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Plenary Lecture

PREDICTING GROWTH AND REMODELING OF ENGINEERED CARDIOVASCULAR TISSUES

Sandra Loerakker
(Presented by Cees Oomens)

Eindhoven University of Technology, Netherlands
S.Loerakker@tue.nl

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Summary: Cardiovascular tissues are widely known to grow and remodel in response to changes in hemodynamics, in an attempt to restore or preserve mechanical homeostasis. For the field of cardiovascular tissue engineering, understanding the responsible growth and remodeling mechanisms is essential for developing living cardiovascular replacements that can last for a lifetime. Due to the dynamic interplay between tissue adaptation and mechanical cues, computational modeling plays an important role in addressing this challenge. We have developed a computational model to predict soft tissue remodeling [1-3], inspired by experimental data on the individual mechanisms, which has contributed significantly to obtaining a mechanistic understanding of in vivo (engineered) valve remodeling. Model predictions showed that TEHVs may remodel differently at aortic pressure conditions compared to pulmonary conditions [4], and a comparison with in vivo remodeling at pulmonary conditions demonstrated that our model could closely mimic the experimentally observed changes in valve characteristics. Besides focusing on TEHVs, we also aim to improve our understanding of the postnatal development of human native heart valves, as these present the benchmark for TEHVs. Using computational-experimental analyses, we investigated the presence of mechanical homeostasis in human heart valves, and dissected the individual contributions of growth and remodeling in preserving mechanical homeostasis. Our data suggest that mechanical homeostasis for human semilunar heart valves is determined by a certain stretch [5]. Interestingly, growth and remodeling appear to play opposing roles in the preservation of this mechanical homeostasis [6].
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References
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