Optic Disc Tilt and Glaucoma Progression in Myopic Glaucoma: A Longitudinal Match-Pair Case-Control Study

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Submitted: September 26, 2018
Accepted: April 3, 2019

Citation: Seol BR, Park KH, Jeoung JW. Optic disc tilt and glaucoma progression in myopic glaucoma: a longitudinal match-pair case-control study. *Invest Ophthalmol Vis Sci*. 2019;60:2127–2133. https://doi.org/10.1167/iovs.18-25839

Purpose. To investigate the long-term follow-up results for tilted disc eyes and case-matched nontilted disc eyes in myopic glaucoma patients.

Methods. We included 28 tilted disc eyes of 28 myopic primary open-angle glaucoma (POAG) patients and 28 case-matched nontilted disc eyes of 28 myopic POAG patients with minimum 5 years of follow-up. One matching set included one tilted disc eye and one case-matched nontilted disc eye. The eyes had similar characteristics including age, axial length, baseline intraocular pressure, and initial visual field mean deviation. The progression of glaucoma was evaluated in functional and structural tests. Kaplan-Meier survival analysis and Cox proportional hazards model were used to evaluate glaucoma progression and identify the factors predictive of glaucoma progression.

Results. The mean age and follow-up duration were 50.1 ± 11.7 years and 90.8 ± 38.1 months, respectively. Of the 56 total eyes, glaucoma progression was detected in 22 (39.3%). Of these, 16 of the 28 nontilted disc eyes (57.1%) and 6 of the 28 tilted disc eyes (21.4%) demonstrated glaucoma progression. Patients with nontilted disc had a greater cumulative probability of progression than those with disc tilt ($P = 0.01$ by log-rank test). A Cox proportional hazards model indicated that lower disc tilt ratio and the presence of disc hemorrhage were significantly associated with disease progression ($P = 0.02$ and 0.04, respectively).

Conclusions. In myopic POAG patients, more stable courses were found in eyes with disc tilt than in those without disc tilt. Clinical evaluation of optic disc morphology might help to predict future progression in myopic glaucomatous eyes.

Keywords: disc tilt, glaucoma, myopia, progression

Because axial elongation in myopic eyes is associated with posterior scleral remodeling, such eyes usually show various characteristic optic nerve head (ONH) features including optic disc tilt, torsion, and large beta-zone parapapillary atrophy.[1] These characteristic features of myopia are known to be associated with the development and progression of glaucoma. Of these, tilted disc is reported to be related with a more stable clinical course of glaucoma.[2–8] It has been assumed that because glaucomatous damage in eyes with myopic tilted disc occurs during the myopic elongation period, eyes with myopic tilted disc have a more stable disease course than nontilted disc eyes after the elongation process is completed. However, the relationship between tilted disc and glaucoma progression is not clear, as several other factors also are known to affect glaucoma progression.[6,7,9]

Recently, Kwon et al.[10] have shown significant differences in glaucoma progression between eyes with and without optic disc tilt. However, if the degree of myopia between the two groups is different, it is difficult to determine whether there is a difference in progression due to myopia itself or due to the myopic tilted disc. Because of this, to clarify the association between disc tilt and glaucoma progression, similar baseline characteristics (including myopia grade) between eyes with and without tilted disc might be needed. Thus, in this study, we used a 1:1 case-matched case-control study design. The control group was matched for age, axial length (AXL), baseline intraocular pressure (IOP), and visual field (VF) mean deviation (MD). This is a distinction of our study compared with previous ones, which have investigated myopic tilted disc eyes. To observe and analyze long-term results, we enrolled only patients who had had at least 5 years of follow-up.

The purpose of our study was to compare the long-term outcomes of glaucoma progression between myopic tilted disc eyes and case-matched myopic nontilted disc eyes. Additionally, we analyzed the risk factors associated with glaucoma progression in myopic eyes.

Subjects and Methods

This study was approved by the Institutional Review Board of Seoul National University Hospital, with informed consent obtained. The study design followed the tenets of the Declaration of Helsinki for biomedical research.

