CORRELATION BETWEEN OCULAR ELASTICITY AND INTRAOCULAR PRESSURE ON OPTIC NERVE DAMAGES

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Introduction. Optic neuropathy in glaucoma causes visual field loss and blindness [1]. The optic nerve damage in the lamina cribrosa (LC) of the sclera, the primary site of glaucoma, is correlated with the intraocular pressure (IOP) [2]. Literature shows that the optic nerves are sheared at high IOP and the scleral biomechanical properties play an important role in the development and progression of glaucomatous damage to the LC and ganglion cell axons with the optic nerve head (ONH). The aim of this study is to determine and characterize the correlation between the corneal, scleral and ONH elasticity, and intraocular pressure on the optic nerve damages.

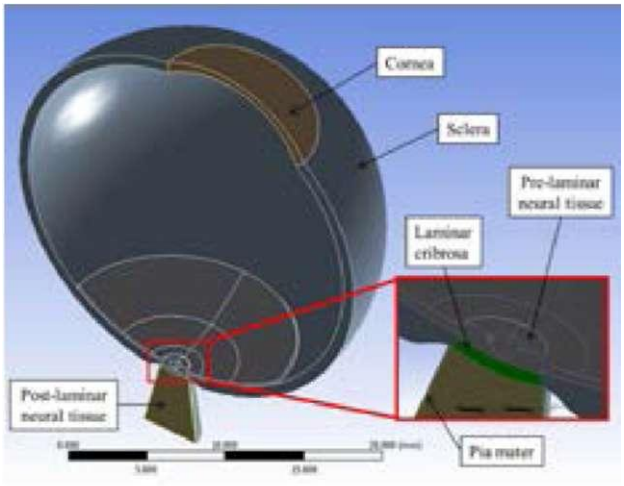

Figure 1. 3D eyeball model.

Methodology. The influence of corneal, scleral and ONH elasticity on the shear stress in lamina cribrosa were modeled using computational finite element analysis (Figure 1). To examine the effects of ocular tissue biomechanical properties, the tangent modulus of the cornea, sclera and lamina cribrosa were varied. The intraocular pressure exerted on the inner surface of pre-laminar neural tissue, sclera and cornea were varied from 10 to 50 mmHg.

Results and discussion. The simulation results showed that the shear stresses in LC increase with increase of ocular tissue elasticity even at the same IOP. Classical Tresca shear failure criterion was adopted for the determination of the vision loss. Using this damage criterion, the results showed that percentage nerve damage increases logarithmically with the corneal elasticity, and also increases with the IOP. The percentage nerve damage at 20 mmHg IOP showed a logarithmic increase with corneal tangent modulus up to 25%.

Conclusions. This finding implies that, the clinical general guidance for the risk assessment of glaucoma development and progression based on the IOP is not enough. The parameter of corneal elasticity should include also in the diagnosis stage. The corneal elasticity can be clinically assessed by various commercially available medical devices like, ORA and Corvis ST, while the clinical measurement of scleral and LC elasticity have been obfuscated by the lack of instruments. The corneal elasticity can be used as an independent parameter or to form a combined parameter with IOP, for the risk assessment of glaucoma development and progression.

References.

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