The Effects of Trabeculectomy on Anterior Segment Parameters Measured by Optical Biometry in Primary Open-angle Glaucoma and Pseudoexfoliation Glaucoma

Primer Açık Açılı Glokom ve Psödoeksfoliatif Glokomda Trabekülektominin, Optik Biyometri ile Ölçülen Ön Segment Değerleri Üzerine Olan Etkileri

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ABSTRACT

Purpose: To compare the effect of trabeculectomy on anterior segment parameters measured by optical biometry in cases with primary open-angle glaucoma (POAG) and pseudoexfoliation glaucoma (PXG).

Material and Methods: Nineteen eyes of 19 cases with POAG and 20 eyes of 20 cases with PXG were included to this prospective parallel-group trial. All the cases had uncomplicated trabeculectomy. Central corneal thickness (CCT), anterior chamber depth (ACD), lens thickness (LT) and axial length (AL) measurements were done by optical biometer before the surgery and at the 1st and 3rd post-operative months. The postoperative differences were compared statistically by t test, Kolmogorov- Smirnov test and chi-square tests.

Results: In POAG, intraocular pressure (IOP) and ACD decreased ($p<0.001$, $p<0.001$) at the 1st and 3rd months significantly. LT increased significantly ($p=0.04$, $p=0.001$), but there were no significant changes in CCT and AL. In PXG, IOP decreased ($p<0.001$, $p<0.001$) and ACD decreased ($p<0.001$, $p=0.003$) at the 1st and 3rd months significantly. CCT increased at the 1st month ($p=0.025$), LT increased at the 1st and 3rd months ($p=0.023$, $p=0.009$) significantly. There were no significant changes in AL at the 1st and 3rd months and CCT at the 3rd month. There were no significant differences in the postoperative changes between the two groups. Significant but minimal myopic shifts in spherical equivalent values were observed postoperatively in both groups.

Conclusion: Trabeculectomy cause some differences in anterior segment parameters in both POAG and PXG cases and the differences between these changes in both groups were found to be insignificant.

Key words: Primary open-angle glaucoma, pseudoexfoliation glaucoma, trabeculectomy, optical biometry, anterior segment.

ÖZ

Amaç: Trabekülektominin, primer açık açılı glokom (PAAG) ve psödoeksfoliatif glokom (PEG) olgularında, optik biyometri ile ölçülen ön segment parametreleri üzerine olan etkilerinin kıyaslanması amaçlandı.

Gereç ve yöntem: PAAG'lu 19 hastanın 19 gözü ve PEG'lu 20 hastanın 20 gözü ileriye dönük paralel grup çalışmamıza dahil edildi. Tüm olgular komplikasyonsuz trabekülektomi cerrahisi geçirdi. Merkezi korneal kalınlık (MKK), ön kamara derinliği (ÖKD), lens kalınlığı (LK) ve aksiyel uzunluk (AU) ölçümleri, cerrahi öncesinde ve cerrahi sonrası 1.ay ve 3. ayda optik biyometri ile gerçekleştirildi. Cerrahi öncesi ve sonrası değerler t test, Kolmogorov- Smirnov test ve ki-kare testleri ile istatistiksel olarak analiz edildi.

Bulgular: PAAG grubunda göz içi basıncı (GİB) ve ÖKD cerrahi sonrası 1 ve 3. ayda anlamlı ölçüde düşük ($p<0.001$, $p<0.001$), LK ise anlamlı ölçüde yüksek bulunurken ($p=0.04$, $p=0.001$), MKK ve AU değerlerinde fark izlenmedi. PEG grubunda cerrahi sonrası 1 ve 3. ayda, GİB ($p<0.001$, $p<0.001$) ve ÖKD ($p<0.001$, $p=0.003$) anlamlı ölçüde düşük bulundu. MKK 1. ayda ($p=0.025$), LK ise 1

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ve 3. ayda (p=0.023, p=0.009) anlamlı ölçüde yüksek bulundu. AU değerlerinde ise 1 ve 3. ayda, MKK değerinde ise 3. ayda anlamlı farklara rastlanmadı. MKK, AU, ÖKD ve LK parametrelerin cerrahi sonrası değişimleri PAAG ve PEG'lu gözlerde kıyaslandığında ise gruplar arasında anlamlı farklar gözlenmedi. Her iki grupta da cerrahi sonrasında, sferik ekuvalan değerlerinde anlamlı ölçüde hafifi bir miyopik kayma gözlendi.

