Overview Image of the Lumen and Vessel Wall in Coronary CT Angiography — The Plaque-Loaded Angiographic View —

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Background There is no post-processing technique that can display an overview image of the lumen and vessel wall of a whole heart in one image. A merging coronary lumen view (Angiographic View) with a plaque image can provide a single, comprehensive image of plaque distribution.

Methods and Results A color-coded plaque image is assigned to different computed tomography attenuation ranges in the coronary artery to visualize plaques. This plaque image is re-formatted into a maximum intensity projection image and loaded onto the Angiographic View image.

Conclusions The integrated image of the coronary lumen and vessel wall of a whole heart is feasible. This image (Plaque-loaded Angiographic View) will give effective information in explaining the distribution of coronary lesions in patients as well as providing opportunities to discuss treatment strategies. (Circ J 2008; 72: 671–673)

Key Words: Cardiac CT; Computed tomography; Coronary artery disease; MDCT; Post-processing

The recent advancement of a Multi-Detector row computed tomography (MDCT) has enabled the non-invasive evaluation of coronary artery stenosis with high accuracy.1–4 The advantage of MDCT over coronary angiography (CAG) is its ability to capture the information from the vessel wall. Several studies have reported that MDCT used in routine clinical diagnosis is capable of detecting coronary plaques.5,6 However, the overall plaque distribution in a whole heart is difficult to assess because multiple images are required for the assessment. There is no post-processing technique that can display an overview image of the lumen and vessel wall of a whole heart in one image, although several novel displaying methods of cardiac computed tomography (CT) have been reported.7–9

Recently, the Angiographic View image has been introduced as a luminography technique, similar to CAG. The Angiographic View image is a maximum intensity projection (MIP) image, where the highest density in the projection ray is projected. The Angiographic View image has the contrast media of ventricles eliminated, so that it displays the distribution of high-dense calcified plaques as well as the lumen in more detail. If the non-calcified plaque image is merged with the Angiographic View image, it can be an effective visualization method to review the distribution of coronary lesions, which would be understandable to the third parties such as referred physicians and patients. In this paper, we propose a visualization technique called the “Plaque-loaded Angiographic View”, which can display an overview image of the lumen and vessel wall in a whole heart, and present its clinical advantages.

A coronary CT angiography was obtained by using LightSpeed 16 (GE Healthcare, Waukesha, WI, USA) with a 16×0.625 mm collimation and gantry rotation time of 0.4 s for case 1 (Fig 1), and a LightSpeed VCT (GE Healthcare) with a 64×0.625 mm collimation and gantry rotation time of 0.35 s for case 2 (Fig 2). The scan was performed under a single breath-hold, covering the entire heart, and with a 120 kV, 600 mA tube current, and a helical pitch of 0.2. The iodine contrast material (Iopamidol 370 mgI/ml, Schering, Berlin, Germany) was injected at a rate of 4 ml/s with the injection duration of 20 s in case 1 and 10 s in case 2, which was immediately followed by 20 ml of saline.

The “Plaque-loaded Angiographic View” is generated in a workstation (GE AW VolumeShare™ experimental version) as follows: First, the color-coded plaque image of each coronary artery is created (Fig 1a). The CT attenuation of the coronary lumen is usually larger than 250 HU10 while that of non-calcified plaque is typically less than 120 HU5. Setting the color code range at less than 120 HU can generate a “plaque image”, in which only the vessel wall and the non-calcified plaques are color-coded. Second, the Angiographic View image of the entire coronary artery (Fig 1b), which is similar to that shown by a CAG (Figs 1c,d) is separately generated, which displays the distribution of calcified plaques as well as the lumen in more detail. Third, the color-coded “plaque image” in curved MPR is re-formatted into a MIP image to merge with the Angiographic View image. Finally, loading the MIP “plaque image” onto the Angiographic View completes the “Plaque-loaded Angiographic View” (Fig 1e). The critical factors in the “Plaque-loaded Angiographic View” are that the merged images are both in MIP format, and taking advantage of a relatively large CT attenuation discrepancy between the lumen and...
non-calcified plaque allows color-coding, which helps to better visualize plaques when loaded onto the Angiographic View.

The “Plaque-loaded Angiographic View” allows the non-invasive visualization of the whole coronary lumen and the vessel wall in one image. This image will provide comprehensive information for coronary CT angiography in discussing the treatment strategy of both coronary stenosis and non-stenotic plaques. In future, when the temporal and spatial resolution of MDCT is improved further, and when the accuracy of plaque volume quantification is enhanced, this image could also be useful in evaluating and demonstrating the therapeutic effect of anti-atherosclerotic drugs in patients with multiple soft plaques in coronary arteries (the so-called vulnerable patients) on one image. Furthermore, the “Plaque-loaded Angiographic View” would enable the overview of the tortuous vessel in the chronic total occlusion (CTO) (Fig 2). This will provide complimentary information that would be useful for the percutaneous revascularization of CTO. The integrated image as well as the “Plaque-loaded Angiographic View” was previously reported in terms of the combination of coronary artery and regional cardiac function. These integrated images would improve the usefulness of cardiac CT.
It is very important to note that the color-coded plaque density in this view does not accurately demonstrate the whole plaque characteristics, because the color is assigned according to the maximum voxel found along the ray. For example, when lipid-rich composition (lower density) is surrounded by fibrous area (higher density) in one plaque, only a higher density area (fibrous area) is assigned a color code.

In conclusion, the integrated image of the coronary lumen and vessel wall of the whole heart is feasible. We believe this image will give effective information in explaining the distribution of coronary lesions in patients, as well as aid in the discussion of treatment strategies at conferences.

*The “Plaque-loaded Angiographic View” is not a registered trademark, but a general term for this new visualization methodology.

**“Plaque-loaded Angiographic View” is now available in GE AW VolumeShare2™.

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References