Study Subjects

Patients with myopic primary open-angle glaucoma (POAG) were enrolled and followed up at the Department of Ophthalmology of Seoul National University Hospital from January 2008 to May 2016. Before the study, all of the subjects

underwent a complete ophthalmic examination, which included visual acuity; IOP measurement (by Goldmann applanation tonometry); corneal pachymetry (Pocket II Pachymeter Echo Graph; Quantel Medical, Clermont Ferrand, France); AXL measurement (Axis II PR; Quantel Medical, Inc., Bozeman, MT, USA); noncycloplegic refraction (Autorefractor KR-8900; Topcon Corporation, Tokyo, Japan); slit-lamp examination; gonioscopy; dilated fundus examination; color disc photography; red-free retinal nerve fiber layer (RNFL) photography (Vx-10; Kowa Optimed, Tokyo, Japan); optical coherence tomography (OCT): Cirrus HD-OCT or Stratus OCT (Carl Zeiss Meditec, Inc., Dublin, CA, USA); and VF testing with the Humphrey Visual Field Analyzer (Carl Zeiss Meditec) using the Swedish interactive threshold algorithm (SITA) with the 30-2 standard program.

Only participants who met the following criteria were included: (1) age between 20 and 79 years, (2) best-corrected visual acuity of 20/40 or better, or spherical equivalent < -0.50 diopters, (3) AXL > 24.0 mm, (4) an open anterior chamber angle, good quality of red-free photography, and reliable VF, (5) POAG diagnosis in one or both eyes at the first clinic visit, (6) no history of IOP-lowering treatment use, (7) attendance at follow-up visits every 6 months for at least 5 years, and (8) treatment with only topical medications during the follow-up period. Patients with a history of surgical therapy, such as glaucoma filtering surgery, were excluded. Patients with any other ocular disease that could interfere with visual function, or any media opacity that would significantly interfere with color disc photography or red-free RNFL photography image acquisition, were excluded.

Consecutive individuals were included if they had POAG. A diagnosis of POAG was made when a patient had findings of glaucomatous optic disc damage and corresponding glaucomatous VF defects and an open angle confirmed by gonioscopic examination. The OCT was additionally used to diagnose glaucoma. Glaucomatous optic disc changes were defined as neuroretinal rim thinning, notching, excavation, or RNFL defects.[5] The VF tests were performed with a Humphrey Field Analyzer (SITA 30-2; Carl Zeiss Meditec). Glaucomatous VF defects were defined as (1) glaucoma hemifield test values outside the normal limits; (2) three or more abnormal points with a <5% probability of being normal, of which at least one point has a pattern deviation of $P < 1\%$; or (3) a pattern standard deviation (PSD) of $P < 5\%$. The VF defects were confirmed on two consecutive, reliable tests (fixation loss rate $\leq 20\%$, false-positive and false-negative error rates $\leq 15\%$). Two glaucoma specialists (BRS, JWJ) evaluated the glaucomatous optic disc and/or RNFL damage and VF defects as based on disc/RNFL photography, OCT, and VF tests. In cases of disagreement, a third glaucoma specialist (KHP) served as an adjudicator.

All patients attended regular follow-up visits at 6-month intervals, at which times each underwent clinical examination, color disc photography, red-free RNFL photography, and VF testing. All were treated for glaucoma at the discretion of the attending ophthalmologist, who aimed to reduce baseline IOP by at least 20%. In cases where this could not be accomplished, further treatment decisions were made by the treating physician. In cases in which both eyes of a subject were eligible for the study, only one eye was chosen randomly for inclusion.

One-to-one (1:1) case matching was performed, each matched set consisting of one myopic tilted disc eye as the study eye and one myopic nontilted disc eye as the control eye. The control eyes were matched for age (±5 years), AXL (±1 mm), baseline IOP (±5 mm Hg), and VF MD (±5 decibels [dB]). Disc tilt was measured on color disc photography by glaucoma experts using the National Institutes of Health (NIH) image analysis software (ImageJ 1.48v, developed by Wayne Rasband; http://imagej.nih.gov/ij/; provided in the public domain by the NIH, Bethesda, MD, USA). Optic disc tilt was defined according to the relevant previous publications, using the ovality index.[10–12] Tilt ratio was calculated as the ratio between the longest and shortest optic disc diameters. The measurements were made from the disc margins defined as the inner border of the peripapillary scleral ring.[13] When the tilt ratio was ≥ 1.3, the optic disc was classified as tilted disc.[10,12] Two observers (BRS, JWJ), who were masked to all other patient information, independently evaluated all photographs. In cases of disagreement (>0.2 difference of tilt ratio), a third glaucoma specialist (KHP) served as an adjudicator.

