Impact of 3-Dimensional Bifurcation Angle on 5-Year Outcome of Patients After Percutaneous Coronary Intervention for Left Main Coronary Artery Disease

A Substudy of the SYNTAX Trial (Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery)

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Objectives This study sought to investigate the impact of left main coronary artery (LMCA) 3-dimensional (3D) bifurcation angle (BA) parameters on 5-year clinical outcomes of patients randomized to LMCA percutaneous coronary intervention (PCI) in the SYNTAX (Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery) trial.

Background BA can affect outcome after bifurcation PCI; 3D angiographic analysis provides reliable BA measurements.

Methods The diastolic distal BA (between left anterior descending and left circumflex) and its systolic-diastolic range were explored. A stratified post-hoc survival analysis was performed for 5-year major adverse cardiac and cardiovascular events (MACCE) (all-cause death, cerebrovascular accident, myocardial infarction, or repeat revascularization), a safety endpoint (all-cause death, cerebrovascular accident, or myocardial infarction), and repeat revascularization. Analysis was performed in patients where 3D BA was available pre- and post-PCI.

Results Of 266 patients eligible for analysis, 185 underwent bifurcation PCI (group B); 1 stent was used in 75 patients (group B1), whereas ≥2 stents were used in 110 patients (group B2). Stratification across pre-PCI diastolic distal BA tertiles (≤ 82°, 82° to 106°, ≥ 107°) failed to show any difference in MACCE rates either in the entire study population (p = 0.99) or in group B patients (p = 0.78). Group B patients with post-PCI systolic-diastolic range < 10° had significantly higher MACCE rates (50.8% vs. 22.7%, p < 0.001); repeat revascularization and safety endpoint rates were also higher (37.4% vs. 15.5%, p = 0.002, and 25.4% vs. 14.1%, p = 0.055, respectively). Post-PCI systolic-diastolic range < 10° was an independent predictor of MACCE (hazard ratio: 2.65; 95% confidence interval: 1.55 to 4.52; p < 0.001) in group B patients.

Conclusions A restricted post-procedural systolic-diastolic distal BA range resulted in higher 5-year adverse event rates after LMCA bifurcation PCI. Pre-PCI BA value did not affect the clinical outcome. (J Am Coll Cardiol Intv 2013;6:1250–60) © 2013 by the American College of Cardiology Foundation.
Percutaneous coronary intervention (PCI) for unprotected left main coronary artery (LMCA) disease is emerging as a reasonable treatment option alternative to coronary artery bypass graft surgery, especially when concomitant coronary artery disease is limited and comorbidities are present (1,2). Data from major randomized trials (3–7) and many registries have led to the upgrade of PCI as a means of revascularization for LMCA ostial and/or shaft stenosis to a class IIa recommendation. However, bifurcation LMCA PCI was assigned a class IIb recommendation; it was deemed to be of considerably higher risk for adverse clinical outcomes than surgery (1,2). Issues such as the choice of (drug-eluting) stent, the number of stents used and individual techniques, SYNTAX (Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery) score, and plaque distribution have all been addressed (8). However, whereas the impact of bifurcation angle (BA) on immediate post-procedural and especially the long-term outcome has been studied in non-LMCA lesions (9–11), its relation to the LMCA PCI is unclear. The studies reporting on this subject were largely on the basis of BA measurements derived from 2-dimensional (2D) quantitative coronary angiography (QCA) and therefore were prone to error; moreover, these studies had a small sample size and/or limited outcome data (12–14).

We have previously explored the 3-dimensional (3D) QCA-based distribution of the LMCA BA variables (diastolic and systolic values, pre- and post-PCI) in a report on the basis of patients that were randomized to PCI in the context of the SYNTAX trial; furthermore, we have provided 12-month outcome data stratified across the distal BA tertile values (15). At that time, the analysis did not show enough evidence to support 3D BA as a potential predictor of outcome; however, there was a weak trend indicating higher adverse event rates in patients with wider distal LMCA angles when ≥2 stents were implanted in the LMCA bifurcation. Now having 5-year outcome data available (16), we investigate once more the topic to attempt to get conclusive evidence on the impact of 3D BA on very long-term outcome after LMCA PCI and, if possible, to gain insight into the possible mechanisms whereby this effect is mediated.

