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Corneal Biomechanics in Patients with Glaucoma: The Effect of Pupillary Dilatation

Glokom Hastalarında Korneal Biyomekanikler: Pupilla Dilatasyonunun Etkisi

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Öz

Amaç: Primer açık açılı glokomlu (PAAG) gözlerde Oküler cevap analizörü kullanılarak pupilla dilatasyonunun göziçi basıncı ve kornea biyomekaniklerine etkisinin değerlendirilmesi
Hastalar ve Yöntem: PAAG'li 15 olgunun 28 gözünde %0,5 tropikamid uygulaması öncesi ve 30 dakika sonrasında Goldmann ile uyumlu göz içi basıncı (GİBg), korneanın biyomekanik özellikleri ile kompanse edilmiş GİB (GİBkk), kornea rezistans faktörü (KRF) ve kornea histerezisi (KH) değerlendirildi.
Bulgular: Olguların ortalama yaşı 57,7±13,2 (45-65 yıl) idi. Tropikamid uygulaması öncesi ortalama KH 9,5±2,2 mmHg, KRF 10,1±2,1 mmHg, GİBg 16,2±2,8 mmHg ve GİBkk 17,2±3,6 mmHg iken uygulama sonrası bu değerler sırasıyla 9,7±2,2 mmHg, 10,1±2 mmHg, 16,9±3,5 mmHg ve18,2±4 mmHg olarak tespit edildi. Tropikamid uygulaması öncesi ve sonrası GİBg ve GİBkk değerlerindeki fark istatistiksel olarak anlamlı iken (p=0,043, p=0,015, sırasıyla; paired t-test), KH ve KRF için istatistiksel olarak anlamlı fark tespit edilmedi (p=0,057 p=0,702, sırasıyla; paired t-test).
Sonuç: PAAG olgularında %0,5 tropikamid ile oluşturulan pupilla dilatasyonunun korneal biyomekanikler üzerine herhangi bir etkisi gözlenmezken GİB üzerine azaltıcı bir etkisi olduğu görülmektedir.

Anahtar Kelimeler: Korneal biyomekanikler, glokom, oküler cevap analizörü, tropikamid, pupilla dilatasyonu

Abstract

Aim: In this study, we aimed to evaluate the effect of pupillary dilatation on intraocular pressure values and corneal biomechanical properties using Ocular response analyzer in eyes with primer open angle glaucoma.
Patients and Methods: Goldmann correlated intraocular pressure, corneal corrected intraocular pressure, corneal hysteresis and corneal resistance factor were all respectively evaluated in 28 eyes of 15 patients with primary open angle glaucoma before and 30 minutes after tropicamide 0.5% instillation.
Results: Their mean age was 57.7±13.2 years (range 45–65 years). The mean corneal hysteresis, corneal resistance factor, Goldmann correlated intraocular pressure and corneal corrected intraocular pressure measurements of the eyes were 9.5±2.2 mmHg, 10.1±2.1 mmHg, 16.2±2.8 mmHg, 17.2±3.6 mmHg before tropicamide instillation, and 9.7±2.2 mmHg, 10.1±2.0 mmHg, 16.9±3.5 mmHg, 18.2±4.0 mmHg after tropicamide instillation, respectively. There was statistically significant difference between pre- and post-tropicamide instillation for Goldmann correlated intraocular pressure and corneal corrected intraocular pressure (p=0.043, p=0.015, respectively; paired t-test) while no statistically significant difference was found for corneal hysteresis and corneal resistance factor (p=0.057 p=0.702, respectively; paired t-test).
Conclusion: Pupillary dilatation with 0.5% tropicamide seems to have a decreasing effect on intraocular pressure while no effect was noted for corneal biomechanical properties in primer open angle glaucoma patients.

