

Vascular Remodeling and Blood Flow Pattern in Elderly Patients with Arterial Hypertension

Lilia A. Sadjaya¹, Georgy V. Simonenko², Lidia A. Tikhonova¹, Lidia I. Malinova¹
1 – Saratov scientific research institute of cardiology; 2 – Saratov state university

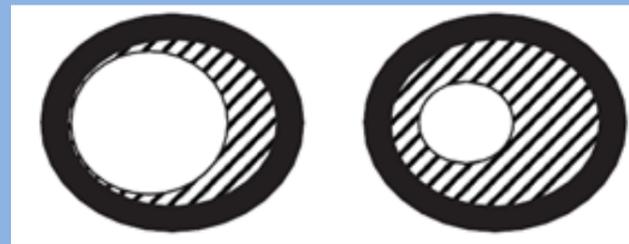
Biomechanical Consequences of Perturbed Flow and Pressure.

Background

The normal artery is subjected to 3 primary mechanical stresses: a blood flow-induced wall shear stress (τ_w), a blood pressure-induced circumferential wall stress (σ_θ), and an axial wall stress (σ_z):

$$\tau_w = \frac{4\mu Q}{\pi a^3}, \quad \sigma_\theta = \frac{Pa}{h}, \quad \sigma_z = \frac{f}{\pi h(2a+h)},$$

where μ - the blood viscosity, Q - the mean volumetric flow rate, a and h the luminal radius and wall thickness in any pressurized configuration, P the transmural pressure (with low perivascular pressure), and f the axial force that maintains the axial "prestretch".

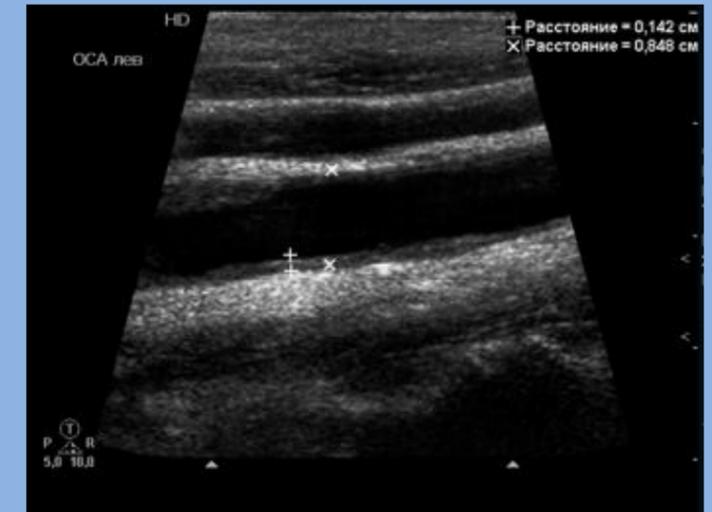


Morphological types of vascular remodeling

Purpose: to investigate relationships among plaque formation, increasing intima-media thickness (IMT), age, and blood flow pattern, we examined ultrasonographically carotid arteries of elderly hypertensive patients who had no clinical signs of atherosclerotic disease.

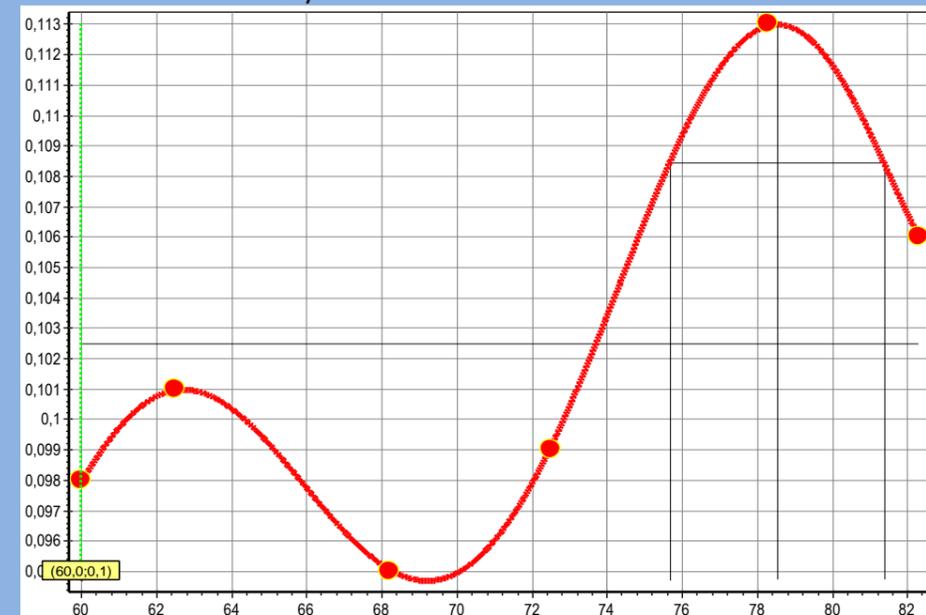


a



b

Common carotid artery. Intima-media wall thickness increase: from a to b



Age related intima-media wall thickness increase in elderly patients with arterial hypertension

Methods. We studied 179 elderly patients with arterial hypertension (100 women, 79 men; age range, 60 to 88 years) and no history of diabetes mellitus, or atherosclerotic disease. Mean intima-media wall thickness (IMT) of common carotid arteries at plaque-free sites and prevalence of plaques were evaluated by B-mode ultrasound. Blood flow characteristics were studied in vitro at 1ml/h blood flow rate by means of PC integrated camera with after going slide by slide analysis



Results—Mean common carotid IMT increased in nonlinear manner with age: relatively stable phase lasted from 60 up to 74 years old, then occurred significant intima-media thickness increase with maximal rate of 0.003 cm per year. In senile patients intima-media complexes were diffusely thickened (IMT 0.103 cm±0.620). Time function, first derivative and phase pattern of intima-media thickness changing revealed two sinks in phase plane "intima-media thickness time function – it's first derivative", both corresponded to 60 and 75 years old, respectively. Plaque prevalence increased up to the seventh decade of life. IMT and plaque prevalence were closely associated in the seventh and eighth decades of life. No significant correlation within IMT and arterial pressure (systolic, diastolic, pulse, general), medication spectrum was revealed in studied patients. IMT correlates with erythrocyte aggregate frequency and leukocyte count in peripheral layer.

Conclusions—The present study suggests that increased IMT is a physiological effect of aging and blood flow pattern that corresponds to diffuse intimal thickening. IMT is distinct from pathological plaque formation even in patients with arterial hypertension.