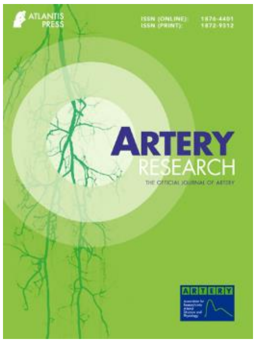


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# P163: REGIONAL DIFFERENCES IN GEOMETRICAL FEATURES AND LAYER-SPECIFIC RESIDUAL STRESSES IN THE BOVINE DESCENDING THORACIC AORTA

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**Introduction:** Ankylosing spondylitis (AS) is an inflammatory rheumatic disease associated with accelerated atherosclerosis and increased cardiovascular morbidity and mortality.
**Objectives:** To assess the local arterial stiffness in carotid artery in subjects with AS compared with controls evaluated by carotid artery pulse wave velocity (carPWV).
**Methods:** Ultrasound examinations were conducted with a Mylab One color Doppler ultrasound diagnostic system (Esaote, Firenze, Italy), the right common carotid artery (RCCA) was scanned, using a 5-12 MHz vascular probe with built-in quality arterial stiffness (QAS) which calculate carPWV.
**Results:** Forty-seven male subjects (20 with Ankylosing Spondylitis and 27 controls) aged between 20 and 75 (mean age 41.17 ± 11) were evaluated. AS patients have not Hypertension, history of cardiovascular risk factors or smoking). Higher carPWV was observed in patients with AS (6.27 ± 0.72 vs 5.56 ± 1.02 m/s; p = 0.0123) compared with controls, respectively.
**Conclusions:** AS subjects showed higher carPWV compared with controls, this novel assessment for local arterial stiffness could be useful in the future to calculate cardiovascular risk, more studies should be developed with this method in this pathology in our population.

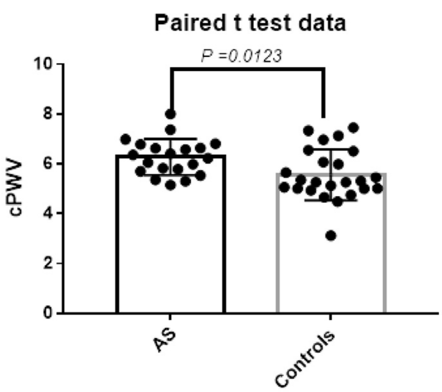


Figure 1. AS, ankylosing spondylitis; cPWV, carotid artery pulse wavevelocity; SD: standard deviation. Continuous variables are shown as median with analysis by t-test.

## Poster Session II — Other

### P161

### RELATIONSHIP OF FIBRINOGEN WITH ARTERIAL STIFFNESS IS DIFFERENT ACCORDING TO GENDER. EVA STUDY

Leticia Gomez-Sanchez [1], Marta Gomez-Sanchez [1], Natalia Sanchez-Aguadero [2], Cristina Lugones-Sanchez [2], Maria C. Patino-Alonso [1], Sara Mora-Simon [1], Jose A. Maderuelo-Fernandez [2], Emiliano Rodriguez-Sanchez [2]
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**Objectives:** To analyze the association of arterial stiffness with the fibrinogen in general population without previous cardiovascular diseases. Differences by gender.
**Methods:** A cross-sectional study. Study population: From the population assigned to the participating healthcare centres, a cluster random sampling stratified by age and gender was performed to obtain 501 participants aged between 35 and 75, 100 per decade, (50% women) without cardio or cerebrovascular disease. Measurements: pulse wave velocity femoral carotid (cfPWV) was determined using the SphygmoCor System and Cardio Anckle Vascular Index (CAVI) using the VaSera. Plasma fibrinogen was measured in blood.
**Results:** Mean values: age 55.9 ± 14.2 years (Males = 65.9 ± 14.3 years, Females = 55.8 ± 14.2 years, p = 0.935); CAVI:8.0 ± 1.4 (Males = 8.1 ± 1.5, Females = 7.9 ± 1.4, p = 0.043); cfPWV: 6.5 ± 2.0 m/sec (Males=6.8 ± 2.2 m/sec, Females=6.2 ± 1.8m/sec, p < 0.001) and fibrinogen: 314 ± 70 mg/Dl (Males = 198 ± 65 mg/Dl, Females = 330 ± 71 mg/Dl, p < 0.001). CAVI and CfPWV showed positive correlation with fibrinogen (r = 0.248 and r = 0.147 in males p < 005 in both cases), but not in the females (r = 0.126 and r = 0.101 p > 0.05 in both cases). In the multiple regression analysis after adjusting for age, cardiovascular risk factors, drugs and lifestyles, the association of CAVI with fibrinogen was β = 0.249 (95% CI 0.033to0.464) p = 0.024, and of the cfPWV with fibrinogen was β = 0.01 (95% CI -0.031 to 0.042) p = 0.684 in males, without finding association between CAVI, cfPWV with fibrinogen in the case of females (p = 0.144 and p = 0.825 respectively).
**Conclusions:**CAVI and cfPWV showed a positive correlation to fibrinogen in males in general population without previous cardiovascular diseases, but not in females. However, after adjusting for confounding factors, the association only remains with CAVI in males.

