15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-99

GROWTH AND REMODELING MECHANISMS - BONE AND CARDIAC TISSUES

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Keywords: biomechanics, mathematical modeling, bone, heart

Summary: Growth and remodeling (G&R) consist in two mechanical procedures essential to the healthy and pathological development of several tissues. In this work, two distinct G&R processes are addressed, one occurring in bone and the other in the cardiac tissue. Although research regarding G&R of bone tissue is extensive, determining the mechanical cues that trigger this process is still challenging. Thus, this work proposes a model that reproduces bone's G&R combining both the mechanical and biological components of the process. The numerical example used to test the implemented algorithm is a two-dimensional bone patch, allowing a micro-scale analysis in time and space. The novel approach proposed correlates the von Mises effective stress field with the autocrine and paracrine signaling pathways with very promising results. Regarding G&R of cardiac tissue, the type of the triggering mechanical stimulus is still undefined and there is a lack of models reproducing large elastic deformations. Therefore, this work implements a mechanical model combining large deformations with advanced discretization techniques supported by experimental data. The mathematical formulation created is a G&R model reproducing a left ventricular diastolic dysfunction caused by aortic stenosis. Therefore, this work presents two very distinct G&R processes and proposes new approaches to overcome the main limitations of the in silico models already existing in the literature.