

ORIGINAL RESEARCH

Percutaneous Coronary Intervention Guided by Optical Coherence Tomography or Intravascular Ultrasound for True Bifurcation Lesions

Seong-Bong Wee, MD,^a Do-Yoon Kang, MD,^a Jung-Min Ahn, MD,^a Han Su Park, MD,^a Soo Yeon An, MD,^a Kyeong-Won Seo, MD,^a Seung Han Lee, MD,^a Sung-Cheol Yun, PhD,^b Seunghee Baek, PhD,^b Seung-Ho Hur, MD,^c Yun-Kyeong Cho, MD,^c Cheol Hyun Lee, MD,^c Soon Jun Hong, MD,^d Subin Lim, MD,^d Sang-Wook Kim, MD,^e Hoyoun Won, MD,^f Young Joon Hong, MD,^g Yong-Hoon Yoon, MD,^h Young Won Yoon, MD,ⁱ Jang-Ho Bae, MD,^j Seung-Jung Park, MD,^a Duk-Woo Park, MD,^a the OCTIVUS Investigators

ABSTRACT

BACKGROUND Imaging-guided percutaneous coronary intervention (PCI) using optical coherence tomography (OCT) or intravascular ultrasound (IVUS) is superior to angiography-guided PCI in true coronary artery bifurcation lesions, yet their comparative effectiveness remains uncertain.

OBJECTIVES The authors sought to compare the effectiveness and safety of OCT-guided vs IVUS-guided PCI in treating true bifurcation lesions.

METHODS The authors conducted a prespecified subgroup analysis of the OCTIVUS (Optical Coherence Tomography Versus Intravascular Ultrasound-Guided Percutaneous Coronary Intervention) trial, which compared OCT- and IVUS-guided PCI in all-comer patients. True bifurcation lesions were identified by coronary angiography. The primary outcome was target-vessel failure, a composite of cardiac death, target-vessel myocardial infarction, or ischemia-driven target-vessel revascularization. Crude and adjusted analyses were performed using inverse probability of treatment weighting and overlap propensity-score weighting.

RESULTS Of the 2,008 patients in the OCTIVUS trial, 428 (21.3%) underwent imaging-guided PCI for true bifurcation lesions; among them, 185 (43.2%) received OCT-guided PCI and 243 (56.8%) received IVUS-guided PCI. During the follow-up period (median, 2.0 years; IQR: 1.1-2.9), the primary outcome occurred in 20 of 185 patients (11.3%; 2-year Kaplan-Meier estimates; 95% CI: 6.2%-16.2%) in the OCT-guided group vs 18 of 243 patients (8.4%; 95% CI: 4.4%-12.2%) in the IVUS-guided group (HR: 1.27; 95% CI: 0.70-2.44; $P = 0.40$). These findings remained consistent in adjusted analyses using inverse probability of treatment weighting (HR: 1.12; 95% CI: 0.57-2.22; $P = 0.74$) and overlap propensity-score weighting (HR: 1.15; 95% CI: 0.16-2.24; $P = 0.69$).

CONCLUSIONS In patients with true bifurcation lesions, OCT-guided PCI demonstrated a similar risk of target-vessel failure compared with IVUS-guided PCI. (Optical Coherence Tomography versus Intravascular Ultrasound-Guided Percutaneous Coronary Intervention; [NCT03394079](https://clinicaltrials.gov/ct2/show/study/NCT03394079)) (JACC Asia. 2026;■:■-■) © 2026 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

From the ^aDivision of Cardiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea; ^bDivision of Biostatistics, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea; ^cDivision of Cardiology, Keimyung University Dongsan Hospital, Daegu, Korea; ^dDepartment of Cardiology, Cardiovascular Center, Korea University Anam Hospital, Seoul, Korea; ^eDivision of Cardiology, Chung-Ang University Gwangmyeong Hospital, Chung-Ang University College of Medicine, Gwangmyeong-si, Korea; ^fDivision of Cardiology, Chung-Ang University Hospital, Chung-Ang University College of Medicine, Seoul, Korea; ^gDepartment of Cardiology, Chonnam National University Hospital, Chonnam National University

**ABBREVIATIONS
AND ACRONYMS****IPTW** = inverse probability of
treatment weighting**IVUS** = intravascular
ultrasound**MI** = myocardial infarction**OCT** = optical coherence
tomography**PCI** = percutaneous coronary
intervention**TVF** = target-vessel failure

Coronary bifurcation lesions represent 15% to 20% of cases requiring percutaneous coronary intervention (PCI).¹ These lesions pose significant technical challenges, and no standardized treatment strategy has been established.² In complex true bifurcation lesions involving both the main vessel and side branch, stent implantation techniques are associated with higher rates of procedural complications and worse clinical outcomes compared with PCI for simpler lesions.³⁻⁵

Although angiography remains the predominant guidance method for PCI in clinical practice, emerging evidence supports the use of intravascular ultrasound (IVUS) and optical coherence tomography (OCT) to optimize complex procedures, particularly in bifurcation lesions.⁶⁻⁸ The OCTOBER (Optical Coherence Tomography Optimized Bifurcation Event Reduction) trial recently demonstrated the superiority of OCT-guided PCI over angiography-guided PCI in complex coronary artery bifurcation lesions, showing reduced target-lesion failure at 2 years.⁸ Based on these findings, current clinical guidelines strongly recommend (Class I, Level of Evidence: A) IVUS or OCT guidance for PCI in anatomically complex lesions, especially those involving the left main artery, true bifurcations, and long lesions.⁹

Despite growing recognition of IVUS and OCT capabilities and their potential value in true coronary interventions, the comparative effectiveness of these imaging tools for true bifurcation lesions remains uncertain. To address this gap, we analyzed data from the OCTIVUS (Optical Coherence Tomography versus Intravascular Ultrasound-Guided Percutaneous Coronary Intervention; [NCT03394079](#)) trial, which randomly compared OCT-guided and IVUS-guided PCI in patients with various coronary artery lesions.¹⁰

METHODS

STUDY DESIGN AND POPULATION. The design and methods of the OCTIVUS trial have been previously published.¹⁰ Briefly, OCTIVUS was a multicenter, open-label, randomized controlled, pragmatic trial

conducted at 9 South Korean sites from April 2018 through January 2022. Following a pragmatic design, the trial included a broad range of patients with various anatomical and clinical characteristics. The trial randomized 2,008 patients with diverse clinical and anatomical characteristics in a 1:1 ratio to undergo either OCT-guided or IVUS-guided PCI. Eligible patients were aged 19 years or older and underwent PCI with contemporary drug-eluting stents or drug-coated balloons (the latter only for in-stent restenosis) for significant coronary artery lesions. Exclusion criteria were limited to patients with ST-segment elevation myocardial infarction (MI), severe renal dysfunction, unstable hemodynamics, decompensated heart failure, or severely calcified or tortuous lesions that prevented intracoronary imaging catheter delivery. The institutional review board at each participating site approved the trial, and all patients provided written informed consent before randomization.

