Evaluation of Anterior Segment Parameters of Clinically Unilateral Pseudoexfoliation Syndrome Using Scheimpflug Imaging Technique

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Abstract

Objective: We aimed to compare the intraocular pressure (IOP), keratometry values (K), and anterior segment parameters of patients with clinically unilateral pseudoexfoliation syndrome (PEX) with the other eyes without PEX and the control group.

Material and Method: Fifty four patients with unilateral PEX findings and 40 participants without PEX findings in both eyes were included in the study as a control group. IOP was measured by Goldmann applanation tonometry. K values and anterior segment parameters [central corneal thickness (CCT), anterior chamber depth (ACD), iridocorneal angle (ICA), and anterior chamber volume (ACV)] were measured using Scheimpflug imaging technique.

Results: The mean age of PEX patients was 67.9±9.2 years, while the mean age of the control group was 58.9±5.7 years. The IOP values of the eyes with PEX were significantly higher than the other eyes ($p=0.02$), and there was no significant difference between them and the control group (p=0.59). In terms of K values and anterior segment parameters, the measurements of eyes with PEX and the other eyes, and eyes with PEX and control group were similar ($p>0.05$).

Conclusion: In our study, eyes with PEX had higher IOP values than the fellow eyes and control group. In addition, thinner CCT, narrower ACD, and ICA values were found in eyes with PEX than in the other eyes. However, these values were not statistically significant.

Keywords: Anterior segment parameters, Corneal topography, Intraocular pressure, Pseudoexfoliation syndrome

Özet

Amaç: Klinik olarak tek taraflı psödoeksfoliasyon sendromu (PES) olan hastaların, göziçi basıncı (GİB), keratometri değerleri (K) ve ön segment parameterlerini, PES olmayan diğer gözleri ve kontrol grubu ile karşılaştırmayı amaçladık.

Gereç ve Yöntem: Tek taraflı PES bulguları olan 54 hasta ile iki gözünde de PES bulguları olmayan 40 kişi kontrol grubu olarak çalışmaya dahil edildi. GİB, Goldmann aplanasyon tonometrisi ile ölçüldü. K değerleri ve ön segment parametreleri (santral kornea kalınlığı, ön kamera derinliği, iridokorneal açı, ön kamera hacmi) Scheimpflug görüntüleme tekniği kullanılarak ölçüldü.

Bulgular: PES hastalarının yaş ortalaması 67,9±9,2 iken, kontrol grubunun yaş ortalaması 58,9±5,7 idi. PES'li gözlerin GİB değerleri diğer gözlerinden anlamlı olarak yüksek idi ($p=0,02$), kontrol grubuyla aralarında anlamlı fark yoktu ($p=0,59$). K değerleri ve ön segment parametreleri bakımından PES'li gözler ile diğer gözleri ve kontrol grubu ölçümleri benzer idi ($p>0,05$).

Sonuç: Çalışmamızda PES'li gözler, diğer gözlerinden ve kontrol grubundan daha yüksek GİB değerlerine sahipti. Ayrıca PES'li gözlerde diğer gözlerinden daha ince santral kornea kalınlığı, daha dar ön kamera derinliği ve iridokorneal açı değerleri bulundu ancak bu değerler istatistiksel olarak anlamlı değildi.

Anahtar Sözcükler: Göziçi basıncı, Korneal topografi, Ön segment parametreleri, Psödoeksfoliasyon sendromu

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Introduction

Pseudoexfoliation syndrome (PEX) is an age-related systemic microfibrillopathy, mostly seen in the structures of the anterior chamber of the eye, in which extracellular granular material accumulates (1). Depending on this material accumulation, it may cause ocular pathologies such as secondary open-angle glaucoma, angle-closure glaucoma, weakness in the zonules, phacodonesis, lens dislocation, and weak pupil dilation (2). While the prevalence of PEX is around 10-20% over the age of 60, this rate is around 40% over the age of 80. In addition, its prevalence is also affected by ethnicity and race (3,4).

Unlike primary open-angle glaucoma (POAG), PEX-induced glaucoma (PEXG) is characterized by higher intraocular pressure (IOP), higher diurnal variation, more severe optic nerve damage, and more rapid visual field loss. In addition, PEXG is more resistant to medical treatment and requires more surgery than POAG (5). Accordingly, PEXG is one of the common causes of blindness worldwide (6). While the PEXG development rate is 5% for 5 years, this rate rises to 60% over 15 years (7,8).

PEX accumulates in the lens capsule, zonules, anterior chamber, and cornea layers. It affects these structures (2). It causes intra/postoperative complications due to zonullar instability, phacodonesis, melanin dispersion, and posterior synechia (9). Scorolli et al. they found that there was a 5-fold higher risk of intraoperative complications in cataract surgery in patients with PEX (10).

