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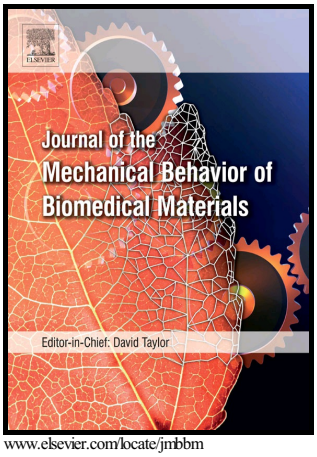

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Characterization of mechanical properties of lamellar structure of the aortic wall: Effect of aging

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Abstract: Arterial wall tissues are sensitive to their mechanical surroundings and remodel their structure and mechanical properties when subjected to mechanical stimuli such as increased arterial pressure. Such remodeling is evident in hypertension and aging. Aging is characterized by stiffening of the artery wall which is assigned to disturbed elastin function and increased collagen content. To better understand and provide new insight on microstructural changes induced by aging, the lamellar model of the aortic media was utilized to characterize and compare wall structure and mechanical behavior of the young and old human thoracic aortic samples. Such model regards arterial media as two sets of alternating concentric layers, namely sheets of elastin and interlamellar layers. Histological and biaxial tests were performed and microstructural features and stress-strain curves of media were evaluated in young and old age groups. Then using optimization algorithms and hyperelastic constitutive equations the stress-strain curves of layers were evaluated for both age groups. Results indicated slight elevation in the volume fraction of interlamellar layer among old subjects most probably due to age related collagen deposition. Aging indicated substantial stiffening of interlamellar layers accompanied by noticeable softening of elastic lamellae. The general significant stiffening of old samples were attributed to both increase of volume fraction of interlamellar layers and earlier recruitment of collagen fibers during load bearing due to functional loss of elastin within wall lamellae. Mechanical characterization of lamellar structure of wall media is beneficial in study of arterial remodeling in response to alternated mechanical environment in aging and clinical conditions through coupling of wall microstructure and mechanical behavior.

Keywords: Aging, Arterial wall, remodeling, lamellar structure, structure- mechanics coupling, constitutive modeling