Macular ganglion cell layer asymmetry analysis in preperimetric and early glaucoma

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Purpose: In normal eyes, the ganglion cell layer (GCL) is nearly symmetric across the fovea, while in the eyes with glaucoma, the GCL is expected to become abnormally asymmetric, particularly on both the sides of the vertical meridian. The purpose of this pilot study was to determine the confidential limits of defined symmetry values of the normal GCL thickness by using speckle-noise-reduced spectral-domain optical coherence tomography (SD-OCT), and to assess whether the symmetry values of the GCL thickness in eyes with preperimetric or early glaucoma are abnormal.

Methods: Macular GCLs of 41 normal eyes (for calculating confidential intervals), another 20 normal eyes (for sensitivity and specificity), 20 eyes with preperimetric glaucoma, and 20 eyes with early glaucoma were visualized after the speckle noise was reduced by averaging 50 B-scans. The inner and outer boundaries of the GCL were manually delineated on the vertical speckle-noise-reduced SD-OCT B-scan images by 2 independent delineators who were masked to any clinical information by using custom-made functions written into the standard built-in Spectralis TM HRA+OCT software by the engineers at Heidelberg Engineering. We defined a macular GCL symmetry index as “Log10” (inferior GCL thickness/superior GCL thickness). We computed the confidential intervals of the symmetry index from the values of the 41 eyes and generated colored maps with 1% and 5% confidential limit curves along the vertical scan. The mean GCL symmetry index at each 0.5-mm segment from the central fovea was calculated. We considered that the GCL symmetry in each eye was “abnormal” if the GCL symmetry index was outside the 99% confidential limit for the mean of the 41 normal eyes in at least one 0.5-mm segment from the central fovea.

Results: In normal eyes, the macular GCL appeared as a well-demarcated hyporeflective layer that had a fairly symmetrical shape on both the sides of the central fovea. The GCL symmetry index values were normally distributed. The macular GCL symmetry index within the 99% confidential intervals of normal eyes was -0.455-0.381, -0.132-0.108, -0.119-0.124, -0.230-0.132, -0.286-0.108, and -0.252-0.170 in the segments of 0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-2.5, and 2.5-3.0 mm from the central fovea, respectively. The macular GCL symmetry index was abnormal in 16 (80%) of 20 eyes with preperimetric glaucoma, and 16 (80%) of 20 eyes in early glaucoma (sensitivity = 80%; specificity = 100% for both groups). The mean number of abnormal segments was 1.50 (1.15), 2.05 (1.64), respectively.

Conclusions: The GCL symmetry assessed on vertical speckle-noise-reduced SD-OCT B-scan images was abnormal in a large part of the eyes with preperimetric and early glaucoma. GCL symmetry analysis may be useful to detect preperimetric and early glaucomatous structural abnormalities in the macula.