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Editorial

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Quantitative Assessment of Coronary Plaques by Coronary CT Angiography: High Inter-Reader and Intra-Reader Agreement is Achieved but Inter-Scanner Variability should not be Ignored

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ABSTRACT

This editorial discusses a recent paper published in the December issue of Radiology 2016 on the quantitative assessment of coronary plaques by coronary computed tomography (CT) angiography. Three main findings are discussed in the editorial: First, coronary CT angiography is an accurate imaging modality for analysis of plaque volume as well as monitoring volume change, with excellent inter- and intra-reader agreement with use of the state-of-the-art CT scanners. Second, the reliability of coronary CT angiography is noticed for low scan variability when plaque volume assessment is performed with the same vendor, but with high variability of nearly 30% when assessment is conducted with different vendors at baseline and follow-up scans. Finally, a large sample size is required to assess non-calcified plaques, in particular with use of different vendors.

KEY WORDS: Coronary artery disease; Coronary CT angiography; Coronary plaque; Volume measurement; Variability.

Coronary CT angiography (CCTA) is currently a widely used imaging modality for the diagnostic assessment of patients with suspected coronary artery disease (CAD) with high diagnostic accuracy reported in the literature.[1-5] Rapid technological developments on cardiac CT imaging have occurred over the last decade which have led to the development and improvement of diagnostic spectrum of CCTA in the quantitative analysis of coronary plaques, in addition to the diagnostic value of coronary artery stenosis. These included characterization of plaque features and the corresponding clinical outcomes such as prediction of major adverse cardiac events, in addition to the routine assessment of coronary lumen stenosis.[6-9]

Detection of plaque components, in particular, differentiation of non-calcified (vulnerable) from calcified (stable) plaques is more significant than detection of lumen stenosis because close association has been reported between plaque composition and myocardial ischemia and development of adverse cardiac events.[10-13] Therefore, the current research direction of CCTA has primarily focused on the quantitative assessment of plaque features instead of coronary lumen analysis because the degree of lumen stenosis is not always associated with myocardial ischemic changes.[14,15]

Intravascular ultrasound (IVUS) and optical coherence tomography (OCT) are two imaging modalities which allow excellent plaque characterization by providing intravascular views of plaque components, however, both are invasive, thus, they are not commonly performed in clinical practice. As a less invasive modality with widespread use in daily practice, CCTA is able to provide quantitative assessment of plaque morphology and components which add

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incremental prognostic value in the diagnosis of CAD.[16,17] There is a growing evidence to show that CCTA has good correlation with IVUS in the quantitative plaque analysis.[18-22] However, limited research is conducted with regard to the inter/intra-reader and inter-scanner agreement or variability of CCTA in the quantitative assessment of coronary plaques. This has been addressed in a recently published study which is discussed in the following sections.

In the 2016 December issue of the Radiology, Symons et al[23] investigated the variability of CCTA for quantifying plaque volume based on different latest multislice CT scanners. Authors prospectively enrolled 40 asymptomatic patients over 55 years old with history of hyperlipidemia who received medical treatment. Coronary artery calcium (CAC) scoring and CCTA were performed at baseline using 320-slice CT Toshiba Aquilion One scanner. Repeat CAC scoring and CCTA were performed with two different CT scanners within 30 days of the baseline scan, with 20 patients undergoing the repeat examinations using the same Aquilion One scanner, while another 20 patients using the Somatom Force 2x 192-slice dual-source scanner. Total plaque volume on a segment level and focal coronary lesion volume were measured and evaluated by two readers at baseline and follow-up scans. There was no significant difference in patient's demographics between the two groups undergoing different scans. High inter-reader and intra-reader agreement (ICC-intraclass correlation coefficients >0.99) was noticed in the assessment of total, non-calcified and calcified plaques by CCTA for Toshiba and Siemens scanners. Scan-rescan variation was revealed when the follow-up CCTA was performed on a different type of CT scanner. The variability of CCTA was 18.4% and 16% for measurement of non-calcified plaque volume for all coronary arteries and for the most significant lesion, respectively when the baseline and follow-up CT scans were used with the same Toshiba CT. In contrast, the corresponding variability of CCTA was 29.9% and 26.4% when baseline scan was done on Toshiba CT and follow-up examination on Siemens CT, indicating high variability when follow-up CCTA was performed on a different type of scanner. The scan-rescan variation of CAC scoring was low with ICC >0.99 for both groups. Because of scan-rescan variability in coronary plaque volume measurement, sample sizes were calculated for non-calcified plaque volume by CCTA. When a different vendor was used for the follow-up of plaque volume change, the estimated patients would be 587 and 753 for lesion-based and vessel-based analysis of non-calcified plaque, respectively.

