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Evaluation of Anterior Segment Parameters Using Scheimpflug Topography Device in Patients Undergoing Nd:YAG Laser Posterior Capsulotomy: Retrospective Study

Scheimpflug Topografi Cihazı Kullanılarak Nd:YAG Lazer Posterior Kapsülotomi Uygulanan Hastalarda Ön Segment Parametrelerinin Değerlendirilmesi: Retrospektif Çalışma

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ABSTRACT Objective: After cataract surgery, a frequent problem is the development of posterior capsule opacification (PCO) which can affect the quality of vision. Our study aims to analyze various eye parameters, such as refraction, intraocular pressure (IOP), intraocular lens (IOL) position, lens rise (LR), and anterior chamber parameters using Sirius Topography, in order to demonstrate the changes that occur after Nd:YAG capsulotomy. **Material and Methods:** In this retrospective study, we reviewed the records of 60 patients post-cataract surgery and Nd:YAG capsulotomy. Twenty-four patients were selected. The evaluation included corrected distance visual acuity (CDVA) and IOP measurements with applanation tonometry. Sirius Topography assessed parameters like anterior chamber depth (ACD), LR and astigmatism angle. Measurements pre- and post-Nd:YAG treatment were compared, and patients were followed up after one week. **Results:** The study showed a significant negative correlation ($p<0.05$) between the change in spherical equivalent and alterations in ACD and horizontal anterior chamber tilt following the Nd:YAG posterior capsulotomy procedure. CDVA increased significantly ($p<0.05$) after the procedure compared to before. LR also showed a significant increase ($p<0.05$) compared to pre-procedure measurements. **Conclusion:** In conclusion, the study found that Nd:YAG posterior capsulotomy is an effective way to enhance visual acuity. Sirius topography can be used to measure LR easily. While rare instances of IOL displacement may occur, particularly posteriorly but occasionally anteriorly in the axial plane, it holds minimal clinical significance.

Keywords: Nd:YAG capsulotomy; corneal topography; lens rise; posterior capsule opacification

ÖZET Amaç: Katarakt cerrahisi sonrası en sık görülen komplikasyon; görme kalitesini olumsuz etkileyen ve görme keskinliğini (GK) azaltan arka kapsül opasifikasyonudur (AKO). Çalışmamızın amacı, komplike olmayan katarakt cerrahisi sonrası AKO gelişen hastalarda Scheimpflug Placido Disk Topografi cihazı kullanılarak refraksiyon, göz içi basıncı (GİB), göz içi lens (GİL) pozisyonu, lens yükselmesi (LY) ve ön kamara parametrelerindeki değişiklikleri değerlendirmektir. **Gereç ve Yöntemler:** Bu retrospektif çalışmaya, daha önce komplike olmayan katarakt ameliyatı geçirmiş ve sonrasında AKO gelişen 60 hastanın 24'ü dâhil edildi. Değerlendirmede, düzeltilmiş görme keskinliği (DGK) ve aplanasyon tonometrisi ile GİB, otorefraktometre ölçümlerine bakıldı. Ayrıca ön kamara derinliği (ÖKD), yatay ön kamara derinliği, LY, iridokorneal açı, yatay ön kamara tilt (YÖKtilt), ön kamara hacmi, arka kapsül açıklığı Scheimpflug Plasido Disc cihazı kullanılarak değerlendirildi. Ölçümler 1 haftalık takipte Nd:YAG lazer tedavisi öncesi ve sonrası olarak karşılaştırıldı. **Bulgular:** İşlem sonrası sferik eş değerdeki değişiklik ile işlem sonrası ÖKD'deki ve YÖKtilt'teki değişiklikler arasında istatistiksel olarak anlamlı ($p<0,05$) negatif korelasyon bulundu. İşlem sonrası DGK işlem öncesi değerlere göre anlamlı ($p<0,05$) artış gösterdi. İşlem sonrası LY, işlem öncesi ölçümlere kıyasla anlamlı ($p<0,05$) bir artış gösterdi. **Sonuç:** Nd:YAG lazer arka kapsülotominin GK'yi iyileştirmek için etkili ve güvenilir bir yaklaşım olduğu kanıtlanmıştır. LY Sirius topografisinde otomatik olarak kolayca ölçülebilmektedir. GİL pozisyonundaki değişiklikler genellikle arkaya doğru olsa da klinik olarak anlamlı özellik göstermemektedir.

