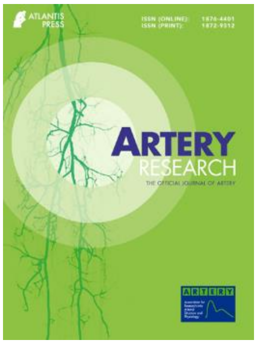

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P6.17: CAROTID ARTERY CROSS-SECTIONAL AREA AND STIFFNESS NON-LINEARITY AS MARKERS OF VASCULAR AGEING

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Variable	Baseline			After six months		
	CH (N=33)	UH (N=33)	RH (N=42)	CH	UH	RH
SBP	122 [118;125]	142 [138;150]	138 [132;147]	126 [117;135]	133 [123;143]	136 [126;143]
PP	52 [45;56]	65 [58;68]	66 [62;70]	55 [43;63]	57 [49;62]	64 [57;70]
PWV	8.3 [7.3;10.6]	9.6 [8.3;11.1]	10.9 [8.4;12.8]	8.8 [7.3;10.1]	8.9 [8;10]	10.3 [8.4;12.8]

P6.15

EFFECT OF BODY POSITION ON THE MEASUREMENTS OF CENTRAL HEMODYNAMIC PARAMETERS: "PLEASE HAVE A SIT?" OR "PLEASE LIE DOWN?"

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Background: Estimation of aortic pressure waveform provides clinical information regarding BP cardiovascular risk additional to the brachial blood pressure (BP). The effect of body position on central haemodynamics (BP, pulse pressure (PP) amplification (amp), augmentation index (AIx), augmentation pressure (AP), subendocardial viability ratio (SVR) have never been investigated. Aim/design: to investigate in a randomized cross over study changes in both the peripheral and central haemodynamics in supine and sitting position. Methods: Sixty one subjects referred for BP assessment were examined (36 males, mean age 50±12 yrs). Brachial and aortic waveforms were assessed in sitting and supine position. In each position: triplicate brachial BP measurements were performed; then 2 consecutive aortic pressure waveforms were estimated by applanation tonometry of the radial artery - pulse wave analysis and the use of transfer functions (Sphygmocor). The average of the last 2 brachial BP recordings was used in statistical analysis and for peripheral waveforms calibration. Results: Mean arterial BP did not differ significantly between the sitting and supine position (table). Brachial and aortic SBP, PP, AP, AIx were significantly higher in the supine position whereas DBP and PP amplification (ratio: brachial/aortic PP) significantly smaller. Moreover, significant alterations were observed in heart rate, ejection duration and SVR. Conclusions: Mean BP remained unchanged but the pulsatile BP component was higher in the supine position. This was more pronounced in the aorta, as shown by PP amplification, in part due to alterations in heart rate, wave reflections leading to alterations in coronary perfusion.

Parameter	Sitting position	Supine position	p-value
Mean BP (mmHg)	110.8 ± 13.7	110.9 ± 14.9	0.945
Brachial SBP (mmHg)	140.1 ± 17.4	142.7 ± 18.5	0.022
Brachial DBP (mmHg)	94.2 ± 14.4	90.1 ± 14.4	<0.001
Brachial PP (mmHg)	45.9 ± 16.0	52.6 ± 15.6	<0.001
Aortic SBP (mmHg)	131.7 ± 16.9	134.4 ± 18.6	<0.001
Aortic DBP (mmHg)	95.0 ± 14.4	91.3 ± 14.5	<0.001
Aortic PP (mmHg)	36.7 ± 15.2	43.1 ± 13.9	<0.001
AP (mmHg)	10.8 ± 7.7	13.9 ± 7.3	<0.001
AIx (%)	26.9 ± 11.9	31.1 ± 10.2	<0.001
PP amplification (ratio)	1.3 ± 0.2	1.2 ± 0.1	<0.001
Heart rate (bpm)	67.2 ± 8.7	64.5 ± 7.4	<0.001
Ejection duration (msec)	297.2 ± 22.7	327.6 ± 17.6	<0.001
SVR	179.6 ± 25.7	161.2 ± 25.8	<0.001

P6.16

DETERMINATION OF CAROTID AND FEMORAL WAVE SPEED AND DISTENSIBILITY IN A HEALTHY POPULATION USING A NEW NON-INVASIVE TECHNIQUE

A. Borlotti [1], S. Vermeersch [2], E. Rietzschel [3], P. Segers [2], A. W. Khir [1]
[1]*Brunel University, Brunel Institute for Bioengineering, Uxbridge, London, United Kingdom*
[2]*Ghent University, IBiTech-bioMMeda, Gent, Belgium*
[3]*Ghent University Hospital, Gent, Belgium* *Local wave speed (c) is a predictor of cardiovascular diseases because is related to arterial distensibility*

In this work, carotid and femoral distensibility were assessed in the Asklepios study population. Local wave speed was determined with a new non-invasive technique based on velocity (U) and diameter (D) measurements (lnDU-loop) [1]. Distensibility was calculated using c and the Bramwell-Hill equation, and changes were studied with respect to age and gender.