The current study included patients with true bifurcation lesions who underwent PCI. Based on previous literature,^{7,11-13} a true bifurcation lesion was defined as a coronary artery lesion involving a significant ($\geq 50\%$) diameter stenosis both in the main vessel and side branch by visual estimation, corresponding to Medina classification 1,1,1/0,1/0,1,1. The side branch was required to have a reference diameter of at least 2.5 mm and a stenosis of 50% or greater within 5 mm from its ostium, as determined by visual assessment.

IMAGING-GUIDED PCI PROCEDURES. Study patients underwent PCI using conventional bifurcation techniques.¹⁴ The treating operator selected the optimal bifurcation PCI technique during the index procedure, choosing between the 1-stent technique (provisional side branch stenting strategy) or the upfront 2-stent technique (1 stent each in the main branch and side branch). In this study, because stent technique data were not collected in a prespecified manner, we defined the 2-stent technique as cases in which a stent was finally implanted in the side branch vessel. It was strongly recommended to perform final kissing balloon inflation when using the 2-stent technique.

Medical School, Gwangju, Korea; ^bDivision of Cardiology, Chungnam National University Sejong Hospital, Sejong, Korea; ^cDivision of Cardiology, Heart Center, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea; and the ^dDepartment of Cardiology, Konyang University Hospital, Daejeon, Korea.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the [Author Center](#).

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Imaging evaluation of both the main vessel and side branch was recommended during bifurcation PCI. Each imaging-guided group used either IVUS with a rotational transducer (Opticross or Opticross HD, Boston Scientific Corporation) or OCT (C7-XR and OPTIS, Abbott) before, during, and immediately after stent implantation. The OPTIS system provided real-time coregistration of OCT images with angiography and automatic measurement capabilities, which facilitated efficient assessment of diseased segments. However, final intracoronary imaging evaluation was required post stent implantation to confirm adequate optimization performed by experienced operators according to the prespecified optimization criteria. Stent parameters and optimization followed a prespecified common algorithm for imaging-guided PCI.¹⁵ This included using a distal lumen or external elastic membrane reference-based stent sizing strategy and achieving stent expansion >80% of the mean reference lumen area while avoiding major stent malapposition or edge dissection.¹⁰ For side branch vessels, relative stent expansion was defined as minimal stent area of the side branch divided by distal reference vessel lumen area.⁸ When optimization criteria were not met, operators performed additional procedures using a high-pressure balloon or additional stent implantation, followed by mandatory repeated intravascular imaging evaluation. The independent angiographic and imaging core laboratories at the Asan Medical Center analyzed all quantitative coronary angiography and intravascular imaging data.

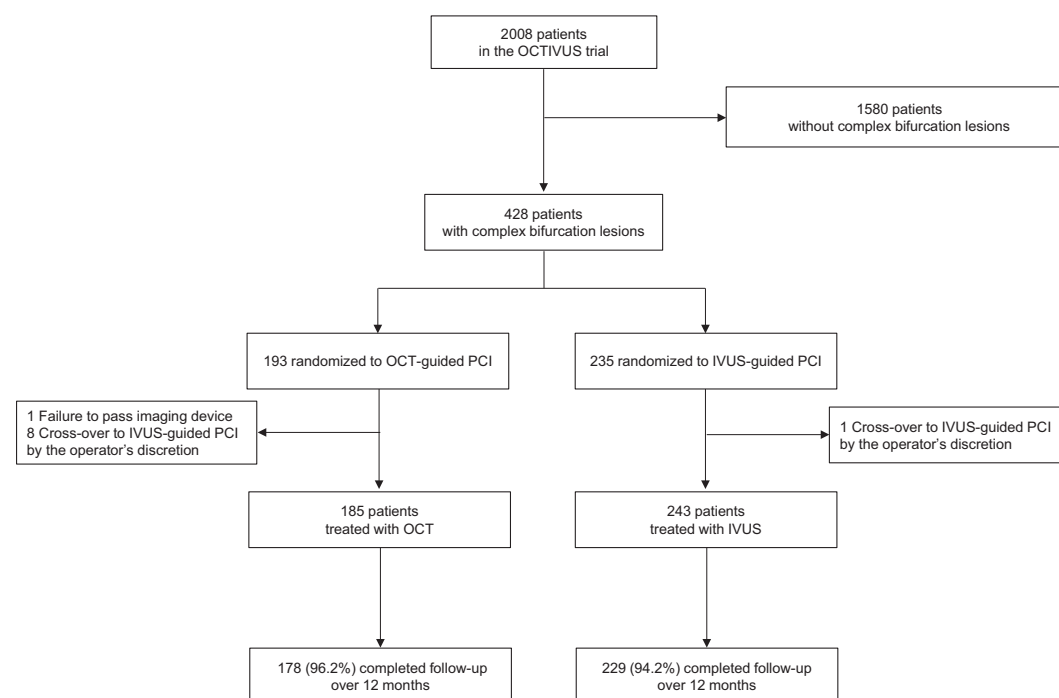
STUDY OUTCOMES AND CLINICAL FOLLOW-UP.

The primary endpoint of the OCTIVUS trial was target vessel failure (TVF), defined as a composite of cardiac death, target vessel-related MI, or ischemia-driven target-vessel revascularization. Key secondary endpoints included the primary endpoint's individual components, target-lesion failure (comprising cardiac death, target vessel MI, or ischemia-driven target lesion revascularization), stent thrombosis, stroke, repeat revascularization, rehospitalization, and bleeding events. Additional secondary endpoints included contrast-induced acute kidney injury, PCI or intravascular imaging-related procedural complications requiring intervention, and angiographic or imaging-based device success. Detailed definitions of clinical endpoints are provided in the [Supplemental Material](#) (section A). An independent clinical endpoint committee, blinded to trial group assignments, adjudicated all definite and possible clinical events.

Follow-up was performed at hospital discharge; at 1, 6, and 12 months; and yearly thereafter. Telephone interviews were conducted for patients unable to attend outpatient clinic visits. During follow-up, physicians strongly recommended guideline-directed medical therapy and intensive secondary prevention according to contemporary clinical guidelines. Clinical events and cardiovascular medication information were systematically collected at each visit. Survival status was verified through the Korean National Health Insurance Service database's national death registry.¹⁶

STATISTICAL ANALYSIS. All statistical analyses were conducted on an as-treated basis. Summary statistics are presented as percentages for categorical variables and as mean $\pm$ SD for continuous variables. Baseline characteristics, procedural data, and imaging characteristics were compared between treatment groups using the Student's *t*-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