Sonuç: Trabekülektomi sonrası ön segment parametrelerinde, PAAG ve PEG olgularında anlamlı değişikliklere sebep olabilirken, bu değişimler açısından her iki grup arasında anlamlı farklara rastlanmadı.

Anahtar kelimeler: Primer açık açılı glokom, psödoeksfoliasyon glokomu, trabekülektomi, optik biyometri, ön segment.

INTRODUCTION

Trabeculectomy is still the gold standard of glaucoma surgery in spite of its serious complications like hypotonous maculopathy, choroidal effusion, cataract formation and long-term bleb-related infections.[1-5] As a result of intraocular pressure (IOP) decrease by bleb formation; it causes some changes in anterior segment morphology postoperatively.[6-12]

Noncontact biometers those work by low-coherence reflectometry method can provide some anterior segment measurements like central corneal thickness (CCT), anterior chamber depth (ACD), lens thickness (LT) and axial length (AL) by using diode laser.[13-14]

Pseudoexfoliation glaucoma (PXG) is one of the most common types of glaucoma. It is more progressive than primary open-angle glaucoma (POAG) and is more resistant to treatment. [15] The cases with PXG have higher IOP values and fluctuations than POAG cases. [16] Also the presence of pseudoexfoliation may cause some anatomical changes like zonular laxity and decrease in ACD.[17] Trabeculectomy may cause some anterior chamber alterations different than POAG. In our study, our aim was to compare the effect of initial trabeculectomy on anterior segment parameters measured by optical biometry in cases with POAG and PXG.

PATIENTS AND METHODS

We prospectively evaluated 19 cases with POAG and 20 cases with PXG who had uncomplicated trabeculectomy surgery with 5-fluorouracil (5-FU) at Ankara Ulucanlar Eye Research Hospital between September 2013 and September 2014. All of the study procedures were conducted in accordance with the Declaration of Helsinki, and informed consents were taken from all of the participants. This study was approved by The Ethical Committee of Numune Training and Research Hospital. All patients were Turkish Caucasians.

The patients had a detailed ophthalmologic examination including best-corrected visual acuities with Snellen charts, anterior and posterior segment examinations, IOP measurements with Goldmann applanation tonometer, CCT measurements by ultrasonic pachymeter, visual field examinations with Humphrey automated perimeter and retinal nerve fiber layer investigation by spectral-domain optic coherence tomography (OCT). The presence of glaucomatous visual field defects like nasal step, seidel or arcuate scotoma with an IOP≥22 mmHg, grade 3-4 open angle according to Shaffer angle grading system and optic nerve head changes like cup to disc ratio ≥0.3, localized neuro-retinal rim defects, peripapillary choroidal atrophy or splitter hemorrhage revealed POAG. The presence of pseudoexfoliation material on the surface of the lens and/or pupillary margin following pupillary dilation revealed PXG Cases ≥40-year-old with POAG or PXG with open angle in whom glaucoma wasn't under control with medical antiglaucomatous agents and those need glaucoma surgery were included in the study. We excluded the cases who were younger than 40 years of age, who had narrow-angle (< grade 2 according to Shaffer grading system), who had other types of glaucoma other than POAG and PXG and who had a history of any ocular trauma, surgery, uveitis or who had early trabeculectomy complications like flat anterior chamber, hyphema, hypotony (<5mm Hg) or hypertony (>21mm Hg) and inflammation. Also we excluded the eyes with spherical equivalent (SE) values > ±1.5 diopter (D).

In addition to complete ophthalmological examination, CCT, ACD, LT and AL measurements of their eyes were obtained by optical biometer (Haag-Streit LenStar® LS 900 Optical Biometer Switzerland) before the surgery and at the first and third postoperative months by the same experienced physician (AT).

