European Heart Journal - Case Reports (2023) **7**, 1–5
https://doi.org/10.1093/ehjcr/ytad207

CASE SERIES
Coronary intervention

Rotational atherectomy for calcified lesions during ST-segment elevation myocardial infarction: a case series and literature review

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Received 15 June 2022; first decision 2 August 2022; accepted 21 April 2023; online publish-ahead-of-print 9 May 2023

Background ST elevation myocardial infarction (STEMI) has traditionally been a relative contraindication for the utilization of rotational atherectomy (RA). However, in severely calcified lesions, RA may be necessary to facilitate stent delivery.

Case summary Three patients who present with STEMI are found to have severely calcified lesions on intravascular ultrasound. Equipment was unable to pass the lesions in all three cases. Rotational atherectomy was therefore performed to allow for stent passage. All three cases had achieved successful revascularization with no intraoperative or post-operative complications. The patients remained angina-free the rest of their hospitalization and at the 4 month follow-up.

Discussion Rotational atherectomy for calcific plaque modification during STEMI when equipment will not pass is a feasible and safe therapeutic option.

Keywords Rotational atherectomy • ST elevation myocardial infarction • Case series

ESC Curriculum 3.2 Acute coronary syndrome • 3.1 Coronary artery disease

Learning points

- ST elevation myocardial infarction (STEMI) lesions that are heavily calcified are difficult and higher risk lesions.
- Rotational atherectomy may have a role for STEMI lesions with heavy calcification in which equipment does not pass.
- Rotational atherectomy may be safe in STEMI lesions with heavy calcification, but larger studies are needed to assess the true safety profile in this unique patient population.

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Tweet: 'Rotational Atherectomy for Calcified Lesions During ST Elevation Myocardial Infarction' See full case series and literature review at (*insert link to article*) authored by @Kristen_BrownMD @AravJhandMD @YChatzizisis @AGoldsweig from @cvUNMC

Introduction

Rotational atherectomy (RA) is a minimally invasive coronary plaque modification procedure using a burr to drill away calcific plaque. PREPARE-Calc, a randomized controlled trial, demonstrated lesion preparation prior to stenting to be a safe and feasible technique in severely calcified coronary lesions.[1] However, ST elevation myocardial infarction (STEMI) has been labelled a relative contraindication by the device manufacturer (Boston Scientific, Marlborough, MA). Since the advent of RA in 1993, there have been only a few reported cases of RA during the treatment of STEMI.[2–13] As the prevalence of heavily calcific coronary artery disease increases with the prevalence of renal disease and the ageing population, it is imperative to explore all avenues for stent delivery in these challenging lesions. For this purpose, we present this series of three cases demonstrating when RA can safely be utilized to treat heavily calcified lesions during STEMI along with a review of the literature.

Timeline

First medical contact (FMC)	Presented to emergency department c/o chest pain
First minute	STAT electrocardiogram (ECG) reveal ST elevation myocardial infarction (STEMI)
Within 30 min of FMC	Emergent coronary angiogram revealed calcified coronary lesions
Within 90 min of FMC	Wire across lesion
Within 120 min of FMC	Intravascular ultrasound demonstrated significant calcification
Within 120 min of FMC	Rotational atherectomy performed
Within 120 min of FMC	Intravascular ultrasound demonstrated reduction in calcific burden
Within 120 min of FMC	Direct stenting of the culprit vessel
Within 120 min Of FMC	Final angiogram