**References**

1. Wykretowicz J, Guzik P, Krauze T, Marciniak R, Komarnicki M, Piskorski J, et al. Fibrinogen and d-dimer in contrasting relation with measures of wave reflection and arterial stiffness. Scand J Clin Lab Invest. 2012 Dec;72(8):629-34.
2. Vlachopoulos C, Pietri P, Aznaouridis K, Vyssoulis G, Vasiliadou C, Bratsas A, Tet al. Relationship of fibrinogen with arterial stiffness and wave reflections. J Hypertens. 2007 Oct;25(10):2110-6.

### P162

### ARTERIAL STIFFNESS AND BODY COMPOSITION IN CHILDREN AND ADOLESCENTS

Tommy Cai [1,2], Alice Meroni [1], Hasthi Dissanayake [1], Melinda Phang [1], Ahmad Qasem [3], Julian Ayer [1,4], Mark Butlin [3], Alberto Avolio [3], David Celermajer [1,5], Michael Skilton [1]
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**Objectives:** Carotid-femoral pulse wave velocity (cfPWV) is a validated non-invasive measure of aortic stiffness. Risk factors for cfPWV are well described in adulthood, and furthermore cfPWV is associated with incident cardiovascular disease in adults (1). However, risk factors for arterial stiffness in childhood are poorly described (2). Accordingly, we sought to determine the risk factors for cfPWV in childhood and adolescence and hypothesized that cfPWV would be higher amongst those with greater adiposity.
**Methods:** We prospectively recruited 88 healthy children (mean age = 11.0 ± 5.3 years old). Age, weight, height, and blood pressure were measured. cfPWV was assessed using a semi-automated cuff-based device (Sphygmocor XCEL; AtCor Medical, Australia), and body composition using air displacement plethysmography (BOD POD; Cosmed, Italy) (3). Associations with cfPWV were determined by multivariable linear regression, with subsequent mediation analyses to inform likely causal pathways.
**Results:** After adjusting for age and sex, cfPWV was significantly associated with weight, body mass index (BMI), systolic blood pressure, mean blood pressure, heart rate, and lean body mass (LBM), while LBM was significantly associated with height, weight, BMI and fat mass (Table 1). After further adjusting for weight, mean blood pressure and heart rate, LBM remained significantly associated with cfPWV (ß = 0.68; p = 0.007). Mediation analyses indicate that weight mediates the association between age and cfPWV (PM = 76%), and that LBM mediates the relationship between weight and cfPWV (Figure 1).
**Conclusion:** Higher cfPWV in healthy children and adolescents is a function of growth, and this association may be in turn mediated by higher LBM rather than adiposity.

### P163

### REGIONAL DIFFERENCES IN GEOMETRICAL FEATURES AND LAYER-SPECIFIC RESIDUAL STRESSES IN THE BOVINE DESCENDING THORACIC AORTA

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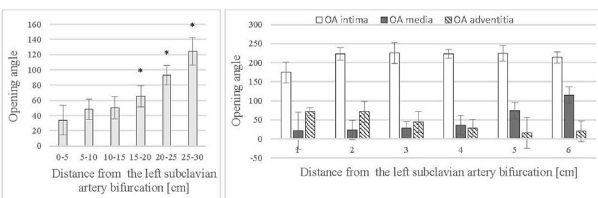
**Background:** The Opening Angle (OA) is widely used as an index of the residual stresses and strains present in the arterial wall not subjected to internal pressure. The aim of this work was to quantify regional variation of the layer-specific OA in the bovine descending thoracic aorta.

