 0.86% of patients. The complexity of the lesions according to society of cardiovascular angiography and interventions (SCAI) classification was, one (1.74%) patient in type 1, fifty-five (47.83%) patients in type 2, thirteen (11.3%) in type 3, forty-five (39.13%) in type 4 category. Eleven (9.5%) patients underwent RA in in-stent restenosis.

Demographics of patients	Values
Age (y)	65.63 ± 7.79
Male (N), %	101 (88%)
Systemic hypertension (N), %	67 (58.26%)
Diabetes mellitus (N), %	56 (48.7%)
Chronic renal failure (N), %	3 (2.61%)
Prior MI (N), %	15 (13.04%)
Prior PCI (N), %	18 (15.6%)
Prior CABG (N), %	4 (3.48%)
Clinical presentation (N), %	
Unstable angina	56 (48.7%)
TMT Positive	16 (13.91%)
NSTEMI	5 (4.35%)
STEMI	38 (33.04%)
LVEF (%)	54.13 ± 12.2
Heamoglobin (g/dl)	12.52 ± 2.17
Creatinine (mg/dL)	1.00 ± 0.35
Plasma glucose (mg/dL)	149 ± 80

Note: Myocardial Infarction (MI), Percutaneous coronary intervention (PCI), Coronary artery bypass grafting (CABG), Tread mill test (TMT), Non st elevation myocardial infarction (NSTEMI), st elevation myocardial infarction (STEMI), Left ventricular ejection fraction (LVEF).

Table 1: Demographics of patients.

In all the cases procedure was done through femoral route. BMW was used in eighty two (71.3%) patients, grand slam was used in nineteen (16.52%) patients whisper ES was used in six (5.22%) patients, fielder xt was used in three (2.61%) patients, cross it 100xt was used in one (0.87%), cross-it 100 in one (0.87%) patient, scion blue in one (0.87%) patient, wizard 3 in one (0.87%) patient. Guiding catheter was EBU in eighty (71.3%) patients, JL in twenty-one (18.2%) patients, JR in twelve (10.5%) patients. The RA was done in single vessel in 114 (99.1%) patients and two vessels in one (0.9%) patient. RA was done in LAD in ninety-six (83.4%) patients, LCX in four (3.5%), LM in one (0.9%) patient and RCA in fourteen (12.2%) patients. The average length of calcium in the vessel is 27 ± 10 mm. The average coronary artery calcium score was 3.84 ± 0.77. The burr size used was 1.25 mm (27 patients-23.48%) and 1.5 mm (88 patients-76.52%). The no of times burred was from 1 to 4 times. The average time of burring was 30.5 ± 7.7 sec. Post dilatation was done in 98% of patients. The mean balloon diameter was 2.91 ± 0.49 mm;

length was 14.58 ± 3.96 mm. The mean Diameter of the stent was 3.32 ± 0.54 mm. The mean length of the stent was 42.72 ± 17.14 mm. The no of vessels stented was 1 to 2. The no of stents in the target vessel was from 1 to 3 stents. Evorilimus stent was used in 84 (73%) patients; sirolimus stent was used in 29 (25%) patients. The average time of PCI was 49.15 ± 16.73 sec. The In-hospital MACE was 3.5%. There were two (1.74%) in-stent thrombosis, two (1.74%) patients had perforation and one (0.87%) patient had dissection. Intra-aortic balloon pump (IABP) was used in one (0.87%) patient, two (1.74%) patients had struck burr. Intravascular ultra sonography (IVUS) was used in five (4.35%) patients, Optical coherence tomography (OCT0 was used in 4 (3.48%) patients. The out of hospital mortality was 6.09% with a mean follow up of 23 months.

Characteristics	Values
CAD vessel numbers (n), %	
Single-vessel disease	41 (35.65%)
Double vessel Disease	49 (42.61%)
Triple vessel Disease	25 (21.74%)
Target vessel (n), %	
Left main	1 (0.87%)
Left anterior descending artery	96 (83.48%)
Left circumflex artery	4 (3.48%)
Right coronary artery	14 (12.17%)
CAC score	3.84 ± 0.77
Length of calcium (mm)	27 ± 10.25
DES implantation (n), %	113 (98.2%)
Mean stent diameter (mm)	3.32 ± 0.54
Total stent length in Target vessel (mm)	42.51 ± 16.64
Total stent length per patient (mm)	50.96 ± 20.83
Balloon post dilatation (n), %	113 (98.26 %)
Average balloon diameter (mm)	2.91 ± 0.49
Average Balloon Length (mm)	14.58 ± 3.96
Average inflation pressure (atm)	14.27 ± 3.07
Note: Coronary artery disease (CAD), Coronary artery calcium score (CAC), Drug eluting stent (DES)	

Table 2: Characteristics of included participants.

