INTERVENTIONAL CARDIOLOGY PERSPECTIVES

Inter Cardio Per

**DOI:** 10.4274/intercardiopers.2026.2026-1-2

ORIGINAL ARTICLE

# Design and Rationale of the DCB-DCS Study: Procedural Success and Short- and Long-Term Outcomes of Drug-Coated Coronary Balloons Used in Different Clinical Scenarios

Fatih Kahraman[1], Mehmet Kılınç[2], Ömer Göktekin[3]

[1]Department of Cardiology, Kütahya Health Sciences University Faculty of Medicine, Kütahya, Türkiye

[2]Clinic of Cardiology, Denizli State Hospital, Denizli, Türkiye

[3]Clinic of Cardiology, Memorial Bahçelievler Hospital, İstanbul, Türkiye

## ABSTRACT

**Background:** Drug-coated balloons (DCBs) are now an established therapeutic option for the treatment of in-stent restenosis (ISR) and small-vessel coronary artery disease. They enable effective local delivery of antiproliferative agents without leaving a permanent metallic scaffold. Nevertheless, real-world evidence regarding the performance of DCBs in broader and more complex coronary lesion subsets remains limited.

**Aim:** The [DCB in different clinical scenarios (DCS)] study (ClinicalTrials.gov identifier: NCT06915597) is designed to evaluate procedural strategies, safety, and clinical outcomes associated with DCB use across a wide range of coronary lesion types in routine clinical practice.

**Study Design:** This is a multicenter, observational, prospective and retrospective study.

**Methods:** The DCB-DCS study is a national, multicenter, observational registry that integrates both prospective and retrospective cohorts from 17 centers across Türkiye. Consecutive patients undergoing DCB angioplasty for *de novo* lesions, ISR, small-vessel disease, bifurcation lesions, or chronic total occlusions will be enrolled. The selection of the DCB device, lesion preparation strategy, and use of intravascular imaging will be left entirely to the operator's discretion. All procedures will be performed in accordance with contemporary DCB recommendations. Routine angiographic follow-up will not be mandated. The primary endpoint is procedural success. Secondary endpoints include target lesion revascularization, target vessel revascularization, acute vessel occlusion, all-cause mortality, and bleeding events.

**Results:** Data collection is currently ongoing. Baseline demographic and clinical characteristics, procedural details, and clinical outcomes will be analyzed after completion of patient enrollment and follow-up.

**Conclusion:** As the largest and most comprehensive DCB registry conducted in Türkiye, the DCB-DCS study will provide real-world evidence on the expanding application of DCBs across diverse coronary scenarios. The findings are expected to identify optimal procedural approaches and inform the design of future randomized controlled trials comparing DCBs with contemporary-generation stent technologies.

**Keywords:** Design and methodology, drug-coated balloon, multicenter trial

## INTRODUCTION

Coronary drug-coated balloons (DCBs) have emerged over the past decade as an important device-based strategy for the treatment of coronary artery disease (CAD). Initially established as an effective therapy for in-stent restenosis (ISR), DCBs combine transient local delivery of an antiproliferative drug with the advantage of leaving no permanent implant. This approach avoids additional layers of metal and preserves future coronary options. The therapeutic rationale, together with accumulating clinical evidence, has driven interest in expanding DCB use to other clinical scenarios, including de novo small-vessel disease and selected complex lesions.[1,2] High-quality randomized trials support the use of DCBs in specific settings. The BASKET-SMALL 2 trial demonstrated non-inferiority of paclitaxel-coated balloon angioplasty compared with drug-eluting stents (DES) for *de novo* small-vessel coronary lesions, establishing DCB as a viable alternative in vessels where stent implantation is undesirable. Similarly, randomized and large observational studies in ISR have consistently reported favorable outcomes with DCB treatment compared with plain balloon angioplasty and a competitive clinical profile relative to repeat stenting.[2,3] Despite growing evidence, several knowledge gaps persist. Most published data originate from selected patient populations, single-device cohorts, or trials focused on a single clinical scenario

**Address for Correspondence:** Fatih Kahraman, Department of Cardiology, Kütahya Health Sciences University Faculty of Medicine, Kütahya, Türkiye

**E-mail:** drfkahraman@gmail.com **ORCID ID:** orcid.org/0000-0003-3860-2755

**Received:** 22.01.2026
**Accepted:** 02.03.2026
**Epub:** 06.03.2026

**Cite as:** Kahraman F, Kılınç M, Göktekin Ö. Design and rationale of the DCB-DCS study: procedural success and short- and long-term outcomes of drug-coated coronary balloons used in different clinical scenarios. *Inter Cardio Pers.* [Epub Ahead of Print]

