Intra-coronary thrombus evolution during acute coronary syndrome: regression assessment by serial optical coherence tomography analyses

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Aims
We investigated the feasibility of thrombus quantification by frequency-domain optical coherence tomography (FD-OCT) methods in patients with highly thrombotic acute coronary syndrome (ACS) treated by deferred stenting strategy.

Methods and results
Patients were suitable for inclusion if they presented (i) an ACS that was successfully revascularized by manual thrombo-aspiration and (ii) a large residual thrombus on coronary angiography and initial FD-OCT analysis. These patients underwent a second procedure including FD-OCT analysis after several days of optimal antithrombotic therapy. Serial area measurements within the athero-thrombotic culprit lesion were performed to evaluate the OCT-thrombus score, volume, and length. Sixteen patients (88% men/age 59.3 ± 4.1 years/94% STEMI) were included in the study. The mean delay between OCT analyses was 3.9 ± 0.3 day. No adverse event was observed during this interval. We observed a reduction of thrombus burden between the two analyses, as assessed by the significant reductions in OCT-thrombus score (22.3 ± 2.6 vs. 10.3 ± 1.3, P = 0.001), OCT-thrombus volume (9.6 ± 2.3 vs. 3.6 ± 0.9 mm3, P = 0.003), and OCT-thrombus length (11.1 ± 1.4 vs. 7.4 ± 0.8 mm, P = 0.01). The percentages of OCT-thrombus score and volume reduction were highly correlated with the inter-OCT analyses delay (respectively r = 0.65 and r = 0.84, P < 0.01 for both).

Conclusion
FD-OCT assessment of thrombus volume in selected ACS patients is feasible, safe, and could allow clot regression monitoring in vivo.

Keywords
acute coronary syndromes • thrombus • optical coherence tomography

Introduction
The restoration of epicardial coronary blood flow by percutaneous coronary intervention (PCI) has dramatically improved the prognosis of patients with acute coronary syndrome (ACS) during the past decades.1 However, PCI success might be limited by the presence of intra-coronary thrombus, which is a prominent component of the unstable coronary atherosclerotic lesion.2,3 Although the use of intra-coronary stent is mandatory according to the European Society of Cardiology (ESC) guidelines (Class IA recommendation),1 a growing number of publications recently challenged this paradigm and proposed a two-step strategy in selected patients, including an initial efficient thrombus removal followed by a deferred stent implantation.4–9 This approach might improve the PCI success rate by decreasing the thrombotic load within the culprit lesion and potential embolization.10 However, thrombus regression pattern and its timing under optimal medical therapy during ACS are partially unknown in vivo, although this parameter is crucial to determine the best timing for stent placement.

Different optical coherence tomography (OCT) methods have been proposed to quantify thrombus burden, but the use of these techniques for thrombus regression monitoring has never been

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The present pilot study evaluated the feasibility of repeated thrombus quantification by OCT and investigated its evolution in patients with ACS.

**Methods**

**Patient selection and study design**

The study global design is given in Figure 1. Patients were suitable for inclusion if they fulfilled the following criteria: (i) ACS (STEMI or NSTEMI) with high thrombus burden (TIMI thrombus grade ≥3) on initial coronary angiography, (ii) successful revascularization (final TIMI 3 flow, no chest pain and ST segment normalization) by manual thrombo-aspiration and the presence of a large residual thrombus, and (iii) decision of deferred coronary stenting by the operator.

These patients underwent initial culprit lesion documentation by frequency-domain OCT (FD-OCT) analysis and were then treated by optimal antithrombotic therapy. A second procedure was then scheduled and the subjects underwent repeated coronary angiography and culprit lesion FD-OCT analysis. Given the absence of consensus regarding the optimal delay between procedures in the literature, the control time point was left at the operator discretion. Our local Ethics Committee approved the study and informed consent was obtained.

