

## CASE REPORT

# Utility of coronary orbital atherectomy with guide-extension system for distally located undilatable in-stent restenosis: A case report

Hiroyuki Yamamoto<sup>1</sup>  | Takahiro Sawada<sup>1</sup>  | Tomofumi Takaya<sup>1,2</sup>  | Hiroya Kawai<sup>1,2</sup>

<sup>1</sup>Division of Cardiovascular Medicine, Hyogo Brain and Heart Center, Himeji, Japan

<sup>2</sup>Department of Exploratory and Advanced Search in Cardiology, Kobe University Graduate School of Medicine, Kobe, Japan

## Correspondence

Hiroyuki Yamamoto, Division of Cardiovascular Medicine, Hyogo Brain and Heart Center, 520 Saisho-Kou, 670-0981 Himeji, Japan.

Email: [y0493589m@hotmail.co.jp](mailto:y0493589m@hotmail.co.jp)

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## Abstract

Orbital atherectomy (OA) may be effective in managing undilatable in-stent restenosis (ISR) despite off-label indications. We demonstrated that optical frequency domain imaging (OFDI)-guided OA, with a guide-extension system was effective even in distally located, undilatable ISR. However, OFDI revealed that inter-struts calcified neoatherosclerosis remained a challenging issue.

## KEYWORDS

calcified neoatherosclerosis, guide-extension catheter, in-stent restenosis, optical frequency domain imaging, orbital atherectomy

## 1 | INTRODUCTION

In-stent restenosis (ISR) remains one of the challenging issues in percutaneous coronary intervention (PCI). Drug-coated balloons (DCBs) are known to be effective in the management of ISR.<sup>1</sup> Lesion preparation prior to DCB angioplasty has been reported to be effective in improving cardiovascular outcomes after PCI.<sup>2</sup> Recent research using optical coherence tomography has shown that using balloon angioplasty alone as lesion preparation was insufficient to achieve optimal results in ISR with hard neointima, such as calcified neoatherosclerosis (C-neoatherosclerosis).<sup>3</sup> In such cases, rotational atherectomy (RA) (Rotalink Plus<sup>TM</sup>, Boston Scientific) is an available option that can be used to reduce C-neoatherosclerosis bulk, thereby leading to greater luminal gain than that in

balloon angioplasty alone.<sup>4</sup> However, performing RA for distally located ISR is sometimes challenging in cases with proximal eccentric and tortuous lesions or with interferences from protruding stents. In contrast, orbital atherectomy (OA) using the Diamondback 360<sup>®</sup> Coronary Orbital Atherectomy System (Cardiovascular Systems Inc.) with a 1.25-mm crown is useful in managing distally located, coronary calcified lesions due to its slender profile and excellent crossability.<sup>5</sup> Although the use of OA for ISR remains limited with off-label indications, several reports have suggested the efficacy and safety of OA for the treatment of ISR.<sup>6,7</sup>

Herein, we report a case that demonstrates the utility of OA with a guide-extension system in performing atheroablation of a distally located, C-neoatherosclerosis in-stent occlusion (ISO).

