



Non-invasive Clinical Measurement of Ocular Rigidity and Comparison to Biomechanical and Morphological Parameters in Glaucomatous and Healthy Subjects

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Purpose: To assess ocular rigidity using dynamic optical coherence tomography (OCT) videos in glaucomatous and healthy subjects, and to evaluate how ocular rigidity correlates with biomechanical and morphological characteristics of the human eye.

Methods: Ocular rigidity was calculated using Friedenwald's empirical equation which estimates the change in intraocular pressure (IOP) produced by volumetric changes of the eye due to choroidal pulsations with each heartbeat. High-speed OCT video was utilized to non-invasively measure changes in choroidal volume through time-series analysis. A control-case study design was based on 23 healthy controls and 6 glaucoma cases. Multiple diagnostic modalities were performed during the same visit including Spectralis-OCT for nerve head video, Pascal Dynamic Contour Tonometry for IOP and ocular pulse amplitude (OPA) measurement, Convis ST for measuring dynamic biomechanical response, and Pentacam for morphological characterization.

Results: Combining glaucoma and healthy cohorts ($n = 29$), there were negative correlations between ocular rigidity and axial length (Pearson $R = -0.53$, $p = 0.003$), and between ocular rigidity and anterior chamber volume ($R = -0.64$, $p = 0.0002$). There was a stronger positive correlation of ocular rigidity and scleral stiffness (i.e., stiffness parameter at the highest concavity [SP-HC]) ($R = 0.62$, $p = 0.0006$) compared to ocular rigidity and corneal stiffness (i.e., stiffness parameter at the first appplanation [SP-A1]) ($R = 0.41$, $p = 0.033$). In addition, there was a positive correlation between ocular rigidity and the static pressure-volume ratio (P/V ratio) ($R = 0.72$, $p < 0.0001$).

Conclusions: Ocular rigidity was non-invasively assessed using OCT video and OPA in a clinic setting. The significant correlation of ocular rigidity with biomechanical parameters, SP-HC and P/V ratio, demonstrated the validity of the ocular rigidity measurement. Ocular rigidity is driven to a greater extent by scleral stiffness than corneal stiffness. These *in vivo* methods offer an important approach to investigate the role of ocular biomechanics in glaucoma.

Keywords: ocular rigidity, glaucoma, ocular biomechanics, optical coherence tomography, stiffness parameter, pressure volume relationships

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