Although PEX is usually diagnosed unilaterally, it is a bilateral disease with asymmetric initiation. Despite its unilateral onset, PEX has been shown to be bilateral in electron microscopy studies (11). PEX findings were also found in conjunctival biopsies taken from the other eyes of clinically unilateral patients (12).

Evaluation of IOP, CCT, and anterior segment structures [anterior chamber depth (ACD), iridocorneal angle (ICA), and anterior chamber volume (ACV)] is important for diagnosis and follow-up in patient with PEX. The Sirius scheimpflug imaging system can objectively evaluate cornea and anterior segment structures non-invasively and rapidly.

In this study, we aimed to compare the IOP, anterior segment parameters, and K values of patients with clinically unilateral PEX with other eyes without PEX and the control group.

Material and Method

This prospective study was carried out in the ophthalmology department of Hitit University Çorum Erol Olçok Training and Research Hospital. 54 clinically unilateral PEX patients and 40 healthy control participants were included in the study. The study was carried out in accordance with the Declaration of Helsinki and with the approval of the ethics committee of Hitit University (2020-327). The written consent form was obtained from the participants.

Patients who had bilateral PEX findings, previous intra and/or extraocular surgery or a history of trauma, glaucoma, active blepharitis or conjunctivitis, using contact lenses, corneal pathologies, using topical or systemic drugs that affect the anterior segment, refractive errors greater than ±3 diopters (D), and with systemic disease (cardiovascular, pulmonary disease, diabetes mellitus except hypertension) were excluded from the study.

After dilating the pupil with topical 1% cyclopentolate and 1% tropicamide, patients with unilateral PEX findings in the anterior lens capsule and/or pupillary edge but without glaucomatous changes were included in the study. The fellow eyes of the same patients without PEX findings in the lens, pupillary margin and angle were considered clinically normal. In addition, participants who did not have PEX findings in both eyes in the post-dilatation examination constituted the control group. At least 2 days later, IOP and corneal topography measurements were made at the same room conditions (between 10-12 am) of the participants. Right eye measurements of the control group were used in the study.

The best corrected visual acuities of all participants were evaluated with snellen charts. Slit-lamp biomicroscopy was performed and IOP was measured with Goldmann applanation tonometry. Detailed fundus examination was performed with a 90 D lens. Trabecular angle was evaluated using the Goldmann tri-mirror for gonioscopy. Participants without glaucomatous cups and normal visual field analysis (Humphrey Automated Perimeter; Humphrey Instruments, San Leandro, CA, USA) were included in the study. All examinations and measurements were performed by the same ophthalmologist under dim light conditions and without pupil dilation (TS).

Anterior segment parameters were evaluated with Scheimpflug-based corneal topography (Sirius; Costruzione Strumenti Oftalmici, Florence, Italy). The Sirius system is a system that uses a scheimpflug camera and a placido disc to evaluate the anterior segment non-contactly. Participants were asked to blink 3 times in a comfortable sitting position after placing their chin and forehead on the device's extraction point. Corneal topography images were taken immediately after blinking. Images with at least 90% acquisition quality were recorded. In our study, IOP, CCT, ACD, ACV, ICA, and K flat (K1), K steep (K2), K mean (Km) values were used. The PEX and non-PEX eyes of the patients in the PEX group were compared and the right eye measurements of the control group without PEX findings in both eyes were compared.

Statistical Analysis

In this study, statistical analyzes were done using SPSS (Version 22.0, SPSS Inc., Chicago, IL, USA) package program. It was tested whether the data were normally distributed with the Kolmogorov-Smirnov test. Data were shown as mean±standard deviation (mean±sd). Normally distributed data were evaluated with the Independent Samples T test between groups, and those that did not show normal distribution were evaluated with the Mann Withney U test. Statistical significance level was accepted as $p<0.05$.

Results

Of the 54 clinically unilateral PEX patients included in the study, 51.9% (n= 28) were female and 48.1% (n= 26) were male. In the 40 healthy control group, 48.3% (n= 19) were male and 51.7% (n= 21) were female. There was no significant difference between the groups in terms of gender. The distribution of the PEX eyes included 36 right eyes (66.6%), and 18 (33.3%) left eyes. Right eye measurements of the control group were included in the study. The mean age of PEX patients was 67.9 (range, 47-79) years, and the mean

age of the control group was 58.9 (range, 52-74) yaers. There was a significant difference between the two groups in terms of age values (*p<0.01*).

The comparison of the IOP, CCT, ACD, ICA, ACV, K1, K2, and Km values of the PEX eye of the patients with PEX and the other healthy eye is shown in Table 1. The mean IOP was 2.9 mmHg higher in eyes with PEX (*p<0.02*).

