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Research Article/Özgün Araştırma

Effect of cataract surgery using iris retractor on corneal endothelium and anterior segment parameters in patients with non-dilated pupils

Pupillası dilate olmayan hastalarda iris retraktörü kullanılarak yapılan katarakt cerrahisinin kornea endoteli ve ön segment parametreleri üzerine etkisi

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Abstract

Aim: To evaluate the outcomes of cataract surgery performed using flexible iris retractor hooks (FIRHs) in patients with non-dilated pupils and assess the effects on corneal endothelium and anterior segment parameters.

Materials and Methods: This retrospective study included patients with non-dilated pupils who underwent cataract surgery using FIRHs. Their best-corrected visual acuity (BCVA), intraocular pressure (IOP), anterior chamber depth (ACD), aqueous depth (AD), central corneal thickness (CCT), and endothelial cell density (ECD) were recorded preoperatively and postoperatively.

Results: This study included 32 eyes from 30 patients. The mean IOP ($p = 0.307$) and CCT ($p = 0.149$) did not differ significantly between the preoperative and postoperative measurements. However, BCVA, ACD, and AD increased significantly from preoperatively to postoperatively, while ECD significantly decreased (all $p < 0.001$).

Conclusion: FIRHs can be safely used for pupil dilation during cataract surgery on patients with small pupils and provide favorable surgical outcomes for both patients and surgeons.

Keywords: Small pupil; Iris retractor hook; Cataract surgery.

Öz

Amaç: Bu retrospektif çalışmada, dilate olmayan pupillalarda fleksibl iris retraktör kancaları (FIRK) kullanılarak gerçekleştirilen katarakt cerrahisinin sonuçlarını, kornea endoteli ve ön segment parametreleri üzerindeki etkilerini değerlendirmeyi amaçladık.

Gereç ve Yöntem: Dilate olmayan pupillalarda katarakt cerrahisinde FIRK kullanılan olgular çalışmaya dahil edildi. Düzeltilmiş en iyi görme keskinliği (DEGK), göz içi basıncı, ön kamara derinliği (ÖKD), aköz derinliği (AD), santral kornea kalınlığı (SKK) ve endotelyal hücre yoğunluğu (EHY) ameliyat öncesi ve sonrasında kaydedildi.

Bulgular: Çalışmaya 30 hastanın 32 gözü dahil edildi. Ortalama göz içi basıncı ve SKK'de ameliyat öncesi ve ameliyat sonrası anlamlı fark gözlenmedi. Ameliyat sonrası DEGK, ÖKD ve AD anlamlı arttı, EHY ise istatistiksel olarak anlamlı azaldı ($p< 0,001$)

Sonuç: FIRH, küçük pupillaya sahip katarakt hastalarında ameliyat sırasında pupilla dilatasyonunda güvenle kullanılabilir, hasta ve cerrah için iyi sonuçlar verir.

Anahtar Kelimeler: Küçük pupil; İris retraktör Kancası; Katarakt cerrahisi.

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Introduction

Cataract surgery is the most frequently performed ophthalmic procedure worldwide, with cataracts representing a leading cause of reversible blindness.[1] Today, cataract surgery is most commonly performed via small-incision phacoemulsification. Cataract surgery is challenging in patients with small pupils, and the risk of developing complications is high. Factors predisposing to non-dilated pupils include the use of adrenoceptor alpha 1A (ADRA1A) blockers, pseudoexfoliation (PEX) syndrome, diabetes mellitus, uveitis, and prior ocular trauma or surgery.[2] In patients with non-dilated pupils, cataract surgery predisposes to complications, with surgeons often encountering difficulties in instrument manipulation, and carries risks such as iris damage, anterior or posterior capsule tear, vitreous loss, inadequate clearance of cortex and nuclear material, and zonule defect.[3,4] These complications may result in decreased visual acuity, pupillary irregularity, and photophobia.

Many methods have been described to dilate the pupil, including sectoral or radial iridectomy, cutting or tearing the iris tissue, sphincterotomy, or pupillary stretching.[5–9] However, these methods are associated with significant safety concerns due to their propensity to cause permanent damage to the iris sphincter, pupillary irregularity, anterior chamber hemorrhage, and postoperative inflammation. Flexible iris retractor hooks (FIRHs) are used in cataract surgery in patients with non-dilated pupils.[10] Compared to the abovementioned pupil dilation methods, FIRHs may facilitate safer surgical procedures with enhanced patient comfort.

