Myocardial Perfusion Imaging with Arterial Spin Labeling Using Saturation-Prepared TrueFISP

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INTRODUCTION

Arterial spin labeling (ASL) is a non-invasive technique used to measure the myocardial perfusion without applying contrast agent. This can be assessed by measuring the difference in the longitudinal relaxation time T_1 between global and slice-selective spin preparation (1). To sample the T_1 relaxation curve several images are acquired within a single breath-hold using a saturation recovery Turbo FLASH (SR-TurboFLASH) pulse sequence (2,3). Due to the low signal to noise ratio (SNR) and contrast to noise ratio (CNR) the image quality is not sufficient for a precise T_1 calculation. In this work a saturation prepared TrueFISP (SR-TrueFISP) (4) combined with ASL is tested to achieve a higer contrast and an improvement in image quality to study the changes in the myocardial perfusion.

MATERIAL AND METHODS

The SR-TrueFISP and SR-TurboFLASH sequences were implemented on a 1.5 T whole body scanner (SIEMENS Symphony, Erlangen, Germany). To sample the T_1 relaxation curve both sequences acquire ten images at ten saturation recovery times TS between 100 ms and 4500 ms, both with slice-selective and global saturation. For each TS, an initial ECG-trigger delay is adjusted by heart rate to acquire enddiastolic images. Depending on the individual heart rate ten images are acquired in a period of 14 -20 seconds within a single breathhold. After the saturation recovery times TS, data acqusition is performed with a TrueFISP and a TurboFLASH acquisition module. Imaging parameter are : (TR / TE / α / FOV / matrix / slice) = FLASH(2,5 msec/ 1,1msec/ 10°/ 280x280mm^2/ 80x128/ 9 mm); TrueFISP (2,8 msec/ 1,4msec/ 50°/ 280x280 mm^2/ 80x128/ 9 mm).

The SR-TrueFISP was tested on a phantom consisting of 8 tubes with different solutions of Gd-DTPA (T_1 between 100-1000 msec). For comparison values were measured with a standard inversion recovery pulse sequence. Experiments on healthy volunteers were performed in short axis plane of the heart. T_1 was fitted with a three-parameter exponential fit from acquired image intensity in the regions of interest (ROI).

RESULTS

T_1-measurement in phantom using SR-TrueFISP shows no systematic deviations and agree within 6% with T_1 values measured by the standard technique. Fig.1 shows one of the ten images in the short axis plane of the heart acquired after global saturation. The left image is acquired with SR-TurboFLASH and the right image with SR-TrueFISP. Saturation time was 800 ms.

The obtained mean T_1 values and the SNR from the ROIs (Fig.1) in SR-TurboFLASH and SR-TrueFISP measurements are:

SR-TrueFISP: $T_{1global}$ = (1210 ± 86) msec, $T_{1selective}$ = (1100 ± 80) msec and SNR = 70 ± 12.

SR-TurboFLASH: $T_{1global}$ = (1260 ± 70) msec, $T_{1selective}$ = (1170 ± 80) msec and SNR = 26 ± 8.

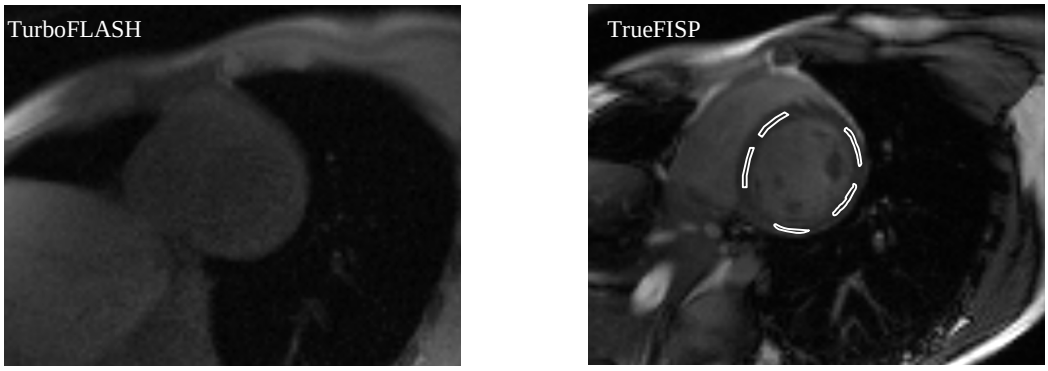

Fig.1: Amplitude images after global saturation (TS = 800 msec). Left: SR-TurboFLASH image. Right: SR-TrueFISP image.

DISCUSSION AND CONCLUSIONS

SR-TrueFISP images show a better quality and provide a higher contrast and SNR compared to the SR-TurboFLASH images. This allows easier, reproducible and more precise drawing of the ROIs in the myocardium for evaluating of T_1 relaxation time. With the evaluated T_1 relaxation time the quantitative myocardial perfusion can be calculated [1]. Additionally changes in the myocardial perfusion can be assessed by measuring the difference in the T_1 relaxation time after slice-selective saturation before and during pharmacological stress induced by adenosine.

REFERENCES

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