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Original Article / *Özgün Araştırma*

Effects of Cataract Surgery on Intraocular Pressure in Patients with and without Glaucoma

Glokomlu ya da Glokomu Olmayan Olgularda Katarakt Cerrahisinin Göz İçi Basıncına Etkisi

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Summary

Purpose: To evaluate the effects of phacoemulsification surgery with primary intraocular lens (IOL) implantation on intraocular pressure (IOP) in various types of glaucoma patients with visually significant cataract and to compare these results with cataract patients without glaucoma.

Material and Method: This retrospective study included consecutive cases of 21 primary open-angle glaucoma patients, 13 primary angle-closure glaucoma (PACG) patients, 11 pseudoexfoliation glaucoma patients, and 21 control eyes without any type of glaucoma; all patients had co-existing cataract. Visual acuities, IOP, number of glaucoma medications used, anterior chamber depth (ACD), and gonioscopic evaluations were noted both pre- and postoperatively. Phacoemulsification and IOL implantations were performed via clear corneal incisions in the whole study group. Study group was followed-up for six months.

Results: Postoperative visits at the 1st, 3rd, and 6th months were noted. After surgery, visual acuities improved significantly ($p=0.001$) in all groups. Intraocular pressures decreased in all groups postoperatively, but the change was statistically significant in the PACG group ($p=0.013$). Increase in ACD was significant in PACG group ($p=0.001$). Widening of iridocorneal angle and decrease in the number of antiglaucoma drugs were observed in all groups, but these were significant in the PACG group ($p=0.001$ and $p<0.05$, respectively).

Discussion: In glaucoma patients with co-existing cataract, phacoemulsification surgery allows both the visual rehabilitation and IOP control. This IOP lowering effect is seen most markedly in the PACG group. *(Turk J Ophthalmol 2013; 43: 167-72)*

Key Words: Anterior chamber depth (ACD), intraocular pressure (IOP), phacoemulsification, primary angle-closure glaucoma (PACG), primary open-angle glaucoma (POAG), pseudoexfoliation glaucoma (PEG)

Özet

Amaç: Çeşitli glokom tiplerinde, eşlik eden görmeyi anlamlı ölçüde azaltan katarakt varlığında, fakoemülsifikasyon cerrahisi ve intraoküler lens (İOL) implantasyonunun göz içi basıncına (GİB) olan etkisinin değerlendirilmesi ve bu sonuçların glokomu olmayan katarakt hastaları ile karşılaştırılması.

Gereç ve Yöntem: Bu retrospektif çalışma, eşlik eden kataraktı bulunan ardışık 21 primer açık açılı glokom, 13 primer açı kapanması glokomu (PAKG), 11 psödoeksfoliatif glokom ve 21 glokomu olmayan kontrol katarakt hastasını içermektedir. Cerrahi öncesi ve sonrasında; görme keskinlikleri, GİB, kullanılan glokom ilaçlarının sayısı, ön kamara derinliği (ÖKD), ve gonioskopik değerlendirmeler kaydedilmiştir. Tüm çalışma grubunda, fakoemülsifikasyon ve İOL implantasyonu, korneal kesiden girilerek uygulanmıştır. Çalışma grubu altı ay takip edilmiştir.

Sonuçlar: Cerrahi sonrası 1., 3. ve 6. aylarda hasta kontrolleri yapılmıştır. Cerrahi sonrasında; tüm gruplarda görme keskinlikleri anlamlı ölçüde artmıştır ($p=0,001$). Tüm gruplarda cerrahi sonrası GİB azalmıştır, ancak bu değişim, PAKG grubunda istatistiksel olarak anlamlıdır ($p=0,013$). Ön kamara derinliği artışı da yine PAKG grubunda anlamlı bulunmuştur ($p=0,001$). Tüm gruplarda iridokorneal açı genişlemesi ve antiglokomatöz ilaç sayısında azalma görülmüştür ama bu değişimler yalnızca PAKG grubunda anlamlı bulunmuştur (sırasıyla $p=0,001$ ve $p<0,05$)

