In Vivo Differentiation of Coronary Lesions with Noninvasive Computed Tomography Angiography and Invasive Intravascular Ultrasound as Compared to Optical Coherence Tomography

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Submitted for publication
Abstract

**Purpose** In vitro studies have shown the feasibility of coronary lesion grading with computed tomography angiography (CTA), intravascular ultrasound (IVUS) and optical coherence tomography (OCT) as compared to histology, whereas OCT had the highest discriminatory capacity. We investigated the ability of CTA and IVUS to differentiate between early and advanced coronary lesions in vivo, OCT serving as the standard of reference.

**Methods** Multimodality imaging was prospectively performed in 30 patients with NSTEMI. A total of 1083 cross-sections of 30 culprit lesions atherosclerotic plaque characteristics were assessed and co-registered among modalities. Fibrous and fibrocalcific plaque on OCT were defined as early plaque type, whereas lipid rich-plaque on OCT was defined as advanced plaque. To assess associations between each plaque type on CTA and IVUS with early or advanced plaque on OCT, odds ratios (OR) adjusted for clustering were calculated.

**Results** On cross-sectional level normal findings on CTA as well as on IVUS were associated with early plaque (OR: 0.09; p<0.001, and OR: 0.02; p<0.001, respectively). Non-calcified plaque on CTA was associated with advanced plaque (OR: 4.04, p<0.001) and a trend towards association between advanced plaque and calcified plaque on CTA was observed. The napkin ring sign on CTA was associated with advanced plaque (OR: 4.66, p<0.001). On IVUS fatty and calcified plaque were strongly associated with advanced plaque on OCT (OR: 151.93, p<0.001).

**Conclusions** In vivo coronary plaque characteristics on CTA and IVUS are associated with plaque characteristics on OCT. Of note, normal findings on CTA relate to early lesions on OCT. Nevertheless, multiple plaque features on CTA and IVUS are related to advanced plaques on OCT which may make it difficult to use qualitative plaque features to recognize advanced coronary plaques.
CHAPTER 7 I  In vivo coronary lesion differentiation

Introduction

Rupture of an atherosclerotic plaque with superimposed luminal coronary artery thrombosis is the most common cause of acute coronary events. Coronary artery plaques that are prone to rupture typically contain a large necrotic lipid-rich core and a thin overlying fibrous cap and are often referred to as vulnerable plaques 1-3. Early detection of vulnerable plaques could potentially prevent coronary events. Computed tomography angiography (CTA) of the coronary arteries is a clinically established tool enabling non-invasive diagnosis of coronary artery disease (CAD) 4. Besides stenosis assessment, it is possible to assess composition of atherosclerotic plaques with CTA and to a certain extent classify plaques. Although the presence of non-calcified plaque component on CTA was associated with the development of coronary events 5, the knowledge on the ability of CTA to discriminate between components of non-calcified plaque is still limited 6-8.

A multi-modality imaging strategy may enhance our understanding of coronary atherosclerotic lesions that are related to coronary events. Invasive coronary plaque characterization may be performed using intravascular ultrasound (IVUS) and optical coherence tomography (OCT) 9. Whereas, IVUS is regarded as reference method for coronary plaque dimensions, OCT has shown a high diagnostic accuracy in characterization of plaques, however its penetration depth is limited 10, 11.

The feasibility of coronary lesion grading with CTA, IVUS and OCT as compared to histology was recently elegantly shown in an in vitro setting 12, 13. OCT yielded the highest discriminatory capacity for advanced plaques as compared to histology 12. Accordingly, in the study we investigated the ability of CTA and IVUS to differentiate between atherosclerotic plaque characteristics in vivo, with OCT serving as a standard of reference.

Methods

Thirty patients presenting with non-ST-elevation myocardial infarction (NSTEMI) were prospectively included in our study. Inclusion criteria for the study were patients with NSTEMI - chest pain suggestive for myocardial ischemia with typical electrocardiogram changes and a rise of (high sensitivity) troponin T - with a clinical indication for invasive coronary angiography (ICA) followed by reperfusion of the ischemia-related target lesion. Only native coronary artery lesions were included. Exclusion criteria were: persistent ST-segment elevation (>1mm in 2 or more leads), the need for emergency ICA with subsequent PCI or coronary artery bypass grafting (CABG), presence of cardiogenic shock, contraindication to CTA (estimated glomerular filtration rate <50 ml/min, known allergy to iodine contrast agents, cardiac rhythm
other than sinus rhythm, inability to lay supine or sustain a breath-hold for 15
seconds) and no informed consent. Dual-source CTA, IVUS and OCT were performed
within 24 hours. The study was approved by the local ethics committee and was
carried out according to the Declaration of Helsinki. Written informed consent was
obtained from each participant.