Assessment of Functional Glaucoma Progression: Visual-Field Evaluation

The VF tests were evaluated by means of standard automated perimetry. Functional progression was defined with reference to previous studies.[14–17] Patients were determined as having functional progression if any of the following conditions were fulfilled: (1) a mean deterioration of ≥ 3 dB compared with two baseline values, observed at least consecutively twice during the follow-up period; or (2) a reproducible reduction in sensitivity of at least 10 dB in a cluster of ≥ 2 contiguous locations or a deterioration of at least 5 dB in a cluster of ≥ 3 contiguous locations, at least one of which had deteriorated by ≥ 10 dB on two consecutive VF tests, compared with two baseline values; or (3) "likely progression" in event-based analysis using the Humphrey Field Analyzer (HFA) with guided progression analysis (GPA) software. The GPA software classifies VF progression as either "possible progression" or "likely progression." In the current study, only "likely progression" was considered to be VF progression.[14,18] Serial VFs also were evaluated by two independent observers (BRS, JWJ) in a masked fashion. The two observers assessed the VF results independently and determined whether these eyes met the specific criteria for functional progression. The two observers double-checked all the VF test results.

In addition, comparisons of VF global indices changes, including VF MD and visual-field index (VFI) change and between tilted disc and nontilted disc eyes, were performed. To evaluate the superior and inferior VF defect separately, the mean of total deviation (TD) of the 52 test points was calculated. The superior mean TD was defined as the average of 26 data points from the superior hemifield, and the inferior mean TD was the average of 26 data points from the inferior hemifield.

Assessment of Structural Glaucoma Progression: Optic Disc and Retinal Nerve Fiber Layer Evaluation

Structural assessment for glaucoma progression was determined by evaluating color disc and red-free RNFL photographs. Progressive optic disc changes (i.e., focal or diffuse rim narrowing, neuroretinal rim notching, increased cup-to-disc ratio, adjacent vasculature position shift) were determined by comparing serial disc photographs and were regarded as indicating glaucoma progression. Changes in an RNFL defect were determined from serial RNFL photographs and defined as the appearance of a new defect or an increase in the width or depth of an existing defect. These were regarded as indicative of structural progression.[19] Two observers (BRS, JWJ), who were masked to all other patient information, independently evaluated all photographs. In cases of disagreement, a third glaucoma specialist (KHP) served as an adjudicator.

Table 1. Comparison of Demographic and Clinical Characteristics Between Nontilted Disc Eyes and Tilted Disc Eyes

	Total ($n = 56$)	Nontilted Disc Eyes ($n = 28$)	Tilted Disc Eyes ($n = 28$)	*P* Value
Baseline factors				
Age, y, mean ± SD	50.1 ± 11.7	49.9 ± 12.7	50.3 ± 10.8	0.88
Sex, male/female	33/23	19/9	14/14	0.28
Tilt ratio, median (interquartile range)	1.26 (1.07–1.36)	1.07 (1.03–1.13)	1.36 (1.32–1.56)	<0.01*
Follow-up duration, mo, mean ± SD	90.8 ± 38.1	94.0 ± 34.9	87.6 ± 30.1	0.47
Presence of DH, number	4	3	1	0.61
Spherical equivalent, diopters, mean ± SD	−6.70 ± 2.40	−6.30 ± 2.53	−7.09 ± 3.08	0.35
AXL, mm, mean ± SD	26.41 ± 0.99	26.51 ± 0.96	26.31 ± 1.02	0.46
CCT, μm, mean ± SD	538.47 ± 32.13	539.89 ± 33.31	537.00 ± 31.47	0.75
IOP				
Baseline IOP, mm Hg, mean ± SD	16.38 ± 2.31	16.57 ± 1.95	16.20 ± 2.64	0.55
Peak IOP during follow-up, mm Hg, mean ± SD	17.00 ± 2.35	16.88 ± 2.02	17.11 ± 2.67	0.72
Mean follow-up IOP, mm Hg, mean ± SD	13.33 ± 1.88	13.23 ± 1.56	13.43 ± 2.18	0.68
Mean reduction of IOP, %, mean ± SD	18.03 ± 10.16	19.74 ± 8.54	16.32 ± 11.46	0.21
VF global indices				
Initial VF MD, dB, mean ± SD	−7.14 ± 4.09	−7.60 ± 3.64	−6.67 ± 4.52	0.40
Initial VF PSD, dB, mean ± SD	7.86 ± 4.65	9.60 ± 4.27	7.11 ± 4.75	0.04*
Initial VFI, %, mean ± SD	83.00 ± 12.38	81.14 ± 11.67	84.86 ± 13.00	0.27

CCT, central corneal thickness.