Cases series

Case 1

A 71-year-old male smoker with a history of hypertension presented to the emergency department complaining of crushing substernal chest pain that began 1 h prior not relieved by sublingual nitroglycerin. Electrocardiogram showed ST elevations in II, III, and aVF with III > II and reciprocal ST depressions in V1–V2 and aVL suggestive of an acute right coronary artery infarct (RCA). Vital signs were stable except for slight bradycardia. The patient was loaded with 325 mg aspirin, given 4000 units of heparin, and loaded with ticagrelor 180 mg. Emergent angiography revealed TIMI flow of 1 with a TIMI thrombus grade of 2. The left system had only mild non-obstructive disease. After predilation, intravascular ultrasound (IVUS) failed to pass the 360° calcified lesion. Given the extent of calcification, RA with 1.5 mm burr was performed for plaque modification prior to stent. Following RA of the vessel, the lesion was predilated using non-compliant balloon. Then, three sequential drug-eluting stents (DES) were placed with two in the mid/proximal RCA and one in the posterolateral branch measuring 3.0 × 18 mm, 2.5 × 20 mm, and 2.5 × 15 mm Synergy DES from proximal to distal. Post stenting, IVUS demonstrated stent well seated with good stent apposition with no evidence of no reflow, dissection, or perforation. Final angiography revealed 0% residual stenosis. The patient was angina-free without any significant arrythmia burden for the remainder of their hospitalization and at the 4 month follow-up with evidence of improved ejection fraction and wall motion on transthoracic echocardiogram.

Case 2

A 64-year-old male diabetic with a history of hyperlipidaemia presented to the emergency department complaining of substernal chest pression, diaphoresis, and ST elevations V1–V4 suggestive of a left anterior descending artery (LAD) infarct. The pain began 3 h prior and was not relieved by sublingual nitroglycerin. Vital signs were stable on presentation except for mild sinus tachycardia. The patient was loaded with 325 mg aspirin, given 4000 units of heparin, and loaded with ticagrelor 180 mg. Emergent angiography revealed TIMI flow of 1 with a TIMI thrombus grade 1. The RCA and circumflex had non-obstructive disease. After predilation, IVUS failed to pass the nearly 360° calcified lesion. Given the extent of calcification, RA with 1.75 burr was advanced over the wire and multiple passes of atherectomy were undertaken. The lesion was then predilated using a 3.0 × 27 mm non-compliant balloon. Following predilation, a 3.0 × 38 mm and 3.0 × 12 mm Synergy DES were deployed. After deployment, the stent was post-dilated with a 3.0 × 12 mm and 3.75 × 15 mm non-compliant balloons. Post stenting, IVUS demonstrated stent well seated with good stent apposition with no evidence of no reflow, dissection, or perforation. Final angiography revealed 0% residual stenosis. The patient was angina-free without any significant arrythmia burden for the remainder of their hospitalization and at the 4 month follow-up with evidence of improved ejection fraction and wall motion on transthoracic echocardiogram.

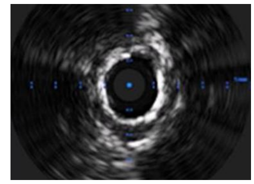
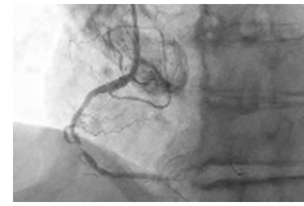
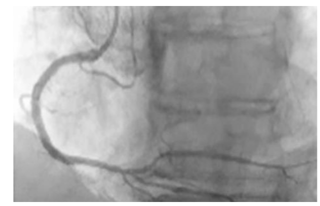
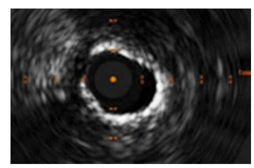
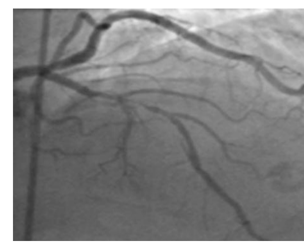
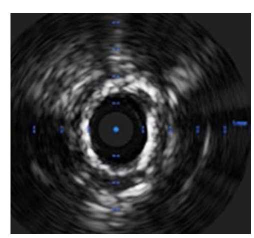
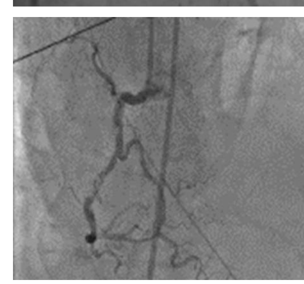
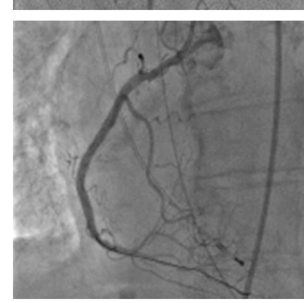
Case 3

