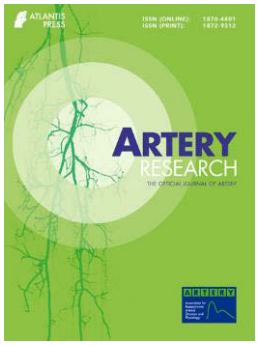

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P136: ALTERED ADVENTITIAL COLLAGEN FIBRIL MECHANICS AND MORPHOLOGY WITH HIGH PULSE WAVE VELOCITY

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(DBP). Accuracy of estimated aortic BP has never been determined when peripheral waveforms are precision calibrated using peripheral intra-arterial SBP/DBP. This is relevant to understanding the best methods to estimate aortic BP accurately and was the aim of this study. We also determined how other calibrations influence estimated aortic BP accuracy.
Methods: Ascending aortic, brachial and radial artery intra-arterial BP was measured among 104 patients (61.8 ± 10 years, 66% male) undergoing coronary angiography. Intra- arterial aortic SBP was compared with estimated aortic SBP by generalised transfer function (SphygmoCor) using: (1) intra-arterial brachial pressure waveforms calibrated with intra-arterial brachial SBP/DBP; (2) intra-arterial radial pressure waveforms calibrated with intra-arterial brachial SBP/DBP and (3) radial SBP/DBP and; (4) intra-arterial aortic mean arterial pressure (MAP)/DBP.
Results: All intra-arterial SBP/DBP peripheral waveform calibrations significantly underestimated intra-arterial aortic SBP ((1) -4.5 ± 7.0 mmHg; (2) -8.8 ± 8.0 mmHg and (3) -5.4 ± 7.6 mmHg; $p < 0.0001$ all). Conversely, intra-arterial aortic MAP/DBP calibration (4) accurately estimated aortic SBP (0.03 ± 4.6 mmHg, $p = 0.95$). Underestimation of intra-arterial aortic SBP was related to lower aortic-to-brachial SBP amplification ($r > 0.25$, $p < 0.009$ all calibrations).
Conclusion: Even when using accurate (intra-arterial) SBP/DBP for precision peripheral waveform calibration, aortic SBP was significantly underestimated. Intra-arterial aortic MAP/DBP was the most accurate calibration, but is not feasible for non-invasive use. These findings highlight the need for improved ways to accurately estimate aortic SBP.

P136
ALTERED ADVENTITIAL COLLAGEN FIBRIL MECHANICS AND MORPHOLOGY WITH HIGH PULSE WAVE VELOCITY

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Background: Arterial stiffening, occurring as part of the natural aging process of the artery, is well- established as a powerful predictor of cardiovascular disease. However, little is known about how localised changes in the extracellular matrix and mechanical properties of arterial tissue contribute to gross stiffening in the vasculature, particularly in the adventitia. The mechanical properties of the adventitia are attributed to the collagen fibrils which exhibit high tensile strength when an axial load is placed on the vessel.
Objective: To determine the relationship between the adventitial collagen fibril properties and carotid-femoral pulse wave velocity (PWV).
Methods: 16 patients were split into high PWV ($13.6 \pm 1.1 ms^{-1}$) and low ($8.5 \pm 0.3 ms^{-1}$) PWV groups (t-test, $P < 0.001$). Internal mammary arteries (IMAs) which were collected during coronary artery bypass grafting (CABG) were used to nano-scale characterisation of the tissue with atomic force microscopy (AFM). AFM was used to determine nanomechanical properties and collagen fibril morphology.
Results: Abundant, highly oriented collagen fibrils were observed in the adventitial layer in both groups. The adventitia had high elastic modulus values in the high PWV group (Low PWV = 2298.64 ± 75.38MPa; High PWV = 2734.63 ± 95.52MPa, $P < 0.001$). The collagen fibril diameters were found to be higher in patients with high PWV (Low PWV = 117.23 ± 22.19nm, High PWV = 119.18 ± 21.96nm, $P < 0.001$).
Conclusion: Nanomechanical properties and collagen fibril morphology in arterial tissue associated with carotid-femoral PWV. Nano-scale changes in the IMA are therefore indicative of systematic changes in arterial stiffness in the vasculature.