(e.g., ISR or small-vessel disease). Comparative effectiveness, safety, and long-term outcomes of different DCB platforms across a broad spectrum of real-world clinical scenarios—including acute coronary syndromes, *de novo* large-vessel lesions, bifurcations, calcified lesions after adequate preparation, and mixed prospective/retrospective cohorts—remain incompletely characterized. Moreover, heterogeneity in lesion preparation, imaging guidance, device selection, and endpoint definitions across studies complicates literature synthesis, prompting calls for standardized definitions and endpoints in DCB research.[4,5] Concurrently, regulatory approvals and the introduction of newer devices have increased access to coronary DCB technology, highlighting the need for real-world data to inform best practices and patient selection. Contemporary registry and consensus literature emphasize the importance of large, multicenter, pragmatic datasets that capture the heterogeneity of routine clinical practice and enable subgroup analyses to identify patients and lesion types most likely to benefit from a DCB-first or DCB-only approach.[6]

Against this background, the DCB-DCS study—a national, multicenter (17 centers in Türkiye), observational registry combining prospective and retrospective cohorts—aims to systematically describe contemporary patterns of DCB use, procedural strategies (including lesion preparation and adjunctive imaging), and clinical and angiographic outcomes across diverse clinical scenarios. The study is designed to address pragmatic evidence gaps by providing real-world effectiveness and safety data, harmonized using standardized endpoints, and to generate hypotheses for future randomized evaluations.

## METHODS

### Study Design

This study is a multicenter, observational registry of DCB interventions, integrating both retrospective and prospective data. Data will be collected from 17 centers across Türkiye, including all consecutive patients undergoing DCB treatment for diverse clinical scenarios—*de novo* lesions, small vessels, ISR, bifurcation lesions, and chronic total occlusions (CTOs). The study was approved by Pamukkale University Ethics Committee (approval no: 07, dated 08.04.2025) and aims to comprehensively evaluate procedural characteristics, lesion preparation strategies, and short- to mid-term outcomes associated with DCB use in routine clinical practice. A summary of the study design is provided in Table 1.

### Rationale for Mixed Prospective and Retrospective Design

A hybrid prospective-retrospective design was adopted to maximize sample size, capture temporal trends in DCB utilization, and enhance external validity. Retrospective data facilitate rapid accrual of real-world cases and hypothesis generation, while the prospective arm allows standardized data collection, predefined endpoint assessment, and bias monitoring. This approach balances feasibility with methodological rigor and supports robust subgroup analyses. All diagnostic and therapeutic procedures, including DCB use, will be performed according to standard clinical indications and physician discretion, without any protocol-mandated interventions or experimental procedures. Data will be collected solely for observational and analytical purposes, and patient management will not be influenced by study participation.

### Study Population

Eligible participants are adults (≥18 years) who underwent percutaneous coronary intervention with a DCB for various clinical scenarios, including *de novo* coronary lesions, small-vessel disease, ISR, bifurcation lesions, and CTO. Inclusion and exclusion criteria are detailed in Table 2. All participants must be capable of providing informed consent. The study flow—including patient enrollment, eligibility assessment, and follow-up—is illustrated in Figure 1.

### Sample Size and Enrollment Strategy

This registry is designed as a large, nationwide, multicenter study intended to reflect contemporary real-world practice across a broad spectrum of clinical scenarios. Based on the procedural volume of participating centers, approximately 2,000–3,000 patients are expected to be enrolled over an 18–30 month recruitment period.

**Table 1.** Study overview and design summary

| Feature | Description |
|---|---|
| **Study name** | DCB-DCS |
| **Design** | Multicentre, observational (retrospective + prospective registry) |
| **Centers** | 17 tertiary cardiology centers across Türkiye |
| **Population** | Consecutive patients undergoing DCB angioplasty |
| **Clinical scenarios** | *de novo* lesions, small vessels, ISR, bifurcation, CTO |
| **Primary endpoint** | Procedural success (residual stenosis <30%, TIMI 3 flow, no major dissection) |
| **Secondary endpoints** | TLR, TVR, death, acute occlusion, bleeding, MACE |
| **Follow-up** | Clinical follow-up at 1, 6, and 12 months; angiographic follow-up per operator discretion |
| **Statistical plan** | Descriptive statistics, Kaplan–Meier survival analyses, subgroup comparison by scenario |