Key words: Corneal biomechanics, glaucoma, ocular response analyzer, tropicamide, pupillary dilation

INTRODUCTION

The in vivo measurement of the corneal resistance to deformation was enabled by the development of the ocular response analyzer (ORA; Reichert Ophthalmic Instruments, Depew, NY) by Luce (1). The ORA measures two corneal biomechanical parameters: corneal hysteresis (CH) and corneal resistance factor (CRF). CH is thought to predominantly reflect the viscous properties of the cornea, and CRF is an empirically determined parameter that reflects the overall resistance of the cornea (2). In addition to the biomechanical parameters of the cornea, the ORA also measures a corneal-compensated intraocular pressure (IOPcc) and a Goldmann-correlated IOP (IOPg). The IOPcc takes the corneal hysteresis into account so that, theoretically at least, it is independent of the viscoelastic parameters of the cornea. The IOPg is the average of both applanation pressures.

IOP measurement is influenced by the corneal rigidity, which can be different in individuals due to

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the corneal tissue structure. It has also been shown that the rate of glaucoma progression is faster in eyes with lower corneal hysteresis. Additionally, it has been reported that the corneal biomechanical properties might affect the risk for developing glaucomatous optic neuropathy (3). Multiple factors may affect corneal biomechanical properties which consequently influence IOP measurements. We have shown in one of our studies that pupillary dilatation may alter corneal biomechanical properties and IOP in healthy individuals (4,5).

Tropicamide is an acetylcholine receptor blocker drug, which has short acting cycloplegic and mydriatic effect. It is commonly used to achieve mydriasis for fundus examination in ophthalmology. It is available in 0.5% and 1% ophthalmic solutions. Its maximum effect is achieved in about 20–25 min and lasts about 20 min, with complete recovery being in 4 to 6 hours (6).

The objective of this study was to determine the potential effects of pupillary dilatation on the biomechanical parameters of the cornea generated by the ORA in patients treated for primary open angle glaucoma (POAG). To the best of our knowledge, the alterations in corneal biomechanical properties in POAG patients after pupillary dilatation have not been reported previously.

PATIENTS AND METHODS

This is an observational, cross-sectional study. The study population consisted of the patients with documented POAG who were followed at the Glaucoma Division, Necmettin Erbakan University Meram Faculty of Medicine Hospital. They were maintaining their target IOP with medical treatment. Informed consent was obtained from each patient at the beginning of the study. The study was approved by the local ethics committee and followed the tenets of the Declarations of Helsinki.

Subjects were excluded if they had a history of intraocular or refractive surgery, refractive errors, active ocular infection, diabetes, contact lens use, or any corneal pathology, including Fuchs' corneal dystrophy and keratoconus. The patients underwent a complete ophthalmological examination, including ORA measurements. Diagnosis of POAG required optic nerve morphology characteristic of glaucomatous optic neuropathy with corresponding, reproducible glaucomatous visual-field defects on standard automated perimetry (SAP: achromatic 24-2 Sita-Standard strategy, Humphrey visual Field Analyzer 750i, Humphrey Instruments, Dublin, CA).

All subjects were evaluated before and 30 min after instillation of one drop of 0.5% tropicamide with the ORA. The CH, CRF, mean IOPcc, and IOPg values were measured with a patented dynamic bidirectional applanation process. All ORA measurements were performed by the same experienced technician while the patient was sitting comfortably in a chair located in the selected room. Four good-quality symmetric, well-defined inward, and outward applanation spike-high measurements were obtained for each eye, and the mean values of each parameter were used for analysis.

In this study, all statistical analyses were performed with commercial software (SPSS for Windows, ver. 15.0; SPSS Inc., Chicago, IL). The values were presented as a mean with standard deviations (SD). A paired t-test was used to compare variables between the pre- and post-tropicamide conditions. The p value less than 0.05 was considered to be statistically significant.

RESULTS

Twenty-eight eyes of 15 subjects [8 male (53.33%), 7 female (46.67 %)] were analyzed. Their mean age was 57.7±13.2 years (range 45–65 years). The mean CH, CRF, IOPg and IOPcc measurements of the eyes were 9.5±2.2 mmHg, 10.1±2.1 mmHg, 16.2±2.8 mmHg, 17.2±3.6 mmHg before tropicamide instillation, and 9.7±2.2 mmHg, 10.1±2.0 mmHg, 16.9±3.5 mmHg, 18.2±4.0 mmHg after tropicamide instillation, respectively. There was a statistically significant difference between pre- and post-tropicamide instillation for IOPg and IOPcc (p=0.043, p=0.015, respectively; paired t-test) while no statistically significant difference for the CH and CRF was obtained (p=0.057 p=0.702, respectively; paired t-test). The results are summarized in Table 1.

