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P10.12: COMBINED B-MODE, ACOUSTIC RADIATION FORCE (ARF), AND DOPPLER REAL-TIME IMAGING SYSTEM FOR ASSESSING CARDIOVASCULAR MECHANICS AND BLOOD FLOW HEMODYNAMICS

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and Newtonian fluid and arterial wall assumed to be elastic, incompressible and isotropic. The governing equations were, continuity and Navier-Stokes equations for fluid domain and equilibrium equations and Hooke's Law for arterial wall. The flow was steady and motion was applied to the arterial wall. Simulations were carried out using the commercially available finite element software. The effect of wall motion on flow patterns and wall shear stress, strain and effective stress distributions have been discussed. The results show that arterial wall motion doesn't change the magnitude of major hemodynamic factors and wall stress and strain distributions considerably and won't lead to aneurismal rupture directly, but obviously affects the blood flow patterns in cerebral aneurysms.

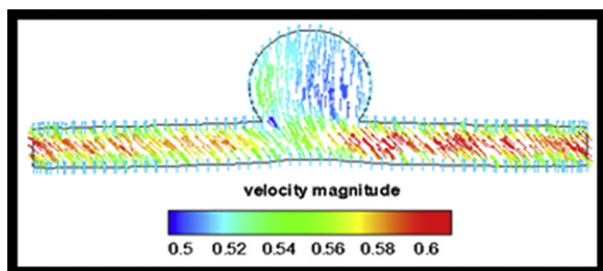


Figure 1 Velocity vectors in model with arterial wall motion

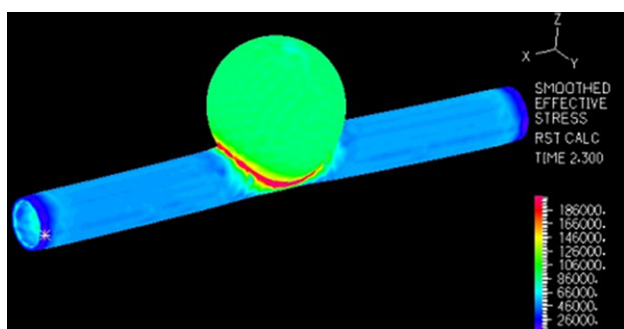


Figure 2 Effective stresses distribution in model with artery wall motion

P10.12 COMBINED B-MODE, ACOUSTIC RADIATION FORCE (ARF), AND DOPPLER REAL-TIME IMAGING SYSTEM FOR ASSESSING CARDIOVASCULAR MECHANICS AND BLOOD FLOW HEMODYNAMICS

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In efforts to monitor the progression of atherosclerosis using ultrasound, Acoustic Radiation Force Impulse (ARFI¹) and Shear Wave Elasticity Imaging (SWEI²) have been implemented to measure the mechanical stiffness of vascular tissue while colorflow Doppler and spectral Doppler techniques have been used to monitor the associated blood flow hemodynamics.

Towards creating an imaging system capable of collecting both the mechanical and hemodynamic information within one acquisition, a series of combined Bmode/ARFI/Doppler imaging tools were developed. These tools acquire multiple frames of co-registered Bmode echogenicity, ARF induced on-axis displacements and transverse wave velocities, along with blood flow velocity estimates and wall-shear rate (WSR) at frame rates up to 20 Hz over several cardiac cycles. Implemented on a diagnostic ultrasound scanner connected to a laptop for off-line processing, the carotid arteries of patients with and without known carotid artery plaques were scanned. Processed images were temporally and spatially stable across multiple frames and acquisitions. Cyclic variations across the cardiac cycle were observed, depicting increased vessel wall stiffness and increased WSR during systole compared to diastole. For combined Bmode/ARFI configurations, overall data acquisition and image processing frame rates of 1 Hz were achieved, enabling feedback during the exam. A series of acquired *in vivo* image sequences will be presented.