Tartışma: Eşlik eden kataraktı bulunan glokom hastalarında, fakoemülsifikasyon cerrahisi, hem görme rehabilitasyonunu hem de GİB kontrolünü sağlamaktadır. Bu GİB azaltıcı etki, en belirgin olarak PAKG grubunda görülmektedir. *(Turk J Ophthalmol 2013; 43: 167-72)*

Anahtar Kelimeler: Göz içi basıncı (GİB), fakoemülsifikasyon, ön kamara derinliği (ÖKD), primer açık açılı glokom (PAAG), primer açı kapanması glokomu (PAKG), psödoeksfoliasyon glokomu (PEG

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Inroduction

The concurrent existence of cataract and glaucoma is a common finding in the aging population and this trend is likely to increase worldwide as the population ages. Cataract surgery is the most commonly performed ophthalmic surgical procedure of any kind. Modern phacoemulsification techniques give us the ability to rehabilitate patients with vision loss secondary to cataract. In addition to the effects of cataract extraction on postoperative visual and refractive outcomes, it has been widely reported that modern cataract extraction results in a long-term reduction in intraocular pressure (IOP).[1-5] This situation is especially important in patients with glaucomatous comorbidities.

Numerous studies have reported that cataract surgery in nonglaucomatous patients may transiently reduce IOP levels which may last for up to five years.[3,6,7] Several theories have been hypothesized to explain these findings, mostly involving anatomical (widening of the anterior chamber and angle) or biochemical alterations induced by the surgical intervention such as decreased aqueous secretion and increased prostaglandin F2 (PGF2) secretion.[8-10]

A series of retrospective and prospective analyses over the last decade have consistently demonstrated reductions in IOP after cataract extraction in patients with varying glaucoma diagnoses, as well. Several studies have found that IOP is reduced, on average, in primary open-angle glaucoma (POAG) patients after cataract surgery;[3-5,11,12] and greater IOP reduction after phacoemulsification has been reported in eyes with pseudoexfoliation.[13-15] Recently, lens removal has been popularized as a first-line treatment for primary angle-closure glaucoma (PACG) as they have thicker lenses and shallower anterior chambers.[16-19] These analyses have demonstrated large variability in the magnitude of IOP reduction apparently related, at least in part, to preoperative angle anatomy.

The purpose of this retrospective study was to evaluate the effects of phacoemulsification surgery with primary intraocular lens (IOL) implantation on IOP in various types of glaucoma patients with visually significant cataract. Intraocular pressures were mostly within the target range with well-tolerated medications in our patient group, with some angle-closure attacks in PACG group. We compared the results of cataract surgeries in glaucoma patients with the results of phacoemulsification surgeries in cataract patients without glaucoma.

Material and Method

This retrospective study included consecutive cases of 21 POAG patients, 13 PACG patients, 11 pseudoexfoliation glaucoma (PEG) patients, and 21 control eyes without any type of glaucoma; all patients had co-existing visually significant cataract. Data were collected by searching patient file records retrospectively, and the patients and the controls included in the study were chosen from the ones scheduled for cataract surgeries between June 2009 and October 2010. Glaucoma cases were being followed up at Glaucoma Section, and control cases were chosen from Cataract Section of Ophthalmology Department. The IOPs of the glaucoma patients were within the target range with well-tolerated medications except for PACG patients with some angle-closure attacks. Visually significant cataract was defined as a cataract of sufficient maturity to lead to a visual acuity of 0.3 or worse (according to Snellen chart), and that the patient's activity of daily living was adversely affected by the poor visual acuity.

Cases having previous intraocular surgery and diseases other than cataract and glaucoma were excluded from the study. No eye had laser trabeculoplasty before cataract surgery. In the PACG group, all eyes had Nd YAG laser iridotomies preoperatively. Cases having any intraocular complications during cataract surgeries were excluded from the study as well.

