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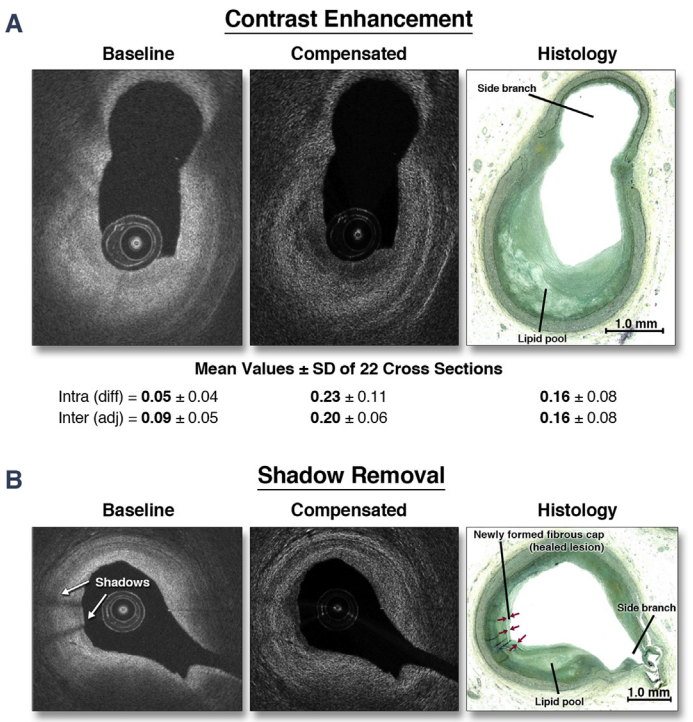
LETTERS TO THE EDITOR

Intravascular Assessment of Arterial Disease Using Compensated OCT in Comparison With Histology

Although optical coherence tomography (OCT) has emerged as the state-of-the-art modality for intravascular imaging, its use for assessment of atherosclerotic plaque is hampered by shadow artifacts and limited penetration depth due to rapid attenuation of OCT signals within tissues (1-4).

FIGURE 1 Baseline and Compensated OCT With Histology Images From the Left Anterior Descending Artery of Patient 1



Results here showed that the compensation improved the interpretation of intraplaque composition in optical coherence tomography (OCT) by enhancing the visualization of deep tissue layers, increasing the contrast between tissues, and removing shadow artifacts. The mean values increased significantly: from 0.05 ± 0.04 to 0.23 ± 0.11 ($p < 0.0001$) for intralayer contrast (different plaque structures; Intra [diff]) and 0.09 ± 0.05 to 0.20 ± 0.06 ($p < 0.0001$) for interlayer contrast (adjacent layers; Inter [adj]) **(A)**. **(B)** The intralayer contrast (between shadowed and nonshadowed areas) decreased after compensation from 0.18 ± 0.05 to 0.05 ± 0.05 ($p < 0.0001$), confirming shadow removal. Comparison also reveals the signal enhancement in deeper structures.

In this study, we evaluated the improvement in image contrast with compensated OCT over conventional OCT.

Twenty-two OCT pullbacks were acquired from pathological coronary artery specimens (subject #1: male, 53 years old, left anterior descending artery; subject #2: male, 46 years old, left circumflex artery) using a C7 intracoronary OCT system (St. Jude Medical, St. Paul, Minnesota). OCT-histology matched sections were obtained from histopathology analysis. OCT pullbacks were exported in raw format and post-processed in MATLAB (MathWorks, Natick, Massachusetts) with an algorithm that was previously developed to compensate for OCT signal attenuation in tissues (3,5). The intralayer and interlayer contrasts were analyzed before and after compensation and compared with histological images.

Comparison was based on 3 parameters: 1) intralayer contrast (between shadowed and nonshadowed areas) to evaluate shadow removal; 2) intralayer contrast (between different intraplaque structures); and 3) interlayer contrast (between adjacent vessel wall layers) to evaluate the clarity of boundaries. Statistical analyses were performed using 1-way analysis of variance with the Tukey multiple post-comparison test (GraphPad Prism software package, GraphPad Software Inc., La Jolla, California), with $p < 0.05$ representing significance. Parameter 1 can take a range of values from 0 to 1, with 0 representing complete shadow removal and 1 representing complete shadowing. Items 2 and 3 can take a range of values from 0 to 1, with 0 representing poorly detectable boundaries and 1 representing highly detectable boundaries.