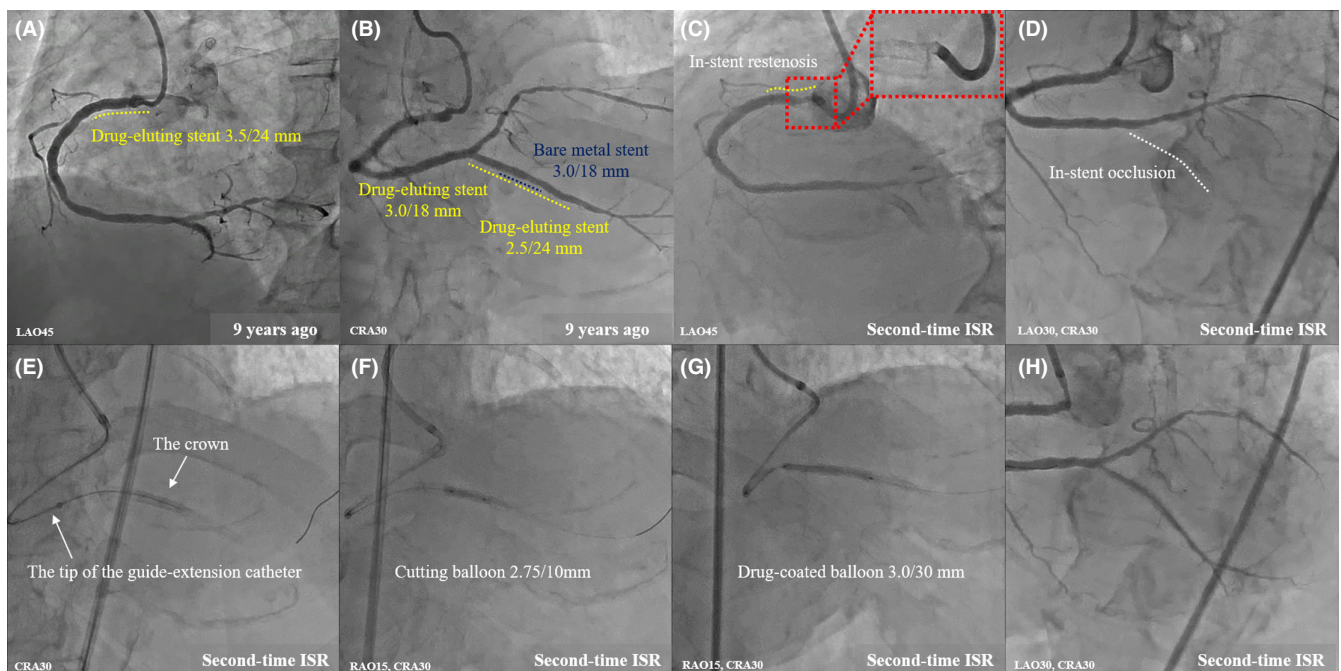
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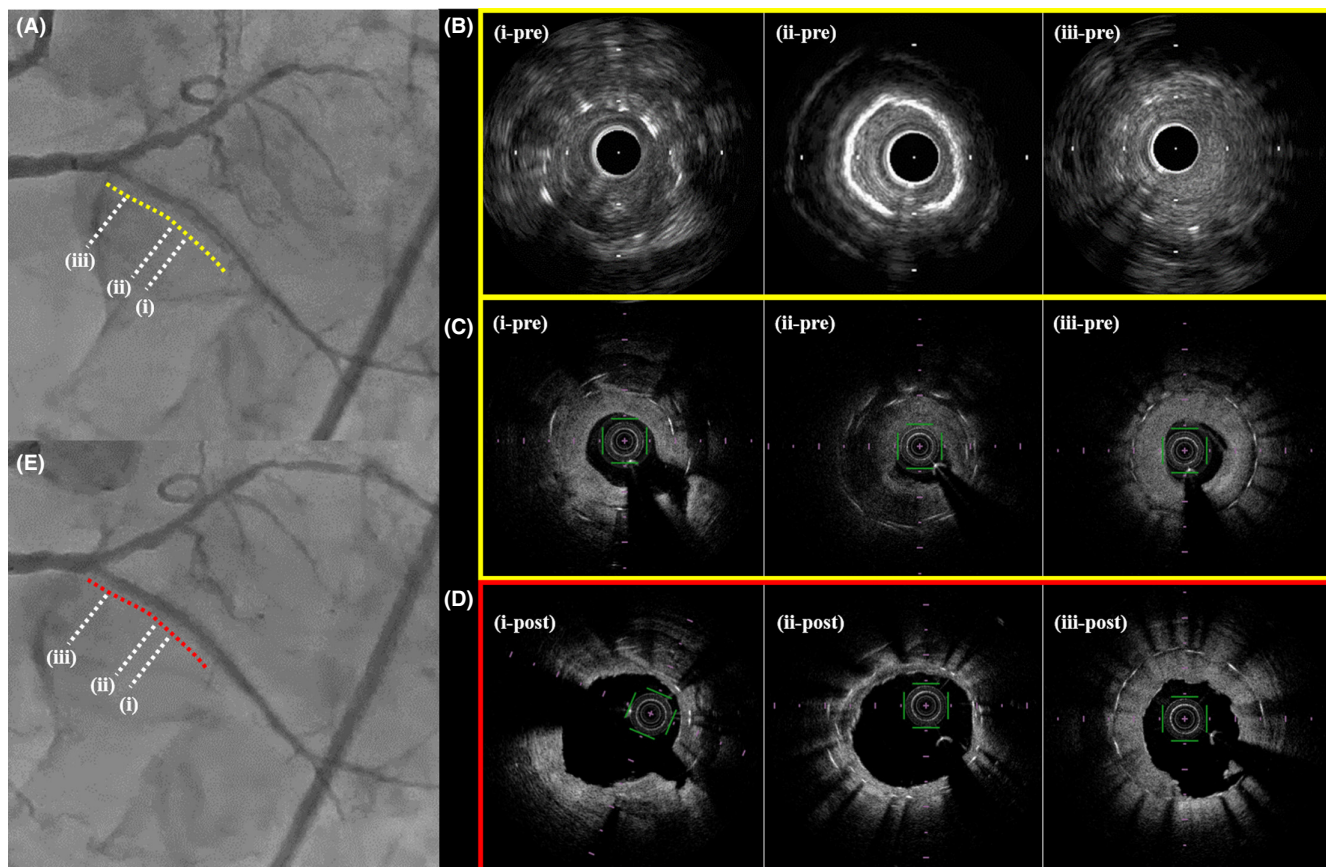
## 2 | CASE REPORT