Anahtar Kelimeler: Nd:YAG kapsülotomi; korneal topografi; lens yükselmesi; arka kapsüler opasifikasyon

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Posterior capsule opacification (PCO), also known as secondary cataract, is a prevalent late complication that often occurs after cataract surgery.[1] It arises due to the excessive growth of residual lens epithelial cells within the posterior capsule.[2] As these cells migrate toward the central region, they can obstruct the visual axis and give rise to diverse visual disturbances known as photic phenomena.[3] Also, the opacification of the posterior capsule can result in a noticeable decline in visual acuity, compromised contrast sensitivity, and the occurrence of monocular diplopia.[4,5]

Nd:YAG laser capsulotomy stands as the foremost choice for effectively, commonly, and safely eliminating PCO.[5,6] This method has garnered favor from both patients and surgeons alike since the 1980s, aiding in the treatment of PCO and the restoration of visual acuity.[7,8] The Nd:YAG laser operates by emitting pulses lasting 2-3 nanoseconds with energy at a wavelength of 1,064 nm. This energy creates a state of elevated pressure and temperature known as plasma, resulting in the disruption of tissues confined within a limited area. The expansion of plasma generates a shock wave, which leads to the incision effect.[9] While offering visual improvement, it is important to note that the procedure can also be associated with potential complications including sudden intraocular pressure elevation, pitting of the intraocular lens (IOL), uveitis, cystoid macular edema, vitreoretinal separations, and refractive changes caused by axial movement of the IOL as well as IOL dislocation.[10-12] Our study aimed to present findings from patients who sought treatment at a tertiary care institution and underwent Nd:YAG laser capsulotomy. While previous studies have mainly focused on the changes in the position of IOL and their refractive status.[11,13-16] We specifically focused on less frequently mentioned lens rise (LR) changes, providing insights not extensively covered in previous studies. LR refers to the vertical measurement between the highest point of the horizontal cornea-iris angle and the highest point of the anterior surface of the IOL.[17] This Sirius Tomography & Topographer by CSO is a reliable tool for accurately quantifying this parameter.

MATERIAL AND METHODS

A retrospective, case-control study, screening was conducted on a group of sixty patients who experienced symptomatic PCO following uncomplicated cataract surgery with the implantation of an intrabag hydrophobic acrylic IOL. These patients sought treatment at a tertiary healthcare institution between March 2022 and March 2023. From this cohort, twenty-four patients met the inclusion criteria and were included in the study. Patients who had a history of ocular surgeries other than phacoemulsification and IOL implantation, experienced complications during the operation, and patients with axial length value <22 mm and >24 mm, had a posterior segment pathology, history of ocular trauma, had pre-existing iris or corneal pathology, were currently experiencing active ocular inflammation, had a diagnosis of glaucoma, or did not comply with regular follow-up visits were excluded from the study. The present study received ethical approval from the review board, adhering to the principles outlined in the Declaration of Helsinki. All included patients provided written informed consent after a detailed explanation of the procedure, as well as the potential benefits and risks associated with participation in the study. Approval was obtained from the Başakşehir Çam and Sakura City Hospital Ethics Committee (no: 2023.02.83, 27.02.2023).

