LAYER-SPECIFIC MECHANICAL PROPERTIES OF HUMAN THORACIC AORTA

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Introduction

The available research of human aorta consider the arterials walls as a single-layer homogeneous structure. However the blood vessels walls are composed of three layers: adventitia (the outer layer), media (the middle layer) and intima (the inner layer). Each layer has specific mechanical functions [Holzapfel et al., 2004], so artery wall is a heterogeneous three-layered structures. Now we know that for example deployment of stent grafts, which are in contact with the intima, can generate high stresses and may cause laceration of this layers [Weisbecker et al., 2012]. In these cases knowledge of mechanical properties of the intima is important. Thus the main aim of this work is determination of mechanical parameters of intima (I), media (M) and adventitia (A).

Material and Method

Four thoracic aortas from four corpses were harvested during autopsy within 24 hours of death. Aortas were obtained from the Department of Forensic Medicine, Wrocław Medical University. In order to determine the layer specific mechanical properties fifty-one circumferential rectangular specimens were cut and then the adventitia (n=12), media (n=24) and intima (n=15) layers were separated. The thickness of layers was measured optically using a videoextensometer (ME 46-350 Meesphysik) and was: $0,20\pm0,11$mm (A), $0,70\pm0,35$mm (M) and $0,27\pm0,18$mm (I). The length of specimens was 50mm and the width was 5mm.

The mechanical parameters was measured in uniaxial stretching until rupture using testing machine MTS Synergie 100. The test was conducted at the constant loading speed of 2mm/s. The number of preconditioning cycles was 4.

Result and Discussion

Based on stress-strain curve obtained during mechanical tests the maximum values of the strength (σ_{max}), strain (ε_{max}) and Young's modulus (E) were calculated.
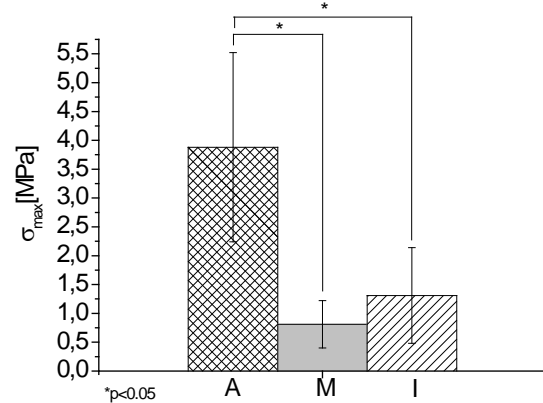

Figure 2. Average values of strength determined for: adventitia (A), media (M) and intima (I)

The mechanical properties of the layers are mostly determined by its components. The main structural component of adventitia is collagen, so strength of this layer is the highest ($3,88\pm1,64$MPa). The adventitia is characterised also by the highest value of Young's modulus (24 ± 8MPa). Two main structural components of media are collagen and elastin fibers. The elasticity of elastin fibers is more than collagen so, the maximum strain of the media is the highest ($0,22\pm0,06$).

References

Holzapfel G.A., *et al*, J Biomech Eng, 126:264-275, 2004.

Weisbecker H. *et al*, J Mech Behav Biomed Mat, 12:93-106, 2012.