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Comparison of drug-coated versus conventional balloons for the side branch of the bifurcation lesion - multicenter randomized controlled study - (OCVC-BIF): Design and rationale

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ABSTRACT

Background: Although several clinical trials have suggested the usefulness of drug-coated balloons (DCB) for side-branch lesions, their efficacy and safety have not yet been established.
Methods and study design: The Osaka Cardiovascular Conference (OCVC) will conduct a multicenter, randomized, open-label, controlled trial aiming to examine whether additional DCB treatment for the side branch after main vessel stenting followed by kissing balloon inflation (KBI) is superior to only KBI by conventional balloons in PCI patients with coronary bifurcation lesions. The primary endpoint is restenosis of side branches documented by scheduled or symptom-driven coronary angiography during 9-month follow-up period after the index PCI. The key secondary endpoints include major adverse cardiac event which consists of cardiac death, myocardial infarction, target lesion revascularization, and stent thrombosis, and optical coherence tomography findings. A total of 300 patients will be enrolled and followed up to 1 year.
Summary: The OCVC-BIF trial is a randomized controlled trial designed to assess whether additional DCB treatment for side branch is superior to only KBI by conventional balloons in patients with coronary bifurcation lesions undergoing PCI with main vessel stenting.

1. Introduction

Percutaneous coronary intervention (PCI) has been widely performed for the stenosis in the coronary artery. Bifurcation lesions are account for 15–20 % of all lesions, and they are one of the most challenging lesions in terms of a lower procedure success rate and long-term major adverse cardiac event [1,2]. For the bifurcation lesions, the main vessel stenting with kissing balloon inflation (KBI) and provisional side branch stenting is the standard approach in the majority of cases [1,2]. However, the satisfactory clinical outcomes for the side branch have not been achieved [3,4]. The restenosis rate of the side branch ≥2.5 mm after the implantation of first-generation drug-eluting stents (DES) in the main branch with KBI reached 20 % at 12 months [3]. Another study demonstrated that binary restenosis rate of side branch ≥2.25 mm after the similar treatment reached 12.5 % at

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6 months [4]. The restenosis rate was relatively high in both studies, and the strategy for side branch should be improved.

On the other hand, drug-coated balloon (DCB) demonstrated acceptable clinical outcomes for small vessel in the native coronary artery [5,6]. SeQuent Please World Wide Registry reported that the 9-month incidences of major adverse cardiac event (MACE) and target lesion revascularization after PCI for *de novo* lesions of 390 patients with DCB alone were 2.6 % and 1.0 %, respectively [5]. BASKET-SMALL 2 trial, in which 758 patients with small *de novo* lesions <3.0 mm, were randomly assigned to DCB treatment or second-generation DES implantation, revealed that the incidence of MACE at 12 months were 7.5 % in DCB group and 7.3 % in DES group and non-inferiority of DCB to DES was established [6].

Taking these results, DCB has been used for the treatment of side branch in the bifurcation lesion recently, however, the efficacy and the safety have not been elucidated well.

2. Methods

2.1. Objective

The objective of the OCVC-BIF trial is to evaluate the efficacy and safety of DCB for side branch in initial PCI for coronary artery bifurcation lesions which are treated by DES implantation in the main vessel with KBI.

2.2. Study design

The OCVC-BIF trial is a multicenter, randomized, open-label trial in which patients will undergo PCI for coronary artery bifurcation lesions treated by DES implantation in the main vessel with KBI. After providing informed consent at each hospital, patients who are eligible for the trial will be randomized to either additional dilatation of the side branch by DCB after KBI (DCB group) or only KBI by conventional balloons without additional dilatation (non-DCB group). Randomization is performed electronically by entering patient information into an automatic data collection system *via* a secure internet connection. The patients are stratified according to the presence or absence of stenosis at the side branch ostium and the presence or absence of left main trunk related bifurcation lesions, and randomly assigned in a 1:1 ratio to either the “DCB group” or the “non-DCB group” according to the allocation chart prepared based on the permuted block method.

