Brain tissue velocimetry (TV): a novel ultrasound technique for detection of brain injury? Proof-of-concept study in healthy volunteers (299/300 words)

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Background: In this feasibility study we assess whether measuring tissue movement in the brain using transcranial Doppler (TCD) ultrasound may help determine brain tissue pathology (swelling, ischaemia and haemorrhage) in patients with suspected stroke or traumatic brain injury. We hypothesize that brain tissue movement and the shape of tissue displacement waveforms will change if brain damage is present. Initial evaluation of this novel technique, coined Brain Tissue Velocimetry (TV), was carried out by recording and evaluating displacement waveforms from the brain tissue of healthy volunteers.

Method: TCD and ECG data were recorded simultaneously from healthy volunteers. The transducer was fixed to the temporal window and the forehead using a headset whilst volunteers lay in three different positions: sitting, 45 degrees and supine. TCD data were collected from 33 gates (22 – 86 mm range) for 8 seconds. Waveforms were filtered to remove respiration and subdivided into cardiac cycles using the ECG R-R intervals. Fourier analysis was then used to estimate the harmonic content for each cardiac cycle before averaging.

Results: Tissue displacement waveforms from all 33 gates were successfully recorded from both positions for 10 healthy volunteers, 5 male (23–37 yrs) and 5 female (20–53yrs). Maximum tissue displacements from the 1st harmonic of 61 ± 17 µm, 68 ± 21 µm and 81 ± 19 µm were measured for sitting, 45 degrees and supine respectively. Waveform shape assessed through Fourier analysis was consistent between gates with the same directional tissue motion (contraction or expansion) but changed for gates containing opposing tissue motion and/or suspected regions of the brain with different acoustic properties.

Conclusions: Brain TV can be used to measure brain tissue pulsations in healthy volunteers from the forehead and temporal window. Brain TV data recorded from Stroke patients and patients with traumatic brain injury is currently underway.