Figure 1 shows changes in carotid and femoral wave speed (a) and distensibility (b) with age and gender. Carotid wave speed increases and distensibility decreases with age (a part from male aged 40-45 and 45-50) and there is no difference between males and females. In the femoral artery, these parameters do not change with age and wave speed is lower and distensibility is higher in females.

The mechanical properties of elastic (carotid) and muscular (femoral) arteries change differently with age, which is in line with results of other investigators. The new technique provides a means for the determination of arterial distensibility using non-invasive measurements of D and U, which can potentially be clinically useful as they could be taken using Doppler ultrasound.

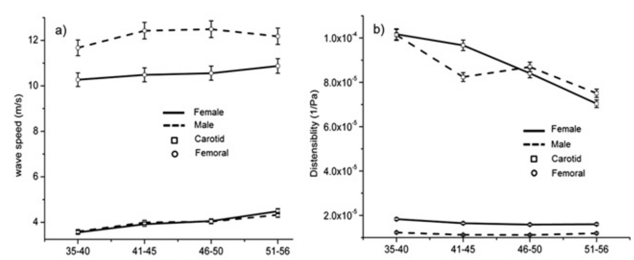

Figure 1 wave speed (a) and distensibility (b) in carotid and femoral arteries

1. Feng and Khir Determination of wave speed and wave separation in the arteries using diameter and velocity. J.Biomech. 43: 3: 455-462, 2010.

P6.17

CAROTID ARTERY CROSS-SECTIONAL AREA AND STIFFNESS NON-LINEARITY AS MARKERS OF VASCULAR AGEING

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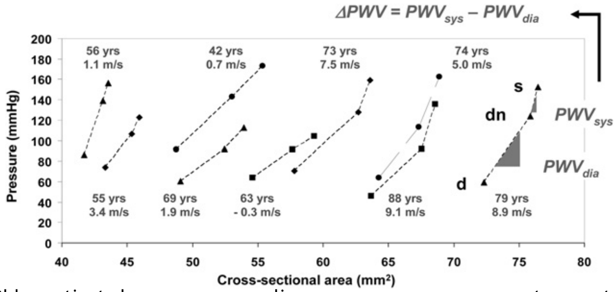
Background: Artery wall ageing involves elastic fibre loss and increased fibrosis, leading to dilatation and increased artery wall stiffness. Notably, the associated gradual transfer of tensile stresses from elastic to stiffer components in the wall will likely increase non-linear elastic behaviour of the vessel wall. We investigated whether age is indeed a determinant of carotid artery cross-sectional area (CSA) and stiffness non-linearity; the latter being quantified as the difference between systolic and diastolic pulse wave velocity: ΔPWV, in m/s (Figure).

Methods and Results: In 29 patients (21m/8f), carotid artery blood pressure and CSA waveforms were obtained by catheter and ultrasound. Diastolic, systolic and dicrotic notch amplitudes were determined for each individual (Figure). In 15 older patients (77±5yrs) compared to 14 younger (59±7yrs) carotid ΔPWV and CSA were increased (+2.6m/s and +7mm^2, resp., $p<0.03$), despite similar blood pressures. Moreover, in multiple regression analyses, age was a determinant of both ΔPWV and CSA, independent of sex, height and pulse pressure ($p<0.01$).



Older patients have a more non-linear preessure-area curve, at a greater cross-sectional area. Tags shows age and ΔPWV of the subjects. S denotes systolic; d, diastolic; dn, dicrotic notch. (Only a sample of 29 is shown for clarity.) PWV values are calculating using Bramwel-Hill: PWV=sqrt(1/rho* distensibility).

Conclusions: Our study demonstrates detectable age-related differences in carotid stiffness non-linearity and cross-sectional area, suggesting these may act as markers of vascular ageing.

P6.18

COMPARISON OF ARTERIAL STIFFNESS ASSESSED BY ARTERIOGRAPH WITH ARTERIAL STIFFNESS ASSESSED BY APPLANATION TONOMETRY AND ECHOTRACKING: A CLINICAL STUDY

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Introduction: Large artery stiffness is recognized as a strong, independent marker of cardiovascular risk, mainly through aortic pulse wave velocity (PWV). Arteriograph is a new non-invasive oscillometric method, which estimates aortic PWV through brachial pressure wave analysis. In a previous study, Trachet et al. *(Annals of Biomedical Engineering* 2010) have shown, using a numerical model of arterial tree, that Arteriograph measured a brachial stiffness instead of aortic stiffness.

Aim: To compare PWV with Arteriograph (Ar PWV) to carotid-femoral PWV (CF PWV), carotid-radial PWV (CR PWV) and carotid-humeral PWV (CH PWV). And to compare Ar PWV to carotid stiffness (CS) and humeral stiffness (HS).