There are three observations from Symons' study that bear discussions. First, the authors have demonstrated the accuracy and reliability of CCTA in the quantitative assessment of plaque volume. This finding is consistent with the current literature which supports the increasing use of CCTA for coronary plaque imaging analysis. Of different plaque features, low-attenuation area or non-calcified plaque represents one of the reliable indicators to determine plaque vulnerability and predict major adverse cardiac events. This has been confirmed by a number of studies showing good correlation between CCTA and IVUS in the differentiation of plaque composition.[24-28] Main findings of these studies concluded that non-calcified or low-attenuating plaques were more often seen in patients associated with acute coronary syndrome or development of major adverse cardiac events when compared to those with stable angina pectoris. Therefore, assessment of non-calcified plaque in terms of total plaque volume has significant clinical value. The high inter-and intra-reader agreement as shown in Symons' study has further verified the diagnostic value of CCTA in this aspect.

The second comment is related to the variability of multislice CT scanner with regard to the plaque volume measurement. The two CT scanners used in this study included Toshiba 320-and Siemens Force scanners. The 320-slice scanner enables longitudinal coverage of 16 cm, although the temporal resolution (137.5 ms) is not as good as that of dual-source CT scanners.[4,29] A number of studies have demonstrated the high diagnostic value of 320-slice CCTA in coronary artery disease,[30-34] while Siemens Force is a 3rd generation dual-source CT which is recently introduced into clinical practice with extended z-axis coverage and improved temporal resolution (125 ms). Recent studies have shown the improved diagnostic performance and lower radiation dose of 3rd generation dual-source CT when compared to early generations of dual-source CT scanners.[35,36] These two types of CT scans represent the latest technological developments in cardiac CT imaging and will continue to be used in clinical practice. Thus, findings from Symons study have significant clinical impact because patients with CAD after medical treatment will be followed up by CCTA using the latest CT scanners and these two vendors are the most commonly used in current practice. From a clinical perspective, Symons and colleagues in their study offered an insight into the scan-rescan variability when CCTA is performed with different vendors.

The third comment is related to the sample size calculation. Authors estimated the required sample size in order to detect 5% plaque volume changes by CCTA according to lesion-based and vessel-based analysis of non-calcified plaque when different vendors are involved in follow-up examinations. It is well known that the sample size plays an important role in study design and research findings. Most of the current studies are limited by small sample size or single center experience, which is frequently mentioned in the study limitations. The sample size estimation proposed by Symons and colleagues provides guidance for other researchers to develop similar studies so that robust conclusion can be drawn.

In summary, Symons and colleagues presented[23] a very interesting study with further confirmation of high diagnostic accuracy of CCTA in the quantitative assessment of plaque volume with high inter- and intra-reader agreement. This study suggests

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that follow-up CCTA should be performed with the same vendor for diagnostic assessment of non-calcified plaque volume to avoid scan-rescan variability. A large sample size is required to detect plaque volume changes by CCTA when different vendors are involved at different periods of CT scans. Despite promising results presented in this study, further research, in particular, a longitudinal study with long-term follow-up of treatment outcomes is necessary to verify the findings.

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