Semi-automatic vendor independent software for assessment of local arterial stiffness

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Background: Stiffened arteries represent a major cardiovascular risk. A reliable non-invasive technique for determining pulse wave velocity (PWV) would be useful to facilitate the clinical determination of arterial mechanical properties.

Aim: This work aims to introduce a vendor independent software for the non-invasive extraction of arterial stiffness from ultrasound images.

Methods: We have developed an intensity-based software for determining the edges of the luminal arterial walls (M-mode) and diameter deformation waveform from ultrasound images in DICOM format. The software also traces the envelope of the blood velocity (PW Doppler). The user selects the starting points and levels for thresholding (brightness level) for the upper, lower walls and the flow velocity. The software displays the resulting diameter waveform, following the subtraction of the two walls, then the extracted flow velocity of the ultrasound image.

The upstroke of the two waveforms is automatically determined by checking the deviation from linearity as well as the slope of the initial linear part when the two waveforms are plotted in ln(D)U-loop[1]. The user can correct for these parameters automatically determined. This lag occurs due to sequential acquisition of the waveforms. Arterial stiffness is determined by extracting PWV, which is proportional to the slope of ln(D)U-loop during early systole.

The software was tested on 10 healthy volunteers (22-32 years, 4 females) recruited form Brunel University students.

The results were compared against carotid-femoral measurements (cfPWV) which was determined using SphygmoCor (Xcel PWA & PWV).

Results: cfPWV is 30% higher than the local PWV in the ascending aorta from ultrasound images (6.0±0.6 vs. 4.1±0.9m/s). This difference is due to the inclusion of smaller arteries in the carotid-femoral pathway.

Conclusions: The software described here can be used to assess non-invasively, local arterial stiffness, by using ultrasound measurements of the diameter and velocity waveforms.

[1] J.Feng, AW.Khir, J Biomechanics 43(2010)455-462.