Original Article

Stentless Interventional Procedure Using Rotational Atherectomy and Drug-Coated Balloon for Noncalcified De Novo Lesions

Jun Shiraishi, MD, Fumiaki Ito, MD, Jun Yoshimura, MD, Yosuke Kirii, MD,
Eisuke Kataoka, MD, Takaaki Ozawa, MD, Daisuke Ito, MD, Akiteru Kojima, MD,
Masayoshi Kimura, MD, Eigo Kishita, MD, Yusuke Nakagawa, MD, Masayuki Hyogo, MD, and
Takahisa Sawada, MD

Department of Cardiology, Kyoto First Red Cross Hospital, Honmachi, Kyoto, Japan

ABSTRACT

Background: Several recent reports have shown that a stentless interventional procedure using rotational atherectomy followed by drug-coated balloon (DCB) treatment (RA/DCB) is a potent revascularization therapy for calcified de novo lesions even in the new-generation drug-eluting stent era; however, the role of the RA/DCB procedure for noncalcified de novo lesions remains unclear.

Methods: A total of 47 consecutive patients (53 lesions) who underwent RA/DCB for coronary de novo lesions were enrolled. According to the presence or absence of severe calcification at target lesions on fluoroscopy, the 47 patients were divided into the noncalcified cases (n = 12) and the calcified cases (n = 35), and the 53 lesions were

RÉSUMÉ

Contexte : Plusieurs rapports récents ont montré qu'une revascularisation sans endoprothèse effectuée par athérectomie rotationnelle (AR) suivie d'un traitement par ballonnet médicamenté (BM) constitue une méthode efficace pour traiter les nouvelles lésions calcifiées, même à l'ère des endoprothèses médicamentées de nouvelle génération; on ne connaît toutefois pas bien l'utilité de l'intervention par AR et BM en cas de nouvelles lésions non calcifiées.

Méthodologie : Au total, 47 patients consécutifs (53 lésions) ayant subi une intervention par AR et BM pour traiter de nouvelles lésions coronariennes ont été admis dans l'étude. Ces 47 patients ont été répartis en deux groupes, en fonction de l'absence (n = 12) ou de la

Drug-eluting stent (DES) implantation has been a standard interventional treatment of coronary artery disease (CAD); however, there still remain several DES-unfavourable clinical or lesion backgrounds, such as bleeding tendency, intolerance to antiplatelet agents, metal allergy, severe or diffuse calcified lesions, calcified nodules, and ostial or bifurcation lesions. For CAD patients complicated with these specific conditions, percutaneous coronary intervention (PCI) without stent implantation "stentless PCI" is theoretically a promising revascularization therapy. Recently drug-coated balloon (DCB)-only angioplasty for de novo lesions has attracted

greater attention, and pretreatment with rotational atherectomy (RA) followed by DCB treatment (RA/DCB) has been reported to be an option of stentless PCI particularly for calcified de novo lesions.[1-4] However, even small-sized data regarding the RA/DCB procedure for noncalcified de novo lesions are still lacking. The purpose of the present retrospective study was therefore to compare angiographic results and clinical outcomes in patients with noncalcified de novo lesions who underwent RA/DCB with patients with calcified de novo lesions in a real-world clinical practice.

Methods

Patient population and procedure

From December 2014 to September 2019, 47 consecutive patients (53 lesions) who eventually underwent stentless PCI using RA/DCB for coronary de novo lesions or restenotic lesions after balloon angioplasty in our hospital were retrospectively enrolled. Lesions requiring bail-out stenting and in-stent restenosis lesions were excluded.

Shiraishi et al.
RA/DCB for Noncalcified Lesions

715

divided into the noncalcified lesions (n = 14) and the calcified lesions (n = 39).

Results: The noncalcified cases tended to have a higher frequency of bleeding risk and had a significantly lower prevalence of dual anti-platelet therapy compared with the calcified cases. The main lesion-specific factors for the RA/DCB procedure among the noncalcified lesions were presence of left circumflex coronary artery ostial lesion. The final burr size, DCB diameter used, and angiographic success rate did not significantly differ between the 2 groups. The noncalcified lesions had a larger reference diameter and a shorter lesion length than the calcified lesions, whereas acute gain and late lumen loss did not differ between the 2 groups. Nine-month clinical outcomes were comparable between the 2 groups.

Conclusions: Under drug-eluting stent-unsuitable clinical or lesion conditions, acute and midterm outcomes of RA/DCB for noncalcified de novo lesions might be comparable with those for calcified de novo lesions.

présence (n = 35) de lésions . cibles sévèrement calcifiées observées à la fluoroscopie. Les 53 lésions ont aussi été réparties en deux groupes : lésions non calcifiées (n = 14) et lésions calcifiées (n = 39).

Résultats : Les patients n'ayant pas de lésion calcifiée étaient généralement plus susceptibles de présenter des saignements et significativement moins nombreux à être sous bithérapie anti-plaquettaire, comparativement aux patients ayant des lésions calcifiées. Dans le cas des lésions non calcifiées, la principale caractéristique justifiant une AR et un traitement par BM était la présence d'une lésion ostiale du rameau circonflexe de l'artère coronaire gauche. La taille de la dernière fraise utilisée, le diamètre du BM utilisé et le taux de réussite objectivée par angiographie étaient comparables dans les deux groupes. Les lésions non calcifiées avaient un diamètre de référence plus grand et étaient plus courtes que les lésions calcifiées, tandis que le gain aigu et la perte luminale tardive étaient similaires dans les deux groupes. Les résultats cliniques à neuf mois étaient aussi similaires dans les deux groupes.

