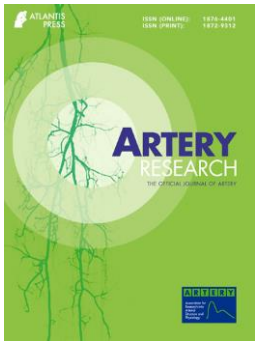

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5.1: ASSESSMENT OF THE ARTERIAL WALL BEHAVIOR ALONG THE COMMON CAROTID ARTERY AT THE LEVEL OF A PLAQUE ACCORDING TO ARTERIAL STIFFNESS GRADIENT

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Oral Presentation Abstracts

5.1
ASSESSMENT OF THE ARTERIAL WALL BEHAVIOR ALONG THE COMMON CAROTID ARTERY AT THE LEVEL OF A PLAQUE ACCORDING TO ARTERIAL STIFFNESS GRADIENT

H. Beaussier [1], I. Masson [2], O. Naggara [3], D. Calvet [3], R. Joannides [4], E. Guegan-Massardier [4], E. Gérardin [4], E. Bozec [1], P. Boutouyrie [1], S. Laurent [1].
[1]*Department of Pharmacology and INSERM URMS 872, Hôpital Européen Georges Pompidou, Paris, France*
[2]*Institut d'Alembert, UMR CNRS 7190, Université Pierre et Marie Curie and UMR CNRS 7054, Paris, France*
[3]*Departments of Neurology and Neuroradiology, EA 4055 Centre Hospitalier Sainte-Anne, Paris, France*
[4]*Departments of Pharmacology and Neurology and INSERM URM 644, CHU Rouen, Paris, France*

Background: We previously described longitudinal strain gradient named bending strain (BS), along the common carotid artery (CCA) with two distinct patterns (Paini, Stroke 2007, Beaussier, Hypertension 2008): Pattern A (larger radial strain at the plaque level than at adjacent CCA) and its opposite, Pattern B.
Aim: To assess the role of change in CCA thickness (IMT) and medial diameter (D) during the cardiac cycle at the level of plaques according to functional patterns of BS.
Method: 45 CCA were analysed at the level of the plaque in 26 patients. Mechanical parameters were measured at 128 sites on a 4 cm long CCA segment by an echotracking system (ArtLab®). Plaque composition was determined by magnetic resonance imaging (MRI). For each plaque, systo-lo(s)-diastolic(d) variation of IMT and D were calculated. We obtained ΔIMT ((IMTs - IMTd)/IMTd), ΔDiameter ((Ds - Dd)/Dd) and ratio R (ΔIMT/ΔD).
Results: R did not significantly differ according to remodeling pattern neither to plaque composition. Plaques exhibiting Pattern B ($n=25$) were characterized by an R 73 % higher than plaques exhibiting Pattern A ($n=20$) (5.9 ± 3.0 versus 3.4 ± 1.6, $p<0.005$). In other words, IMT strain is disproportionately larger than diameter strain among Pattern B than among pattern A.
Conclusion: The arterial stiffness gradient at the level of the plaque may influence the arterial wall behavior: an inward BS may be associated with exaggerated compressibility and local stresses within the wall in comparison to an outward BS with reduced local stresses.

5.2
THE RELATIONSHIP BETWEEN LARGE ARTERY STIFFNESS, WAVE REFLECTION AND PULSATILITY IN THE MICRO-CIRCULATION: NEW INSIGHTS INTO THE MANAGEMENT OF BOTH HYPERTENSION AND DIABETES

B. J. McDonnell [1], J. Coulson [2], M. Munnery [2], N. S. Gale [2], K. Mortlock [2], I. Munnery [2], I. B. Wilkinson [3], C. M. McEniery [3], J. R. Cockcroft [2].
[1]*Cardiff School of Health Sciences, University of Wales Institute Cardiff, Cardiff, United Kingdom*
[2]*Wales Heart Research Institute, Cardiff University, Cardiff, United Kingdom*
[3]*Department of Clinical Pharmacology, Cambridge University, Cambridge, United Kingdom*

Background: Increased arterial stiffness is associated with a reduced buffering capacity of the large arteries, therefore predisposing the microcirculation to increased flow and pressure pulsatility. However, increased wave reflection may be protective, by reducing the amount of pulsatility transmitted to the microcirculation. The aim of this study was to examine this hypothesis by exploring the relationship between large artery stiffness, wave reflections and pulsatility in the microvasculature.
Methods: 38 volunteers, aged 63±10 years, not taking any sympathomimetic compounds and free from any acute ocular symptoms participated. Aortic pulse wave velocity (aPWV) and augmentation index (AIx) were recorded using the SphygmoCor system as measures of large artery stiffness and wave reflection, respectively. Retinal artery resistance index (RI), a measure of early retinal organ damage and pulsatility ratio (PR), a measure of retinal artery pulsatility were recorded using doppler ultrasound (Aloca).
Results: aPWV was significantly associated with RI ($r=0.55, P=0.001$) and PR ($r=0.66, P=<0.001$) whereas AIx was significantly and inversely related to RI ($r=-0.37, P=0.03$) and PR ($r=-0.425$, $P=0.01$, respectively). Stratifying individuals according to tertile of aPWV and AIx revealed that RI and PR were significantly higher in those individuals with high aPWV but low AIx, compared with individuals with low aPWV and high AIx (0.58±0.10 vs 0.41±0.09, $p=0.001$, RI; and 2.5±0.57 vs 1.7±0.30; $p=0.006$, PR).
Conclusions: Increased large artery stiffness is implicated in microcirculatory damage. However, increased wave reflections may exert a protective effect. Future mechanistic studies linking the macro and micro-circulations may provide important insights into the management of conditions such as hypertension and diabetes.

5.3
AGE-RELATED CHANGES IN THE MICROMECHANICAL PROPERTIES OF OVINE AORTA

R. Akhtar, C. Kridiotis, H. K. Graham, M. J. Sherratt, A. W. Trafford, J. K. Cruickshank, B. Derby.
The University of Manchester, Manchester, United Kingdom

Scanning Acoustic Microscopy (SAM) images have a spatial resolution at 1 GHz comparable to conventional optical microscopy. Each pixel in the image can be analysed to determine mechanical properties, allowing their precise correlation with microstructural components of tissue. Although loss of elasticity is a common feature of most ageing tissues, their micromechanical properties remain to be determined. In this study, mechanical properties of aortic tissue sections were measured for young (18 months old) and aged (≥ 8 years) sheep using quantitative analysis on SAM images. Acoustic wave speed (AWS), which is related to tissue stiffness, was determined using SAM at ultra-high frequencies (960 MHz to 1.1 GHz). Collagen and elastin content were determined using polarised light microscopy on picrosirius red stained sections (collagen) and fluorescence microscopy on H&E stained sections (elastin).
SAM revealed increased AWS of approximately 20 ms^{-1} in the old sheep aorta compared to young sheep aorta. Histological assessment revealed an increase in both collagen content ($44.9\% \pm 5.0$ vs. $31.0\% \pm 2.6$) and elastin content ($63.8\% \pm 4.0$ vs. $51.8\% \pm 3.6$) in the old aorta vs the young ($P<0.05$, $n=6$). Increased elastin content was coupled with a lack of organisation with fenestrations visible in the aged aorta. These data show that age-related disturbances in the collagen and elastin architecture of elastic arteries impact upon their micromechanical properties and hence contribute to arterial stiffening.

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