Cross-Platform Comparison of Brain MRE

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Introduction

Magnetic resonance elastography (MRE) is a technique for noninvasively measuring tissue stiffness [1]. MRE begins with the introduction of shear waves via an external vibration source. The resulting shear waves are imaged with a phase-contrast MRI pulse sequence incorporating motion-encoding gradients synchronized to the external motion. Finally, the shear wave images are mathematically inverted to calculate tissue stiffness. MRE is currently under investigation for its potential to aid in the diagnosis of brain diseases [2-8]. A well-developed MRE exam of the brain should be reproducible even when performed on different MR imaging platforms. The purpose of this work was to compare the reproducibility of MRE of the brain on two MR platforms manufactured by GE and Siemens.

Methods

MRE was performed on six male volunteers without known neurological disease after obtaining informed written consent. Coronal images were collected on a 1.5T GE Excite scanner with the following parameters: 60-Hz vibration, FOV=25.6 cm, TR/TE=83.3/20.3 ms, 2x SENSE acceleration, 30° flip angle, eight 4-mm slices, 64x64 imaging matrix reconstructed to 256x256, through-plane motion encoding with a single 16.7-ms gradient with amplitude 2.3 G/cm, and 4 phase offsets over one period of motion. The images collected on the Siemens scanner (1.5T Espree) were the same except: TE=23.2 ms, 2x GRAPPA acceleration, and a 256x64 imaging matrix reconstructed to 256x256 and a motion encoding gradient amplitude of 1.6 G/cm. Each scanner was equipped with an active acoustic driver system located outside of the scan room as described in [9] and the passive component was a thin flexible driver [10] 15x21x2 cm placed under the head. The wave images were filtered with eight 2D directional filters with a radial Butterworth bandpass filter with cutoffs of 8 and 40 waves/FOV [11]. The first harmonic of the filtered images were inverted with a 3D direct inversion algorithm in an 11x11x3 window [12]. The median stiffness for each MRE exam was calculated over a region of interest that included the two central slices of the collected volume excluding 12 voxels from the edge of the brain. Regression analysis was performed with a Spearman correlation and the two groups were compared with a paired-sample T-test.

Results

Example images from both platforms for one volunteer are shown in Figure 1. A Pearson's correlation yielded an R-value of 0.92 and a p-value of 0.01 (Fig.2). The two-way T-test demonstrated no significant difference between the stiffness measured on the two platforms (p=0.63). The median and maximum percent differences in the group of six were 2.19% and 9.40%, respectively.

Discussions

The results indicate that the stiffness measurements on the two platforms were significantly correlated, and the mean stiffness of the two groups did not differ. The percent differences between the two platforms for the six volunteers were comparable to typical repeatability of MRE of the brain [3].

References

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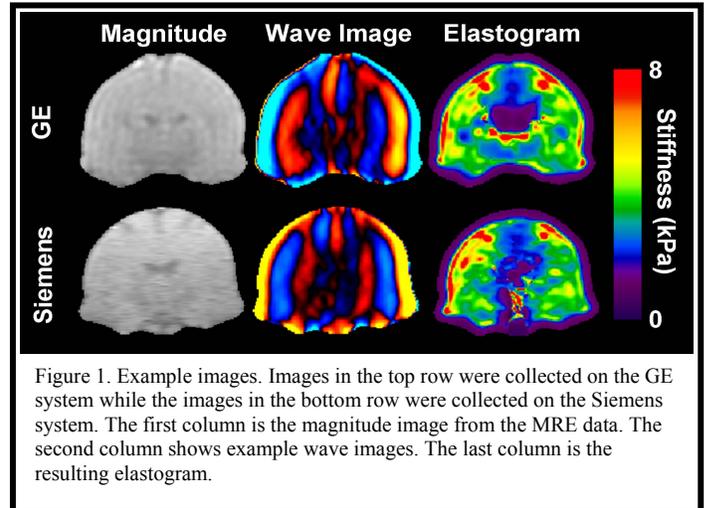
Figure 1. Example images. Images in the top row were collected on the GE system while the images in the bottom row were collected on the Siemens system. The first column is the magnitude image from the MRE data. The second column shows example wave images. The last column is the resulting elastogram.
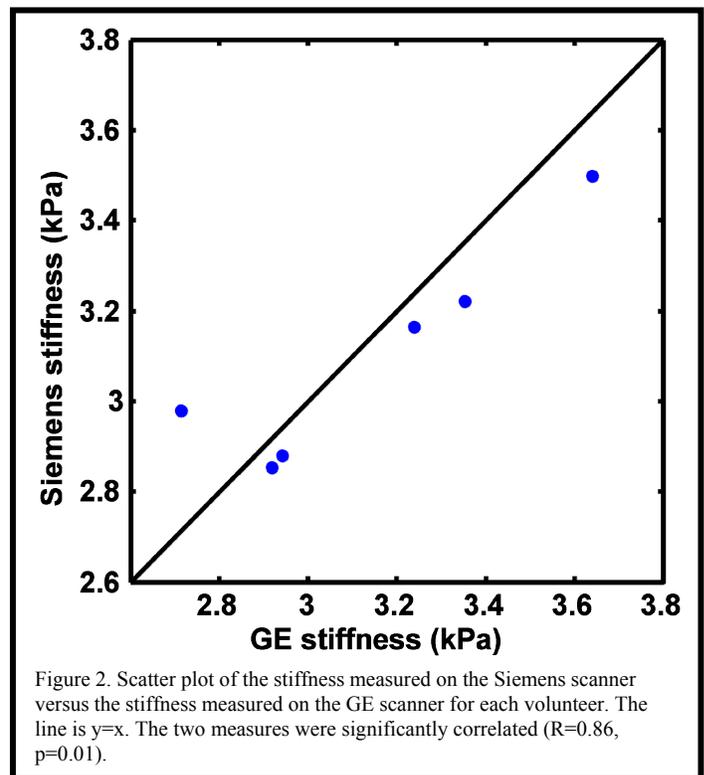

Figure 2. Scatter plot of the stiffness measured on the Siemens scanner versus the stiffness measured on the GE scanner for each volunteer. The line is y=x. The two measures were significantly correlated (R=0.86, p=0.01).