Cumulative event probabilities were estimated using the Kaplan-Meier method. In time-to-first-event analyses, HRs and 95% CIs were calculated using Cox proportional hazards models. The proportional hazards assumption regarding the treatment modalities was tested using Schoenfeld residuals, confirming no violations.¹⁷ Randomization was not stratified by the presence or absence of true bifurcation lesions, resulting in potential baseline imbalances between treatment groups (OCT vs IVUS). To minimize confounding, we conducted propensity-score-adjusted analyses using inverse probability of treatment weighting (IPTW) and overlap weighting methods. Overlap weighting is a propensity-score method that aims to replicate key attributes of randomized clinical trials, ensuring that outliers do not dominate the results and compromise precision.¹⁸ Propensity scores were derived from multivariable logistic regression models incorporating all available baseline clinical and anatomical covariates.^{19,20} Standardized differences were estimated for all the baseline covariates before and after propensity-score adjustment to assess the similarities in covariates; an absolute mean standardized difference ≤ 0.10 indicates good balance.²¹ Weighted Cox proportional hazards regression models with IPTW or overlap propensity-score weighting were used to compare the treatment effects of the 2 imaging modalities. Furthermore, the consistency of treatment effects across prespecified clinical, anatomical, and procedural characteristics was evaluated by assessing

FIGURE 1 Trial Profile

This diagram shows the assessment of eligibility, randomization, and follow-up of the trial participants. IVUS = intravascular ultrasound; OCT = optical coherence tomography; OCTIVUS = Optical Coherence Tomography Versus Intravascular Ultrasound-Guided Percutaneous Coronary Intervention; PCI = percutaneous coronary intervention.

heterogeneity using Cox models with multiplicative interaction terms.

All reported *P* values were 2-sided, and $P < 0.05$ was considered significant for all tests. The 95% CIs for secondary outcomes were not adjusted for multiple comparisons; therefore, these intervals should not be used to infer definitive treatment effects. All statistical analyses were conducted using SAS software, version 9.4 (SAS Institute), and R software, version 4.3.2 (R Foundation for Statistical Computing).

RESULTS

STUDY POPULATION AND BASELINE CHARACTERISTICS.

Of 2,008 randomized patients in the OCTIVUS trial, 428 (21.3%) underwent imaging-guided PCI for true bifurcation lesions. Baseline characteristics comparing patients with and without true bifurcation lesions are shown in [Supplemental Table 1](#). Patients with true bifurcation lesions demonstrated higher rates of stable angina, higher SYNTAX (Synergy between Percutaneous Coronary Intervention with

Taxus and Cardiac Surgery) scores, and greater procedural complexity compared with those without true bifurcation lesions.

Among the 428 patients with true bifurcation lesions, 193 were randomized to OCT-guided PCI and 235 to IVUS-guided PCI. In the OCT-guided group, 9 patients did not receive OCT imaging because of device delivery failure or protocol violations (crossover to IVUS-assisted PCI by operator discretion). In the IVUS-guided group, 1 patient crossed over to OCT-assisted PCI because of protocol violations. Thus, the final analysis included 185 patients (43.2%) who underwent OCT-guided PCI and 243 (56.8%) who underwent IVUS-guided PCI for true bifurcation lesions ([Figure 1](#)).

Baseline clinical characteristics were well balanced between groups except for sex ([Table 1](#)). Anatomical and procedural characteristics are summarized in [Table 2](#) and [Supplemental Table 2](#). Both groups showed similar lesion locations and true bifurcation lesion types. Approximately 25% of patients had left main coronary artery bifurcation lesions and 78% had true bifurcation lesions involving proximal and distal

main vessels and side branches (Medina 1,1,1). The 2-stent technique was used in 39% of OCT-guided and 45% of IVUS-guided procedures ($P = 0.29$). The OCT-guided group used more contrast but had shorter procedure times compared with the IVUS-guided group. Both groups achieved angiographic procedural success in more than 99% of cases.

Quantitative coronary angiography and intravascular imaging results are presented in [Table 3](#), [Supplemental Table 3](#). The OCT-guided group showed a smaller minimum stent area and stent expansion compared with the IVUS-guided group. Procedure-related complications are listed in [Supplemental Table 4](#), with no complications related to either IVUS or OCT use.

To address potential baseline characteristic imbalances, we conducted propensity-score analyses ([Supplemental Table 5](#)). After adjustment with IPTW and overlap propensity-score weighting, most baseline clinical and anatomical characteristics were balanced between the OCT-guided and IVUS-guided groups.

CLINICAL OUTCOMES. During the follow-up period (median: 2.0 years; IQR: 1.1-2.9), complete ascertainment of trial endpoints was achieved in 95.1% of patients (OCT group, 96.2% vs IVUS group, 94.2%) and obtained vital status data for all participants ([Figure 1](#)). The use of concomitant cardioactive medications remained similar between imaging groups at baseline and during follow-up ([Supplemental Table 6](#)).

Primary and secondary clinical outcomes for both imaging modalities are presented in [Table 4](#). The primary outcome occurred in 20 of 185 patients (11.3%, 2-year Kaplan-Meier estimates; 95% CI: 6.2%-16.2%) in the OCT-guided group vs 18 of 243 patients (8.4%; 95% CI: 4.4%-12.2%) in the IVUS-guided group (unadjusted HR: 1.27; 95% CI: 0.70-2.44; $P = 0.40$) ([Table 4](#), [Central Illustration](#)). This finding remained consistent in adjusted analyses using IPTW (HR: 1.12; 95% CI: 0.57-2.22; $P = 0.74$) and overlap propensity-score weighting (HR: 1.15; 95% CI: 0.16-2.24; $P = 0.69$) ([Table 4](#), [Figure 2](#)). Both unadjusted and adjusted analyses showed similar incidence rates between groups for key secondary outcomes, including target-lesion failure, all-cause mortality, stent thrombosis, repeat revascularization, rehospitalization, bleeding events, and contrast-induced nephropathy.

SUBGROUP ANALYSIS. The primary composite outcome showed consistent results across clinical, anatomical, and procedural subgroups between OCT-guided and IVUS-guided PCI groups ([Figure 3](#)). There

TABLE 1 Baseline Characteristics of the Patients With True Bifurcation Lesion

	OCT-Guided PCI (n = 185)	IVUS-Guided PCI (n = 243)	P Value
Age, y	65.5 ± 9.8	65.5 ± 9.7	0.98
Female	56 (30.3)	46 (18.9)	0.01
Body mass index, kg/m ²	24.6 ± 3.2	24.9 ± 2.9	0.33
Diabetes	72 (38.9)	87 (35.8)	0.58
Insulin treatment	10 (5.4)	6 (2.5)	0.18
Hypertension	125 (67.6)	156 (64.2)	0.53
Hyperlipidemia	162 (87.6)	205 (84.4)	0.42
Current smoker	35 (18.9)	53 (21.8)	0.54
Family history of premature CAD ^a	12 (6.5)	15 (6.2)	>0.99
Previous myocardial infarction	17 (9.2)	14 (5.8)	0.24
Previous PCI	44 (23.8)	47 (19.3)	0.32
Previous CABG	6 (3.2)	6 (2.5)	0.85
Previous stroke or TIA	11 (5.9)	19 (7.8)	0.58
Congestive heart failure	3 (1.6)	5 (2.1)	>0.99
Chronic pulmonary disease	4 (2.2)	7 (2.9)	0.88
Peripheral vascular disease	5 (2.7)	11 (4.5)	0.47
Atrial fibrillation	6 (3.2)	12 (4.9)	0.53
End-stage renal disease on dialysis	3 (1.6)	3 (1.2)	>0.99
LVEF, % ^b	60.5 ± 7.2	60.7 ± 6.7	0.78
LVEF ≤50%	17/168 (10.1)	20/194 (10.3)	>0.99
Clinical indication for index PCI			0.54
Silent ischemia	20 (10.8)	23 (9.5)	
Chronic coronary syndrome	138 (74.6)	175 (72.0)	
Acute coronary syndrome	27 (14.6)	45 (18.5)	
Unstable angina	18 (9.7)	22 (9.1)	
NSTEMI	9 (4.9)	23 (9.5)	