**PCI and ACS medical management**

All procedures were performed through radial access. PCI was performed with a 6-Fr guiding catheter in all patients. A 0.014-inch guide wire was placed distally in the target vessel. Thrombo-aspiration was performed using a manual thrombectomy device (Eliminate. TERUMO, Tokyo, Japan). The number of passes was left at the operator discretion. All the patients were treated in accordance with the ESC guidelines for management of patients with STEMI and NSTEMI, including double anti-platelet therapy, low molecular weight heparin, and use of abciximab or bivalirudin.

**Coronary angiography analysis**

Two operators retrospectively reviewed coronary angiography and analysed pre- and post-thrombectomy culprit lesion characteristics, including antegrade angiographic flow and thrombus grade in the culprit vessel according to the TIMI criteria (angiographic thrombus score). The degree of stenosis (before and after thrombectomy) was calculated by a dedicated quantitative coronary angiography (QCA) software (Centricity CA1000/GE Healthcare, Buc, France).

**FD-OCT images acquisition**

FD-OCT images were acquired with a commercially available system (C7 System; LightLab Imaging, Inc./St Jude Medical, Inc., Westford, MA, USA). The OCT catheter (C7 Dragonfly; LightLab Imaging, Inc./St Jude Medical, Inc.) was first advanced to the distal end of the target lesion after successful completion of the thrombectomy and direct intra-coronary injection of 1 mg nitrates. The entire length of the target area was then scanned using the integrated automated pullback device at 20 mm per second and rotation speed of 100 MHz. During image acquisition, coronary blood flow was replaced by continuous flushing of contrast media directly from the guiding catheter at a rate of 4 mL per second with a power injector to create a virtually blood-free environment.

**FD-OCT images analysis**

All images were recorded digitally, stored, and each frame read by two independent investigators blinded to timing of the analysis (initial vs. deferred).
subsequent analysis), and angiographic features. Systematic images analysis was performed in 1-mm intervals. Offline analysis was performed with proprietary software (Lightlab Imaging, Inc./St Jude Medical, Inc.) after confirming calibration settings of the Z-offset.

Thrombi were defined as masses protruding into the vessel lumen, discontinuous from the surface of the vessel wall, and characterized according to the signal characteristics. White thrombus was identified as a signal-rich, low-backscattering mass, while red thrombus was identified

![Figure 2: Example of thrombus burden optical coherence tomography analysis in a mid-left anterior descending artery lesion. The first (A1 and A2) and second optical coherence tomography runs (B1 and B2) were acquired, respectively, following thrombo-aspiration and after 5 days of antithrombotic therapy. Both sets of images (1-mm intervals) are displayed head to head, from proximal to distal part of the lesion (top to bottom), with (columns A2 and B2) and without (columns A1 and B1) thrombus area and intralumen area delimitations. Each row depicts the thrombus burden reduction on the exact same position within the culprit lesion, which was determined by longitudinal view analysis.](image-url)
as high-backscattering protrusions inside the lumen of the artery, with
signal-free shadowing in the OCT.13 The longitudinal view was used to
mark and measure the length of the athero-thrombotic culprit lesion.
The distance between the most distal and the most proximal frame
that showed intraluminal material suggestive of thrombus defined the
thrombus length.11

The OCT-thrombus score was graded, according to the method pro-
posed by the ESC OCT expert review document.14 Thrombus score
grading was based on the semi-quantitative assessment of thrombus
(number of involved quadrants in the cross-sectional OCT images) and
the longitudinal extension of the thrombus itself. By applying this
method, in each cross-section, a thrombus was classified as absent or sub-
tending 1, 2, 3, or 4 quadrants. The global OCT-thrombus score was then
calculated as the sum of each cross-section score.14,15

Figure 2. Intra-lumen area (LA) and thrombus area (TA) were measured
for each interval within the lesion, and the OCT-thrombus volume (TV)
was calculated as follows11:

\[
TV = \text{mean TA} \times \text{Thrombus length.}
\]