**Methods**

**Study population.** This is a substudy of the SYNTAX trial (4), which was a randomized, prospective, multicenter, all-comers clinical trial with the overall goal of assessing the optimum revascularization treatment for patients with de novo 3-vessel disease or LMCA disease (either isolated or in combination with 1-, 2-, or 3-vessel disease). Patients (N = 1,800) amenable to either treatment option were randomized to PCI with polymer-based, paclitaxel-eluting Taxus Express (Boston Scientific Corporation, Natick, Massachusetts) stents or coronary artery bypass graft surgery; they were also stratified according to the presence or absence of LMCA disease. For the purpose of this study, we reviewed the cineangiograms of the 354 patients who actually underwent PCI of the LMCA stem (5). Patients with both distal and nondistal LMCA lesions were evaluated; the ones in whom 3D angiographic reconstruction could be performed to derive the LMCA BA parameters both pre- and post-procedure constituted our original study population (Fig. 1) (15). This study was not pre-specified in the SYNTAX trial protocol and was not subsidized by the official sponsor of the trial, Boston Scientific Corporation. Nevertheless, previous permission was sought and granted by the steering committee to access and analyze this dataset.

**Treatment.** Procedures were performed according to local practice and at the investigator’s discretion. In the Taxus arm, clopidogrel was mandated for at least 6 months after the procedure, whereas patients were advised to maintain aspirin indefinitely. Recommended procedural techniques included complete coverage of lesions with stent overlapping (where required) at both margins by ~4 mm and use of final kissing balloons inflation after bifurcation stenting (5).

**Endpoints and definitions.** The primary endpoint of the SYNTAX trial was a composite of major adverse cardiac and cardiovascular events (MACCE) (4). The primary endpoint of this study was major adverse cardiac events (MACCE) defined as death, non-fatal myocardial infarction (MI), or target lesion revascularization (TLR).

**Abbreviations and Acronyms**

- **BA** = bifurcation angle
- **CI** = confidence interval(s)
- **HR** = hazard ratio(s)
- **LMCA** = left main coronary artery
- **MACCE** = major adverse cardiac and cardiovascular events
- **MI** = myocardial infarction
- **PCI** = percutaneous coronary intervention
- **QCA** = quantitative coronary angiography
- **SB = side branch**
- **SDR = systolic-diastolic range**
- **2D = 2-dimensional**
- **3D = 3-dimensional**

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Angiographic analysis. 3D reconstruction was performed before and after PCI in only 266 patients. Out of the entire randomized study population of 1800 patients, 354 patients actually underwent PCI of the LMCA stem; however, 3D angiographic reconstruction could be performed both pre- and post-PCI in only 266 patients. Thereof, 185 patients underwent distal LMCA PCI, wherein 2 stents or more were placed in 110 patients. LMCA = left main coronary artery.

During the 12-month period following treatment allocation, Definitions of clinical events have been previously described in detail (4,17). All adverse events were adjudicated by an independent clinical events committee; stent thrombosis has been adjudicated according to the study protocol. Patient follow-up has been conducted on an annual basis until 5 years after treatment allocation. Definitions of clinical events have been previously described in detail (4,17). All adverse events were adjudicated by an independent clinical events committee; stent thrombosis has been adjudicated according to the study protocol. Patient follow-up has been conducted on an annual basis until 5 years after treatment allocation.

Angiographic analysis. 3D reconstruction was performed offline by 2 experienced operators (C.G. and Y.O.), who were blinded to individual patient data and clinical outcome, with a validated program for 3D QCA (CardiOp-B system, version 2.1.0.151, Paieon Medical Ltd., Rosh Ha’ayin, Israel). The distal BA was measured between the left anterior descending and the left circumflex coronary arteries designated as the distal main vessel and the side branch (SB), respectively; 3D reconstructions were performed at end diastole and end systole, both pre- and post-procedure. In this study, the diastolic distal BA and its systolic-diastolic range (SDR) were explored pre- and post-procedure. The latter variable (SDR) was defined as the absolute difference between diastolic and systolic distal BA values. On occasion, systolic values exceeded the diastolic ones; however, only absolute (positive) terms were studied. To prospectively grade the complexity of coronary artery disease, the Angiographic Core Laboratory (Cardialysis BV, Rotterdam, the Netherlands) scored the angiograms according to the SYNTAX score algorithm (18). LMCA bifurcation lesion type was adjudicated according to Medina; [1,1,1], [1,0,1], and [0,1,1] lesion types are summarily called true bifurcation lesions. Because the staff of the angiographic core laboratory was blinded to site information, adjudicated lesions for the SYNTAX score derivation could not be matched between core laboratory and site; we chose to report bifurcation type per site to be concordant with the choice of stenting technique.