Surgical technique: All surgeries were performed by the same experienced surgeon (UE) after subtenon anesthesia (with lidocaine hydrochloride 20 mg/ml). A fornix-based conjunctival flap was prepared superiorly. After the dissection of the conjunctiva and Tenon's capsule, thin cellulose sponge (approximately 5x10 mm) soaked with 5-FU with a concentration of 50 mg/ml, was placed between the conjunctival Tenon's capsule flap and the sclera for 5 minutes without any contact with limbus and cornea. During this procedure the cornea was covered with methylcellulose. After the irrigation of 5-FU with sterile BSS solution, one-half thickness approximately 4x4 mm square scleral flap was dissected. Then a trabeculectomy (approximately 2x2 mm), and a peripheral iridectomy was performed. No viscoelastic material was injected into the anterior chamber during the procedure. The scleral flap was sutured with 10-0 nylon sutures at its corners. The conjunctiva and Tenon's capsule were closed in a continuous layer of 8-0 polyglactin suture anchored at the limbus. Topical moxifloxacin hydrochloride (Vigamox® 0.5% Ophthalmic Solution Alcon) 4x1 (1

month), prednisolone acetate (Predforte ® %1 Ophthalmic Solution Allergan) 4x1 (2months) and cyclopentolate 2x1 (2weeks) were used postoperatively.

Statistical Analysis The pre and postoperative values and the differences between POAG and PXG were compared statistically by t test, Kolmogorov- Smirnov test and chi-square test.

RESULTS

The mean age of 10 female and 9 male totally 19 cases of POAG was 64.8±5.1 (53-72years) and the mean age of 10 female and 10 male totally 20 cases of PXG was 69.4±3.5 (63-75years). The difference between the sex of the groups was not significant (p=0.87) but PXG cases were significantly older than POAG cases (p=0.031) (Table 1).

The preoperative IOP under maximum topical medical glaucoma treatment, CCT, AL, LT and ACD are summarized in table 2. The differences of preoperative values of IOP and the other parameters between the POAG and PXG groups weren't significant (Table 2).

The preoperative and postoperative IOP, CCT and other anterior segment parameters and their postoperative changes are summarized in table 3. In POAG group: The intraocular pressure (IOP) decreased significantly (p<0,001, p<0,001)

Table 1: *The demographic characteristics of the cases*

	POAG	PXG	P value
Age (mean±SD. range):	64.8±5.1 (53-72 years)	69.4±3.5 (63-75 years).	p=0.031
Sex (n.%):	10 female (52.6%) 9 male (47.4%)	10 female (50%) 10 male (50%)	p=0.87

PXG: Pseudoexfoliative glaucoma, POAG: Primary open angle glaucoma

Table 2: *The mean preoperative IOP, CCT, AL, LT and ACD values of the two groups*

	PXG group	POAG group	P value
IOP (mmHg)	29.9± 4.7	28.4± 4.1	p=0.28
CCT (µm)	519.7± 19.4	539.6± 29.2	p=0.16
AL (mm)	23.32± 0.54	23.19± 0.44	p=0.42
LT (mm)	4.26±0.32	4.27±0.38	p=0.92
ACD (mm)	3.21± 0.24	3.29± 0.22	p=0.85

PXG: Pseudoexfoliative glaucoma, POAG: Primary open angle glaucoma IOP: Intraocular pressure, CCT: Central corneal thickness
AL: Axial length, ACD: Anterior chamber depth LT: Lens thickness

Table 3: *The differences between the preoperative and postoperative 1st month IOP, CCT, AL, LT and ACD values of the two groups*

