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PROCEEDINGS

Mechanical Characterisation and Material Modelling of Human Aortas with Vascular Smooth Muscle Activation

Ivan Breslavsky[1,*], Giulio Franchini[2], Francesco Giovanniello[3], Ali Kassab[3,4], Gerhard A. Holzapfel[5,6] and Marco Amabili[1,3]

[1]Westlake University, School of Engineering, Hangzhou, 310030, China

[2]Technology Innovation Institute, Miral HQ, Abu Dhabi, UAE

[3]McGill University, Department of Mechanical Engineering, Montreal, H3A 0C3, Canada

[4]Centre Hospitalier de l'Université de Montréal, Research Center, Montreal, H2X 0A9, Canada

[5]Graz University of Technology, Institute of Biomechanics, Graz, 8010, Austria

[6]Norwegian University of Science and Technology, Department of Structural Engineering, Trondheim, 7491, Norway

[*]Corresponding Author: Ivan Breslavsky. Email: ibreslavsky@westlake.edu.cn

ABSTRACT

Despite the critical role of vascular smooth muscle (VSM) activation in the biomechanics of human aortas, comprehensive experimental data and corresponding active material models remain limited. This study addresses this gap by presenting a detailed mechanical characterisation of human descending thoracic aortas under both passive and VSM-activated conditions.

Specimens were obtained from thirteen heart-beating donors. Mechanical testing was conducted within hours of explantation. VSM activation was induced using potassium chloride and noradrenaline, and both isometric and quasistatic stress–strain responses were measured in circumferential and longitudinal tissue strips.

Dynamic mechanical testing under physiologically relevant cyclic loading and pre-stretch conditions revealed significant differences in viscoelastic properties between passive and active states. The data enabled the development of a novel constitutive model that captures both passive and active mechanical behaviour at all levels of activation of human aortic tissue.

This multiscale investigation emphasises the essential contribution of VSM activation to both static and dynamic aortic behaviour. The findings support the design of next-generation bioinspired aortic grafts that more closely mimic native tissue mechanics and contribute to blood pressure regulation.

KEYWORDS

Microstructural characterization; smooth muscle activation; mechanical material model; human aorta

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