Computed tomography angiography
Image acquisition
CTA was performed using a 64-slice dual-source computed tomography scanner
(Somatom Definition, Siemens Healthcare, Frochheim, Germany). During CTA
acquisition non-ionic contrast medium was administered (Iomeron 400, Bracco,
Italy). Beta-blocker treatment (orally or intravenously) and nitroglycerine was
administered to achieve optimal image quality. In order to reduce radiation exposure,
electrocardiogram-gated current modulation was used in all patients. The following
scan parameters were used for the 64-slice dual-source CT scanner: 64 x 2 x 0.6
mm collimation, gantry rotation time of 330 ms, temporal resolution of 83 ms, tube
voltage 100 or 120 mV, and maximal tube current of 560 mAs. Upon completion of
the scan, images were directly reconstructed in order to achieve motion-free images
of the coronary arteries.

Image analysis
Evaluation of CTA images was performed on a remote workstation with dedicated
software (QAngio CT, Medis Medical Imaging Systems, Leiden, the Netherlands) 14
in consensus by two experienced observers blinded to other imaging modalities.
A predefined window and level setting (window 700 HU, level 200 HU) was used
for analysis of lumen and plaque 7. Display settings were manipulated for optimal
analysis of vessel lumen and plaque characteristics, if deemed necessary. Analysis
of presence and composition of atherosclerosis were performed on a per segment
and on a per cross-section basis. In addition, in all other existing coronary segments
the presence and composition of plaque as well as the degree of stenosis were
also analyzed. Coronary segments were differentiated into seventeen segments,
according to a modified American Heart Association classification 15.
Coronary atherosclerosis was defined as tissue structures >1 mm² within or
adjacent to the coronary artery lumen but distinctive from surrounding pericardial
or epicardial tissue. The degree of luminal narrowing of coronary artery lumen was
quantified visually, based on comparison of the luminal diameter of the plaque-
containing segment to the luminal diameter of the most normal-appearing site
immediately proximal to the plaque. Plaques with ≥50% luminal narrowing were classified as obstructive. The composition of plaque was classified to one of three types: 1. non-calcified plaque (plaques with lower density compared to contrast-enhanced lumen), 2. calcified plaque (plaques with high density structures compared to contrast-enhanced lumen), or 3. mixed plaque (non-calcified and calcified constituents in single plaque). In addition, the presence of thrombus was assessed on per segment level, which was defined as a homogenous non-calcified structure with irregular borders with a density of <55HU.

On cross-sections with non-calcified plaque component (non-calcified and mixed plaques) the presence of napkin-ring sign (NRS) was scored as a plaque core with low CTA attenuation surrounded by a rim-like area of higher attenuation. Non-calcified and mixed plaques were additionally classified according to their attenuation as low-attenuation (<30HU) and higher attenuation (≥30HU) plaques.

**Optical coherence tomography**

**Image acquisition**

The C7 imaging system (St. Jude/LightLab Imaging Inc, MN, USA) was used to perform OCT acquisition. After crossing the culprit lesion with an angioplasty guide wire the OCT catheter (DragonFly catheter, St. Jude Medical/LightLab Imaging Inc, MN, USA) was advanced over the wire and placed distal to the lesion. In order to reduce vasospasm intracoronary nitro-glycerin was administered before OCT acquisition. OCT images were obtained during the intracoronary injection of 13 to 20 ml of contrast medium (Xenetix 300, Guerbet, France) at a rate of 3-4 ml/s and an automatic pullback at a rate of 20 mm/s.

**Image analysis**

Off-line IVUS and OCT cross-section analyses were performed using dedicated software (QIVUS 2.1, Medis medical imaging systems, Leiden, the Netherlands) in consensus by two observers blinded to CTA, IVUS and OCT images of the same patient.

