Poster Session : P30

Mechanical characterisation of polyvinyl-alcohol cyrogel for non-standard sample geometries

Andrew Malone [a], Seán Cournane [b], Andrew Fagan [c], Jacinta Browne [c]

[a] *Technological University Dublin, Ireland*
[b] *St Vincent's University Hospital, Ireland*
[c] *Mayo Clinic, Ireland*

Polyvinyl-alcohol cyrogel (PVAc) is a polymer, the stiffness of which can be adjusted through application of consecutive freeze-thaw cycles. This material has potential applications in the production of tissue mimicking phantoms in diagnostic ultrasound. PVAc may be used to produce a range of geometrically and acoustically identical vessel phantoms modelling various stages of atherosclerosis. The gold standard method for measuring the elastic properties of materials, as outlined in ISO 37:2017, details a tensile testing method specifically for dumbbell and O-ring sample geometries, with no provision for non-standard clinically relevant objects, such as vessel phantom models. The mechanical properties of PVAc are dependent on several production factors in addition to the number of freeze-thaw cycles that are not accounted for in ISO37. There is, therefore, a need for an accurate tensile testing method for establishing the mechanical properties of PVAc vessel phantoms. In this work, a modified procedure of ISO 37:2017 was used to compare between different sample geometries of PVAc where all other parameters of the freeze-thaw cycle were kept constant. This allowed for a direct comparison between the mechanical properties of ISO 37:2017 dumbbell test samples with in-vivo vessel sample geometries. It was found that there was no significant difference in the mechanical properties of the dumbbell test samples and the vessels for any number of freeze thaw cycles, with a correlation coefficient of R2 = 0.96 across the dataset, indicating that a direct comparison between the mechanical properties of the dumbbell test samples and the phantom vessels was established.

https://doi.org/10.1016/j.ejmp.2019.09.228

Poster Session : P31

Investigation of Intrinsic Spectral Broadening on the Aixplorer ultrafast ultrasound system

Andrew Malone [a], Seán Cournane [b], Andrew Fagan [c], Jacinta Browne [c]

[a] *Technological University Dublin, Ireland*
[b] *St Vincent's University Hospital*
[c] *Mayo Clinic, Ireland*

For Doppler velocity measurements, Intrinsic Spectral Broadening (ISB) is a broadening of the Doppler spectrum due to the finite spacing between the transducer elements, leading to a range of insonation angles. This effect leads to overestimation in velocity and a decrease in quantification precision. There have been limited attempts to quantify the Intrinsic Spectral Broadening (ISB) of the Aixplorer system under a wide range of imaging conditions. This could be of clinical relevance as it remains unclear whether ultrafast Doppler suffers from the same degree of imprecision as conventional Doppler imaging. In this work, the Aixplorer system ISB was measured using a Doppler string phantom for a range of velocities (10–200 cm/s) and vessel depths (1–4 cm). The results of this analysis showed that, for all depths, the ISB could be modelled using a power law fit with respect to velocity, with a percentage ISB in the range of 3–10 ± 2%. With respect to depth, the ISB did not appear to change significantly, with a percentage ISB in the range of 3–4 ± 2% measured. When utilising ultrafast acquisitions, the percentage ISB was 0.44–0.63 ± 0.07%, affecting an ISB reduction of a factor of 6.5 ± 0.3. These results indicate that the velocity dependence of ISB is strong, with low velocities suffering a high degree of overestimation. Despite the expected result of a strong dependence of ISB on depth, none was observed. Finally, by utilising ultrafast acquisitions, the percentage of ISB can be dramatically reduced.

https://doi.org/10.1016/j.ejmp.2019.09.229

Poster Session : P32

A comparison of three techniques for flow-based diagnosis of atherosclerosis

Andrew Malone [a], Seán Cournane [b], Andrew Fagan [c], Jacinta Browne [c]

[a] *Technological University Dublin, Ireland*
[b] *Vincent's University Hospital, Ireland*
[c] *Mayo Clinic, Ireland*

The gold standard diagnosis of cardiovascular disease (CVD) is the detection of arterial stenoses using digital subtraction angiography or Doppler ultrasound. There exists a need for a diagnostic screening technique based on detecting atherosclerosis, which presents earlier in CVD than stenoses. Wall-shear-stress (WSS) measurements represent one potential diagnostic tool, however, it requires high signal-to-noise ratio as well as good velocity and temporal resolution. Methods have been suggested to calculate the WSS using only the peak velocity value based on the Hagen-Poiseuille Eq. (1). Alternatively, Multifrequency (MF) signal processing methods can be utilised for the improvement of SNR and velocity resolution 2. In this work, three vessel phantoms were constructed exhibiting varying values of Young's Modulus (60,110,320 kPa). Vessel WSS maps were produced for steady-flow using each technique. The maps were analysed using a paired t-test to examine if there was a significant difference in the flow profile for soft-to-medium (60–110 kPa) and soft-to-hard (60–320 kPa) stiffness. For traditional pulsed wave Doppler, there was no significant difference in the soft-to-medium test (psm = 0.161) and a significant difference in the soft-to-hard test (psh = 0.041). The Hagen-Poiseuille method had similar results for both tests (psm = 0.154 and psh = 0.039). The MF signal processing method showed a significant difference for both tests (psm = 0.045 and psh = 0.032) This indicates that the multifrequency Doppler technique may provide the best potential route in the use of ultrasound-based WSS measurements. 1. Blake, et al. Ultrasound Med Biol. 34, 760–774 (2008) 2. Loupas, Gill, IEEE Trans. Ultrason. Ferroelectr. Freq. Control 41, 522–531 (1994).

https://doi.org/10.1016/j.ejmp.2019.09.230