	PXG group	POAG group
IOP (mmHg)	Preop: 29.9±4.7 Postop. 1st month: 12.9±2.9 (p<0.001 *) Postop. 3rd month: 13.7±2.5 (p<0.001 *)	Preop: 28.4±4.1 Postop. 1st month: 12.3±2.9 (p<0.001 *) Postop. 3rd month: 12.5±2.1 (p<0.001 *)
CCT (µm)	Preop: 519.7±19.4 Postop. 1st month: 521.2±20.6 (p=0.025*) Postop. 3rd month: 518.8±20.8 (p=0.269)	Preop: 539.6±29.2 Postop. 1st month: 540.4±28.6 (p=0.279) Postop. 3rd month: 538.6±28.7 (p=0.309)
AL (mm)	Preop: 23.32±0.54 Postop. 1st month: 23.28±0.45 (p= 0.051) Postop. 3rd month: 23.28±0.44 (p=0.108)	Preop: 23.19±0.44 Postop. 1st month: 23.17±0.41(p= 0.334) 3rd month: 23.17±0.40 (p=0.187)
LT (mm)	Preop: 4.26±0.32 Postop. 1st month: 4.28±0.33 (p=0.023 *) Postop. 3rd month:4.29 ±0.32 (p=0.009 *)	Preop: 4.27±0.38 Postop. 1st month: 4.29±0.37 (p=0.04 *) Postop. 3rd month: 4.31±0.36 (p=0.001 *)
ACD (mm)	Preop: 3.21±0.24 Postop. 1st month: 3.20±0.18 (p<0.001 *) Postop. 3rd month: 3.23±0.15 (p=0.003 *)	Preop: 3.29±0.22 Postop. 1st month: 3.21±0.23 (p<0.001*) Postop. 3rd month: 3.25±0.22 (p=0.001 *)

PXG: Pseudoexfoliative glaucoma, POAG: Primary open angle glaucoma IOP: Intraocular pressure, CCT: Central corneal thickness, LT: Lens thickness
AL: Axial length, ACD: Anterior chamber depth *statistically significant Preop: Preoperative, postop: Postoperative

and the ACD decreased significantly (p<0.001, p=0,001) at the first and third postoperative month. LT increased significantly (p=0,04, p=0,001), but there were no significant changes between the preoperative and postoperative values of CCT and AL (1st month: p=0.279, p= 0.334, 3rd month: p=0.309, p=0.187 respectively). In PXG group: The IOP decreased significantly (p<0.001, p<0.001) and the ACD decreased significantly (p<0.001, p=0.003) at the first and third postoperative month. CCT increased significantly at the first postoperative month in PXG (p= 0,025). LT increased significantly postoperatively (p=0.023, p=0.009). But there were no significant changes between the preoperative and postoperative values of AL (p= 0.051, p=0.108) and preoperative and postoperative CCT at the 3rd month (p=0.269) (Table 3). None of the eyes needed anti-glaucomatous agent postoperatively. Postoperative massage was necessary in 7 eyes with POAG and in 12 eyes with PXG during the first postoperative month and it was performed by the same surgeon (UE) at these follow-up visits. The mean preoperative, postoperative first and third month SE values were 0.37±0.83 D, -0.31±0.95 D and -0.34±0.79 D in eyes with POAG respectively (p=0.042, p=0.039). The mean preoperative, postoperative first and third month SE values were 0.44±0.72 D, -0.21±0.85 D and -0.24±0.89 D in eyes with PXG respectively (p=0.037, p=0.036).

We also compared the postoperative changes in IOP, CCT, ACD, LT and AL in both groups. There were no significant differences between the changes of preoperative and postoperative IOP (1st month p=0.523, 3rd month p=0.825), CCT (1st month p=0.478, 3rd month p=0.936), ACD (1st month p=0.743, 3rd month p=0.433), LT (1st month p=0.908, 3rd month p=0.882) and AL (1st month p=0.417, 3rd month p=0.728) values between the two groups (Table 4).

DISCUSSION

A non-physiological route of humor aqueous related with the surgical procedure of trabeculectomy and postoperative decrease in IOP may cause some changes in anterior segment of the eye.[6-11] Here in our study we included the cases with POAG and PXG with phakic eyes and open angle who had initial trabeculectomy because of the inadequacy of medical treatment for the control of glaucoma. Our main goal was to compare the effect of trabeculectomy on IOP, CCT, AL, LT and ACD measured by optical biometry, a relatively new technology, in cases with POAG and PXG. Our secondary goal was to investigate the differences of these postoperative changes between the two groups.