Complete eye examinations including uncorrected and best-corrected visual acuities (UCVA and BCVA), IOPs, number of glaucoma medications used, anterior chamber depth (ACD), and gonioscopic evaluations were noted both pre- and postoperatively. The UCVA and BCVA were measured according to Snellen chart and then converted into logMAR equivalent. The IOPs were measured with Goldmann applanation tonometer. Postoperative IOP at 1st day, 1st week, 1st month, 3rd months, 6th months, and 1st year (if available) were recorded. Anterior chamber depth and ocular biometry were measured with A-scan ultrasonography (Quantel Medical Echograph, B-scan Vplus/biovision). Gonioscopic examinations and iridocorneal angle (ICA) evaluations were made by using Goldmann 3-mirror lens in a room with a standard dim illumination, and ICA was graded from 1 to 4 according to the Shaffer classification system. All measurements were performed by the same investigator (A.Y.).

Surgical technique: A single surgeon (A.Y.) performed all operations. Under topical anaesthesia (proparacaine hydrochloride 0.5% and lidocaine hydrochloride 0.2%), phacoemulsification and in-the-bag foldable IOL implantation were performed through 2.75 mm superior clear corneal incision. All patients had supplemental anaesthesia with intracameral lidocaine 1% preservative-free. A continuous curvilinear capsulorrhexis was completed after a dispersive viscoelastic injection (Viscoat, 4% chondroitin sulfate-3% sodium hyaluronate; Alcon Laboratories), and hydrodissection was performed using sterile intraocular irrigating solution (BSS plus, Alcon Laboratories). After removing the nucleus with using either a divide-and-conquer or a chop technique (Dorc phacovitrectomy device), irrigation and aspiration of soft lens material were performed. After inflating the capsular bag with a cohesive viscoelastic (Provisc, 1% sodium hyaluronate; Alcon Laboratories), a foldable, posterior-chamber IOL (Acrysof SA60AT; Alcon Laboratories) was implanted in the capsular bag through an injector system. The viscoelastic agent was completely aspirated from the anterior chamber at the end of surgery. Stromal hydration was then performed to achieve wound integrity. Intracameral moxifloxacine 0.5% (0.1 ml Vigamox,

Alcon Laboratories) was administered through the paracentesis. All cases had uneventful cataract surgeries and they were followed up at least six months after surgery.

Postoperatively, patients used prednisolone acetate 1% along with moxifloxacine 0.5% 12x1 daily for 3 days, and 4 times daily for the next 3 weeks.

The study population was informed about the objectives of the study and proper informed consent was received for their participation in the research. This study was approved by the Institutional Review Board of Mersin University Faculty of Medicine, and the study was performed following the guidelines of the Declaration of Helsinki and is in adherence to all laws in the authors' country.

Statistical Analysis

Data were analyzed using SPSS version 11.5. Normality was tested by Shapiro-Wilks analysis. Time-dependent changes of groups were compared using the repeated-measures analysis of variance (ANOVA). The differences between preoperative and postoperative values were assessed by the paired-samples t-test or the Wilcoxon signed-rank test. Data were presented as mean ± standard deviation; a p-value less than 0.05 was considered statistically significant.

Results

Mean age ± standard deviation (MD ± SD) of the POAG, PACG, PEG patients and the control group were 69.19±9.23 years, 60.85±10.29 years, 72.45±10.21 years, and 62.24±14.53 years, respectively. Patient and control groups were not similar according to age distribution (p=0.026). After surgery, both UCVA and BCVA improved significantly (p=0.001) in all groups, beginning with the postoperative 1st month (Table 1). Increase in visual acuity was inversely related to cup/disc ratio in glaucoma patients.

The mean preoperative and postoperative 1st, 3rd, and 6th month IOP values (not corrected for central corneal thickness and postoperatively with rearrangement of topical antiglaucoma medications) are given in Table 2. Intraocular pressures decreased in all groups postoperatively, but the change was statistically significant in the PACG group, beginning with the postoperative 1st month (p=0.013). Increase in ACD and decrease in IOP was found to be significantly correlated with each other in the PACG group.

The mean preoperative and postoperative ACDs were 2.95±0.32 mm and 3.27±0.46 mm in POAG group; 2.18±0.25 mm and 3.29±0.30 mm in PACG group; 3.05±0.40 mm and 3.37 ± 0.30 mm in PEG group; 3.28±0.34 mm and 3.48±0.31 mm in the control group (Figure 1). This increase was found to be significant in the PACG group (p=0.001).