Values are n (%), mean ± SD, or n/N (%) unless otherwise noted. Percentages may not total 100 due to rounding. ^aA family history of premature CAD was defined as the diagnosis of the disease in a male first-degree relative before 55 years of age or in a female first-degree relative before 65 years of age. ^bData were available for 362 patients (84.6%): 168 patients (90.8%) in the OCT-guided PCI group and 194 (79.8%) in the IVUS-guided PCI group.

CABG = coronary artery bypass grafting; CAD = coronary artery disease; IVUS = intravascular ultrasound; LVEF = left ventricular ejection fraction; NSTEMI = non-ST-segment elevation myocardial infarction; OCT = optical coherence tomography; PCI = percutaneous coronary intervention; TIA = transient ischemic attack.

were no significant interactions between the imaging modalities and any of the subgroups. Although IVUS-guided PCI showed a trend toward better outcomes in the 2-stent technique subgroup, the interaction between imaging modality and stent technique was not statistically significant (P for interaction = 0.15). In 109 patients with distal left main bifurcation lesions, primary outcome was comparable between OCT-guided and IVUS-guided PCI ([Supplemental Table 7](#)).

OPTIMIZATION. Although pre- and post-PCI imaging was performed in most cases for the main vessel, among the 182 lesions that underwent side branch stenting, pre-PCI imaging was performed in 54.4% and post-PCI imaging was performed in 79.1% ([Supplemental Table 2](#)). In the main vessel, optimization criteria were met in 45.8% vs 60.1% in the OCT vs IVUS groups, respectively, whereas optimization criteria were met in 71.7% vs 81.2% in the side branch

TABLE 2 Anatomical and Procedural Characteristics

	OCT-Guided PCI (185 Patients With 188 Lesions)	IVUS-Guided PCI (243 Patients With 253 Lesions)	P Value
Anatomical or lesion characteristics			
Trial bifurcation vessels			0.32
LMCA-LAD-LCX	46 (24.5)	63 (24.9)	
LAD-D	112 (59.6)	149 (58.9)	
LCX-OM	19 (10.1)	34 (13.4)	
RCA-PDA-PLA	11 (5.9)	7 (2.8)	
Medina classification (site report)			0.74
(1,1,1)	150 (79.8)	194 (76.7)	
(1,0,1)	21 (11.2)	32 (12.6)	
(0,1,1)	17 (9.0)	27 (10.7)	
Mean SYNTAX score ^a	20.6 ± 10.0	21.2 ± 9.4	0.57
Procedural characteristics			
PCI approach			0.90
Radial access	85 (45.9)	109 (44.9)	
Femoral access	100 (54.1)	134 (55.1)	
PCI modality			0.47
Use of drug-eluting stent	180 (97.3)	237 (97.5)	
Used of drug-coated balloon (only for in-stent restenotic lesions)	5 (2.7)	6 (2.5)	
Median number of stents per patient (IQR)	2.0 (1.0-3.0)	2.0 (1.0-3.0)	0.57
Stent technique			0.29
1-Stent technique	109 (60.6)	130 (54.9)	
2-Stent technique	71 (39.4)	107 (45.1)	
Main vessel			
Mean stent size, mm	3.19 ± 0.41	3.30 ± 0.39	0.003
Mean stent length, mm	29.72 ± 7.46	29.31 ± 8.82	0.61
Maximal balloon diameter after stenting, mm	3.67 ± 0.45	3.81 ± 0.49	0.003
Post-dilatation with a larger balloon or high-pressure balloon use ^b	171 (95.0)	232 (96.2)	0.99
Side branch vessel			
Mean stent size, mm	2.67 ± 0.27	2.70 ± 0.31	0.56
Mean stent length, mm	20.54 ± 7.29	21.23 ± 7.80	0.54
Maximal balloon diameter after stenting, mm	2.86 ± 0.30	2.88 ± 0.37	0.70
Total amount of contrast dye used, mL	283.3 ± 136.1	257.5 ± 129.5	0.047
Total PCI time, min	56.4 ± 25.3	64.1 ± 26.4	<0.01
Procedural success			
Angiography-based ^c	184 (99.5)	242 (99.6)	>0.99
Imaging-based ^d	74 (40.9)	120 (50.4)	0.07
Procedural complications requiring active intervention ^e			
Any	3 (1.6)	13 (5.3)	0.08
IVUS or OCT procedure-related complications	0 (0.0)	0 (0.0)	NC

Values are n (%) or mean ± SD unless otherwise noted. Percentages may not total 100 due to rounding. ^aThe SYNTAX (Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery) score provides a comprehensive angiographic assessment of the coronary vasculature. A higher score denotes greater anatomical complexity. Scores were calculated by the core laboratory. ^bAdditional post-stent larger balloon or high-pressure balloon was used to resolve incomplete stent expansion or incomplete stent apposition. ^cAngiographic device success is defined as successful PCI at the intended target lesion with final in-stent residual stenosis of less than 30% by quantitative coronary angiography. ^dBy patient-level analyses: imaging-based device success is defined as successful PCI at the intended target lesion, which fulfills all optimal criteria for stent implantation by IVUS or OCT. Among patients with multivessel interventions, all treated lesions should be met for optimization criteria. ^eProcedural complications (eg, major dissection, coronary perforation, vasospasm, thrombus formation, air embolization, slow flow or no reflow, distal embolization, acute closure, ventricular arrhythmia, cardiac tamponade, or cardiogenic shock) requiring active intervention (prolonged balloon inflations, additional stenting required, thrombus aspiration, pericardiocentesis, cardioversion, or the use of mechanical circulatory support devices), which were related to PCI or the use of intravascular imaging.

