Optic Disc of the Myopic Eye: Relationship between Refractive Errors and Morphometric Characteristics

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Because the optic disc in myopic eyes is different from a normal optic disc, there are many difficulties in examining the optic discs of myopic eyes. To study optic disc change due to myopia, we performed a morphometrical study of stereophotographs of 61 men, 109 eyes, who had no glaucoma history. The range of refractive error was from +0.75 diopeter to −12.75 diopeter, and all subjects had intraocular pressure below or equal to 21 mmHg. According to the increase in the myopic degree, the temporal slope of the disc cup was significantly decreased, but the ratio of the vertical disc diameter (VDD) to the horizontal disc diameter and the ratio of the width of peripapillary atrophy (PPA) to the VDD were significantly increased. The above results suggests that in high myopia the optic disc was tilted and the rim-cup border was indistinct and there are some problems in the estimation of the morphometric parameters. Also in evaluation of the PPA of myopic glaucoma patients, there may be some difficulty in deciding whether it is due to myopic change or glaucomatous damage.

Key words: horizontal disc diameter, myopia, optic disc, peripapillary atrophy, temporal slope, vertical disc diameter.

INTRODUCTION

In myopic patients, it is difficult to identify and monitor glaucomatous changes because of physiologically large cups, tilting of the disc, myopic conus, and peripapillary atrophy.1-7 As the progressive changes of disc appearance in these patients are difficult to identify or interpret, the value of the optic disc as a parameter may be limited.

This study was designed to measure the morphometric changes of the optic disc and of peripapillary atrophy due to myopia.

SUBJECTS AND METHODS

The subjects for this study came from the outpatients who wanted a prescription for glasses or visited for a routine eye examination at Seoul National University Hospital. All subjects had no ocular disease, no family history of glaucoma, no ocular trauma, and no ocular surgery. And anyone who had systemic diseases which might affect the optic disc was excluded.

Intraocular pressures (IOPs) were measured by a Goldmann applanation tonometer. Anyone whose IOP was above 21 mmHg or in who the...
difference of IOP between both eyes was above 2 mmHg was excluded. Refraction was performed with a streak retinoscope after instillation of 1% cyclopentolate. Eyes whose astigmatism was greater than 1.5 diopters were excluded. Refractive errors were converted to spherical equivalent. In order to see whether subjects had axial myopia, the axial length of the eyeball was measured with an A-scan ultrasonograph.

The subjects included in this study were 61 males, 109 eyes. The mean age of the subjects was 21.8 ± 3.0 years (ranged from 18 years to 36 years).

As reported previously,8 we took a sixty-degree plain fundus colorphoto and a pair of thirty-degree stereophotos of the optic disc. The angle between the long axis of the disc and the line from the center of the disc to the fovea, the temporal slope of the disc cup to the inner surface of the adjacent retina, the ratio of the vertical disc diameter (VDD) to the horizontal disc diameter (HDD), and the ratio of the widest width of the peripapillary atrophy (PPA) to VDD were measured (Fig. 1).

The data from these morphometric parameters were examined to find the relationship to the degree of the myopia.

RESULTS

As myopia increases from +0.75 diopter to −12.75 diopter, there was a steady increase in the axial length of the eyeball (p < 0.0001, r = 0.298) (Fig. 2).

There was no significant correlation between the angle of the long axis of the optic disc to the line drawn from the center of the optic disc to the fovea and the refraction (p > 0.1, r = −0.012) (Fig. 3).

There were significant correlations between the slope of the temporal disc cup to the retinal surface and the refraction (p < 0.0001, r = −0.319).

![Fig. 1. Left, The angle between the long axis of the disc and the line from the center of the disc to the fovea (*) was measured. Middle, 'X' means the horizontal disc diameter (HDD), and 'Y' means the vertical disc diameter (VDD). The ratio of the VDD to HDD was calculated. Right, The ratio of the widest width of the peripapillary atrophy ('b') to the vertical disc diameter ('a') were measured.]

