

## ORIGINAL RESEARCH

# OCT-Guided PCI According to Lesion Length and Vessel Diameter

## Post Hoc Analysis of OCCUPI Trial

Ji Woong Roh, MD,<sup>a,\*</sup> Oh-Hyun Lee, MD,<sup>a,\*</sup> Seok-Jae Heo, PhD,<sup>b</sup> Eui Im, MD,<sup>a</sup> Deok-Kyu Cho, MD,<sup>a</sup> Seung-Jun Lee, MD,<sup>c</sup> Jong-Young Lee, MD,<sup>d</sup> Jin Won Kim, MD,<sup>e</sup> Sang Min Kim, MD,<sup>f</sup> Seung-Ho Hur, MD,<sup>g</sup> Jung Ho Heo, MD,<sup>h</sup> Ji-Yong Jang, MD,<sup>i</sup> Jin Sin Koh, MD,<sup>j</sup> Hoyoun Won, MD,<sup>k</sup> Jun-Won Lee, MD,<sup>l</sup> Soon Jun Hong, MD,<sup>m</sup> Dong-Kie Kim, MD,<sup>n</sup> Jeong Cheon Choe, MD,<sup>o</sup> Jin Bae Lee, MD,<sup>p</sup> Tae-Hyun Yang, MD,<sup>q</sup> Jung-Hee Lee, MD,<sup>j</sup> Young Joon Hong, MD,<sup>r</sup> Jong-Hwa Ahn, MD,<sup>s</sup> Sung-Jin Hong, MD,<sup>c</sup> Chul-Min Ahn, MD,<sup>c</sup> Jung-Sun Kim, MD,<sup>c</sup> Young-Guk Ko, MD,<sup>c</sup> Donghoon Choi, MD,<sup>c</sup> Myeong-Ki Hong, MD,<sup>c</sup> Yangsoo Jang, MD,<sup>t</sup> Yongcheol Kim, MD,<sup>a</sup> Byeong-Keuk Kim, MD,<sup>c</sup> the OCCUPI Investigators

## ABSTRACT

**BACKGROUND** The clinical impact of optical coherence tomography (OCT)-guided percutaneous coronary intervention (PCI) based on lesion characteristics remains unclear.

**OBJECTIVES** This study aimed to assess the impact of OCT-guided PCI for complex lesions on clinical outcomes according to lesion length and reference vessel diameter (RVD).

**METHODS** In the OCCUPI (Optical Coherence Tomography-guided Coronary Intervention in Patients with Complex Lesions) trial, 1,604 patients with complex lesions were classified according to the median lesion length (32 mm) and RVD (2.8 mm) measured by quantitative coronary angiography. The primary endpoint was the 1-year incidence of major adverse cardiac events, a composite of cardiac death, myocardial infarction, stent thrombosis, or ischemia-driven target vessel revascularization. The median follow-up duration was 365 days (Q1-Q3: 365-365 days).

**RESULTS** The OCT guidance group showed a lower incidence of major adverse cardiac events than the angiography guidance group in patients with lesion length  $\geq 32$  mm (HR: 0.55; 95% CI: 0.32-0.95;  $P = 0.031$ ) and RVD  $< 2.8$  mm (HR: 0.51; 95% CI: 0.28-0.92;  $P = 0.026$ ). Across stratified groups based on lesion length and RVD, OCT guidance consistently demonstrated a direction of effect favoring OCT-guided PCI across all lesions ( $P$  for interaction = 0.526), with a particularly significant reduction in lesions  $\geq 32$  mm with RVD  $< 2.8$  mm (HR: 0.46; 95% CI: 0.23-0.94;  $P = 0.041$ ).

**CONCLUSIONS** This post hoc analysis of the OCCUPI trial showed that clinical outcomes consistently favored OCT-guided PCI across varying lesion lengths and RVD, with the most pronounced benefit evident in lesions  $\geq 32$  mm with RVD  $< 2.8$  mm. (Optical Coherence Tomography-guided Coronary Intervention in Patients With Complex Lesions: a Randomized Controlled Trial [OCCUPI Trial]; [NCT03625908](https://doi.org/10.1016/j.jacasi.2026.02.023)) (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 <sup>a</sup>Yongin Severance Hospital, Yonsei University College of Medicine, Yongin, Korea; <sup>b</sup>Department of Biomedical Systems Informatics, Yonsei University College of Medicine, Seoul, Korea; <sup>c</sup>Severance Cardiovascular Hospital, Yonsei University College of Medicine, Seoul, Korea; <sup>d</sup>Kangbuk Samsung Hospital, Sungkyunkwan University, Seoul, Korea; <sup>e</sup>Korea University Guro Hospital, Korea University College of Medicine, Seoul, Korea; <sup>f</sup>Chungbuk National University Hospital, Chungbuk National University, Cheongju, Korea; <sup>g</sup>Keimyung University Dongsan Hospital, Daegu, Korea; <sup>h</sup>Kosin University Gospel Hospital, Busan, Korea; <sup>i</sup>National Health Insurance Service Ilsan Hospital, Goyang, Korea; <sup>j</sup>Gyeongang National University Hospital, Jinju, Korea; <sup>k</sup>Chung-Ang University Hospital, Seoul, Korea; <sup>l</sup>Wonju Severance Christian Hospital, Wonju, Korea; <sup>m</sup>Korea University Anam Hospital, Seoul, Korea; <sup>n</sup>Haeundae Paik Hospital, University of Inje College of Medicine, Busan, Korea; <sup>o</sup>Pusan National University Hospital, Busan, Korea; <sup>p</sup>Daegu Catholic University Medical Center, Daegu, Korea; <sup>q</sup>Inje University Busan Paik Hospital, Busan, Korea; <sup>r</sup>Chonnam National University Hospital, Gwangju, Korea; <sup>s</sup>Gyeongang National University Changwon Hospital, Changwon, Korea; and the <sup>t</sup>CHA Bundang Medical Center, CHA University College of Medicine, Seongnam, Korea. \*These authors contributed equally to this work.

**ABBREVIATION  
AND ACRONYMS****DES** = drug-eluting stent**IVUS** = intravascular  
ultrasound**MACE** = major adverse cardiac  
events**OCT** = optical coherence  
tomography**PCI** = percutaneous coronary  
intervention**QCA** = quantitative coronary  
angiography**RVD** = reference vessel  
diameter**TVR** = target vessel  
revascularization

**A**s lesion complexity increases, precise intravascular imaging guidance via optical coherence tomography (OCT) or intravascular ultrasound (IVUS) becomes crucial for optimal stent deployment and improved clinical outcomes following percutaneous coronary intervention (PCI) using drug-eluting stents (DES).<sup>1-8</sup> With the substantial evidence of the clinical benefit of intravascular imaging guidance during PCI, current guidelines recommend imaging-guided PCI to reduce ischemic events in patients with complex lesions.<sup>9,10</sup> Achieving stent optimization during imaging-guided PCI has been particularly associated with better clinical outcomes than not achieving stent optimization, with

the length of the lesion and reference vessel diameter (RVD) influencing stent optimization.<sup>11-13</sup> Of the intravascular imaging tools, OCT is a high-resolution intracoronary imaging modality providing detailed visualization and guiding optimal stent selection and proper deployment, making it particularly valuable for anatomically challenging lesions.<sup>6,7</sup> However, data on the impact of OCT guidance on specific anatomical features, particularly lesion length and RVD, are limited.

The OCCUPI (Optical Coherence Tomography versus Conventional Guidance for Complex Percutaneous Coronary Intervention) trial recently demonstrated that OCT-guided PCI significantly reduces the incidence of major adverse cardiac events (MACE) at 1 year compared with angiography guidance in patients undergoing complex PCI.<sup>14</sup> Therefore, the present post hoc analysis of the OCCUPI trial assesses whether lesion length and RVD affect the clinical efficacy of OCT-guided PCI compared with angiographic guidance.

**METHODS**

**STUDY DESIGN AND POPULATION.** This study is a post hoc analysis of the multicenter, prospective, open-label, randomized controlled OCCUPI trial, which involved 1,604 patients with complex coronary artery disease across 20 centers in South Korea. The full design and primary results of the OCCUPI trial have been reported previously.<sup>14</sup> Eligible

participants were adults 19 to 85 years of age undergoing PCI for complex coronary lesions, which were defined as the presence of at least 1 of the following: long lesion (expected stent length  $\geq 28$  mm based on angiographic estimation), small vessel disease (RVD  $\leq 2.5$  mm), acute myocardial infarction, chronic total occlusion, calcified lesion, bifurcation lesion, unprotected left main disease, intracoronary thrombus, stent thrombosis, in-stent restenosis, or bypass graft lesion. The detailed inclusion and exclusion criteria are provided in [Supplemental Methods 1](#). The study protocol was approved by the institutional review board or ethics committee of each participating center (Yonsei University Health System Institutional Review Board, 1-2018-0018). Written informed consent was obtained from participants, and the study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

**RANDOMIZATION AND TREATMENT.** Patients were randomly assigned at a ratio of 1:1 to undergo OCT-guided or angiography-guided PCI using a centralized, Web-based system with block randomization stratified by center. This strategy was applied throughout the procedure, from lesion assessment to stent implantation and postdilatation. All procedures were performed using second-generation everolimus-eluting stents (Xience Alpine or Xience Sierra; Abbott Vascular). In the OCT-guided PCI group, pre- and post-PCI OCT imaging was recommended to determine lesion morphology, stent length and diameter, apposition and expansion, following a predefined optimization protocol.<sup>14</sup> The operator made procedural decisions, including predilatation, lesion preparation techniques, stent selection, and the use of adjunctive devices (eg, rotational atherectomy) while adhering to the assigned guidance strategy.