LAD-D = left anterior descending-diagonal; LMCA-LAD-LCX = left main coronary artery-left anterior descending-left circumflex; LCX-OM = left circumflex-obtuse marginal; NC = not calculated; RCA-PDA-PLA = right coronary artery-posterior descending artery-posterolateral artery; other abbreviations as in [Table 1](#).

vessel. When both main vessel and side branch vessel achieved optimization criteria, the rates were 42.9% vs 57.4% ([Table 3](#)). The primary outcome showed a significant difference according to optimization

status (14.0% vs 4.9%, 2-year Kaplan-Meier estimates; nonoptimized group vs optimized group, HR: 0.35; 95% CI: 0.16-0.74; Log-rank $P = 0.004$), and this difference was more prominent in the OCT group

TABLE 3 Core Laboratory-Imaging Analysis and Imaging-Guided Optimization Criteria: Lesion-Level Analysis

	OCT-Guided PCI (n = 185, 188 Lesions)	IVUS-Guided PCI (n = 243, 253 Lesions)	P Value
Core lab imaging analysis, final post-PCI			
Main vessel			
Minimum stent area, mm ²	5.15 ± 1.61	6.53 ± 1.95	<0.001
Distal reference lumen area, mm ²	4.07 ± 1.80	5.41 ± 2.34	<0.001
Minimum stent expansion, %	81.9 ± 16.9	87.9 ± 21.9	0.004
Minimum stent area by distal reference lumen area, %	144.5 ± 47.3	128.5 ± 32.8	<0.001
Side branch vessel ^a	n = 46	n = 96	
Minimum stent area, mm ²	3.68 ± 1.20	4.26 ± 1.19	0.008
Distal reference lumen area, mm ²	2.92 ± 1.03	3.46 ± 1.29	0.020
Minimum stent area by distal reference lumen area, %	136.84 ± 43.1	132.33 ± 48.9	0.62
Optimization imaging-guided PCI criteria ^b			
All stent-optimization criteria met, ^c n/total n (%)	72/168 (42.9)	128/223 (57.4)	0.006
Main vessel stent-optimization criteria met, n/total n (%)	77/168 (45.8)	134/223 (60.1)	0.007
Side branch vessel stent-optimization criteria met, n/total n (%)	33/46 (71.7)	78/96 (81.2)	0.29
Optimal stent expansion ^d			
Main vessel segment	95/168 (56.5)	146/223 (65.5)	0.09
Side branch treated segment	39/46 (84.8)	87/96 (90.6)	0.46
Plaque burden at stent landing zone <50%			
Main vessel segment	118/129 (91.5)	192/212 (90.6)	0.93
Side branch treated segment	26/32 (81.2)	81/91 (89.0)	0.41
No major malapposition ^e			
Main vessel segment	152/168 (90.5)	217/223 (97.3)	0.007
Side branch treated segment	43/46 (93.4)	95/96 (98.9)	0.19
No large dissection ^f			
Main vessel segment	164/168 (97.6)	221/222 (99.5)	0.22
Side branch treated segment	46/46 (100)	96/96 (100)	NA
A relative stent expansion of >90%			
Main vessel segment	45/143 (31.5)	89/210 (42.4)	0.05
Side branch treated segment	34/39 (85.0)	82/89 (92.1)	0.22

Values are mean ± SD or n/N(%) unless otherwise noted. The presented data outline the analysis of the main vessel. Percentages may not total 100 due to rounding. ^aOnly in patients treated with 2-stent techniques. All stent-optimization criteria analysis excludes 2 of 48 patients who underwent post-stenting imaging in the OCT-guided group because of inadequate imaging quality for optimization assessment. ^bPractical recommendations for stent implantation with optimization criteria by IVUS or OCT are described in the [Supplemental Material](#), Section B. These criteria were based on the expert consensus document with regard to the clinical use of intracoronary imaging including IVUS and OCT. ^cAll stent-optimization criteria were met when both main vessel and side branch stents satisfied optimization parameters, or when only the main vessel met criteria in cases in which side branch assessment was not feasible. ^dOptimal stent expansion was defined as a relative stent expansion of >80% (an in-stent minimum stent area divided by average reference lumen area). In lesions with nonevaluable reference lumen area, optimal stent expansion was defined as an absolute in-stent minimum stent area of >5.5 mm² by IVUS imaging and >4.5 mm² by OCT imaging. For side branch vessels, relative stent expansion was defined as minimal stent area of the side branch divided by distal reference vessel lumen area. ^eExtensive stent malapposition was defined as an acute stent malapposition of ≥0.4 mm with longitudinal extension >1 mm of the stent over its entire length against the vessel wall, that further stent expansion be considered. ^fLarge dissection was defined as a dissection that occurred 5 mm from the edge of the stent, extended to extensive lateral >60°, longitudinal extension >2 mm, and flap extending to media or adventitia.

Abbreviations as in [Table 1](#).

([Supplemental Figure 1](#)). In addition, the non-left main bifurcation group showed higher stent-optimization achievement rates compared with the left main bifurcation group (51.7% vs 30.2%, non-left main bifurcation vs left main bifurcation), but neither the optimized nor nonoptimized groups showed significant differences in primary outcomes according to imaging modality ([Supplemental Table 7](#)).

DISCUSSION

In this prespecified analysis of the OCTIVUS trial, we evaluated the comparative effectiveness and

safety of OCT-guided vs IVUS-guided PCI in patients with true coronary artery bifurcation lesions. Our major findings were as follows: 1) OCT-guided and IVUS-guided PCI demonstrated similar risk of TVF in patients with true bifurcation lesions at 2-year median follow-up ([Central Illustration](#)), with consistent results across left main and non-left main bifurcation lesions; 2) both groups showed low incidence of procedure-related complications, with no significant differences between them; 3) although the OCT group required more contrast dye during PCI, contrast-induced nephropathy rates were similar between groups; 4) although IVUS-guided PCI showed a trend toward better