Proximal and distal reference LAs, as well as minimal lumen area
(MLA), were measured for each lesion. References were defined as the
most ‘normal-appearing’ segments 5 mm proximal and distal to the
lesion shoulders by OCT. The reference LA was the average of proximal
and distal reference LAs. Percent area stenosis was calculated as follows:16

\[
100 \times \frac{\text{(reference LA} - \text{MLA)}}{\text{reference LA}}.
\]

Statistical analysis
Statistical analysis was performed with SPSS 16.0 (SPSS software,
Chicago, IL, USA) software. Data are expressed as mean and standard
error to the mean. Continuous and categorical variables were compared
using the Mann–Whitney U-test (for independent samples), Student’s
t-test (for paired samples), and the \( \chi^2 \) test or Fisher’s exact test. Univari-
ate correlations were assessed by Pearson’s correlation or Spearman’s
rho (\( \rho \)) test after log transformation of variables. The inter-observer re-
producibility of TV and score measurements was prospectively assessed
in patients, using Pearson’s correlations, the Bland–Altman plot analysis,
and the coefficient of variation.17 A two-sided alpha level of 0.05 was used
for all superiority testing.

Results
Baseline characteristics
A total of 290 NSTEMI + STEMI patients were screened for in-
clusion between September 2011 and December 2012. Eighty-two of
these patients presented initial TIMI thrombus grade \( \geq \) 3 and bene-
fitted from manual thrombectomy. Nineteen of these subjects ful-
filled the inclusion criteria and underwent initial OCT analyses.
Three out of these (16%) subjects were excluded for inadequate
image quality related to abundant red thrombus on initial analysis
(inducing inability to accurately delimitate TAs and LAs); 16 patients
(i.e. 32 OCT runs) were finally analysed. The baseline characteristics
of the study patients are given in Table 1. Patients were predominant-
ly men and suffered from STEMI in 94% of the cases. A previous
thrombolysis was given in 25% of patients.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Population baseline characteristics (n = 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>59.3 ± 4.1</td>
</tr>
<tr>
<td>Male gender, n (%)</td>
<td>13 (88)</td>
</tr>
<tr>
<td>STEMI, n (%)</td>
<td>15 (94)</td>
</tr>
<tr>
<td>Stent thrombosis, n (%)</td>
<td>3 (19)</td>
</tr>
<tr>
<td>Initial TIMI flow grade</td>
<td></td>
</tr>
<tr>
<td>Grade 0, n (%)</td>
<td>6 (37)</td>
</tr>
<tr>
<td>Grade 1, n (%)</td>
<td>5 (32)</td>
</tr>
<tr>
<td>Grade 2, n (%)</td>
<td>4 (25)</td>
</tr>
<tr>
<td>Grade 3, n (%)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Initial thrombus TIMI grade</td>
<td></td>
</tr>
<tr>
<td>Grade 3, n (%)</td>
<td>2 (13)</td>
</tr>
<tr>
<td>Grade 4, n (%)</td>
<td>8 (50)</td>
</tr>
<tr>
<td>Grade 5, n (%)</td>
<td>6 (37)</td>
</tr>
<tr>
<td>Culprit lesion localization</td>
<td></td>
</tr>
<tr>
<td>LAD, n (%)</td>
<td>11 (69)</td>
</tr>
<tr>
<td>RCA, n (%)</td>
<td>2 (12)</td>
</tr>
<tr>
<td>Cx, n (%)</td>
<td>3 (19)</td>
</tr>
<tr>
<td>Pre- and Per thrombo-aspiration management</td>
<td></td>
</tr>
<tr>
<td>Previous thrombolysis, n (%)</td>
<td>4 (25)</td>
</tr>
<tr>
<td>Initial bivalirudin infusion, n (%)</td>
<td>4 (25)</td>
</tr>
<tr>
<td>Initial abciximab infusion, n (%)</td>
<td>8 (50)</td>
</tr>
<tr>
<td>Post thrombo-aspiration management</td>
<td></td>
</tr>
<tr>
<td>Aspirin, n (%)</td>
<td>16 (100)</td>
</tr>
<tr>
<td>Clopidogrel, n (%)</td>
<td>3 (19)</td>
</tr>
<tr>
<td>Prasugrel, n (%)</td>
<td>12 (75)</td>
</tr>
<tr>
<td>Ticagrelor, n (%)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Low molecular weight heparin, n (%)</td>
<td>16 (100)</td>
</tr>
</tbody>
</table>