A 77-year-old male patient with hypertension, diabetes mellitus, and dyslipidemia presented with recurrent, worsening, exertional chest discomfort. Twenty years prior, the patient underwent PCI with a 3.0/18-mm bare-metal stent (BMS) for a de novo lesion in the distal right coronary artery (RCA). Eleven years following his first PCI, severe stenosis of the proximal RCA and an ISR of the distal RCA were confirmed. Recurrent PCI with drug-eluting stents (DESs) was performed. Specifically, 3.0/18-mm and 2.5/24-mm DESs were additionally implanted to partially overlap with the proximal and distal site of BMS in the distal RCA, and a 3.5/24-mm DES was implanted at the proximal RCA protruding a few millimeters from the ostium of the RCA (Figure 1A,B). The patient had already been treated with optimal medical therapy (OMT), including a calcium channel blocker (amlodipine 10 mg/day), a beta-blocker (bisoprolol 5 mg/day), an angiotensin II receptor antagonist (irbesartan 100 mg/day), an anti-platelet (aspirin 100 mg/day), and a statin (pitavastatin 2 mg/day). In spite of receiving OMT, stress cardiac scintigraphy for investigating exertional chest discomfort revealed a significant ischemic area (total perfusion deficit of 17% >10%) in the inferior myocardium, suggesting a recurrent cardiovascular event in the RCA (Figure S1). Subsequent coronary angiography showed an ISR in the proximal RCA and

an ISO in the distal RCA, and several collateral arteries from the left coronary artery to the distal RCA were observed (Figure 1C,D). To reduce intractable exertional chest discomfort and to improve myocardial ischemia, PCI was performed using a 7-French (Fr) guiding-system via the right femoral artery. However, an interference of the protruding proximal DES impaired adequate cannulation of the guiding catheter to the anomalous RCA ostium (anterior take-off RCA). Successful wiring into the proximal stent without passing any stent struts from the outside was achieved using a double-lumen catheter (Crusade Type R, Kaneka) under intravascular ultrasound (IVUS) (AltaView, Terumo Corp) guidance. Subsequent balloon angioplasty using a 4.0-mm non-compliant balloon for the proximal ISR was performed. Thereafter, a coronary wire of X-treme XT-A and Gaia First (Asahi Intecc) with a double-lumen catheter succeeded in passing through the occluded DESs. We then performed balloon angioplasty for the lesion using a 2.5-mm non-compliant balloon with high pressure; however, adequate dilation could not be achieved. Furthermore, IVUS was difficult to precisely evaluate the stent condition due to acoustic shadows caused by heavy calcification (Figures 2A,B and 3A). To clarify the etiology of this undilatable ISR, we performed optical frequency domain imaging (OFDI; FastView, Terumo Corp), which clearly revealed diffuse in-stent hard neointima and C-neoatherosclerosis of the inter-struts between older BMS



**FIGURE 1** Coronary angiogram. (A, B) Final coronary angiogram of the initial percutaneous coronary intervention (PCI) for in-stent restenosis (ISR) 9 years prior. (C, D) Initial coronary angiogram of the present PCI for recurrent ISR and in-stent occlusion. (E) Orbital atherectomy with a guide-extension catheter. (F, G) Angioplasty with a 2.75-mm cutting balloon and (F) a 3.0/30-mm drug-coated balloon (G). (H) Final coronary angiogram of the present PCI