In this study, we aimed to retrospectively evaluate the results of cataract surgery performed using FIRHs in patients with non-dilated pupils and the effects on anterior segment parameters.

Materials and Methods

Type of study

This study was designed to be retrospective.

Sample size

This study retrospectively reviewed the records of 30 patients (32 eyes) who underwent cataract surgery by the same surgeon (B.Ö) at the Department of Ophthalmology of a tertiary care university hospital between February 2022 and March 2025 using FIRHs because their pupils were non-dilated. It included cases in which FIRHs were used due to PEX syndrome, uveitis, glaucoma, trauma, and previous eye surgery, and for which preoperative and 1-month postoperative control examination records were available.

Data collection tools

Best-corrected visual acuity (BCVA), expressed as logarithms of the minimum angle of resolution (logMAR), and intraocular pressure (IOP), measured using Goldmann applanation tonometry, were recorded preoperatively and postoperatively. Anterior chamber depth (ACD), aqueous depth (AD), and central corneal thickness (CCT), measured using a LenStar 900 biometer (Haag-Streit, Köniz, Switzerland), and endothelial cell density (ECD), measured using a CEM-530 specular microscope (Nidek Co., Ltd, Gamagori, Japan), were recorded. The patients' demographic characteristics, cataract types (nuclear, posterior subcapsular, mature, or traumatic), anesthesia type (topical, subtenon, or general), additional interventions performed during surgery, additional materials used, and preoperative complications were recorded.

All cataract surgeries were performed using a peristaltic phacoemulsification device (Centurion Vision System; Alcon Laboratories Inc., Fort Worth, TX, USA). Eye drops containing cyclopentolate hydrochloride (1%), tropicamide (1%), and phenylephrine (2.5%) were instilled into all patients three times at 5-minute intervals to dilate the pupil 1 hour preoperatively. A 2.2-mm incision was made on the clear corneal vertical axis determined according to the keratometric value, and temporal and nasal side ports were created at 3 o'clock from the main incision. Diluted adrenaline was administered into the anterior chamber, and viscodilation was attempted with viscoelastic material. Four clear corneal incisions were created using a 23-gauge blade. The hooked component of the FIRH was

inserted into the anterior chamber, and the iris was grasped and retracted peripherally to create a square-shaped pupil of adequate diameter for surgical manipulation. The FIRH silicone pad was pulled toward the cornea and fixed (Figure 1). The nucleus was emulsified using the stop-and-chop technique. Dispersive viscoelastic material was used to protect the corneal endothelium during the nucleus emulsification stage, and cohesive viscoelastic material was used during the intraocular lens implantation stage. In patients with zonular defects such as phacodonesis, the anterior capsule was suspended with the help of the FIRH after capsulorhexis, and a capsule tension ring was placed inside the bag. A single-piece foldable hydrophobic monofocal intraocular lens was implanted into the capsular bag. A three-piece foldable hydrophobic monofocal intraocular lens was implanted in patients with zonular defects. The FIRH was removed after intraocular lens implantation. All patients received intracameral cefuroxime operatively. All corneal incisions were closed with stromal hydration.

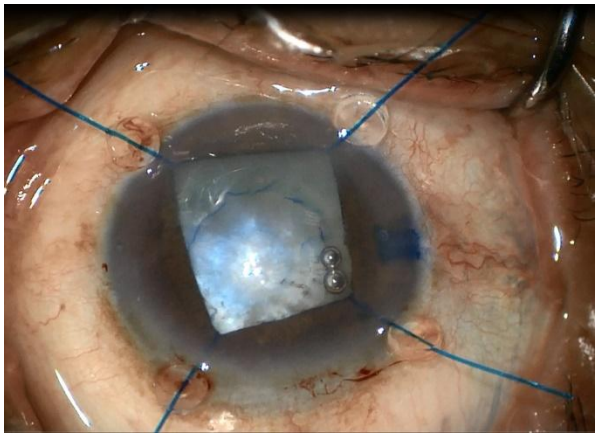

Figure 1. Pupil dilation created with 4 flexible iris retractor hooks during surgery in an eye with pseudoexfoliation syndrome.

