Fast Magnetization Transfer Imaging, a comparative study.

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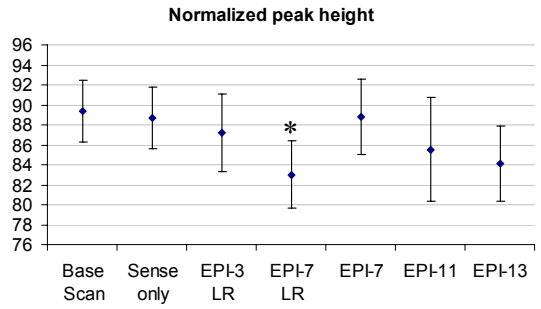
Aim: Explore the effect of scan time reduction by use of parallel imaging and segmented EPI on basic MTR histogram parameters.

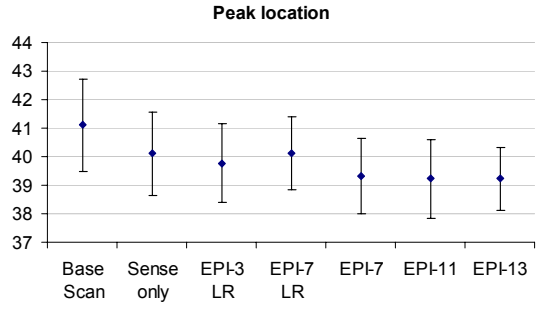
Introduction: Magnetic Transfer Imaging (MTI) has become an important measure to reveal parenchymal integrity in diseases like Multiple Sclerosis, NPSLE and Alzheimer's Disease.[1,2,3] Since MTI requires a proton density weighted scan with 2 dynamics (one with and one without radiofrequency saturation pulse), acquisition times of more then 10 minutes are not uncommon. However, for a broader clinical application, reduction of scan time is essential. In the present study we investigated the effect of parallel imaging (SENSE) and segmented Echo-Planar Imaging (EPI) on MTI parameters.

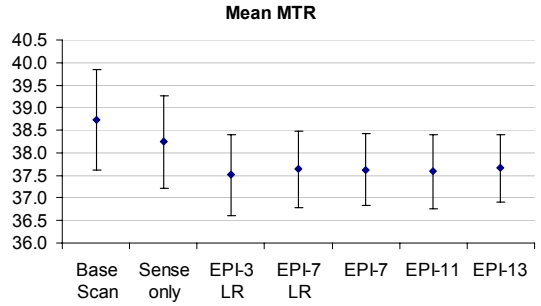
Methods: Nine healthy volunteers were included (age 24-47 years, 6m/3f). Baseline MTI consisted of a spoiled 3D FFE sequence, with and without an off resonance MT pulse. The following parameters were used: TR/TE/FlipAngle: 100ms/3.7ms/6^0, FOV: 220 mm, Matrix size: 224x224, slice thickness: 7.2 mm, 20 contiguous slices. All nine subjects underwent 7 MTI scans: Table shows main difference in acquisition parameters. In two scans, marked with LR (low resolution), the in-plane resolution was reduced. To reduce acquisition time, parallel imaging (SENSE) and segmented Echo-Planar Imaging (EPI) were applied. The base scan was used for intra cranial volume segmentation using SNIPER[4] software, after which the cerebellum and brainstem were removed manually. This edited segmentation mask of the base scan was used for final analysis and was co-registered to all other scans. Voxels containing CSF were excluded by applying a MTR cut off value of ≤ 20, followed by an erosion of the brain parenchyma with one voxel. To study the effects of acquisition time reduction on MTI parameters changes in MTR histogram peak height, peak location and mean MTR were evaluated.

Scan name	SENSE factor	EPI factor	In-plane voxel size mm	Scan time mm:ss
Base Scan	--	--	1.0 x 1.0	12:29
Sense only	2	--	1.0 x 1.0	6:24
EPI-3 LR	2	3	1.0 x 2.1	1:19
EPI-7 LR	2	7	1.0 x 2.0	0:32
EPI-7	2	7	1.0 x 1.0	1:08
EPI-11	2	11	1.0 x 1.0	0:42
EPI-13	2	13	1.0 x 1.0	0:37

Main difference in parameters in subsequent MTI scans. EPI factor represents the number of k-space profiles collected per excitation pulse.







Results: The graphs show normalized peak height, peak location and mean MTR. The values shown are the average of 9 subjects; bars indicate ± 1 standard deviation. One-way ANOVA followed by Bonferroni post hoc tests showed no significant differences in histogram peak height for the base scan and fast MTI scans, except for the low resolution EPI-7 ($p < 0.05$) compared to base scan. No significant differences between base scan and fast MTI scans was found for the histogram peak location and mean MTR. Moreover, no significant difference was found in standard deviation among the separate scans for all three MTR parameters.

Conclusions and discussion: The most important findings of this study are twofold: 1. Average histogram peak height, peak location, and mean MTR do not change significantly for fast MTI. 2. Standard deviation for histogram peak height, peak location, and mean MTR do not change significantly for fast MTI.
These findings implicate that parallel imaging and segmented EPI enables whole brain MTI in strongly reduced acquisition time of less then one minute. Furthermore, since the standard deviation is also unaffected with decreasing acquisition time, these rapid MTI scans achieve same statistical power as compared to studies where a non SENSE and non EPI scan is applied.
Although histogram characteristics do not change significantly, sensitivity for different kinds of pathology needs to be evaluated for fast MTI.

References:

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