Conclusions : Lorsque les conditions cliniques ou les lésions ne se prêtent pas à l'utilisation d'une endoprothèse médicamentée, le traitement des nouvelles lésions non calcifiées par AR et BM pourrait donner des résultats immédiats et à moyen terme comparables à ceux du traitement des nouvelles lésions calcifiées.

According to the presence/absence of severe calcification at target lesions on fluoroscopy, the 47 patients were divided into noncalcified cases (n = 12) and calcified cases (n = 35), and the 53 lesions were divided into the noncalcified lesions (n = 14) and the calcified lesions (n = 39). Severe calcification was defined as radiopacity at the stenotic or occlusive sites of the target lesions involving both sides of the vessel wall, visible without cardiac motion before contrast injection on fluoroscopy.[5] Patients with ≥ 1 RA/DCB-treated target lesion with severe calcification were classified as the calcified cases, and patients with only target lesion without severe calcification were classified as the noncalcified cases. RA/DCB procedures were applied to the cases/lesions, which the attending physician/operator judged suitable for stentless PCI using RA/DCB on the basis of the clinical background such as bleeding tendency, the angiographic findings such as ostial lesion, and/or the findings from coronary angiography (CAG) and intravascular imaging such as degree of residual stenosis/dissection and distribution of calcification after RA/predilation during the procedure. RA was performed using the Rotablator (ROTALink Plus/ROTAPRO; Boston Scientific, Marlborough, MA). The maximal burr size and the rotational speed in each lesion was according to the judgement of the operator in charge. After RA, adjunctive predilation using a conventional or cutting balloon was done at the physician's discretion. Finally, the DCB angioplasty was performed using a paclitaxel-coated balloon (SeQuent Please; B. Braun, Melsungen, Germany). The DCB was dilated for at least 60 seconds at more than nominal pressure. These interventional treatments were performed using optical frequency domain imaging or intravascular ultrasound imaging guidance. Figure 1 shows a representative non-calcified case during RA/DCB.[6] Figure 2 shows serial optical frequency domain images during the RA/DCB treatment of the representative case.[6] The study protocol was approved by the institutional ethics committee.

Data collection

The patients' demographic information and coronary risk factors were recorded. Severe thrombocytopenia was defined as platelet count of < 50,000/µL at baseline. Preprocedural medication of antiplatelet or anticoagulation agents was defined as regular intake of those agents before PCI, in which loading and restart of those agents during and after PCI were excluded. Dual antiplatelet therapy (DAPT) consisted of aspirin and thienopyridine (clopidogrel or prasugrel). Oral anticoagulants were warfarin and direct oral anticoagulants.

Quantitative CAG

Follow-up CAG was encouraged at 6-9 months after the index PCI. Pre-/postprocedural and follow-up CAG were examined using the QAngio XA Version 7.1 (Medis Medical Imaging Systems BV, Leiden, The Netherlands). Binary restenosis was defined as a stenosis > 50% of reference diameter at the follow-up phase. Late lumen loss (LLL) was defined as the delta between minimal lumen diameter (MLD) just after the procedure and MLD at the follow-up phase.