On OCT cross-sections morphological characterization of plaques was performed as follows (19): normal vessel wall; fibrous plaque, homogenous high-backscattering areas; lipid-rich plaque, signal poor regions with diffuse borders in >2 quadrants; fibrocalcific plaque, fibrous plaques with calcific areas (well-delineated, low back-scattering heterogenous regions). Thin cap fibro-atheroma (TCFA) was defined as a lipid-rich plaque with an overlying fibrous cap with a thickness of ≤65 µm (20). When a cross-section showed various plaque types, the most advanced plaque type
was assigned in the following order: lipid-rich plaque > fibrocalcific plaque > fibrous plaque. For comparisons we categorized plaques in early and advanced plaques. Based on associations found in the ex vivo study by Maurovich-Horvat et al. absence of plaque, fibrous and fibrocalcific plaques were defined as early plaques and lipid-rich plaques were defined as advanced plaques \(^\text{12}\). Plaque rupture was identified as the presence of fibrous-cap discontinuity with a cavity formation in the plaque \(^\text{21}\). The presence of thrombus was visually assessed. Intracoronary thrombus was defined as a mass protruding the coronary vessel lumen discontinuous from the vessel wall.

**Intravascular ultrasound**

*Image acquisition*

After OCT acquisition, the IVUS catheter (40MHz Atlantis SR pro catheter, Boston Scientific, MA, USA) was advanced to perform IVUS acquisition. The iLab ultrasound imaging system (Boston Scientific, MA, USA) was used to perform IVUS acquisition.

*Image analysis*

Assessment of IVUS cross-sections was performed in accordance with the working group on intracoronary imaging of the European Society of Cardiology using the following criteria \(^\text{22}\): normal vessel wall, <0.3 mm of intima-media thickness; vessel wall containing plaque, ≥0.3 mm of intima-media thickness; fibrous plaque, >2 quadrants constituted by tissue, with echoreflectivity higher than that of the adventitia; fatty plaque, >2 quadrants constituted by tissue, with echoreflectivity lower than that of the adventitia; fibrocalcific plaque, <2 quadrants of total calcified arc; and calcified plaque, >2 quadrants of total calcific arc.

*Image co-registration*

Anatomic landmarks, such as side-branches and/or calcifications were used to align CTA, IVUS and OCT images and co-registered cross-sections. Multiplanar CTA reconstructions were created perpendicular to the vessel centerline. At first a visual co-registration was performed to align CTA, IVUS and OCT longitudinal segments. Subsequently, dedicated software (Matcher, Medis Medical Imaging Systems, Leiden, the Netherlands) was used to confirm the performed visual co-registration. Where feasible, the co-registration was revised in order to achieve the best-matched result of the three imaging modalities. Anatomic landmarks were used to match the rotational direction of the cross-sections of CTA, IVUS and OCT.
Statistical analysis

Normally distributed continuous variables are presented as mean±SD. Continuous variables with skewed distribution are presented as medians with 25th and 75th percentile. Categorical variables are presented as numbers and percentages. Group differences were tested using ANOVA test, Pearson χ2, or Fishers exact test where appropriate.

Crude associations of each category of CTA and IVUS with early or advanced plaque defined by OCT were assessed by calculating odds ratios (OR) for each category with the odds of normal plaque serving as reference. An OR >1.0 indicated an increased probability of a lesion being advanced, and an OR <1.0 indicated an increased probability of a lesion being early. Significance of these crude associations was tested using the Fishers exact test. Additionally the associations were recalculated accounting for clustering effect within lesions by using multilevel mixed effect modeling (STATA procedure xtmelogit). Bonferroni correction was used because of multiple testing. For each modality the plaque categories were recoded as a new, single variable. For CTA the new variable had three degrees of freedom and for IVUS the new variable had four degrees of freedom. A mixed effects logistic regression for each modality was fitted with the category normal plaque serving as the reference category.

Statistical significance was defined as p-value of <0.05. Statistical analyses were performed using STATA version 11 (College Station, TX, USA).

Results

Study population

A total of thirty patients with NSTEMI were included in the study and multi-modality imaging was performed in 30 culprit lesions.

A total of 1083 cross-sections from 30 culprit segments were available for analysis. The mean number of available cross-sections was 36 per patient. Baseline characteristics of the population are presented in Table 1. The mean age was 68.3 years old, and half were of male gender.

