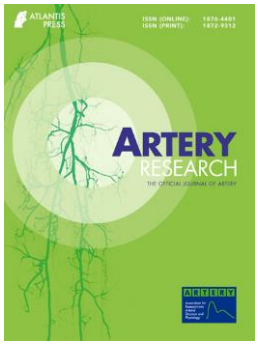


Artery Research

ISSN (Online): 1876-4401 **ISSN (Print): 1872-9312**
Journal Home Page: https://www.atlantis-press.com/journals/artres

P10.05: DOES THE AORTIC VALVES CORRESPOND TO A STABLE ANATOMICAL LANDMARK?

M. Hallab, A. Dahou, P. Chevalet

To cite this article: M. Hallab, A. Dahou, P. Chevalet (2011) P10.05: DOES THE AORTIC VALVES CORRESPOND TO A STABLE ANATOMICAL LANDMARK?, Artery Research 5:4, 189–190, DOI: https://doi.org/10.1016/j.artres.2011.10.149

To link to this article: https://doi.org/10.1016/j.artres.2011.10.149

Published online: 14 December 2019

of this receptor in the maternal uteroplacental circulation during pregnancy. To investigate this question, mice were injected with an anti-VEGFR-1 antibody (35 mg/kg i.p.) every other day beginning on day 8 (n= 9) or 12 (n=11) of gestation; vehicle-only injected mice were used as controls (n=12). All animals were killed late in pregnancy (day 19), prior to onset of parturition for determination of average pup number, resorption rate, and fetal and placental weights. Gestational vascular remodeling was evaluated by measuring the unstressed diameter and length of the main uterine artery and vein, as well as segmental artery diameter and length. Day 8 Ab injection resulted in a reduction in the average number of viable pups from 10 ± 1.2 to 3 ± 1.0 ($p<0.01$) and a high rate of fetal resorption (75 ± 7% vs. <5% in controls; $p<0.05$). Reproductive performance was also compromised in the day 12 group, although to a lesser extent. Placental and pup weights were similar throughout. Main and segmental uterine artery diameters were unchanged in either Ab group, although the diameter of the main uterine vein was reduced by 38 and 33% in both 8- and 12-day Ab-injected mice, respectively ($p<0.05$), Main uterine and segmental artery lengths were also significantly reduced. These results indicate that VEGFR-1 inhibition significantly compromises both reproductive performance and uterine vascular remodeling during murine pregnancy.

P10.02

INSTABILITY PHENOMENA IN THE MECHANICAL BEHAVIOR OF THE ANEURYSM ARTERY

E. Diouf [1], M. Zidi [2]
[1]*Université de Ziguinchor, Département de Mathématiques, Ziguinchor, Senegal*
[2]*Université Paris-Est Créteil, EAC CNRS 4396, Créteil, France*

This study proposes a mathematical model to investigate stability of arteries. The artery is considered as a prestressed thick-walled tube subjected to dynamical pressure and made of a hyperelastic and composite material [1]. To model the mechanical contributions of the different arterial components, the here considered constitutive law of the wall takes into account the isotropic part due to the elastin-dominated matrix and the anisotropic due to the collagen fibers [2]. In this context, the purpose of this work focuses on the initial formation of aneurysms in human arteries which may be modelled as instability phenomena. For that, a perturbation technique is used on the equations of motion to highlight possible instabilities of the artery. This instability interpretation provides a theoretical approach under which different biological mechanisms leading to the risk of aneurysm formation can be assessed.
The proposed approach shows the influence of disturbances on the time variation of the radial deformation at the inner surface of the arterial wall. This means that the stress distributions are very sensitive to disturbances and may explain the aneurysm formation and its growth.
[1] E. Diouf, M. Zidi, *Finite azimuthal shear motions of a transversely isotropic compressible elastic and prestressed tube*, International Journal of Engineering Science 43, 262-274, 2005.
[2] I. Masson, C. Fassot, M. Zidi, *Finite dynamic deformations of a hyperelastic, anisotropic, incompressible and prestressed tube. Applications to in vivo arteries*, European Journal of Mechanics - A/Solids 29, 523-529, 2010.

