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# A mathematical model for compression of poroviscoelastic biological material like articular cartilage

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The articular cartilage consists of two main phases – solid phase and fluid phase. The solid phase is chiefly composed of complex macromolecules including collagen and proteoglycans. The fluid phase is presented by interstitial fluid filling in the solid phase's pores and comprises up to 85 percent of the tissue by weight. The rheological behavior of such poroviscoelastic material during compression depends upon the intrinsic interaction between the solid matrix's deformation and the interstitial fluid's motion.

The mathematical model is based on the biphasic poroelastic (BPE) theory [1] which couples the interstitial fluid flow and matrix deformation. 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 compression of cartilage, analytic solutions for the solid matrix deformation, fluid flow fields, and stress relaxation have been obtained. An optimization procedure, using experimental results [2], for estimation of the model parameters (hydraulic permeability and short-time and long-time relaxation) was elaborated.

Recently it has been shown [3] that the BPE model failed in predicting stress relaxation, that is, the flow-dependent viscoelastic mechanism is not able solely (coincidence 41.4% of the theoretical and experimental data) to cover the stress relaxation mechanism. In the current presentation we discuss on a several ways for combination of the fluid flow-dependent and fluid flow-independent viscoelastic mechanisms in accounting for the true mechanical behavior of articular cartilage under compression.

*Keywords: articular cartilage, stress relaxation, viscoelastic mechanisms, partial differential equations*

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