Influence of Flip Angle Sweep on image contrast in liver imaging at 3T

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Introduction: T2 weighted Turbo- or Fast Spin Echo Sequences (TSE/FSE) are the backbone of abdominal and pelvic imaging at 1.5T. At higher field strength the benefit of TSE Sequences in reducing acquisition time is restricted by SAR restrictions. SAR increases among other things proportionally with the square of the field strength and the square of the angle of the radio frequency pulses, so SAR is mainly affected by the several 180 degree pulses in TSE Sequences. The numerous 180 degree pulses in TSE sequences are the main contribution to the energy deposition. To overcome the SAR limitations techniques to modulate the angles of the refocusing pulses along the echo train were established, such as; Hyperecho or Flip Angle Sweep (FAS). The value of refocusing angle modulations at 3T was shown in brain and pelvic studies but information on the impact on image contrast is poor. Aim of this study was to analyse alterations of image contrast in liver MRI at 3T using different FAS angles.

Material and Methods: Seven volunteers were examined at a 3T system (Intera, Philips, Best – NL) with a respiratory triggered T2 weighted multishot TSE sequence (TR/TE: > 4000/80 ms; fov/matrix: 4000/256; slice thickness/gap/slices: 8/20 mm/5; ETL:18) using a synergy six element cardiac coil. Two syringes filled with water and manganese solution (0.6 mmol) were placed left and right of the volunteers. The sequence was performed without FAS and with FAS angles of 150, 120, 90, 75, 60 and 30 degrees. SNR was calculated by the mean of three measurements in each tissue. ROI were placed in the liver, the paravertebral muscles, the spleen, the kidneys, the subcutaneous fat as well as in both syringes. ROI did not vary in size, shape or location between the different data sets. Noise was measured outside the body perpendicular to the phase encoding direction. Contrast between the liver and the different tissues / probes was calculated by: (SNR(Liver) – SNR(tissue x)) / (SNR(Liver) + SNR(tissue x)).

Results:
With decreasing refocusing pulses the SNR values of the kidney parenchyma, the spleen, the subcutaneous fat and the water decreases by about 35 – 50% (FAS 180° versus 30°) while the SNR of the liver parenchyma and the paravertebral muscle did not significantly change (muscle –5.7%, liver –1.8%) (Fig.1). Consequently the contrast between the liver tissue and the other tissues is reduced at smaller FAS angles. However we found an increase in SNR of the manganese solution of about 300% by lowering the FAS angle from 180° to 30° (Fig.2).

Discussion:
The decrease of the SNR does mainly affect the tissues / probes with initially high SNR values while intermediate tissues like the liver and muscles parenchyma do not show relevant changes. The manganese solution with a T1 time of about 180 ms and a T2 time of 25 ms shows an SNR increase. The explanation for this finding remains unclear. It is not likely that the reduction of the FAS angle leads to a lowering of the effective TE. Further studies are required to show if stimulated echoes or the profile ordering in k – space contributes to the observed phenomenon. Apart from the technical aspect the consequence for clinical imaging is to use techniques like FAS with caution because the reduced contrast may affect lesion detection and characterisation.

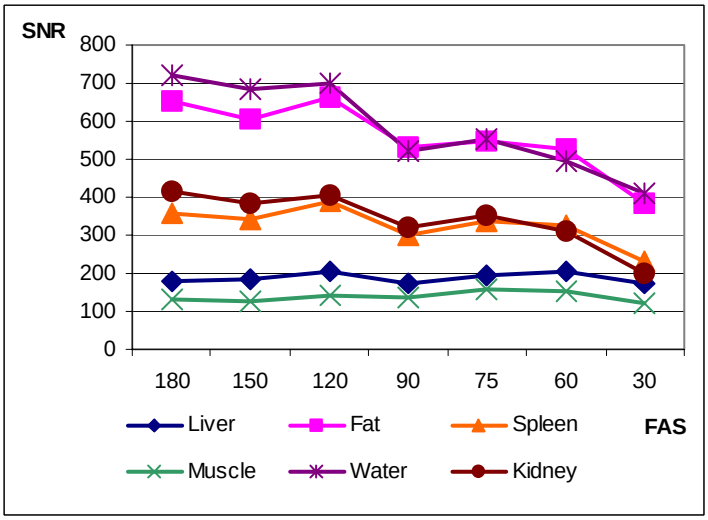

Fig.1: Tissue SNR at different FAS angles

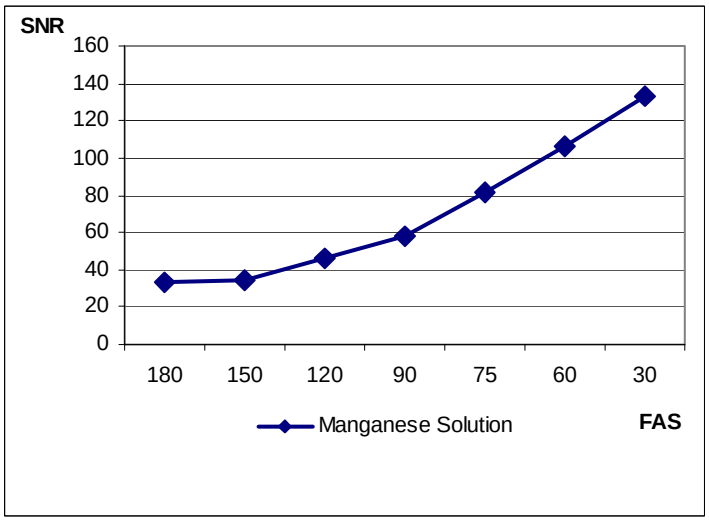

Fig.2: SNR of manganese solution at different FAS angles