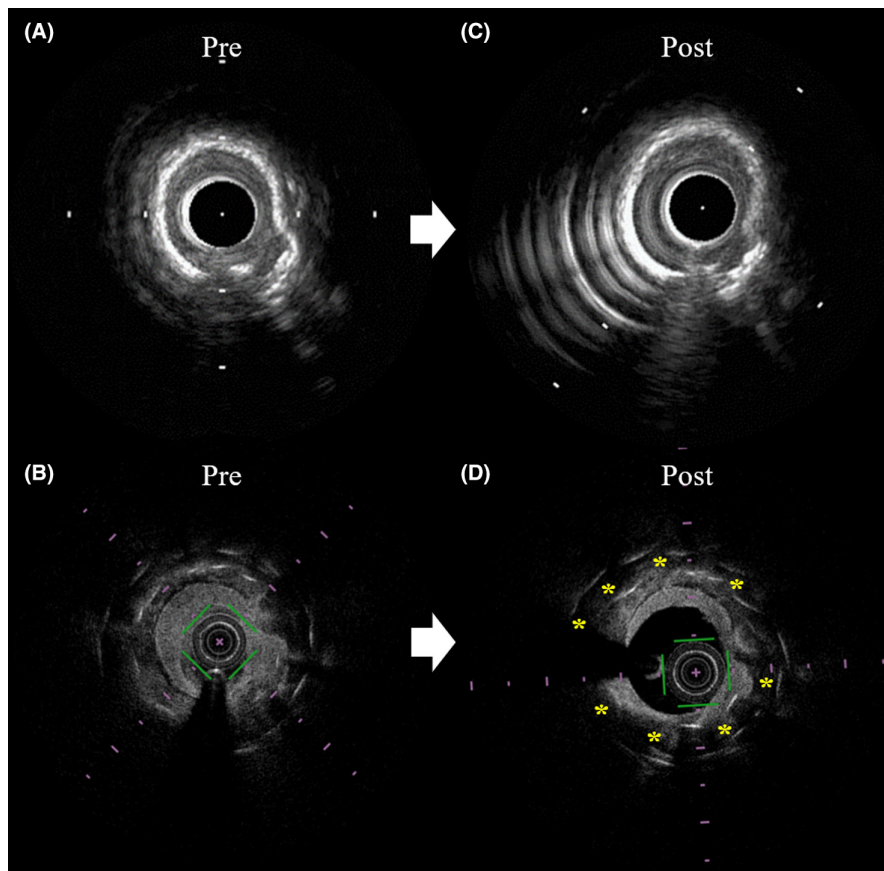
**FIGURE 2** Comparison of coronary imaging before and after orbital atherectomy. (A) Coronary angiogram before orbital atherectomy (OA). (B, C) Comparisons of the intravascular ultrasound (IVUS) and optical frequency domain imaging (OFDI) at the pre-OA following frame (i)-(iii), wherein OFDI revealed in-stent calcification and a hard homogeneous neointima. (D) OFDI at the timing of OA followed by balloon angioplasty. (E) Coronary angiogram after OA

and DES (Figures 2C and 3B). Performing atheroablation for this undilatable ISR was required to achieve a larger lumen gain. Since RA was unsuitable due to the risk of burr entrapment and given the difficulty of the guiding catheter to stabilize in co-axial alignment because of protruding proximal stent-struts and anomalous RCA (anterior take-off), a guide-extension system might be useful in resolving these concerns. However, this was limited because a large RA-burr (>1.5 mm) could not be delivered within a 7-Fr guide-extension system. Nevertheless, OA with a 1.25-mm crown reportedly helped achieve a larger lumen gain of up to approximately 1.75 mm by multiple passes.<sup>8</sup> Therefore, we performed OA with a guide-extension catheter to the distally located, undilatable ISR. A 7-Fr guide-extension catheter (Guide-Liner®, Vascular Solutions) was advanced to the mid RCA using the balloon anchor technique, and the OA crown was delivered to the target lesion without using the OA glide-assist mode (5000 rpm) during advancement within the guide-extension catheter. We then advanced the crown backward starting from the distal position of the target in-stent lesion six times at low speed (80,000 rpm) and 12

times at high speed (120,000 rpm) (Figure 1E). Following this, OFDI post-OA revealed that sufficient debulking of the hard neointima was achieved. Additional angioplasty was performed using a 2.75/10-mm cutting balloon, followed by a 3.0/30-mm drug-coated balloon, which could provide an acceptable result without any flow disturbance (Figures 1F-H and 2D,E). However, the final OFDI revealed that high-pressure balloon angioplasty post-OA to achieve further expansion at the site of C-neoatherosclerosis within the inter-struts between the older BMS and DES was still challenging (Figure 3C,D). The usage of OA for undilatable ISR was approved by the appropriate review board of our institution (approval number: R0242). Informed consent was obtained from the patient to publish the case and any accompanying images.