* Comparison was performed by using independent *t*-test for continuous variables and Fisher's exact tests for categorical variables. Significant values: $P < 0.05$.

Statistical Analysis

Comparisons of the baseline characteristics between the two groups were performed, using the independent *t*-test for continuous variables and Fisher's exact test for categorical variables. Kaplan-Meier survival analysis was used to assess the cumulative incidence probabilities of glaucoma nonprogression. The relationships among the tilt ratio and rate of VF MD change were shown with scatter plot. The Cox proportional hazards models were used to identify risk factors for functional and/or structural progression. Univariable analysis was performed for each factor. Multivariable Cox proportional hazards model was performed by using the factors with $P < 0.2$ (covariates were tilt ratio, the presence of disc hemorrhage (DH), mean reduction of IOP, and initial VF MD) on univariable analysis. Backward elimination was used to develop the final multivariable model, and adjusted hazard ratios (HRs) with 95% confidence intervals were calculated. All of the statistical analysis was performed by using statistical analysis software (SPSS 18.0; SPSS, Inc., Chicago, IL, USA); *P* values less than 0.05 were considered statistically significant.

Results

Baseline Characteristics

The study involved the 676 eyes of 676 myopic POAG patients analyzed with color disc photography, red-free RNFL photography, and VF testing. Of these, 272 were excluded because they did not follow-up for more than 5 years because of intermittent visits; or because of follow-up loss. Also, 77 were excluded because of the poor quality of color disc photography or red-free RNFL photography. In addition, 98 were excluded because of the low reliability of VF testing, leaving a sample of 229 eyes of 229 patients. Of the 229 patients, 56 eyes of 56 subjects (28 tilted disc eyes and 28 case-matched nontilted disc eyes) who were matched for age, AXL, baseline IOP, and VF MD were selected for the analysis. This procedure was performed by one of the authors (BRS) who was masked to the test results.

The demographics and baseline characteristics of the subjects are summarized in Table 1. Among the baseline characteristics, tilt ratio and VF PSD showed statistically significant differences between tilted disc and nontilted disc eyes. Median values (interquartile ranges) of tilt ratio were 1.36 (1.32–1.56) and 1.07 (1.03–1.13) in tilted disc and nontilted disc eyes. PSD was lower in tilted disc eyes (7.11 ± 4.75 dB) than in nontilted disc eyes (9.60 ± 4.27 dB) ($P < 0.01$ and $P = 0.04$, respectively). None of the other factors showed any statistically significant differences between tilted disc and nontilted disc eyes.

Longitudinal Assessment of Visual-Field Global Indices and Mean Total Deviation Value

In the VF global indices evaluation, the nontilted disc eyes showed faster rates of VF MD and VFI change (–0.20 ± 0.60 dB/y, –0.98 ± 1.94 %/y) than did the tilted disc eyes (0.15 ± 0.67 dB/y, 0.16 ± 1.66 %/y). The rates of VF MD and VFI

Table 2. Comparison of Visual Field Global Indices Change Between Nontilted Disc Eyes and Tilted Disc Eyes

	Nontilted Disc Eyes ($n = 28$)	Tilted Disc Eyes ($n = 28$)	*P* Value
VF global indices			
Mean rate of VF MD change, dB/mo	−0.20 ± 0.60	0.15 ± 0.67	0.04*
Mean rate of VFI change, %/mo	−0.98 ± 1.94	0.16 ± 1.66	0.02*
VF mean total deviation			
Mean rate of mean TD change in superior hemifield, dB/mo	−0.25 ± 0.07	0.01 ± 0.07	0.07
Mean rate of mean TD change in inferior hemifield, dB/mo	−0.01 ± 0.06	0.00 ± 0.04	0.30

* Comparison was performed by using independent *t*-tests. Significant values: $P < 0.05$.

Table 3. Comparison of Prevalence of Glaucoma Progression Between Nontilted Disc Eyes and Tilted Disc Eyes

	Nontilted Disc Eyes ($n = 28$)	Tilted Disc Eyes ($n = 28$)	*P* Value
Structural progression, No. (%)	13 (46.4)	3 (10.7)	0.01*
Functional progression, No. (%)	6 (21.4)	3 (10.7)	0.47
Structural or functional progression, No. (%)	16 (57.1)	6 (21.4)	0.01*

* Comparison was performed by using Fisher's exact tests. Significant values: $P < 0.05$.

change were significantly different between the tilted disc and nontilted disc eyes ($P = 0.04$ and 0.02, respectively) (Table 2). In the superior and inferior analysis, mean rate of mean TD change did not show any significant difference between nontilted disc eyes and tilted disc eyes ($P = 0.07$ and 0.30, respectively). The relationship between the tilt ratio and the rates of VF MD change is shown in Supplementary Figure S1.