Clinical end point measurements and follow-up

Angiographic success was defined as < 50% stenosis without flow delay on final postprocedural CAG, estimated using visual evaluation according to the American Heart Association classification[7] and the Thrombolysis In Myocardial Infarction (TIMI) classification. Clinical information during the follow-up period was obtained by reviewing hospital records and/or interviewing the patient's primary-care physicians. Each death was classified as cardiac, noncardiac, or sudden death of unknown cause. Death related to acute myocardial infarction, heart failure, or arrhythmia were categorized as cardiac death, whereas those ascribed to cerebrovascular disease, pneumonia, cancer, decrepitude, and so on were classified as noncardiac death. Major adverse cardiac and cerebrovascular events were defined as a composite of cardiac
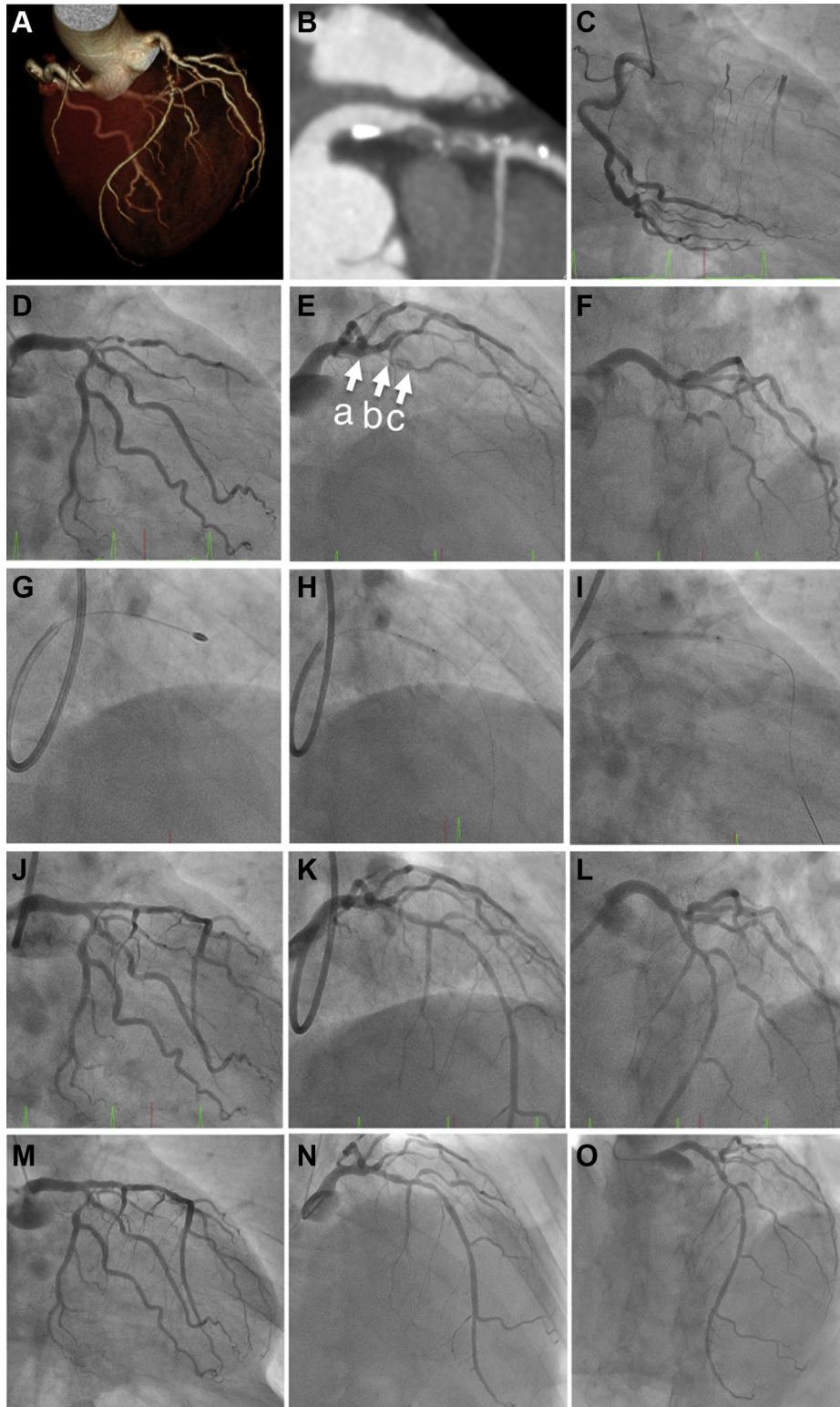
Figure 1. Representative noncalcified patient who underwent stentless percutaneous coronary intervention using rotational atherectomy/drug-coated balloon (DCB). A 65-year-old man with silent myocardial ischemia had an old apical myocardial infarction and nearly intact left main/left circumflex coronary artery, and underwent rotational atherectomy/DCB against a functional occlusive diffuse lesion with double routes in the ostial-proximal left anterior descending coronary artery (LAD) to avoid left main-LAD crossover stenting. Volume-rendered 3-dimensional image (A) and slab maximum intensity projection image (B, right anterior cranial view) of the coronary computed tomography showed no major calcification in the ostial-proximal LAD lesion. Right coronary angiography (CAG; C) showed a distal segment of the LAD via septal-perforator collaterals. Left CAG (D-F). Ablation with a 2.0-mm burr (G). Predilation with 2.5-mm cutting balloon (H). Adjunctive 2.75-mm DCB dilation (I). Final left CAG showed an acceptable result (J-L). Six-month follow-up CAG showed no restenosis (M-O). (C, D, I, J, M) Right anterior caudal view; (E, G, H, K, N) right anterior cranial view; and (F, L, O) left anterior cranial view. (A, B, E, G, K, N) Reproduced from Shiraishi et al.[6] with permission from Wolters Kluwer Health, Inc.

Shiraishi et al.
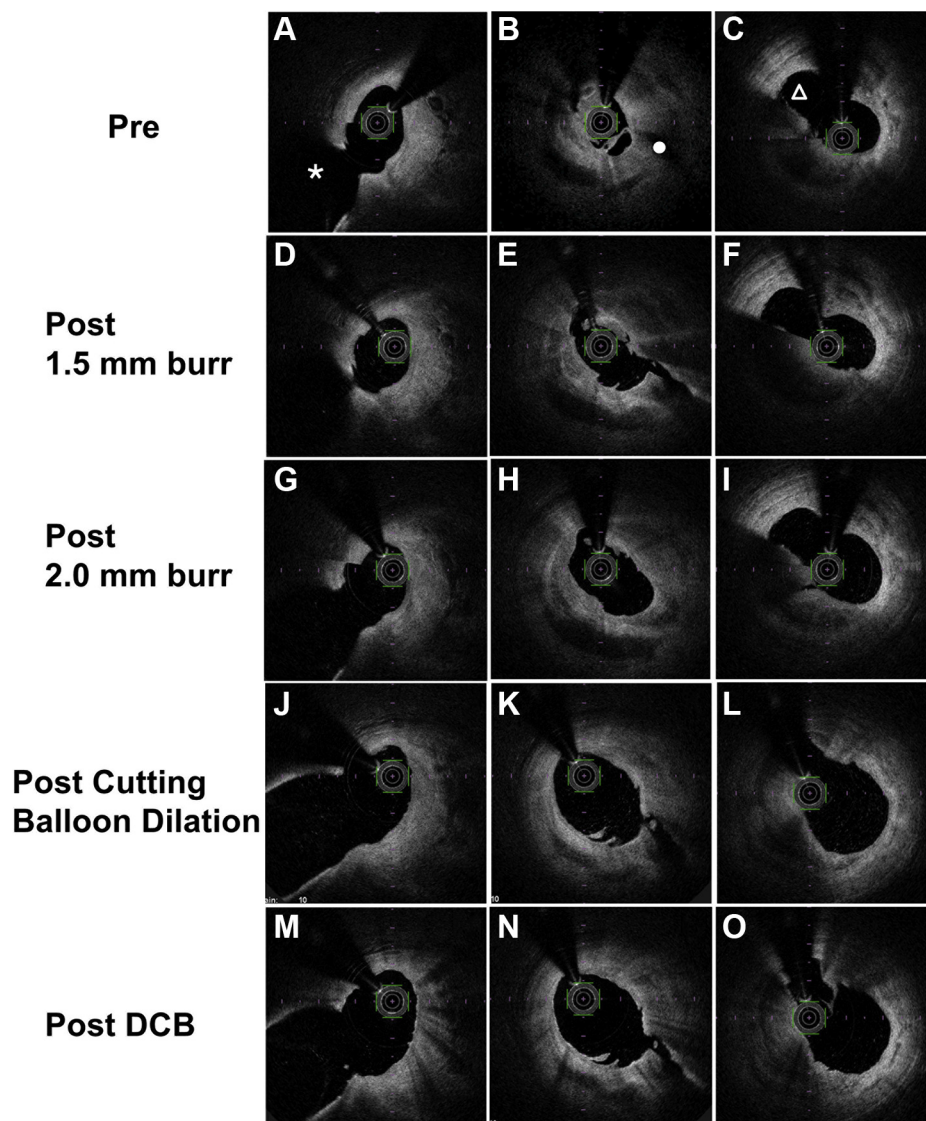RA/DCB for Noncalcified Lesions