Study design. Tertile and/or median values of the aforementioned angulation variables were used to stratify clinical outcomes. Pre-procedural values were explored over the entire study population, that is patients with nondistal (group A) and distal LMCA PCI (group B) (Fig. 1). However, regarding the post-procedure values and the change in LMCA bifurcation geometry conferred by PCI, it was deemed more meaningful to study their association with clinical outcomes only for patients in group B, whether they had 1 stent (group B1) or ≥2 stents (group B2) placed across the LMCA bifurcation.

Statistical analysis. Statistical analysis was performed using SPSS for Windows (version 19.0, SPSS Inc., Chicago, Illinois). Continuous variables are expressed as mean ± SD and compared between groups by the unpaired Student t test; paired Student t test was employed for within-group comparisons. Categorical variables are presented as counts and/or percentages; comparisons were performed with the chi-square test and the Fisher exact test as appropriate.

Cumulative 5-year event rates for MACCE, a safety composite endpoint (all-cause death, cerebrovascular accident, or MI) and stent thrombosis were calculated according to the Kaplan-Meier method. Event rates were compared according to the Cox proportional hazards model. Independent predictors of 5-year MACCE, repeat revascularization, and the safety endpoint were sought among variables significant beyond the level of p = 0.10 in univariable analysis. Potential predictors were checked for collinearity before entering a Cox regression multivariable backward stepwise model; variables with a variance inflation factor >2.5 were disqualified. Crude and adjusted hazard ratios (HRs) and corresponding 95% confidence intervals (CIs) are reported for qualifying variables. All statistical tests were 2-sided and a p value of <0.05 was considered statistically significant.

Results

Five-year clinical follow-up was attained for 259 (97.4%) patients (median: 1,826 days, range: 4 to 2,082 days); 7 patients were lost to follow-up and were censored at days 389, 1,105, 1,442, 1,462, 1,462, 1,473, and 1,489.
respectively. The baseline characteristics of the study population are shown in Table 1 stratified according to LMCA lesion location and bifurcation stenting technique (1 or ≥2 stents). Compared with group A patients, in group B patients, coronary artery disease was significantly more extensive as indicated by the increased SYNTAX score (32.6 ± 13.5 vs. 23.5 ± 10.5, p < 0.001) and percentage of patients with LMCA plus 2- or 3- vessel disease (81.6% vs. 42.0%, p < 0.001). Complete revascularization rates were comparable between groups A and B (67.9% vs. 64.3%, p = 0.68); 3.0 ± 1.9 stents with a total length of 51.0 ± 39.0 mm were used in the former, whereas 4.2 ± 2.4 stents with a total length of 77.7 ± 47.9 mm were used in the latter (p < 0.001 for both).

Complex stenting techniques were applied to patients with more complex bifurcation disease; 85 of 108 true bifurcation lesions were treated with ≥2 stents (Table 2). However, in 19 cases of a [1,1,1] bifurcation lesion, provisional T stenting was performed; in 14 of these cases, the procedure was finished with a kissing balloon inflation. Overall, final kissing balloon inflation was employed more frequently after complex bifurcation stenting (p < 0.001).

**BA variables.** Angulation variables for patients with LMCA bifurcation PCI are shown in Table 3. There is a significant post-procedural decrease in the diastolic distal BA (Δ = −6.3°, p < 0.001), whereas SDR is only slightly decreased (Δ = −0.5°, p = 0.50). On average, SDR is slightly increased after single-stenting (Δ = 0.7°, p = 0.45), whereas moderately decreased by complex stenting (Δ = −1.3°, p = 0.17); however, direction and extent of change vary significantly among 2-stent techniques (p < 0.01) (Fig. 2).

