Refractive Errors and Optical Biometry Parameters Associated with Tilted Disc Syndrome

Tilte (Eğik) Disk Sendromunda Kırılma Kusuru ve Optik Biyometri Özellikleri

[1]Dilruba Köseoğlu, [1]Hüseyin Gürsoy, [2]Muzaffer Bilgin, [2]Ertuğrul Çolak
[1]Eskişehir Osmangazi Üniversitesi Tıp Fakültesi, Göz Hastalıkları Anabilim Dalı, Eskişehir, Türkiye
[2]Eskişehir Osmangazi Üniversitesi Üniversitesi Tıp Fakültesi , Biyoistatistik Anabilim Dalı, Eskisehir, Türkiye

Abstract: Evaluation and comparison of optical biometry parametres of patients with tilted disc to myopia cases to elucidate the origin of astigmatism. Upon fundoscopic examination 22 right eyes with tilted disc (Group 1) and 21 right eyes with a refractive error of ≥-0,75 (Diopters=D) (Group 2), who were diagnosed between 2014 and 2016 were included. Refraction and optical biometry measurements were obtained and compared 30 minutes after instilling %1 cyclopentholate. The mean age (years) of Group 1 was 41.5±17.6, while it was 26.2±7.8 in group 2. The mean spherical equivalent (D) was -5.10±3.72 in group 1, and -2.81±3.29 in group 2 (p=0.047). The mean cylindrical power (D) was -2.43±1.96 in group 1, and -0.63±0.67 in group 2 (p=0.001). The best corrected visual accuities (logMAR) were significantly lower in group 1 (p=0.001). The mean axial length of group 1 was 25.96±1.47 mm, while in group 2 it was 24.56±1.51 mm (p=0.001). There were no significant differences between two groups regarding lens thickness, anterior chamber depth and keratometry values. The mean keratometric values (D) were; K1: 42.60±1.93 in group 1 and 43.03±1.56 in group 2; K2: 44.46±2.14 in group 1 and 44.03±1.54 in group 2. The mean central corneal thickness (micron) was significantly lower in group 1; 523.82±25.90 (group 1) and 552.10±36.76 (group2) (p=0.006). Considering the fact that the difference between the keratometric values among groups was not significant, we concluded that the link between astigmatism and tilted disc could be due to lenticular and/or retinal changes.
Key Words: tilted disc, optical biometry, astigmatism, myopia

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Özet: Tilte diskli olgulardaki optik biyometri ölçümlerinin, miyop olgularla karşılaştırılarak astigmatizma değerlerin kaynağının değerlendirilmesi.2014-2016 yılları arasında, fundus muayenesinde tilte disk saptanan 22 hastanın sağ gözü (Grup 1) ile -0,75 (Diyoptri=D) ve üzeri miyopik refraksiyon kusuru saptanan 21 hastanın sağ gözü (Grup 2) dahil edildi. %1'lik siklopentolat uygulamasından 30 dk. sonra, refraksiyon ve optik biyometri ölçümleri yapıldı. Grup 1 ve 2 için elde edilen veriler karşılaştırıldı. Grup 1'in ortalama yaşı (yıl) 41,5±17,6 iken, grup 2'nin 26,2±7,8 idi. Ortalama siferik değerler (D) grup 1'de -5,10±3,72, grup 2'de -2,81±3,29 saptandı (p=0,047). Ortalama silindirik değerler (D) grup 1'de -2,43±1,96, grup 2'de -0,63±0,67 idi (p=0,001). En iyi düzeltilmiş görme keskinliği (EİDGK) (logMAR) grup 1'de anlamlı düzeyde düşüktü (p=0,001). Ortalama aksiyel uzunluk grup1'de 25,96±1,47, grup 2'de ise 24,56±1,51 olarak bulundu (p=0,001). İki grup arasında lens kalınlığı, ön kamara derinliği ve keratometri değerleri (D) açısından anlamlı fark yoktu. Grup 1 K1 değerleri 42,60±1,93, grup 2 ise 43,03±1,56; grup 1 K2 değerleri 44,46±2,14, grup 2 ise 44,03±1,54 olarak bulundu. Ortalama merkezi kornea kalınlığı (mikron) grup 1'de anlamlı olarak düşüktü; 523,82±25,90'e, 552,10±36,76 (p=0,006). Astigmatizma ile eğik optik disk görünümü arasındaki ilişkinin, keratometri değerlerimize yansımamış olması nedeniyle, astigmatizmanın lense ve/veya retinaya bağlı farklılıklardan ortaya çıkabileceğini düşünüyoruz.
Anahtar Kelimeler: tilte disk, optik biyometri, astigmatizma, miyop

