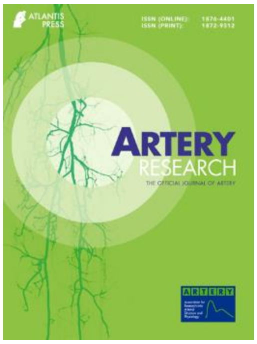


Artery Research

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

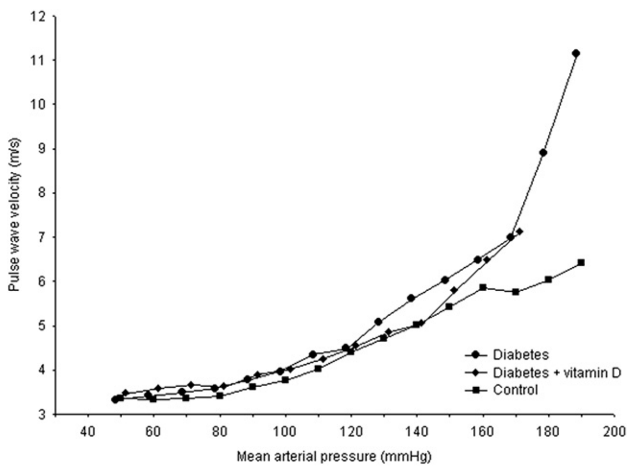
P4.07: ON THE RELEVANCE OF A PPG BASED TWO PULSE SYNTHESIS MODEL FOR SCREENING AGAINST CORONARY ARTERY DISEASES

D. Goswami, B.P. Chatterjee, S. Ray, K. Chaudhuri, J. Mukherjee

To cite this article: D. Goswami, B.P. Chatterjee, S. Ray, K. Chaudhuri, J. Mukherjee (2011) P4.07: ON THE RELEVANCE OF A PPG BASED TWO PULSE SYNTHESIS MODEL FOR SCREENING AGAINST CORONARY ARTERY DISEASES, Artery Research 5:4, 161–161, DOI: https://doi.org/10.1016/j.artres.2011.10.052

To link to this article: https://doi.org/10.1016/j.artres.2011.10.052

Published online: 14 December 2019



P4.06
MECHANICAL PROPERTIES AND STRESSES IN CAROTID ARTERIES QUANTIFIED USING CLINICAL DATA FROM NORMOTENSIVE AND HYPERTENSIVE HUMANS

I. Masson [1], H. Beaussier [2], P. Boutouyrie [2], S. Laurent [2], J. D. Humphrey [3], M. Zidi [1]
[1]*Université Paris-Est Créteil Val de Marne (UPEC), CNRS EAC 4396, Créteil, France*
[2]*Service de Pharmacologie, Université René Descartes, Hôpital Européen Georges Pompidou, INSERM U970, Paris, France*
[3]*Department of Biomedical Engineering, Malone Engineering Center, Yale University, New Haven, United States of America*

Objectives: To model the in vivo nonlinear mechanical behavior of human common carotid arteries (CCAs), to compute wall stresses and to deduce changes in wall micro-constituents (elastin-dominated matrix, collagen fibers, vascular smooth muscle cells (VSMC)) in normotensive subjects (NT) and hypertensive patients (HT).
Methods: Clinical data were obtained non-invasively from CCAs in 16 NT (21-64 years old) and 25 treated HT (44-69 years old). Medial diameter, intimal-medial thickness and blood pressure (BP) were measured during several cardiac cycles by high-resolution echotracking (Art.Lab®) and applanation tonometry (SphygmoCor®) systems, respectively. For the theoretical mechanical modeling, the CCAs were assumed to be hyperelastic, anisotropic, active-passive, and residually- stressed. We semi-analytically solved the boundary value problem to compute the intraluminal pressure from carotid distension, while accounting for perivascular tissue. Best-fit values of model parameters were adjusted by minimizing the difference between computed and measured inner BP over the cardiac cycle.
Results: In NT, age was positively correlated ($p<0.05$) with residual stresses and fibrillar collagen (stiffness and orientation). Despite treatment, HT had increased VSMC tone ($p=0.003$, +17.3%), a stiffer elastin-dominated matrix ($p=0.01$, +20.5%), and higher levels of stresses.
Conclusions: We were able to estimate wall stress fields and to quantify changes in mechanical characteristics of wall micro-constituents with aging and hypertension from non-invasive clinical data, though mechanical modeling of the wall behavior. Our results are consistent with prior reports on effects of age and hypertension, but provide increased insight into evolving contributions of cell and matrix mechanics to arterial behavior in vivo.

