Complex Shear modulus and shear wave speed measurements of QIBA-SWS CIRS Phantoms by using MR Elastography (MRE)

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There were three major steps to measure stiffness on QIBA phase II phantoms (CIRS) using MR Elastography (MRE): 1) Shear wave generation using shear driver: To generate shear wave propagation in the phantoms, a square MRE electromechanical PVC shear driver (6.4 cm X 6.4 cm X 0.3 cm) was placed on top of the phantom with a light compression for keeping the shear mechanical coupling. The driver frequency ranged from 60 Hz to 200 Hz (20Hz interval), with MRE performed at each mono frequency respectively. 2) Shear wave Imaging sequence: To acquire shear wave propagation images in the phantoms using a 3D MRE wave imaging sequence, the following major parameters were used in the study: FOV = 21.6 cm, matrix = 128X128, TR = 1600 - 2314 ms, TE = 62.7 - 119 ms, slice thickness/spacing = 3.5/0 mm, 16 slices, motion sensitivity (MENC) = 4.5 - 25.2 micron/pi radians, motion sensitivity direction = x/y/z, axial imaging plane. One channel head coil and a 1.5T GE Signa scanner (Waukesha, WI, USA) were used. 3) Complex shear modulus calculation: To process wave images and compute elastograms, 3D MRE direct inversion (DI) algorithm was used [[1](#_ENREF_1)]. ROIs were then drawn in the middle 8 slices of stiffness map. Mean and standard deviation of magnitude complex shear stiffness (kPa), as well as its real and imaginary parts (kPa) were reported. Wave speed, phase velocity (m/s) was calculated by converting complex shear modulus according to = + ,   , whereas and are the real and imaginary parts of the complex shear modulus (kPa), and is the phase velocity (m/s) [[1](#_ENREF_1)].

Prior to the MRE exams, phantoms were kept in different rooms at different temperatures (20°C and 23.9°C) overnight for at least 8 hours to achieve temperature equilibrium.

1. Oliphant, T.E., et al., *Complex-valued stiffness reconstruction for magnetic resonance elastography by algebraic inversion of the differential equation.* Magnetic resonance in medicine, 2001. **45**(2): p. 299-310.