717

Figure 2. Serial optical frequency domain imaging (OFDI) during the rotational atherectomy/drug-coated balloon procedure of the representative case (Fig. 1). Preprocedural OFDI (**A-C**; corresponding to **white arrows** in Fig. 1E) showed a diffuse fibrous plaque as well as multiple channels of various sizes and deep-layered area with low-intensity signal, suggesting recanalization of organized thrombus in the proximal left anterior descending coronary artery lesion. Repeat OFDI confirmed gradual luminal enlargement without major dissections. Post ablation with 1.5 mm burr (**D-F**, corresponding to **A-C**, respectively), post ablation with 2.0 mm burr (**G-I**, corresponding to **A-C**, respectively), and post graduation with 2.5-mm cutting balloon (**J-L**, corresponding to **A-C**, respectively) images of OFDI. Post drug-coated balloon OFDI (**M-O**, corresponding to **A-C**, respectively) showed a relatively smooth luminal surface with small incisions. **White asterisks**, **white circle**, and **white triangle** indicate left circumflex coronary artery ostium, small septal perforator, and the junction of diagonal branch-side recanalized route, respectively. Reproduced from Shiraishi et al.[6] with permission from Wolters Kluwer Health, Inc.

death, nonfatal myocardial infarction, nonfatal stroke, and target lesion revascularization (TLR).

Statistics

The data are presented as the mean ± SD for continuous variables and numbers (percentage) for categorical variables. The noncalcified and the calcified cases/lesions were compared using the χ^2 test for categorical variables and unpaired Student t test for continuous variables. Statistical analyses were performed using statistical software (Statcel 3, add-in software

for Excel, OMS Publishing, Tokorozawa, Japan). In all analyses, statistical significance was accepted at $P < 0.05$.

Results

Patient and lesion characteristics

The clinical characteristics of the study population are summarized in Table 1. The noncalcified cases tended to have a higher prevalence of dyslipidemia, and lower frequencies of diabetes mellitus and hemodialysis compared with the

Table 1. Clinical characteristics

	Noncalcified case (n = 12)	Calcified case (n = 35)	P
Mean age ± SD, years	75 ± 11	76 ± 7	0.681
Male sex	8 (66.7)	25 (71.4)	0.756
Hypertension	9 (75.0)	25 (71.4)	0.811
Diabetes mellitus	6 (50.0)	25 (71.4)	0.176
Dyslipidemia	9 (75.0)	18 (51.4)	0.154
Smoking	5 (41.7)	18 (51.4)	0.559
Hemodialysis	2 (16.7)	14 (40.0)	0.141
PCI indication			
Stable AP	3 (25.0)	11 (31.4)	0.519
SMI	6 (50.0)	20 (57.1)	
ACS	3 (25.0)	4 (11.4)	
Preprocedural Medication			
Aspirin	10 (83.3)	30 (85.7)	0.842
Thienopiridine	6 (50.0)	27 (77.1)	0.076
DAPT	5 (41.7)	26 (74.3)	0.040
Anticoagulant	3 (25.0)	7 (20.0)	0.715

Data are presented as n (%) except where otherwise noted.

ACS, acute coronary syndrome; AP, angina pectoris; DAPT, dual antiplatelet therapy; PCI, percutaneous coronary intervention; SMI, silent myocardial ischemia.

calcified cases, but not significantly. The distributions of PCI indication did not differ significantly between the 2 groups. The noncalcified cases had a lower prevalence of DAPT as preprocedural medications than the calcified cases. The lesion characteristics are summarized in Table 2. The distributions of target vessels did not differ to a statistically significant extent between the 2 groups, whereas left circumflex coronary artery (LCx) rather than left anterior descending coronary artery (LAD) was a common target vessel among the noncalcified lesions.

Table 3 shows case-specific factors and lesion-specific factors except for severe/diffuse calcification for performing the stentless procedure using RA/DCB. The noncalcified cases tended to have a higher frequency of bleeding risk (severe thrombocytopenia, gastrointestinal bleeding, recurrent hemoptysis, and/or anticoagulation therapy) compared with the calcified cases, but not significantly ($P = 0.076$). The main lesion-specific factors for stentless PCI using RA/DCB among the noncalcified lesions were the presence of LCx ostial lesions.