CTO: Chronic total occlusion, DCB: Drug-coated coronary balloon, ISR: In-stent restenosis, MACE: Major adverse cardiac events, TLR: Target lesion revascularization, TVR: Target vessel revascularization, TIMI 3: Thrombolysis in myocardial infarction grade 3, DCS: Different clinical scenarios

**Table 2.** Inclusion and exclusion criteria

| Inclusion criteria | Exclusion criteria |
|---|---|
| Age ≥18 years | Cardiogenic shock at presentation |
| Undergoing DCB angioplasty for eligible lesion | Unsuitable anatomy for DCB treatment |
| Any clinical presentation (stable CAD, ACS) | Contraindication to antiplatelet therapy |
| Availability of complete procedural data | Life expectancy <1 year |

DCB: Drug-coated coronary balloon, CAD: Coronary artery disease, ACS: Acute coronary syndrome

Consecutive patient inclusion will be encouraged at each site to minimize selection bias.

Given the observational nature of the registry, a formal power calculation was not considered mandatory. Nevertheless, the planned sample size is expected to provide adequate statistical precision for evaluating clinical outcomes and to support meaningful subgroup analyses. Enrollment distribution across centers will be monitored to ensure balanced representation and data quality.

### Procedural Characteristics

No specific intervention is mandated by the study protocol; the decision to use a DCB is entirely at the discretion of the treating physician, based on clinical judgment and individual patient characteristics. All procedures will be performed in accordance with current DCB recommendations and best-practice guidelines.

Lesion preparation is considered a key determinant of procedural success. Operators will aim for residual stenosis <30%, thrombolysis in myocardial infarction grade 3 (TIMI 3) flow, and absence of major dissections (type A–C dissections are acceptable). Predilatation may be performed using standard, cutting, or scoring balloons, according to lesion characteristics. Intravascular imaging modalities, such as intravascular ultrasound (IVUS) or optical coherence tomography (OCT), are encouraged to optimize vessel sizing, guide lesion preparation, and assess adequacy of DCB delivery. DCBs will generally be sized at a 1:1 ratio relative to the reference vessel diameter, with inflation maintained for 30–60 seconds to ensure optimal drug transfer. Bailout stenting is permitted in cases of significant recoil or flow-limiting dissection following DCB deployment. A summary of recommended lesion preparation strategies and procedural steps is provided in Table 3.

Patients with cardiogenic shock, contraindications to antiplatelet therapy, active bleeding, uncontrolled coagulopathy, known allergy to the drug coating or balloon material, life expectancy <1 year, or pregnancy will be excluded from the study.

### Clinical Endpoints

The primary endpoint of the registry is target lesion failure at 12 months, defined as a composite of cardiac death, target-vessel myocardial infarction, and clinically driven target lesion revascularization (TLR).

Econdary endpoints include major adverse cardiac events, defined as a composite of all-cause death, myocardial infarction, and clinically driven target vessel revascularization (TVR) as well as the individual components of these composites. Myocardial infarction will be defined according to the Fourth Universal Definition of Myocardial Infarction.

Procedural success is a key secondary procedural endpoint and is defined as successful treatment of the target lesion with a DCB resulting in final TIMI 3 flow, residual stenosis <30% by visual estimation, and absence of flow-limiting dissection requiring bailout stent implantation.

Clinically driven TLR/TVR is defined as repeat revascularization performed in the presence of ischemic symptoms and/or objective evidence of myocardial ischemia, including positive non-invasive testing or angiographic findings consistent with acute coronary syndrome.

Bleeding events will be classified according to the Bleeding Academic Research Consortium criteria. Acute vessel closure is defined as abrupt occlusion of the treated segment occurring during the procedure or within 24 hours.

Angiographic endpoints, including late lumen loss, will be evaluated in patients undergoing clinically indicated follow-up angiography. As routine angiographic follow-up is not mandated, these analyses will be considered exploratory.