### 3 | DISCUSSION

The present case suggests the feasibility and utility of OA with a guide-extension system for the treatment



**FIGURE 3** Comparison of undilatable in-stent restenosis. (A, C) Intravascular ultrasound (IVUS) and (B, D) optical frequency domain imaging (OFDI) of undilatable, in-stent restenosis (ISR) pre- and post-orbital atherectomy. OFDI revealed that the calcification within the overlapped inter-stents caused difficulty in debulking using orbital atherectomy. Yellow asterisks indicate calcified neoatherosclerosis within the older bare-metal stent and the drug-eluting stent

of distally located, undilatable ISRs induced by a hard neointima and C-neoatherosclerosis. A hard neointima with C-neoatherosclerosis is reportedly a major cause of undilatable ISR, which is occasionally observed in the late phase of stent implantation.<sup>3</sup> Although atheroablation for ISR is effective in order to achieve a larger lumen gain, OA is still considered an off-label indication<sup>9</sup>; furthermore, there is a lack of data on the utility of OA in treating distally located, undilatable ISR. In treating such lesions, a guide-extension catheter is useful in strengthening the back-up force of a guiding catheter and in delivering the coronary devices easily to the target lesion.<sup>10</sup> Although RA using a burr size of >1.5 mm within a 7-Fr guide-extension catheter is currently unavailable, OA, which can theoretically achieve a larger lumen gain (>1.75 mm) with multiple passages at high speed, is compatible in all commercially available 7-Fr guide-extension catheters and in particular 6-Fr guide-extension catheters.<sup>11</sup> Thus, OA along with the guide-extension system would be suitable for the treatment of distally located, undilatable, calcified ISRs. However, there are some precautions that should be taken when using OA for distally located lesions. First, an OA system should be inserted into the entrance of the guide-extension catheter under fluorography guidance because this entrance may interfere with the crown of the OA. Second, an OA system should be advanced

without using the glide-assist mode (5000 rpm) within a guide-extension catheter because the inner surface of the guide-extension catheter might be damaged and may lead to its disruption.

Potential complications of OA for ISR reportedly include stent/device interaction (entrapment), stent deformation/fracture, and coronary perforation.<sup>12</sup> To avoid such complications, precise evaluation by intravascular imaging is recommended. As shown in our case, OFDI could precisely evaluate the stent conditions (no malapposed struts) and in-stent, thick-hard neointima, suggesting that OA could be safely performed. Moreover, OFDI post-OA revealed C-neoatherosclerosis within the inter-stents of the overlapped stents (older BMS and DES), which posed difficulty in full expansion even by debulking with OA. Thus, OFDI would be useful since it can provide a high-resolution image, allowing the visualization of stent conditions and differentiation of ISR etiology. Although our case suggested that OA is effective in ablating a hard neointima that is undilatable using balloon angioplasty alone, there are some limitations regarding the use of OA for ISR. The safety and effectiveness of OA for stent ablation remains controversial, in spite of reports of previous studies regarding its safety for ISR.<sup>6</sup> We should keep in mind the potential risk of stent/device interaction (entrapment) and make preparations for the bail-out method in anticipation

of potential complications (using guide-extension system into a large-sized guiding catheter as shown in our case). Furthermore, in cases with hard homogeneous neointima, excimer laser coronary atherectomy (ELCA) could be a potential treatment option for ablating distally located, undilatable ISRs. In cases with stent under-expansion due to stent recoil, RA may be more suitable for ablating stents as compared to OA due to its lower risks of device entrapment. Further research on whether RA or OA is suitable for the management of undilatable ISR should be conducted. Additional intervention using ELCA with a contrast medium or intravascular lithotripsy may also be a potential option for this challenging setting (peri-stent C-neoatherosclerosis) in order to achieve further expansion.<sup>13,14</sup> As inter-strut C-neoatherosclerosis would be expected to lead to recurrent cardiovascular events, it is essentially important to avoid additional stent implantation in ISR due to C-neoatherosclerosis.

In conclusion, this case suggests that OFDI-guided OA with a guide-extension system could be useful for the treatment of distally located, undilatable ISR, while preventing potential OA complications. However, calcified neoatherosclerosis within overlapped older inter-stents is a cause of undilatable ISR, which remains challenging to treat even with OA.

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#### CONFLICT OF INTEREST

All authors declare no conflicts of interest, funding, or relationship with industries.

#### AUTHOR CONTRIBUTION

HY and TS mainly conducted the study, analyzed the data, and wrote the initial draft of the manuscript. TT and HK contributed to engaging technical support and supervised the study.

#### ETHICAL APPROVAL

The present study is approved by the appropriate review board of our institution (approval number: R0242).

#### CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

#### ORCID

Hiroyuki Yamamoto  <https://orcid.org/0000-0002-5268-4606>

Takahiro Sawada  <https://orcid.org/0000-0002-9986-9923>

Tomofumi Takaya  <https://orcid.org/0000-0001-5775-8072>

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