Cx, circumflex artery; LAD, left anterior descending artery; RCA, right coronary artery.

Reproducibility of the data
Both observers independently analysed the first 18 pullbacks to de-
termin inter-observer variability of thrombus score and volume
measurement. Bland–Altman plots for inter-observer variability
are illustrated in Figure 3. The variability and limits of agreement
showed acceptable reliability for these parameters according to
the definitions.17

OCT-thrombus parameters correlation
There was a high degree of correlation between all the thrombus
parameters on the 32 OCT analyses: the OCT-thrombus score
correlated to the OCT-thrombus volume (Spearman’s \( \rho = 0.85, P < 0.01 \); Figure 4) and the thrombus length (\( \rho = 0.77, P < 0.001 \)),
whereas thrombus length and volume were also correlated
(\( \rho = 0.81, P < 0.01 \)). These correlations remained highly significant
using the Pearson’s \( r \) correlation. However, there was no significant
correlation between any thrombus OCT parameters and thrombus
angiographic TIMI grade.

Thrombus regression on serial OCT
analyses
The delay between OCT analyses ranged from 2 to 6 days, with an
average value of 3.94 ± 0.3 days. During this period, all patients
were given low molecular weight heparin + double antiplatelet therapy (Table 1). Initial abciximab or bivalirudin infusions were, respectively, administered to 50 and 25% of the patients. There was no adverse event reported during the inter-OCT course, including no recurrence of myocardial ischaemia, ventricular arrhythmia, heart failure, target vessel re-oclusion, or significant bleeding events (BARC class ≥2).

The evolution of the angiography and OCT parameters is given in Table 2. The angiographic thrombus score significantly decreased between the two procedures. We also observed significant 50.5 ± 4.8% reduction in OCT-thrombus score, 55.6 ± 6.3% decrease in OCT-thrombus volume, and 26. ± 7.4% diminution in thrombus length. Moreover, there were significant increases in the culprit lesion MLA, the distal reference segment cross-sectional area, and OCT area stenosis. Altogether, these data suggested a reduction in the thrombotic burden and limited vasodilation of the target vessel under optimal medial therapy. However, the degree of stenosis assessed by QCA methods did not significantly change between measurements over time (Table 2).

The thrombus burden reduction depended on the duration of medical therapy (as assessed by the inter-OCT analyses delay). Hence, we observed highly significant correlations between inter-OCT delay and OCT-thrombus volume (Spearman’s ρ = 0.84, P < 0.001; Figure 5), OCT-thrombus score (ρ = 0.65, P = 0.006; Figure 5), and OCT-thrombus length (ρ = 0.68, P = 0.01) reductions. There was no significant difference in OCT-thrombus score or volume variations in patients with white or red thrombus on initial procedure (respectively 57 ± 7.3 vs. 49.7 ± 2.7%, P = 0.7, and 52.5 ± 5.3 vs. 41.6 ± 5.2%, P = 0.44). Finally, we did not observe significant differences in OCT-thrombus score and volume reduction percentages between patients treated with bivalirudin or abciximab infusions (respectively 65 ± 9.1 vs. 52.6 ± 11, P = 0.37, and 48.5 ± 6.5 vs. 53.2 ± 8.1, P = 0.93).

