Comparative analysis of Spin Echo and Gradient Echo sequences for MTR evaluation

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OBJECTIVE: To date, Magnetization Transfer Imaging (MTI) has been performed using either Spin Echo (SE) or Gradient Echo (GRE) sequences, generating varying sequence dependent Magnetization Transfer Ratio (MTR) values. Previous studies have addressed the reproducibility of MTR values obtained from different scanners and at different imaging centers. The objective of this study was to determine whether on the same scanner, a consistent correlation factor with which to relate MTR values obtained from commonly used SE and GRE sequences could be found. If so, quantitative MTR data can be consistently evaluated using either of the two sequences.

SUBJECTS AND METHODS: Imaging was performed on a 1.5T GE Signa scanner, and for both the sequences, 20 slices with a thickness of 5 mm and interslice gap of 1.5 mm were obtained. The parameters for the SE sequence were: TR= 416, TE = 8, FOV = 24x18 with an RF pulse of 1.2 kHz and a bandwidth of 15.63 Hz, while the parameters for the 2D GRE sequence were: TR = 600, TE = 12, Flip angle = 20º, FOV = 24x18 with an RF pulse of 1.5 kHz and a bandwidth of 250 Hz. The two scanning protocols were performed on 10 Normal subjects (7 males and 3 females) with no prior history of any brain related illness. The images obtained were initially segmented into white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF). MTR was calculated for WM, GM and total brain (TB) without CSF by the formula MTR= (Mo-Ms)/Mo, where Mo is the magnitude of the voxel without the saturation pulse and Ms is the magnitude of the voxel with the saturation pulse applied. MTR histograms were created for each sequence and the peak height, peak height location and the mean MTR calculated for the whole brain volume.

RESULTS: The intensities of images with and without the saturation pulse have a greater spatial resolution for the GRE sequence as compared to SE; therefore the GRE sequence used for this study produces greater visual contrast and consequently higher MTR values than the SE used (Fig. 1 and Fig.2).

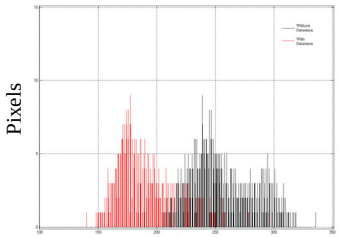

Figure 1. Image intensity histograms of images with (red) and without (black) saturation for GRE

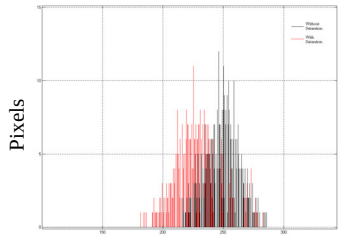

Figure 2. Image intensity histograms of images with (red) and without (black) saturation for SE

Correlation Factor was computed by calculating the difference between the mean MTR values for WM, GM and TB; and this value was found out to be consistent for all the subjects. The correlation factor value for WM was 0.07 ± 0.01, for GM it was 0.11 ± 0.01 and for TB it was 0.10 ± 0.01. The correlation factor, mean MTR, peak height and peak height location for both the SE and for the GRE sequence are as shown in the Table.1 below:

	White Matter		Gray Matter		Total Brain	
	GRE	SE	GRE	SE	GRE	SE
Mean MTR	0.32 ± 0.03	0.25 ± 0.02	0.29 ± 0.03	0.18 ± 0.02	0.31 ± 0.03	0.21 ± 0.02
Normalized Peak Height	0.09	0.08	0.08	0.06	0.07	0.05
Peak Height Location	0.34 ± 0.03	0.25 ± 0.01	0.31 ± 0.03	0.18 ± 0.01	0.32 ± 0.03	0.22 ± 0.02
Correlation Factor (GRE-SE)	0.07 ± 0.01		0.11 ± 0.01		0.10 ± 0.01	

Table 1: The mean values of Mean MTR, Peak Height and Peak Height Location for all the subjects for both SE and GRE.

The difference between the two sets of data is observed from the MTR histograms for the two sequences as seen in fig. 3. Student's t-test was performed (fig. 4) and as expected, a significant difference was found between the two datasets confirming that MTR is a highly sequence dependent parameter.

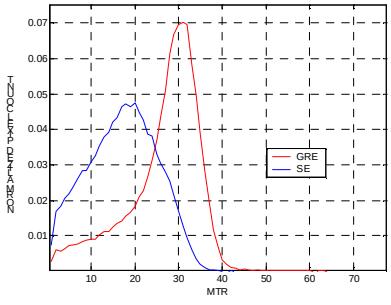

Figure 3.MTR histograms of GRE and SE

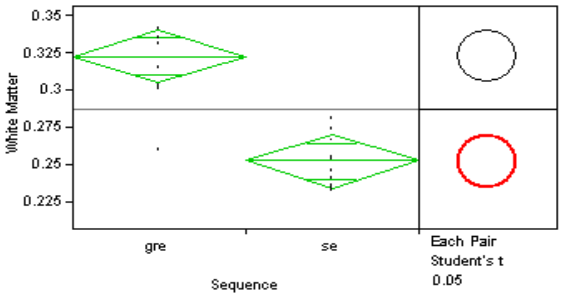

Figure 4. Results of Student's t-test.

CONCLUSION: MTI is an innovative contrast enhancing technique that highly sequence dependent, and the contrast change depends on the type of sequence used. We have shown that while there is no standard value for MTR, a correlation factor (0.07 for White Matter, 0.11 for Gray Matter and 0.10 for Total Brain) can be calculated in order to consistently correlate the data from SE and GRE sequences. With this correlation factor, it may be possible to evaluate MTR data regardless of which of the two sequences is used. This study was limited by a small sample size (n=10), and future studies are needed to increase the precision of the comparability of the results obtained from the two sequences.