P135: PRECISION CALIBRATION OF PERIPHERAL PRESSURE WAVEFORMS USING INTRA-ARTERIAL BLOOD PRESSURE REVEALS THE NEED FOR IMPROVED WAYS TO ACCURATELY ESTIMATE AORTIC BLOOD PRESSURE

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(VC) in patients with end-stage renal disease (ESRD) and its association with clinical parameters of arterial stiffness.

Methods: In 68 adults with ESRD on maintenance hemodialysis for >3 months (45.6% males, median age 58.3 (interquartile range (IQR) 54.6; 61.6) years, dialysis duration 62.7 (47.8; 77) months, echocardiography and applanation tonometry was performed.

Results: Calcification of the aortic, mitral and both valves was revealed in 46 (67.6%), 34 (50%) and 33 (48.5%) of patients. 20 (29%) patients had no signs of VC. Patients with vs without AVC were older (65.1 ± 9.5 vs 41.4 ± 11.9 years, p < 0.001), had higher dialysis duration (51 ± 232 vs 21 ± 10.38 months, p < 0.001), lower peripheral diastolic blood pressure (DBP) (76 ± 17 vs 84 ± 12 mmHg, p < 0.05), reflected wave transit time (RWTT) (131 ± 17 vs 137 ± 15 ms, p < 0.05). Patients with vs without MVC were older (67.8 ± 8.2 vs 47.9 ± 13.5 years, p < 0.001), had higher dialysis duration (51 ± 111 vs 36 ± 14; 57 months, p < 0.001), carotid-femoral pulse wave velocity (10.1 ± 2.7 vs 8.9 ± 3.5 m/s, p < 0.05), lower peripheral DBP (73 ± 17 vs 84 ± 14 mmHg, p < 0.01), central DBP (75 ± 15 vs 82 ± 11 mmHg, p < 0.05), reflected wave transit time (RWTT) (131 ± 17 vs 137 ± 15 ms, p < 0.05). Patients with vs without AVC were older (65.1 ± 9.5 vs 41.4 ± 11.9 years, p < 0.001), had higher dialysis duration (51 ± 232 vs 21 ± 10.38 months, p < 0.001), lower peripheral diastolic blood pressure (DBP) (76 ± 17 vs 84 ± 12 mmHg, p < 0.05), reflected wave transit time (RWTT) (131 ± 17 vs 137 ± 15 ms, p < 0.05). Patients with vs without MVC were older (67.8 ± 8.2 vs 47.9 ± 13.5 years, p < 0.001), had higher dialysis duration (51 ± 111 vs 36 ± 14; 57 months, p < 0.001), carotid-femoral pulse wave velocity (10.1 ± 2.7 vs 8.9 ± 3.5 m/s, p < 0.05), lower peripheral DBP (73 ± 17 vs 84 ± 14 mmHg, p < 0.01), central DBP (75 ± 15 vs 82 ± 11 mmHg, p < 0.05), reflected wave transit time (RWTT) (131 ± 17 vs 137 ± 15 ms, p < 0.05). Patients with vs without AVC were older (65.1 ± 9.5 vs 41.4 ± 11.9 years, p < 0.001), had higher dialysis duration (51 ± 232 vs 21 ± 10.38 months, p < 0.001), lower peripheral diastolic blood pressure (DBP) (76 ± 17 vs 84 ± 12 mmHg, p < 0.05), reflected wave transit time (RWTT) (131 ± 17 vs 137 ± 15 ms, p < 0.05).

Conclusion: High prevalence of VC (71%) was revealed in patients with ESRD on maintenance hemodialysis. Patients with vs without VC were older, had higher duration of dialysis and more pronounced arterial stiffness.

P111
ALBUMIN-TO-CREATININE RATIO IS ASSOCIATED WITH TARGET ORGAN DAMAGE IN HYPERTENSION
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Purpose/Background/Objectives: Hypertension is associated with higher cardiovascular risk as well as several markers of subclinical target organ damage (TOD). Albumin to creatinine ratio (ACR) in urine has been recognised as an independent risk factor for cardiovascular events. We hypothesised that there is a relationship between ACR and markers of TOD in never-treated hypertensives.

Methods: We enrolled 924 consecutive essential hypertensives (mean age 53 ± 12 years, 486 males) without known cardiovascular disease (CVD). Markers of subclinical TOD (left ventricular mass index (LVMI), pulse wave velocity (PWV), ankle-brachial index (ABI) and estimated glomerular filtration rate (eGFR)) were evaluated in all patients. LVMI was assessed echocardiographically using the Devereux formula. Carotid-femoral PWV was estimated with the Complior device. eGFR was calculated by the Cockcroft-Gault formula. ABI was calculated by dividing the highest ankle systolic blood pressure by the highest brachial systolic blood pressure.

