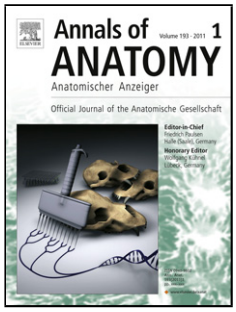

Title: The composition and biomechanical properties of human cryopreserved aortas, pulmonary trunks, and aortic and pulmonary cusps

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PII: S0940-9602(17)30046-8
DOI: http://dx.doi.org/doi:10.1016/j.aanat.2017.03.004
Reference: AANAT 51150

To appear in:

Received date: 14-11-2016
Revised date: 6-1-2017
Accepted date: 21-3-2017

Please cite this article as: Kubíková, Tereza, Kochová, Petra, Brázdil, Jan, Špatenka, Jaroslav, Burkert, Jan, Králíčková, Milena, Tonar, Zbyněk, The composition and biomechanical properties of human cryopreserved aortas, pulmonary trunks, and aortic and pulmonary cusps.Annals of Anatomy http://dx.doi.org/10.1016/j.aanat.2017.03.004

<AT>The composition and biomechanical properties of human cryopreserved aortas, pulmonary trunks, and aortic and pulmonary cusps

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<ABS-HEAD>Abstract

<ABS-P>Human cryopreserved allografts of pulmonary and aortic heart valves, aortas and pulmonary trunks are used for valve replacement. However, it is unknown how the composition of these allografts relate to their mechanical properties. Our aims were to correlate the histological compositions and passive mechanical properties of aortic and pulmonary valves and to observe the microcracks of aortas and pulmonary trunks. The following parameters were quantified: ultimate stress; ultimate strain; Young's modulus of elasticity; valve cusp wall thickness; pulmonary and aortic intima-media thickness; area fraction of elastin, collagen and calcification; and length density of elastic fibres. The propagation of experimentally induced microcracks avoided elastic fibres. Ultimate strain was negatively correlated with the area fraction of calcification ($r = -0.4$) in aortas. Ultimate stress ($r = 0.27$) and Young's modulus in small deformation ($r = 0.29$) and in large deformation ($r = 0.32$) correlated with wall thickness in valve cusps. Young's modulus ($r = 0.34$) and ultimate strain ($r = 0.31$) correlated with intima-media thickness. Ultimate strain correlated with the area fraction of elastin ($r = -0.40$) and collagen in the arteries ($r = 0.31$). As conventional histology does not fully explain the mechanical properties of cryopreserved grafts, both morphological and biomechanical tests should be used complementarily when characterizing the ageing of the grafts.
<KWD>Keywords: calcification; elastin; microcracks; tissue banking; ultimate strain; wall thickness; Young's modulus

INTRODUCTION

Human cryopreserved allografts of pulmonary and aortic heart valves, as well as the roots of these major elastic arteries, are routinely used for aortic and pulmonary root and valve replacement in a selected group of patients. This operation is needed mostly because of valvular aortic stenosis (Huygens et al., 2016), but the allograft heart valves are used for other aortic and pulmonary valve pathologies when valve surgical repair is not feasible. Together with surgical