A 61-year-old female diabetic with hypertension and end-stage renal disease presented to the emergency department complaining of unrelenting substernal chest pain that began 2 h prior not relieved by sublingual nitroglycerin. Vital signs were stable except mild bradycardia. Electrocardiogram revealed ST elevations in II, III, and aVF suggestive of an RCA STEMI. The patient was loaded with 325 mg aspirin and ticagrelor 180 mg and given 4000 units of heparin. Emergent angiography revealed the RCA had TIMI flow of 0 with a TIMI thrombus grade 3. The LAD and circumflex had no acute pathology but did have significant disease. After predilation, IVUS failed to pass the 360° calcified lesion. Rotational atherectomy with a 1.5 burr was used for plaque modification. The lesion was then predilated, a 2.5 × 15 mm non-compliant balloon. Following pre-dilatation, a 2.75 × 38 mm Resolute Onyx DES was deployed. Post stenting, IVUS demonstrated stent well seated with good stent apposition with no evidence of no reflow, dissection, or perforation. The final angiography revealed 10% residual stenosis. The patient was angina-free without any significant arrythmia burden for the remainder of their hospitalization and at the 4 month follow-up with evidence of improved ejection fraction and wall motion on transthoracic echocardiogram.

Discussion and literature review

While RA is traditionally used to modify stable calcified lesions prior to stenting,[1] the idea of using RA for stent delivery in STEMI has long been considered taboo due to the perceived risk of dissecting the friable ruptured plaque. Our case series demonstrates RA's role in the treatment of heavily calcified STEMI lesions when equipment cannot otherwise be passed. All three cases described in our case series (*Table 1a*) and 100% of cases reported in the literature (*Table 1b*) achieved successful plaque

Table 1 **Current and previously reported cases**

	Age (y)/sex	Comorbidities	Target vessel	Death at 30 days	IVUS	Angiogram before and after
1a: current cases						
1	71/M	HTN, smoker	RCA	No		 
2	64/M	DM, HLD	LAD	No		 
3	61/F	HTN, HLD, ESRD	RCA	No		 
1b: previously reported cases						
Ho *et al.* (2005)[2]	71/M	HTN, HLD	LAD	—		
Mokabberi *et al.* (2010)[3]	77/F	—	RCA	—		
Hussain *et al.* (2011)[4]	73/F	—	LAD	No		

Continued

Table 1 ***Continued***

	Age (y)/ sex	Comorbidities	Target vessel	Death at 30 days	IVUS	Angiogram before and after
Showkathali and Sayer (2013)[5]	70/M	Smoker, HTN	RCA	—		
Bareseghian *et al.* (2014)[6]	83/F	HTN, HLD	RCA	—		
Devidutta *et al.* (2016)[7]	64/M	HTN, HLD	RCA	—		
Goh *et al.* (2017)[8]	73/M	—	LAD	—		
Ielasi *et al.* (2018)[9]	67/M	Smoker	RCA	—		
Shahin *et al.* (2018)[10]	70/M	Smoker, HLD	LAD	No		
Islami *et al.* (2021)[11]	62/M	—	LAD	No		
Kassimis *et al.* (2021)[12]	84/M	HTN, HLD	RCA	—		
Mukhopadhyay *et al.* (2021)[13]	60/M	HTN, HLD, Smoker	LAD	No		

ESRD, end-stage renal disease; HLD, hyperlipidaemia; HTN, hypertension; IVUS, intravascular ultrasound; —, not reported.

modification and revascularization of the affected target vessel. No complications were reported in any of the cases.

