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P10.09: ANALYZE OF A STOCHASTIC ANISOTROPIC FIBROUS CONSTITUTIVE LAW EFFECT ON THE HUMAN ARTERIAL PRESSURE

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Table 1 Comparison of the WSS and pressure magnitudes of the characteristic points between Newtonian and non-Newtonian simulations

Point Number	Newtonian		Non-Newtonian		% Difference	
	WSS [Pa]	Pressure [Pa]	WSS [Pa]	Pressure [Pa]	WSS	Pressure
1	0.688	15831.600	0.852	15832.500	19.284	0.006
2	2.980	15783.900	3.236	15784.600	7.911	0.004
3	5.670	15616.300	5.989	15616.600	5.325	0.002
5	4.403	15851.600	4.717	15852.500	6.639	0.006

P10.08**COMPARATIVE INVESTIGATION OF MECHANICAL CHARACTERISTICS OF STABLE AND UNSTABLE CAROTID ATHEROSCLEROTIC PLAQUES**

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The prognosis of patients with carotid atherosclerosis is determined by the factor of unstable atherosclerotic plaque. Change of longitudinal strain in junction place of healthy artery wall to plaque determined by local artery elasticity and leads to instability.

Aim of the study: Comparative investigation of mechanical characteristics of the stable and unstable plaques in a carotid artery.

Methods: In the main group (MGr) were studied 16 plaques with stenosis 70-90%, and control group (CGr) 33 plaques with stenosis 25-45%. Carotid ultrasound examinations (PHILIPS iU22) were performed for estimated structure and stenosis of plaques. The "healthy" wall stiffness (free from plaques - β_{hw}) and plaques zone stiffness (in adventitia - β_{adv} and in plaques surface - β_{pl}) were estimated using echo-tracking method by ALOKA α 7 in B/M mode ultrasound imaging.

Results: In the MGr majority of plaques had structure with hypoechoic area (>50%) and calcification, third plaques had rough or ulcerated surface. In CGr dominated heterogeneous plaques with smooth surface. In both groups β_{hw} was significantly lower, than β_{adv} (MGr: $8,95 \pm 3,14$ vs $22,73 \pm 10,43$, CGr: $9,43 \pm 2,64$ vs $14,45 \pm 6,7$, $p < 0,001$), β_{adv} was significantly higher than β_{pl} (MGr: $22,73 \pm 10,43$ vs $7,7 \pm 5,04$; CGr: $14,45 \pm 6,7$ vs $11,69 \pm 6,84$, $p < 0,001$). Relative changes of plaques zone stiffness ($100 \cdot \beta_{pl} \times 100 / \beta_{adv}$) was significantly higher in the MGr ($51,28 \pm 24,17\%$ vs $26,93 \pm 21,45\%$, $p = 0,036$).

Conclusions: Our results confirm presence the significant gradient of stiffness in junction place of healthy artery wall to plaque. In group with unstable plaques this gradient was significantly higher, that allows considering the possibility of the unstable plaques criteria developing by echo-tracking method.

P10.09**ANALYZE OF A STOCHASTIC ANISOTROPIC FIBROUS CONSTITUTIVE LAW EFFECT ON THE HUMAN ARTERIAL PRESSURE**

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This research work deals with a stochastic approach using the entropy maximum principle to investigate the effect of parameters uncertainties on the arterial pressure. Motivated by a composite constitutive law with collagen fiber families [1], a set of uncertain parameters describing the mechanical behavior of the artery wall was considered. On the light of the available information, probability density functions were considered for the random variables governing the constitutive law in order to describe the dispersion of mechanical model response. Numerous realizations were performed according to the probability distributions and the corresponding arterial pressure results were compared to human non invasive clinical data recorded over a mean cardiac cycle. To prove the convergence of the probabilistic model, simulations of Monte Carlo were performed [2]. The different realizations were useful to define a reliable confidence region in which the probability to have a realization is equal to 95%. The obtained results demonstrate that the error in the estimation of the arterial pressure can reach 35% when the estimation of model parameters is subjected to an uncertainty ratio of 5%. Eventually, a sensitivity analysis was performed to discuss the influence of every uncertain parameter on the arterial pressure to identify the main parameters which contribute significantly in the

constitutive law for a better understanding and characterization of the arterial wall mechanical behavior.