P10.03

EVALUATION OF ARTERIAL STIFFNESS IN ATHEROSCLEROTIC RABBITS IN VIVO VIA ECHOTRACKING

C. Vayssettes-Courchay, C. Ragonnet, S. Simonet, T. J. Verbeuren, J. P. Vilaine
Servier Research Institute, Suresnes, France

Objectives: We have shown that large artery stiffening, a major risk factor in cardiovascular diseases, can be evaluated in hypertensive rats by echotracking, analysing arterial compliance and also the arterial pulsatile diameter distension. We aimed to analyze similarly arterial stiffness in a model of atherosclerosis.
Methods: Male 9 week-old rabbits were fed 0.3 % cholesterol diet (ATH) or standard diet (CON) during 28 weeks. Then, under anaesthesia, blood pressure was recorded by catheterization and diameter via an ArtLab device, in a motion mode to detect pulsatile displacement of aortic walls (distension).
Results: Compliance, distension and distension/pressure loop were greatly decreased in ATH aorta versus CON, without mean diameter or blood pressure alteration. Basal femoral artery parameters were lower than aortic parameters. In ATH femoral artery, compliance, distension and the distension/pressure loop were reduced when recorded at a plaque level but increased at the upstream adjacent site; mean diameter was increased at both sites versus CON. Aortic endothelial function, assessed by ACh relaxation ex vivo was abolished in aorta and reduced in femoral artery; the lesions area in aorta (55 %) was 4x that observed in femoral artery.
Conclusions: This study analysed for the first time the in vivo dynamic arterial compliance in atherosclerotic rabbit. The data indicate a reduced arterial compliance and pulsatile distension and also show that the upstream adjacent site of a plaque is submitted to a higher stress and increased distension, in agreement with human data, which may participate to the plaque progression.

P10.04

ELASTIN AND COLLAGEN DEGRADATION REDUCES THE MECHANICAL STABILITY OF ARTERIES

A. Y. Lee, B. Han, R. Martinez, H. C. Han
University of Texas at San Antonio, San Antonio, United States of America

Arteries with elastin deficiency demonstrate tortuosity in human and animals, but the underlying mechanism has not been clearly elucidated. Our previous studies suggested that mechanical instability is a mechanism that leads to vessel tortuosity [1]. The objective of this study was to determine the role of extracellular matrix proteins in maintaining the mechanical stability of arteries. To this end, two groups of porcine carotid arteries were treated with elastase (8U/ml) and collagenase (2000 U/ml) respectively and tested before and after the treatments. The arteries were tested for pressurized inflation and the data were fitted with a Fung strain energy function to determine their stress-strain relationship. The critical pressures, at which the arteries became unstable and started to bend, were determined by a buckling test. The specimens were then processed for elastin staining and collagen staining and microscopy examinations. Our results demonstrated that elastase and collagenase treatment led to significant decreases in wall stiffness and critical buckling pressure of arteries. For example, the pre- and post- elastase treatment critical pressures of arteries are 19.9±5.3 kPa and 9.1±3.6 kPa, respectively, at *in vivo* length (n=6. $p<0.05$, see Figure 1). These results suggested that elastin and collagen degradation reduced the stability of arteries making them more susceptible to buckling and that mechanical buckling could initiate vessel tortuosity.
Acknowledgment: Supported by the NSF CAREER award 644646 and NHLBI grant HL095258 and NO1-HV-00244.
Reference: 1. Han HC: Blood vessel buckling within soft surrounding tissue generates tortuosity. J Biomech 2009;42:2797-2801.

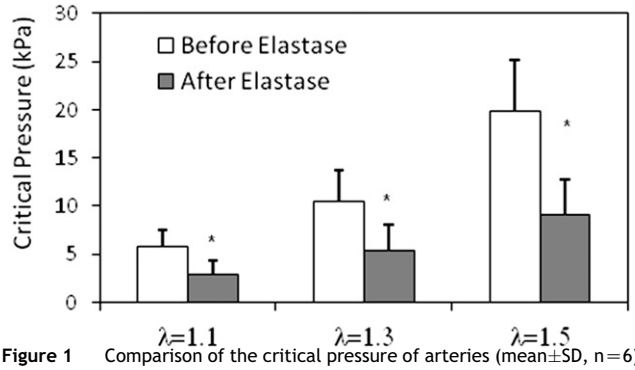


Figure 1 Comparison of the critical pressure of arteries (mean±SD, n=6) measured before and after elastase treatment. * $p < 0.05$.