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Yazışma Adresi / Correspondence Address
Haluk Hüseyin GÜRSOY
mail: hhgursoy@hotmail.com

1. Introduction

Tilted disc is a common optic disc anomaly encountered in routine ophthalmological examinations and the diagnosis is based on the appearance of the disc. In fundoscopic examination, tilted disc can be observed in two ways. Either the disc may seem elevated with the posterior displacement of the inferonasal portion, or the disc can have an obliquely oriented long axis resulting in horizontal tilting[1]. It can be related to high myopia or can be a congenital defect in non-myopic eyes. In congenital cases the disc is mostly tilted inferonasally, and can be accompanied with thinning of retina pigment epithelium and choroid, posterior staphyloma and reversed positioning of the retinal vessels (situs inversus) [2]. In cases with high myopia, the degree of the disc angulation depends on the severeness of the refractive error. The tilt is shown to be related to the oblique entrance of the optic nerve to the eye. In high axial myopic eyes, the axial length (AL) of the eye also elongates which results in straining of the temporal quadrant of the disc and tilting of the optic disc vertically[3,4]. Due to this retinal distortion, tilted disc can be associated with myopic astigmatism[5,6]. In this study, we aimed to evaluate the refractive errors and optical biometry parameters and elucidate the origins of astigmatism values associated with the tilted disc syndrome.

2. Materials and Methods

The study had been approved by the Institutional Review Boards (2016 June-164). The data collection conformed to all the local laws and was compliant with the principles of the Declaration of Helsinki. This retrospective study included subjects examined at ..... Department of Ophthalmology between January 2014 and January 2016. Group 1 was composed of eyes with unilateral or bilateral tilted optic discs, whereas Group 2 consisted of myopic eyes without tilted disc. Tilted disc diagnosis was made upon fundoscopic examination of the disc. Spherical equivalent of ≤-0.50 diopters (D) was considered to be myopic. Spherical equivalent (SEq) was calculated by adding the spherical value and half of the cylindrical value. The optical biometry was performed using the Lenstar LS900 (Haag-Streit AG, Koeniz, Switzerland), and refractive errors were measured using Topcon RMA 7000B auto refractometer (Topcon Corporation, Tokyo, Japan). Initially the best corrected visual acuities (BCVA) were noted. Then auto refractometer and optical biometry measurements were obtained 30 minutes after instilling %1 cyclopentholate. The AL, central corneal thickness (CCT), anterior chamber depth (ACD), lens thickness (LT) and keratometry values were evaluated. The results from both groups (Group 1 and 2) were compared. All the data was evaluated with Shapiro Wilk statistical test using IBM SPSS Statistics 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0 Armonk, NY: IBM Corp.). The data that did not distribute normally according to Shapiro-Wilk were then evaluated with Mann-Whitney U test. The data that distributed normally were compared using independent sample t-test. The distribution of gender in groups was evaluated with Chi-square test. Significance was attributed when $p < 0.05$.

3. Results

Tilted disc was bilateral in 20 patients. However, we analyzed only right eyes of 22 patients. The control group was also composed of right eyes of 21 subjects. Group 1 consisted of 22 subjects with a mean age value of 41.5±17.6 years and group 2 included 21 subjects with a mean age of 26.2±7.8 years. The mean SEq (D) was -5.10±3.72 in group 1 and -2.81±3.29 in group 2 (p=0.047). The mean cylindrical power (D) of group 1 and 2 were -2.43±1.96 and -0.63±0.67, respectively (p=0.001). The mean BCVA (logMAR) was significantly lower in group 1 (p=0.001).

Patients' BCVAs and refractive values are presented in Table 1.

Table 1.
The baseline characteristics of patients with tilted disc (group 1) and control group (group 2).