Change in ICA width was seen in all groups (Figure 2), but this was significantly different in the PACG group (p=0.001).

Number of antiglaucoma drugs decreased in all groups after surgery (Figure-3), but this decrease was significant in the PACG group (p<0.05).

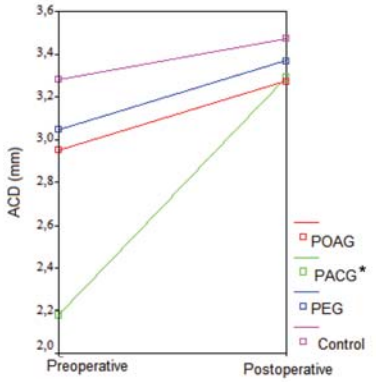

Figure 1. Change in anterior chamber depth (ACD) after surgery

*: statistically significant (p=0.001)

Table 1. Postoperative best corrected visual acuity (BCVA) change in groups (LogMar scores)

Groups	Preoperative BCVA (Mean±SD)	Postoperative BCVA (Mean±SD)	Statistical significance
POAG (n=21)	0.119±0.117	0.468±0.317	p=0.001
PACG (n=13)	0.169±0.268	0.423±0.342	p=0.001
PEG (n=11)	0.044±0.058	0.266±0.240	p=0.001
Control (n=21)	0.174±0.142	0.723±0.225	p=0.001

POAG: Primary open angle glaucoma. PACG: Primary angle closure glaucoma. PEG: Pseudoexfoliation glaucoma. n: Number. SD: Standard deviation

Table 2. Postoperative intraocular pressure (IOP) change in groups

Groups	Preoperative IOP (mmHg) (Mean±SD)	Postoperative 1st month IOP (mmHg) (Mean±SD)	Postoperative 3rd month IOP (mmHg) (Mean±SD)	Postoperative 6th month IOP (mmHg) (Mean±SD)	P value
POAG (n=21)	14.67±3.68	14.62±3.60	13.00±2.53	12.52±2.62	>0.05
PACG (n=13)	20.54±10.84	14.85±3.89	12.31±2.59	11.46±1.94	0.013
PEG (n=11)	15.27±4.38	15.09±4.51	12.36±2.34	10.91±2.26	>0.05
Control (n=21)	14.10±2.63	14.33±1.85	12.67±1.28	12.00±1.55	>0.05

POAG: Primary open angle glaucoma. PACG: Primary angle closure glaucoma. PEG: Pseudoexfoliation glaucoma. n: Number. SD: Standard deviation

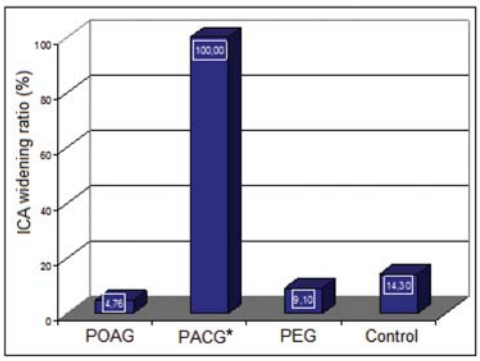

Figure 2. Ratio of patients showing iridocorneal angle (ICA) widening in groups after surgery

*: statistically significant (p=0.001)

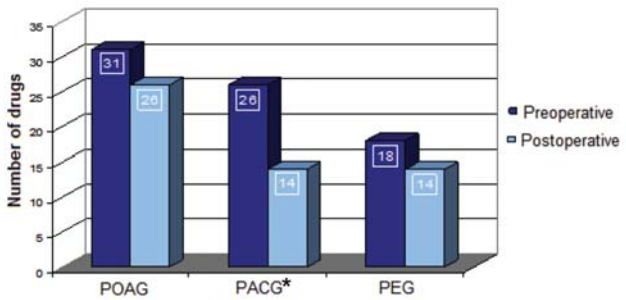

Figure 3. Number of used antiglaucoma drugs in the groups before and after surgery

*: statistically significant (p<0.05)

None of the eyes had clinical progression of glaucomatous optic neuropathy after surgery during the follow-up period.