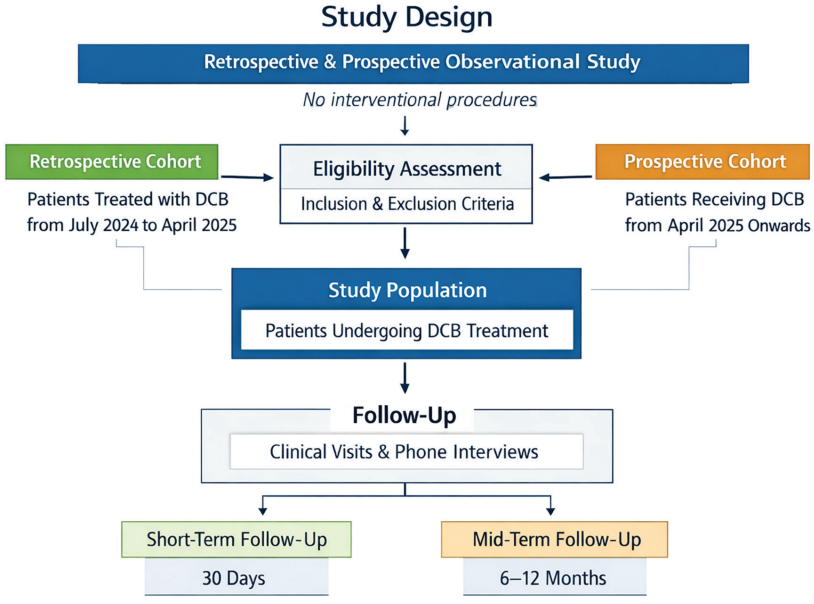


**Figure 1.** Study flow diagram
*DCB: Drug-coated coronary balloon*

**Table 3.** Lesion preparation and procedural recommendations

| Procedural step | Recommendation/target |
|---|---|
| Lesion preparation | Predilatation with standard, cutting, or scoring balloon |
| Optimal result before DCB | <30% residual stenosis, TIMI 3 flow, no ≥ type C dissection |
| Balloon sizing | 1:1 ratio with reference vessel diameter |
| Inflation duration | At least 30–60 seconds |
| Bailout stenting | Permitted if flow-limiting dissection or recoil |
| Imaging use | IVUS or OCT encouraged for vessel sizing and optimization |

DCB: Drug-coated coronary balloon, IVUS: Intravascular ultrasound, OCT: Optical coherence tomography, TIMI 3: Thrombolysis in myocardial infarction grade 3

### Follow-up and Outcome Assessment

Clinical follow-up will be conducted at 1, 6, and 12 months after the index procedure, with additional evaluations performed as clinically indicated. Follow-up data will be collected through outpatient clinic visits, structured telephone interviews, and review of hospital records. When available, national health system databases may also be used to enhance event detection and minimize loss to follow-up.

To ensure data quality and consistency across participating centers, standardized data collection forms will be employed. Clinical events will be reported by each site and systematically recorded in the registry database. Where necessary, source document verification may be performed to confirm reported outcomes.

Every effort will be made to achieve complete follow-up. Patients for whom follow-up information cannot be obtained will be censored at the time of the last confirmed contact.

### Statistical Analysis

All statistical analyses will be performed using SPSS (IBM Corp., Armonk, NY, USA) or R software (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables will be presented as mean ± standard deviation or median with interquartile range, depending on data distribution. Categorical variables will be expressed as counts and percentages. Normality will be assessed using the Kolmogorov–Smirnov test. Comparisons between groups will be performed using the Student's t-test or Mann–Whitney U test for continuous variables, and the chi-square or Fisher's exact test for categorical variables, as appropriate.

Time-to-event outcomes will be analyzed using Kaplan–Meier survival estimates and compared using the log-rank test. To identify independent predictors of clinical outcomes and adjust for potential confounders related to patient characteristics, lesion complexity, device type, and procedural strategy, multivariable regression models will be constructed. Cox proportional hazards models will be used for time-to-event analyses, with results reported as hazard ratios and 95% CIs. Covariates will be selected based on clinical relevance, prior literature, and variables demonstrating significance in univariate analyses.

Given the multicenter design, clustering by participating centers will be addressed using mixed-effects models or robust standard errors, as appropriate, to account for potential inter-center variability and operator-dependent effects. Subgroup analyses may be conducted across predefined clinical scenarios when clinically meaningful.

Considering the hybrid retrospective–prospective design, the two cohorts will initially be analyzed separately to identify potential differences in baseline characteristics, treatment patterns, and outcomes. Cohort type will then be incorporated as a predefined covariate in multivariable models. Sensitivity analyses restricted to the prospective cohort will be performed to evaluate the robustness of the findings. Additionally, stratified analyses by enrollment period may be conducted to explore potential temporal changes in clinical practice.

Efforts will be made to minimize missing data through standardized collection procedures across centers. When appropriate, multiple imputation techniques may be applied, and sensitivity analyses will be considered to assess the impact of missing data on study outcomes. All tests will be two-sided, and a p value <0.05 will be considered statistically significant.

