Method for Multi-Slice Quantitative Measurement of Myocardial Perfusion

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Introduction:

Current techniques of myocardial perfusion quantification using MR require the measurement of the arterial input function or the concentration of the contrast media in the blood pool. The notched perfusion acquisition of Slavin, et al. (1) meets the requirements of being able to provide good spatial coverage of the myocardium and high image S/N through the use of longer actual TI times (2) after the application of a saturation-recovery preparation rf pulse. However, as the signal in the ventricular blood pool may contain a mixture of saturated and unsaturated spins, it is not an accurate representation of the arterial input function. The proposed method seeks to maintain the spatial coverage advantage of the notched saturation but yet allow the acquisition of a measurement slice for a more accurate representation of the arterial input function.

Methods:

In the notched perfusion sequence, a saturation recovery rf pulse (SR1) is followed immediately by the acquisition sequence of slice 1 (SL1). A saturation recovery rf pulse and slice acquisition occurs after SL1 for each slice in the scan. Each saturation pulse rf pulse is effective everywhere except for the immediate slice being acquired. The spins in SL2 will have experienced the effect of SR1 with an actual TI time equivalent to the time needed to play out the preparation segment, SR1 and the image acquisition segment, SL1. Similarly, SR2 is effective everywhere except over the slice location SL2 and prepares the magnetization for readout at a later TI time at SL3. The TI time for SL1 is the result of the last saturation rf pulse from the previous R-R interval and may be inconsistent due to variations in heart rate. Unsaturated blood from the notched pulse can flow into any imaged slice and mix with saturated blood leaving the blood pool signal indeterminate and somewhat independent of contrast media concentration. In the proposed approach, the first notched preparation pulse is replaced by a non-selective rf pulse SR1'. In addition, SL1 is modified to have half the spatial resolution of the other imaging sequences. The acquisition and TI times for slice 1 are now SL1' = SL1/2 and TI1' = SL1/2 respectively. The non-selective saturation recovery pulse, SR1', is effective for slice 1 and also the next slice (SL2) in the series. SL1' can now be placed at any orientation or plane independently of the other slice locations. This allows the user to prescribe a slice along the pulmonary vein or aortic outflow tract for a better measurement of the contrast media concentration (input function).

Results And Conclusions

The Figures below show the "calibration slice" through the aorta and one-of-three short-axis ventricular slices (LV), and the time series plots of the out flow from the aorta and three LV slices. With a reduced spatial resolution of 128x64 pixel, the first pass of a 0.05 mmol/kg of gadolinium in the aortic outflow tract is clearly noted. The proposed technique allows the same number of slices (6-10) per acquisition as with the conventional notched saturation sequence. As shown in Fig. 3, the input function measured in the aorta using the hybrid approach shows less distortion in the time-course profile as noted in that measured from the ventricular blood in the short axis slices. This hybrid technique provides a means to acquire a high quality, repeatable input function of the contract bolus and multi-slice perfusion data in the heart in a single scan.

FIGURE 1
AORTA CALIBRATION SLICE

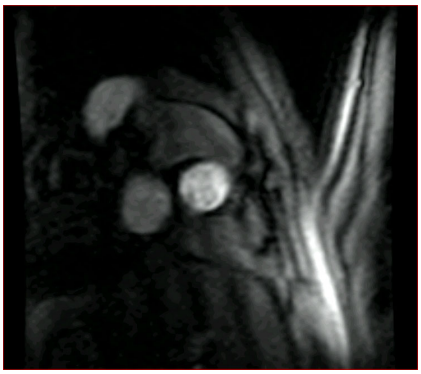
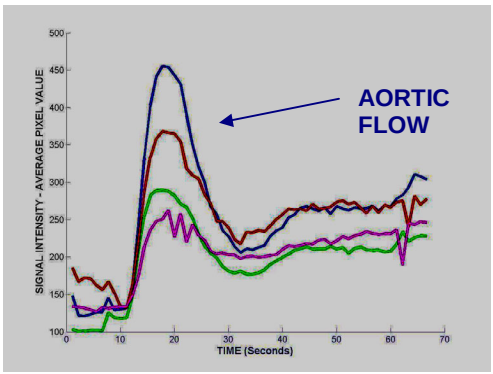


FIGURE 2
LEFT VENTRICLE

FIGURE 3
OUTFLOW OF AORTA & 3 LV SLICES



References:

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