Data		Group 1 (n=22)	Group 2 (n=21)	p value
Gender (female/male)		13/9	12/9	1[1]
Age (year)	Mean	41.5±17.6	26.2±7.8	0.004[2]*
	Median	38.5 (25.5-59.5)	26.0 (22.0-28.0)	
Spherical equivalent (D)	Mean	-5.10±3.72	-2.81±3.29	0.047[2]*
	Median	-4.50 (-7.81- -1.44)	-1.50 (-3.25- -1.25)	
Cylindrical power (D)	Mean	-2.43±1.96	-0.63±0.67	0.001[2]*
	Median	-2.63 (-3.81- -1.50)	-0.50 (-0.75- -0.25)	
Axis (degree)	Mean	92.73±61.70	85.90±65.68	0.562[2]
	Median	95.0 (31.0-160.3)	92.5 (4.8-150.8)	
BCVA (logMAR)	Mean	0.23±0.30	0.02±0.09	0.001[2]*
	Median	0.13 (0-0.35)	0 (0-0)	

D: diopters, BCVA: best corrected visual acuity
*: Statistical significance p<0.05.
[1]: Comparison with Chi-square test,
[2]: Comparison with Mann-Whitney U test

The mean ALs (mm) in group 1 were 25.96±1.47 and 24.56±1.51 in group 2 (p=0.001). There was no significant difference between two groups concerning the LT, ACD and keratometry values. K1 values were 42.60±1.93 in group 1 and 43.03±1.56 in group 2. K2 values were 44.46±2.14 in group 1 and 44.03±1.54 in group 2. CCT values were significantly lower in group 1; 523.82±25.90 in group 1 vs. 552.10±36.76 in group 2 (p=0.006).
Optical biometry results of both groups are presented in Table 2.

Table 2.
The comparison of the optical biometry parameters among patients with tilted disc (group 1) and control (group 2).

		Group 1 (n=22)	Group 2 (n=21)	P value
AL (mm)	Mean	25.96±1.47	24.56±1.51	0.001[1]*
	Median	25.59 (24.66-27.44)	24.49 (23.41-25.13)	
LT (mm)	Mean	3.86±0.78	3.66±0.37	0.083[1]
	Median	3.89 (3.66-4.27)	3.75 (3.38-3.86)	
CCT (micron)	Mean	523.82±25.90	552.10±36.76	0.006[2]*
ACD (mm)	Mean	3.51±0.49	3.48±0.42	0.829[2]
K1 (D)	Mean	42.60±1.93	43.03±1.56	0.425[2]
K2 (D)	Mean	44.46±2.14	44.03±1.54	0.448[2]

AL: Axial Length, CCT: Central Corneal Thickness, ACD: Anterior Chamber Depth, LT: Lens Thickness, K: Keratometry, D: diopters.
*: Statistical significance p<0.05.
[1]: Comparison with Mann-Whitney U test,
[2]: Comparison with independent sample t-test of differences.

4. Discussion

Tilted disc is a common optic disc anomaly. Even though it can also be a congenital defect, it is mostly associated with high myopic[2,3] and astigmatic refractive errors. In congenital cases, the disc is usually tilted inferonasally, whereas in myopic patients the disc tends to tilt towards the temporal side[3]. A higher degree of angulation in the discs with higher myopic refractive errors suggests that this condition can be progressive[2]. In a recent study, Kyung-ah et al.[2] showed, after a follow-up of 5 years, children with low BCVA and tilted disc ended up with higher myopic refractive errors. In a study evaluating the optic nerve changes in myopic patients, Nakazawa et al.[7] showed that higher myopic refractive errors were associated with severeness of tilting of the disc.

High refractive errors also indicate lower BCVAs. A Danish study conducted by Goldschmit et al[8] shows refractive changes of myopic infants through a follow up time of 40 years. According to this study, peak changes in refractive errors, were observed mostly in the first decade (4-8 D), then a lower peak was seen in adult ages (3-3,5 D). In concordance with current literature, along with the progression of the refractive errors they also witnessed a decrease in BCVAs.

Tilted discs are also considered to be highly associated with myopic astigmatism as well[5,9]. In our study, both the spherical equivalent and the cylinder power of the tilted eyes were significantly higher than those in the non-tilted group. In coherence to these results, BCVAs were significantly lower in group 1. This could be due to existing amblyopia, as previously shown in Weiss's study[10]. In this study, the reduced acuities lower than 20/200 were most likely to be associated with either anisometropic amblyopia or contributing ocular abnormalities.