Assessment of Glaucoma Progression

In the structural evaluation, the nontilted disc eyes showed a significantly higher frequency in event of progression (13 of 28, 46.4%) than did the tilted disc eyes (3 of 28, 10.7%) ($P = 0.01$). In the functional evaluation, there was no statistically significant difference between the tilted disc and nontilted disc eyes in that regard ($P = 0.47$). In the structural or functional evaluation, the nontilted disc eyes showed a higher frequency in event of progression (16 of 28, 57.1%) than did the tilted disc eyes (6 of 28, 21.4%) ($P = 0.01$) (Table 3).

Risk Factors for Glaucoma Progression

The Kaplan-Meier survival analysis revealed that the patients with nontilted disc eyes had a greater cumulative progression probability than did those with tilted disc eyes ($P = 0.01$, log-rank test) (Fig. 1). The univariable Cox proportional hazards model revealed that the lower tilt ratio and the presence of DH were significantly associated with glaucoma progression ($P = 0.01$ and 0.03, respectively). In multivariable analysis, lower tilt ratio and the presence of DH were significantly associated with glaucoma progression ($P = 0.02$ and 0.04, respectively) (Table 4).

Representative Cases

Case-matched myopic glaucomatous eyes with similar baseline characteristics except for the presence of disc tilt are shown in Figures 2 and 3. Figure 2 shows a representative myopic nontilted disc eye that manifested significant glaucoma progression during the 7-year follow-up period. Figure 3 shows a representative myopic tilted disc eye that did not manifest any significant progression during the 7-year follow-up period.

Discussion

In this study, the myopic eyes with tilted disc showed a more stable glaucoma progression than the eyes without tilted disc. Several previous studies[6,8,10,20] have reported similar results, but the mechanism is unclear. Myopic eyes are known to experience tilting of disc and deformation of lamina cribrosa (LC) during axial elongation.[5,6,10,21] The damage of LC will not proceed any longer after the change of myopia is stabilized as an adult.[6,20] In other words, glaucomatous changes in the tilted disc eyes may be associated with myopic changes that occur during childhood or adolescence.[5,6,8,10,22] Our study indicates that morphologic changes to the ONH might be important to prediction of future progression in myopic glaucomatous eyes.

As shown in Table 3, eyes showing glaucoma progression were more frequently found in structural assessment than in functional assessment. Poor agreement between functional and structural assessment of glaucoma progression is not surprising, in that several prior studies[23–25] have reported similar results. In regard to the structure-function relationship, previous cross-sectional studies[26–28] have suggested that progression by RNFL thickness evaluation is more noticeable than by VF examination in early stages of glaucoma. However, in several studies,[26–28] progression could be confirmed more clearly by VF examination than by RNFL thickness evaluation in advanced stages of glaucoma. In the present study, the subjects showed an average MD value of −7.14 dB, which might be the reason that glaucoma progression was more detectable on structural assessment than on functional assessment.

To our knowledge, this is the first study to compare glaucoma progression between myopic nontilted disc eyes and myopic tilted disc eyes in a 1:1 case-matched study design. Matching was done according to age, AXL, baseline IOP, and initial VF MD. In this study, AXL was matched for matching of myopia grade, because myopia itself is reported to be a risk factor for glaucoma