Discussion

In this study, we observed a significant improvement in both UCVA and BCVA in all groups after cataract surgery, that was in accordance with the previous glaucomatous optic neuropathy in glaucoma patients. IOP decreased in all groups postoperatively, but the change was more evident and significant in the PACG group.

Although the short- and long-term effects of cataract extraction on IOP have been studied for many years, the mechanism of effects of cataract removal on IOP is not fully understood. Postulated mechanisms for the observed reduction in IOP after cataract surgery include a reduction in aqueous production, an increase in uveoscleral outflow, and an increase in conventional outflow mediated by the relief of latent and/or relative pupillary block in eyes with shallow anterior chambers.[8-10,20,21] In addition, phacoemulsification surgery performed with the high fluid flow rate in a closed area may be beneficial by resolving deposits of glycosaminoglycan (GAG) and debris in the trabecular meshwork. Also, causing mechanical insult to the trabecular meshwork, it may induce cell division and renew phagocytosis of meshwork debris.[4]

Traction on the ciliary body, due to fibrosis and contraction of the posterior lens capsule after cataract surgery, may result in the hyposecretion of the aqueous humor.[10,22] It is known that PGF2 increases the outflow facility by a uveoscleral pathway.[23] Mathalone et al suggested that postoperatively released endogenous PGF2 may decrease IOP by enhancing uveoscleral outflow.[4] Increase in conventional outflow is considered to be mediated by a backward shift of the iris (with a consequential mean opening of the anterior chamber angle by 10°) after removal of the crystalline lens.[24] Fraser and Wormald reported a reduction in the need for management of ACG in conjunction with the reducing threshold and consequential increase in volume of cataract surgery in the United Kingdom.[25] Their findings are consistent with the hypothesis that IOP reduction after cataract surgery is attributable to enhanced aqueous outflow through the anterior chamber angle after this procedure. More recently, phacoemulsification and lens implantation have proven effective in the treatment of PACG.[16-19]

Although the decreased resistance to aqueous outflow is expected from the deepening of anterior chamber or release of endogenous PGF2 , in normal eyes, anterior chamber deepening may not be the most important factor in IOP reduction after cataract surgery. Increased blood-aqueous barrier (BAB) permeability has also been proposed as a cause of reduced IOP. Pseudoexfoliation is known to cause impaired BAB over a longer period of time.[14,15,26] In addition, in cases with pseudoexfoliation, the IOP reduction after cataract surgery may be related to both the removal of a source of pseudoexfoliative material (anterior lens capsule) and the increased outflow facility, owing to the clearance of the fibrillar and pigment material from the anterior segment and the trabecular meshwork during aspiration.[14]

Numerous studies about the changes in IOP after phacoemulsification with IOL implantation have been published.[3,4,11,18,19,21,27] These studies reported reductions in mean IOP with variations. The amount of IOP decrease appears to depend on the type of glaucoma. Eyes with ACG, have a shallow anterior chamber, high preoperative IOP, and a large mean IOP reduction.[16-19] Eyes with OAG have a lower preoperative mean IOP and lower IOP reduction after surgery.[3-5,11,12] Moreover, it appears that PEG patients have a greater IOP lowering postoperatively than POAG ones.[13-15] In our study, IOPs decreased in all groups in the postoperative 6-month follow-up period, especially with the significant reduction in the PACG group, similar to previous studies. Also, we observed more decrease in IOP in PEG group compared to POAG group. Finding the significant correlation between the increase in ACD and decrease in IOP in the PACG group, beginning with the postoperative 1st month, supports the hypothesis that aqueous outflow increases through the anterior chamber angle after cataract surgery. Besides, we believe that the clearance of deposits of GAG and pseudoexfoliative material during phacoemulsification surgery plays an effective role in IOP decrease in PEG and then in POAG patients. It should be kept in mind that the number of used antiglaucoma drugs decreased

in all groups after surgery and given postoperative IOPs are measured after the modifications of these drugs.