**Impact on outcome.** Stratification across pre-PCI diastolic distal BA tertiles (<82°, 82° to 106°, ≥107°) failed to show any difference in MACCE rates either in the entire study population (37.1%, 37.7%, and 35.6%, respectively, p = 0.99), or in group B patients (33.7%, 40.3%, and 35.6%, respectively, p = 0.78). Kaplan-Meier curves slightly diverged for patients in group B2 (p = 0.41), mainly due to relatively increased safety endpoint rates for patients in the middle tertile; this was not the case for group B1 (Fig. 3). Repeat revascularization rates did not show any significant differences across tertiles (p = 0.42 and 0.77 for groups B1 and B2, respectively) (Fig. 3); on the other hand, there was a strong trend for increased MI rates for patients with BA <82° in group B2 (17.5%, 16.8%, and 0.0% for low, mid-, and high tertiles, respectively, p = 0.06) that was not seen in group B1 (5.3%, 4.2%, and 6.6%, respectively, p = 0.91).

Stratification across post-PCI diastolic distal BA tertile values (<79°, 79° to 98°, ≥99°) did not show any significant difference in MACCE rates in group B (37.1%, 31.0%, and 42.0%, respectively, p = 0.29). There was a trend for increased safety endpoint rates in patients in the third tertile (13.5%, 17.7%, and 27.7% for low, mid-, and high tertiles, respectively, p = 0.12); however, this was not the case for

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repeat revascularization rates (31.5%, 23.5%, and 23.8%, respectively, p = 0.55).

Systolic-diastolic BA range both pre- and post-procedure had a median value of 10°. There was no significant difference in MACCE rates for patients in group B with pre-PCI SDR >10° (40.6% vs. 32.5%; HR: 1.25; 95% CI: 0.77 to 2.02; p = 0.37). Conversely, patients with post-PCI SDR <10° showed significantly higher MACCE rates for group B (50.8% vs. 22.7%; HR: 2.65; 95% CI: 1.58 to 4.44; p < 0.001), group B1 (46.9% vs. 16.4%; HR: 3.47; 95% CI: 1.41 to 8.55; p = 0.01) and group B2 (52.8% vs. 28.0%; HR: 2.16; 95% CI: 1.15 to 4.07; p = 0.02). The event rates for all different endpoints for the entire group B are reported in Table 4 stratified across the post-PCI SDR median value. Moreover, in both subgroups, higher event rates were recorded for patients with post-PCI SDR <10° regarding repeat revascularization (p = 0.07 and 0.02 for groups B1 and B2) and the safety endpoint (p = 0.08 and 0.35 for groups B1 and B2) (Fig. 4). Finally, group B patients with even minimally increased SDR post-procedure (ΔSDR = post-PCI SDR minus pre-PCI SDR) showed significantly lower MACCE rates (28.6% vs. 43.9%; HR: 0.60; 95% CI: 0.37 to 0.99, p = 0.045), compared with patients with ΔSDR ≤0.

**Stent thrombosis.** Per protocol, stent thrombosis was adjudicated in 13 patients in the entire study population (4.9%). Of those, 9 had LMCA bifurcation PCI (4.9%); thereof 8 belonged to group B2. Among these 9 patients, 5 events occurred early (<30 days), 1 event late (day 318), and 3 events very late (days 598, 835, and 1,594). If stratified across diastolic distal BA, there was a trend for higher stent thrombosis rates in the lowest angle tertiles (8.5%, 5.4%, and 1.6%, p = 0.23, and 8.5%, 3.5%, and 3.3%, p = 0.33, pre- and post-PCI, respectively); however, difference was mainly driven by early events (3 events each in the lowest angle tertiles). There was also a trend for higher event rates for patients with narrower post-PCI SDR (8.0% vs. 2.2%; HR: 3.75; 95% CI: 0.78 to 18.2, p = 0.37). Conversely, patients with post-PCI SDR minus pre-PCI SDR >10° showed significantly higher MACCE rates (HR: 2.39; 95% CI: 1.26 to 4.52, p < 0.01) next to poor left ventricular ejection fraction (HR: 7.53; 95% CI: 2.63 to 21.6, p < 0.001) and the total number of stents placed in a patient (HR: 1.13; 95% CI: 1.03 to 1.24, p < 0.01). Following a similar analysis, a narrow post-PCI SDR independently predicted increased rates for both repeat revascularization (HR: 2.39; 95% CI: 1.26 to 4.52, p < 0.01) next to the total number of stents (HR: 1.16; 95% CI: 1.05 to 1.29, p < 0.01) and for the safety endpoint (HR: 2.06; 95% CI: 1.03 to 4.12, p = 0.04) next to previous MI (HR: 2.93; 95% CI: 1.50 to 5.71, p < 0.01) and poor left ventricular ejection fraction (HR: 4.78; 95% CI: 1.37 to 16.6, p = 0.01).

