Coronary computed tomography angiography indicates complexity of percutaneous coronary interventions

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Abstract: BACKGROUND: Coronary computed tomography angiography (CCTA) provides information regarding lesion morphology and three-dimensional coronary anatomy incremental to coronary angiography. We addressed the question whether preprocedural CCTA bears potential for guiding percutaneous coronary interventions (PCI). METHODS AND RESULTS: Sixty-six coronary lesions attempted with PCI within 6 months of preprocedural CCTA were retrospectively assessed. Lesion parameters from unenhanced computed tomography (CT) for calcium scoring and CCTA were analyzed and compared with PCI complexity. Complex PCI was defined as use of buddy wire, kissing balloon, necessity of high pressure balloons, or rotablator. Complex PCIs were observed in 32 interventions (48%). Median Agatston score and Hounsfield units were higher in lesions with complex as compared to those with non-complex interventions with 130 (interquartile range, 23-276) vs 29 (0-158; P=.01), and 493 (245-631) vs 341 (68-520 Hounsfield Units; P=.04), respectively. Median local plaque volume and plaque mass were higher in complex PCI with 17 (2-39) vs 5 (0-19.5 mm^3; P=.007), and 48 (15-99) vs. 16 (1.5-63 mg hydroxyapatite/mm^3; P=.03), respectively. Lesions leading to complex PCI were longer [1.8 (1.2-2.8) vs 1.3 (0.8-1.7) cm; P=.03], and had a higher rate of calcified plaques (23% vs 3%; P=.03). There was a significant correlation between CCTA- and angiography-derived local SYNTAX Scores (P<.001); the CCTA-derived score seems to be predictive for failed and complex PCI (area under curve = 0.75 ± 0.13 and 0.66 ± 0.08, respectively). CONCLUSIONS: Preprocedural lesion assessment by CCTA indicates complexity of PCI. In patients with suspected complex coronary anatomy, prior CCTA adds important information for planning PCI.

Coronary Computed Tomography Angiography Indicates Complexity of Percutaneous Coronary Interventions

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Abstract: Background. Coronary computed tomography angiography (CCTA) provides information regarding lesion morphology and three-dimensional coronary anatomy incremental to coronary angiography. We addressed the question whether preprocedural CCTA bears potential for guiding percutaneous coronary interventions (PCI). **Methods and Results.** Sixty-six coronary lesions attempted with PCI within 6 months of preprocedural CCTA were retrospectively assessed. Lesion parameters from unenhanced computed tomography (CT) for calcium scoring and CCTA were analyzed and compared with PCI complexity. Complex PCI was defined as use of buddy wire, kissing balloon, necessity of high pressure balloons, or rotablator. Complex PCIs were observed in 32 interventions (48%). Median Agatston score and Hounsfield Units were higher in lesions with complex as compared to those with non-complex interventions with 130 (interquartile range, 23-276) vs 29 (0-158; *P*=.01), and 493 (245-631) vs 341 (68-520 Hounsfield Units; *P*=.04), respectively. Median local plaque volume and plaque mass were higher in complex PCI with 17 (2-39) vs 5 (0-19.5 mm3; *P*=.007), and 48 (15-99) vs. 16 (1.5-63 mg hydroxyapatite/mm^3; *P*=.03), respectively. Lesions leading to complex PCI were longer [1.8 (1.2-2.8) vs 1.3 (0.8-1.7) cm; *P*=.03], and had a higher rate of calcified plaques (23% vs 3%; *P*=.03). There was a significant correlation between CCTA- and angiography-derived local SYNTAX Scores (*P*<.001); the CCTA-derived score seems to be predictive for failed and complex PCI (area under the curve = 0.75 ± 0.13 and 0.66 ± 0.08, respectively). **Conclusions.** Preprocedural lesion assessment by CCTA indicates complexity of PCI. In patients with suspected complex coronary anatomy, prior CCTA adds important information for planning PCI.

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Percutaneous coronary intervention (PCI) nowadays has become standard of care in symptomatic coronary artery disease (CAD) with suitable anatomy, and it is increasingly used in the treatment of complex CAD.[1] However, overall lesion complexity impacts in many respects on the procedure itself, as well as on short- and long-term outcome.[2,3] Lesion localization, severe calcifications, and vessel tortuosity may challenge the skills of the operator and increase the risk of procedural complications such as coronary artery dissection, perforation, and plaque shift. Hence, comprehensive preprocedural patient evaluation and lesion characterization are fundamental. In recent years, coronary computed tomography angiography (CCTA) has become a promising non-invasive imaging technique, mostly applied prior to coronary angiography. Although preferentially used in patients with low to intermediate probability of CAD to avoid invasive diagnostics for exclusion of the condition in these patients,[4] CCTA provides nevertheless important incremental information to coronary angiography with regard to lesion characterization and three-dimensional coronary anatomy.