Computed tomography angiography

On lesion level, the majority of the culprit coronary plaques (17; 56.7%) were classified as mixed plaques, whereas 5 (16.6%) were classified as non-calcified plaques and 8 (26.7%) were classified as calcified plaques. Thrombus was scored in 9 (30.0%) of the culprit segments.

On frame level, of the 1083 coronary CTA cross-sections, 257 (23.7%) were classified
as normal, 360 (33.2%) as showing non-calcified plaque, 178 (16.4%) as showing mixed plaque, and 288 (26.7%) as showing calcified plaque. A total of 28/538 (5.2%) cross-sections exhibited a NRS.

**Optical coherence tomography**

On lesion level, thrombus was detected in 20 (66.7%), plaque rupture in 25 (83.3%), and TCFA in 13 (43.3%) of the culprit lesions.
On frame level, of the 1083 OCT cross-sections, 35 (3.3%) were classified as normal, 296 (27.3%) as fibrous plaques, 467 (43.1%) as fibrocalcific plaques and 285 (26.3%) as lipid-rich plaques. Thrombus was present in 97 (9.0%) frames. TCFA was present in 24 (2.2%) frames.

**Intravascular ultrasound**

On lesion level, characteristics visualized by IVUS were as follows: thrombus was detected in 8 (26.7%) culprit segments, and rupture was detected in 13 (43.3%) plaques.

On frame level, of the 1083 IVUS cross-sections, 45 (4.2%) were classified as normal, 380 (35.1%) as fibrous plaques, 369 (34.0%) as fibrocalcific plaques, 173 (16.0%) as calcified plaques, and 116 (10.7%) as fatty plaques. Thrombus was detected in 21 (1.9%) cross-sections.

**Table 2.** Association between thrombus on OCT and plaque characteristics on coronary CT angiography and IVUS

<table>
<thead>
<tr>
<th></th>
<th>Thrombus on OCT</th>
<th>No thrombus on OCT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Segment level</strong></td>
<td>(n=20)</td>
<td>(n=10)</td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombus</td>
<td>9 (45.0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>NRS</td>
<td>5 (25.0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>HU &lt;30</td>
<td>10 (50.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>Non-calcified</td>
<td>2 (10.0)</td>
<td>3 (30.0)</td>
</tr>
<tr>
<td>Mixed</td>
<td>13 (65.0)</td>
<td>4 (40.0)</td>
</tr>
<tr>
<td>Calcified</td>
<td>5 (25.0)</td>
<td>3 (30.0)</td>
</tr>
<tr>
<td>IVUS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombus</td>
<td>6 (30.0)</td>
<td>2 (20.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(n=97)</th>
<th>(n=986)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cross-sectional level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombus</td>
<td>20 (20.6)</td>
<td>7 (0.7)</td>
</tr>
<tr>
<td>NRS</td>
<td>16 (16.5)</td>
<td>12 (1.2)</td>
</tr>
<tr>
<td>HU &lt;30</td>
<td>19 (19.6)</td>
<td>11 (1.1)</td>
</tr>
<tr>
<td>Non-calcified</td>
<td>52 (53.6)</td>
<td>308 (31.2)</td>
</tr>
<tr>
<td>Mixed</td>
<td>23 (23.7)</td>
<td>155 (15.7)</td>
</tr>
<tr>
<td>Calcified</td>
<td>22 (22.7)</td>
<td>266 (26.9)</td>
</tr>
<tr>
<td>IVUS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombus</td>
<td>13 (13.4)</td>
<td>8 (0.8)</td>
</tr>
<tr>
<td>Fibrous</td>
<td>21 (21.7)</td>
<td>359 (36.4)</td>
</tr>
<tr>
<td>Fibrocalcific</td>
<td>31 (31.96)</td>
<td>338 (34.3)</td>
</tr>
<tr>
<td>Calcified</td>
<td>25 (25.8)</td>
<td>148 (15.0)</td>
</tr>
<tr>
<td>Fatty</td>
<td>20 (20.6)</td>
<td>96 (9.7)</td>
</tr>
</tbody>
</table>

The data are numbers (%). CTA = computed tomography angiography; HU = Hounsfield Units; IVUS = intravascular ultrasound; NRS = napkin ring sign; OCT = optical coherence tomography; TCFA = thin-cap fibroatheroma.
Comparison between computed tomography angiography versus optical coherence tomography

On per lesion basis, culprit lesions were grouped based on the presence of thrombus on OCT (Table 2). On CTA, thrombus and NRS were only observed in the groups of lesions with thrombus on OCT, but only in a limited number of lesions. Moreover, limited correlation was observed between the low attenuation value on CTA and the presence of thrombus on OCT. No correlation was observed between the plaque type on CTA and the presence of thrombus. The sensitivity for CTA to detect thrombus was 45% (9/20) and the specificity was 100% (10/10).