**Correlations between OCT and angiographic parameters**

We pooled the analyses from the 32 procedures (Post-TA and control) led in the 16 patients to assess the relationships between OCT and angiographic parameters (Table 3). We observed modest significant inverse correlations between OCT-thrombus volume and QCA, as...
well as OCT area stenosis and QCA. Moreover, we compared OCT-derived thrombus parameters in patients with low (angiographic TIMI thrombus score ranging from 0 to 2, $n = 25$) vs. high thrombotic load (angiographic TIMI thrombus score $\geq 3$, $n = 7$) on angiography. There was no significant difference in OCT-thrombus volume ($9.3 \pm 4.9$ vs. $5.9 \pm 1.1$, $P = 0.69$) or OCT-thrombus score ($17.6 \pm 2.6$ vs. $15.9 \pm 2.2$, $P = 0.37$) between the two groups.

### Table 2 Angiography and OCT parameters evolution between analyses (mean delay: $3.9 \pm 0.3$ days)

<table>
<thead>
<tr>
<th></th>
<th>Post-TA analysis</th>
<th>Control analysis</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angiography parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesion length (mm)</td>
<td>$15.5 \pm 1.5$</td>
<td>$14.6 \pm 1.4$</td>
<td>0.55</td>
</tr>
<tr>
<td>Reference diameter (mm)</td>
<td>$3.0 \pm 0.1$</td>
<td>$3.2 \pm 0.1$</td>
<td>0.09</td>
</tr>
<tr>
<td>Stenosis percentage (%)</td>
<td>$54.2 \pm 4.5$</td>
<td>$49.7 \pm 3.5$</td>
<td>0.33</td>
</tr>
<tr>
<td>Thrombus TIMI grade 0 ($%$)</td>
<td>$2.3 \pm 0.3$</td>
<td>$0.9 \pm 0.2$</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>Grade 1 ($%$)</td>
<td>4 (25)</td>
<td>9 (56)</td>
<td></td>
</tr>
<tr>
<td>Grade 2 ($%$)</td>
<td>5 (31)</td>
<td>3 (19)</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>Grade 3 ($%$)</td>
<td>6 (37)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grade 4 ($%$)</td>
<td>1 (7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grade 5 ($%$)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>OCT parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal reference LA (mm²)</td>
<td>7.3 ± 1.1</td>
<td>7.7 ± 1.1</td>
<td>0.14</td>
</tr>
<tr>
<td>Distal reference LA (mm²)</td>
<td>6.0 ± 0.9</td>
<td>6.8 ± 1.1</td>
<td>0.03</td>
</tr>
<tr>
<td>Thrombus score</td>
<td>22.3 ± 2.6</td>
<td>10.3 ± 1.3</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>TV (mm³)</td>
<td>9.6 ± 2.3</td>
<td>3.6 ± 0.9</td>
<td>$&lt;0.001$</td>
</tr>
<tr>
<td>Thrombus length (mm)</td>
<td>11.1 ± 1.4</td>
<td>7.4 ± 0.8</td>
<td>0.01</td>
</tr>
<tr>
<td>MLA (mm²)</td>
<td>1.7 ± 0.2</td>
<td>2.6 ± 0.4</td>
<td>0.002</td>
</tr>
<tr>
<td>Area stenosis (%)</td>
<td>71.8 ± 3.4</td>
<td>59.4 ± 6.8</td>
<td>0.01</td>
</tr>
<tr>
<td>White thrombus presence, $n$ (%)</td>
<td>88</td>
<td>81</td>
<td>0.62</td>
</tr>
</tbody>
</table>

### Discussion

In this pilot study, we used FD-OCT imaging techniques to identify and quantify thrombus burden in patients with ACS. The present data illustrate that (i) serial thrombus analyses by OCT following manual thrombectomy are feasible and safe in selected patients and (ii) thrombus burden diminishes over time under optimal medical therapy and this decrease can be monitored by intra-coronary imaging.

