Relative Contributions of Intraocular and Cerebrospinal Fluid Pressures to the Biomechanics of the Lamina Cribrosa and Laminar Neural Tissues

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PURPOSE: The laminar region of the optic nerve head (ONH) , thought to be the site of damage to the retinal ganglion cell axons in glaucoma, is continuously loaded on its anterior and posterior surfaces by dynamic intraocular pressure (IOP) and orbital cerebrospinal fluid pressure (CSFP) , respectively. Thus, translaminar pressure (TLP; TLP = IOP-CSFP) has been proposed as a glaucoma risk factor.

METHODS: Three eye-specific finite element models of the posterior human eye were constructed, including full 3D microstructures of the load-bearing lamina cribrosa (LC) with interspersed laminar neural tissues (NTs) , and heterogeneous, anisotropic, hyperelastic material formulations for the surrounding peripapillary sclera and adjacent pia. ONH biomechanical responses were simulated using three combinations of IOP and CSFP loadings consistent with posture change from sitting to supine.

RESULTS: Results show that tensile, compressive, and shear stresses and strains in the ONH were higher in the supine position compared to the sitting position (P CONCLUSIONS: Whereas TLP has been hypothesized to play a prominent role in ONH biomechanics, the IOP and CSFP effects are not equivalent, as IOP-driven stress, strain, and deformation play a more dominant role than CSFP effects.

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