**Methods:** Descending thoracic aortae from 7 cows were segmented into 3—4 mm wide rings. Geometrical features (mean internal/external radius Rin and Rout, wall thickness h) were measured. A radial cut was made on the anterior region of each ring, and then the rings were placed in a temperature-controlled water bath (37 °C) for 1.5 h to express the OA. The rings were separated into their three layers and the layer-specific OA was investigated. The separation of the intima from the media is a complex procedure due to its limited thickness. The isolated intima was therefore thicker than values reported in the literature.

**Results:** Except for the most proximal region, h/Rin decreased towards the periphery (table 1). The medial and whole aortic wall OA increased moving towards the periphery, whilst the adventitia showed the opposite behaviour. The intimal OA was significantly higher and relatively constant (figure 1).

**Conclusions:** The present set of experiments indicates that the compressive residual stresses are concentrated mainly in the internal part of the intima-media layer independently from the considered axial region. The other layers exhibit comparable OAs to the whole arterial wall.

| Distance | 0-5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 |
|---|---|---|---|---|---|---|
| $h/R_{in}$ | 0.37 | 0.50 | 0.45 | 0.40 | 0.34 | 0.31 |




## P164

### INDICES TO ASSESS AORTIC STIFFNESS FROM THE FINGER PHOTOPLETHYSMOGRAM: IN SILICO AND IN VIVO TESTING

Peter Charlton [1], Maria Aresu [2], Jeanette Spear [2], Phil Chowienczyk [1], Jordi Alastruey [1]
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**Purpose:** Aortic stiffness is predictive of cardiovascular morbidity and mortality. However, the gold standard method for assessing aortic stiffness, carotid-femoral pulse wave velocity, is time-consuming and requires a trained operator. An alternative approach could be to derive an arterial stiffness index (ASI) from the easily measured finger photoplethysmogram (PPG). Our aim was to investigate the performance of PPG-derived ASIs for assessing aortic stiffness.

**Methods:** An insilico dataset of arterial pulse waves (PWs) was generated using a model of pulse wave propagation (1). PWs were generated for virtual healthy subjects aged 25 to 75. Several simulations were run for each age decade to mimic population-level variation in cardiac and vascular properties. PPG PWs were simulated from blood pressure PWs (2). The dataset was used to design an algorithm to calculate over 30 ASIs described in the literature from the finger PPG. In vivo testing was performed using 6,506 subjects from the Airwave dataset (3) who had triplicate PPG and reference PWV measurements.

**Results:** In silico and in vivo performances of ASIs, including the stiffness index (SI) and reflection index, varied greatly. The SI performed well in vivo, showing strong correlation with reference PWVs. However, in silico assessment demonstrated that the SI and other ASIs were affected by other cardiac and vascular properties as well as aortic stiffness.

**Conclusions:** This study identified the best-performing ASIs in both in silico and in vivo datasets. In the future multiple ASIs should be combined to improve performance, since different ASIs have different physiological determinants.

### References

1. Willemet MC, Chowienczyk PJ, Alastruey J. A database of virtual healthy subjects to assess the accuracy of foot-to-foot pulse wave velocities for estimation of aortic stiffness. American Journal of Physiology-Heart and Circulatory Physiology. 2015; 309(4): H663—H675.
2. Charlton PH, Celka P, Farukh B, Chowienczyk PJ, Alastruey J. Assessing Mental Stress from the Photoplethysmogram: A Numerical Study. Physiological Measurement. 2018; 39(5): 054001.
3. Elliott P, Vergnaud A, Singh D, Neasham D, Spear J, Heard A. The Airwave Health Monitoring Study of police officers and staff in Great Britain: Rationale, design and methods Environmental Research. 2014; 134: 280-285