This study has been registered in the Japan Registry of Clinical Trials (jRCTs 052200077) and has been approved by the certified review board at Osaka university hospital.

2.3. Eligibility criteria

The study population consists of patients with coronary artery bifurcation lesions undergoing an initial PCI. A coronary artery bifurcation lesion is defined as a coronary artery narrowing occurring adjacent to, and/or involving, the origin of a significant side branch [7]. A significant side branch is a branch that the operator does not want to lose in the global context of a particular patient [7], with a diameter of the side branch >2.0 mm in the current study. Inclusion and exclusion criteria are summarized in Table 1. A signed, certified review board-approved informed consent form is obtained from each patient prior to any trial-related procedure.

Table 1
Inclusion and Exclusion criteria.

Inclusion criteria
1. Patients whose age was older than 20 years at the time of their consent
2. Patients who agree to be enrolled in the study giving signed written informed consent by themselves or the proxies
3. Patients who undergo initial percutaneous coronary intervention for bifurcation lesion
4. Lesions with side branch diameter greater than and equal to 2.0 mm and <3.0 mm
5. Lesions which can be treated by single stent implantation (drug-eluting stent only into main branch) judged by the operator
6. Patients who are eligible to dual-antiplatelet therapy according to the lates guideline
7. Patients who agree to undergo follow-up coronary angiography 9 months after percutaneous coronary intervention
Exclusion criteria
1. Patients who are pregnant or breast-feeding
2. Lesions with in-stent restenosis
3. Lesions in bypass graft
4. Patients with acute coronary syndrome
5. Patients who had acute myocardial infarction within 1 month
6. Patients with active bleeding
7. Patients who are scheduled to participate in clinical trial or intervention study before the end of the follow-up of the current study
8. Patients whose life expectancy within 1 year
9. Patients with hemodialysis
10. Lesions with chronic total occlusion
11. Patients whom the physician in charge judges as inappropriate

2.4. Procedures

2.4.1. Baseline coronary angiography (CAG)

Baseline CAG is performed by >2 directions in which the lesion is not observed with shortening after the injection of nitrous acid. The flame rate must be >15 flame/s, and the size of angiographic catheter must be >5 French.

2.4.2. Pre-dilatation, DES implantation and KBI

After the passage of each guidewire into main vessel and side branch, pre-dilatation is done for main vessel by scoring balloon. If necessary (*e.g.*, if ischemia occurs due to the passage of the guidewire into the side branch), pre-dilatation will be performed for the side branch using a conventional balloon with a diameter of 2.0 mm or less. If angiographic result after pre-dilatation is acceptable, DES (Coroflex ISAR NEO®, B. Braun, Melsungen, Germany) is implanted in the main vessel. Stent diameter is decided according to the diameter of the distal main vessel. Proximal optimization technique (POT) is recommended, and the size of the POT balloon will be selected based on the diameter of the proximal main vessel. The distal balloon marker is placed in the middle part of the bifurcation. After removing guidewire of the main vessel (or by using new guidewire supported by double-lumen catheter), the guidewire is recrossed into the most distal cell by angiography or the optimal point by optical coherence tomography (OCT) [8]. The guidewire crossed in the side branch underneath the stent is removed and recrossed to the main branch (only removal if new guidewire will be used). KBI is performed by using two non-compliant balloons. Each size of the balloon is decided based on the distal vessel size of each branch.

2.4.3. Additional procedure

In the DCB group, DCB inflation is performed only for the side branch by using SeQuent Please® (B. Braun) or SeQuent Please NEO® (B. Braun) for at least 30 s. While balloon/artery ratio is 0.8–1.0 in principle, the optimal size is selected by the operator. The length of DCB is ≥2 mm longer than the balloon used for kissing balloon inflation of the side branch. If necessary, additional kissing balloon inflation and recurrent POT (re-POT) will be performed. In the non-DCB group, if necessary, re-POT will be performed.

2.4.4. Bail-out DES implantation for the side branch

Bail-out DES implantation for the side branch can be considered by the operator if one of the following criteria is detected in the side branch: 1) dissection with National Heart, Lung, and Blood Institute (NHLBI) grade C and more [9]; 2) coronary flow limitation with Thrombolysis in Myocardial Infarction (TIMI) grade 2 and less [10]; 3) residual stenosis >50 %.