On per frame basis, thrombus was visible in only 21% of CTA frames with thrombus on OCT (Table 3). The same limited association was observed between the presence of thrombus on OCT and the NRS and low attenuation plaque.

Normal findings on CTA were associated with early plaque on OCT (Table 4). On the contrary, non-calcified were associated with advanced plaque on OCT and calcified plaques showed trend toward association with advanced plaque. Moreover, NRS was significantly associated with advanced plaque on OCT (OR: 4.66 p<0.001).

**Table 3.** Plaque composition as assessed at coronary CT angiography and IVUS within atherosclerotic plaque categories as assessed at OCT

<table>
<thead>
<tr>
<th>Modality and plaque composition</th>
<th>Associated with early lesions</th>
<th>Associated with advanced lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>23 (9.0)</td>
<td>152 (59.1)</td>
</tr>
<tr>
<td>Non-calcified</td>
<td>10 (2.8)</td>
<td>108 (30.0)</td>
</tr>
<tr>
<td>Mixed</td>
<td>0 (0)</td>
<td>18 (10.1)</td>
</tr>
<tr>
<td>Calcified</td>
<td>2 (0.7)</td>
<td>18 (6.2)</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>92</td>
</tr>
<tr>
<td><strong>CT additional information</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napkin ring sign</td>
<td>0 (0)</td>
<td>1 (3.6)</td>
</tr>
<tr>
<td><strong>IVUS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>30 (66.7)</td>
<td>13 (28.9)</td>
</tr>
<tr>
<td>Fibrous</td>
<td>5 (1.3)</td>
<td>233 (61.3)</td>
</tr>
<tr>
<td>Fibrocalcific</td>
<td>0 (0)</td>
<td>44 (11.9)</td>
</tr>
<tr>
<td>Calcific</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Fatty</td>
<td>0 (0)</td>
<td>6 (5.2)</td>
</tr>
</tbody>
</table>

The data are numbers (%). CTA = computed tomography angiography; HU = Houndsfield Units; IVUS = intravascular ultrasound; OCT = optical coherence tomography.
Comparison between grayscale intravascular ultrasound versus optical coherence tomography

On lesion level, a very limited correlation between the presence of thrombus on OCT and IVUS was observed (Table 2). For IVUS the sensitivity and specificity were 30% (6/20) and 80% (8/10), respectively.

On frame level, the correlation between the presence of thrombus on OCT and the findings on IVUS was even lower than on lesion level (Table 2). Normal findings on IVUS were associated with early plaque on OCT. On the contrary, calcified plaque was associated with advanced plaque on OCT, whereas fatty plaque on IVUS was strongly associated with advanced plaque on OCT (Tables 3 and 4).

An example of findings on all three imaging modalities is presented in Figure 1.

Discussion

In this in vivo study in patients with NSTEMI describing a systematic assessment of coronary lesions using CTA and IVUS compared to OCT as a standard of reference, the findings may be summarized as follows: [1] Normal findings on CTA and IVUS are associated with early plaque as defined by OCT; [2] Non-calcified plaque, NRS and to a lower extent calcified plaque on CTA as well as fatty and calcified plaque on IVUS are significantly associated with advanced plaque as defined by OCT.

