Assessment of Myocardial Perfusion Reserve in Patients with Ischemic Heart Disease on 3 Tsela MRI

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Introduction

Clinical protocols of 3 Tesla MRI systems in the assessment of ischemic heart disease are currently under active development. The diagnostic accuracy of myocardial ischemia using 3 Tesla MRI has not been validated yet. Therefore, the purpose of this study is to study the feasibility of the first-pass contrast-enhanced myocardial perfusion technique applied on a 3 Tesla MR scanner, and to determine the diagnostic accuracy of myocardial perfusion reserve index derived from the image data.

Materials and Methods

Study population

The study population consisted of 5 patients with typical angina pectoris and 12 age-matched healthy volunteers. All subjects underwent both rest and stress first-pass contrast-enhanced MR studies on a 3 Tesla MRI scanner (Trio, Siemens, Germany). Within 72 hours after MR exam, patients received coronary angiography and were proven to have lumen stenosis of >75% in various vessels; two in 1 vessel, one in 2 vessels, and two in 3 vessels.

Image acquisition

Three short-axis planes at basal, mid left ventricular (LV) and apical levels were acquired using SR-TrueFISP pulse sequence (TR/TE/FA=160ms/0.98ms/10°,spatial resolution=2mm, temporal resolution=RR interval and the total number of time frames=80). Right after the scanning started, Gd-DTPA (0.05mmol/kg) was injected via left antecubital vein at a rate of 4 ml/sec. The stress study was performed in the same way, except that vasodilator (dipyridamole, 140μg/kg^{-1}/min^{-1}) was infused intravenously via right antecubital vein for 4 min and the image acquisition began at 7 min when the maximal vasodilation was achieved.

Image analysis

LV myocardium and cavity were segmented semi-automatically and myocardium was divided into 16 equiangular segments according to the definition of coronary artery territories (1). Baseline signals measured before contrast enhanced were used to correct for the depth dependent signal variation resulted from the receiver surface coils. Myocardial perfusion was quantified by measuring the maximum upslope of the first pass signal intensity curve from the LV myocardium, normalized relative to that from the LV cavity. Myocardial perfusion reserve (MPR) index was calculated by dividing the results at maximal vasodilation by the results at rest (2). Color mapping of MPR in bull's eye view was used for visual comparison (Fig. 1).

Statistic analysis

Group differences were tested by one-way ANOVA and Wilcoxon nonparametric tests. Significance was defined as $P<0.05$. Receiver operating characteristic (ROC) analyses were performed to evaluate the diagnostic sensitivity, specificity, and accuracy of this method.

Results

Ischemic segments (0.90±0.32) showed significant difference in MPR index comparing with remote non-ischemic segments (1.57±0.47; p=0.004) and normal subjects (1.95±0.46; p<0.001). There was no significant difference between remote and normal myocardium (Fig. 2). In the ROC analysis, cutoff value of 1.3 was chosen and the sensitivity, specificity, and diagnostic accuracy were 90%, 91% and 97%, respectively.

Conclusions

We derived MPR index with the first-pass contrast-enhanced technique on a 3 Tesla MR scanner, and showed significant difference between normal and ischemic segments. These results are consistent with those reported using 1.5T MR scanners (3). This study promises the use of the first-pass perfusion study on 3 Tesla MR scanners to assess ischemic heart disease.

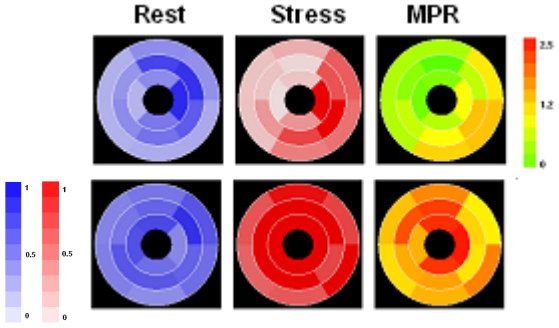

Fig 1. Color mapping of myocardial perfusion in a patient with LAD stenosis (top row) and a normal subject (bottom row).

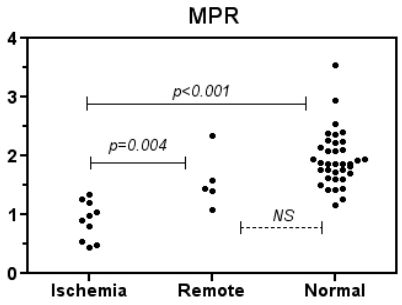

Fig 2. MPR in ischemic segments are significantly different from MPR in remote and normal controls, whereas there is no significant difference between remote and normal controls.

References

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