2.4.5. Final CAG

Final CAG is performed with the same 2 directions as the initial CAG after the removal of guidewires and the injection of nitrous acid.

2.5. Follow-up schedule

The study flow is summarized in Fig. 1. Before the index PCI, baseline information, previous history, and medication history are collected. During this visit, a blood test is performed. During the PCI, detailed information of the procedure including OCT findings and adverse events are collected. The blood test (creatine kinase, CK-MB, and cardiac troponin) is measured the day after the index PCI. The antiplatelet regimen will be determined according to the latest guideline [11].

Patients are followed up 9 and 12 months after the index PCI. A follow-up CAG is acquired at 9 months. Follow-up OCT is also performed at the same time at follow-up CAG. Any adverse events are recorded throughout the study period.

2.6. OCT procedure and evaluation

OCT-guided PCI is recommended. OCT evaluation is performed at the pull-back speed of 18 mm/s for the main vessel and the side branch. The observation timing and region of the main vessel and side branches are as follows: 1) main vessel: immediately after recrossing the guidewire into the side branch, immediately after PCI, and at the time of 9-month follow-up; from the distal longer than 10 mm of the stent distal edge to the proximal longer than 10 mm of the stent proximal edge; 2) side branch: immediately after PCI and at the time of 9-month follow-up; from the distal longer than 10 mm of the side branch ostial to the proximal longer than 10 mm of the side branch ostial.

2.7. Study endpoints

The primary endpoint of the study is the restenosis of side branch at the bifurcation lesion documented by scheduled at 9 months or symptom-driven CAG during 1-year follow-up period after the index PCI. "Restenosis of side branch" is defined as ≥50 % stenosis at the side branch documented by quantitative coronary angiography (QCA).

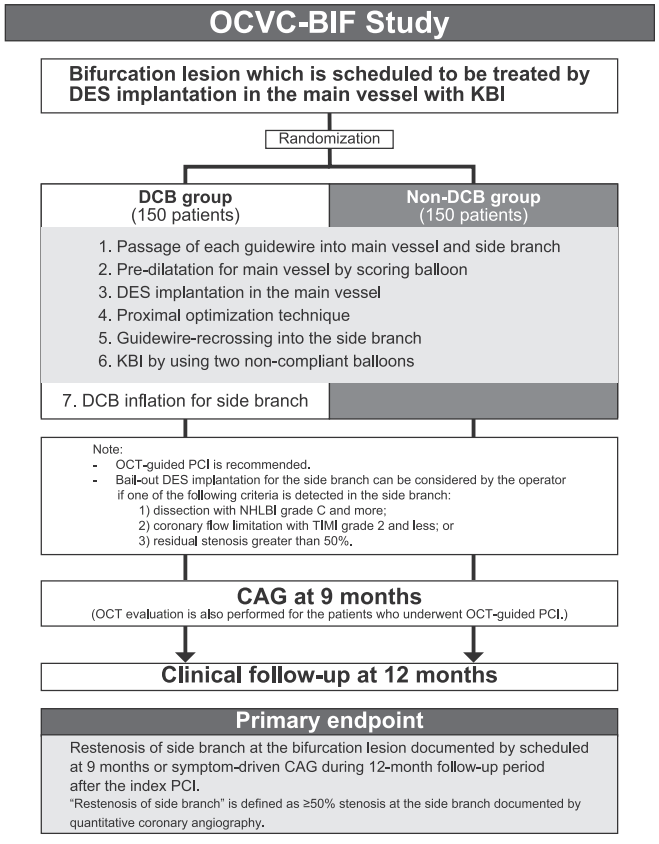

Fig. 1. Study flow chart.
CAG, coronary angiography; DCB, drug-coated balloon; DES, drug eluting stent; KBI, kissing balloon inflation; NHLBI, National Heart, Lung, and Blood Institute; OCT, optical coherence tomography; PCI, percutaneous coronary intervention; TIMI, Thrombolysis in Myocardial Infarction.