The angiographic SYNTAX score, developed to determine the complexity of CAD, is a comprehensive lesion-based scoring system, comprising the number of lesions, location, and complexity such as tortuosity, length, and calcification.[1,3,5] An individual score is calculated for each significant lesion, and the total SYNTAX score is derived by adding all separate scorings together. The SYNTAX score has become an easily applicable angiographic scoring tool to assist in patient selection for interventional or surgical revascularization and risk stratification with respect to major adverse events following PCI.[2,3]

So far, the potential incremental information of CCTA for guiding PCI has been studied only for chronic total occlusions (CTO), although suggestions for a broader use have been made.[6-8] Indeed, lesion length >15 mm, target vessel tortuosity, and severe calcification assessed by CCTA and unenhanced computed tomography (CT) have been identified as independent predictors of procedural failure for CTO.[9-15]

Thus, we hypothesized that preprocedural lesion characterization by CCTA and unenhanced CT might contribute to predict PCI complexity in extensive and complex CAD. To support this hypothesis and to provide the rationale for future research, we analyzed retrospectively the correlation between specific CCTA parameters and indicators of complex PCI, an operational study definition for the purpose of this study, comprising use of buddy wire, kissing balloon, necessity of high-pressure balloon, or use of rotablator due to heavy calcifications. Furthermore, we compared the lesion-related SYNTAX scores obtained by CCTA with those obtained by coronary angiography. Preprocedural lesion characterization by CCTA might provide important additional information on lesion complexity prior to invasive diagnostics, and thus may allow for early stratification of the most appropriate PCI strategy.

Methods

Patients. The study population comprises 39 patients in whom 49 PCIs were performed for 66 single coronary lesions within 6 months of preprocedural CCTA. The study population was recruited out of 326 consecutive patients who underwent both unenhanced CT and CCTA for any clinical or scientific purposes at our institution. CT and CCTA are performed at our institution in patients with low to intermediate probability of significant CAD. Thus, the majority of patients with unenhanced CT and CCTA did not have subsequent coronary interventions. Due to the retrospective design of this study,

the patient selection was completely investigator-independent. Although the PCI operators were entitled to access the CCTA data, no single cardiac catheterization report in the study group keeps record of having made use ... ssment of cardiac biomarkers was performed the day followir ... erse cardiac events (MACE) including death, myocardi ... rization were assessed.[16]

CT data acquisition. All CT examinations were performed using a LightSpeed VCT XT scanner (GE Healthcare) with a protocol for prospective triggering (SnapShot Pulse, GE Healthcare). Scanning parameters for the unenhanced calcium scoring scan were: 120 kV tube voltage, 200 mA tube current, 0.35 s rotation time, ... received a single dose of 2.5 ... prior to the scan. Intravenou ... necessary to achieve the tar ... 320 mg/mL; GE Healthcare) ... flow rate of 5 mL/s followed by 50 mL saline solution. Bolus tracking was performed with a region of interest (ROI) placed into the ascending aorta, and image acquisition was started with a delay of 4 s after reaching a threshold of 120 Hounsfield Units. Body mass index (BMI), adapted tube voltage (100 kV: BMI <25 kg/m^2; 120 kV: BMI ≥25 kg/m^2), and tube current (450 mA: BMI <22.5 kg/m^2; 500 mA: BMI 22.5-25 kg/m^2; 550 mA: BMI 25-27.5 kg/m^2; 600 mA: BMI 27.5-30 kg/m^2; 650 mA: BMI >30 kg/m^2) were applied. CCTA images were acquired using prospective triggering at 75% of the RR-interval without padding. Further scanning parameters were: 0.35 s rotation time and 64 × 0.625 mm slice acquisition. Images were reconstructed with a slice thickness of 0.6 mm, using a standard medium-soft tissue convolution kernel. All images were transferred to an external workstation (AW 4.4; GE Healthcare) for further evaluation. The effective radiation dose of each CT scan was calculated as the product of the dose-length product (DLP) and a conversion coefficient for the chest (k = 0.017 mSv/mGy cm).

CT data analysis. All unenhanced CT calcium scoring images were analyzed using dedicated software (SmartScore; GE Healthcare). Coronary artery calcium scores were separately obtained for each of the main epicardial coronary arteries: the left anterior descending artery (LAD), including the left main artery (LMA), the left circumflex artery (LCX), and the right coronary artery (RCA).

Characterization of the 66 single lesions for which PCI was attempted was retrospectively performed using CCTA and unenhanced CT parameters. Lesion morphology was assessed from CCTA, coronary artery plaques were divided into mixed, soft, and calcified plaques according to the degree of calcification as previously shown.[17] The following parameters were analyzed from unenhanced CT: local plaque density (Hounsfield Units), Agatston score (segmental, per lesion), local plaque volume (mm^3), and local plaque mass (mg hydroxyapatite/mm^3). Local plaque length (mm) and local SYNTAX scores of each lesion were calculated from CCTA using axial source images, multiplanar reformations and curved reformations with the SYNTAX score algorithm as previously described and available on the SYNTAX score website (www.syntaxscore.com).[5] The SYNTAX score comprises lesion location, vessel tortuosity, lesion anatomy, lesion length (>20 mm), plaque calcification, total occlusion, and thrombosis, as well as diffuse CAD.[5]

The investigators assessing CCTA and unenhanced CT were blinded to baseline characteristics, angiographic SYNTAX scores, angiographic and procedural data, as well as patient symptoms and outcomes. SYNTAX scores and calcium scores were analyzed by independent investigators.

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