Results: ACR exhibited significant association with LVMI (r = 0.277, p = 0.001), PWV (r = 0.277, p = 0.001) ABI (r = 0.307, p = 0.018) and eGFR (r = 0.277, p = 0.001). In further analysis, ACR was associated with TOD as suggested by the 2013 European Guidelines for Hypertension [left ventricular hypertrophy (LVMI > 115 g/m² in men and >95 g/m² in women), increased PWV (PWV > 10m/s), decreased ABI (ABI < 0.9) and decreased renal function (eGFR < 60ml/min)]. Specifically, ACR exhibited a significant association with the number of TOD and this association was independent of age and gender (p < 0.05).

Conclusions: Our findings support the close relationship between ACR and TOD in hypertension, as well as, the predictive ability of ACR for TOD.

P114
ARTERIAL STIFFNESS IS ASSOCIATED WITH AMBULATORY BLOOD PRESSURE PARAMETERS IN PATIENTS ON MAINTENANCE HEMODIALYSIS
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Introduction: Arterial stiffness is a principal pathogenetic mechanism of aortic systolic blood pressure (SBP) augmentation, left ventricular hypertrophy and sudden cardiac death. The aim of the study was to evaluate the association between parameters of pulse wave and 44-hour ambulatory blood pressure (ABP) variables in patients with end-stage renal disease.

Methods: In 68 patients with ESRD on maintenance hemodialysis (45.6% males, median age 58.3 (interquartile range (IQR) 54.6; 61.6) years, dialysis duration 62.7 (47.8; 77) months, echocardiography and applanation tonometry was performed.

Results: Carotid-femoral pulse wave velocity (PWV) < 10 vs PWV > 10m/s was revealed in 52 (76.5%) of patients respectively. Patients with PWV > 10 vs < 10 m/s had higher diastolic duration (median 60; IQR 36; 84 vs 28; IQR 11; 50.5) months, p < 0.05), peripheral SBP (148 ± 24,8 ± 140.7 ± 23.6 mmHg, p < 0.05), diastolic blood pressure (DBP) (85.7 ± 19,2 vs 83.3 ± 12.7 mmHg, p < 0.05); 48-hour heart rate (HR) (74.7 ± 13.0 vs 72 ± 8.7 bpm, p < 0.05), mean day one HR (78.7 ± 7.5 vs 72.5 ± 9.7 bpm, p < 0.05), 48-hour DBP variability (DBPV) (78 ± 13 vs 88 ± 12 mmHg, p < 0.01), day two SBP variability (13.5 ± 4.4 vs 13 ± 4.1 mmHg, p < 0.05), mean day two BD variability (12 ± 3.9 vs median 11; 11.8 ± 3.6 mmHg, p < 0.05).

Patients with PWV > 10 vs < 10 m/s had lower daytime DBPV (median 8.5; IQR 7; 9 vs IQR 10 (8; 11 mmHg, p < 0.05), day one DBPV (median 8; IQR 8; 9) vs 9 IQR 8; 10 mmHg, p < 0.01).

Conclusions: Patients with PWV > 10 m/s had higher duration of dialysis, higher values of ambulatory DBP and higher — of HR. These findings may have implications in gaining further insights into the mechanism of arterial stiffness.
(DBP). Accuracy of estimated aortic BP has never been determined when pe-
ripheral 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, brachial and radial artery intra-arterial BP was
measured among 104 patients (61.8 ± 10 years, 66% male) undergoing coro-
nary 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 signifi-
cantly 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
waveform calibration, aortic SBP was significantly underesti-
mated. 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 dis-
ease. However, little is known about how localised changes in the extracellular
matrix and mechanical properties of arterial tissue contribute to gross stiff-
ening in the vasculature, particularly in the adventitia. The mechanical prop-
erties 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 ± 1.1ms −1 and low
(8.5 ± 0.3ms −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 mi-
croscopy (AFM). AFM was used to determine nanomechanical properties and
collagen fibril morphology.

Results: Abundant, highly orientated 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 = 228±.64 ± 75.38kPa; High
PWV = 2734.63 ± 95.52kPa, 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 (R² = 0.97; P < 0.001; mean differ-
ence 5 ± 2 ms), ha- PT (R² = 0.96; P < 0.001; 150 ± 23 ms), ba-PTT
(R² = 0.96; P < 0.001; 70 ± 13 ms) and ft-PTT (R² = 0.95; P < 0.001; 14 ± 10 ms).
Consequently, good correlation was also observed for the PWV values
derived from 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 de-
velopment. 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 diag-
nosed 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 2–3MHz/1–7MHz. The diameter and velocity wave-
forms 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 (r² = 0.77) and FGR (r² = 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 r² values. (For interpretation of the references to colour in
this figure legend, the reader is referred to the web version of this article.)