Secondary endpoints include the following: restenosis rate in the side branch at 9 months after PCI, revascularization rate of side branch up to 12 months after PCI, procedural success which is defined as residual stenosis of <30 % in main branch and < 50 % in side branch, with TIMI III flow in both branches [3], rate of PCI, incidence of complications related to PCI procedure, MACE which is defined as a composite of cardiac death, myocardial infarction, target lesion revascularization, and stent thrombosis, the change of lumen area in OCT at the side branch ostium from immediately after PCI to the follow-up CAG at 9 months after PCI, late loss evaluated by OCT of the side branch from immediately after PCI to the follow-up CAG at 9 months after PCI, percentage of stent malapposition at 9 months after PCI, percentage of uncovered struts at 9 months after PCI, the volume of stent malapposition at 9 months after PCI, and percentage of thrombus in stent at 9 months after PCI.

The raw data comprising the CAG and OCT imaging files will undergo core-lab assessment in all cases in order to ensure an independent, consistent evaluation.

2.8. Study organization and status (Osaka Cardiovascular Conference)

The Osaka Cardiovascular Conference (OCVC) consists of cardiologists belonging to the Osaka University Graduate School of Medicine or one of 30 affiliated hospitals in Osaka, Japan. The OCVC was launched in 2015 to investigate clinical questions in the cardiovascular field. Among the participating institutions, members of eight hospitals that frequently perform PCI comprise OCVC-BIF investigators and participated in the present study. Details of the study organization are shown in the Supplementary Appendix.

OCVC-BIF started enrollment in October 2019, and it was completed in September 2024. Completion of the study is expected by December 2026.

2.9. Statistical considerations

In a report comparing data at 12 months in the DCB group with a Taxus stent in the trunk and a CB group with a DCB in the side branches, restenosis rates were reported to be 7 % and 20 %, respectively [3]. The PEPCAD BIF study of the efficacy of DCB in side branches of bifurcation lesions with lesions only in the side branches of native coronary arteries reported restenosis rates of 6 % in the DCB group and 26 % in the CB group at 9 months [12]. Based on these studies, we assumed the restenosis rate in the CB group to be 20 % with a significance level (two-sided) of 5 % and a statistical power of 80 %, if the restenosis rate in the DCB group were varied from 5 % to 10 %, the required total sample size was calculated to be 164 to 428 cases. Additionally, the dropout rate was expected to exceed 10 % because the primary endpoint assessment was highly invasive. Therefore, considering the dropout rate and feasibility, we set the sample size at 300, at which a statistically significant difference would be observed if the restenosis rate in the DCB group was 7 %.

The analysis set is defined as the set of all randomized patients who meet all inclusion criteria, and its statistical evaluation is based on the intention-to-treat (ITT) principle.

Analysis for the primary endpoint is based on the logistic regression analysis at a significance level (two-sided) of 5 % with the presence of stenosis at the side branch ostium and left main trunk involvement as covariates. As a sensitivity analysis, a chi-square test of independence for the restenosis rate and an additional analysis similar to the primary analysis except for patients treated with bailout stenting will be performed to confirm the robustness of the main analysis. No interim analyses will be conducted in this trial.

3. Discussion

DEBSIDE trial was a prospective, non-randomized, multicenter, interventional study evaluating the dedicated paclitaxel-eluting stent (Nile

PAX®; Minvasys, Gennevilliers, France) implantation for main branch followed by final DCB inflation using the DANUBIO (Minvasys) balloon for the treatment of side branches of *de novo* bifurcation lesions with a side branch reference vessel diameter ≥ 2.0 mm and ≤ 3.0 mm [13]. In the trial, 52 patients with bifurcation lesions suitable for stenting were enrolled, and the primary endpoint of side branch LLL was −0.04 ± 0.34 mm and the secondary endpoint of MB LLL was 0.54 ± 0.60 mm at six-month follow-up. Judging from this result, DCB would be effective for the treatment of the side branch. However, due to the aspect of the single-arm study, the 15th consensus document from the European Bifurcation Club mentioned that "studies exploring DEB efficacy in *de novo* bifurcation lesions had major limitations and to date have provided no conclusive evidence" [7]. The OCVC-BIF study will produce the reliable evidence which shows the effectiveness of DCB for a side branch in the bifurcation lesions.