Statistical analysis

The collected data were statistically analyzed using SPSS (version 22.0; IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test, and are reported as the mean ± standard deviation if normally distributed or median (minimum−maximum) if non-normally distributed. Preoperative and postoperative measurements were compared using a paired samples *t*-test if normally distributed or the Wilcoxon signed rank test if non-normally distributed. A $p < 0.05$ was considered statistically significant.

Ethics committee approval

This study was approved by the ethics committee of Adıyaman University (approval number: 2025/4-6, approval date: April 29, 2025) and was conducted in accordance with the Declaration of Helsinki. The requirement for informed consent was waived as this study was retrospective.

Results

This study included 32 eyes (18 right, 14 left) from 30 patients, 16 males and 14 females. The patients' ages ranged from 20 to 82 years, with a mean of 60.56 ± 16.11 years. The cataract type was nuclear in 21 eyes, posterior subcapsular in 6 eyes, mature in 4 eyes, and traumatic in 1 eye. The causes of the non-dilated pupils were PEX syndrome in 25 eyes, uveitis in 3 eyes, glaucoma in 2 eyes, trauma in 1 eye, and previous vitreoretinal surgery in 1 eye (Table 1). The anesthesia used operatively was topical in 27 eyes, subtenon in 3 eyes, and general in 2 eyes because the patients were unsuitable for local anesthesia. Capsular tension rings were placed in seven eyes with zonular defects, and a FIRH was also placed in the anterior capsule in five eyes with phacodonesis due to large zonular defects. In the one patient with a traumatic cataract, posterior capsule rupture due to trauma sequelae was observed, and a three-piece foldable monofocal lens was implanted into the capsular bag after posterior capsulorhexis.

Table 1. Demographic characteristics of patients, cataract type and causes of small pupil.

Age(Years)*	60,56 ± 16,11 (20 – 82)
Male/Female	16/ 14
Eye (Right/Left)	32(18/14)
Cataract Type	Nuclear (21) Posterior Subcapsular (6) Mature (4) Traumatic (1)
Small Pupil Cause	PEX (25) Glaucoma (2) Uveitis (3) Trauma (1) Previous Surgery (1)

PEX: Pseudoexfoliation Syndrome
* Mean ± standard deviation (minimum and maximum)

The examination findings recorded preoperatively and 1-month postoperatively were compared (Table 2). The mean IOP did not differ significantly between the preoperative (18.34 ± 2.93 mmHg) and postoperative (17.96 ± 2.17 mmHg) measurements ($p = 0.307$). Similarly, the mean CCT did not differ significantly between the preoperative (551.59 ± 36.14 µm) and postoperative (555.06 ± 36.72 µm) measurements ($p = 0.149$). However, the mean BCVA did differ significantly between the preoperative (LogMAR: 1.34 ± 0.60) and postoperative (LogMAR: 0.1562 ± 0.15) measurements ($p < 0.001$), indicating a significant improvement in visual acuity. In addition, significant preoperative to postoperative increases were observed in the mean ACD (3.18 ± 0.47 vs. 4.62 ± 0.68 mm, $p < 0.001$) and mean AD (2.65 ± 0.44 vs. 4.08 ± 0.67 mm, $p < 0.001$, Figure 2). In contrast, a significant preoperative to postoperative decrease was observed in the mean ECD (2326.78 ± 500.52 vs. 2103.3125 ± 558.83 cells/mm², $p < 0.001$), reflecting a mean preoperative to postoperative decrease in ECD of 223.13 ± 149.68 cells/mm² (10.48% ± 8.31%). The perioperative and postoperative complications are presented in Table 3.

Table 2. Comparison of preoperative and postoperative BCVA, intraocular pressure, CCT, ACD, AD and ECD values.

(n: 32) Mean ± Standard Deviation	**Preoperative**	**Postoperative 1st month**	***p***
BCVA (LogMAR)[a]	1.34 ± 0.60	0.15 ± 0.15	**<0.001**
Intraocular Pressure (mmHg)[a]	18.34 ± 2.93	17.96 ± 2.17	0.307
CCT (µm)[b]	551.59 ± 36.14	555.06 ± 36.72	0.149
ACD (mm)[b]	3.18 ± 0.47	4.62 ± 0.68	**< 0.001**
AD (mm)[b]	2.65 ± 0.44	4.08 ± 0.67	**< 0.001**
ECD (cell /mm2)[b]	2326.78 ± 500.52	2103.3125 ± 558.83	**< 0.001**