Even though an association between high myopic refractive errors and tilted disc is commonly known, the fact that tilted disc does not exist in every myopic patient suggests that there may be other factors contributing to the pathology.

Tilted disc is usually associated with astigmatism as well but the origin of the astigmatic error is debatable, and most likely differs from the myopic astigmatism which is commonly corneal.

Astigmatism in myopic patients is usually caused by alterations in the curvature of the cornea; therefore changes in keratometric measurements are expected in eyes with astigmatism. As Read et al[11] mentioned in their review, infants show a relatively high prevalence of astigmatism due to a steep cornea, even though cornea flattens with age corneal astigmatism remains due to corneal curvature changes. Bozkurt et al.[12] showed that astigmatism was significantly relevant with tilted disc syndrome. They evaluated 23 eyes of 13 tilted disc syndrome patients and detected corneal astigmatism in 18 eyes, mixed astigmatism (both corneal and lenticular) in 4 eyes and lenticular astigmatism in 1 eye.

In a population based study conducted to find the prevalence of tilted disc syndrome among Chinese population in Singapore, How et. al[13] found no significant correlation between corneal astigmatism and the index of the tilt of the optic disc. In contrary to previous studies[5,6] these results actually coincides with our findings of this current study.

Jonas et al [6] also conducted a study of 882 patients with a mean refractive error of -1.09±2.76 D to evaluate the possible association of refractive errors with the presence of an abnormally shaped optic disc. In contrary to ours, their study showed a significant relevance ($p<0.01$) of corneal astigmatism to the presence of a tilted disc.

Gunduz et al[14], investigated the relevance of lenticular astigmatism to tilted disc syndrome in a study consisting of 32 patients with tilted disc syndrome (TDS) and a control group of 20 people. According to this study, there was no difference of corneal astigmatism between groups, whereas lenticular astigmatism was significantly higher in the TDS group. Lenticular astigmatism was obtained in 29 of 32 patients in TDS group and the astigmatic refractive errors were higher than -1.0 D in 19 of these patients.

In a study where Dehghani et al.[15] evaluated and then compared both spherical equivalents

and astigmatical changes of tilted disc and control groups, they detected that corneal astigmatism was higher in the control group, whereas tilted disc group showed a higher rate of lenticular astigmatism. In contrary to our study, they also detected that lens thickness values were also higher in the TDS group.

In another study, Ornek et al.[16] compared the CCT values of 61 tilted disc patients to a control group. To the contrary of our study, they did not detect any significant difference between groups.

Samarawickrama et al.[9] showed similar results to ours, where both higher spherical equivalent refractions and higher cylindrical errors were obtained in the TDS group. On the contrary to our study, they also found that axial lengths in the TDS group were longer.

In our study, the mean SE measurements were significantly higher in group 1, and the mean AL was consistently longer in eyes with tilted disc. Ozsoy et al.[1] compared eyes with tilted disc with a control group which was equal to the study group in age, gender, and refraction. In that study, the AL was similar among both groups.

We also found lower CCT values in eyes with tilted disc. Our finding was consistent with Ozsoy et al[1], but inconsistent with the findings of Dehghani et al.[15], where similar CCT values were obtained in both groups.

There was also no difference involving keratometric values. In light of this information, in unison with the literature, we considered the cause of the higher astigmatic values in tilted disc patients, to be related to lenticular and/or retinal alterations, rather than corneal.

5. Restrictions

Our study included 22 patients with tilted disc compared with a control group of 21 eyes with myopic refractive errors without a tilted disc. Because of a limited number of cases in our study, which could restrict data, further studies may be conducted with larger sample groups.

The fact that we only included right eyes and conducted our study without matching the spherical equivalent values between groups, although it doesn't affect the final outcome, could be a handicap concerning the BCVAs. Further studies can be done between refractive error matched groups for more accurate comparison.

6. Conclusion

Tilted disc patients also commonly have higher myopic astigmatic and astigmatic values. BCVAs of these patients could be significantly lower than people with spherical and/or cylindrical myopic refractive errors with a normal optic disc. Due to the fact that our keratometry results do not define the association between tilted disc and astigmatism, we believe that it could be related to lenticular and/or retinal alterations.

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