COMSOL® Experience Of Biomechanical Modeling Of Shells And Plates In Ophthalmology

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Abstract

Modern problems of biomechanics, in particular, the problems of modeling vision correction in ophthalmology are associated with the study of the stress-strain state of shells and plates made of complex materials. These problems are essentially nonlinear in geometry and in physical properties. It is necessary to model large and inelastic deformations on the one hand, and to set complex loading systems on the other. Solving such problems is analytically impossible, so modeling using FEM methods is the best way to study them.
Two main problems are considered:
1. the effect of intraocular pressure on the stress-strain state of the human optic nerve, modeled on a real microscopic picture as a plate problem,
2. deformation of a significantly plastic anisotropic plate under hydrostatic loading, which simulates the bending of the section of the central eye nerve when intraocular pressure increases.
Results for the first problem:
• FE modeling shows that areas next to an aorta and a vein are highly stress, which means that high intraocular pressure has negative impact on blood circulation and can lead to different eye diseases.
• It is shown that difficult geometrical FE problems in the ophthalmology field can be solved with COMSOL Multiphysics®.
Results for the second problem:
• Results of FE modeling in software package COMSOL Multiphysics® are in best agreement with experimental data comparing to results received with other FE software package.
• COMSOL Multiphysics® allows to setup newly developed yield criterion in the Plasticity section, and makes it possible to study biological materials that do not comply with Huber's — Mises's classical criteria.