In accordance with ex vivo studies, the absence of plaque on CTA was correlated to...
early plaque on OCT \cite{12,13}. Indeed, Maurovich-Horvath et al. have recently observed in an experimental model that normal findings by CTA were strongly associated with early atherosclerotic plaque on histological examination (OR: 0.02; p<0.001) \cite{12}. The finding is line with prospective clinical studies which have shown that the absence of CAD on CTA resulted in no coronary events during follow-up \cite{23-25}. This finding further supports the application of coronary CTA for exclusion of CAD. Moreover, correlation between certain coronary plaque characteristics on CTA and advanced lesions on OCT has been observed. A significant correlation between non-calcified plaque on CTA and advanced plaque on OCT has been found in our dataset, which is contrary to the findings in the previous ex vivo study where correlation between advanced lesions on histology and mixed plaque on CTA was observed \cite{12}. From a clinical point of view both types of plaques (non-calcified and mixed) were related to coronary events on follow-up \cite{5,23,26-28}. Moreover, the difference in the findings may be related to the different reference standard used in our study (OCT versus histopathology). Another interesting observation is the correlation between the NRS on CTA and advanced coronary plaque. Previous studies have shown the relation between the NRS and high-risk coronary plaques \cite{13,29-31}. In a study with donor hearts the specificity of NRS to identify histopathologically advanced lesions and TCFA was as high as 99\% \cite{13}. Moreover, another study demonstrated that the presence of NRS within a coronary

\textbf{Figure 1.} An example of a lesion in left anterior descending artery with corresponding cross-sections on computed tomography, intravascular ultrasound and optical coherence tomography Multiplanar reformatted image of the left anterior descending coronary artery (A) with a mixed plaque with large non-calcified portion (white arrowheads) and some calcified plaques more distally (black arrowheads). The cross-sectional computed tomography images (B, C) show a coronary plaque with napkin-ring sign attenuation pattern (L = lumen). The circumferential outer rim (dashed blue line) has a higher contrast attenuation as compared to the inner part of the plaque. Intravascular ultrasound (D, E) images show a predominantly fibrous plaque (white arrowheads). Optical coherence tomography (F, G) of the corresponding cross-sections shows (mural) thrombus in both positions (white arrowheads). * represents the shadow of the guidewire.
plaque is strongly associated with future cardiac events independent of other high-risk CTA features, such as positive remodeling and low attenuation plaque. Nevertheless, we have also observed a trend toward correlation between advanced lesions on OCT and calcified plaque on CTA. The same finding has been reported in a study by Maurovich-Horvat et al. Since multiple coronary plaque features are related to advanced coronary lesions on OCT or histology as a standard of reference, it may be difficult to use qualitative coronary plaque features on CTA for further risk stratification.

Similar correlations between coronary plaque features and OCT were observed also on IVUS. Indeed, normal findings on IVUS were related to early lesions on OCT, whereas a strong correlation between the fatty plaque on IVUS and advanced plaque on OCT was observed. Also, similar to the findings on CTA calcified plaque on IVUS was related to advanced lesions. The findings are somewhat discrepant from the findings in a previous ex vivo study, which could be related to different classification scheme applied in our study and a small sample size.

In the present study we also assessed the ability of CTA and IVUS with inferior spatial resolution as compared to OCT to characterize non-calcified plaque component, including the assessment of thrombus. Thrombus was present in 66.7% of culprit lesions evaluated with OCT, which corresponds well to the prevalence of thrombus in culprit lesions of NSTEMI patients using OCT (65 – 68%) as compared to OCT and coronary angioscopy. Regarding CTA, there are only a few reports available on the detection of coronary thrombus. As expected, the accuracy of thrombus detection on CTA in our study was as low as 45%. Moreover, no other plaque features were associated with intracoronary thrombus on IVUS and CTA either on segmental or frame level (Table 2), which further emphasizes the limitation of IVUS and CTA to characterize non-calcified tissue. Accordingly, the presence of thrombus on IVUS and CTA should be interpreted with caution.

Our results should be interpreted in the context of several limitations. First, an important limitation of this study is the lack of histopathological data, however this study was designed as an in vivo study. Second, as the used modalities are different from the technical point of view, the plaque classification schemes were also different. Therefore direct comparison of plaque characteristics was difficult to perform. Finally, performing a complex multi-modality imaging study is difficult due to the costs and logistical difficulties. Therefore only a small number of patients could...
be recruited to participate in the study resulting in a limited sample size.

In conclusion, in vivo coronary plaque characteristics on CTA and IVUS are associated with plaque characteristics on OCT. Of note, normal findings on CTA relate to early lesions on OCT. Nevertheless, multiple plaque features on CTA and IVUS are related to advanced plaques on OCT which may make it difficult to use qualitative plaque features to recognize advanced coronary plaques in clinical practice. Future studies in bigger samples are necessary to confirm the findings.
References


by 0.5-mm-slice multislice computed tomographic imaging. Circ J 2007;71(3):363-366.


