MP-RAGE compared to 3D IR SPGR for Optimal T1 Contrast and Image Quality in the Brain at 3T

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Purpose

High resolution 3D T1 weighted imaging is of great clinical utility in neuroradiology. The superior gray-white contrast that these sequences provide is critical to identify subtle cortical malformations in patients with epilepsy. These techniques are also useful when performing volumetric analyses such as hippocampal volume measurements.

MP-RAGE and IR-SPGR are two commonly used techniques for 3D T1 weighted imaging. Both utilize spoiled fast gradient echoes for data acquisition during inversion recovery, but differ in view order and acquisition timing. Although both techniques produce images with good tissue contrast and spacial resolution, their results have not been thoroughly compared. This work evaluates the performance of MP-RAGE and IR-SPGR for high resolution 3D T1 weighted brain imaging by means of expert review and quantitative measurements.

Methods

Following IRB approval, ten healthy volunteers were scanned with both MP-RAGE and IR-SPGR in a single session on a 3T scanner using an 8 channel head coil. For MP-RAGE, an optimized protocol of 8^o flip angle, 7.1 ms TR, 3.0 ms TE, $\pm$ 32 kHz BW, 900 TI, 2400 ms TD, 24x18 FOV, 1.2 slice thickness, 256x256 matrix and 1 signal average was used to acquire a coronal 3D volume with 200 slices. The imaging parameters were the same for IR-SPGR except 15^o flip angle, 300 TI and 240 slices. The scan time for both MP-RAGE and IR-SPGR were matched at 7:23. On both pulse sequences, the gradient area of the end-of-sequence spoilers on the readout and slice-encoded axes was increased to 14mT/m · ms to reduce discrete ghosting, and the RF bandwidth of the inversion was pulse increased to 2.0kHz to reduce regions of incomplete inversion.

Images of both techniques were blindly reviewed and rated for overall image quality, perceived SNR, perceived CNR, definition of grey/white boundary and artifacts by three practicing neuroradiologists on a scale of 1 (poor) to 9 (excellent). SNR and CNR were also measured based on signal intensities in the ROIs of grey matter (GM), white matter (WM) and background noise regions.

Results

Table 1 shows the median ratings and statistical significance (Wilcoxon Signed-Rank Test) from the blind review. Table 2 shows the mean SNR and CNR measurements and statistical significance (paired T-test).

Table 1: Median Radiologist Ratings

	SNR	CNR	Sharpness	Artifact	Overall
MP-RAGE	9	9	8.5	8	9
IR-SPGR	8	8	8	7	8
$p < 0.01$	* (0.009)	* (0.009)	(0.09)	* (0.006)	* (0.006)

Table 2: Mean SNR and CNR Measurements

	GM SNR	WM SNR	WM-GM CNR
MP-RAGE	10.8	15.7	4.9
IR-SPGR	9.7	13.3	3.6
$p < 0.05$	* (0.011)	* (0.001)	* (0.001)

Discussion

While both the MP-RAGE (A) and 3D IR-SPGR (B) sequences scored well on blinded review, the MP RAGE sequence was favored. The results show a small, but highly significant improvement in various perceived indices of image quality of MP-RAGE versus IR-SPGR, with quantitative SNR and CNR measurements objectively supporting these results. Further evaluation needs to be performed on patients to evaluate lesion conspicuity as well as image quality in the presence of expected patient motion.

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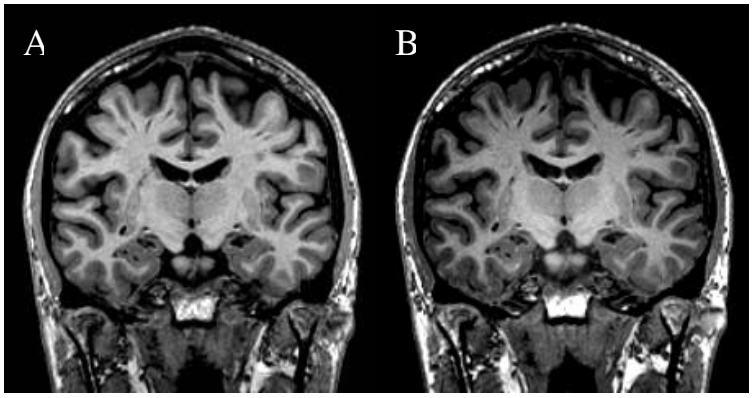

Similar coronal sections employing 3D MP RAGE (A) and 3D IR SPGR (B). Both sequences demonstrate pronounced T1 contrast, high SNR, and good spatial resolution