A preliminary assessment of magnetic resonance low-multi-b values diffusion weighted imaging in patients with hypertrophic cardiomyopathy

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Introduction: Hypertrophic cardiomyopathy (HCM) is one of the most common cardiomyopathies in clinical. Myocardial microvascular level and ischemic condition is closely related to the disease expression and clinical prognosis of HCM [1, 2]. The patients with HCM could be liable to take place a sudden death because of microvascular perfusion abnormalities and ischemia. But, it is unclear whether the degree of myocardial hypertrophy is associated with the corresponding lower perfusion reserve. Microcirculation dysfunction is an independent predictive factor for the clinical change and deterioration of HCM patients [3], so it is very important to quantitatively assess the microcirculation perfusion status of HCM patients. At present, the study on microcirculation status and ischemia mechanism of HCM is rare. The conventional technology used to detect the ischemia (SPECT, PET, MR first-pass perfusion, etc) has their limitations and deficiencies[4]. Magnetic resonance multi-b values (the higher b value is no more than 200 s/mm^2) diffusion weighted imaging is a unique method based on the intravoxel incoherent motion model without contrast agents. Multi-b values imaging could noninvasively evaluate the myocardial perfusion condition. In this study, the myocardial microcirculation perfusion status in patients with HCM was investigated with a comparison with normal volunteers using a multi-b value imaging.

Methods: 3 patients with HCM (3 male), clinically confirmed, and 3 healthy volunteers (2 female and 1 male) were enrolled in the study and underwent low-multi-b values diffusion weighted imaging (0, 20, 50, 100, 200s/mm^2) on the left ventricular short axis from apex to basal on a 1.5-T MRI unit (GE Signa HDxt) with an 8 channel chest coil. Main measurement parameters of low-multi-b values imaging included Standard ADC, Slow ADC, Fast ADC and fraction of Fast ADC values, with an empirical threshold of b value to separate coronary microcirculation and diffusion set as 100s/mm^2. All the above measurable was measured on the left ventricular septum, anterior, lateral and inferior wall on the left ventricular short axis, using 46-90 mm^2 ROI size respectively[5], as illustrated in Fig.1. We quantitatively evaluated the difference of each left ventricular myocardial perfusion parameters between normal volunteers and HCM by nonparametric test statistics and correlation analysis.

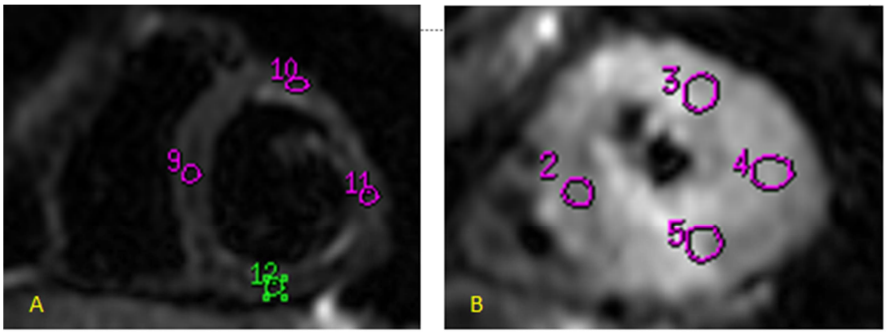

Figure 1 normal volunteer(A) and HCM patient(B) on short axis. Each ROI was put on septal, anterior, lateral and inferior every slice. And the size of ROI is from 46-90mm^2.

Results: The Standard ADC value of left ventricular myocardium in patients with HCM was significant lower than that of healthy volunteers ($5.943\times10^{-3}\pm1.975\times10^{-3}$, $7.611\times10^{-3}\pm1.125\times10^{-3}$, p=0.007, r=0.483). The Slow ADC value and fraction of Fast ADC value in patients with HCM was significant lower than the healthy volunteers ($6.475\times10^{-3}\pm1.052\times10^{-3}$, $8.090\times10^{-3}\pm0.825\times10^{-3}$, p=0.003, r=0.521; $674.250\times10^{-3}\pm242.029\times10^{-3}$, $821.25\times10^{-3}\pm147.369\times10^{-3}$, p=0.044, r=0.318). Fast ADC values in HCM patients were significantly lower than the healthy volunteers ($102{,}075\times10^{-3}\pm50.022\times10^{-3}$, $170.375\times10^{-3}\pm24.179\times10^{-3}$, p=0.001, r=0.604). At the same time, we also found that the areas with the lower Standard ADC value, the Slow ADC value, Fast ADC value and fraction of Fast ADC value often correspond to the myocardial fibrosis regions on delay-enhancement imaging.

Discussion: Multi-b values diffusion weighted imaging could evaluate water molecular diffusion and blood perfusion condition. Low b value (0-100 s/mm^2) imaging could mainly monitor the myocardial microcirculation perfusion status without contrast agents. So it could avoid the risk of the contrast medium allergy and nephrogenic systemic fibrosis related to gadolinium contrast agent. It would also be advantageous to repeatedly follow-up of HCM. For HCM patients, myocardial microcirculation perfusion status is related to ventricular reconstruction, risk stratification and prognosis. Therefore, it is significant to quantitatively evaluate and monitor the myocardial microcirculation perfusion status in HCM patients. This study found that Standard ADC, Slow ADC, Fast ADC and fraction of Fast ADC value in patients with HCM are significant lower than that of healthy volunteers. Low-multi-b values diffusion weighted imaging could quantitatively evaluate microcirculation perfusion in patients with HCM. At the same time, the areas with the lower Standard ADC value, the Slow ADC value, Fast ADC value and the fraction of Fast ADC value were often corresponding to myocardial fibrosis regions.

Conclusion: Low-multi-b values diffusion weighted imaging could be used to quantitatively evaluate myocardial microcirculation perfusion status in patients with HCM noninvasively.

Reference: [1]To AC, et al. JACC. 2011;4(10):1123-1137 [2]Knaapen P，et al. Am J Physiol Heart Circ Physiol. 2008;294(2):H986-H993 [3]Cecchi F, et al. N Engl J Med.2003;349(11):1027-1035 [4]Lu Huang. Chin J Med Imaging Technol.2013;29(3): 394-397 [5]Benedicte M.A，et al. Invest Radiol. 2012;47: 662-670