Procedure characteristics and angiographic outcomes

Procedure details are shown in Table 4. The distribution of the approach sites did not differ to a statistically significant extent between the 2 groups, whereas a significant difference was seen between the 2 groups in the distribution of the guiding catheter size. The largest burr size used, frequency of pre-balloon dilation, predilation balloon diameter, and the

DCB diameter were similar between the 2 groups, whereas the calcified lesions tended to have a higher prevalence of cutting balloon usage as pre-balloon dilation compared with the noncalcified lesions, but not significantly. The noncalcified lesions and the calcified lesions had high angiographic success rates.

The quantitative CAG data of the index stentless procedure are shown in Table 5. At baseline, the noncalcified lesions had a larger reference diameter and a shorter lesion length than the calcified lesions, whereas MLD and diameter stenosis were comparable between the 2 groups. Postprocedural MLD and diameter stenosis as well as acute gain were similar between the 2 groups. Repeat CAG was performed for 9 lesions of the 14 noncalcified lesions, and for 30 lesions of the 39 calcified lesions (Table 5). Time interval between the index PCI and repeat CAG in the noncalcified lesions and that in the calcified lesions were 6.4 ± 2.3 months and 7.7 ± 3.8 months, respectively ($P = 0.357$). Frequency of binary restenosis and values of LLL did not differ to a statistically significant extent between the 2 groups. As for ostial lesions, repeat CAG was performed for all of the 6 noncalcified ostial lesions, and for 6 lesions of the 7 calcified ostial lesions. Binary restenosis was observed in 3 of the 12 ostial lesions (3 in the 6 noncalcified ostial lesions; 0 in the 6 calcified ostial lesions), and average LLL was 0.24 ± 0.36 mm in the overall ostial lesions (0.19 ± 0.46 mm for the noncalcified ostial lesions; 0.29 ± 0.25 mm for the calcified ostial lesions).

Table 2. Lesion characteristics

	Noncalcified lesion (n = 14)	Calcified lesion (n = 39)	P
Target vessel			
RCA	3 (21.4)	9 (23.1)	0.095
LAD	5 (35.7)	24 (61.5)	
LCx	6 (42.9)	6 (15.4)	
AHA/ACC classification B2/C	13 (92.9)	38 (97.4)	0.462
Restenosis	2 (14.3)	1 (2.6)	0.167

Data are presented as n (%) except where otherwise noted.

ACC, American College of Cardiology; AHA, American Heart Association; LAD, left anterior descending coronary artery; LCx, left circumflex coronary artery; RCA, right coronary artery.

Shiraishi et al.
RA/DCB for Noncalcified Lesions

719

Table 3. Factors for stentless PCI using RA/DCB

Factor		
Patient-specific	**Noncalcified lesion (n = 12)**	**Calcified lesion (n = 35)**
Severe thrombocytopenia	2	0
Gastrointestinal bleeding	0	2
Recurrent hemoptysis	1	0
Anticoagulation therapy	3	7
Lesion-specific	**Noncalcified lesion (n = 14)**	**Calcified lesion (n = 39)**
Ostial lesion	6	7
Ostial RCA/LAD/LCx/other	0/1/5/0	2/2/1/2
Inlet/outlet of coronary aneurysm	2	0

LAD, left anterior descending coronary artery; LCx, left circumflex coronary artery; PCI, percutaneous coronary intervention; RA/DBC, rotational atherectomy followed by drug-coated balloon treatment; RCA, indicates right coronary artery.

Clinical outcomes

Table 6 shows 9-month clinical outcomes. Prevalence of all-cause death, stroke, TLR, and major adverse cardiac and cerebrovascular events were comparable between the 2 groups. The noncalcified cases had 1 in-hospital noncardiac death (acute kidney injury related to antineutrophil cytoplasmic antibody-associated vasculitis) and 1 post discharge noncardiac death (aspiration pneumonia), whereas the calcified cases had 2 in-hospital deaths composed of 1 cardiac death (cardiogenic shock due to acute coronary syndrome) and 1 sudden death of unknown cause (hemodialysis case complicated with probable colon carcinoma) as well as 3 post discharge deaths composed of 2 noncardiac deaths (sepsis due to cellulitis and critical limb ischemia) and 1 sudden death of unknown cause (probable gastrointestinal bleeding). During the 9-month follow-up period, there was neither definite myocardial infarction nor acute/subacute closure of target vessels. At the periprocedural period, DAPT was used in the noncalcified lesions and the calcified lesions in 71.4% and 87.2%, respectively ($P = 0.178$). At 3 months after the stentless procedure, frequency of DAPT in the noncalcified lesions was significantly lower than that in the calcified lesions (Table 7).

Discussion

The present study suggests that acute and midterm outcomes of stentless PCI using RA/DCB for noncalcified de novo lesions might be comparable with those for calcified de novo lesions, despite significant difference in lesion characteristics at baseline. At present, RA as a lesion modification, adjunctive high-pressure balloon dilation, and subsequent DES implantation is a standard PCI strategy in CAD patients with heavily calcified lesions. Additionally, several recent

