Introduction

Open-angle glaucoma (OAG) is a chronic, irreversible disease, and visual field testing is essential for its diagnosis and management. Asymmetric glaucomatous damage is one characteristic of the disease. In an individual patient, one eye can have severe glaucomatous neuropathy with visual field loss while the other eye has a normal visual field. Several risk factors have been suggested as important for asymmetric glaucomatous damage. Intraocular pressure (IOP) appears to be an important risk factor for asymmetric glaucoma, whereas vascular factors appear to be related to asymmetry as well. Whether optic disc size is a risk factor for asymmetric glaucoma has long been a subject of debate. Some studies report that large optic discs might be more prone to glaucomatous damage than small discs, while other studies found that disc size is not associated with the development of glaucoma. These contradictory conclusions may be explained in at least three ways: First, there is a large variation in disc size both within each population and among populations. Second, different measurement techniques can provide different estimates of disc size, limiting comparison among studies. Third, disc size itself may influence the clinical evaluation leading to the diagnosis of glaucoma, thus providing a potential source of bias. Comparing optic disc size of asymmetric glaucoma with unilateral visual field defects can minimize the deviation of the first two.

To determine the optic disc features of asymmetric primary OAG with unilateral visual field defects, we studied...
optic disc morphology using Heidelberg Retina Tomography III (HRT-III).

**Subjects and Methods**

Ethical approval was obtained from the Ethical Committee Review Board of Peking University Eye Center, Peking University Third Hospital. The study was conducted in adherence to the tenets of the World Medical Association’s Declaration of Helsinki.

From February 2006 through August 2008, 292 patients with OAG attended the Glaucoma Service of Peking University Eye Center, Peking University Third Hospital. Of these, 240 patients had bilateral visual field defects and 52 had unilateral visual field defects. Subjects in this study were consecutive OAG patients with unilateral visual field defects. The definition of OAG was glaucomatous optic neuropathy and visual field defects in at least one eye, an open angle, normal or elevated IOP without any secondary causes. All subjects underwent a complete ophthalmologic examination, including visual acuity, refraction, slit-lamp biomicroscopy, gonioscopy, Goldmann applanation tonometry, and fundus examination. The inclusion criteria were either the presence of OAG in which the IOP was well controlled medically or normal-tension glaucoma; best-corrected visual acuity greater than 20/30; refractive error within ±6 dioptries spherical equivalent, transparent ocular media (nuclear color/opalescence, cortical or posterior subcapsular lens opacity <1) according to the Lens Opacities Classification System III,31 and reliable visual field test results (Octopus 101, G2 program, false positives or false negatives <30%) that showed unilateral visual field defects. Subjects with previous intraocular surgery, diabetes or other systemic diseases, a history of ocular or neurologic disease, or current use of a medication that could affect visual field sensitivity were excluded.

At least two reliable visual field tests were performed with an Octopus 101 Field Analyzer G2 program (Interzeag, Schlieren, Switzerland). Repeatable visual field defects over two reliable visual fields were used in this study to minimize the learning effect. An abnormal standard automated perimetry (SAP) result was defined as one in which at least three adjacent points had a 5 dB or greater loss or at least one point had a 10 dB or greater loss in a compared numerical map. A normal SAP result was defined as one in which no more than two adjacent points had a 5 dB or greater loss or no point had a 10 dB or greater loss in a compared numerical map. According to the SAP results, all eyes were classified into either the SAP abnormal group or the SAP normal group; therefore, each patient in this study had one eye in the SAP abnormal group and the fellow eye in the SAP normal group.

Topographic analysis of the optic disc was performed using a confocal scanning laser ophthalmoscope, the HRT-III (Heidelberg Engineering, Heidelberg, Germany), with a diode laser (670 nm wavelength). The HRT provides topographic measurements of the optic nerve head derived from 16 to 64 optical sections to a depth of 4 mm, depending on the longitudinal field of view.32 Topographic images were obtained through undilated pupils and analyzed using the Advanced Glaucoma Analysis 3.0 software. All scans had an interscan standard deviation of less than 40 μm. After scanning, a contour line was manually placed around the optic nerve head edge by two experienced investigators masked to the subject’s diagnosis according to a common standard operating procedure. Briefly, the investigators took into consideration both the mean reflectance and the mean intensity images to identify the very edge of the optic disc better, corresponding to the inner edge of the Elschnig ring, where either four or five points were placed to define the contour line. Special care was taken to avoid any peripapillary atrophy within the contour line.

HRT-III automatically classifies optic discs into one of three groups according to the optic disc area of the normative database: large, medium, or small. A large optic disc area is >2.5 mm²; a medium optic disc area is between 1.6 and 2.5 mm²; and a small optic disc area is <1.6 mm².

Stereoscopic fundus photographs were acquired for each patient after pupil dilation. Fundi were examined with an ophthalmoscope, and fundus photographs were evaluated by two glaucoma specialists who were blinded to the visual field results. Glaucomatous optic neuropathy (GON) was defined as a rim-to-disc ratio <0.1, or disc splinter hemorrhage, or retinal nerve fiber layer (RNFL) defects.33 All ophthalmic examinations, visual field tests, and the topographic analysis with HRT-III were performed within 6 months.

SPSS 16.0 (SPSS, Chicago, IL, USA) statistical software was used. A paired t test or rank sum test was used to compare the means of the optic disc parameters, age, refractive error, IOP, and visual field mean defects. The nominal significance level was alpha = 0.05.

**Results**

A total of 104 eyes of 52 patients with OAG (26 women and 26 men) were included in the study. All subjects were Chinese, and 28 were patients with normal-tension glaucoma. Their mean age (± standard deviation) was 62.1 ± 11.5 years (range, 25–76). The mean spherical equivalent (± standard deviation) was −2.39 ± 2.18 diopters (range, −6 to +2.25).

Both the SAP abnormal group and the SAP normal group comprised 52 eyes each. The clinical characteristics of the two SAP groups are shown in Table 1.

The HRT-III parameters in the two SAP groups are shown in Table 2. The optic disc areas of the abnormal SAP eyes were significantly larger than those of the fellow normal SAP eyes (P = 0.03). The optic disc areas of 33 eyes (63.5%) with abnormal SAP were larger than those of the fellow eyes with normal SAP, and the difference was at least 0.01 mm². Furthermore, according to the HRT-III classification, 16 patients had asymmetric optic disc sizes: 12 had a large disc in one eye and a medium disc in the other, and