Thrombosis plays a critical role in the pathophysiology of ACS, as disruption of an atherosclerotic plaque triggers activation of platelets and formation of fibrin within the vessel lumen. However, intra-coronary thrombus identification remains an issue for interventional cardiologists, since angiography has limited sensitivity. FD-OCT accurately differentiates red or white thrombus from the underlying atherosclerotic plaque. Previous reports showed that OCT is comparable to coronary angioscopy and histologic examinations for identifying the underlying mechanism for culprit lesion thrombosis was identified as plaque fibrous cap rupture in 11, stent thrombosis in 3, and plaque erosion in 2 patients. Twelve out of 16 patients were finally treated by stent implantation during the second procedure (drug eluting stent in nine patients). No thrombus embolization or no-reflow was observed during the PCIs. The remaining four patients did not undergo stent placement because of limited residual atherosclerotic burden with MLA $>4$ mm² or the presence of stent thrombosis with uncovered struts: these patients did not receive previous thrombolysis and benefited from an initial double antiplatelet therapy that was continued after hospital discharge, including aspirin in all cases, associated to clopidogrel in 2 and prasugrel in 2. Average troponin Ic peak was 121.2 ± 37.7 IU/L, and left ventricle ejection fraction at discharge was 50.1 ± 2.1%. Clinical follow-up was obtained in 15 patients (median follow-up time: 694 days/interquartile range: 90 days); there was no major adverse cardiovascular event (death + myocardial infarction + target vessel revascularization) observed during this period.

### Figure 5

Time course of thrombus burden reduction in patients with acute coronary syndrome as a function of the duration of post-thrombectomy medical therapy. The thrombus volume (A) and score (B) reductions were highly correlated to the delay between analyses.
thrombus detection during ACS, in vivo and ex vivo. Moreover, as FD-OCT imaging relies on consecutive cross-sectional analyses, it might allow thrombus quantification within the culprit atherosclerotic plaque. Several groups investigated FD-OCT methods for this purpose. Hence, the COCTAIL study investigators proposed a semi-quantitative thrombus score that was based on the length and quadratic extension of thrombus on cross-sectional images. More recently, Magro et al. reported the accuracy of residual atherothrombotic burden quantification following stent implantation in STEMI. In the present study, we investigated the feasibility of repeated thrombus volumetric quantification by OCT in high-risk ACS before placement of any stent. Our results show that this method was accurate for thrombus quantification and volume variation assessment. Interestingly, the thrombus volumes we measured were highly correlated to the semi-quantitative thrombus score values, suggesting that this parameter might adequately reflect the global thrombotic load. As we did not observe any distal embolization, severe spasm, artery re-occlusion or dissection during the post-thrombectomy, and control analyses, our data confirm previous observation regarding the safety of FD-OCT during STEMI.

Our results indicate that thrombus progressively decreases over time under medical treatment. Although this evolution during ACS has been previously hypothesized and observed on angiography, our data are the first to provide indications on the thrombus load diminution rate in vivo. The thrombus progressive dissolution is sub-tended by the interaction between two main effectors. First, antithrombotic therapy (dual antiplatelet therapy + anticoagulation) given to the subjects blocks the pro-aggregatory and pro-thrombotic pathways and prevents the thrombus growth. Secondly, the endogenous fibrinolysis systems progressively dissolve the established fibrin-stabilized platelet aggregates. Both actors contribute thus to the thrombus dissolution, but their respective influence is largely unknown during ACS in vivo. However, the differences in the initial medical therapy (including use of prasugrel or clopidogrel), the interindividual variable response to antiplatelet drugs, as well as the differences in patients endogenous fibrinolysis status might have partially influenced our results and account for the observed variations in thrombus decrease rate.