BCVA: Best corrected visual acuity, CCT: Central corneal thickness,
ACD: Anterior chamber depth, AD: Aqueous depth, ECD: Endothelial cell density,
µm : Micrometer, mm: Millimeter
a:Wilcoxon Test, b: Paired T-test

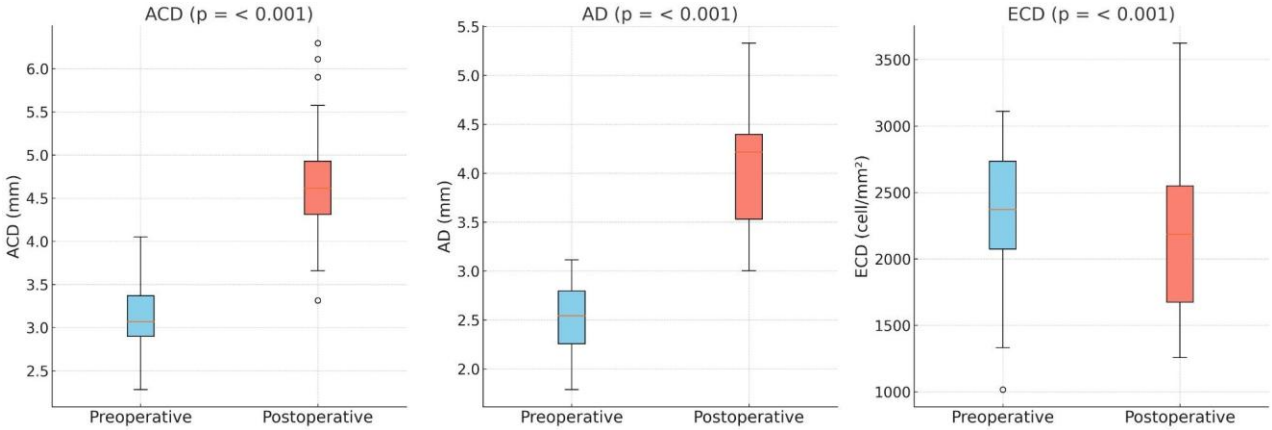

Figure 2. Box plot images showing the difference in preoperative and postoperative anterior chamber depth (ACD), aqueous depth (AD) and endothelial cell density (ECD).

Table 3. Perioperative and postoperative complications.

Perioperative Complications (n)	**Postoperative Complications (n)**
İris prolapse (6)	İrregular pupil (4)
Floppy iris syndrome (5)	Pupillary atony (3)
Anterior capsule rupture (0)	Inflammation (2)
Posterior capsule rupture (1)	Endophthalmitis (0)
Anterior chamber hemorrhage (1)	Cystoid macular edema (1)
Zonule defect (7)	Intraocular lens dislocation (0)

Discussion

The most critical prerequisite for minimizing complication rates and ensuring safer, more efficient cataract surgery is adequate pupillary dilation.[11] Mydriatic drops are used to dilate the pupil preoperatively, but

dilation may sometimes be insufficient. In cases where pupil dilation is insufficient, the surgeon can also perform viscodilation with a viscoelastic substance or inject diluted adrenaline into the anterior chamber operatively. In cases where all these applications are ineffective, one of the most commonly used methods is the FIRH. Juan et al.[12] first used FIRHs in vitreoretinal surgery, and Nichamin et al.[10] later used them in cataract surgery. In this study, we retrospectively examined the data of patients with non-dilated pupils who underwent cataract surgery after their pupils were dilated in a square shape by inserting four FIRHs, 90° apart from each other, perpendicular to the limbus.

Masket et al.[13] emphasized the importance of appropriate adjustment of retractor tension in patients receiving iris retractors. Over-tension of the iris may result in an atonic and irregular pupil postoperatively. In our cases, decreased light reflex and irregular pupils were observed in one patient with uveitis and three patients with PEX syndrome, but our cases did not raise any complaints. One study reported that iris atony that developed due to the use of iris retractors did not cause any change in patients' complaints.[14] We attribute the absence of any complaints in our cases to this. Our findings corroborate previous observations regarding the minimal symptomatic impact of iris retractor-associated changes.

Operatively, a capsule tension ring was placed in seven eyes with zonular weakness, and a FIRH was placed in the anterior capsule in five eyes to prevent further zonular weakness. Ceylan et al.[15] compared capsule to iris retractor hooks in 46 eyes with zonular weakness, observing anterior capsule tears in four cases where the capsule was suspended with iris retractor hooks. No anterior capsule tears were observed in any of our cases, which we attribute to the fact that we avoided over-tensioning the anterior capsule and suspended it only to support the zonules.