Discussion

Rotational atherectomy remains a valuable tool for treating severely calcified complex coronary arteries disease in the cardiac Cath lab despite a lot of helpful techniques and devices. RA is a debulking device that physically removes the plaque and reduces plaque rigidity altering vessel compliance, similar to that achieved by a dental drill. The principle of RA is of "differential cutting", ablating only the calcified and fibrotic "non-compliant" tissue, while retaining the elastic arterial wall and the "ablated" plaque is broken into particles that are smaller than 5 micro M in diameter that pass through the vasculature and absorbed by the Reticulo-endothelial System [10]. These lesions should be pre-treated, and thereby reducing the vessel rigidity and facilitating subsequent interventions [11].

Excimer laser is one of the reasonable alternatives and is very expensive and not available in most Cath labs and is useless in heavily calcified lesions [12,13]. In the bare metal stent (BMS) era, the combination of RA and BMS was reported to be likely associated with optimal final lumen dimensions [14]. The results of RA plus BMS were not so good as expected [15]. RA is an effective and less expensive debulking modality and readily available in most Cath labs. RA is more cumbersome to set up, more difficult to use, especially for distal lesions, and more prone to complications if not adequately prepared or performed [16,17].

Therefore, RA has usually been underused, even in this era [18]. A total of 115 patients underwent RA, when compared with Garcia ET al and Chiang et al. where the study population was 50 and 67 patients respectively [19,20]. The mean age of presentation in our study was 65.6 ± 7.7 years, when compared to Chiang et al (73.2 ± 10.3 years) and Clavijo et al. (71.5 ± 9.6 years) [19,21]. The calcium score in our study was 3.7 ± 0.77, when compared with Chiang et al. it was 2.5 ± 0.619.

Parameters	Distribution (n=115) Number	Percentage
In hospital MACE		
Death	4	3.48
Q wave MI	0	0
Non Q wave MI	0	0
Target vessel revascularization	2	1.74
Out of hospital MACE		
Death	7	6.09
Q wave MI	0	0
Non Q wave MI	0	0
Target vessel revascularization	0	0
Stent thrombosis	2	1.74
Definite	2	1.74
Probable	0	0
Possible	0	0
Acute	2	1.74
Subacute	0	0
Late	0	0
Very late	0	0
Note: MACE-Major Adverse Cardiovascular Events		

Table 3: In hospital mace and stent thrombosis incidence.

There were recorded arrhythmias in eleven patients where in patients, seven (6.09%) patients who have reversible AV blocks (were put on temporary pacemaker and removed on second or third day. One (0.8%) patient had paroxysmal atrial fibrillation. Three (2.61%) patients had ventricular tachycardia and cardioverted to sinus rhythm.

Four (3.48%) patients died in the hospital, when compared with Garcia et al which was 4%, Chiang et al. which was 7.5%, our overall mortality is less [19-21]. Two patients had acute in-stent thrombosis and two patients had cardiogenic shock and went into acute kidney injury and expired. There were two (1.74%) perforations on the table and were immediately treated by implanting a covered stent. One (0.87%) patient had cardiac tamponade and emergency pericardiocentesis was done.

There was one (0.87%) dissection during the procedure and stent was deployed at that site. There was struck burr in two (1.74%) patients. There were seven deaths (6.09%) on follow up. Four (3.49%) patients died of non-cardiac cause, two died of Pneumonia, one died of sepsis secondary to diabetic foot and one died of chronic kidney diseases. Three (2.6%) patients died of probable cardiac cause at home. There was no mortality in the first 30 days and 6 months. There was one mortality in the first year, three in the second year and three in the third year. The mortality due to probable cardiac cause was one in first year, one in second year and one in third year. The MACE events and stent thrombosis were shown in Table 3.

There were some of the limitations in our study. The sample size in this single centre study when compared with the no of PCI was less as there were financial constraints for many people. There was no routine angiographic follow up in our study. We had to limit RA use in our study to patients with very unfavourable angiographic characteristics, which otherwise would preclude successful PCI treatment without prior mechanical ablation.

Conclusion

In conclusion, the plaque modification with RA to ensure appropriate stent deployment in complex, heavily calcified lesions appear to be crucial, clinically rewarding, and could be safely accomplished with very low complication and low in hospital and out-of-hospital MACE rates even in high-risk patients. The procedure can be affront in heavily calcified lesions in the present era. The high procedural success rate and very pleasing cumulative MACE incidence convince us to sustain and even broaden the use of this novel but under-used procedure in this era.

Conflicts of Interest

There are no conflicts of interest for the present study.

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