Table 4. Procedural characteristics

	Noncalcified lesion (n = 14)	Calcified lesion (n = 39)	P
Approach site			
Femoral	5 (35.7)	10 (25.6)	0.558
Brachial	1 (7.1)	7 (17.9)	
Radial	8 (57.1)	22 (56.4)	
GC size			
6 Fr	2 (14.3)	0 (0.0)	0.010
7 Fr	8 (57.1)	35 (89.7)	
8 Fr	4 (28.6)	4 (10.3)	
Burr size, mm			
Largest	1.85 ± 0.17	1.78 ± 0.27	0.386
1.25	0 (0.0)	4 (10.3)	
1.5	1 (7.1)	7 (17.9)	
1.75	7 (50.0)	9 (23.1)	
2.0	5 (35.7)	18 (46.2)	
2.15	1 (7.1)	0 (0.0)	
2.25	0 (0.0)	1 (2.6)	
Pre-balloon dilation	9 (64.3)	28 (71.8)	0.600
Cutting balloon	4 (28.6)	19 (48.7)	0.161
Balloon diameter, mm	2.53 ± 0.29	2.48 ± 0.42	0.767
DCB diameter, mm	2.71 ± 0.45	2.69 ± 0.43	0.834
Inflation pressure, atm	8.8 ± 2.0	8.9 ± 2.6	0.857
IVUS usage	0 (0.0)	6 (15.4)	0.301
OFDI usage	14 (100.0)	33 (84.6)	0.301
Complication			
No reflow	0 (0.0)	1 (2.6)	
Coronary perforation	1 (7.1)	0 (0.0)	
Acute closure	0 (0.0)	0 (0.0)	
Angiographic success	13 (92.9)	38 (97.4)	0.462

Data are presented as mean ± SD or n (%), except where otherwise noted.

DCB, drug-coated balloon; Fr, French; GC, guiding catheter; IVUS, intravascular ultrasound imaging; OFDI, optical frequency domain imaging.

Table 5. Quantitative results of the index PCI and repeat CAG procedures

Variable	Noncalcified lesion	Calcified lesion	P
Overall lesions	n = 14	n = 39	
Preprocedure			
Reference diameter, mm	3.08 ± 0.84	2.41 ± 0.76	0.008
Lesion length, mm	12.82 ± 5.99	23.33 ± 12.87	0.007
MLD, mm	0.65 ± 0.50	0.65 ± 0.40	0.988
Diameter stenosis, %	78.8 ± 16.4	72.9 ± 13.9	0.201
Postprocedure			
MLD, mm	1.98 ± 0.51	1.87 ± 0.49	0.504
Diameter stenosis, %	32.7 ± 15.0	26.8 ± 11.2	0.134
Acute gain, mm	1.33 ± 0.71	1.22 ± 0.55	0.585
Lesions with repeat CAG	n = 9	n = 30	
Preprocedure			
Reference diameter, mm	3.35 ± 0.90	2.40 ± 0.83	0.005
Lesion length, mm	12.58 ± 6.36	24.72 ± 13.98	0.017
MLD, mm	0.76 ± 0.54	0.71 ± 0.40	0.745
Diameter stenosis, %	76.1 ± 18.1	70.3 ± 13.5	0.299
Postprocedure			
MLD, mm	2.11 ± 0.58	1.83 ± 0.46	0.145
Diameter stenosis, %	35.9 ± 17.2	27.0 ± 10.5	0.064
Acute gain, mm	1.35 ± 0.86	1.12 ± 0.48	0.321
Follow-up			
MLD, mm	1.83 ± 0.91	1.61 ± 0.52	0.356
Diameter stenosis, %	44.4 ± 24.7	36.0 ± 15.7	0.229
Late lumen loss, mm	0.28 ± 0.50	0.22 ± 0.37	0.718
Binary restenosis, %	4 (44.4)	6 (20.0)	0.141

Data are presented as mean ± SD except where otherwise noted.

CAG, coronary angiography; MLD, minimal lumen diameter; PCI, percutaneous coronary intervention.

reports have indicated that stentless PCI using RA/DCB could also be a revascularization therapy of choice particularly for calcified lesions.[1-4] In contrast, the role of RA for noncalcified lesions in the current DES era still remains uncertain. According to previous reports in the pre-stent era, RA effectively debulked even noncalcified lesions on intravascular ultrasound imaging, and the procedural initial success rate of RA did not differ between noncalcified and calcified lesions.[8,9] As to plaque characteristics, not only calcified/fibrous lesions but also organized/recanalized thrombotic lesions might have lower risk of flow disturbance during RA, compared with lipidic lesions and fresh thrombotic lesions.[6,10,11] In practice, however, RA followed by plain balloon dilation itself had a significant high restenosis rate.[12] Thus, in the presence or absence of calcification, precise tissue characterization using an intravascular imaging device and DCB treatment are indispensable to overcome the risk of slow flow/no reflow and restenosis due to intimal hyperplasia in the RA-based stentless procedures.[2,13]

As a primary interventional treatment for small-vessel de novo lesions, usefulness of DCB has been nearly established.[14-16] A recent report from Japanese investigators has indicated that among de novo coronary lesions with a mean reference diameter of 2.22 mm, angiographic and clinical outcomes of DCB-based stentless PCI in the noncalcified lesions were comparable with those in the calcified lesions.[17] As for large vessel de novo lesions, a single report has shown that DCB-based stentless PCI is safe and effective even among coronary arteries (> 2.75 mm) with average reference diameter of 3.16 mm and calcification frequency of approximately 20%.[18] The noncalcified lesions tended to have a larger reference diameter and a shorter lesion length than the calcified lesions, which might account for the difference in the distribution of the guiding catheter size between the noncalcified and calcified lesions in the present study. Debulking intimal plaque as much as possible using larger burrs through ≥ 7-French guiding catheters is desirable to decrease risk of pre-balloon dilation/DCB-induced major dissections and accomplish stentless PCI without bailout stenting particularly in large vessels.

In contrast, 2 noncalcified lesions treated via 6-French guiding catheters were complicated with severe

Table 6. Nine-month clinical outcomes

Outcome	Noncalcified case (n = 12)	Calcified case (n = 35)	P
Death (in-hospital death)	2 (1)	5 (2)	0.842
Cardiac	0	1	
Noncardiac	2	2	
Sudden death	0	2	
Stroke	1	1	0.450
MI	0	0	
TLR	1	2	0.749
MACCE	2 (16.7)	4 (11.4)	0.639

MACCE, major adverse cardiac and cerebrovascular events; MI, myocardial infarction; TLR, target lesion revascularization.

