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Wave propagation modes and arterial stiffness

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Introduction. Arterial elasticity is an independent predictor of cardiovascular disease and mortality. Measurment of waves in thin shells can be used to estimate the circumferential and the longitudinal elastic moduli.
Methods. Latex tubes and excised pig arteries were used as isotropic and anisotropic models. Waves were generated using focused ultrasound (1 ms, 3MHz) in different locations of the wall. The modes of propagation of the waves were detected with a laser vibrometer or an ultrasound pulse echo tool while the excitation was moved known distances.
Results. Bending waves were predominant when exciting in the center of the wall, while a combination of torsion and bending waves resulted from exciting off center. Wave speeds of 15 m/s and 5 m/s respectively were measured for the bending waves. Using the Moens-Korteweg equation, values of 1.1 and 0.350 MPa were found for the longitudinal elastic modulus in the tube and artery respectively.
Conclusion. Generation of different modes in the tubes and arteries is possible using focused ultrasound. Elastic components of the tubes and vessels in the longitudinal and the circumferential direction can be estimated from the speed of propagation and the frequency of the bending and the torsional waves.