Twelve individual cases of RA during the treatment of STEMI have been described previously (*Table 1b*). Many of these patients were receiving treatment for hyperlipidaemia, presumably with statin medications. It is now well-known that statin therapy, whilst protective against plaque rupture, increases coronary calcification.[14] With increasing use of statin therapy, increasing incidence of renal disease, and an ageing population, the incidence of heavily calcified STEMI lesions is likely increasing. Therefore, RA may become more widely necessary for the management of these lesions, not only in the setting of elective PCI, but also in the setting of STEMI.

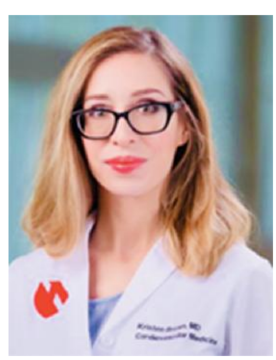
With a possible increase in need for use in the future as these unique cases increase, it is important to note the limitations, complications, and possible alternatives to this technique. While the authors certainly do not recommend the routine use of RA in STEMI, its use in heavily calcified or fibrotic vessels that are otherwise difficult to cross may be necessary. It is important to note that RA should only be used by experienced operators during STEMI. Rotational atherectomy can cause complications such as distal embolization and dissection and may become entrapped if employed inappropriately. Another possible complication is the no reflow phenomenon. The authors attempted to prevent this by avoiding post-dilation of the deployed stents in this small case series. Despite these limitations and possible complications, we urge cautious optimism that RA has now been reported successful in 15 STEMI cases.

Rotational atherectomy at present should be used as a bailout procedure only. There are several tips and tricks for this procedure to optimize success. The authors suggest using IVUS before and after plaque modification to visualize the degree and nature of the stenosis. Once an operator determines the need for RA with the presence of heavy calcium on IVUS with difficulty passing equipment over the wire, then the ideal burr size should be selected. Most operator use a 0.7 burr-to-artery ratio.[15] If IVUS demonstrates large thrombus burden, care should be had to prevent distal embolization. In some cases, thrombectomy may be appropriate. If RA is used, the importance of predilation following RA should be emphasized to achieve optimal plaque modification. If desired plaque modification is not achieved, then operators may choose to further modify the plaque using intravascular lithotripsy (IVL).

Intravascular lithotripsy is an emerging plaque modification technology approved by the Food and Drug Administration (FDA) for the treatment of heavily calcified coronary arteries.[16] Both RA and IVL have been shown to successfully modify heavily calcified lesions.[17] However, there are certain situations when one tool may be chosen over the other such as the inability to pass the IVL balloon may preclude IVL use and severely tortuous vessels may preclude RA. Either way, plaque modification in heavily calcified vessels has a baseline high risk for periprocedural complications with the use of either device.

We acknowledge the inherent selection bias in retrospectively aggregating our 3 current and the literature's 12 prior successful cases. We urge caution to readers in extrapolating this data to clinical practice. We also would like to point out that this technique has only been demonstrated to be successful in the RCA and LAD. None of the reported cases involved the left circumflex, where angulated anatomy could potentially make RA difficult. This series and literature review merely demonstrates a possible role for RA in STEMIs involving heavily calcified lesions in which equipment is unable to cross the target lesion. Large trials are necessary to validate the safety of plaque modification in STEMIs involving heavily calcified lesions.

Lead author biography



Dr Kristen Brown is an in upcoming young female physician in the field of cardiology. She is pursuing a career in interventional/structural cardiology. As by example of this manuscript, she will no doubt be a star in the field.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports*.

Acknowledgements

None.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: Consents were obtained in accordance with the Committee on Publication Ethics (COPE) guidelines.

Conflict of interest: None declared.

Funding: No funds were received for the development of this manuscript. Dr Goldsweig reports consulting fees from Inari Medical and research support from the National Institute of General Medical Sciences, 1U54GM115458, and the University of Nebraska Medical Center for Heart and Vascular Research.

Data availability

The data underlying this article are available in the article and in its online supplementary material.

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