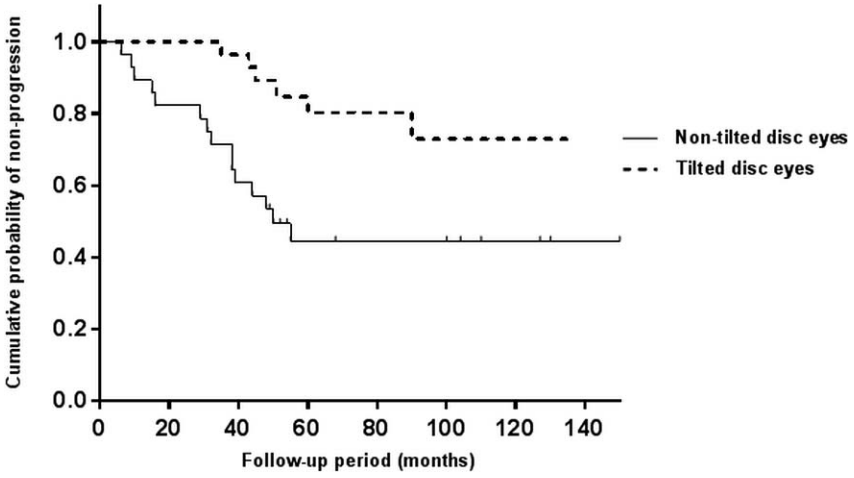

Figure 1. Kaplan-Meier curves comparing cumulative progression probability in patients with tilted disc eyes and those with nontilted disc eyes. The statistical endpoint was defined as the time of first structural or functional glaucoma progression indication. Patients with nontilted disc eyes had a greater cumulative progression probability than those with tilted disc eyes ($P = 0.01$, log-rank test).

Table 4. Univariable and Multivariable Cox Proportional Hazards Model Data for Prediction of Progression

	Univariable			Multivariable		
	HR	95% CI	*P* Value	HR	95% CI	*P* Value
Age, y	0.980	0.943–1.017	0.28			
Tilt ratio	0.024	0.001–0.404	0.01*	0.032	0.002–0.559	0.02*
Presence of DH	3.971	1.141–13.824	0.03*	4.026	1.062–15.262	0.04*
AXL, mm	1.106	0.731–1.674	0.63			
CCT, μm	1.001	0.986–1.016	0.90			
Baseline IOP, mm Hg	1.040	0.878–1.233	0.65			
Peak IOP, mm Hg	0.983	0.820–1.179	0.85			
Mean follow-up IOP, mm Hg	0.891	0.700–1.134	0.35			
Mean reduction of IOP, %	1.034	0.987–1.082	0.16	1.048	0.992–1.108	0.09
Initial VF MD, dB	0.932	0.842–1.032	0.18	0.958	0.862–1.065	0.43
Initial VFI, %	0.981	0.950–1.013	0.24			

Multivariable model is adjusted for tilt ratio, presence of DH, mean reduction of IOP, initial VF MD, and PSD. CI, confidence interval.
* Comparison was performed by using univariate and multivariable Cox proportional hazards models. Significant values: $P < 0.05$.

development in some studies.[29–33] We assumed that, for accurate evaluation of the effect of disc tilt on glaucoma progression, matching of myopia grade is necessary. In addition to AXL, we matched for age because increasing age is considered to be associated with glaucoma progression.[34–37] We also matched for baseline IOP, because baseline IOP is known to be related to IOP reduction. Finally, we matched for severity of glaucoma, as previous studies[38,39] have reported that advanced glaucoma is associated with a higher risk of glaucoma progression.

It is well-known that false-positives are likely to occur on OCT in myopia.[40] Eyes with tilted disc are more prone to false-positive glaucoma classification, which might explain their