Table I. Comparison of clinically unilateral PEX patient with PEX and normal fellow eye

	PEX (n= 54)	Fellow Eye (n= 54)	P
AGE	67.9± 9.2 (47- 79)		
GENDER (M/F)	26/ 28		
IOP	18.1±4.1	15.2±3.2	***0.02***[a]
CCT	539.8±36.4	543.0±34.5	*0.75*[b]
ACD	2.56±0.4	2.59±0.4	*0.70*[b]
ICA	39.9±8.6	43.3±10.2	*0.19*[b]
ACV	118.2±29.3	107.3±26.2	*0.16*[b]
K1	43.59±1.5	43.59±1.5	*0.96*[b]
K2	45.23±1.6	45.31±1.8	*0.87*[b]
Km	44.40±1.5	44.45±1.5	*0.91*[b]

IOP: Intraocular pressure, CCT: Central corneal thickness, ACD: Anterior chamber depth, ICA: Iridocorneal angle, ACV: Anterior chamber volüme, K1: Flat keratometry, K2: Steep keratometry, Km: Mean keratometry, [a]: Wilcoxon test, [b]: Dependent Samples T-test, bold: *p<0.05*

The comparison of IOP, CCT, ACD, ICA, ACV, K1, K2, and Km values of eyes with PEX and control group eyes is shown in Table 2. There was no significant difference between the measurements (*p>0.05*). The comparison of IOP, CCT, ACD, ICA, ACV, K1, K2, and Km values of the other eyes of the patients with PEX and the eyes of the control group is shown in Table 3. There was a statistically significant difference in ICA and ACV measurements between fellow eyes and control groups (*p=0.01, p=0.03*. respectively). The distribution of IOP values of these three groups is shown in Figure 1.

In the correlation analysis, there was a negative correlation between IOP and ACD (*r=-0.22, p=0.04*), a positive correlation between ACD and ACV (*r=0.81, p<0.01*), and positive correlation between ACD and ICA (*r=0.63, p<0.01*). There was also a positive correlation between ACV and ICA (*r=0.55, p<0.01*).

Table II. Comparison of PEX eye and control group measurements

	PEX (n= 54)	Control (n= 40)	*P*
AGE	67.9±9.2 (47- 79)	58.9±5.7 (52- 74)	***<0.01***
GENDER (M/F)	26/ 28	19/ 21	*1.00*[*]
IOP	18.1±4.1	17.0±3.0	*0.59*[a]
CCT	539.8±36.4	528.5±30.4	*0.21*[b]
ACD	2.56±0.4	2.65±0.3	*0.33*[b]
ICA	39.9±8.6	36.9±5.4	*0.14*[b]
ACV	118.2±29.3	121.7±20.4	*0.61*[b]
K1	43.59±1.5	43.78±1.8	*0.75*[b]
K2	45.23±1.6	45.54±1.9	*0.09*[b]
Km	44.40±1.5	44.16±1.8	*0.45*[b]

IOP: Intraocular pressure, CCT: Central corneal thickness, ACD: Anterior chamber depth, ICA: Iridocorneal angle, ACV: Anterior chamber volüme, K1: Flat keratometry, K2: Steep keratometry, Km: Mean keratometry, a: Mann-Whitney U test, b: Independent Samples T-test, *: Fisher's exact test, bold: *p<0.05*.

