Mathematical Methods and Models in Biosciences
June 18-23, 2023, Pomorie, Bulgaria
https://biomath.math.bas.bg/biomath/index.php/bmcs

Estimation of the parameters of the mathematical model for articular cartilage compression

Stoyan Stoytchev

Institute of Mechanics,
Bulgarian Academy of Sciences, Bulgaria
stoyan@imbm.bas.bg

The mathematical model is based on the biphasic poroviscoelastic theory which couples the inter-porous fluid flow and solid matrix deformation. The material properties of the articular cartilage are presented by the elastic modulus, hydraulic permeability, and short-time and long-time relaxation. The model equations result in partial differential equations for the solid and fluid phases separately, which were solved numerically. For some practical applications, such as the compression of cartilage, analytic solutions for solid matrix deformation, fluid flow fields, and stress relaxation have been obtained. An optimization procedure, using experimental results, for the estimation of the model parameters was elaborated. The results suggest that the flow-dependent viscoelastic mechanism cannot solely cover the stress relaxation mechanism (coincidence 41.4% of the theoretical and experimental data). On the other hand, Fung's viscoelastic model was very successful at predicting stress relaxation with a 5.7% difference between the theoretical and experimental data.