

Elastic modulus determination of normal and glaucomatous human trabecular meshwork

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PURPOSE: Elevated intraocular pressure (IOP) is a risk factor for glaucoma. The principal outflow pathway for aqueous humor in the human eye is through the trabecular meshwork (HTM) and Schlemm's canal (SC). The junction between the HTM and SC is thought to have a significant role in the regulation of IOP. A possible mechanism for the increased resistance to flow in glaucomatous eyes is an increase in stiffness (increased elastic modulus) of the HTM. In this study, the stiffness of the HTM in normal and glaucomatous tissue was compared, and a mathematical model was developed to predict the impact of changes in stiffness of the juxtacanalicular layer of HTM on flow dynamics through this region.

METHODS: Atomic force microscopy (AFM) was used to measure the elastic modulus of normal and glaucomatous HTM. According to these results, a model was developed that simulated the juxtacanalicular layer of the HTM as a flexible membrane with embedded pores.

RESULTS: The mean elastic modulus increased substantially in the glaucomatous HTM (mean = 80.8 kPa) compared with that in the normal HTM (mean = 4.0 kPa). Regional variation was identified across the glaucomatous HTM, possibly corresponding to the disease state. Mathematical modeling suggested an increased flow resistance with increasing HTM modulus.

CONCLUSIONS: The data indicate that the stiffness of glaucomatous HTM is significantly increased compared with that of normal HTM. Modeling exercises support substantial impairment in outflow facility with increased HTM stiffness. Alterations in the biophysical attributes of the HTM may participate directly in the onset and progression of glaucoma.

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