Since no study has evaluated the effect of using FIRH on ECD, ACD, AD, BCVA, CCT, and IOP after cataract surgery in patients with non-dilated pupils, we could not compare our results to existing evidence. Wang et al.[16] reported a significant increase in BCVA and a significant decrease in ECD and IOP after cataract surgery performed on patients with lens subluxation using an iris retractor and a capsule tension ring. Another study reported that cataract surgery performed using two different techniques led to a significant decrease in ECD with both, and that the decrease in ECD was greater in patients with low ACD; however, it did not observe a significant change in CCT.[17] While Demir et al.[18] reported a significant increase in ACD after cataract surgery in patients with PEX syndrome, they also observed a nonsignificant decrease in IOP postoperatively. Ganekal et al.[19] compared CCT measurements before and after cataract surgery, observing a significant increase in CCT in the first week, but no significant change in the sixth week.

In our study, we found similar results to those reported in these studies, with ECD showing a significant decrease postoperatively. It is known that the ECD may decrease by 4%–25% after cataract surgery.[20] Potti et al.[21] compared the use of iris retractors, B-HEX rings, and Gupta rings in cataract surgery on eyes with small pupils, reporting that while the preoperative to postoperative decrease in ECD was similar in the three groups, the decrease was smaller in the group operated on using the iris retractor. In this study observed intraoperative anterior capsule ruptures, posterior capsule ruptures, and iris bleeding. However, no anterior capsule ruptures were observed in our study. Nonetheless, we observed posterior capsule rupture due to previous trauma without vitreous loss in one patient, and minimal iris hemorrhage due to iris retraction in one patient. The results of Potti et al. and our study were similar in terms of complications.

A study involving 30 eyes undergoing cataract surgery without the use of a small-pupil iris retractor reported complications such as increased IOP, residual cortex, sterile hypopyon, and cell accumulation on the intraocular lens.[3] Such complications were not observed in our study, so the use of FIRHs is safe. Wang et al.[22] used six different methods to dilate non-dilated pupils during cataract

surgery; among them, the smallest decrease in ECD at 6 months postoperative was observed with iris retractor hooks and the Malyguin ring. In our study, the mean preoperative to postoperative decrease in ECD was 223.12 ± 149.68 cells/mm², decreasing at a rate of 10.47 ± 8.31. Although the cases included in our study were complex, at greater risk of complications, and involved the use of FIRHs, our observed rate of decrease in ECD was consistent with previously reported values. We observed significant increases in ACD and AD postoperatively, as well as a nonsignificant decrease in IOP. An increase in CCT can be expected in the early period due to corneal edema, especially after dense nuclear cataract surgery. However, since we measured the CCT at 1-month postoperative, we did not observe a significant difference compared to preoperative values in our study.

Our study had several limitations, including the small number of cases examined, the retrospective design, surgeries being performed by a single physician at a single center, and a follow-up period of only 1 month. In addition, since the lens nucleus density of the cases was unknown, the effect of cataract hardness on the decrease in ECD could not be evaluated. Therefore, multicenter studies involving larger patient cohorts, multiple surgeons, and longer follow-up periods are warranted.

Conclusions

The use of FIRHs in cataract surgery on patients with non-dilated pupils increased the ACD and AD, but the decrease in ECD was similar to that of standard cataract surgery. The use of FIRHs facilitates safer and more efficient completion of cataract surgery in eyes with small pupils, yielding superior outcomes for both patients and surgeons.

Ethics Committee Approval

This study received ethical approval from the Non-interventional Clinical Research Ethics Committee of Adıyaman University (approval number: 2025/4-6, approval date: April 29, 2025).

Informed Consent

The requirement for informed consent was waived since our study was retrospective.

Author Contributions

Concept: B.Ö.; Literature Review: B.Ö. and İH.T.; Design: B.Ö. and İH.T.; Data Acquisition: B.Ö. and İH.T.; Analysis and Interpretation: B.Ö.; Manuscript Writing: B.Ö.; Critical Revision of the Manuscript: B.Ö. and İH.T.

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Conflict of Interest

The authors declare no conflicts of interest.

Financial Disclosure

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Peer-review

Externally peer-reviewed.

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