**LESION CHARACTERIZATION AND SUBGROUP DEFINITION.**

Lesion characteristics were assessed using quantitative coronary angiography (QCA) at an independent core laboratory at Severance Cardiovascular Hospital. A detailed explanation is provided in [Supplemental Methods 2](#). Lesion length and the RVD were measured according to standardized QCA methodology. In the overall OCCUPI trial population, patients were stratified into subgroups based on the

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median values of lesion length and RVD on QCA and the treatment strategy (OCT guidance or angiography guidance) ([Supplemental Figure 1](#)).

**STUDY OUTCOMES AND FOLLOW-UP.** The primary endpoint of this study was the 1-year incidence of MACE, defined as a composite of cardiac death, myocardial infarction, stent thrombosis, and ischemia-driven target vessel revascularization (TVR). Secondary endpoints included the individual components of MACE, contrast-induced nephropathy, and the rate of OCT-defined stent optimization. Patients were followed up at 1, 6, and 12 months post-index procedure through outpatient visits or telephone interviews. The definition of each event is provided in the [Supplemental Methods 3](#).

**STATISTICAL ANALYSIS.** Baseline characteristics are presented as median (Q1-Q3) for continuous variables and as counts with corresponding percentages for categorical variables. Given that all continuous variables were non-normally distributed based on the Shapiro-Wilk test (all  $P$  values  $<0.001$ ), between-group comparisons for continuous variables were performed using the Mann-Whitney  $U$  test. Categorical variables were compared using the chi-square or Fisher exact tests, as appropriate. Time-to-event outcomes were analyzed using the Kaplan-Meier method to estimate cumulative event rates over time, and survival curves were compared between groups using the log-rank test. HRs with 95% CIs were estimated using Cox proportional hazards models to compare the risk of clinical events. The interaction between treatment strategy (OCT vs angiography) and lesion length or RVD was evaluated using multiplicative interaction terms in the Cox models. Lesion length and RVD were assessed as continuous and dichotomous variables, based on their respective median values (lesion length:  $\geq 32$  mm vs  $< 32$  mm; RVD:  $< 2.8$  mm vs  $\geq 2.8$  mm). The proportional hazards assumption was assessed using tests based on Schoenfeld residuals. No significant violations of the proportional hazards assumption were observed for any Cox model. As an exploratory analysis, restricted cubic spline functions were used to assess potential nonlinear relationship of the treatment effect of OCT-guided PCI (vs angiography-guided PCI) across continuous measures of lesion length and RVD. The optimal number of knots was selected based on the Akaike information criterion. Linearity and nonlinearity were evaluated using Wald tests of the nonlinear spline terms. Spline curves were generated to visualize the modifying effect of lesion complexity on clinical outcomes. All analyses were performed

following the intention-to-treat principle. A 2-sided  $P$  value  $<0.05$  was considered statistically significant. Statistical analyses were conducted using R version 4.4.1 (R Foundation for Statistical Computing).

## RESULTS

### STUDY POPULATION AND BASELINE CHARACTERISTICS.

This post hoc analysis of the OCCUPI trial included 1,604 patients, with the distribution of lesion length and RVD shown in [Supplemental Figure 2](#). The median lesion length and RVD were 32 mm and 2.8 mm, respectively. Based on these values, patients were categorized into the following groups: lesion length  $\geq 32$  mm ( $n = 960$ ) and  $< 32$  mm ( $n = 644$ ) and RVD  $\geq 2.8$  mm ( $n = 794$ ) and  $< 2.8$  mm ( $n = 810$ ) ([Supplemental Table 1](#)). The median follow-up duration was 365 days (Q1-Q3: 365-365 days).

Baseline characteristics are presented in [Table 1](#). The mean age was  $63.3 \pm 9.8$  years, with 80.4% ( $n = 1,290$  of 1,604) of the total study population being male. Patients with lesion length  $\geq 32$  mm were more likely to have hypertension and less likely to have a history of prior PCI than those with lesion length  $< 32$  mm. Patients with RVD  $< 2.8$  mm had a slightly lower body mass index and higher rates of potent P2Y<sub>12</sub> inhibitor use at discharge than those with RVD  $\geq 2.8$  mm. Other demographic and clinical characteristics, including prevalence of diabetes, chronic kidney disease, and clinical presentation, were similar between groups.

Among the total population, lesions with greater anatomical complexity were more frequently observed in the subgroup with lesion length  $\geq 32$  mm. The following complex lesion characteristics were more common in this group: chronic total occlusion, long lesions requiring a stent length of  $\geq 28$  mm, and bifurcation lesions. In contrast, in-stent restenosis was more frequently observed in lesions  $< 32$  mm. Patients with RVD  $< 2.8$  mm had a higher prevalence of complex lesion characteristics, including long lesions requiring a stent length  $\geq 28$  mm, bifurcation lesions, and small vessel disease. Conversely, patients with RVD  $\geq 2.8$  mm frequently had unprotected left main disease and a higher number of treated lesions per patient.

### PROCEDURAL CHARACTERISTICS AND QCA ANALYSES.

Procedural characteristics and QCA analyses are presented in [Table 2](#). Patients with lesion length  $\geq 32$  mm had more implanted stents, larger stent diameters, longer total stent lengths, higher contrast volumes, and a longer procedural time during PCI. Regarding QCA analyses, patients with lesion