[1] I. Masson, P. Boutouyrie, S. Laurent, J.D. Humphrey, M. Zidi, *Characterization of arterial wall mechanical behavior and stresses from human clinical data*, Journal of Biomechanics 41, 2618-2627, 2008.

[2] A. Eddhahak-Ouni, I. Masson, E. Allaire, M. Zidi, *Stochastic approach to estimate the arterial pressure*, European Journal of Mechanics - A/Solids 28, 712-719, 2009.

P10.10**THE INFLUENCE OF ANTIHYPERTENSIVE TREATMENT ON ARTERIAL STIFFNESS AND SELECTED MATRIX METALLOPROTEINASES PLASMA ACTIVITY**

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The aim of the study was to compare the effects of 5 selected drugs on arterial stiffness and matrix metalloproteinases (MMPs) plasma activity in patients with essential arterial hypertension (HT). Material and methods: 95 pts. with HT stage 1 and 2, (N=19 in each treatment group) were treated for 6 months by: quinapril 20-40 mg/d (group-1), amlodipine 5-10mg/d (group-2), hydrochlorothiazide 12,5-25mg/d (group-3), losartan 50-100 mg/d (group 4), bisoprolol 5-10 mg/d (group-5). Before and then after 1,3 and 6 months of treatment office blood pressure (BP) was measured using Omron M5-l device. Carotid femoral pulse wave velocity (PWV) was measured using 3 devices Complior®, Sphygmocor® and Arteriograph™. Plasma concentration of (MMPs): MMP1, MMP2, MMP3, MMP9 and MMPs tissue inhibitor (TIMP1) was measured twice i.e. before and after 6 months of treatment using micro-ELISA method. Results: At the baseline no differences between groups were observed in BP, PWV and MMPs activity. ANOVA for repeated measurements revealed for all groups during treatment significant decrease in systolic BP ($p < 0.001$), diastolic BP ($p < 0.001$), PWV ($p < 0.001$), MMP2 ($p < 0.05$) and MMP3 ($p < 0.001$) and increase of TIMP1 ($p < 0.001$) plasma concentration. No between treatment groups differences were observed in above mentioned effects. Decrease of PWV was in significant relation to its baseline value ($B = 0.498$, $p = 0.00041$), decrease of MMP3 ($B = 0.211$, $p = 0.0021$) and increase of TIMP1 ($B = 0.263$, $p = 0.0052$). Conclusion: Antihypertensive treatment reduces arterial stiffness proportionally to its baseline value and independently of the used drug. The reduction of arterial stiffness depends on decrease of extracellular matrix degradation.

P10.11**THE EFFECT OF WALL MOTION ON THE HAEMODYNAMICS OF MIDDLE CEREBRAL ARTERY (MCA) ANEURYSM**

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External forces, accelerations and displacements, due to sudden motions of head or traumas, may affect the haemodynamics and flow patterns in a cerebral aneurysm. Despite several studies on blood flow dynamics and arterial wall mechanics in intracranial aneurysms, limited investigations considered the external forces or motion of the arterial wall. Therefore in this study, we have numerically analyzed the effects of wall movement on cerebral aneurysms with the fluid and structure interaction (FSI) theories. A 3Dimensional Model of Middle Cerebral Artery (MCA) aneurysm (geometry adopted from R. Torii et al., *Int. J. Numerical Methods in Fluids*, 54:995-1009, 2007) was constructed and exposed to a realistic head motion in sagittal plane. Blood was considered as a homogeneous, incompressible