**Discussion**

The following are the main findings of this study. 1) The pre-procedural 3D QCA-derived diastolic distal BA of the
LMCA bifurcation could not predict long-term clinical outcomes after PCI for LMCA coronary artery disease. Even when patients with LMCA bifurcation PCI were examined separately, there was still no significant impact of this parameter on long-term clinical outcomes. 2) A narrow (<10°) post-PCI systolic-diastolic range of this angle was shown to be significantly associated with worse 5-year clinical outcomes in patients undergoing LMCA bifurcation PCI. Adjusted for various clinical, angiographic (including extent of concomitant disease), and procedural variables, it still proved an independent predictor of 5-year MACCE.

To our knowledge, this is the first study ever to report on such long-term clinical outcomes of LMCA PCI stratified across BA parameters exclusively derived from 3D angiographic bifurcation analysis. The relative merits of 3D angiography have already been stressed (15); regarding the BA derivation, 3D angiographic analysis is of apparent importance as the bifurcation is a 3D structure, and therefore its maximal opening can be accurately appreciated only in a 3D space (19). Moreover, on the basis of a phantom validation study, 3D QCA has recently been shown to provide more accurate and precise BA measurements than 2D software does (20).

Effect of SDR. The idea that a decreased post-PCI systolic-diastolic range of movement of the LMCA (or any) bifurcation is associated with higher event rates may on first
inspection sound like a paradox. It would be assumed that in the long term an increased range of torsion, flexion, and stretching of any metallic structure would lead to metal fatigue and eventually strut fracture (21,22). The premise we are making is the same, only seen in a different perspective. The diminished range of movement after the procedure, even more pronounced after complex stenting (Fig. 2), implies that the bifurcation has been “stiffened” by the stents and forced into an unnatural configuration. Therefore, the myocardium and hence the epicardial coronary arteries strive

Figure 3. Impact of Pre-PCI Diastolic Distal BA on 5-Year MACCE, All-Cause Death, CVA, or MI (Safety Endpoint), and Repeat Revascularization

Kaplan-Meier curves shown for group B1 (A, C, E) and group B2 (B, D, F). CVA = cerebrovascular accident; HR = hazard ratio; LMCA = left main coronary artery; MACCE = major adverse cardiac and cardiovascular events; MI = myocardial infarction; other abbreviations as in Figures 1 and 2.
to revert to the previous geometry (23,24), thereby exerting increased and repetitive strain on the metallic scaffolds. It has been reported that the Taxus Express metallic platform is not prone to strut fractures at least to the same extent as the Cypher stent (Cypher, Cordis, Johnson and Johnson Corporation, Miami, Florida) (22). This has been attributed to the Taxus Express open-cell design, which is said to enhance its conformability around bends (23) as well as to its diminished radiopacity, which makes fractures more difficult to detect angiographically. Stent strut fractures have been mostly explored in straight vessel segments; even there, high vessel tortuosity and excessive vessel angulation during the heart cycle were reported to be precipitating factors (24–26), especially in the presence of long overlapping stents. Even so, stent strut fractures seldom translate into stent thrombosis, MI, or sudden death (22), but rather in a hinge motion associated with in-stent restenosis (26); however, when seen in the context of the LMCA bifurcation, otherwise occult restenotic lesions could very well lead to catastrophic outcomes.

**Effect of distal BA.** Intuitively, the distal BA has been associated with the risk of SB occlusion during stent implantation in the main vessel (27); a shallow distal BA makes a carina shift more probable, thereby resulting in considerable residual stenosis (28). Moreover, for BA 70°, classic T stenting cannot fully scaffold the SB ostium without stent struts protruding into the main vessel (29); dedicated techniques, such as the crush and the culotte, that fully cover the SB ostium have been developed to address this issue. However, a shallow angle necessitates an increased stent cell size to avoid jailing the SB ostium after the crush or causing a napkin ring stenosis in the ostium of the distal main vessel after a culotte. Theoretically, for BA 60°, a distal main vessel diameter of 3 mm and an SB diameter of 2.75 mm, a stent cell diameter of 3.3 mm would be required (30), which could be achieved with the Taxus Express metallic stent platform (31).