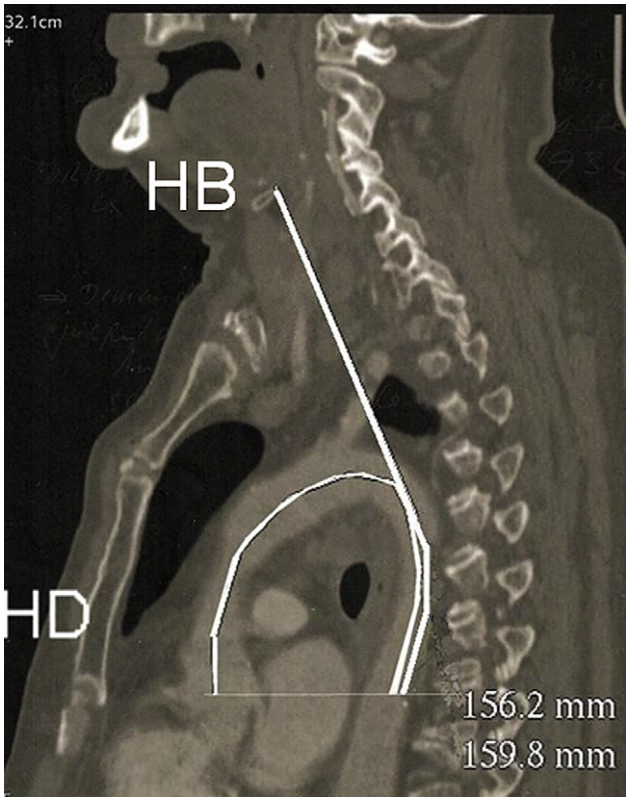
P10.05

DOES THE AORTIC VALVES CORRESPOND TO A STABLE ANATOMICAL LANDMARK?

M. Hallab [1], A. Dahou [2], P. Chevalet [1]
[1]*Hôpital Bellier CHU de Nantes, Nantes, France*
[2]*Service de Radiologie CHU de Nantes, Nantes, France*

Purpose: In order to determine if the height of a subject could be a reliable surrogate variable to determine the pulse wave travelling distance within the aorta, we investigated the anatomical distance between the aortic valve nidus and the hyoid bone.
Methods: Using 28 patient's chest CT-scans. From MPR reconstructed oblique plans we measured 1) the length of the aortic arch from the aortic valve (AV) to the intercept of an horizontal line passing through the aortic valves

and crossing the descending aorta at mark HD (see figure), and 2) the distance between the HD mark to the Hyoid Bone (HB).

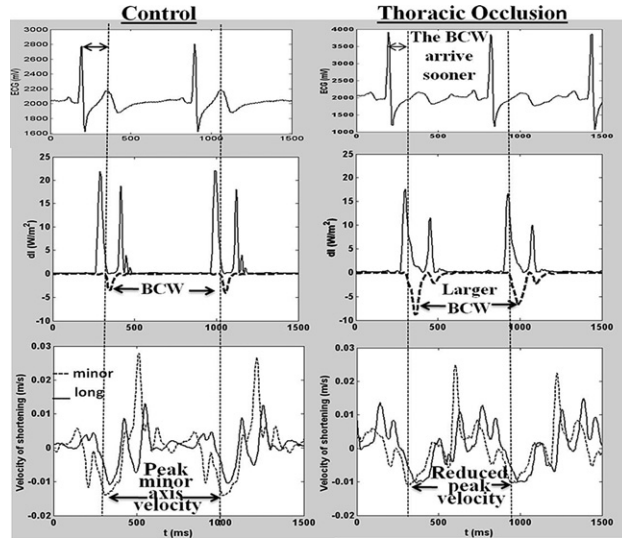


Results: There was a correlation between the AV-HD distance and the HD-HB distance (non parametric $r = 0.66$, $p < 0.0001$) and the AV-HD distance were positively correlated to the height of the subjects ($r = 0.60$, $p < 0.002$).
Conclusions: 1- The AV-HD distance projects to a constant anatomical landmark (i.e. the hyoid bone) 2- The size of this arterial segment is significantly correlated to the height of the subjects. These preliminary results could be useful for a more accurate determination of the pulse wave velocity.

P10.06
IS THE BACKWARD REFLECTED WAVE DETRIMENTAL TO LEFT VENTRICLE PERFORMANCE?