**TABLE 1 Baseline Characteristics**

|                                                 | Total Population<br>(N = 1,604) | Lesion Length       |                     |         | Vessel Diameter      |                      |         |
|-------------------------------------------------|---------------------------------|---------------------|---------------------|---------|----------------------|----------------------|---------|
|                                                 |                                 | ≥32 mm<br>(n = 960) | <32 mm<br>(n = 644) | P Value | <2.8 mm<br>(n = 810) | ≥2.8 mm<br>(n = 794) | P Value |
| Age, y                                          | 64.0 (57.0-70.0)                | 64.0 (57.0-71.0)    | 64.0 (57.0-70.0)    | 0.792   | 64.0 (58.0-70.0)     | 64.0 (57.0-71.0)     | 0.729   |
| Male                                            | 1,290 (80.4)                    | 766 (79.8)          | 524 (81.4)          | 0.475   | 652 (82.1)           | 638 (78.8)           | 0.104   |
| Body mass index, kg/m <sup>2</sup>              | 24.7 (22.9-26.6)                | 24.6 (22.9-26.6)    | 24.8 (23.1-26.6)    | 0.486   | 24.5 (22.8-26.3)     | 24.8 (23.0-26.8)     | 0.023   |
| Hypertension                                    | 917 (57.2)                      | 569 (59.3)          | 348 (54.0)          | 0.043   | 470 (58.0)           | 447 (56.3)           | 0.517   |
| Diabetes mellitus                               | 523 (32.6)                      | 320 (33.3)          | 203 (31.5)          | 0.481   | 279 (34.4)           | 244 (30.7)           | 0.125   |
| Chronic kidney disease <sup>a</sup>             | 110 (6.9)                       | 55 (5.7)            | 55 (8.5)            | 0.037   | 56 (6.9)             | 54 (6.8)             | 0.987   |
| Dyslipidemia                                    | 1,345 (83.9)                    | 812 (84.6)          | 533 (82.8)          | 0.367   | 679 (83.8)           | 666 (83.9)           | 0.965   |
| Current smoker                                  | 307 (19.1)                      | 185 (19.3)          | 122 (18.9)          | 0.922   | 154 (19.0)           | 153 (19.3)           | 0.946   |
| Prior myocardial infarction                     | 82 (5.1)                        | 46 (4.8)            | 36 (5.6)            | 0.551   | 43 (5.3)             | 39 (4.9)             | 0.805   |
| Prior percutaneous coronary intervention        | 330 (20.6)                      | 175 (18.2)          | 155 (24.1)          | 0.006   | 161 (19.9)           | 169 (21.3)           | 0.525   |
| Prior coronary bypass graft surgery             | 24 (1.5)                        | 13 (1.4)            | 11 (1.7)            | 0.717   | 12 (1.5)             | 12 (1.5)             | 1.000   |
| Prior stroke                                    | 84 (5.2)                        | 57 (5.9)            | 27 (4.2)            | 0.155   | 40 (4.9)             | 44 (5.5)             | 0.667   |
| Clinical presentation                           |                                 |                     |                     | 0.047   |                      |                      | 0.446   |
| Stable angina                                   | 814 (50.7)                      | 496 (51.7)          | 318 (49.4)          |         | 397 (49.0)           | 417 (52.5)           |         |
| Unstable angina                                 | 463 (28.9)                      | 284 (29.6)          | 179 (27.8)          |         | 247 (30.5)           | 216 (27.2)           |         |
| Non-ST-segment elevation myocardial infarction  | 223 (13.9)                      | 131 (13.6)          | 92 (14.3)           |         | 115 (14.2)           | 108 (13.6)           |         |
| ST-segment elevation myocardial infarction      | 104 (6.5)                       | 49 (5.1)            | 55 (8.5)            |         | 51 (6.3)             | 53 (6.7)             |         |
| Left ventricular ejection fraction, %           | 59.0 (57.3-65.3)                | 59.0 (57.2-66.0)    | 59.0 (57.5-65.0)    | 0.883   | 59.0 (57.0-66.0)     | 59.0 (58.0-65.0)     | 0.479   |
| Antiplatelet therapy at discharge               |                                 |                     |                     |         |                      |                      |         |
| Aspirin                                         | 1,571 (97.9)                    | 941 (98.0)          | 630 (97.8)          | 0.928   | 797 (98.4)           | 774 (97.5)           | 0.266   |
| P2Y <sub>12</sub> inhibitor                     | 1,582 (98.6)                    | 946 (98.5)          | 636 (98.8)          | 0.884   | 804 (99.3)           | 778 (98.0)           | 0.048   |
| Clopidogrel                                     | 1,232 (76.8)                    | 735 (76.6)          | 497 (77.2)          | 0.823   | 628 (77.5)           | 604 (76.1)           | 0.526   |
| Potent P2Y <sub>12</sub> inhibitor <sup>b</sup> | 350 (21.8)                      | 211 (22.0)          | 139 (21.6)          | 0.900   | 176 (21.7)           | 174 (21.9)           | 0.976   |
| Complex lesion characteristics                  |                                 |                     |                     |         |                      |                      |         |
| Acute myocardial infarction                     | 327 (20.4)                      | 180 (18.8)          | 147 (22.8)          | 0.054   | 166 (20.5)           | 161 (20.3)           | 0.964   |
| Chronic total occlusion                         | 115 (7.2)                       | 84 (8.8)            | 31 (4.8)            | 0.004   | 62 (7.7)             | 53 (6.7)             | 0.507   |
| Long lesion <sup>c</sup>                        | 1,152 (71.8)                    | 808 (84.2)          | 344 (53.4)          | <0.001  | 632 (78.0)           | 520 (65.5)           | <0.001  |
| Calcified lesion <sup>d</sup>                   | 149 (9.3)                       | 99 (10.3)           | 50 (7.8)            | 0.102   | 79 (9.8)             | 70 (8.8)             | 0.575   |
| Bifurcation lesion                              | 381 (23.8)                      | 259 (27.0)          | 122 (18.9)          | <0.001  | 215 (26.5)           | 166 (20.9)           | 0.010   |
| Unprotected left main artery disease            | 229 (14.3)                      | 135 (14.1)          | 94 (14.6)           | 0.821   | 92 (11.4)            | 137 (17.3)           | <0.001  |
| Small vessel disease <sup>e</sup>               | 267 (16.6)                      | 153 (15.9)          | 114 (17.7)          | 0.389   | 178 (22.0)           | 89 (11.2)            | <0.001  |
| Intracoronary thrombus visible on angiography   | 130 (8.1)                       | 86 (9.0)            | 44 (6.8)            | 0.151   | 60 (7.4)             | 70 (8.8)             | 0.346   |
| Stent thrombosis                                | 1 (0.1)                         | 0 (0.0)             | 1 (0.2)             | 0.841   | 1 (0.1)              | 0 (0.0)              | >0.999  |
| In-stent restenosis                             | 171 (10.7)                      | 81 (8.4)            | 90 (14.0)           | <0.001  | 80 (9.9)             | 91 (11.5)            | 0.344   |
| Bypass graft lesion                             | 3 (0.2)                         | 1 (0.1)             | 2 (0.3)             | 0.728   | 1 (0.1)              | 2 (0.3)              | 0.986   |

Values are median (Q1-Q3) or n (%). <sup>a</sup>Chronic kidney disease was defined as an estimated glomerular filtration rate of <60 mL/min/1.73 m<sup>2</sup> of body surface area. <sup>b</sup>Potent P2Y<sub>12</sub> inhibitor indicates ticagrelor or prasugrel. <sup>c</sup>Long lesion was defined as requiring a stent length ≥28 mm. <sup>d</sup>Calcified lesion was defined as a lesion with severe calcification, showing radiopacities without cardiac motion before contrast injection, usually affecting both sides of the arterial lumen. <sup>e</sup>Small vessel disease was defined as a lesion with reference vessel diameter <2.5 mm.

length ≥32 mm had a smaller RVD and preprocedural minimal lumen diameter. Patients with RVD <2.8 mm had more implanted stents, smaller stent diameters, longer total stent lengths, higher contrast volumes, and a longer procedural time during PCI than patients with RVD ≥2.8 mm. QCA analyses revealed that patients with RVD <2.8 mm frequently had smaller pre- and postprocedural minimal lumen diameters and longer lesion lengths. **CLINICAL OUTCOMES ACCORDING TO THE LESION LENGTH AND PCI STRATEGY.** In patients with lesion length ≥32 mm, patients undergoing OCT-guided PCI had a significantly lower incidence of 1-year MACE

than those undergoing angiography-guided PCI (4.3% [n = 21 of 490] vs 7.7% [n = 36 of 470]; HR: 0.55; 95% CI: 0.32-0.95; P = 0.031) (**Figure 1A, Table 3**). MACE rate reduction in the OCT-guided PCI group for lesion length ≥32 mm was primarily driven by the decreased risk of ischemia-driven TVR (1.6% [n = 8 of 490] vs 4.3% [n = 20 of 470]; HR: 0.38; 95% CI: 0.17-0.86; P = 0.020). In patients with lesions <32 mm, MACE risk was numerically lower in the OCT-guided PCI group than in the angiography-guided PCI group (5.1% [n = 16 of 313] vs 6.9% [n = 23 of 331]; HR: 0.73; 95% CI: 0.39-1.38; P = 0.336) (**Figure 1B, Table 3, Supplemental Table 2**). This difference was primarily

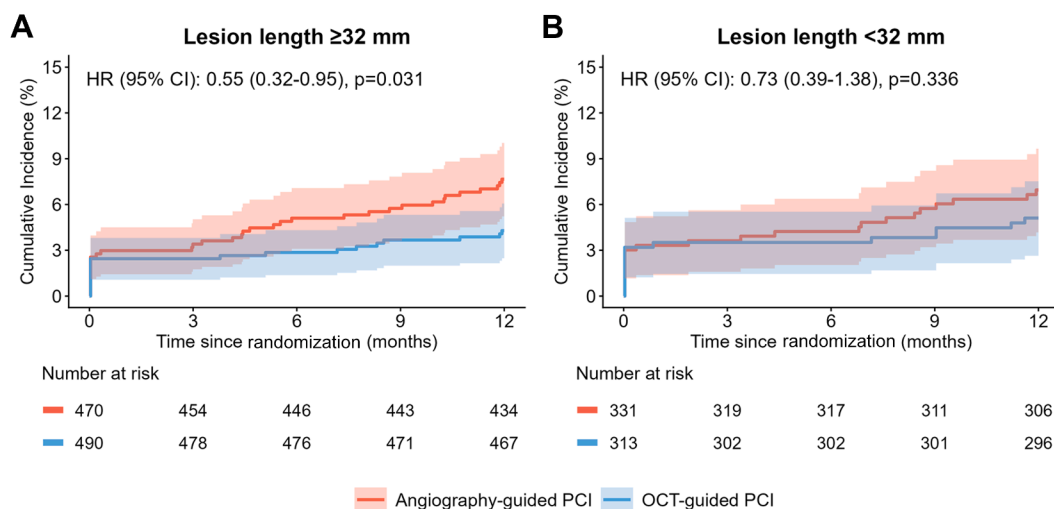
**TABLE 2** Procedural Characteristics and Quantitative Coronary Angiographic Analyses