Okamura T et al. suggested the classification according to the jailing configuration and recrossing point by using 3D-OCT reconstruction for the bifurcation lesions after main branch stenting with recrossing into side branch [14]. They defined the jailing configuration type with no link at carina and distal recross position as "link-free distal (LFD)" and the others as "non-LFD". In terms of the meaning of this classification, incomplete stent apposition rate at the ostium of side branch was significantly lower in LFD compared to non-LFD. On the other hand, Onuma Y et al. suggested another classification of the optimal recrossing point by using optical frequency domain imaging (OFDI) [8]. They divided the jailing configurations into three types and proposed the optimal recrossing point in each configuration. OPTIMUM trial, in which patients with bifurcation treatment were randomly allocated to either online 3D-OFDI-guided or angiography-guided PCI and patients randomized to 3D-OFDI guidance underwent online 3D-OFDI assessment after rewiring into the jailed side branch after stenting and proximal optimization technique, demonstrated that the post-procedural average percentage of incomplete stent apposition per lesion assessed by OFDI was lower in the 3D-OFDI guided PCI than in angiography-guided PCI [15]. The OCVC-BIF study will elucidate the relationship between the jailing configuration/recrossing point and the efficacy of DCB because OCT-guided PCI will be performed in many cases.

CRediT authorship contribution statement

Tomoharu Dohi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Takayuki Ishihara:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Hirota Kida:** Writing – review & editing, Supervision, Data curation. **Daisuke Nakamura:** Writing – review & editing, Supervision, Investigation. **Atsushi Kikuchi:** Writing – review & editing, Investigation. **Tsutomu Kawai:** Writing – review & editing, Investigation. **Naoki Mori:** Writing – review & editing, Investigation. **Naotaka Okamoto:** Writing – review & editing, Investigation. **Yasunori Ueda:** Writing – review & editing, Supervision, Investigation. **Ryu Shutta:** Writing – review & editing, Supervision, Investigation. **Minoru Ichikawa:** Writing – review & editing, Supervision, Investigation. **Toshiaki Mano:** Writing – review & editing, Supervision. **Tetsuya Watanabe:** Writing – review & editing, Supervision. **Yoshiharu Higuchi:** Writing – review & editing, Supervision. **Masami Nishino:** Writing – review & editing, Supervision. **Eisuke Hida:** Writing – review & editing, Supervision, Software, Formal analysis, Data curation. **Tomoharu Sato:** Writing – review & editing, Software, Formal analysis, Data curation. **Shungo Hikoso:** Writing – review & editing, Supervision. **Daisaku Nakatani:** Writing – review & editing, Supervision. **Yohei Sotomi:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Funding acquisition. **Yasushi Sakata:** Writing – review & editing, Supervision, Resources, Funding acquisition.

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Declaration of competing interest

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Appendix A. Supplementary data

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References

[1] Lassen JF, Holm NR, Stankovic G, Lefèvre T, Chieffo A, Hildick-Smith D, et al. Percutaneous coronary intervention for coronary bifurcation disease: consensus from the first 10 years of the European bifurcation Club meetings. EuroIntervention. 2014; 10:545–60. https://doi.org/10.4244/EIJV10I5A97.

[2] Sawaya FJ, Lefèvre T, Chevalier B, Garot P, Hovasse T, Morice MC, et al. Contemporary approach to coronary bifurcation lesion treatment. J Am Coll Cardiol Intv. 2016;9: 1861–78. https://doi.org/10.1016/j.jcin.2016.06.056.

[3] Herrador JA, Fernandez JC, Guzman M, Aragon V. Drug-eluting vs. conventional balloon for side branch dilation in coronary bifurcations treated by provisional T stenting. J Interv Cardiol. 2013;26:454–62. https://doi.org/10.1111/joic.12061.