## P165

### EVALUATING CAROTID FEMORAL PULSE WAVE VELOCITY MEASURED BY CUFF-BASED APPROACH AGAINST THE TONOMETRY-BASED REFERENCE STANDARD IN A PAEDIATRIC POPULATION

Tommy Cai [1,2], Alice Meroni [1], Hasthi Dissanayake [1], Melinda Phang [1], Alberto Avolio [3], David Celermajer [1,4], Mark Butlin [3], Michael Skilton [1], Ahmad Qasem [3]
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**Background:** Carotid femoral pulse wave velocity (cfPWV) is directly associated with arterial stiffness in major elastic arteries and predicts future cardiovascular events (1). Little is known of cfPWV as a marker of vascular health in children. Semi-automated cuff-based devices for assessing cfPWV are increasingly popular, although these utilize an algorithm developed and validated in adults (2). Physiological differences between adults and children may thus reduce the accuracy of cuff-based.

**Methods:** We sought to determine the accuracy of a cuff-based cfPWV device in healthy children and determine whether an age-appropriate algorithm increases accuracy. Methods we prospectively recruited 29 healthy children (mean age $= 11.5 \pm 5.2$ years old). cfPWV was measured using a tonometer on the carotid artery and an inflated cuff on the thigh (Sphygmocor XCEL; AtCor Medical, Australia), and using a tonometer on both the carotid artery and femoral artery (SphygmoCor CvMS; AtCor Medical, Australia) as a reference method. We assessed the accuracy of the cuff-based device with its standard algorithm that was developed in adults, and an adjusted algorithm corrected for physiological differences in leg (femoral to thigh cuff) PWV between adult and children (3).

**Results:** Cuff-based device estimates of cfPWV in children had excellent agreement to the reference standard ($r = 0.85$; $\Delta = -0.26$ $ms^{-1}$ [SD 0.44]). The adjusted algorithm improved the accuracy of the cuff-based method ($r = 0.84$; $\Delta = 0.02$ $ms^{-1}$ [SD 0.44]) (Figure 1).

**Conclusions:** Although the cuff-based semi-automatic approach estimates cfPWV with excellent agreement to the reference standard, adjusting the algorithm for known differences in leg PWV improves the accuracy of cuff-based measurement in children.

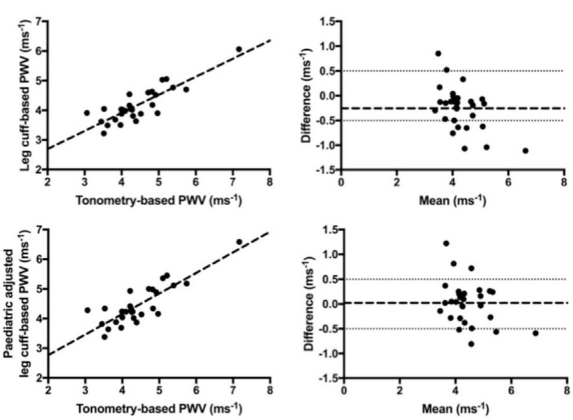


**Figure 1. Bland-Altman analysis of a cuff-based pulse wave velocity device versus a reference tonometry-based pulse wave velocity device.** Above – standard algorithm; Below – adjusted algorithm; Left – dashed line represents line of best fit; Right – dashed line represents the mean difference, dotted line represents $\pm 0.5 ms^{-1}$

### References

1. Laurent S, Cockcroft J, Van Bortel L, Boutouyrie P, Giannattasio C, Hayoz D, et al. Expert consensus document on arterial stiffness: methodological issues and clinical applications. Eur Heart J. 2006;27(21):2588-605.
2. Butlin M, Qasem A, Battista F, Bozec E, McEniery CM, Millet-Amaury E, et al. Carotid-femoral pulse wave velocity assessment using novel cuff-based techniques: comparison with tonometric measurement. J Hypertens. 2013;31(11):2237-43.
3. Avolio AP, Chen SG, Wang RP, Zhang CL, Li MF, O'Rourke MF. Effects of aging on changing arterial compliance and left ventricular load in a northern Chinese urban community. Circulation. 1983;68(1):50-8.