|                                              | Total Population<br>(N = 1,604) | Lesion Length       |                     | P Value | Vessel Diameter      |                      | P Value |
|----------------------------------------------|---------------------------------|---------------------|---------------------|---------|----------------------|----------------------|---------|
|                                              |                                 | ≥32 mm<br>(n = 960) | <32 mm<br>(n = 644) |         | <2.8 mm<br>(n = 810) | ≥2.8 mm<br>(n = 794) |         |
| Total number of treated complex lesions      | 1,894                           | 964                 | 703                 |         | 923                  | 856                  |         |
| Number of target lesions treated per patient | 1 (1-2)                         | 1 (1-1)             | 1 (1-1)             | <0.001  | 1 (1-1)              | 1 (1-2)              | 0.002   |
| Number of stents implanted per patient       | 1 (1-2)                         | 2 (1-2)             | 1 (1-1)             | <0.001  | 2 (1-2)              | 1 (1-2)              | <0.001  |
| Stent diameter, mm                           | 3.12 (3.00-3.50)                | 3.08 (2.88-3.38)    | 3.00 (3.00-3.50)    | 0.001   | 3.00 (2.75-3.25)     | 3.38 (3.00-3.50)     | <0.001  |
| Total stent length, mm                       | 36.99 (28.93-53.18)             | 53.01 (42.48-66.36) | 29.50 (26.57-32.54) | <0.001  | 39.69 (29.75-57.29)  | 36.15 (28.99-48.30)  | <0.001  |
| Adjunct postdilatation                       | 1,808 (95.5)                    | 920 (96.2)          | 663 (94.3)          | 0.083   | 891 (96.5)           | 810 (94.6)           | 0.065   |
| High-pressure postdilatation                 | 1,048 (55.3)                    | 550 (57.5)          | 371 (52.8)          | 0.061   | 513 (55.6)           | 469 (54.8)           | 0.774   |
| Maximal inflation pressure, atmosphere       | 16.0 (14.0-18.0)                | 16.0 (14.0-18.0)    | 16.0 (12.0-18.0)    | <0.001  | 16.0 (14.0-18.0)     | 16.0 (14.0-18.0)     | 0.352   |
| Final balloon size, mm                       | 3.50 (3.00-4.00)                | 3.50 (3.00-4.00)    | 3.50 (3.00-4.00)    | 0.008   | 3.50 (3.00-3.50)     | 3.50 (3.00-4.00)     | <0.001  |
| Contrast volume used per patient, mL         | 250 (200-330)                   | 250 (200-350)       | 220 (180-300)       | <0.001  | 250 (200-350)        | 236 (200-320)        | 0.006   |
| Procedural time per patient, min             | 49.0 (34.0-65.0)                | 52.0 (38.0-71.0)    | 43.0 (30.0-57.0)    | <0.001  | 50.0 (35.0-69.0)     | 47.0 (32.0-61.8)     | 0.003   |
| Quantitative coronary angiographic analyses  |                                 |                     |                     |         |                      |                      |         |
| Reference vessel diameter, mm                | 2.81 (2.52-3.12)                | 2.76 (2.46-3.06)    | 2.92 (2.62-3.24)    | <0.001  | 2.51 (2.32-2.67)     | 3.12 (2.95-3.35)     | <0.001  |
| Minimal lumen diameter, mm                   | 0.70 (0.46-0.94)                | 0.68 (0.44-0.92)    | 0.74 (0.47-0.97)    | 0.011   | 0.62 (0.40-0.82)     | 0.79 (0.53-1.01)     | <0.001  |
| Lesion length, mm                            | 32.1 (24.3-48.4)                | 48.2 (37.7-61.9)    | 24.8 (21.7-27.8)    | <0.001  | 34.7 (25.2-52.8)     | 31.1 (24.3-43.7)     | <0.001  |
| Postprocedural minimal lumen diameter, mm    | 2.67 (2.42-2.98)                | 2.65 (2.40-2.99)    | 2.68 (2.40-3.04)    | 0.166   | 2.53 (2.30-2.79)     | 2.83 (2.57-3.15)     | <0.001  |
| Postprocedural diameter stenosis, %          | 13.0 (8.7-18.0)                 | 13.3 (8.0-18.0)     | 13.0 (9.7-18.0)     | 0.020   | 12.2 (7.0-17.1)      | 14.0 (9.0-19.0)      | <0.001  |

Values are median (Q1-Q3) or n (%).

attributed to a reduced risk of ischemia-driven TVR in the OCT-guided PCI group (1.3% [n = 4 of 313] vs 3.9% [n = 13 of 331]; HR: 0.32; 95% CI: 0.10-0.98; *P* = 0.046). No significant interaction was observed between the lesion length and the PCI strategy for MACE (*P* for interaction = 0.514). Regarding OCT-

defined stent optimization in the OCT-guided PCI group, patients with lesion length ≥32 mm had a significantly lower rate of stent optimization through OCT guidance than did those with lesion length <32 mm (68.0% [n = 319 of 469] vs 75.8% [n = 226 of 298]; *P* = 0.025). The restricted cubic

**FIGURE 1** Major Adverse Cardiac Events by Lesion Length and PCI Strategy

The Kaplan-Meier curves show the incidence of major adverse cardiac events at 12 months in optical coherence tomography (OCT)-guided percutaneous coronary intervention (PCI) (blue) and angiography-guided PCI (red) in patients with lesion length (A) ≥32 mm and (B) <32 mm. OCT = optical coherence tomography.

**TABLE 3 Clinical Outcomes According to the Lesion Length and Treatment Strategy**

|                                                                                                                                                       | Lesion Length ≥32 mm (n = 960) |                                  |                  |         | Lesion Length <32 mm (n = 644) |                                  |                   |         | P for Interaction <sup>a</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------|------------------|---------|--------------------------------|----------------------------------|-------------------|---------|--------------------------------|
|                                                                                                                                                       | OCT-Guided PCI (n = 490)       | Angiography-Guided PCI (n = 470) | HR (95% CI)      | P Value | OCT-Guided PCI (n = 313)       | Angiography-Guided PCI (n = 331) | HR (95% CI)       | P Value |                                |
| Primary endpoint                                                                                                                                      |                                |                                  |                  |         |                                |                                  |                   |         |                                |
| Major adverse cardiac event (composite of cardiac death, myocardial infarction, stent thrombosis, or ischemia-driven target vessel revascularization) | 21/490 (4.3)                   | 36/470 (7.7)                     | 0.55 (0.32-0.95) | 0.031   | 16/313 (5.1)                   | 23/331 (6.9)                     | 0.73 (0.39-1.38)  | 0.336   | 0.514                          |
| Secondary endpoints                                                                                                                                   |                                |                                  |                  |         |                                |                                  |                   |         |                                |
| Cardiac death                                                                                                                                         | 0/490 (0.0)                    | 3/470 (0.6)                      | —                | —       | 1/313 (0.3)                    | 2/331 (0.6)                      | 0.53 (0.05-5.82)  | 0.602   | —                              |
| Myocardial infarction                                                                                                                                 | 18/490 (3.7)                   | 23/470 (4.9)                     | 0.75 (0.40-1.38) | 0.355   | 11/313 (3.5)                   | 17/331 (5.1)                     | 0.68 (0.32-1.46)  | 0.324   | 0.856                          |
| Spontaneous myocardial infarction                                                                                                                     | 6/490 (1.2)                    | 11/470 (2.3)                     | 0.52 (0.19-1.40) | 0.195   | 1/313 (0.3)                    | 8/331 (2.4)                      | 0.13 (0.02-1.04)  | 0.055   | 0.196                          |
| Periprocedural myocardial infarction                                                                                                                  | 12/490 (2.4)                   | 12/470 (2.6)                     | 0.96 (0.43-2.13) | 0.912   | 10/313 (3.2)                   | 10/331 (3.0)                     | 1.06 (0.44-2.55)  | 0.893   | 0.862                          |
| Stent thrombosis                                                                                                                                      | 3/490 (0.6)                    | 6/470 (1.3)                      | 0.48 (0.12-1.91) | 0.295   | 1/313 (0.3)                    | 4/331 (1.2)                      | 0.26 (0.03-2.35)  | 0.232   | 0.645                          |
| Definite                                                                                                                                              | 2/490 (0.4)                    | 3/470 (0.6)                      | 0.64 (0.11-3.81) | 0.621   | 0/313 (0.0)                    | 1/331 (0.3)                      | —                 | —       | —                              |
| Probable                                                                                                                                              | 1/490 (0.2)                    | 3/470 (0.6)                      | 0.32 (0.03-3.05) | 0.320   | 1/313 (0.3)                    | 3/331 (0.9)                      | 0.35 (0.04-3.37)  | 0.364   | 0.952                          |
| Ischemia-driven target vessel revascularization                                                                                                       | 8/490 (1.6)                    | 20/470 (4.3)                     | 0.38 (0.17-0.86) | 0.020   | 4/313 (1.3)                    | 13/331 (3.9)                     | 0.32 (0.10-0.98)  | 0.046   | 0.814                          |
| Contrast-induced nephropathy <sup>b</sup>                                                                                                             | 4/490 (0.8)                    | 6/470 (1.3)                      | 0.64 (0.18-2.26) | 0.486   | 6/313 (1.9)                    | 1/331 (0.3)                      | 6.38 (0.77-53.03) | 0.086   | 0.039                          |
| Rate of OCT-defined stent optimization <sup>c</sup>                                                                                                   | 319/469 (68.0)                 |                                  |                  |         | 226/298 (75.8)                 |                                  |                   |         | 0.025 <sup>d</sup>             |

Values are n/N (%). <sup>a</sup>P value for interaction between lesion length and OCT guidance strategy. <sup>b</sup>Contrast-induced nephropathy defined as an increase in serum creatinine level  $> 25\%$  or an absolute rise of serum creatinine level of 0.5 mg/dL (44.2  $\mu\text{mol/L}$ ) from baseline within 72 hours of the index procedure. <sup>c</sup>Stent optimization, defined as acceptable stent expansion and apposition without major edge dissection, was assessed in patients in the OCT guidance group with available final OCT evaluations (n = 767). <sup>d</sup>P value was calculated using the chi-square test for the difference in stent optimization rate in the OCT group between lesion length  $\geq 32$  mm and  $< 32$  mm.