Moving to steeper angles, bench studies have shown that for BA >80°, full stent strut apposition cannot be achieved with the crush (32,33) or the culotte techniques despite sequential kissing balloon inflations (34); straightening of the LMCA curvature could cause added distortion. Thereby, gaps in support and drug application are left at the SB ostium, which probably translate into higher adverse event rates for highly angulated bifurcations (9–12). At the same time, increasing BA have been associated with decreasing lower wall shear stress values and increased oscillatory flow at the lateral walls opposite the carina (35,36), which facilitate plaque proliferation and eventually restenosis; contrary to sirolimus, paclitaxel cannot modify the effect of low wall shear stress on neointima formation (37). Expectedly, all these phenomena are exacerbated in the presence of multiple stent strut layers, metallic neo-carinas, and protruding and malapposed struts.

**Implementation and clinical implications.** A single 3D angiographic reconstruction of a bifurcation requires 2 adequate images 30° apart with the least possible amount of foreshortening and vessel overlap. For a given bifurcation, there is usually 1 optimal view, whereas in any other direction certain features, usually the SB ostium, may be obscured; retrospective collection of 2 adequate images can be challenging. However, new software algorithms can retrieve missing information even from 2 suboptimal images, whereas the optimal view, if not among the images initially acquired, can be suggested by a provisional 3D reconstruction on the basis of 2 suboptimal views (20). Moreover, dedicated computation algorithms implemented in commercially available 2D and 3D bifurcation QCA software allow for accurate and reproducible BA calculation; time requirements (<10 s for reconstruction of 2 images, <60 s for 3 images) are not an issue.

The interventional cardiologist can do little to change the geometrical configuration of the LMCA bifurcation after the stent implantation, as long as this is done according to sound clinical practice facilitating free access to SB and good stent strut apposition to the vessel wall. Our findings may suggest a lesser degree of bifurcation stiffening with single bifurcation stenting; however, no solid recommendation could be issued on the basis of a single study. Nevertheless, in those cases where a decreased post-procedural range of movement can be manifested, there would probably be a need for potent and prolonged platelet inhibition and increased clinical surveillance.

**Study limitations.** This study was not pre-specified in the SYNTAX trial protocol and therefore was probably underpowered regarding the detection of a plausible effect of pre-PCI angulation parameters on clinical outcomes. Our analysis may have been further confounded by marked heterogeneity in bifurcation techniques, the number of stents used, the bifurcation type, the extent of final kissing balloon inflation, and other unforeseen and possibly unaccounted for peri-procedural phenomena. In addition, data on maintenance of dual antiplatelet therapy were not available. On the
other hand, per SYNTAX trial design, repeat revascularization events have not been adjudicated as to their anatomic location (5); therefore, clinical events cannot be necessarily ascribed to the LMCA lesion treatment. However, specifically for SDR analysis, events have been adjusted in multivariable analysis for individual patient characteristics, including additional vessel disease. Finally, Medina classification according to visual assessment is less precise in stratifying bifurcation lesion complexity; thus, detailed subsegmental angiographic analysis would be warranted for a better understanding of lesion complexity and possible association with outcomes. As already mentioned, 3D QCA analysis was not pre-specified in the SYNTAX trial protocol; therefore, such detailed results are not available.

Figure 4. Impact of Post-PCI SDR of the Distal BA on 5-Year MACCE, All-Cause Death, CVA, or MI (Safety Endpoint), and Repeat Revascularization

Kaplan-Meier curves shown for group B1 (A, C, E) and group B2 (B, D, F). Abbreviations as Figures 1 to 3.
from the current analysis. Angiographic analysis including prospective collection of BA data in the ongoing EXCEL (Evaluation of Xience Prime Everolimus Eluting Stent System [EECSS] or Xience V EECSS or Xience Xpedition EECSS of Xience Pro EECSS Versus Coronary Artery Bypass Surgery for Effectiveness of Left Main Revascularization) trial on ~3,100 patients undergoing LMCA PCI could help us shed more light on this subject.

Conclusions

This study assessed the impact of 3D distal BA parameters on 5-year clinical outcomes after LMCA PCI on the basis of the largest randomized trial to date. A restricted post-procedural systolic-diastolic distal BA range translated into significantly higher adverse event rates 5 years after LMCA bifurcation PCI; on the contrary, pro-procedural distal BA did not affect the long-term clinical outcomes. It is possible that this study provides us with new insights into the biomechanics of stent failure in bifurcation lesions, the LMCA bifurcation being the most important of all in the human coronary tree.

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