The concept of a two-step approach (initial thrombectomy followed by deferred stenting) has been recently developed by different groups to improve the PCI results by limiting its complications in some selected patients. Nevertheless, the deferral interval is highly variable in these different studies, and the optimal timing between the initial and subsequent procedure is still unknown. Our data indicate that the thrombus disappearance is a progressive phenomenon. We thus observed that more than a half of the initial burden is resorbed after 5 days of optimal medical treatment. The results might suggest that this delay could be chosen in case of a deferred stenting procedure to minimize the culprit lesion residual thrombus, yet it might also lead to an increased hospital stay.

Several limitations of the study warrant consideration. First, our results are based on data collected from a single catheterization facility, and the sample size is small. The volumetric thrombus assessment might thus provide different information in other clinical situations. Furthermore, the small sample size might explain why several angiography parameters (such as the QCA measurement) did not significantly decrease over time. Moreover, our imaging analysis was not corroborated by pathological analysis, as this procedure could not be performed in vivo in ACS patients, and thrombus aspiration products are not analysed routinely in our institution. Finally, our thrombus evaluation is based on FD-OCT analysis. This technique might be limited in some cases by the signal attenuation caused by large amounts of red thrombus. This might alter the lumen and thrombus outlines drawing and impace accurate delimitation. In this series, the analysis was possible in 84% of the screened patients and revealed evidences of white thrombus in 88% of the cases. This high proportion of white thrombus might be related to the characteristics of the population we studied. Very few data are available regarding the thrombus characteristics in STEMI and the way the antithrombotic therapy could interfere with the natural evolution of thrombus from white to red. Hence, Wieringa et al. recently observed that white thrombus was present in a vast majority of NSTE-MI patients after 3 days of pre-PCI treatment and allowed correct OCT analysis of culprit lesion. Although we acknowledge that red thrombus is a limit to thrombus quantification, our data support the feasibility of the method and show adequate reproducibility compared with other published reports in the field. Finally, there was no standardization of antithrombotic therapy between patients, which might have affected the inter-individual thrombus regression rate. In summary, this current pilot study shows for the first time that repeated

| Table 3 Correlations between angiographic and OCT parameters in the 32 pooled procedures |
|---------------------------------|----------------|----------------|----------------|----------------|----------------|
| OCT-thrombus volume  | OCT-thrombus score | OCT area stenosis | QCA  | MLA  |
| OCT-thrombus volume  | X              | R = 0.69        | R = -0.08 | R = -0.37     | R = 0.25      |
|                       |                | P < 0.001       | P = 0.67 | P = 0.04       | P = 0.17       |
| OCT-thrombus score   | R = 0.69       | X              | R = 0.21 | R = 0.007      | R = -0.18      |
|                       | P < 0.001      |                | P = 0.25 | P = 0.97       | P = 0.33       |
| OCT area stenosis    | R = -0.08     | R = 0.21        | X      | R = 0.48       | R = -0.87      |
|                       | P = 0.67       |                |        | P = 0.01       |                |
|                       |                | P = 0.25       |        |                | P < 0.001     |
| QCA                 | R = -0.37     | R = 0.007      | R = 0.48 | X             | R = -0.63     |
|                       | P = 0.04       |                | P = 0.97 |                |                |
| MLA                 | R = 0.25      | R = -0.18      | R = -0.87 | R = -0.63     |                |
|                     | P = 0.17       |                | P < 0.001 | P < 0.001     |                |

R, Pearson’s correlation coefficient
thrombus volumetric analyses are feasible and safe by using FD-OCT technique in selected patients with ACS. This method provides valuable information on thrombus regression in vivo under optimal medical therapy. Further research is needed to assess the reproducibility and the impact of these preliminary results in larger multi-centric ACS cohorts with standardized antithrombotic therapy.

Conflict of interest: N.A., G.S., P.M., and C.C. received consulting fees from St Jude Medical; G.S. and P.M. received consulting fees from Terumo.

References