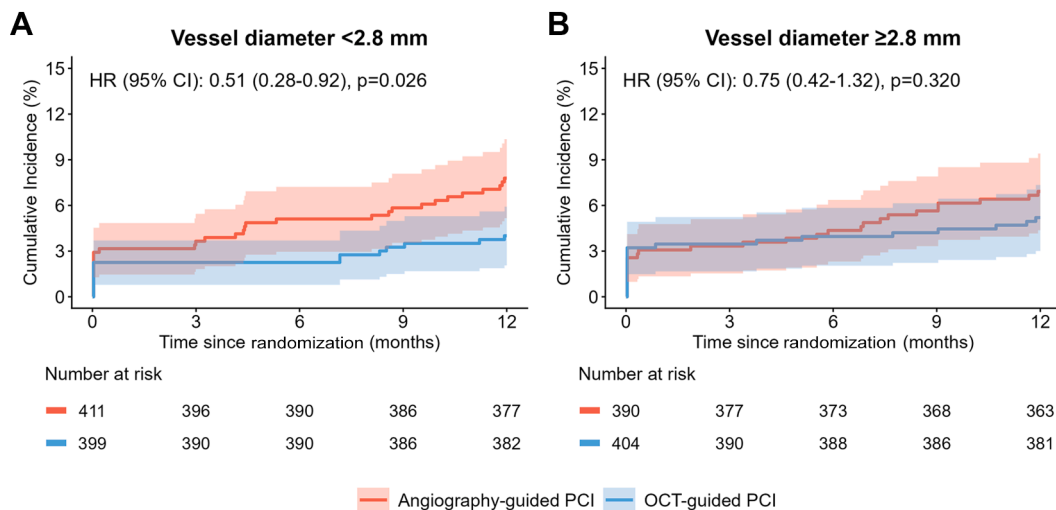
OCT = optical coherence tomography; PCI = percutaneous coronary intervention.

spline curve showed that the HR for OCT-guided PCI vs angiography-guided PCI gradually decreased with increasing lesion length. However, the interaction effect was not statistically significant ( $P = 0.780$ ) (Supplemental Figure 3A).

**CLINICAL OUTCOMES ACCORDING TO THE RVD AND PCI STRATEGY.** Among patients with RVD  $< 2.8$  mm, the OCT-guided PCI group had a significantly lower MACE risk than did the angiography-guided PCI group (4.0% [n = 16 of 399] vs 7.8% [n = 32 of 411]; HR: 0.51; 95% CI: 0.28-0.92;  $P = 0.026$ ) (Figure 2A, Table 4, Supplemental Table 2). The reduction of MACE rates in the OCT-guided PCI group for RVD  $< 2.8$  mm was primarily driven by the decreased risk of ischemia-driven TVR (1.5% [n = 6 of 399] vs 3.9% [n = 16 of 411]; HR: 0.38; 95% CI: 0.15-0.97;  $P = 0.042$ ). Among patients with RVD  $\geq 2.8$  mm, the incidence of MACE was numerically lower in the OCT-guided PCI group than in the angiography-guided PCI group (5.2% [n = 21 of 404] vs 6.9% [n = 27 of 390]; HR: 0.75; 95% CI: 0.42-1.32;  $P = 0.320$ ) (Figure 2B, Table 4). This difference was also primarily attributed to a reduced risk of ischemia-driven TVR in the OCT-guided PCI group (1.5% [n = 6 of 404] vs 4.4% [n = 17 of 390]; HR: 0.34; 95% CI: 0.13-0.85;  $P$

$= 0.022$ ). No significant interactions were observed between the vessel diameter and the PCI strategy for MACE ( $P$  for interaction = 0.354). Regarding stent optimization in the OCT-guided PCI group, patients with RVD  $< 2.8$  mm had a significantly lower rate of OCT-guided stent optimization than did patients with RVD  $\geq 2.8$  mm (59.5% [n = 226 of 380] vs 82.4% [n = 319 of 387];  $P < 0.001$ ). Restricted cubic spline analysis revealed that the HR for OCT-guided PCI vs angiography-guided PCI gradually decreased with decreasing vessel diameter without a significant interaction effect ( $P = 0.965$ ) (Supplemental Figure 3B).

**CLINICAL OUTCOMES STRATIFIED BY LESION LENGTH, RVD, AND PCI STRATEGY.** The consistently direction of effect favoring OCT-guided PCI reduced MACE ( $P$  for interaction = 0.526) in all 4 groups compared with angiography-guided PCI, with a particularly significant reduction in the groups with lesions length  $\geq 32$  mm and RVD  $< 2.8$  mm (4.1% [n = 11 of 266] vs 8.9% [n = 24 of 271]; HR: 0.46; 95% CI: 0.23-0.94;  $P = 0.041$ ) (Figure 3A, Supplemental Table 3). Other clinical outcomes among the groups stratified by combined lesion length (32 mm) and RVD (2.8 mm) derived from the

**FIGURE 2** Major Adverse Cardiac Events by Vessel Diameter and PCI Strategy

The Kaplan-Meier curves show the incidence of major adverse cardiac events at 12 months in OCT-guided PCI (blue) and angiography-guided PCI (red) in patients with reference vessel diameter (A) <2.8 mm and (B) ≥2.8 mm. Abbreviations as in Figure 1.

overall OCCUPI trial population are summarized in Supplemental Table 3. The MACE rate reduction in patients undergoing OCT-guided PCI for the group with lesion length ≥32 mm and RVD <2.8 mm was

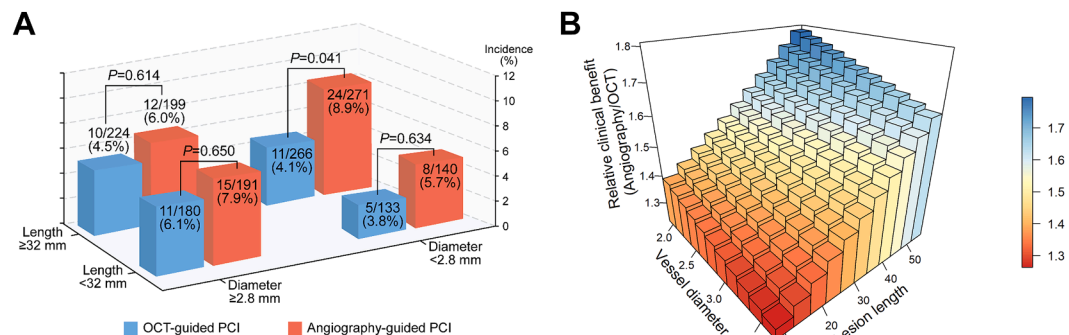
primarily driven by the decreased risk of ischemia-driven TVR (1.5% [n = 4 of 266] vs 4.8% [n = 13 of 271]; HR: 0.31; 95% CI: 0.10-0.94; *P* = 0.039). Regarding the rate of stent optimization through

**TABLE 4** Clinical Outcomes According to the Reference Vessel Diameter and Treatment Strategy

|                                                                                                                                                       | Vessel Diameter <2.8 mm (n = 810) |                                  |                  |                | Vessel Diameter ≥2.8 mm (n = 794) |                                  |                   |                | <i>P</i> for Interaction <sup>a</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------------------------|------------------|----------------|-----------------------------------|----------------------------------|-------------------|----------------|---------------------------------------|
|                                                                                                                                                       | OCT-Guided PCI (n = 399)          | Angiography-Guided PCI (n = 411) | HR (95% CI)      | <i>P</i> Value | OCT-Guided PCI (n = 404)          | Angiography-Guided PCI (n = 390) | HR (95% CI)       | <i>P</i> Value |                                       |
| Primary endpoint                                                                                                                                      |                                   |                                  |                  |                |                                   |                                  |                   |                |                                       |
| Major adverse cardiac event (composite of cardiac death, myocardial infarction, stent thrombosis, or ischemia-driven target vessel revascularization) | 16/399 (4.0%)                     | 32/411 (7.8%)                    | 0.51 (0.28-0.92) | 0.026          | 21/404 (5.2%)                     | 27/390 (6.9%)                    | 0.75 (0.42-1.32)  | 0.320          | 0.354                                 |
| Secondary endpoints                                                                                                                                   |                                   |                                  |                  |                |                                   |                                  |                   |                |                                       |
| Cardiac death                                                                                                                                         | 0/399 (0.0%)                      | 4/411 (1.0%)                     | —                | —              | 1/404 (0.2%)                      | 1/390 (0.3%)                     | 0.97 (0.06-15.50) | 0.983          | —                                     |
| Myocardial infarction                                                                                                                                 | 13/399 (3.3%)                     | 21/411 (5.1%)                    | 0.63 (0.32-1.26) | 0.194          | 16/404 (4.0%)                     | 19/390 (4.9%)                    | 0.81 (0.42-1.58)  | 0.544          | 0.606                                 |
| Spontaneous myocardial infarction                                                                                                                     | 4/399 (1.0%)                      | 10/411 (2.4%)                    | 0.41 (0.13-1.30) | 0.129          | 3/404 (0.7%)                      | 9/390 (2.3%)                     | 0.32 (0.09-1.18)  | 0.086          | 0.783                                 |
| Periprocedural myocardial infarction                                                                                                                  | 9/399 (2.3%)                      | 12/411 (2.9%)                    | 0.77 (0.32-1.82) | 0.551          | 13/404 (3.2%)                     | 10/390 (2.6%)                    | 1.26 (0.55-2.87)  | 0.584          | 0.416                                 |
| Stent thrombosis                                                                                                                                      | 3/399 (0.8%)                      | 5/411 (1.2%)                     | 0.61 (0.15-2.56) | 0.502          | 1/404 (0.2%)                      | 5/390 (1.3%)                     | 0.19 (0.02-1.65)  | 0.133          | 0.358                                 |
| Definite                                                                                                                                              | 1/399 (0.3%)                      | 2/411 (0.5%)                     | 0.51 (0.05-5.64) | 0.584          | 1/404 (0.2%)                      | 2/390 (0.5%)                     | 0.48 (0.04-5.32)  | 0.551          | 0.973                                 |
| Probable                                                                                                                                              | 2/399 (0.5%)                      | 3/411 (0.7%)                     | 0.68 (0.11-4.06) | 0.672          | 0/404 (0.0%)                      | 3/390 (0.8%)                     | —                 | —              | —                                     |
| Ischemia-driven target vessel revascularization                                                                                                       | 6/399 (1.5%)                      | 16/411 (3.9%)                    | 0.38 (0.15-0.97) | 0.042          | 6/404 (1.5%)                      | 17/390 (4.4%)                    | 0.34 (0.13-0.85)  | 0.022          | 0.860                                 |
| Contrast-induced nephropathy <sup>b</sup>                                                                                                             | 4/399 (1.0%)                      | 6/411 (1.5%)                     | 0.68 (0.19-2.43) | 0.557          | 6/404 (1.5%)                      | 1/390 (0.3%)                     | 5.82 (0.70-48.34) | 0.103          | 0.057                                 |
| Rate of OCT-defined stent optimization <sup>c</sup>                                                                                                   | 226/380 (59.5%)                   |                                  |                  |                | 319/387 (82.4%)                   |                                  |                   |                | <0.001 <sup>d</sup>                   |