Figure I. Comparison of IOP values of PEX eye, fellow eye and control group

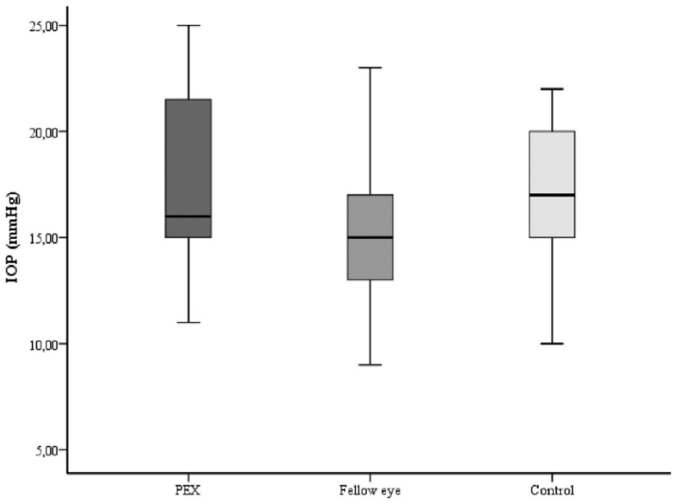

Table III. Comparison of fellow eye and control group measurements

	Fellow Eye (n= 54)	Control (n= 40)	*P*
AGE	67.9±9.2 (47- 79)	58.9±5.7 (52- 74)	***<0.01***
GENDER (M/F)	26/ 28	19/ 21	*1.00*[*]
IOP	15.2±3.2	17.0±3.0	*0.43*[b]
CCT	543.0±34.5	528.5±30.4	*0.10*[b]
ACD	2.59±0.4	2.65±0.3	*0.59*[b]
ICA	43.3±10.2	36.9±5.4	*0.01b*[*]
ACV	107.3±26.2	121.7±20.4	*0.03b*[*]
K1	43.59±1.5	43.78±1.8	*0.79*[b]
K2	45.31±1.8	45.54±1.9	*0.08*[b]
Km	44.45±1.5	44.16±1.8	*0.39*[b]

IOP: Intraocular pressure, CCT: Central corneal thickness, ACD: Anterior chamber depth, ICA: Iridocorneal angle, ACV: Anterior chamber volüme, K1: Flat keratometry, K2: Steep keratometry, Km: Mean keratometry, [b]: Independent Samples T-test, *: Fisher's exact test, *p<0.05*.

Discussion

PEX is a systemic disease in which fibrillar material is deposited, especially in the ocular anterior segment structures. PEX is one of the common causes of unilateral glaucoma. Poor response to medical treatment and rapid progression of optic nerve damage are the features that distinguish PEX from other types of glaucoma (5). In our study, we compared the patients with clinically detectable PEX with the other eyes without PEX findings and the control group. The mean IOP was higher in eyes with PEX than in the fellow eyes and control group. In terms of other parameters, there was no significant difference between eyes with PEX, fellow eye, and control groups.

In the Vesti and kivela studies, they found IOP approximately 2 mmHg higher in the eye with PEX than in the other eye without PEX (13). In the "Reykjavik Eye Study", the IOP value was found to be significantly higher in the PEX group than in their normal eyes (14). Gaile et al. evaluated 29 patients with at least one-sided PEX and 42 patients with non-PEX cataract before surgery, and they found higher IOP in the PEX group (15). In our study, IOP was on average 2.9 mmHg higher in

eyes with PEX than in fellow eyes. In addition, the IOP of eyes with PEX was on average 1.1 mmHg higher than the control group.

Consideration of CCT is important for correct assessment of IOP. However, studies on CCT in patients with PEX are inconsistent in the literature. While there are studies showing that it is thinner in the PEX group (16-18), there are also studies showing that it is thicker (19-21). There are also studies showing that CCT does not change (20,22,23). They attributed the reason for these different results to the measurement method, ethnic differences, and the difference in the number of participants. In our study, although the CCT of the PEX group was thicker than the control group, there was no significant difference.

There are also different results in studies on anterior chamber parameters and K values. Ozcura et al. in their study with 48 (PEX and PEXG) and 48 control group patients, no difference was found between the groups in terms of anterior chamber parameters and keratometry values (18). Bartholomew et al., found no difference between PEX and normal groups in terms of ACD (24). The 'Reykjavik Eye Study' showed that PEX was unrelated to CCT, and aqueous depth (AD) (21).

In contrast to these studies, You et al. showed that PEX was associated with age and narrow AC (25). Doğanay et al., while they found that the ACD was narrower in the PEXG group, they did not find a significant difference between the PEX and control groups (17). Mohammedi et al. found a narrower ACD in the PEX group (26). They used anterior segment optical coherence tomography. Damji et al. in their study with A scan biometry, showed that those with PEX had narrower AC than those with POAG (27). Omura et al. found higher IOP, narrow ACV, and decreased endothelial number in the PEX group, but they did not find any difference between the groups in terms of CCT and AD (28). The narrower ACD in patients with PEX has been attributed to the anterior shift of the lens due to weakening of the lens zonules (27,29,30). In our study, when comparing ACD, ICA, ACV, and K values, there were no significant differences between eyes with PEX and fellow eyes or eyes with PEX and control groups.

There are also limitations of our study. First, there was a significant age difference between the PEX group and the control group. Secondly, the number of participants was relatively small. Third, the patient group with PEXG was not included in the study. In addition, since Turkish people were included in the study, different results may occur in other racial and ethnic groups.

Conclusion

PEX is a disease that affects both eyes, although it starts unilaterally. The high IOP (compared to the fellow eye and control group) even before the development of glaucoma findings in the early-onset eye indicates that these patients should be followed closely. If PEX patients are diagnosed and followed early, glaucoma damage and blindness can be prevented. Especially in cataract surgery, it should be kept in mind that the anterior chamber of patients with PEX are narrower and their zonules may be weaker. Further studies with larger populations are needed to understand the effects of PEX on the anterior segment.

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