[4] Korn HV, Yu J, Ohlow MA, Huegl B, Schulte W, Wagner A, et al. Interventional therapy of bifurcation lesions: a TIMI flow-guided concept to treat side branches in bifurcation lesions–a prospective randomized clinical study (Thueringer bifurcation study, THUEBIS study as pilot trial). Circ Cardiovasc Interv. 2009;2:535–42. https://doi.org/10.1161/CIRCINTERVENTIONS.108.833046.

[5] Wöhrle J, Zadura M, Möbius-Winkler S, Leschke M, Opitz C, Ahmed W, et al. SeQuentPlease world wide registry: clinical results of SeQuent please paclitaxel-coated balloon angioplasty in a large-scale, prospective registry study. J Am Coll Cardiol. 2012;60:1733–8. https://doi.org/10.1016/j.jacc.2012.07.040.

[6] Jeger RV, Farah A, Ohlow MA, Mangner N, Möbius-Winkler S, Leibundgut G, 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. https://doi.org/10.1016/S0140-6736(18)31719-7.

[7] Burzotta F, Lassen JF, Lefèvre T, Banning AP, Chatzizisis YS, Johnson TW, et al. Percutaneous coronary intervention for bifurcation coronary lesions: the 15th consensus document from the European bifurcation Club. EuroIntervention. 2021;16:1307–17. https://doi.org/10.4244/EIJ-D-20-00169.

[8] Onuma Y, Katagiri Y, Burzotta F, Holm NR, Amabile N, Okamura T, et al. Joint consensus on the use of OCT in coronary bifurcation lesions by the European and Japanese bifurcation clubs. EuroIntervention. 2019;14:e1568–77. https://doi.org/10.4244/EIJ-D-18-00391.

[9] Huber MS, Mooney JF, Madison J, Mooney MR. Use of a morphologic classification to predict clinical outcome after dissection from coronary angioplasty. Am J Cardiol. 1991;68:467–71. https://doi.org/10.1016/0002-9149(91)90780-o.

[10] The TIMI Study Group. The thrombolysis in myocardial infarction (TIMI) trial. Phase I findings. N Engl J Med. 1985;312:932–6. https://doi.org/10.1056/NEJM198504043121437.

[11] Nakamura M, Kimura K, Kimura T, Ishihara M, Otsuka F, Kozuma K, et al. JCS 2020 guideline focused update on antithrombotic therapy in patients with coronary artery disease. Circ J. 2020;84:831–65. https://doi.org/10.1253/circj.CJ-19-1109.

[12] Kleber FX, Rittger H, Ludwig J, Schulz A, Mathey DG, Boxberger M, et al. Drug eluting balloons as stand alone procedure for coronary bifurcational lesions: results of the randomized multicenter PEPCAD-BIF trial. Clin Res Cardiol. 2016;105:613–21. https://doi.org/10.1007/s00392-015-0957-6.

[13] Berland J, Lefèvre T, Brenot P, Fajadet J, Motreff P, Guerin P, et al. DANUBIO - a new drug-eluting balloon for the treatment of side branches in bifurcation lesions: six-month angiographic follow-up results of the DEBSIDE trial. EuroIntervention. 2015; 11:868–76. https://doi.org/10.4244/EIJV11I8A177.

[14] Okamura T, Nagoshi R, Fujimura T, Murasato Y, Yamawaki M, Ono S, et al. Impact of guidewire recrossing point into stent jailed side branch for optimal kissing balloon dilatation: core lab 3D optical coherence tomography analysis. EuroIntervention. 2018;13:e1785–93. https://doi.org/10.4244/EIJ-D-17-00591.

[15] Onuma Y, Kogame N, Sotomi Y, Miyazaki Y, Asano T, Takahashi K, et al. A randomized trial evaluating online 3-dimensional optical frequency domain imaging-guided percutaneous coronary intervention in bifurcation lesions. Circ Cardiovasc Interv. 2020;13: e009183. https://doi.org/10.1161/CIRCINTERVENTIONS.120.009183.