Values are n/N (%). <sup>a</sup>*P* value for interaction between vessel diameter and OCT guidance strategy. <sup>b</sup>Contrast-induced nephropathy defined as an increase in serum creatinine level >25% or an absolute rise of serum creatinine level of 0.5 mg/dL (44.2 μmol/L) from baseline within 72 hours of the index procedure. <sup>c</sup>Stent optimization, defined as acceptable stent expansion and apposition without major edge dissection, was assessed in patients in the OCT guidance group with available final OCT evaluations (n = 767). <sup>d</sup>*P* value was calculated using the chi-square test for the difference in stent optimization rate in the OCT group between vessel diameter ≥2.8 mm and <2.8 mm.

Abbreviations as in Table 3.

**FIGURE 3 Major Adverse Cardiac Events Stratified by Lesion Length, Vessel Diameter, and PCI Strategy**

(A) A 3-dimensional bar graph showing the 1-year incidence of major adverse cardiac events according to combined anatomical subgroups of lesion length ( $\geq 32$  mm vs  $< 32$  mm) and reference vessel diameter ( $\geq 2.8$  mm vs  $< 2.8$  mm), comparing OCT-guided (blue) with angiography-guided PCI (red). (B) The 3-dimensional heat map visualizes the relative clinical benefit for 1-year major adverse cardiac events, expressed as the ratio of predicted 1-year cumulative event risk (angiography-guided/OCT-guided PCI) derived from the Cox proportional hazards model. For each combination of lesion length and reference vessel diameter, survival probabilities were estimated from the fitted model for both treatment strategies, and the corresponding 1-year event risks were calculated to obtain the risk ratio. The x-axis represents vessel diameter (mm), the y-axis shows lesion length (mm), and the z-axis displays the estimated relative clinical benefit. Color gradients reflect the magnitude of this benefit, with blue indicating greater clinical benefit of OCT guidance (higher value) and red indicating lesser benefit (lower value). Abbreviations as in [Figure 1](#).

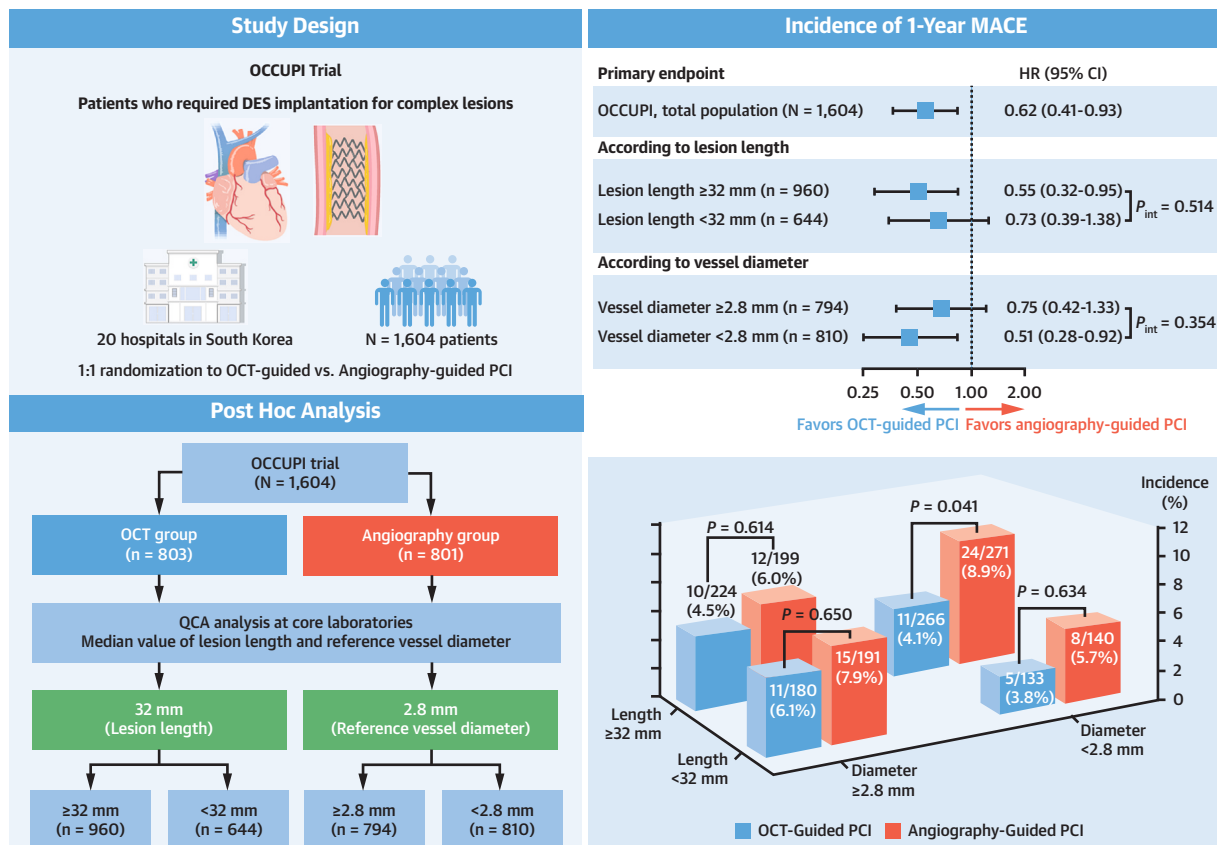
OCT guidance, the group with lesion length  $\geq 32$  mm and RVD  $< 2.8$  mm had the lowest rate of OCT-defined stent optimization (59.1% [n = 150 of 254]) compared with the other 3 groups ( $P < 0.001$ ). A detailed analysis of the specific components of OCT-defined stent optimization (expansion, apposition, and edge dissection) for each anatomical subgroup is provided in [Supplemental Table 4](#). A 3-dimensional heat map showed that OCT guidance outperformed angiography guidance in reducing 1-year MACE across all lesions, regardless of lesion length and RVD, with the greatest benefit in lesions with longer lengths or smaller RVDs ([Figure 3B](#)).

**IMPACT OF OCT-DEFINED STENT OPTIMIZATION ON CLINICAL OUTCOMES.** Regarding lesion length, OCT-defined stent optimization was consistently associated with a lower risk of MACE at 12 months, independent of lesion complexity. In patients with lesion length  $\geq 32$  mm, the optimization group had a significantly lower MACE rate compared with the suboptimization group (HR: 0.34; 95% CI: 0.14-0.84;  $P = 0.019$ ) ([Supplemental Table 5](#), [Supplemental Figure 4A](#)). Similarly, in patients with lesions  $< 32$  mm, stent optimization was associated with a significant reduction in MACE (HR: 0.30; 95% CI: 0.11-0.81;  $P = 0.017$ ) ([Supplemental Table 5](#), [Supplemental Figure 4B](#)). There was no significant

interaction between lesion length and the clinical benefit of stent optimization ( $P = 0.882$ ).

In contrast, the clinical impact of stent optimization differed significantly according to RVD ( $P = 0.028$ ). In vessels with RVD  $< 2.8$  mm, the MACE rate did not differ significantly between the optimization and suboptimization groups (HR: 0.68; 95% CI: 0.24-1.94;  $P = 0.473$ ) ([Supplemental Table 5](#), [Supplemental Figure 5A](#)). However, in vessels with RVD  $\geq 2.8$  mm, OCT-defined stent optimization was strongly associated with a reduced risk of MACE (HR: 0.15; 95% CI: 0.06-0.35;  $P < 0.001$ ) ([Supplemental Table 5](#), [Supplemental Figure 5B](#)). Further analysis of combined subgroups ([Supplemental Table 6](#)) reinforced these findings, showing that the lack of stent optimization was associated with particularly poor outcomes in large vessels, regardless of lesion length, whereas outcomes in small vessels were less sensitive to optimization status.