## RESULTS

Data collection is ongoing, and the complete analysis will be reported in a future publication. Key procedural characteristics, clinical outcomes, and follow-up data will be presented once the study is finalized.

## DISCUSSION

The DCB-DCS study will provide one of the largest and most comprehensive datasets on the use of DCBs across diverse real-world clinical settings in Türkiye. While the efficacy of DCBs is well established in ISR and small-vessel disease, their expanding role in more complex lesions such as bifurcations, CTO, and large-vessel *de novo* disease—remains an area of growing clinical interest. This registry aims to address this knowledge gap by systematically documenting procedural strategies, device selection, and outcomes in routine interventional practice. Over the last decade, evidence supporting the "leave nothing behind" strategy has gained momentum. DCB angioplasty enables effective antiproliferative drug delivery without permanent scaffolding, representing a paradigm shift in coronary intervention. Randomized and observational studies have demonstrated comparable efficacy and superior preservation of vessel physiology compared with new-generation DES in appropriately selected lesions.[7-9] Additionally, the avoidance of polymer hypersensitivity, late stent thrombosis, and impaired vasomotion makes DCBs particularly advantageous in patients with diffuse disease, high bleeding risk, or contraindications to prolonged dual antiplatelet therapy.[6,10] Despite these advances, real-world data remain heterogeneous, reflecting variability in lesion

preparation, balloon technology, and operator experience. The DCB-DCS registry is designed to address these limitations by combining retrospective and prospective cohorts from 17 centers, thereby capturing temporal trends and practice evolution within a standardized framework. This pragmatic design aligns with recommendations from the Drug-Coated Balloon Academic Research Consortium for harmonized data collection and endpoint definitions.[5,11] Moreover, the inclusion of multiple DCB platforms—paclitaxel- and sirolimus-based—will allow indirect comparison of performance across technologies under real-world conditions.

A key strength of the DCB-DCS study is its inclusivity. By enrolling all-comer patients across a broad spectrum of clinical scenarios and permitting procedural discretion by treating physicians, the registry reflects genuine clinical decision-making rather than protocol-driven treatment algorithms. This approach complements efforts to expand the evidence base beyond tightly controlled randomized trials, acknowledging that registry data provide critical insights into external validity and long-term safety.[12,13] Furthermore, the study will examine how lesion preparation strategies, imaging support (IVUS or OCT), and bailout stenting decisions influence outcomes across lesion subsets. Previous studies have highlighted the importance of meticulous vessel preparation and optimal balloon sizing in achieving durable results with DCBs.[14,15] Incorporating imaging guidance is expected to further refine procedural endpoints and identify predictors of restenosis or late vessel remodeling. The results of the DCB-DCS registry are anticipated to inform clinical practice by identifying patient and lesion subsets that derive the greatest benefit from a DCB-first or DCB-only approach, clarifying procedural best practices, and generating hypotheses for future randomized evaluations. Beyond its national scope, the study may also contribute to international efforts to standardize DCB methodology and integrate this technology into global treatment algorithms for CAD.

### Study Limitations

This registry has several limitations inherent to observational research. Despite planned multivariable adjustments, residual confounding cannot be entirely excluded. Additionally, treatment strategies and device selection are at the discretion of the operator, which may introduce variability reflective of real-world practice.

The hybrid retrospective–prospective design may result in heterogeneity in data quality and follow-up completeness; however, predefined statistical strategies are planned to mitigate this effect. Routine angiographic follow-up is not mandated; therefore, angiographic outcomes should be interpreted with caution and considered exploratory.

Although every effort will be made to ensure comprehensive follow-up, missing data or loss to follow-up cannot be completely eliminated. Nonetheless, standardized data collection procedures and structured follow-up methods are expected to support the overall reliability of the registry.

## CONCLUSION

The DCB-DCS study is designed to provide comprehensive real-world evidence on the contemporary use of DCBs across a broad spectrum of coronary lesion subsets and clinical scenarios. By including all-comer patients and reflecting routine clinical decision-making, this registry complements existing randomized data and enhances understanding of procedural strategies, imaging guidance, and bailout stenting practices associated with DCB therapy.

The findings are expected toprovide valuable insights into external validity, long-term safety, and outcome optimization, thereby informing daily clinical practice and guiding future recommendations and guideline development.