Shiraishi et al.
RA/DCB for Noncalcified Lesions

721

Table 7. Postprocedural administration of DAPT

DAPT usage	Noncalcified lesion (n = 14)	Calcified lesion (n = 39)	P
In periprocedural period	10 (71.4)	34 (87.2)	0.178
At 1 month	8 (57.1)	32 (82.1)	0.063
At 3 months	6 (42.9)	31 (79.5)	0.010
At 6 months	4 (28.6)	24 (61.5)	0.034
At 9 months	1 (7.1)	22 (56.4)	0.001
At 12 months	1 (7.1)	12 (30.8)	0.078

DAPT, dual antiplatelet therapy.

thrombocytopenia at baseline in the present study population.[11,19] A higher prevalence of bleeding risk might account for lower frequency of preprocedural and post procedural DAPT administration in the noncalcified cases/lesions. A major advantage of DCB-based stentless PCI is absence of a residual metal cage, leading to shorter DAPT, compared with DES-based PCI. Indeed, accumulating reports have already shown that 1-month DAPT is feasible for non-acute coronary syndrome patients receiving DCB treatments.[15,20,21] Moreover, for high bleeding risk patients undergoing DCB-alone treatment, very short (< 1 month) DAPT or single antiplatelet therapy might be appropriate, from the viewpoint of risks of bleeding complications and coronary thrombosis.[11,19] However, recent clinical trials have indicated feasibility of 1-month DAPT among patients receiving drug-coated stent or DES.[22-24] However, these randomized clinical trials included only patients who were judged to be eligible to enroll by attending physicians in charge, and might exclude not only very high bleeding risk patients without tolerance for even 1-month DAPT but also the patients with a high risk of stent thrombosis. Thus, cases complicated with very high bleeding risk, such as patients complicated with severe thrombocytopenia and those complicated with bleeding cancer, in particular might obtain more benefits from the DCB-based stentless PCI with short-term DAPT.

The main target lesions of the noncalcified cases that underwent RA/DCB were LCx ostial lesions. For LCx "just" ostial lesions, ostial stenting is technically very tricky, and left main-LCx crossover stenting followed by kissing balloon inflation might be a conventional interventional treatment. However, the TLR rate at the LCx ostium is high in cases that undergo left main-LCx crossover stenting,[25] and stentless procedures might be a revascularization strategy of choice for LCx ostial lesions.[26] However, directional coronary atherectomy (DCA) might be a leading debulking procedure particularly for noncalcified lesions in the ostial/proximal LAD. A recent report from Japanese investigators has shown that DCA followed by DCB treatment might be an alternative revascularization therapy for de novo lesions, and ostial/proximal LADs were common target sites (39.1% and 34.8%, respectively).[27] In clinical settings, however, DCA is not easy to use for debulking, and it is technically very difficult to perform DCA for diffuse lesions and LCx ostial lesions.

New-generation DES-based PCI has become a mainstay of interventional treatment for noncalcified large vessel de novo lesions. Similar to the stentless RA/DCB procedure for calcified lesions, that for the noncalcified lesions had smaller values of acute gain and larger values of LLL, compared with previous reports regarding DES-based procedures. Moreover, the noncalcified lesions had a numerically (not significantly) higher binary restenosis rate than the calcified lesions. Nevertheless, most of the present noncalcified cases/lesions had DES-unsuitable clinical/lesion condition, such as bleeding risk, severe thrombocytopenia, recurrent hemoptysis, or anticoagulation therapy as well as ostial lesions or inlet/outlet of coronary aneurysm. Together, even in noncalcified lesions, plaque debulking using RA, which tends not to cause acute recoil or major dissection, might contribute to accomplishment of DCB-based stentless PCI. Indeed, there were no de novo lesions requiring bailout stenting after DCB treatment among patients in whom RA/DCB was attempted during the study period. Stentless PCI using RA/DCB might be therefore a revascularization therapy of choice for patients with very high bleeding risk and/or ostial lesions. Interventional cardiologists should fully evaluate merits and demerits of the stentless RA/DCB procedure in each noncalcified case/lesion.

Study limitations

First, this was a single-centre retrospective analysis of a very small number of patients/lesions. Second, cases receiving follow-up CAG were limited. Third, the follow-up period was not enough to evaluate long-term clinical outcomes of stentless PCI using RA/DCB. Fourth, qualitative and quantitative angiographic analyses were not performed by 1 dedicated individual, but were conducted by the physicians/operators in charge. In addition, interindividual degree of agreement/variation was not assessed. Fifth, there were significant differences in lesion characteristics at baseline between the noncalcified and the calcified lesions.

Conclusions

Under DES-unsuitable clinical/lesion conditions, acute and midterm outcomes of stentless PCI using RA/DCB for noncalcified de novo lesions might be comparable with those for calcified de novo lesions. The very small sample size and short-term observation period are major limitations, and a larger/longer follow-up study should be performed to confirm our findings.

Funding Sources

Disclosures

References

1. Rissanen TT, Uskela S, Siljander A, et al. Percutaneous coronary intervention of complex calcified lesions with drug-coated balloon after rotational atherectomy. J Interv Cardiol 2017;30:139-46.

2. Shiraishi J, Kataoka E, Ozawa T, et al. Angiographic and clinical outcomes after stent-less coronary intervention using rotational atherectomy and drug-coated balloon in patients with de novo lesions. Cardiovasc Revasc Med 2020;21:647-53.