**DISCUSSION.** In this post hoc analysis of the OCCUPI trial, the clinical impact of OCT-guided PCI according to lesion length and RVD, based on the median values of lesion length (32 mm) and RVD (2.8 mm) using QCA derived from the overall OCCUPI trial population, was evaluated. The main findings are as follows ([Central Illustration](#)): 1) OCT-guided PCI had a significantly lower incidence of MACE than angiography-guided PCI did in patients with lesion

**CENTRAL ILLUSTRATION OCT-Guided PCI Outcomes by Lesion Length and Vessel Diameter**

Roh JW, et al. JACC Asia. 2026;■(■):■-■.

This post hoc analysis from the OCCUPI (Optical Coherence Tomography-guided Coronary Intervention in Patients with Complex Lesions) trial evaluated the effect of optical coherence tomography (OCT) guidance during complex percutaneous coronary intervention (PCI) according to lesion length and reference vessel diameter (RVD). Forest plots reveal that the beneficial effect of OCT-guided PCI in reducing major adverse cardiac events was consistent across different lesion lengths and RVD. The 3-dimensional bar graph shows that the favorable benefit of OCT guidance was particularly evident in patients with lesion length  $\geq 32$  mm and RVD  $< 2.8$  mm. DES = drug-eluting stent; MACE = major adverse cardiac events; QCA = quantitative coronary angiography.

length  $\geq 32$  mm and RVD  $< 2.8$  mm, without significant interaction between these anatomical lesion subgroups and PCI strategy; and 2) among the groups stratified by combined lesion length and RVD, the clinical benefit of OCT-guided PCI in reducing 1-year MACE was consistently direction of effect favoring OCT-guided PCI across all 4 subgroups, with a particularly significant benefit in the group with lesion length  $\geq 32$  mm and RVD  $< 2.8$  mm.

Several randomized clinical trials have shown that IVUS-guided PCI improves clinical outcomes in patients with high ischemic risk, including those with acute coronary syndrome and complex lesions, such as diffuse long lesions or chronic total occlusion.<sup>3,4,8</sup> Regarding the clinical impact of OCT-guided PCI, 3

recent randomized trials, including the OCCUPI trial, have demonstrated the procedural and clinical benefit of OCT-guided PCI in patients with complex lesions, including complex bifurcation lesions.<sup>6,7,14</sup> However, despite the significance of lesion length and vessel size in lesion complexity assessment, no OCT studies have been conducted on this topic. We evaluated the impact of OCT based on lesion characteristics and our findings were consistent direction of effect favoring OCT-guided PCI improved 1-year MACE compared with angiography-guided PCI, regardless of lesion length or vessel size. Our post hoc analysis of the OCCUPI trial confirms and expands on previous studies regarding intravascular imaging guidance during PCI, offering new insights

into lesion-specific risk stratification. Importantly, as the OCCUPI trial only recruited patients with complex coronary lesions, subgroup analyses according to lesion length or vessel diameter do not represent a transition from noncomplex to complex anatomy. Instead, these subgroups reflect different levels of complexity within a population that is already at high risk, where lesion length and vessel diameter characterize lesion subtypes associated with distinct technical challenges during PCI. Additionally, it provides new evidence by evaluating OCT-guided PCI and demonstrating consistent direction of effect favoring complex lesions of all lengths and vessel diameters. These findings build upon the main OCCUPI trial, which established the superiority of OCT guidance over angiography in patients with overall complex lesions, as evidenced by reduced MACE at 1 year. Our post hoc analysis extended these findings through QCA-based classification, showing that OCT guidance provides clinical benefit even in challenging cases, such as diffuse long lesions ( $\geq 32$  mm) and small vessel disease ( $< 2.8$  mm), where evidence previously relied heavily on IVUS trials. These insights indicate that the benefits of OCT-guided PCI are closely related to lesion complexity, providing a rationale for tailoring imaging strategies in future practice and guidelines.

The length of coronary artery lesions is crucial for predicting patient prognosis after PCI.<sup>15,16</sup> This is because as the lesion extends, longer lesions require longer stents, which are associated with higher risks of stent failure, including in-stent restenosis and thrombosis.<sup>17</sup> Although IVUS-guided PCI has been associated with improved clinical outcomes in patients requiring long-length DES ( $> 28$  mm), most previous trials regarding OCT guidance have focused on broader complex PCI populations, rendering its role in diffuse long lesions uncertain.<sup>6,7</sup> The substudy of ILUMIEN IV: OPTIMAL PCI (Optimal Coherence Tomography Guided Coronary Stent Implantation Compared with Angiography: a Multicenter Randomized Trial in PCI) trial revealed that a small minimum stent area and a longer stent length are crucial predictors of adverse outcomes, reflecting the well-known link between these lesion features and stent under-expansion.<sup>12</sup> The present post hoc analysis addresses this gap by showing that OCT-guided PCI could reduce the incidence of MACE in patients with longer lesion length. These findings suggest that the high-resolution imaging capability of OCT effectively benefits diffuse long lesions, possibly by facilitating precise lesion preparation, accurate stent sizing and landing zone selection, tailored post-dilatation, and effective complication management.

Small vessel disease, accounting for approximately one-third to two-thirds of all PCI cases, remains a persistent challenge in interventional practice.<sup>18</sup> Even in the present DES era, smaller RVDs have been consistently associated with higher stent failure rates, primarily owing to technical challenges in achieving adequate minimal stent area.<sup>19</sup> IVUS-guided PCI has improved minimal stent area and procedural optimization, suggesting a theoretical benefit in small vessel disease.<sup>11</sup> However, data specifically supporting the role of intravascular imaging, particularly OCT, in lesions with small vessel diameter are limited. In the present analysis, the OCT-guided PCI group had a lower incidence of MACE than did the angiography-guided PCI group in patients with RVD  $< 2.8$  mm. These findings support the potential benefits of OCT in small-caliber vessels, in which angiographic assessment may underestimate anatomical severity and compromise procedural outcomes. A patient-level pooled analysis revealed that patients with long lesions in small vessels had a higher rate of MACE after DES implantation than did those with short lesions in large vessels<sup>20</sup>; however, the impact of OCT guidance on clinical outcomes according to combined anatomical subgroups based on lesion length and RVD during PCI has remained uninvestigated.

The clinical benefits of OCT are largely driven by its ability to modify operator behavior based on detailed anatomical information.<sup>21</sup> Specifically, pre-PCI OCT enables precise lesion preparation and accurate stent sizing and length selection, thereby preventing geographical miss. Subsequently, post-stenting OCT guides the selection of appropriate balloon sizes for postdilatation, ensuring optimal expansion and reducing the risk of complications such as edge dissection or perforation. These procedural refinements, particularly the detection and treatment of high-risk features such as edge dissections, are often unrecognizable in angiography-guided PCI.

Recent evidence from the OCT-based stent optimization analysis of the OCCUPI trial suggests that long lesion length and small vessel diameter are independent predictors of OCT-defined stent suboptimization in patients with complex coronary lesions.<sup>22</sup> In such cases, angiographic guidance alone may be insufficient to ensure adequate stent optimization. The present analysis showed that patients with a lesion length  $\geq 32$  mm and an RVD  $< 2.8$  mm had the lowest rate of OCT-defined stent optimization (59.1%). However, they simultaneously experienced the greatest reduction in MACE with OCT-guided PCI compared with angiography-guided PCI. These

results imply that the presence of both long lesion length and small vessel diameter increases anatomical complexity in an additive manner, thereby magnifying the limitations of angiography-guided PCI and increasing the clinical value of OCT guidance. In these anatomically challenging lesions, OCT guidance could mitigate the adverse consequences of stent underexpansion or malapposition and help prevent procedural complications such as edge dissection, ultimately translating into significant clinical benefits.

During intravascular imaging guidance, stent optimization is consistently associated with favorable clinical outcomes, despite varying optimization criteria across randomized trials of imaging-guided PCI.<sup>4,8,14,23-25</sup> However, the achievement rate of OCT-guided stent optimization based on lesion characteristics has remained unevaluated. In our post hoc analysis, patients undergoing OCT-guided PCI with long lesions or small vessel diameters had a higher proportion of suboptimal stent outcomes. Moreover, the stent optimization rate with OCT guidance was the lowest in patients with long lesions in small vessels among all groups. These results highlight that although optimizing PCI for long lesions and/or small vessel disease is challenging in clinical settings, maximum effort is required to achieve stent optimization when OCT is used to assess expansion, apposition, and edge dissection. A notable finding of our study is the apparent paradox observed in the subgroup with long lesions ( $\geq 32$  mm) and small vessels ( $< 2.8$  mm). Despite exhibiting the lowest rate of OCT-defined stent optimization (59.1%), this subgroup demonstrated the greatest reduction in MACE with OCT guidance compared with angiography guidance. This discrepancy suggests that, in anatomically extreme subsets, the clinical benefit of OCT is driven less by achieving ideal expansion targets, which are often unfeasible because of inherent anatomical constraints, and more by the identification and correction of factors related to acute procedural events. Our lesion-level analysis supports this interpretation, showing that although strict expansion criteria were frequently unachievable in the long lesion and small vessel subgroup, OCT guidance effectively preserved procedural safety by preventing major edge dissections in 99.0% of cases. These findings highlight that the critical role of intravascular imaging in complex lesions lies in mitigating complication risks that remain undetected by angiography alone. Consequently, the detection and correction of these clinically relevant safety issues translate into improved clinical

outcomes, regardless of whether predefined numerical expansion targets are not achieved.