TABLE 4 Primary and Secondary Outcomes

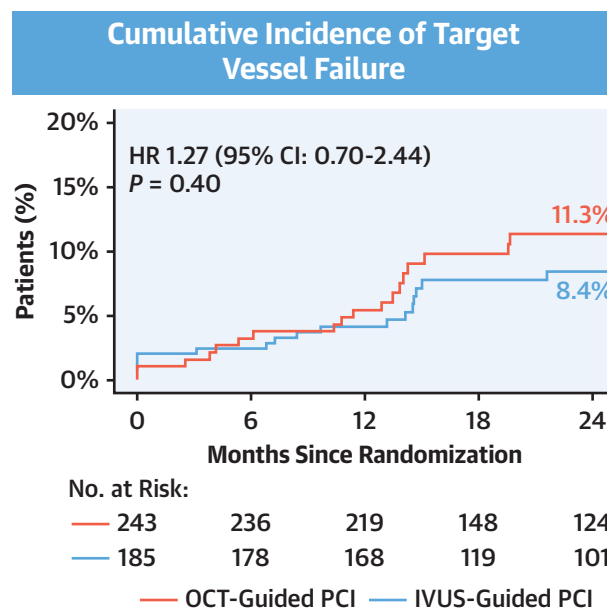
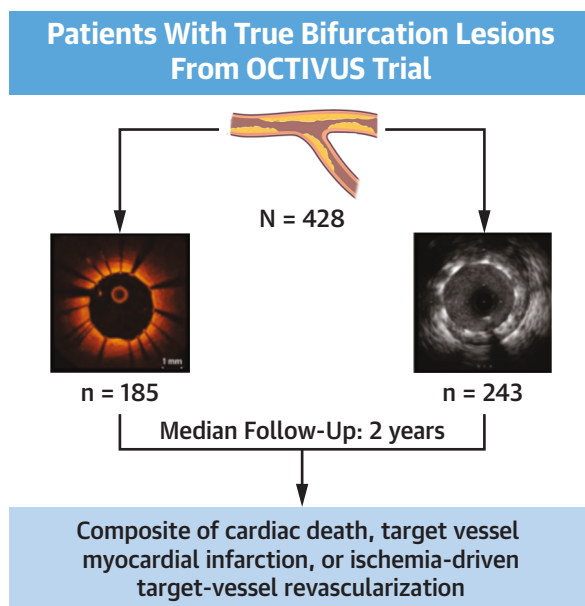
	Crude			
	OCT (n = 185)	IVUS (n = 243)	HR (95% CI)	P Value
Primary endpoint				
Target-vessel failure ^a	20 (11.3)	18 (8.4)	1.27 (0.70-2.44)	0.40
Secondary endpoints				
Target-lesion failure ^b	18 (10.0)	17 (7.8)	1.24 (0.63-2.44)	0.53
Death				
From any causes	3 (1.3)	6 (3.0)	0.42 (0.09-2.10)	0.29
From cardiac causes	2 (0.6)	2 (1.1)	0.64 (0.06-7.07)	0.72
Target-vessel MI ^c	3 (1.6)	6 (2.6)	0.65 (0.16-2.60)	0.54
Periprocedural	2 (1.1)	4 (1.6)	0.66 (0.12-3.58)	0.63
Spontaneous	1 (0.5)	2 (1.0)	0.64 (0.06-7.09)	0.72
Definite or probable stent thrombosis ^d	0 (0)	2 (0.8)	NC	NC
Stroke	1 (0.5)	1 (0)	1.48 (0.09-23.74)	0.78
Any revascularization	19 (10.5)	16 (8.1)	1.46 (0.75-2.85)	0.27
Target-lesion revascularization	13 (7.9)	11 (5.0)	1.44 (0.64-3.23)	0.38
Target-vessel revascularization	15 (9.2)	12 (5.6)	1.54 (0.72-3.30)	0.27
Rehospitalization from cardiac causes	16 (7.9)	21 (9.0)	0.84 (0.43-1.64)	0.61
Bleeding event ^e	2 (1.1)	5 (1.9)	0.53 (0.10-2.72)	0.44
BARC type 3-5				
Contrast-induced nephropathy ^f	3 (1.6)	3 (1.2)	1.00 (0.98-1.03)	0.74

TABLE 4 Continued

	IPTW				Overlap Weighting			
	OCT (n = 185)	IVUS (n = 242)	HR (95% CI)	P Value	OCT (n = 172)	IVUS (n = 226)	HR (95% CI)	P Value
Primary endpoint								
Target-vessel failure ^a	19.4 (11.1)	20.2 (9.0)	1.12 (0.57-2.22)	0.74	18.5 (11.3)	18.9 (9.3)	1.15 (0.16-2.24)	0.69
Secondary endpoints								
Target-lesion failure ^b	17.6 (10.0)	19.3 (8.5)	1.04 (0.51-2.13)	0.91	16.6 (10.1)	18.1 (8.8)	1.06 (0.15-2.14)	0.87
Death								
From any causes	3.2 (1.3)	7.1 (3.6)	0.35 (0.06-2.00)	0.24	2.8 (1.3)	5.6 (3.2)	0.38 (0.05-2.17)	0.27
From cardiac causes	1.9 (0.3)	1.9 (1.0)	0.42 (0.04-4.73)	0.48	1.6 (0.3)	1.9 (1.0)	0.32 (0.05-3.73)	0.37
Target-vessel MI ^c	3.2 (1.8)	6.3 (2.7)	0.66 (0.16-2.76)	0.57	3.1 (1.8)	6.2 (2.8)	0.65 (0.09-2.63)	0.54
Periprocedural	2.2 (1.1)	4.6 (1.8)	0.62 (0.11-3.61)	0.59	2.0 (1.2)	4.5 (2.0)	0.56 (0.08-3.25)	0.54
Spontaneous	1.0 (0.6)	1.7 (0.9)	0.78 (0.07-8.68)	0.84	1.0 (0.6)	1.6 (0.8)	0.82 (0.12-9.26)	0.87
Definite or probable stent thrombosis ^d	0 (0)	2.2 (0.9)	NC	NC	0 (0)	2.3 (1.0)	NC	NC
Stroke	1.0 (0.6)	0.9 (0)	1.80 (0.15-21.54)	0.64	1.0 (0.6)	0.9 (0)	1.88 (0.26-22.35)	0.62
Any revascularization	17.6 (10.1)	18.2 (9.0)	1.19 (0.59-2.41)	0.64	16.8 (10.4)	16.7 (9.1)	1.24 (0.17-2.49)	0.53
Target-lesion revascularization	12.5 (7.9)	12.9 (5.7)	1.18 (0.50-2.80)	0.71	11.9 (8.1)	11.7 (5.7)	1.25 (0.18-2.89)	0.60
Target-vessel revascularization	14.3 (9.1)	13.7 (6.2)	1.29 (0.57-2.90)	0.55	13.8 (9.4)	12.5 (6.2)	1.37 (0.19-3.02)	0.44
Rehospitalization from cardiac causes	14.3 (7.2)	23.3 (9.7)	0.66 (0.32-1.33)	0.24	13.6 (7.4)	21.1 (9.6)	0.70 (0.10-1.40)	0.31
Bleeding event ^e	1.7 (1.0)	7.2 (3.2)	0.31 (0.05-1.73)	0.18	1.7 (1.0)	6.3 (2.9)	0.36 (0.05-1.95)	0.24
BARC type 3-5								
Contrast-induced nephropathy ^f	3.1 (1.7)	3.0 (1.2)	1.00 (0.98-1.03)	0.71	2.9 (1.7)	2.7 (1.2)	1.01 (0.98-1.03)	0.67

Values are n (%) unless otherwise indicated. Clinical endpoints were evaluated throughout the entire follow-up period (ie, from the time of randomization to the day of the first occurrence of a primary endpoint event, the day of the last office or telephone visit, or the day of death during follow-up). All analyses were performed on an as-treated basis. Event numbers (n) represent the total events observed during follow-up and percentages represent Kaplan-Meier estimates at 2 years (median follow-up duration) after randomization. Therefore, the reported rates do not correspond to the simple ratio of the numerator and denominator. The HR is for the OCT-guided PCI group in comparison with the IVUS-guided PCI group. Because CIs for secondary outcomes have not been adjusted for multiple comparisons, the inferences drawn from these intervals may not be reproducible and should not be used to infer definitive treatment effects for secondary endpoints. ^aTarget-vessel failure was a composite of death from cardiac causes, target-vessel MI, or ischemia-driven target-vessel revascularization. ^bTarget-lesion failure was a composite of death from cardiac causes, target-vessel MI, or ischemia-driven target-lesion revascularization. ^cMI was assessed according to the protocol definition. ^dStent thrombosis was defined as either definite or probable stent thrombosis according to the Academic Research Consortium. In the IVUS-guided PCI group, only 2 cases of definite thrombosis were observed, occurring at 1 day and 95 days post-procedure. ^eBleeding events are assessed according to the BARC criteria, in which BARC type 3-5 indicates severe bleeding. ^fContrast-induced nephropathy was defined as either a greater than 25% increase in serum creatinine or an absolute increase in serum creatinine of 0.5 mg/dL from baseline within 72 hours after the index PCI procedure. For contrast-induced nephropathy, a weighted logistic regression model was used to calculate the OR with 95% CI, using IPTW and overlap weighting. The event rates (%) of contrast-induced nephropathy are presented as calculated percentages.