Methods: CF, CH, and CR PWV were assessed by applanation tonometry (SphygmoCor®). Ar PWV was assessed by Arteriograph and CS, HS were assessed by echotracking system (Mylab®). Pearson's correlation coefficient, r, between the methods was calculated.

Results: 43 subjects were included: 20 healthy subjects and 23 patients with essential hypertension. The correlation between CF PWV and Ar PWV is good and significant in healthy subjects and all subjects ($r=0.77$ and $r=0.76$ respectively $p<0.001$), and weak but not significant in hypertensive subjects. The same with CS in all subjects only ($r=0.72$, $p<0.001$) There are no significant correlation between Ar PWV and CH PWV, CR PWV, HS.

Conclusion: Arteriograph is well correlated with CF PWV and CS in all subjects but not with brachial stiffness. Nevertheless, it is necessary to include more subjects in this study to see if the correlation is as well in healthy subjects and hypertensive patients.

P6.19

EFFECTS OF CARDIAC MOTION ON THE LEFT CORONARY ARTERY FLOW RATE

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The aim of this work was to investigate the effects of physiologically idealized cardiac-induced motion on flow rate in human left coronary arteries. The blood flow rate were numerically simulated in a elastic modelled left anterior descending coronary artery (LAD) having a uniform circular cross section of 3.6 mm diam. Blood was considered to be a non-Newtonian fluid and Arterial motion was specified based on monoplane physiologically idealized bending. Simulations were carried out with dynamic pressure difference conditions between inlet and outlet in both fixed and moving LAD models, to evaluate the relative importance of LAD motion, flow rate, and the interaction between motion and time-averaged flow rate. LAD motion was caused variations in time-averaged flow rate magnitude about 30% of the fixed models. There was significant variability in the magnitude of this motion-induced flow variation. However, the magnification of time-averaged flow rate is depending to specification of the cardiac motion. Furthermore, the effects of pressure pulsatility dominated LAD motion induced effects; specifically, there were local flow variation and secondary flow in the simulations conducted in moving LAD models. LAD motion has big effect on time-averaged flow rate and secondary flow. Therefore, the hemodynamic effects of LAD motion can not to be ignored as a first approximation in modelling studies.

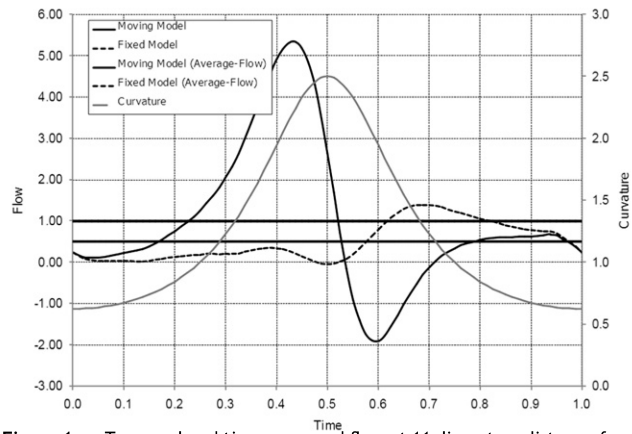

Figure 1 Temporal and time-averaged flow at 11 diameters distance from the LAD inlet for both moving and fixed models.

P6.20

VASCULAR ACCESSES FOR HAEMODIALYSIS IN THE ARM CAUSE GREATER REDUCTION IN THE CAROTID-BRACHIAL STIFFNESS THAN THOSE IN THE FOREARM: STUDY OF GENDER DIFFERENCES

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Purpose: to evaluate in chronically-haemodialysed patients (CHP) if, 1) the vascular access (VA) position (arm or forearm) is associated with differential changes in upper-limb arterial stiffness; 2) differences in arterial stiffness exist between genders associated with the VA; 3) the vascular substitute (VS) of choice, in biomechanical terms, depends on the previous VA location and CHP gender.

Methods: Clinical and biochemical parameters and left and right carotid-brachial pulse wave velocity (PWVcb) were measured in 38 CHP (males:18; Age:53±17 years; VA in arm:18). In *in vitro* studies, PWV was obtained from ePTFE prostheses and human arterial and venous homografts (brachial, femoral and carotid arteries and saphenous veins). The biomechanical mismatch (BM) between CHP native vessel (NV) and VS was calculated.

Results: PWVcb in upper-limbs with VA was lower than in the intact contralateral limbs, and differences were higher ($P<0.02$) when the VA was performed in the arm. Differences between PWVcb in upper limbs with VA (in the arm) with respect to intact upper-limbs were higher ($P<0.01$) in males than in females. Independently of the arterial region in which the VA was performed, the type of homograft that ensured the minimal BM was the brachial artery. The BM between VS and NV was highly dependent on gender and the location in the upper-limb in which the VA was performed.