The study showed that compensation: 1) enhanced the detectability of intraplaque morphology and deep-tissue boundaries as evidenced by the increase in contrast between different structures within the plaque components (from 0.05 to 0.23; $p < 0.0001$) and between adjacent layers of the vessel wall (from 0.09 to 0.20; $p < 0.0001$) (Figure 1A); 2) enhanced the visibility of deep structures, which is important for accurate OCT-based identification of plaque composition and disease burden; and 3) reduced shadow artifacts (decrease in intralayer contrast [Figure 1B]) between shadowed and neighboring areas.

In this study performed in vitro on coronary artery specimens, compensated OCT seemed to improve plaque interpretation. Such compensation of OCT images, if proven in more definitive in vivo studies, may increase the accuracy of plaque assessment with OCT.

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Diagnostic Performance of Myocardial CT Perfusion Imaging With or Without Coronary CT Angiography

Myocardial computed tomography perfusion (CTP) imaging is used as an alternative to established myocardial perfusion imaging modalities (1). Although coronary computed tomography angiography (CTA) has value in ruling out coronary artery disease (CAD), it is also characterized by high false positive rates and the inability to distinguish functionally significant from insignificant lesions (2). The addition of CTP to CTA may improve its diagnostic performance by providing functional information of coronary stenoses. Results of studies attempting to define the diagnostic characteristics of CTP with or without CTA have been variable. In this meta-analysis, we synthesized available evidence on the diagnostic performance of CTP with or without coronary CTA in reference to invasive coronary assessment.

Two investigators searched the MEDLINE, EMBASE, and CENTRAL databases using relevant key words for studies published before December 2014. References of eligible studies were perused for additional eligible studies. We included studies evaluating pharmacological stress CTP with or without CTA in reference to quantitative coronary angiography (QCA) or fractional flow reserve (FFR) for the diagnosis of CAD. We only included studies in which qualitative perfusion assessment was performed. We constructed 4 × 4 diagnostic performance tables adhering to QCA and FFR cutoffs adopted by individual studies for CAD definition. When results for different cutoffs were available, for consistency we used QCA stenosis >50% and FFR <0.80 thresholds. We calculated summary sensitivity, specificity, and areas under the receiver-operating characteristic curves (AUC_{ROC}) with 95% CI using bivariate random-effects meta-analysis on a per-vessel basis. Although traditional diagnostic meta-analysis unifies sensitivity and specificity into 1 measure (the summary ROC), bivariate meta-analysis maintains their distinct characteristics and takes into account their potentially negative correlation. Heterogeneity was quantified with the I^2 statistic.

Twelve studies including 920 patients (median n = 39) and 1,563 coronary vessels (median n = 104) were eligible. Stenosis of 50% (n = 5 studies) or 70% (n = 2) per QCA and FFR <0.8 (n = 4) or <0.75 (n = 1) were the reference cutoffs. By QCA or FFR, a median 51.5% of patients (interquartile range: 35% to 71%) had significant CAD. The diagnostic performance of CTP alone and CTP/CTA was assessed in 8 and 9 studies, respectively. Per-vessel summary sensitivity, specificity, and AUC_{ROC} (95% CI) for CTP were 0.87 (0.74 to 0.94), 0.84 (0.74 to 0.91), and 0.92 (0.89 to 0.94), respectively. The respective summary values for CTP/CTA were 0.88 (0.78 to 0.94), 0.91 (0.88 to 0.93), and 0.91 (0.88 to 0.93) (**Figure 1**). No significant differences were observed in separate analyses for QCA and FFR as reference methods or when studies using QCA stenosis >50% as reference were excluded. Heterogeneity was significant (I^2 > 50%) in the main and sensitivity meta-analyses of both CTP and CTP/CTA.

This bivariate meta-analysis indicated favorable diagnostic performance of CTP compared with "gold-standard" invasive methods for CAD assessment. Addition of CTA to CTP resulted in slightly improved specificity without significantly improved sensitivity or overall performance. We note the significant

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