DISCUSSION

Corneal biomechanical properties are important in many ocular diseases and their evaluation can provide knowledge to pathologic changes of the cornea. It has been shown that CH is affected with some ocular diseases such as glaucoma, keratoconus, Fuchs' dystrophy, and post-LASIK patients (7-10). However, the influence of pupillary dilatation on corneal biomechanical properties in glaucomatous eyes is not very well understood. In this observational, cross-sectional study we evaluated the influences of pupillary dilatation on corneal biomechanics and IOP

Table 1. The measured values of CH, IOPcc, CRF and IOPg in the pre and post-tropicamide.

	Pre-tropicamide	Post-tropicamide	p Value*
CH (mmHg)	9.5±2.2	9.7±2.2	0.057
CRF (mmHg)	10.1±2.1	10.1±2.0	0.702
IOPg (mmHg)	16.9±3.5	16.2±2.8	0.043
IOPcc (mmHg)	18.2±4.0	17.2±3.6	0.015

CH, corneal hysteresis; CRF, corneal resistance factor; IOPcc, corneal compensated intraocular pressure; IOPg, Goldmann applanation compensated intraocular pressure.
*Paired t-test.

in 28 glaucomatous eyes.

In our study, we have shown a decrease in IOP values in contrast to the results of the studies by Kim JM et al. (11) and Mocan MC et al. (12) that reported an increase in IOP after pupillary dilatation with tropicamide eye drops. Shaw and Lewis (13) found that significant pressure elevation occurred in 32% of open angle glaucoma patients following dilatation with 2.5% phenylephrine and 1% tropicamide. Siam GA et al. (14) reported that the change in IOP after dilatation ranged from -8 to +10 mmHg. The mechanism responsible for IOP fluctuation after pupillary dilatation is unclear. The most important and commonly accepted mechanism that induce IOP elevations in glaucomatous eyes are iris pigment liberation into the anterior chamber and subsequent obstruction of the trabecular meshwork. Another mechanism that has been described is decreased contractility of ciliary muscle on the trabecular meshwork leading to decreased aqueous outflow (12). However, these suggested hypotheses do not seem to fully explain the mechanism of increase in IOP after pupillary dilatation.

In our study, the mean IOP values increased in nine patients after pupillary dilatation (32.1%). This can be explained by the mechanisms described above. However, in the majority of our patients we detected a decrease in the IOP value. Furthermore, results of this study is parallel with our previous findings (5). Temporary imbalance of aqueous flow may have an effect on these patients. Also, pupillary dilation can cause a greater anterior chamber depth and a wider contact region between the trabecular meshwork and the humor aqueous. For this reason IOP may not increase after pupillary dilation. It may be advised that, during the evaluation of IOP of patients with POAG, the ORA measurements be taken before tropicamide instillation.

Some previous studies have demonstrated that CH is significantly lower in glaucomatous patients than in healthy subjects (15,16). Another study has also concluded that reduced CH could be an important marker of increased susceptibility of the optic nerve to glaucomatous damage (17). Therefore, low CH levels likely increase the risk for developing glaucomatous optic neuropathy.

While the CH values are important in evaluating glaucoma patients, the possible effect of pupillary dilatation on values of CH would be important for us. However our results revealed that the corneal biomechanical properties are not significantly altered by the administration of tropicamide.

Our study has been conducted based on instillation of one drop of tropicamide and measuring its effect on ORA measurements. For pupillary dilation, 2-3 drops of tropicamide 10-15 minutes apart is used in most instances. Therefore, more frequent instillation of tropicamide may reveal different results and should be further studied.

One limitation of our study is the sample size which may not have been large enough to reflect the real magnitude of CH changes following pupillary dilatation.

In conclusion, the results of our study suggest that eyes with POAG may have decreased IOP after pupillary dilatation. The effects of pupillary dilatation on IOP measurements should be taken into account during the examination of patients with POAG.

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