Myocardial BOLD Imaging: Comparison between TrueFISP and TSE Sequences

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Introduction: Blood oxygen level dependent (BOLD) T_2 map of myocardium during pharmacological stress can be applied to diagnose coronary artery stenosis. The segmented TSE sequence is a well-established technique to quantify T_2 map of tissues. However, a multi-slice TSE acquisition to cover the entire myocardium remains a technical problem and the long data acquisition time may aggravate artifact due to heart motion. Taking into account the advantages of the high signal noise ratio (SNR) and fast data acquisition of multi-slice or 3D image of TrueFISP sequence, T_2-prepared TrueFISP imaging demonstrated promising results in delineating regional difference in myocardial BOLD imaging. To minimize the effect of coil profile, a pseudo T_2 map of the myocardium was calculated from the trueFISP images to outline a suspectable diseased coronary artery area. In this study, this pseudo T_2 map from the T_2-prepared trueFISP image was measured and compared with the apparent T_2 map acquired from TSE sequence at the same slice position during baseline and during dipyridamole induced vasodilatation.

Methods: Five dogs (three dogs with 70% stenosis in the left circumflex coronary artery (LCx) and two normal dogs) were studied in a 1.5T scanner. Scout image was first performed to locate a slice in the short axis view of the left ventricle (LV). A pair of T_2-prepared trueFISP imaging was acquired consecutively with two TEs (15 and 60 ms) at baseline and at different time points after the injection of dipyridamole (intravenous infusion of 0.14 mg/kg body weight for 4 minutes). Other parameters included: FOV of 220 x 156 mm^2, matrix size of 256 $\times$ 160, spatial resolution of 0.9 x 1.0 mm and a slice thickness of 8 mm. Comparable segmented 2D TSE with three echo times (effective TE of 10, 40 and 60 ms) was also acquired at the same slice location and same time points after the dipyridamole injections. All acquisitions were taken at middle diastole with a breath-hold to minimize effect of cardiac and respiratory motion.

The pesudo T_2 map was calculated from paired TrueFISP images with different TEs. Apparent T_2 map was calculated from TSE images with three different TEs using a least-square method. ROIs were drawn on the LV wall in both pesudo and apparent T_2 map at LCx and septal regions (SEP). These regional pseudo T_2 was compared with associated apparent T_2 spatially and temporally.

Results and Discussion: During the dipyridamole induced vasodilation, the pseudo and apparent T_2 values in the normal SEP region increased 10.0±4.1% and 7.2±1.5%, respectively, in both the stenotic and normal dogs. However, the diseased LCx area showed a relatively low T_2 values. Fig.1 shows a paired pseudo and apparent T_2 map at the peak of the vasodilation in a stenotic dog. There is a matched local low T_2 values on the posterior LV wall supplied by LCx. Fig.2 displays a regional difference in T_2 from the pesudo and apparent T_2 maps at the baseline and during the vasodilation. For the normal dogs, there is no obvious difference in the regional T_2 (LCx vs. SEP) during the vasodilation compared with the baseline dataset. In contrast, for the stenotic dog, after the injection of the dipyridamole, there is an apparent difference in the regional T_2 (SEP > LCx). The LCx area has a 15.9% lower in pseudo T_2 and 6.4% lower in apparent T_2 relative to its SEP area. Therefore, pesudo T_2 showed a slightly higher (larger regional difference) sensitivity to the change in myocardial blood flow during the vasodilatation because of the T_1 effect of increased blood flow during vasodilatation.

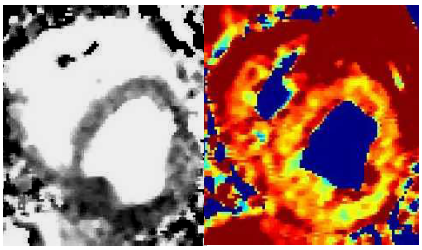

Fig.1: Pseudo (from trueFISP sequence) and apparent T_2 map (from TSE) in a dog with moderate stenosis in the distal LCx at the peak of DIP induced hyperemia

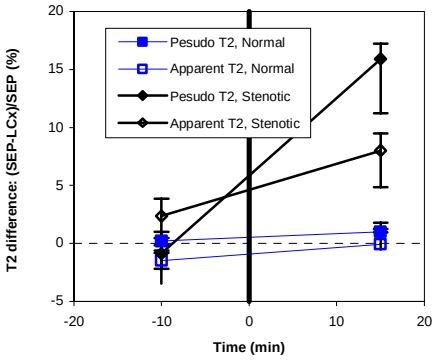

Fig.2: Regional T_2 difference percentage (SEP-LCx/SEP) calculated from pseudo and apparent T_2 map in the normal and stenotic dogs

Conclusions: Regional changes in myocardial blood flow and/or oxygenation in the myocardium during pharmacological induced stress can lead to regional differences in T_2-weighted MR images. Pesudo T_2 maps obtained by using T_2-prepared trueFISP sequence could detect significantly higher regional difference than the apparent T_2 maps acquired by the TSE sequence. The Pesudo T_2 maps may be useful to define the ischemia regions in a clinical setting.