Kaohsiung Journal of Medical Sciences (2015) 31, 420–425

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.kjms-online.com

ORIGINAL ARTICLE

Posterior pole asymmetry analysis and retinal thickness measurements in young relatives of glaucoma patients

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Received 30 December 2014; accepted 27 May 2015
Available online 29 June 2015

KEYWORDS
Ganglion cell complex;
Posterior pole asymmetry analysis;
Primary open-angle glaucoma;
Retinal arteriolar caliber;
Retinal thickness

Abstract The presence of a family history of glaucoma is a known risk factor for primary open-angle glaucoma (POAG) in middle-aged and older individuals. In this study, our aim was to demonstrate possible early glaucomatous alterations in young first- and second-degree relatives of POAG patients by spectral-domain optical coherence tomography. A total of 104 participants (52 relatives of POAG patients and 52 healthy individuals) were recruited in this cross-sectional study. All the participants were between 17 years and 45 years of age. All eyes underwent testing with spectral-domain optical coherence tomography. Peripapillary retinal nerve fiber layer thickness, hemifield macular thickness, macular ganglion cell complex thickness, posterior pole asymmetry analysis, and retinal arteriolar caliber measurements were taken for comparison between the study and control groups. The mean peripapillary retinal nerve fiber layer thickness was 104.9 ± 8.8 μm in the study group and 105.6 ± 7.4 μm in the control group ($p = 0.68$). Although whole macular thickness measurements were higher in the control group when compared with the study group ($p = 0.008$), the macular ganglion cell complex thickness was similar in both groups ($p = 0.87$). The posterior pole asymmetry analysis revealed no statistically significant difference between the groups in the aspect of consecutive black squares ($p = 0.79$). The mean retinal arteriolar caliber was 85.9 ± 4.8 μm in the study group and 86.0 ± 5.0 μm in the control group ($p = 0.90$). In conclusion, young relatives of POAG patients do not show characteristic glaucomatous damage when compared with the controls.

Conflicts of interest: All authors declare no conflicts of interest.

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http://dx.doi.org/10.1016/j.kjms.2015.06.001

Introduction

Primary open-angle glaucoma (POAG) is the most common type of glaucoma, and is characterized by progressive degeneration of retinal ganglion cells and axons [1]. Risk factors of POAG include increased intraocular pressure (IOP), thinner central corneal thickness (CCT), older age, and a positive family history of POAG [2,3]. There is a 20% risk of glaucoma in both first- and second-generation relatives of those affected compared with controls [4]. As vision loss from POAG is preventable when the disease is managed in its initial stages, early detection is important in high-risk populations such as relatives of POAG patients [5].

Screening and examining for POAG diagnosis mainly includes IOP measurements, evaluation of the optic nerve head, and visual field testing. Although these examinations are very important, they are not always enough to make an early diagnosis. The earliest observable damage in POAG is atrophy of the retinal nerve fiber layer (RNFL) [6]. It was demonstrated that up to 35% of retinal ganglion cells may be lost before a defect occurs in standard visual field analysis [7]. Sometimes, a loss of a lesser percentage of retinal ganglion cells can produce a small but definite visual field defect when it happens to be confined to an entire RNFL axon bundle.

Recently, a new assessment tool—evaluation of asymmetry in hemifield macular thickness—has been introduced for the early diagnosis of glaucoma [8]. Additionally, it was reported that retinal arteriolar narrowing is associated with long-term risk of POAG [9]. The aim of this study was to evaluate the peripapillary RNFL thickness, macular ganglion cell complex (GCC) thickness, posterior pole asymmetry, and retinal arteriolar caliber (RAC) in young relatives of POAG patients. One of our starting points was that it is possible that relatives of glaucoma patients have fewer retinal ganglion cells at the start of their lives and are therefore more likely to display thinner retinal layers. In contrast to previous reports, we included only young adults in order to eliminate age-related glaucoma risk [5,6]. We hypothesized that new early diagnostic techniques may show some defects in the posterior pole retina of young relatives of POAG patients.

Materials and methods

In this cross-sectional and comparative study, a total of 104 participants were recruited (52 participants in the "relatives of POAG patients" group and 52 healthy young adults in the control group). This study was conducted in accordance with the ethical standards of the Declaration of Helsinki and was approved by the Pamukkale University Ethics Committee.

Study population

The eligibility criteria for the study group include the following: (1) being between 17 years and 45 years of age; (2) having visual acuity of at least 20/20; (3) having normal anterior and posterior segments by clinical examination; (4) having at least one POAG relative (1st or 2nd degree); and (5) being able to perform high-quality optical coherence tomography (OCT) examinations. Individuals with pre-existing systemic medical conditions, pre-existing ocular disorders, any history of ocular surgery, a refractive error of $>$2.0 D, or abnormal keratometry readings (i.e., $>$46 D or $<$42 D), or those using ocular or systemic medications were excluded from the study. There were no relationships between the participants in the study group. In the present study, the participants' first- and second-degree relatives who had POAG consisted of parents ($n = 38$), grandparents ($n = 8$), and aunts and uncles ($n = 6$). The inclusion and exclusion criteria for the age-matched healthy controls were the same, except for having a POAG relative. Participants who were not sure about their family history for glaucoma were also excluded. Additionally, we checked the medical records of the patients in order to confirm the POAG diagnosis. In some cases, we invited the patients' relatives to perform the ophthalmological examination. Despite our efforts to reveal the exact family history of the participants, it is not always possible to have the complete glaucoma history of every member of the family tree.

Ocular examination techniques

One of the eyes of each participant was selected randomly for the study. There were 28 right eyes and 24 left eyes in the study group, and there was 32 right eyes and 20 left eyes in the control group. All the participants underwent ocular examinations, including a visual acuity assessment (Snellen chart), an automatic refractometer measurement, biomicroscopy, gonioscopy, IOP measurement, stereo-examination of the optic nerve head and macula, pachymetry, and OCT. The OCT measurements were taken with spectral-domain (SD) OCT (Spectralis software version 5.8, Heidelberg Engineering, Heidelberg, Germany). Posterior pole asymmetry analysis (PPAA), macular hemifield thickness, peripapillary RNFL thickness, macular GCC thickness, and RAC measurements were performed with the SD-OCT.

In the PPAA technique, a macular thickness map is divided into 64 squares (an 8 $\times$ 8 square grid) centered on the foveola (Figure 1). PPAA provides the data derived from the square-to-square comparison between corresponding squares across the hemisphere within each eye. In this study, we compared the mean superior hemisphere thickness and mean inferior hemisphere thickness, in addition to the square-to-square comparison. Hemisphere asymmetry was calculated by comparing each cell in the inferior hemisphere with the corresponding cell in the superior hemisphere, and displayed as an asymmetry map. For a square-to-square comparison between superior and inferior hemispheres, at least two consecutive black squares were taken into consideration. A black square indicates that the difference between two corresponding superior—inferior retinal square thicknesses is $>$ 30 μm. Squares that cut through a blood vessel were not included for analysis, as the retinal thickness in these squares is measured to be thicker. The PPAA screen also shows the average thickness values of superior and inferior macular hemifields. For peripapillary RNFL analysis, the thicknesses of all the quadrants (superior, inferior, temporal, and nasal) were recorded separately.