Myocardial Perfusion Reserve with Dual-Bolus First-Pass MR Imaging

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INTRODUCTION

MR first-pass perfusion imaging assembles a series of T1 weighted images during passage of a contrast bolus through the heart to characterize myocardial blood flow. Absolute myocardial blood flow (MBF) expressed in ml/min/g and myocardial perfusion reserve (MPR) defined as the ratio of hyperemic and resting blood flow are both clinically important indices for assessing myocardial ischemia. Theoretical and experimental studies suggest that commonly used semiquantitative methods based on upslope or contrast enhancement as simplified MPR indices should underestimate MPR compared to fully quantitative methods [1,2].

MATERIALS AND METHODS

Rest and dipyridamole stress perfusion imaging of eight normal volunteers were performed by administration of dual-bolus gadolinium contrast agent (0.005 and 0.1 mmol/kg). A magnetization prepared fast gradient echo sequence was used to obtain a series of T1 weighted images on a 1.5T GE scanner. Epicardial and endocardial borders were manually traced on each image and subdivided into six sectors to generate ventricular and myocardial time signal intensity curves. All signal intensity curves were corrected for surface-coil intensity variation and adjusted to the baseline intensity. Corrected signal intensity curves were then fitted using a Fermi model constrained deconvolution to quantify absolute myocardial blood flow. Myocardial perfusion reserve was compared using three different techniques: fully quantitative model constrained deconvolution (MCD), semiquantitative upslope index (SLP) and contrast enhancement ratio (CER) measurements.

RESULTS

MBF estimated with Fermi model constrained deconvolution (MCD) averaged 0.99 ± 0.22 (ml/min/g) at rest and 3.20 ± 0.47 (ml/min/g) for stress perfusion studies. MPR was 3.36±0.79 using MCD. MPR index based on semiquantitative parameters (SLP or CER) significantly underestimated MPR ($p<0.001$, fig 1). Furthermore, while MCD clearly separated rest and stress blood flow, both SLP and CER failed to discriminate rest and stress perfusion (overlap between circles and triangles in fig2).

CONCLUSION

Dual bolus MR perfusion imaging, a quantitative method validated by microsphere [1], found normal MPR averaged 3.36 which fits within published ranges. Semiquantitative methods such as SLP and CER significantly underestimated myocardial perfusion reserve and effectively diminished the benefit of increased blood flow during vasodilation.

REFERENCE

1. Christian TF, et al. Radiology 2004;232:677-684.
2. Jerosch-Herold M, et al. JMRI 2004;19:758-770.

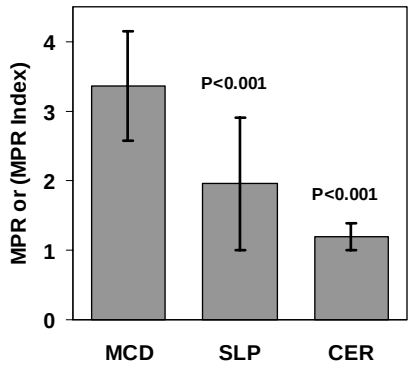

Figure 1

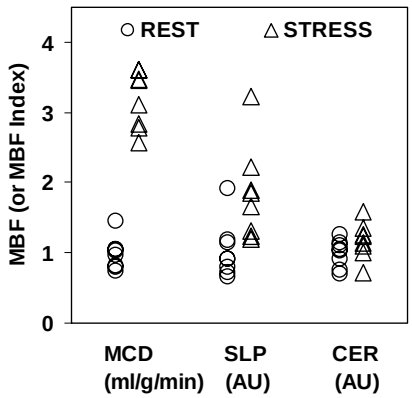

Figure 2