Journal Article Review

Earlier detection of glaucoma progression using high-density 3-dimensional spectral-domain OCT optic nerve volume scans

Based on:

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Background and Purpose

Early detection and monitoring of glaucoma progression are crucial to effective management and treatment. However, current methods to assess glaucoma progression, such as disc photography (DP), visual field (VF) assessment, and 2-dimensional (2D) spectral-domain (SD) optical coherence tomography (OCT) for retinal nerve fiber layer (RNFL) thickness measurement, are not without limitation. This study aims to maximize SD-OCT imaging for detecting glaucoma progression with quantitative, 3-dimensional (3D) measurements of the minimum distance band (MDB), in a five-year longitudinal study.

Methods

A cohort of 124 patients had a comprehensive eye exam with DP (Visucam Pro NM, Carl Zeiss Meditec Inc), VF testing (Swedish interactive threshold algorithm 24-2 test of the Humphrey Visual Field Analyzer 750i), and SD-OCT imaging (SPECTRALIS, Heidelberg Engineering GmbH) with dilated pupils on the same day. 2D analysis of the RNFL was performed with the commercially available 12-degree circle scan. 3D analysis of the optic nerve head (ONH) was performed with 193 B-scan raster, research protocol with ART 3 at each location. The MDB was calculated based upon 100 points terminating at the retinal pigment epithelium (RPE) and Bruch's membrane (BM), from a raw data export. Graders were blinded to exam components and other tests as they evaluated DP, VF tests, as well as RNFL and MDB measurements for progression. Each method was analyzed for its ability to indicate event-based glaucoma progression, which was defined as follows:

- VF progressed if the scotoma deepened, expanded or if there was a localized defect in a previously normal position.
- RNFL progressed if serial measurements were greater than 5 µm globally and 8 µm inferiorly and superiorly.
- MDB progressed if serial measurements were greater than 7 µm globally and 5 µm inferiorly and superiorly.

Results

- In this study, MDB thickness measurements indicated glaucoma progression in 65 of 124 eyes (52.4%), followed by VF testing (43.5%), DP (16.1%), and RNFL thickness measurements (15.3%).
- In 30 of 65 eyes (46.2%) determined to have progressed, the result derived from MDB thickness measurement was confirmed simultaneously (15 eyes, 23.1%) or later (15 eyes, 23.1%) by other conventional methods.
- Global MDB thickness measurements indicated glaucoma progression approximately one to two years earlier than DP and global RNFL thickness measurements over an average of five years.
- No statistically significant differences were found in glaucoma progression detection between global, inferior, and superior regions for MDB and RNFL thickness measurements.
- False predictive rate of progression was 12.9% (16 eyes) in RNFL and 25% (31 eyes) in MDB (these eyes were not included in the final progression count).

Conclusions

The study shows that MDB is the high-density alternative to 2D Bruch's membrane opening-based minimum rim width (BMO-MRW) measurement. It is the shortest distance between the RPE-BMO complex and the internal limiting membrane ILM on the neuroretinal rim in 3D space. It overcomes the subjectivity of DP, the repeatability of VF, and the floor effect in RNFL thickness measurements in glaucoma. However, there is still no gold standard test/definition for glaucoma progression and every method may include both true and false positive progression. It is still recommended that tests be combined to determine glaucoma progression.

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