Several researchers have investigated different anterior segment parameters after uneventful phacoemulsification, using both qualitative and quantitative methods.[9,20,24,27-31] These investigations have demonstrated that cataract extraction causes deepening of the anterior chamber and widening of the anterior chamber angle. Although it is subjective and dependent on the visibility of tissues specific to the iridocorneal angle, gonioscopy with the help of contact lenses is the general method used to evaluate ICA. Altan et al,[9] using A-scan ultrasonography and Goldmann 3-mirror lens, showed that in nonglaucomatous eyes with an open ICA preoperatively, uneventful phacoemulsification increased ACD and widened ICA. Similarly, Shin et al reported that phacoemulsification with foldable IOL implantation effectively deepened the anterior chamber and widened ICA by using A-scan ultrasonography and Goldmann 3-mirror lens.[30] They observed that the effect was more pronounced in eyes with occludable angles. In our study, direct anterior chamber angle visualization was carried out with the use of Goldmann 3-mirror lens, and ACD was measured by A-scan ultrasonography. Like in previous studies, we have seen an increase in both ICA width by gonioscopy and ACD by A-scan ultrasonography postoperatively in all groups, with a significant change in the PACG group.

Anterior chamber angle width can be quantitatively evaluated by Scheimpflug photography, optical coherence tomography, ultrasound biomicroscopy, Orbscan, and Pentacam. Marked anterior chamber changes have been reported following cataract surgery with phacoemulsification and foldable IOL implantation using these devices.[20,24,27-29,31] Hayashi et al[27] found 17° and 10° angle widening measured by Scheimpflug videokeratography in ACG and POAG patients, respectively. They have shown that the width and depth of the drainage angle in PACG increases and becomes similar to those of normal eyes after phacoemulsification. In normal eyes, ACD has been found to be 0.90-1.35 mm deeper after cataract surgery.[24,27] In ACG patients, deepening of the anterior chamber depth after surgery was more evident: a change of 1.36-2.0 mm on average was observed.[17,28] Doganay et al.[20] reported 1.86 mm deepening in ACD, and 11° widening in ICA after uneventful phacoemulsification in normal eyes with the use of Pentacam rotating Scheimpflug camera.

Because of the unavailability of certain clinical equipment, ocular biometry measurements (ACD) were performed using contact A-scan ultrasonography, and ICA was evaluated by Goldmann 3-mirror lens in our study. Even though the same examiner performed all measurements, the indentation force of the contact method used in ocular biometry measurements could have introduced error. Besides, gonioscopy by Goldmann 3-mirror lens is a subjective method of evaluating angle structures to some extent. These can be assumed as the limitations of our study.

Previous investigators have reported that the observed reduction in IOP after cataract extraction can allow for reduction in the use of anti-glaucoma medications in the postoperative period in subjects with POAG, PEG and PACG.[4,12,19,32] In our study, number of antiglaucoma drugs decreased in all groups after surgery, but this decrease was significant in the PACG group.

Study limitations: Our study was performed on a relatively small number of patients. We evaluated the effects of phacoemulsification surgery on IOP, anterior segment anatomy, and the number of antiglaucoma medications in different types of glaucoma patients and compared these results in the same study. It may be thought that it would be more appropriate to compare the effects of cataract surgery in these different glaucoma types in different studies with sufficient number of patients. Further studies with different designs in larger patient groups are needed.

In summary, our study has implications for management of patients who have glaucoma and visually significant cataract. In this setting, we have to decide whether to proceed with simple cataract extraction or combine this procedure with a glaucoma procedure such as trabeculectomy. In all types of glaucoma patients with mild or moderately damaged optic nerves with well-controlled or borderline control of IOP, when there is an accompanying cataract, we recommend proceeding cataract extraction with clear corneal phacoemulsification technique. This surgery will allow us not only to provide visual rehabilitation of our patients but also to achieve IOP control, especially in case of PACG. Proceeding through the cornea rather than the sclera in these patients is preferred so as to preserve conjunctiva in case of the need of future filtration surgery. Careful preoperative examination including gonioscopy may improve the practitioner's ability to preoperatively predict the postoperative IOP course. A larger study group with a longer follow-up period would be beneficial in determining the effect of cataract surgery in these eyes.

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