

## Characterization of coronary plaque using MPRAGE at 3T MRI : Comparison with MDCT and IVUS findings

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**TARGET AUDIENCE:** Clinicians who are related to diagnosis of coronary artery disease. Scientists who are interested in coronary artery plaque imaging using MRI.  
**PURPOSE:** We evaluated the characterization of coronary plaque using MPRAGE (magnetization-prepared rapid acquisition with gradient-echo: 3D inversion-recovery-based T1WI) compared with the CT and IVUS findings.

**METHODS:** Between December 2011 and October 2012, Twenty-two patients (20 male, mean age of 66.1 years) with coronary artery stenosis ( $\geq 50\%$ ) confirmed by coronary angiography underwent cardiac MRI at 3T machine (MAGNETOM Verio, Siemens). Plaque imaging was performed using MPRAGE with ECG trigger, navigator-gated free breathing and fat suppression in trans-axial section covering whole heart. Imaging parameters were slice thickness 1.0mm, FOV 280mm, TR 728msec, TE 2.24msec, TI 650msec and voxel size 1.2x1.1x1.0mm. To identify the coronary lumen, whole heart coronary MRA using T2-weighted SPACE was also scanned. A total of 44 lesions with  $\geq 50\%$  stenosis on coronary angiography were evaluated by MPRAGE. We measured the signal intensity ratio of the plaque to adjacent myocardium (PMR) for quantitative assessment. PMR was compared with the following findings on CT and IVUS; (1) CT density of the plaque. (2) Remodeling index (RI) on CT (calculated by dividing the cross-sectional vessel diameter in the lesion by the reference segment). (3) Ultrasound attenuation on conventional IVUS (evaluated using 3-point scale with higher scores indicating higher degree of attenuation). (4) The percentage of lipid area (%LIP) and fibrous area (%FIB) of the plaque using IB-IVUS (integrated backscatter-IVUS).

**RESULTS:** In 39 of 44 lesions (89%), the plaque was successfully visualized on MPRAGE. Mean PMR was 1.16 (0.60 to 2.51). PMR and CT density of plaque had significant negative correlation ( $r=-0.560 / p=0.01$ ), and PMR and RI had significant positive correlation ( $r=0.757 / p=0.0003$ ). PMR was correlated positively with the degree of ultrasound attenuation and %LIP on IB-IVUS ( $r=0.742 / p=0.0351$ ,  $r=0.678 / p=0.0213$ , respectively). Whereas, PMR and %FIB had negative correlation ( $r=-0.677$ ). Fig. 1, 2 and 3 show the detection of coronary plaque by MPRAGE with correlation with CT and IVUS images.

**DISCUSSION:** The vulnerable plaque of coronary artery has a strong association with cardiac ischemic events. Therefore, noninvasive and easily repeatable methods that detect instability of coronary plaque are crucial for management of patients. Lipid-rich necrotic core, positive remodeling and intraplaque hemorrhage are considered to be the feature of vulnerable plaque. On CT study, the presence of lower CT density of the plaque and positive remodeling are correlated with vulnerable plaques associated with acute coronary syndrome<sup>1</sup>. On IVUS, ultrasound attenuation is defined as backward attenuation of signals behind the atheroma without calcification, and the mechanism is thought to involve the existence of thrombus, hemorrhage, cholesterol crystal and so on. Slow-flow and no-reflow phenomenon occur with high frequency during percutaneous coronary intervention (PCI) for high attenuation plaques, and therefore this finding is considered as high-risk plaque. Recently developed IB-IVUS has allowed the quantitative tissue characterization of plaque and can automatically calculate the percentage of each component (lipid, fibrous, mixed and calcification) of the plaque. Previous study, using IB-IVUS, demonstrate that plaque caused acute coronary syndrome have greater %LIP and smaller %FIB<sup>2</sup>. In this study, PMR on MPRAGE is significantly associated with these CT and IVUS findings that are related to vulnerable plaque. In carotid plaque, it is widely known that T1WI high signal is associated with complicated plaque (AHA type IV) and recent cerebrovascular events<sup>3</sup>. Also in coronary artery, T1WI such as MPRAGE may noninvasively provide clinically important information regarding plaque vulnerability without the administration of contrast media and radiation exposure. Further prospective studies are needed to put coronary plaque imaging using MPRAGE to practical use, such as prediction for PCI complication, monitoring of therapeutic effect and prognostic information.

**CONCLUSION:** Hyperintense plaque on MPRAGE is strongly associated with low CT density, positive remodeling, ultrasound attenuation and increase in lipid area on IB-IVUS. The results suggest that MPRAGE has a potential as marker for plaque vulnerability.

### REFERENCES:

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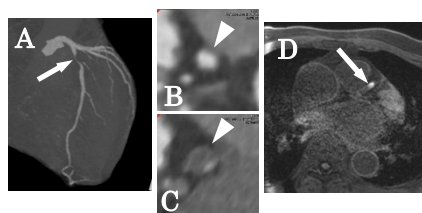


Figure 1. On CT angiography (A), severe stenosis in left anterior descending artery is shown. Cross sectional image of the reference normal lumen (B) and the lesion (C) demonstrate the low density positive remodeling plaque (35 HU, RI=1.25). On the corresponding MPRAGE (D), this plaque is visualized as high intensity (PMR=2.27).

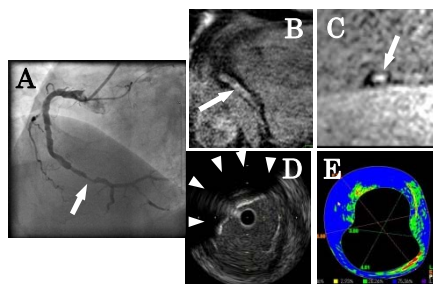


Figure 2. On coronary angiography (A), severe stenosis in the right coronary artery is shown. MPRAGE (B, C) demonstrates a high signal plaque (PMR 1.85). The corresponding IVUS image (D) shows the marked ultrasound attenuation (arrowhead). And, color-coded map using IB-IVUS (E) demonstrate the high percentage of lipid area (blue, % Area =75.4 %).

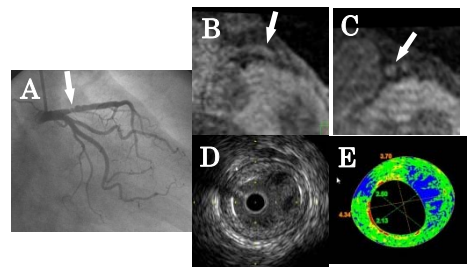


Figure 3. On coronary angiography (A), moderate stenosis in the left anterior descending artery is shown. MPRAGE (B, C) display no hyperintensity (PMR 0.85). The corresponding IVUS image show little ultrasound attenuation. And, color-coded map using IB-IVUS demonstrate the high percentage of fibrous area (green, % Area =60.4 %).