MR Elastography using Switching-Gradient-Induced Vibration of the Patient Table - Assessment of Reproducibility -

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INTRODUCTION

Magnetic resonance elastography (MRE) is a noninvasive technique for measuring tissue viscoelasticity [1]. A switching-gradient(s)-induced vibration (SGIV) before a conventional MRE pulse sequence could be used as a mechanical driving mechanism for MRE [2, 3]. To obtain large amplitude shear waves and accurate storage and loss modulus maps, SGIV was performed at selected harmonics of the mechanical resonance frequency of the patient table [3]. The advantage of this approach is that it can be easily adapted for clinical application, but reproducibility has not been confirmed. In this study, to evaluate reproducibility of MRE with SGIV scanning, the shear wave amplitude in gel phantoms of different weight were compared and the viscoelasticity of the human brain was measured twice to test the reproducibility of the technique.

MATERIALS AND METHODSs

A spin-echo EPI MRE sequence with SGIV (MREwSGIV) was used for data acquisition. Experiments were performed using a GE Signa HDx 3.0T MRI with an eight-channel phased-array head coil. The shear wave amplitude of tissue-simulating homogeneous polyacrylamide gel phantoms and *in-vivo* human brain (a healthy female, 21 years old), and storage and loss moduli of the brain were measured. We performed the brain study twice under identical conditions. The cylindrical gel phantoms weighed 2 kg and 5 kg and had a known storage modulus of 1.6 kPa. For the 2 kg gel phantom study, a 60 kg water tank was placed in the middle of the patient table to simulate the weight of a human body. The MREwSGIV imaging protocol was: repetition time (TR) = 2000 ms, field of view (FOV) = 224 x 224 mm^2, image matrix = 64 × 64, slice thickness = 3.5 mm, number of slices = 7, phase offsets = 4, number of motion-sensitizing gradient (MSG) cycles = 1, MSG gradient amplitude = 4.0 G/cm, SGIV gradient amplitude = 0.2 G/cm (phantom), 4.0 G/cm (*in-vivo*), MSG and SGIV driving frequency = 25 to 60 Hz, spacing 1 Hz (phantom), 26 to 47 Hz, spacing 7 Hz (*in-vivo*) and SGIV duration time = 0.5 s. SGIV and MSG were applied along the x-axis. A direct inversion algorithm [4] was applied in order to calculate the storage and loss modulus maps.

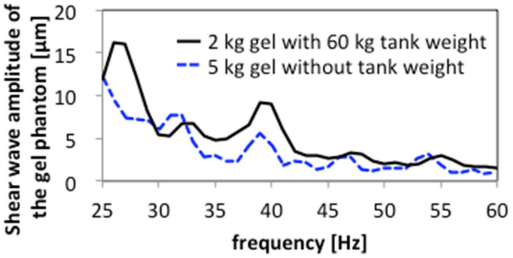

Figure 1 Shear wave amplitude of the gel phantoms.

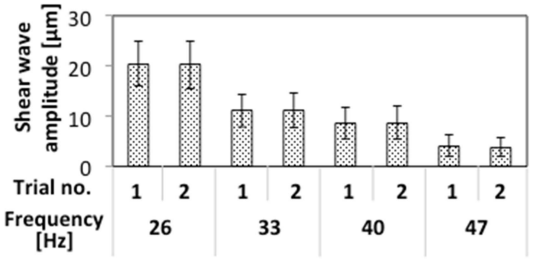

Figure 2 Shear wave amplitude of *in-vivo* human brain.

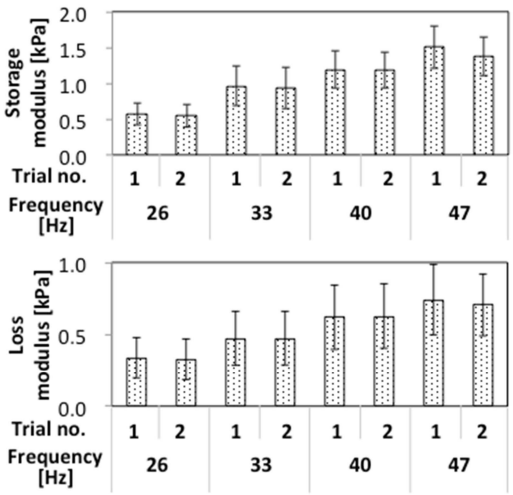

Figure 3 The storage and loss moduli of *in-vivo* human brain.

RESULTS

Figure 1 shows the shear wave amplitude of the gel phantom at each driving frequency. Independent of phantom weight, an interval of about 7 Hz separated resonance peaks. For the 2 kg gel + 60 kg tank study, the peaks at 26, 33, 40, and 47 Hz have amplitudes of 16, 7, 9, and 3 μm, respectively. The shear wave amplitude of *in-vivo* human brain gradually decreased with driving frequency as shown in Figure 2. The storage and loss moduli of *in-vivo* human brain both gradually increased with the driving frequency as shown in Figure 3 and Figure 4. There were no statistical differences between the values measured from the two experiments repeated under identical conditions.

DISCUSSION

The reason that the shear wave amplitude of the brain gradually decreases and the storage and loss moduli of the brain gradually increase with frequency is probably because the viscosity of the tissue is high.

CONCLUSION

In this study, we successfully measured the vibration amplitude and storage and loss moduli of in vivo brain with MREwSGIV scanning. The results suggest that MREwSGIV enables reproducible measurement of the brain elasticity.

REFERENCES

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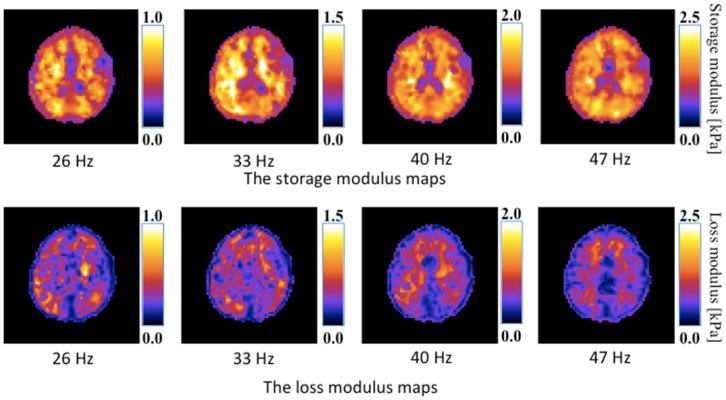

Figure 4 The storage and loss modulus maps of *in-vivo* human brain.