According to the previous reports, AL is one of the most important parameter that was affected by glaucoma surgery. Francis et al. included 39 cases undergoing trabeculectomy and 22 cases undergoing Baerveldt tube shunt implantation in their study and investigated the IOP and AL changes within the 3 months postoperatively by optical biometry.[6] In both groups they observed small but significant decrease in AL and stated that this result was related with the amount of IOP reduction.[6] Different from Francis et als' study, Husain et al.[7] investigated the long-term changes in AL after trabeculectomy in 122 cases. They also observed AL decrease and stated that this change was persistent over a period of 5 years.[7] As postoperative AL decrease was thought to be related with the amount of IOP reduction[6], it should have been associated with hypotony. Matsumoto et al. [8] investigated the effect of AL reduction on the development of hypotony maculopathy in their study and found a relation between AL reduction and hypotony maculopathy. In our study, we also observed postoperative AL decreases in both groups but the differences weren't statistically significant. Different from the both studies, all of our of cases had open-angle glaucoma and none of them had any ocular surgeries before. The other two studies included primary angle closure glaucoma cases, pseudophakic and even aphakic eyes. We observed significant decreases in IOP in all of our cases but we excluded the cases with postoperative hypotony. This might be related with insignificant postoperative changes in AL in our study.

ACD is another parameter that may be affected by glaucoma surgery.[7,9-10] Husain et al.[7] investigated the long-term

Table 4: *The differences of the postoperative changes in IOP, CCT, AL, LT and ACD values between the two groups*

	P value
The difference between the changes in IOP:	Baseline- postop. 1st month: p=0.525 Baseline- postop. 3rd month: p=0.825
The difference between the changes in CCT:	Baseline- postop. 1st month: p=0.478 Baseline- postop. 3rd month: p=0.936
The difference between the changes in AL:	Baseline- postop. 1st month: p=0.743 Baseline- postop. 3rd month: p=0.433
The difference between the changes in LT:	Baseline- postop. 1st month: p=0.908 Baseline- postop. 3rd month: p=0.882
The difference between the changes in ACD:	Baseline- postop. 1st month: p=0.417 Baseline- postop. 3rd month: p=0.728

IOP: Intraocular pressure, CCT: Central corneal thickness AL: Axial length, ACD: Anterior chamber depth LT: Lens thickness postop: Postoperative

postoperative changes in ACD in their study. They observed persistent decrease in ACD over a period of 5 years. We also observed significant decreases in ACD at the 1st and 3rd postoperative months in both POAG and PXG cases. This might be related with both the non-physiological route of humor aqueous after surgery and a probable increase in LT. Rasooly et al.[11] investigated the changes in LT after trabeculectomy by using ultrasonography. They observed increases in LT and stated that this was related with the loss of osmotic homeostasis and an increase in lens hydration. Like Rasooly et al. we observed significant increases in LT in both postoperative 1st and 3rd months in both POAG and PXG cases. We observed minimal myopic shift postoperatively in both POAG and PXG cases and these might have been related with the increases in LT. Rodoplu et al. showed decreases in AL and ACD in early postoperative period after trabeculectomy and also investigated some changes in astigmatism related with these ACD and AL changes.[18]

We also examined the postoperative changes in CCT in our study. Within the postoperative few months, corneal endothelial cell loss can be seen after trabeculectomy especially with antifibrotic agents.[19] This may cause an increase in CCT. We only observed significant increase in CCT in only PXG cases at the first postoperative month and this fact can be explained by more prominent endothelial loss in PXG cases than POAG. We used 5-FU in our cases. But this effect is very rare with 5-FU than mitomycin C so we thought this increase at the first month might have been related with the inflammation.

We included POAG and PXG cases with open angles to our study and aimed to investigate these effects of surgery in these cases and find the differences between the POAG and PXG groups. There were no significant differences between the changes of preoperative and postoperative IOP and other parameters between POAG and PXG cases. We aimed to find the effects of the presence of pseudoexfoliation on these postoperative changes. Our hypothesis was that these surgically-induced changes should have been more prominent in PXG cases as PXG was a more severe glaucoma type than POAG. The presence of pseudoexfoliation material and probable zonular laxity were thought to induce more prominent changes in anterior segment parameters.

In conclusion trabeculectomy can decrease IOP significantly and cause changes in anterior segment parameters like shallowing in ACD, increase in LT in both POAG and PXG cases. To best of our knowledge there have been no reports so far that compare the effects of trabeculectomy on anterior segment morphology of the cases with PXG and POAG. The more prominent increase in ACD in PXG postopertively was thought to be related with zonular laxity in PXG. Further investigations with great number of cases and with different types of glaucoma and with other imaging systems like rotating Scheimpflug camera system or anterior segment OCT should be encouraged.

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