Napkin-Ring Sign on Coronary Computed Tomography Angiography-Tiered Enhancement of Coronary Lumen and Plaque

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We present the case of an 85-year-old man showing the “napkin-ring sign” tiered enhancement pattern on dual-phase coronary CT angiography using a 320-row multidetector CT. This has not been previously reported. In the first-phase scan, only the coronary arterial lumen was opacified. In the second-phase scan, not only the coronary arterial lumen but also the plaque margin was clearly enhanced (the “napkin-ring sign”). We considered that the tiered enhancement pattern might reflect the pathology of the “napkin-ring sign” which includes a necrotic core in the center of a plaque surrounded by fibrosis with proliferation of microangiogenesis.

Key words Coronary artery disease · Plaque · Atherosclerotic · Multidetector computed tomography.

INTRODUCTION

The “napkin-ring sign” on coronary CT angiography (CTA) is clinically important because it is an established CT feature of a high-risk coronary plaque associated with acute coronary syndrome [1-3]. Recent practice guidelines stated that the napkin-ring sign should be reported as one of the characteristics of a vulnerable plaque in the Coronary Artery Disease-Reporting and Data System (CAD-RADS) [4].

CASE REPORT

An 85-year-old man presented with atypical chest pain. Prospective electrocardiogram-gated coronary CTA was performed for the evaluation of CAD by using 320-row multidetector CT (Aquilion ONE Genesis Edition; Toshiba, Tokyo, Japan). The following parameters were employed: 320 rows×0.5-mm collimation; rotation time 0.275 s; tube voltage 120 kV; tube current 200 mA determined by automatic exposure control. Initial in-

jection of 60-mL contrast material (370 mgI/mL) at 4 mL/s was immediately followed by a 30-mL saline flush at the same rate. As heavy calcification was present in the coronary arteries on a calcium score scan (Agatston score of 812), dual-phase coronary CTA was performed for the purpose of subtraction- and transluminal attenuation-gradient (TAG) coronary CTA [5,6]. On coronary CTA, a large non-calcified plaque was detected in the proximal right coronary artery (Fig. 1). In the first-phase scan, only the coronary arterial lumen was opacified (Fig. 1B, arrowhead), but the peripheral area of the plaque showed no significant enhancement (Fig. 1B, arrow). In the second-phase scan, not only the coronary arterial lumen but also the plaque margin were clearly enhanced (the “napkin-ring sign”) (Fig. 1C, arrowhead and arrow). Semi-automated plaque assessment by dedicated software (Vitrea; Toshiba, Tokyo, Japan) demonstrated a low-attenuation component suggestive of a lipid-rich atheromatous plaque with a large central necrotic core (Fig. 1D, asterisk). The time interval between the first- and second-phase scans was 11 s. The CT number of the plaque margin was 51, 60, and 165 HU on the non-contrast-, first-phase-, and second-phase scans, respectively. Invasive scrutinies such as intravascular ultrasound and optical coherence tomography were not performed because he was very aged

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Fig. 1. (A) Non-contrast CT (calcium score scan) showing no calcification in the right coronary artery (arrow). (B) First-phase contrast-enhanced CT showing enhancement of coronary lumen (arrowhead) with no significant plaque enhancement (arrow). Coexistence of an atrial septal aneurysm is seen (asterisk). (C) Second-phase contrast-enhanced CT showing clear enhancement of coronary lumen (arrowhead) and plaque (arrow) (the napkin-ring sign). Coexistence of an atrial septal aneurysm is seen (asterisk). (D) The automated plaque quantification tool revealed the low attenuation component (<40 HU) (asterisk). On the color map image (right), red, blue, and yellow shows <40 HU, 40- to 120 HU, and >120 HU, respectively.

and myocardial ischemia was not detected on stress perfusion scintigraphy. Intensive statin therapy was initiated based on coronary CTA.

DISCUSSION

Vulnerable plaques, believed to cause acute coronary syndrome, are advanced atherosclerotic lesions characterized by a large necrotic core and a thin fibrous cap. Coronary CTA allows for the evaluation of coronary plaque morphology and composition. Maurovich-Horvat et al. [1] reported the napkin-ring sign has a high specificity and high positive predictive value for the presence of vulnerable plaques. Seifarth et al. [7] demonstrated that napkin-ring sign was histologically correlated with a large necrotic core in the center of the plaque surrounded by fibrosis with proliferation of microangiostuctures. Based on the previous studies [5,6], we performed dual-phase coronary CTA to facilitate the diagnostic capability of CAD in this patient who presented with a high calcium score. We employed the time interval of 11 s between the first- and second-phase coronary CTA. We presumed that the interval of 10–15 s was appropriate in this patient because it was the median time interval of the subtraction coronary

CTA (18 s) [5] and that for TAG (5- to 8 s) [6]. The present case showed the tiered enhancement pattern of initial luminal enhancement followed by gradual ring-like enhancement of the plaque, which may reflect the histology of the napkin-ring sign. Based on the previous study by Yamamoto et al. [8], a lipid-rich plaque shows low attenuation of <40 HU on coronary CTA, and the present case also showed such a low-attenuation component in the center of the plaque, suggesting a “high-risk” plaque. Although there is limited intracoronary imaging such as virtual histology intravascular ultrasound, we believe the CT imaging finding of the “napkin-ring sign” corresponds well with histologic characteristics. Moreover, the present case report suggests that appropriate scan timing may be critically important for the assessment of plaque characteristics because early CTA scan timing may miss the delayed enhancement of plaque margins characteristic of the napkin-ring sign.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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