![Fig. 2. Correlation between axial length (antero-posterior diameter) (y) and the degree of myopia by cycloplegic refraction (CR) (x) is shown. As myopia increases from +0.75 diopter to −12.75 diopter, there is a steady increase in the axial length of the eyeball (regression line: y = 0.319x + 24.3, p < 0.0001, r = 0.298).]
Fig. 3. Scattergram of the angle between the long axis of the disc and the line from the center of the disc to the fovea (y) and the degree of myopia by cycloplegic refraction (CR) (x). There was no significant correlation between the two parameters (regression line: \( y = -0.096x + 89.4, p > 0.1, r = -0.012 \)).

Fig. 5. Scattergram of the ratio of vertical disc diameter (VDD) to the horizontal disc diameter (HDD) (y) and the degree of myopia by cycloplegic refraction (CR) (x). There was a proportional relationship between the VDD/HDD ratio and the CR (regression line: \( y = 0.0185x + 1.11, p < 0.01, r = -0.298 \)).

Fig. 4. The relationship of the temporal slope of the disc cup to the inner surface of the adjacent retina (y) and the degree of myopia by cycloplegic refraction (CR) (x). There was significant correlation between the slope of the temporal disc cup to the retinal surface and the refraction (regression line: \( y = -3.34x + 54.3, p < 0.0001, r = -0.556 \)).

0.556) (Fig. 4), between the VDD/HDD ratio and the refraction (\( p < 0.01, r = -0.298 \)) (Fig. 5), and between the width of the PPA/VDD ratio and refraction (\( p < 0.0001, r = 0.533 \)) (Fig. 6).

Fig. 6. Scattergram of the ratio of the widest width of the peripapillary atrophy (PPA) to the vertical disc diameter (VDD) (y) and the degree of myopia by cycloplegic refraction (CR) (x). There was significant correlation between the PPA/VDD ratio and CR (regression line: \( y = 2.86x + 11.6, p < 0.0001, r = 0.533 \)).

DISCUSSION

In general, myopes may be more predisposed to glaucomatous damage at any level of intraocular pressure. However, interpretation of the optic disc may be confused because of physiologically large cups, tilting of the disc, myopic conus,
and peripapillary atrophy. In high myopia the scleral canal usually takes an oblique course toward the nasal aspect of the orbit and an oblique insertion of the optic disc was more common in the high myopes (≥ −5 diopters). In this study we measured the VDD/HDD ratio to examine the amount of obliqueness of an optic nerve and the ovalness of an optic disc. There was significant correlation between the VDD/HDD ratio and the refraction (p < 0.01, r = −0.298) (Fig. 5). The more myopia, the greater increase in the VDD/HDD ratio. We also observed the disc rotation along the vertical axis of the optic disc by stereophotography. The nasal half of the optic disc was elevated anteriorly, the temporal half was depressed posteriorly and hidden into the scleral canal. Excessive axial development of the eye and superation of the optic disc may also give the impression of temporal tilting. This horizontal rotation made the decrease in HDD, the much rotated, the less HDD of the temporal side and more exposed the sclera canal. According to the increase of myopia, the optic disc rotated much more and the VDD/HDD ratio increased.

This disc tilting from the oblique insertion of the optic disc and the long axial length of the eyeball caused not only the exposure of the anterior temporal aspect of the posterior scleral canal but also decreased the temporal slope of the optic cup. This temporal slope of the optic cup was found on the stereophotographs. The more myopia increased, the more the temporal slope decreased (Fig. 4). This decrease of the temporal slope made for difficulty in defining the disc rim border and the evaluation of the cup/disc ratio in high myopia.

There is also some problem in the evaluation of PPA. Jonas et al. reported that refraction, size of the disc, and area of the parapapillary chorioretinal atrophy region were significantly correlated with each other, the more myopic the eye and the larger the disc, the larger the parapapillary atrophic region. Fig. 6 shows that the more myopic the eye the more increase the ratio of the widest width of PPA to the VDD.

In summary, the more myopic the eye was, the more tilted and the more indistinct the cup margin optic disc was. Also there may be difficulties in measuring how much the high intraocular pressure contributed to PPA in myopia.

REFERENCES