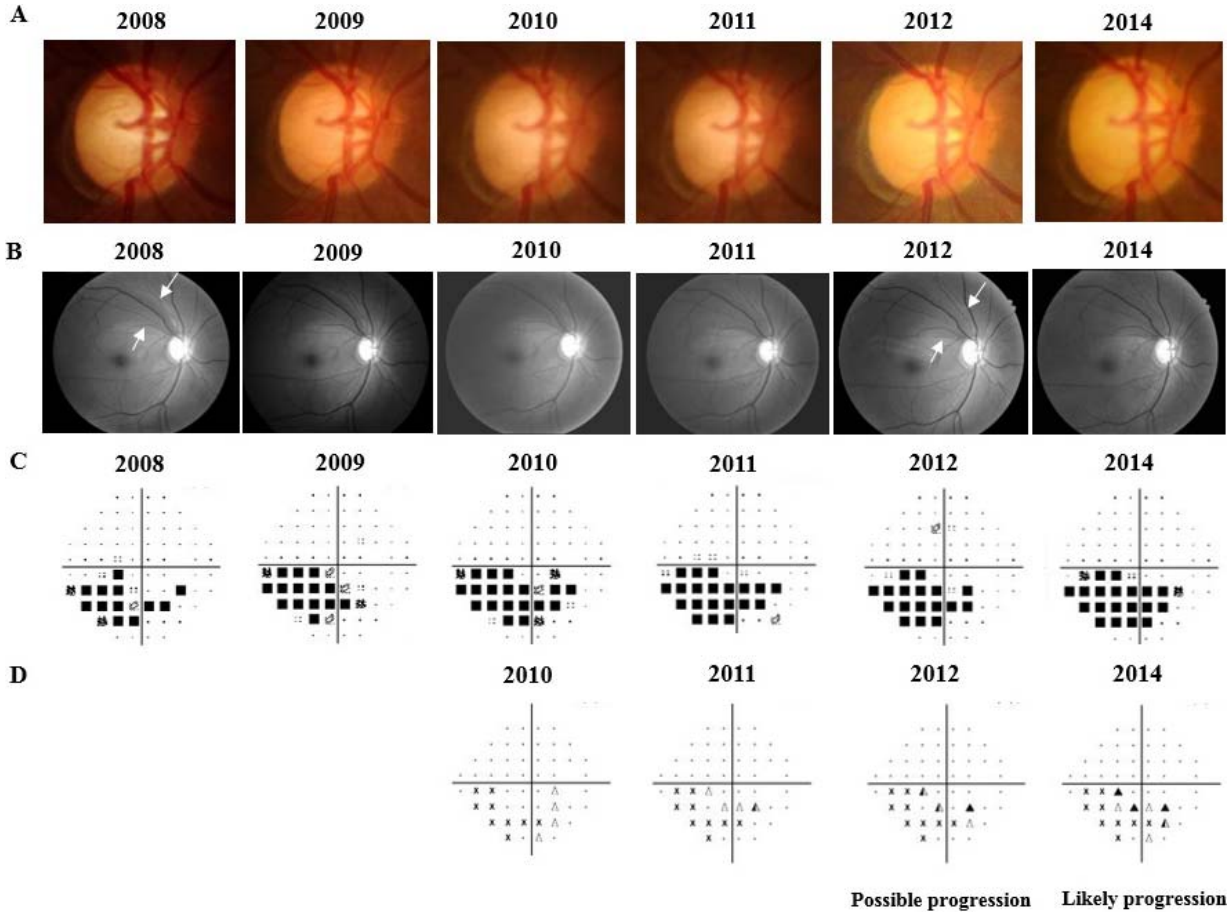

Figure 2. Right eye of a 42-year-old woman in the myopic nontilted disc group. Her intraocular pressure was 17 mm Hg, and the mean deviation of VF was –6.71 dB on initial examination. The axial length was 26.29 mm, and the disc tilt ratio was 1.03. She had RNFL defect on the superior side and corresponding VF damage. (**A**) Serial color disc photography shows nontilted disc in the right eye. (**B**) Serial RNFL photography. The *white arrow* indicates the margin of the RNFL defect. It was widened in the course of serial follow-ups. (**C**) Serial VFs with pattern deviation plots. (**D**) Serial VF with guided progression analysis. The 2012 VF examination detected progression of glaucoma.