P4.07
ON THE RELEVANCE OF A PPG BASED TWO PULSE SYNTHESIS MODEL FOR SCREENING AGAINST CORONARY ARTERY DISEASES

D. Goswami [1], B. P. Chatterjee [2], S. Ray [2], K. Chaudhuri [1], J. Mukherjee [1]
[1]*Indian Institute of Technology, Kharagpur, India*
[2]*AMRI Hospital, Kolkata, India*

Abstract: Arterial stiffness is an independent predictor for coronary artery diseases (CAD). Various methods to predict coronary artery involvement are known but most of them have limited applicability in large-scale population screening due to cost barrier [1].
Photoplethysmography (PPG) to capture digital volume pulse signal is a simple, low-cost and noninvasive method for rapid assessment of arterial health conditions. An important application of PPG signal analysis has been towards early detection of altered arterial stiffness leading to increased risk of CAD. A Two Pulse Synthesis (TPS) model has been suggested recently for measurement of vascular parameters based on PPG signal and the usefulness of the model has been established for hypertensive and diabetic subjects [2].
This communication reports the outcome of a study based on the use of TPS model on finger-tip PPG of 40 suspected CAD subjects. The TPS model-based parameters considered in the study are Rise Time, Reflection Index, Foot-to-Foot Delay, Differential-Pulse-Spread and the Spread-Delay Ratio. Angiography has been subsequently carried out on these subjects and the findings have been compiled to find out sensitivity, specificity, positive and negative predictive values.
The study shows that the Positive Predictive Value of the TPS model is respectable (69%) while the Negative Predictive Value (93%) is high. It appears that this mathematical model may be applied to predict or rule out CAD conditions fairly successfully. Gradual development of functional embarrassments even in the absence of clinical manifestations may be possible with PPG analysis through periodic application of TPS model.

References
1. Laurent S., Boutouyrie P., Asmar R., Gautier I., Laloux B., Guize L., Pierre Ducimetiere P., Benetos A., 'Aortic stiffness is an independent predictor of all-cause and cardiovascular mortality in hypertensive patients'; *Hypertension* 2001; **37**: 1236—1241.
2. Goswami D., Chaudhuri K., Mukherjee J., 'A New Two-Pulse Synthesis Model for Digital Volume Pulse Signal Analysis,' *J. of Cardiovascular Eng;* DOI 10.1007/s10558-010-9098-8.

P4.08
BIOMECHANICAL STUDY OF ANEURYSM RUPTURE

J. Kim [1], A. Romo [1], P. Badel [1], A. Duprey [2], J. N. Albertini [2], J. P. Favre [2], S. Avril [1]
[1]*Ecole Nationale Supérieure des Mines de Saint-Etienne, Center for Health Engineering, CNRS UMR5146, INSERM IFRESIS, Saint Etienne, France*
[2]*CHU Nord University Hospital Center, Department of Vascular Surgery, Saint Etienne, France*

The rupture of aortic aneurysms is a catastrophic event that represents a major public health issue. It has received a large interest from the scientific community. However, only limited research has provided quantitative values of mechanical stresses that may assess the risks of rupture of aneurysms [1].
In this study we have applied an imaging approach for measuring the deformations of the aneurysmal tissue tested in a biaxial inflation test [2]. The tissues have been taken from the thoracic ascending aorta of 6 diseased patients operated for aneurysm treatment by conventional surgery at the University Hospital of Saint-Etienne, France.
Quantitative values of ultimate stresses are reported in Tab. 1. Rupture is anisotropic, but primarily induced by axial stresses. Moreover, it is observed that rupture in aneurysms is preceded by a local weakening of the mechanical properties of the tissue, especially in the intima and media layers which are more fragile, and that these effects announcing a pending rupture can be detected by advanced imaging techniques. Our investigations continue in that sense for proposing novel diagnosis methodologies based on these observations.
Refs:
[1] Li ZY, Sadat U, U-King-Im J, Tang TY, Bowden DJ, Hayes PD and Gillard JH: Association between aneurysm shoulder stress and abdominal aortic aneurysm expansion - a longitudinal follow-up study. Circulation 2010, 122(18):1815-22.
[2] Kim J, Avril S, Badel P, Duprey A, Favre JP. Characterization of failure in human aortic tissue using digital image correlation. Computer Methods in Biomechanics and Biomedical Engineering, 2011, in press.

Tab. 1. Quantitative values of ultimate stress measured at rupture

Patient gender	M	M	M	M	M	M
Age	81	81	68	69	76	76
Type	adventitia	media	media	media	media	adventitia
Stress at rupture (MPa)	0.6257	0.3719	0.3686	0.4107	0.3483	1.0522