C. M. Park [1], M. Y. Henein [2], A. D. Hughes [1], A. W. Khir [3]
[1]*Imperial College London, London, United Kingdom*
[2]*Umea Heart Centre, Umea, Sweden*
[3]*Brunel Institute for Bioengineering, London, United Kingdom*

The effect of the backward reflected wave (BCW) on left ventricular (LV) performance is a highly debated area. The aim of this study was to establish whether the arrival of a BCW has a detrimental effect on LV axis shortening.
Methods: Invasively acquired ascending aortic velocity, pressure and LV long and minor axes dimensions were measured simultaneously in 11 open-chest anaesthetised dogs. LV axes dimensions were measured by sonomicrometry and differentiated with respect to time to identify maximum shortening velocity. Wave Intensity analysis was used to identify the arrival time of BCW. Data were acquired during control and during occlusion conditions of the proximal thoracic aorta, created using a snare. Statistical agreement was assessed using the concordance correlation coefficients (CCC).
Results: During control the BCW arrived back at the heart at the time of LV minor axis maximum velocity of shortening (difference 3±4ms, CCC=0.96). Aortic occlusion was associated with a large increase in the magnitude and earlier arrival of the BCW. LV minor axis' maximum velocity of shortening was attenuated by 20% and also occurred earlier, at the time of BCW arrival (mean difference 3±5ms, CCC=0.98). The LV long axis was less affected by arrival of BCW (Figure).
Conclusions: The arrival of BCW results in deceleration of the rate of shortening of the LV minor axis but does not cause deceleration of the long axis. The BCW appears to be detrimental to the canine LV minor axis function.



P10.07
VERIFYING THE NEWTONIAN ASSUMPTION FOR BLOOD FLOW IN ANEURISMAL GROWTH MODELLING

M. Nabaei, N. Fatouraee
Biomedical Eng. Faculty, Amirkabir University of Technology, Tehran, Iran, Islamic Republic of

A few number of studies have examined the effect of hemodynamic factors on the initiation and growth procedure of cerebral aneurysms. The Newtonian behaviour is assumed for blood flow in almost all of the mentioned investigations. Since the majority of intracranial aneurysms occur at bifurcations, to verify this assumption, we constructed a 3D model of the basilar artery bifurcation that includes the luminal hemodynamics and the arterial wall response within a computational fluid-structure interaction (FSI) framework. The arterial wall was assumed to be elastic and isotropic. The flow was considered steady, laminar, and incompressible. The blood flow was assumed to behave both Newtonian and no-Newtonian following Carreau model (Cho, YI, Kensey, KR, Biorheology, 28:241—262, 1991). The fully coupled fluid and structure models were solved with the finite elements package ADINA 8.5. The blood pressure and velocity and the wall shear stress (WSS), effective stress and deformation distributions were compared in two cases. The results show similar patterns except the WSS magnitudes which were under-estimated with the Newtonian assumption. This difference was evident in the low velocity regions like the apex of the bifurcation (about 20%) which is a probable position for the aneurysm formation. WSS is one of the critical hemodynamic factors affecting aneurismal initiation and development. Therefore, we believe that it is worth to consider the non-Newtonian behaviour of blood flow in order to investigate the detailed relationship between hemodynamic factors and vascular diseases, and it may affect the growth procedure of cerebral aneurysms.

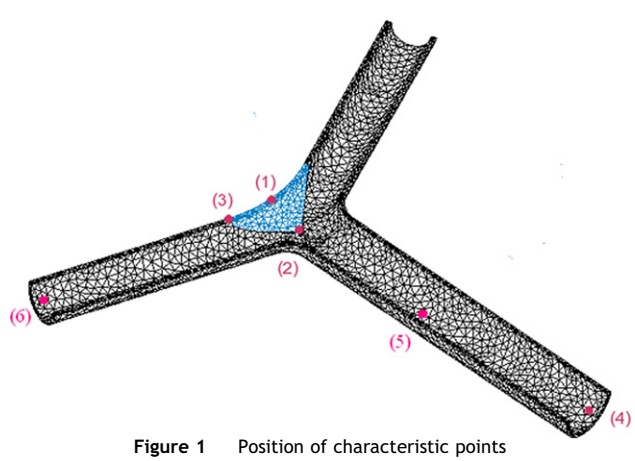


Figure 1 Position of characteristic points