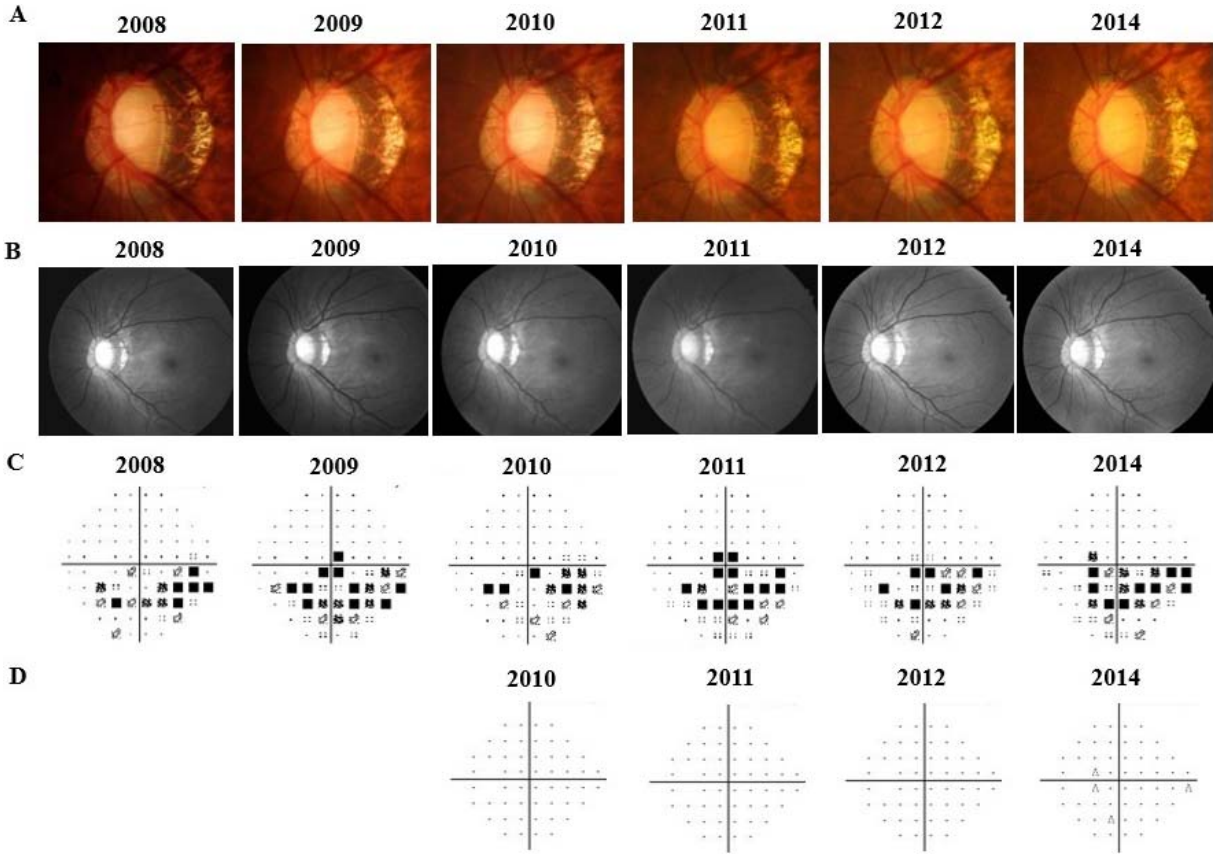

FIGURE 3. Left eye of a 42-year-old woman in the myopic tilted disc group. Her intraocular pressure was 15 mm Hg, and the mean deviation of VF was −6.36 dB on initial examination. The axial length was 26.30 mm, and the disc tilt ratio was 1.76. She had RNFL defect on the superior side and corresponding VF damage. (**A**) Serial color disc photography shows tilted disc in the left eye (no progression). (**B**) Serial RNFL photography (no progression). (**C**) Serial VFs with pattern deviation plots (no progression). (**D**) Serial VF with guided progression analysis (no progression).

stability during follow-up. To minimize this possibility, two glaucoma specialists confirmed the diagnosis of glaucoma and in cases of disagreement, a third glaucoma specialist served as an adjudicator. Kim et al.[41] have reported that there are characteristic false-positive patterns of OCT deviation map. Therefore, we paid particular attention to the diagnosis of patients with these characteristics.

Our study had several limitations. First, it included a relatively small number of patients. Therefore, further prospective large-scale studies are needed. Second, we did not consider other characteristics of myopic ONH such as disc torsion or beta-zone peripapillary atrophy. These optic disc changes are known to be correlated with VF defects in myopic eyes.[11,12,42,43] Also, we did not analyze the possible association of disc tilt direction with glaucoma progression. A further study investigating the relationship between various myopic optic disc changes and glaucoma progression with a special focus on disc tilt direction is required. Third, in this study, we matched AXL to match the degree of myopia between the two groups. Although AXL can imply the degree of myopia, these factors are not necessarily interchangeable and there are factors other than the AXL that can contribute to the degree of myopia. Fourth, in this study, various factors such as optic disc microperfusion, vascular autoregulation, obstructive sleep apnea, translaminar cribrosa pressure gradient, and nocturnal blood pressure/blood pressure dipping may affect the progress of glaucoma. Thus, this study should be considered when interpreting the results. Fifth, in this study, longitudinal OCT analysis was not performed. Further studies are needed to elucidate the long-term OCT results for tilted disc eyes in myopic glaucoma.

In summary, more stable courses were found in eyes with disc tilt than those without disc tilt among myopic POAG patients. Additionally, the lower disc tilt ratio was determined to be a risk factor for glaucoma progression in myopic eyes. Clinical evaluation of optic disc morphology might help to predict future progression in myopic glaucomatous eyes.

Acknowledgments

Presented at the Association for Research in Vision and Ophthalmology annual meeting, Honolulu, Hawaii, May 2018.

Disclosure: **B.R. Seol**, None; **K.H. Park**, None; **J.W. Jeoung**, None

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