BARC = Bleeding Academic Research Consortium; IPTW = inverse probability of treatment weighting; MI = myocardial infarction; other abbreviations as in [Tables 1 and 2](#).

CENTRAL ILLUSTRATION Time-to-Event Curves for the Primary Endpoint

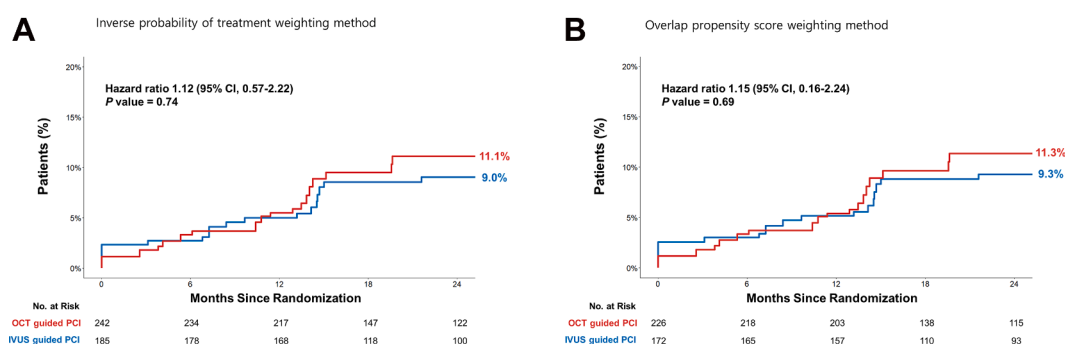
Wee S-B, et al. JACC Asia. 2026;■(■):■-■.

The prespecified subgroup analysis of the OCTIVUS trial included 428 patients with true bifurcation lesions, with 185 receiving OCT-guided PCI and 243 receiving IVUS-guided PCI. Kaplan-Meier curves show the cumulative incidence of the primary endpoint (target-vessel failure; a composite of cardiac death, target-vessel-related myocardial infarction, or ischemia-driven target-vessel revascularization) with no significant difference between 2 intracoronary imaging groups. IVUS = intravascular ultrasound; OCT = optical coherence tomography; OCTIVUS = Optical Coherence Tomography Versus Intravascular Ultrasound-Guided Percutaneous Coronary Intervention; PCI = percutaneous coronary intervention.

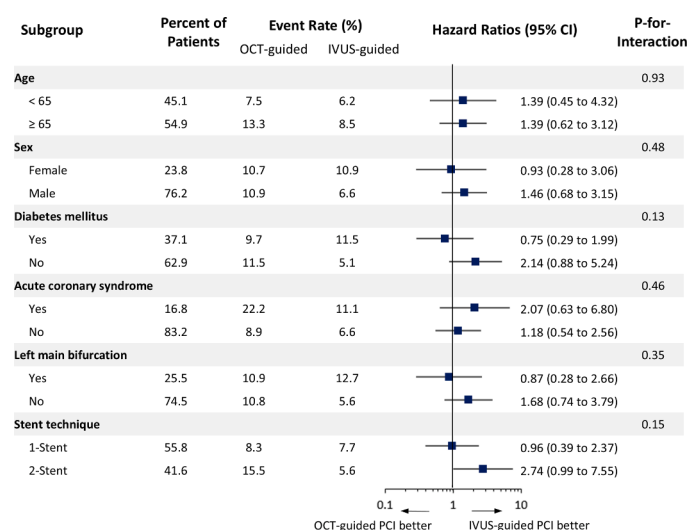
outcomes in 2-stent techniques, no significant interaction emerged between imaging modality and bifurcation stent techniques (provisional or 2-stenting) regarding the primary outcome; and 5)

stent optimization in true bifurcation lesions requiring 2 stents in the main vessel and the side branch vessel was significantly associated with a lower incidence of TVF.

FIGURE 2 Primary Endpoint in the Propensity-Score-Adjusted Cohort



(A) shows the inverse probability of treatment weighting-adjusted curves and (B) shows curves adjusted using the overlap propensity-score-weighting method. The primary endpoint was a composite of death from cardiac causes, target-vessel-related myocardial infarction, or ischemia-driven target vessel revascularization. The HRs are for the OCT-guided PCI group in comparison with the IVUS-guided PCI group. Abbreviations as in Figure 1.

FIGURE 3 Subgroup Analysis of True Bifurcation Lesions for the Primary Endpoint

Data are shown as the number of primary endpoint events per total number of patients in each subgroup, along with the corresponding event rates. HRs are for the primary composite endpoint of death from cardiac causes, target-vessel-related myocardial infarction, or ischemia-driven target-vessel revascularization throughout the entire follow-up period. The *P* value for interaction represents the likelihood of an interaction between the variable and the treatment effect of OCT vs IVUS. Abbreviations as in Figure 1.

Patients with true bifurcation lesions undergoing PCI historically show worse clinical outcomes than those without such lesions.^{3,4} Given the limitations of angiography alone in evaluating bifurcation lesions—which can lead to suboptimal stent sizing, malapposition, edge dissection, or other procedural complications—imaging-guided PCI is recommended for these cases.²² Three recent large randomized trials have examined intracoronary imaging benefits during complex PCI involving coronary bifurcation lesions. RENOVATE-COMPLEX PCI (Randomized Controlled Trial of Intravascular Imaging Guidance Versus Angiography-Guidance on Clinical Outcomes After Complex Percutaneous Coronary Intervention) primarily studied IVUS (74% IVUS, 26% OCT),⁷ whereas OCTOBER and ILUMIEN IV (Optical Coherence Tomography [OCT] Guided Coronary Stent Implantation Compared to Angiography: a Multicenter Randomized Trial in PCI [ILUMIEN IV: OPTIMAL PCI]) focused on OCT.^{8,23} In the RENOVATE-COMPLEX PCI true bifurcation subgroup, intravascular imaging-guided PCI showed no benefit over angiography-guided PCI for TVF at 2 years (10.3% vs 11.8%; HR: 0.97; 95% CI: 0.49-1.93).⁷ The OCTOBER trial, studying complex bifurcation lesions,

demonstrated lower target-lesion failure risk with OCT-guided vs angiography-guided PCI at 2 years (10.1% vs 14.1%; HR: 0.70; 95% CI: 0.50-0.98).⁸ However, in ILUMIEN IV, OCT-guided PCI failed to reduce TVF in both the overall population (7.4% vs 8.2%; HR: 0.90; 95% CI: 0.67-1.19) and the true bifurcation subgroup requiring the 2-stent technique (7.8% vs 7.0%; HR: 1.10; 95% CI: 0.22-5.46).²³ Despite these inconsistent findings, current guidelines strongly recommend (Class I) intracoronary imaging guidance by either IVUS or OCT for anatomically complex lesions, particularly left main or true bifurcation lesions.⁹

