Comparison of the Reproducibility of Myocardial Perfusion Measurements using TrueFISP and TurboFLASH

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Aim:

Intra- and interobserver variability of semi quantitative myocardial perfusion MRI with TrueFISP and TurboFLASH pulse sequences at low dose contrast agent dosage (0.04 mmol/kg BW) should be compared.

Materials and Methods:

All measurements were performed on a 1.5T Magnetom Sonata (Siemens, Erlangen, Germany).

For the examinations two pulse sequences were used: Saturation Recovery TurboFLASH with TR/TE/TI/α=192ms/1ms/100ms/18° and a bandwidth of 765Hz/pixel, and Saturation Recovery TrueFISP with TR/TE/TI/α=192ms/0.91ms/100ms/50° and a bandwidth of 1260Hz/pixel. Both pulse sequences had a slice thickness of 8mm and a matrix of 128x78 pixels. Both pulse sequences had the same temporal and spatial resolution. Using ECG-gating 3 slices could be acquired per heartbeat.

With each pulse sequence 20 patients were examined. They underwent 2 first-pass perfusion examinations both under resting and under stress-conditions (Adenosin 140µg/kg BW/min). Contrast agent dosage was 0.04mmol Gd-DTPA/kg BW to remain in the linear rage of the CA to signal-intensity relation. Evaluation was performed using 6 segments per slice [1].

For determination of the inter- and intraobserver variability every examination was evaluated by 2 observers (AK and AZ) whereby one observer (AZ) did the evaluation twice. To compare the two pulse sequences the mean variation coefficient (VC) was calculated following Eq. 1. Moreover, the median Signal-Noise-Ratio (SNR) before arrival of the CA was calculated for each pulse sequence (Eq. 2).

$$VC = \sqrt{\frac{1}{2}} \cdot \frac{|x_1 - x_2|}{\frac{1}{2}(x_1 + x_2)} \cdot 100\%$$

[Eq. 1]

x1 and x2 are results from different evaluations in the same patient/segment

$$SNR = \frac{SI_{preCA}}{\sigma_{noise}}$$

[Eq. 2]

SI_{preCA} is the mean signal intensity before arrival of the CA in the myocardium and σ_{noise} the standard deviation in a noise region.

Results:

For each pulse sequence approximately 320 segments could be evaluated by both observers.

TurboFLASH: The VC of the Interobserver variability was (24±22)%, of the Intraobserver variability (26±23)% (cf. Fig. 2). The smallest VC was obtained in the medial slice (Inter (20±8)%, Intra (20±18)%), the highest in the apical slice (Inter (30±24)% Intra (31±26)%) (cf. Fig. 3b). In the medial slice a mean SNR of 18±4 was reached.

TrueFISP: The VC of the Interobserver variability was (21±20)%, of the Intraobserver variability (23±22)% (cf. Fig. 2). The smallest VC were also reached in the medial slice (Inter (14±14)%, Intra (14±15)%), the highest in the apical slice (Inter (25±20)% Intra (32±26)%) (cf. Fig 3a). In the medial slice a mean SNR of 25±6 was measured which was significantly different from the SNR reached by the TurboFLASH pulse sequence ($p<0.001$, t-test, cf. Fig. 2).

Variability differed significantly between the two sequences ($p<0.05$, Rank Sum test). Moreover, the variability of the medial slice was significantly smaller than the variability of the other two slices when acquired by the TrueFISP pulse sequence, and significantly smaller than the variability of the apical slice when acquired with the TurboFLASH pulse sequence ($p<0.01$, Rank Sum test).

Discussion and Conclusion:

Compared to the TurboFLASH pulse sequence the TrueFISP pulse sequence shows a better reproducibility and should be used for MPR-determination.

The better reproducibility is a result of the better SNR of the TrueFISP pulse sequence compared to the TurboFLASH pulse sequence, an observation also made in other studies [2, 3]. It leads to a better differentiation between myocardium, ventricles, and pericardial tissue.

Also noticeable is the difference in reproducibility between the medial and the apical slice which is caused by reduced partial volume effects in the medial slice.

In conclusion our results demonstrate that an increase of the quality of the examination up to 50% can be obtained by using the TrueFISP pulse sequence and by performing an accurate slice positioning to avoid partial volume effects.

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Literature:

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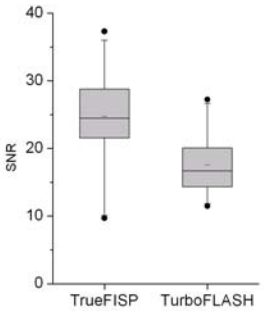

Fig. 1: *Mean pre contrast SNR of both pulse sequences. Values of the TrueFISP pulse sequence are significantly higher ($p<0.001$).*

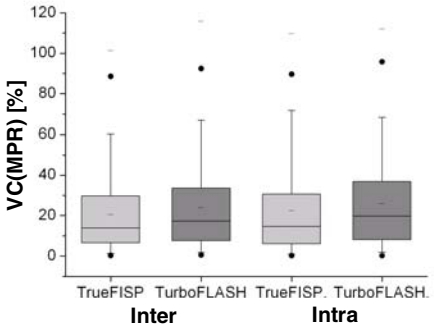

Fig. 2: *Inter- (left) and intraobserver variabilities (right) for the two pulse sequences. The differences between the pulse sequences are significant.*

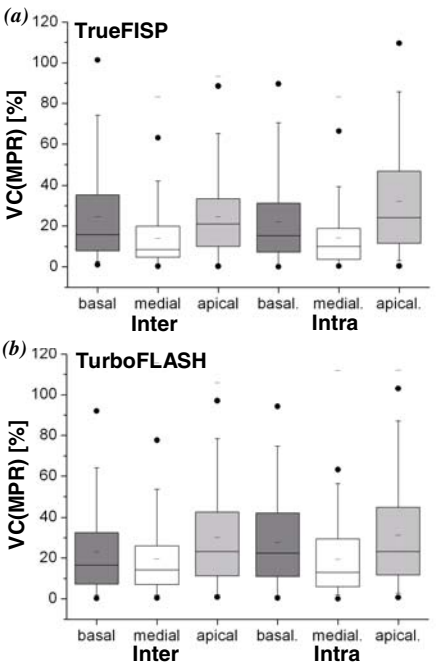

Fig. 3a + b: *Inter- (left) and intraobserver variabilities (right) for the two pulse sequences separated for the three slices. The differences between the medial slice and the other two slices are significant for the TrueFISP pulse sequence (a) and between the median slice and at least the apical slice for the TurboFLASH pulse sequence (b).*