**Ethics Committee Approval:** The study was approved by Pamukkale University Ethics Committee (approval no: 07, dated 08.04.2025)

**Informed Consent:** Retrospective and prospective observational study.

**Authorship Contributions:** Surgical and Medical Practices: F.K., M.K., Ö.G., Concept: F.K., M.K., Ö.G., Design: F.K., M.K., Ö.G., Data Collection or Processing: F.K., M.K., Ö.G., Analysis or Interpretation: F.K., M.K., Ö.G., Literature Search: F.K., Writing: F.K., Ö.G.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study received no financial support.

## REFERENCES

1. Jeger RV, Eccleshall S, Wan Ahmad WA, et al; International DCB consensus group. Drug-coated balloons for coronary artery disease: third report of the international DCB consensus group. *JACC Cardiovasc Interv.* 2020;13:1391-1402.
2. Rittger H, Waliszewski M, Brachmann J, et al. Long-term outcomes after treatment with a paclitaxel-coated balloon versus balloon angioplasty: insights from the PEPCAD-DES study (treatment of drug-eluting stent [DES] in-stent restenosis with sequent please paclitaxel-coated percutaneous transluminal coronary angioplasty [PTCA] catheter). *JACC Cardiovasc Interv.* 2015;8:1695-1700.
3. Jeger RV, Farah A, Ohlow MA, et al; BASKET-SMALL 2 investigators. Drug-coated balloons for small coronary artery disease (BASKET-SMALL 2): an open-label randomised non-inferiority trial. *Lancet.* 2018;392:849-856.
4. Shahrori ZMF, Frazzetto M, Mahmud SH, Alghwyeen W, Cortese B. Drug-coated balloons: recent evidence and upcoming novelties. *J Cardiovasc Dev Dis.* 2025;12:194.
5. Fezzi S, Scheller B, Cortese B, et al. Definitions and standardized endpoints for the use of drug-coated balloon in coronary artery disease: consensus document of the Drug Coated Balloon Academic Research Consortium. *EuroIntervention.* 2025;21:e1116-1136.
6. Her AY, Ahmad WAW, Bang LH, et al. Drug-coated balloons-based intervention for coronary artery disease: the second report of Asia-Pacific consensus group. *JACC Asia.* 2025;5:701-717.
7. Jeger RV, Farah A, Ohlow MA, et al. Long-term efficacy and safety of drug-coated balloons versus drug-eluting stents for small coronary artery disease (BASKET-SMALL 2): 3-year follow-up of a randomised, non-inferiority trial. *Lancet.* 2020;396:1504-1510.

8. Cortese B, Testa G, Rivero F, Erriquez A, Alfonso F. Long-term outcome of drug-coated balloon vs drug-eluting stent for small coronary vessels: PICCOLETO-II 3-year follow-up. *JACC Cardiovasc Interv.* 2023;16:1054-1061.
9. Baan J Jr, Claessen BE, Dijk KB, et al. A randomized comparison of paclitaxel-eluting balloon versus everolimus-eluting stent for the treatment of any ın-stent restenosis: the DARE trial. *JACC Cardiovasc Interv. 2018*;11:275-283.
10. Räber L, Mintz GS, Koskinas KC, et al. Clinical use of intracoronary imaging. Part 1: guidance and optimization of coronary interventions. An expert consensus document of the European Association of Percutaneous Cardiovascular Interventions. *EuroIntervention.* 2018;14:656-677.
11. Fezzi S, Serruys PW, Cortese B, et al. Indications for use of drug-coated balloons in coronary intervention: Academic Research Consortium Position Statement. *J Am Coll Cardiol*. 2025;86:1170-1202.
12. Wöhrle J, Scheller B, Seeger J, et al; BASKET-SMALL 2 investigators. Impact of diabetes on outcome with drug-coated balloons versus drug-eluting stents: the BASKET-SMALL 2 trial. *JACC Cardiovasc Interv.* 2021;14:1789-1798.
13. O'Callaghan D, Rai H, Giacoppo D, et al. Drug coated balloons versus drug-eluting stents in patients with de novo coronary artery disease. *Catheter Cardiovasc Interv*. 2025;106:1843-1853.
14. Kim S, Kang DO, Her AY, Song WH, Shin ES. Drug-coated balloon-based percutaneous coronary intervention in de novo coronary artery disease and tips for procedural success. *J Cardiovasc Interv*. 2024;3:190-198.
15. Yamamoto M, Hara H, Kubota S, Hiroi Y. Predictors of late lumen enlargement after drug-coated balloon angioplasty for de novo coronary lesions. *EuroIntervention.* 2024;20:602-612.