3. Ueno K, Morita N, Kojima Y, et al. Safety and long-term efficacy of drug-coated balloon angioplasty following rotational atherectomy for severely calcified coronary lesions compared with new generation drug-eluting stents. J Interv Cardiol 2019;2019:9094178.

4. Nagai T, Mizobuchi M, Funatsu A, Kobayashi T, Nakamura S. Acute and mid-term outcomes of drug-coated balloon following rotational atherectomy. Cardiovasc Interv Ther 2020;35:242-9.

5. Moussa I, Ellis SG, Jones M, et al. Impact of coronary culprit lesion calcium in patients undergoing paclitaxel-eluting stent implantation (a TAXUS-IV sub study). Am J Cardiol 2005;96:1242-7.

6. Shiraishi J, Matsubara Y, Hyogo M, Sawada T. Stent-less percutaneous coronary intervention using rotational atherectomy to the noncalcified occlusive lesion with recanalized thrombus. Coron Artery Dis 2020;31: 661-4.

7. Austen WG, Edwards JE, Frye RL, et al. A reporting system on patients evaluated for coronary artery disease. Report of the Ad Hoc Committee for Grading of Coronary Artery Disease, Council on Cardiovascular Surgery, American Heart Association. Circulation 1975;51:5-40.

8. Dussaillant GR, Mintz GS, Pichard AD, et al. Effect of rotational atherectomy in noncalcified atherosclerotic plaque: a volumetric intravascular ultrasound study. J Am Coll Cardiol 1996;28:856-60.

9. MacIsaac AI, Bass TA, Buchbinder M, et al. High speed rotational atherectomy: outcome in calcified and noncalcified coronary artery lesions. J Am Coll Cardiol 1995;26:731-6.

10. Tomey MI, Kini AS, Sharma SK. Current status of rotational atherectomy. JACC Cardiovasc Interv 2014;7:345-53.

11. Shiraishi J, Ohshiro M, Matsubara Y, et al. Optical frequency domain imaging –guided rotational atherectomy followed by drug-coated balloon dilation to the non-calcified lesion in a patient with severe thrombocytopenia. Cardiovasc Interv Ther 2018;33:395-7.

12. Whitlow PL, Bass TA, Kipperman RM, et al. Results of the study to determine rotablator and transluminal angioplasty strategy (STRATAS). Am J Cardiol 2001;87:699-705.

13. Fujii K, Kawakami R, Hirota S. Histopathological validation of optical coherence tomography findings of the coronary arteries. J Cardiol 2018;72:179-85.

14. Latib A, Colombo A, Castriota F, et al. A randomized multicenter study comparing a paclitaxel drug-eluting balloon with a paclitaxel-eluting stent in small coronary vessels: the BELLO (Balloon Elution and Late Loss Optimization) study. J Am Coll Cardiol 2012;60:2473-80.

15. Jeger RV, Farah A, Ohlow MA, et al. Drug-coated balloons for small coronary artery disease (BASKET-SMALL 2): an open-label randomised non-inferiority trial. Lancet 2018;392:849-56.

16. Tang Y, Qiao S, Su X, et al. Drug-coated balloon versus drug-eluting stent for small-vessel disease: the RESTORE SVD China randomized trial. JACC Cardiovasc Interv 2018;11:2381-92.

17. Ito R, Ueno K, Yoshida T, et al. Outcomes after drug-coated balloon treatment for patients with calcified coronary lesions. J Interv Cardiol 2018;31:436-41.

18. Rosenberg M, Waliszewski M, Krackhardt F, et al. Drug coated balloon-only strategy in de novo lesions of large coronary vessels. J Interv Cardiol 2019;2019:6548696.

19. Shiraishi J, Koshi N, Matsubara Y, et al. Stent-less percutaneous coronary intervention using rotational atherectomy and drug-coated balloon: a case series and a mini review. Cardiovasc Revasc Med 2018;19:705-11.

20. Kleber FX, Schulz A, Waliszewski M, et al. Local paclitaxel induces late lumen enlargement in coronary arteries after balloon angioplasty. Clin Res Cardiol 2015;104:217-25.

21. Benezet J, Gutiérrez-Barrios A, Agarrado A, et al. Paclitaxel-coated balloon angioplasty for de novo coronary lesions: a long-term follow-up study. Minerva Cardioangiol 2016;64:15-22.

22. Urban P, Meredith IT, Abizaid A, et al. Polymer-free drug-coated coronary stents in patients at high bleeding risk. N Engl J Med 2015;373: 2038-47.

23. Watanabe H, Domei T, Morimoto T, et al. Effect of 1-month dual antiplatelet therapy followed by clopidogrel vs 12-month dual antiplatelet therapy on cardiovascular and bleeding events in patients receiving PCI: the STOPDAPT-2 randomized clinical trial. JAMA 2019;321:2414-27.

24. Windecker S, Latib A, Kedhi E, et al; ONYX ONE Investigators. Polymer-based or Polymer-free Stents in Patients at High Bleeding Risk. N Engl J Med 2020;382:1208-18.

25. Naganuma T, Chieffo A, Basavarajaiah S, et al. Single-stent crossover technique from distal unprotected left main coronary artery to the left circumflex artery. Catheter Cardiovasc Interv 2013;82:757-64.

26. Shiraishi J, Nishimura T, Hyogo M, Sawada T. Detection of trailing edge of calcified nodule after rotational atherectomy using optical frequency domain imaging. CJC Open 2019;1:216-8.

27. Sato A, Kijima M, Ichimura S, et al. Short-term outcome of percutaneous coronary intervention with directional coronary atherectomy followed by drug-coated balloon: a preliminary report. Cardiovasc Interv Ther 2019;34:149-54.