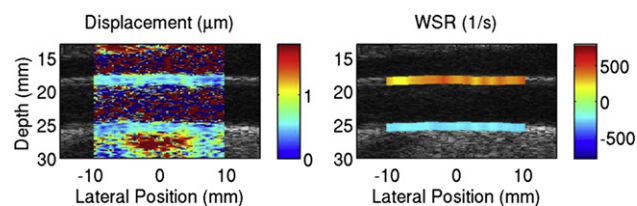


Figure 1 Co-registered ARFI displacement image (left) and WSR image (right) shown overlaid on a B-mode image obtained *in vivo* using a combined B-mode/ARFI/Doppler system.

¹Nightingale et al. *J. Acoust Soc Am.* 110(1). 2001, 625-634.

²Sarvazyan et al. *Ultrasound Med Biol.* 24(9). 1998, 1419-1435.

P11 – Clinical Science 2

P11.01 AUGMENTED AORTIC FORWARD PRESSURE WAVE AMPLITUDE CONTRIBUTES TO INCREASED LEFT VENTRICULAR MASS IN OVERWEIGHT ADOLESCENTS

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We hypothesized that aortic forward pressure wave amplitude, which is determined by characteristic impedance (Z_c) and peak flow in the proximal aorta, contributes to increased left ventricular (LV) mass observed in overweight (OW) adolescents. Aortic pulsatile hemodynamics were measured non-invasively in sixty healthy adolescents (age 14-19 yrs; 42% male) by sequential recordings of pulse waveforms via tonometry, brachial BP, and pulsed Doppler and diameter of aortic outflow tract using 2D echocardiography. LV structure and function was assessed by 2D echo. OW adolescents ($n=23$; age 16.0 ± 0.3 yrs; BMI $\geq 85^{\text{th}}$ percentile) had higher LV mass index (LVMI), brachial and carotid systolic BP and PP (all $P < 0.05$), but not mean BP, carotid-femoral PWV or augmentation index compared with normal-weight (NW, $n=37$; 16.7 ± 0.3 yrs; BMI $< 85^{\text{th}}$ percentile) ($P > 0.05$). OW demonstrated lower resistance (Z_0 , 1512 ± 91 vs. 1786 ± 70 dyne \times sec/ cm^5) and higher Z_c normalized to Z_0 (0.13 ± 0.01 vs. 0.11 ± 0.01) and forward wave amplitude (Pf, 48 ± 3 vs. 40 ± 2 , mmHg) compared with NW (all $P < 0.05$). Adjusting for age and sex, LVMI correlated with brachial and carotid systolic BP and PP ($r=0.26-0.30$), Z_0 ($r=-0.27$), Z_c normalized to Z_0 ($r=0.29$), and Pf ($r=0.32$) (all $P < 0.05$). Stepwise multiple regression revealed that BMI ($\beta \pm \text{SE}$; 0.69 ± 0.19 ; $R^2=0.26$) and Pf (0.23 ± 0.07 ; R^2 change=0.11) were the best predictors of LVMI (total $R^2=0.37$, $P < 0.01$). These findings suggest that augmented Pf is a major hemodynamic determinant of increased LV mass with obesity in adolescents.

P11.02 INFLAMMATION AND PRE-ATHEROSCLEROTIC VASCULAR CHANGES IN HEALTHY 5 YEAR OLD CHILDREN

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Background: Inflammation is important in atherosclerosis development. Whether common causes of inflammation, like common infections and allergies, contribute to vascular changes already in childhood remains unknown. **Methods:** In the first 345 five-year-olds of the WHISTLER birth cohort, carotid intima media thickness (CIMT), distensibility and Elastic Modulus (EM) were obtained ultrasonographically. Information on primary health care consumption for infections and allergies was obtained from the general practitioners' electronic files. Moreover, parental history of allergies was collected. **Results:** Neither lifetime nor recent consultations for infections, nor the number of visits for more severe infections was associated with vascular measures (adjusted for age, gender, BMI, parental smoking, gestational age, infant feeding and allergies). Lifetime prescription of antibiotics was not related to vasculature, but antibiotic prescription in the last 3 months was associated with a $18.1 \mu\text{m}$ increased CIMT (95%-confidence interval (CI): $1.2 - 35.1$).