**STUDY LIMITATIONS.** First, the subgroup analysis was not prespecified in the original study protocol, and the post hoc nature of the comparisons implies the possibility of residual confounding. Furthermore, although the event rates were numerically lower in the OCT group than in the angiography group, the lack of statistical significance is likely attributable to the insufficient sample size within the subgroups of short lesions ( $< 32$  mm) or large RVD ( $\geq 2.8$  mm). Therefore, these findings should be considered hypothesis-generating. Further large-scale prospective studies with extended follow-up and higher event rates are required to definitively assess whether short lesion and large vessel modify the clinical benefit of OCT-guided PCI, as well as to identify the long-term relationship between OCT-guided stent optimization and clinical outcomes across varying degrees of lesion complexity. Second, lesion length and RVD were measured using QCA at core laboratories, which although standardized may not match the accuracy of OCT-based assessments and may be subject to technical variability. Third, the subgroup cutoffs for lesion length ( $\geq 32$  mm) and vessel diameter ( $< 2.8$  mm) were based on median values derived from the study population, rather than prespecified clinical thresholds. However, our restricted cubic spline analyses demonstrated a continuous association without distinct inflection points, indicating that the benefit of OCT guidance progressively increases with longer lesion length and smaller vessel diameter. Thus, the clinical benefit should be interpreted as a continuum related to anatomical complexity rather than a threshold-dependent effect. Fourth, although this was a multicenter trial, all participating centers were in South Korea, which may limit generalizability to other populations. Additionally, the trial included a few female patients, which could affect external applicability. Fifth, the follow-up duration was limited to 1 year, and longer-term outcomes remain to be evaluated. Despite these limitations, this analysis provides clinically relevant insights into the use of OCT based on lesion-level anatomy and highlights its role in improving outcomes in complex PCI.

## CONCLUSIONS

This post hoc analysis of the OCCUPI trial showed consistently direction of effect favoring OCT-guided PCI for complex lesions, compared with angiography-guided PCI, for the MACE across lesion

length and vessel diameter. This effect was particularly pronounced in the group with lesion length  $\geq 32$  mm with RVD  $< 2.8$  mm, which were the median values obtained using QCA in the OCCUPI trial population.

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**ADDRESS FOR CORRESPONDENCE:** Dr Yongcheol Kim, Cardiovascular Center, Yongin Severance Hospital, 363 Dongbaekjukjeon-daero, Giheung-gu, Yongin-si, Gyeonggi-do 16995, South Korea. E-mail: [yongcheol@yuhs.ac](mailto:yongcheol@yuhs.ac). OR Dr Byeong-Keuk Kim, Division of Cardiology, Severance Cardiovascular Hospital, Yonsei University College of Medicine, 50-1 Yonsei-ro Seodaemun-gu, 03722 Seoul, Republic of Korea. E-mail: [KIMBK@yuhs.ac](mailto:KIMBK@yuhs.ac).

#### REFERENCES

1. Neumann FJ, Sousa-Uva M, Ahlsson A, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J*. 2019;40:87-165.
2. Writing Committee Members, Lawton JS, Tamis-Holland JE, Bangalore S, et al. 2021 ACC/AHA/SCAI guideline for coronary artery revascularization: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2022;79:e21-e129.
3. Kim BK, Shin DH, Hong MK, et al. Clinical impact of intravascular ultrasound-guided chronic total occlusion intervention with zotarolimus-eluting versus biolimus-eluting stent implantation: randomized study. *Circ Cardiovasc Interv*. 2015;8:e002592.
4. Hong SJ, Kim BK, Shin DH, et al. Effect of intravascular ultrasound-guided vs angiography-guided everolimus-eluting stent implantation: the IVUS-XPL randomized clinical trial. *JAMA*. 2015;314:2155-2163.
5. Lee JM, Choi KH, Song YB, et al. Intravascular imaging-guided or angiography-guided complex PCI. *N Engl J Med*. 2023;388:1668-1679.
6. Ali ZA, Landmesser U, Maehara A, et al. Optical coherence tomography-guided versus angiography-guided PCI. *N Engl J Med*. 2023;389:1466-1476.
7. Holm NR, Andreasen LN, Neghabat O, et al. OCT or angiography guidance for PCI in complex bifurcation lesions. *N Engl J Med*. 2023;389:1477-1487.
8. Li X, Ge Z, Kan J, et al. Intravascular ultrasound-guided versus angiography-guided percutaneous coronary intervention in acute coronary syndromes (IVUS-ACS): a two-stage, multicentre, randomised trial. *Lancet*. 2024;403:1855-1865.
9. Vrints C, Andreotti F, Koskinas KC, et al. 2024 ESC guidelines for the management of chronic coronary syndromes. *Eur Heart J*. 2024;45:3415-3537.
10. Rao SV, O'Donoghue ML, Ruel M, et al. 2025 ACC/AHA/ACEP/NAEMSP/SCAI guideline for the management of patients with acute coronary syndromes: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2025;85:2135-2237.
11. Hong SJ, Kim D, Kim BK, et al. Acute and one-year clinical outcomes of pre-stenting intravascular ultrasound: a patient-level meta-analysis of randomised clinical trials. *EuroIntervention*. 2021;17:202-211.
12. Landmesser U, Ali ZA, Maehara A, et al. Optical coherence tomography predictors of clinical outcomes after stent implantation: the ILUMIEN IV trial. *Eur Heart J*. 2024;45:4630-4643.
13. Kim H, Kang DY, Ahn JM, et al. Proportion and clinical impact of stent optimization during imaging-guided percutaneous coronary intervention: the OCTIVUS trial. *JACC Cardiovasc Interv*. 2025;18:1089-1099.
14. Hong SJ, Lee SJ, Lee SH, et al. Optical coherence tomography-guided versus angiography-guided percutaneous coronary intervention for patients with complex lesions (OCCUPI): an investigator-initiated, multicentre, randomised, open-label, superiority trial in South Korea. *Lancet*. 2024;404:1029-1039.
15. Kastrati A, Dibra A, Mehilli J, et al. Predictive factors of restenosis after coronary implantation of sirolimus- or paclitaxel-eluting stents. *Circulation*. 2006;113:2293-2300.
16. Daemen J, Wenaweser P, Tsuchida K, et al. Early and late coronary stent thrombosis of sirolimus-eluting and paclitaxel-eluting stents in routine clinical practice: data from a large two-institutional cohort study. *Lancet*. 2007;369:667-678.
17. Kong MG, Han JK, Kang JH, et al. Clinical outcomes of long stenting in the drug-eluting stent era: patient-level pooled analysis from the GRAND-DES registry. *EuroIntervention*. 2021;16:1318-1325.
18. Colombo A, Chieffo A. Drug-eluting stent update 2007: part III: Technique and unapproved/unsettled indications (left main, bifurcations, chronic total occlusions, small vessels and long

lesions, saphenous vein grafts, acute myocardial infarctions, and multivessel disease). *Circulation*. 2007;116:1424-1432.

19. Sanz-Sanchez J, Chiarito M, Gill GS, et al. Small vessel coronary artery disease: rationale for standardized definition and critical appraisal of the literature. *J Soc Cardiovasc Angiogr Interv*. 2022;1:100403.

20. Morice MC. Stenting for small coronary vessels. *J Invasive Cardiol*. 2003;15:377-379.

21. Wijns W, Shite J, Jones MR, et al. Optical coherence tomography imaging during percutaneous coronary intervention impacts physician

decision-making: ILUMIEN I study. *Eur Heart J*. 2015;36:3346-3355.

22. Lee YJ, Kim Y, Lee OH, et al. Optical coherence tomography-guided percutaneous coronary intervention in acute coronary syndrome patients with complex lesions: a subgroup analysis of the randomised OCCUPI Trial. *EuroIntervention*. 2025;21:e1269-e1280.

23. Zhang J, Gao X, Kan J, et al. Intravascular ultrasound versus angiography-guided drug-eluting stent implantation: the ULTIMATE trial. *J Am Coll Cardiol*. 2018;72:3126-3137.

24. Kim Y, Kim JH, Hong SJ, et al. Widespread use of imaging-guided PCI in Asia: time for extended application. *JACC Asia*. 2024;4:639-656.

25. Lee SJ, Lee SJ, Hong SJ, et al. Optical coherence tomography-guided stent optimization for complex coronary lesions: the OCCUPI trial. *Eur Heart J*. 2026;47:608-621.

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**KEY WORDS** drug-eluting stents, optical coherence tomography, percutaneous coronary intervention

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**APPENDIX** For expanded Methods and References sections and supplemental tables and figures, please see the online version of this paper.