fusion coefficients for PVA and PVP molecules are estimated as 0,01 and $7 \cdot 10^{-6}$ $(\text{rad})^2/\text{ps}$, respectively.

Thus, the PVP rotational diffusion coefficient is more than three orders of magnitude smaller as compared to the PVA one. Moreover, the difference exists not only in the numerical values; some qualitative characteristics differ as well. For the PVA molecule the mean square center of mass displacements as well as the mean square angles of rotation linearly depend on time and its diffusion can be considered as ordinary one. This is not the case for PVP molecule where the mean square deviations are characteristic for subdiffusional behavior $\langle(\Delta g)^2\rangle \propto t^{\alpha}$ $g=\mathbf{r}_C$, $\boldsymbol{\varphi}$ with $\alpha \cong 0.5$. This subdiffusion behavior can be the main reason for strong difference between diffusion characteristics of PVA and PVP molecules if they are considered as ordinary diffusion for both of them.

The MD simulation results show that the properties of PVA and PVP molecules significantly differ. Although both molecules demonstrate globular structure the former is close to a spherically symmetric body while the latter is angularly-shaped. Moreover, the mean densities of the molecules calculated as the ratio of their masses to their volumes estimated through the radius and the ellipsoid axes are equal to $1{,}14 \cdot 10^3$ and $0{,}96 \cdot 10^3$ kg/m^3 for PVA and PVP molecules, correspondingly, i.e. the density of the PVP molecule is significantly smaller because of its bigger monomers resist more strongly to the compaction process.

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FINITE ELEMENT MODELLING FOR INTRAOCULAR PRESSURE MEASUREMENTS AFTER REFRACTIVE SURGERY

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Introduction. Applanation tonometry measures intraocular pressure (IOP) either by the force required to flatten the prescribed area of the cornea (Goldmann tonometry, GAT) or by the area flattened by a prescribed force, (Maklakoff tonometry, MAT) [1]. The special clinic tables for IOP calculations were based on the re-

search, in which an eyeball was modeled as a thin-walled spherical shell with averaged mechanical properties. The problem of the IOP measurements standardization, the assessment of the effect of individual variations in geometrical and mechanical parameters of the eyeball on the accuracy of IOP readings have acquired special attention as new types of refractive surgery are being explored [3, 4].

The aim of the present work is to study the impact of corneal multilayer structure on IOP measurements and to analyzed how corneal changes after refractive surgeries may affect the accuracy of tonometry.

Material and Methods. An axisymmetric two-dimensional finite element model of the corneoscleral shell was constructed [1]. Simulated corneoscleral shell was considered as two joined transversal isotropic shells with different mechanical properties.

The corneal thickness was divided into four layers~[2]. Each of these layers had its own set of material properties. The corneal material exhibits the strong anisotropy: the elastic moduli in the meridional E_m and circumferential E_c directions are about 100 times greater than elastic moduli measured in the direction orthogonal to the surface E_r [2]. For each corneal layer we assumed E_m=E_c. The ratio between elastic moduli in the radial and the meridional directions was taken as 20 or 100, i.e. $E_r = E_m /20$ or $E_r = E_m /100$. Only elastic parameters of corneal layers were varied in order to estimate the effect of multilayer structure of the cornea on IOP reading.

For each calculation run the averaging of elastic moduli of the cornea layers was fulfilled and the cornea was treated as a single-layer structure with an average elastic modulus:

$$E_{av} = \frac{1-\nu_{\text{av}}^2}{\sum_{i=1}^{4} h_i} \sum_{i=1}^{4} \frac{h_i E_i \nu_i}{1-\nu_i^2},\ \nu_{\text{av}} = \sum_{i=1}^{4} \frac{h_i E_i \nu_i}{1-\nu_i^2} \left(\sum_{i=1}^{4} \frac{E_i \nu_i}{1-\nu_i^2} \right)^{-1},\ E = \{E_m, E_r\},\ \nu = \{\nu_m, \nu_r\}.$$

Nonlinear analyses were carried out using the finite element software ANSYS, Inc. We analyzed the influence of elastic properties of corneal layers on the diameter of the contact area tonometer-cornea for MAT and on the applied load for GAT.

The results obtained with the multilayer corneal model for MAT (with the weight of 10 g) and GAT before and after refractive surgery were compared with the results for a single-layer corneal model with an averaged elastic moduli.

Discussion and Conclusion. For multilayer corneal model the larger contact area of the plummet and the cornea during tonometry and lower tonometric pressure values were obtained comparing with those for one-layer model. The applied load in the Goldmann's tonometry is lower for the multilayer corneal model compared to the one-layer model. The better estimation of the actual intraocular pressure can be obtained with the multilayer corneal model.

After LASIK surgery the additional layer (flap) appears. The increasing the layers number makes stiffness of the cornea smaller, and therefore, makes smaller the IOP-values measured using both Goldmann's and Maklakoff's tonometers. The results obtained by GAT are significantly more sensitive to all parameters of refrac-

tive surgery than those found with MAT with 10 g load.

Note that the simulation results are in a good agreement with the experimental data from St.-Petersburg Branch IR & TC «Eye Microsurgery»' and those published in literature, e.g. [3, 4].

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SIMULATION OF CARDIAC CELL-SEEDED MEMBRANES USING THE EDGE-BASED SMOOTHED FEM

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Experimental setup. Since 2001 the Laboratory of Medical and Molecular Biology develops the so-called CellDrum^{TM} device that inflates circular membranes on which cells are cultured and measures its center deflection in order to determine the mechanical effect of the cells on the membrane. As we are interested in the stress of cardiomyocytes we cultivate 2D or 3D cardiac tissue on a circular silicone membrane that is fully clamped in the CellDrum^{TM}. After approximately 7 days of cultivation we perform inflation tests producing pressure-deflection curves that enable us to determine not only mechanical properties of the composite tissue and its components but also material parameters for our constitutive model that we apply in simulations.

Kinematics. As the composite tissue is a very thin structure with a radius to thickness ratio between 100 and 2000 it can be modeled as a plate. Using Reissner-Mindlin assumptions the 5-parameter model can be described as

$$u_1(x_1, x_2, x_3) = u_1^0(x_1, x_2) + x_3\theta_{x_2}(x_1, x_2),$$
$$u_2(x_1, x_2, x_3) = u_2^0(x_1, x_2) - x_3\theta_{x_1}(x_1, x_2),$$