Although both OCT and IVUS provide intravascular visualization, each has distinct advantages and limitations. OCT provides high-resolution images that allow a more detailed assessment of plaque morphology and stent apposition. IVUS, however, offers deeper tissue penetration, providing better visualization of larger vessels and their morphology.^{15,24} Until recently, no comparative studies have evaluated the relative effectiveness and safety of OCT- vs IVUS-guided PCI for true bifurcation lesions. The prior OPINION (Optical Frequency Domain Imaging vs Intravascular Ultrasound in Percutaneous Coronary Intervention) trial compared these 2 intravascular imaging modalities but was not sufficiently powered and excluded patients with left main disease.²⁵ The OCTIVUS trial, a large-scale, pragmatic randomized controlled trial, compared these 2 contemporary imaging strategies for PCI guidance in an all-comer setting.¹⁰ In our current prespecified subgroup analysis of true bifurcation lesions, we found no significant between-group difference in target-vessel revascularization incidence at 2 years, confirming similar effectiveness between OCT-guided and IVUS-guided PCI for true bifurcation lesions. Therefore, from a practical standpoint, either OCT or IVUS can be used safely and efficiently, with equally good acute and long-term results in patients with true bifurcation lesions.

Interestingly, IVUS-guided PCI tended to show more favorable outcomes than OCT-guided PCI when a 2-stent technique was used for bifurcation PCI. Although the exact explanation for these findings remains unclear, it may relate to differences in stent optimization approaches between imaging modalities. In practice, OCT-guided PCI typically employs a lumen-based approach, whereas IVUS-guided PCI usually follows a vessel-based (ie, external elastic lamina-based) approach. As shown in our imaging analysis, this resulted in substantial differences in minimum stent area and degree of stent expansion,

with smaller measurements observed in OCT-guided PCI compared with IVUS-guided PCI. Previous studies have consistently reported that stent underexpansion was associated with worse clinical outcomes, particularly when a 2-stent technique was used for bifurcation PCI.²⁶⁻²⁸ In the subgroup analysis of the OCTOBER trial, the benefit of OCT-guided PCI over angiography-guided PCI tended to be less pronounced with the 2-stent technique compared with the 1-stent technique.⁸ However, because planned stent technique data were not collected in a prespecified manner, the 2-stent technique group may include patients who underwent provisional 1-stent technique but subsequently required bail-out stenting due to side branch compromise, which should be considered when interpreting these findings. In addition, given the limited number of patients, these findings should be confirmed or refuted through larger clinical studies.

Previous studies have demonstrated the significant impact of stent optimization on clinical outcomes. In the secondary analysis of the OCTIVUS trial, stent optimization was achieved in approximately 52% of cases despite operators' dedicated efforts, demonstrating that TVF rates were significantly lower in the optimized group compared with the nonoptimized group.²⁹ This imaging-based beneficial effect was more pronounced in the OCT group than in the IVUS group. Consistent with these findings, the OCCUPI (Optical Coherence Tomography-guided Coronary Intervention in Patients with Complex Lesions) trial demonstrated that optimization was achievable in 71% of cases exclusively including complex lesions, with significantly lower major adverse cardiac events observed in the optimized group compared with the suboptimized group.³⁰ This clinical benefit of stent optimization remained consistent in this true bifurcation lesion cohort. Considering the procedural complexity of true bifurcation lesions, the overall optimization rate (51.2%) was relatively lower compared with the total population from the OCTIVUS trial (56.9%).¹⁰ Notably, stent optimization in the side branch vessel was achieved more frequently compared with the main vessel. This finding can be attributed to the different criteria for optimal stent expansion, which represents the largest proportion of optimization failures. Because of frequent ostial disease involvement, only the distal reference vessel lumen was used as the criterion for stent optimization in the side branch vessel. Current bifurcation-specific optimization criteria warrant further discussion and refinement in future studies.

STUDY LIMITATIONS. First, although patients with true bifurcation lesions were a prespecified subgroup of interest in the original OCTIVUS trial, no adjustments were made for multiple testing, and this study was statistically underpowered to detect clinically relevant events; therefore, these findings should be interpreted as hypothesis-generating. Second, the trial was unblinded, making it impossible for the operator to remain unaware of the patient's assigned trial group. Consequently, some degree of ascertainment or selection bias cannot be excluded. Third, our study did not collect comprehensive quantitative coronary angiography and whole imaging data for the side branch vessel, including ostial dimensions and vessel characteristics that are important for interpreting outcomes in true bifurcation lesions, thereby limiting the interpretation of our study results. However, we performed additional analysis of post-PCI imaging data from patients who underwent side branch stenting to demonstrate the impact of side branch stent optimization on clinical outcomes in true bifurcation lesions. Fourth, because randomization was not stratified by the presence of true bifurcation lesions, there was an imbalance in the use of specific imaging modalities for bifurcation PCI. However, the overall findings remained consistent after rigorous statistical adjustments using the IPTW method and overlap propensity-score weighting. Fifth, the generalizability and reproducibility of the trial results may be limited because of considerable geographic variability in the widespread use of imaging-guided PCI. In addition, ethnic differences should be considered, as East Asian individuals may exhibit variations in vessel diameters and outcomes compared with other populations.

CONCLUSIONS. Among high-risk patients with true coronary artery bifurcation lesions, OCT-guided PCI demonstrated a comparable risk of the primary endpoint of TVF when compared with IVUS-guided PCI during a median follow-up period of 2 years. Our study supports the notion that both OCT and IVUS can be utilized safely and effectively as adjunctive intravascular imaging modalities for patients with true coronary bifurcation lesions undergoing PCI.

DATA AVAILABILITY The data pertaining to this article may be provided by the corresponding author on reasonable request.

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ADDRESS FOR CORRESPONDENCE: Dr Duk-Woo Park, Division of Cardiology, Asan Medical Center, University of Ulsan College of Medicine, 88, Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea. E-mail: dwpark@amc.seoul.kr.

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KEY WORDS bifurcation, IVUS, OCT, PCI

APPENDIX For supplemental material, tables, and figure, please see the online version of this paper.