P137
NUMERICAL ASSESSMENT AND COMPARISON OF PULSE WAVE VELOCITY METHODS PRESUMING TO MEASURE AORTIC STIFFNESS

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Recently several methods have been proposed as tools to measure aortic pulse wave velocity (aPWV). The carotid-femoral pulse wave velocity (cf-PWV), the current clinical gold standard method for the noninvasive assessment of aPWV, uses the carotid–femoral pulse transit time (cf-PTT) to derive cf-PWV. The heart-ankle PWV (ha-PWV), brachial-ankle PWV (ba-PWV) and finger-toe (ft-PWV) are also methods presuming to approximate aPWV based on time delays between physiological signals at two locations (~heart-ankle PTT, ha-PTT; ~brachial-ankle PTT, ba-PTT; ~finger-toe PTT, ft-PTT). To test the validity of these methods, we used a 1D arterial network model (143 segments) including the foot and hand circulation.
The arterial tree dimensions and properties were taken from the literature and completed with CT-scans data. We calculated PTT's with all the methods above.
The calculated PTT's were compared with the aortic PTT (aPTT), considered as the absolute reference method in this study. The correlation between methods and aPTT was good and significant, cf-PTT ($R^2 = 0.97$; $P < 0.001$; mean difference 5 ± 2 ms), ha- PTT ($R^2 = 0.96$; $P < 0.001$; 150 ± 23 ms), ba-PTT ($R^2 = 0.96$; $P < 0.001$; 70 ± 13 ms) and ft-PTT ($R^2 = 0.95$; $P < 0.001$; 14 ± 10 ms). Consequently, good correlation was also observed for the PWV values derived with the tested methods, but absolute values differed because of different path lengths used. In conclusion, our computer model based analyses demonstrate that for PWV methods based on peripheral signals, PTT's closely correlate with the aPTT, supporting the use of these methods in clinical practice.

P138
CAN PULSE WAVE VELOCITY BE MEASURED IN THE FETAL ASCENDING AORTA?

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Background: Routine ultrasound exams are conducted to assess fetus development. Heart defects and cardiac function are the main areas investigated in an ultrasound assessment. However, prenatal assessment of the fetal arterial stiffness is yet to be established in the ascending aorta.
Aim: To investigate whether pulse wave velocity (PWV) can be determined in the fetus ascending aorta using ultrasound examination.
Methods: 35 fetuses (19 normal, 16 growth restricted) were included in the study. High quality recordings were achieved in 6 normal and 8 fetuses diagnosed with fetal growth restriction (FGR). Images of the diameter and blood velocity in the ascending aorta were recorded (Voluson, GE and Samsung) with a curvilinear probe 2–8MHz/1–7MHz. The diameter and velocity waveforms were extracted from DICOM images, offline, using in-house developed codes in Matlab. The extraction was based on thresholding of the grey-scale images. Local PWV was determined using the ln(D) U-loop method [1].
Results: PWV in the fetal ascending aorta increased with gestational age in both normal ($r^2 = 0.77$) and FGR ($r^2 = 0.55$) fetuses. Mean PWV in the fetal ascending aorta per gestational week was 0.045m/s in normal and 0.066m/s in FGR fetuses, with a percentage difference of 32%.

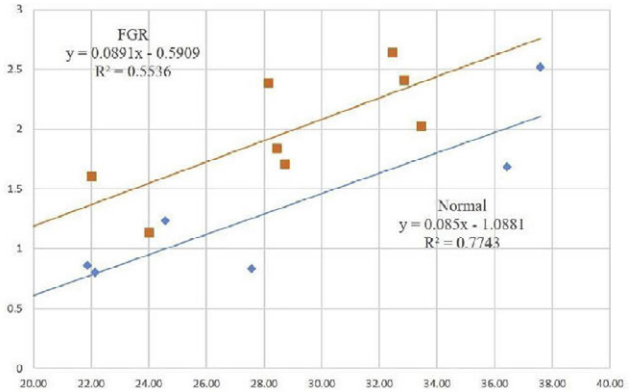

Figure 1. PWV vs gestational age in weeks for normal (blue diamond ♦) and FGR (red squares ■) fetuses and the trendlines with equations describing them and their r^2 values. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)