Baseline assessments were performed before the procedure, which involved recording uncorrected and best corrected visual acuity, refraction values, astigmatism axis using auto-refractometry (RK-F2 Full Auto Ref-Keratometer by Canon, USA), intraocular pressure measurements via applanation tonometry and documentation of the specific IOL model used. Subsequently, complete pupil dilation was achieved through the administration of 1% tropicamide eye drops. The corneal and anterior chamber parameters were assessed using the Sirius topography device (Sirius+Tomography & Topographer by CSO, Firenze, Italy), which utilizes a combination of Scheimpflug camera and Placido disc imaging techniques to capture the anterior segment of the eye. Sirius is a rapid and highly reliable non-contact device that produces a comprehensive image of the area be-

tween the front corneal surface and the back surface of the lens. The Scheimpflug camera rotates 180 degrees in a short time, evaluating 36,632 points on the anterior corneal surface and 30,000 points on the posterior surface. This process generates 25 cross-sectional digital images of the entire cornea and anterior segment at 7-8 degree intervals, accurately representing the elevation points. Three measurements were then taken using Sirius topography. Additional parameters, such as the iridocorneal angle (ICA), anterior chamber depth (ACD), horizontal ACD (H-ACD), anterior chamber volume (ACV), pachymetry, anterior and posterior corneal keratometric values and LR, were also recorded using Sirius Scheimpflug tomography. Subsequently, the posterior capsulotomy procedure was carried out using an Nd:YAG laser device (A.R.C Laser Q-LAS). All laser posterior capsulotomies were performed by a single surgeon (Dag Y), utilizing the Nd:YAG laser (Figure 1). Once optimal pupil dilation was achieved, 0.5% proparacaine hydrochloride was administered for topical anesthesia. A 2% hypromellose gel was employed as a bonding agent for the contact capsulotomy lens. The posterior capsulotomy procedure aimed to create a minimum 4 mm opening in a cruciate pattern. The average power delivered ranged between 1-4 mJ per pulse, with the number of pulses recorded between 5-15 on average. One hour following the capsulotomy procedure, intraocular pressure was measured using applanation tonometry. To aid in the postoperative care, all patients were prescribed topical 1% prednisolone acetate to be administered four times daily. A standardized medical protocol was administered to all patients both before and after the procedure. Before the Nd:YAG capsulotomy, patients received 2 mg/mL brimonidine eye drops, administered 30 minutes in advance. One week later, the patients were scheduled for a follow-up visit, during which their uncorrected and best-corrected visual acuity, refraction values, astigmatism axis, and intraocular pressure values were recorded once again. Following a similar procedure, three measurements were taken using Scheimpflug tomography for further evaluation. A free application named (Astig-MATIC) was used for vector analysis.[18] After evaluating patients for potential complications, the recorded parameters before and after capsulotomy were further analyzed and compared for assessment.

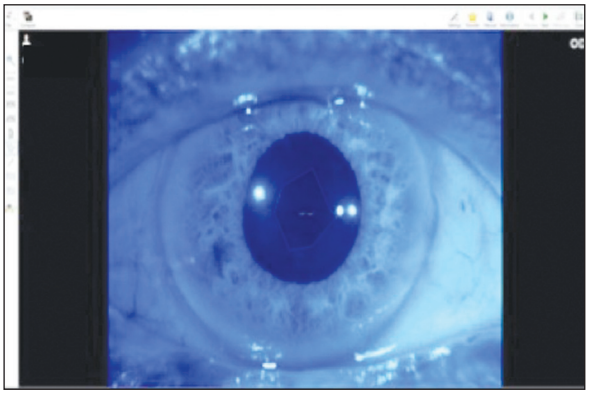

FIGURE 1: Measurement of capsular opening area in Nd:YAG capsulotomy using Sirius topography.

STATISTICAL ANALYSIS

The sample size estimation was determined based on the number of eyes required to achieve 80% power with a 5% significance level for an increase in spherical equivalence (SE). Consequently, a total of 20 eyes were deemed necessary to complete the study. Descriptive statistics for the data included the calculation of mean, standard deviation, median, lowest, and highest values, as well as frequency and ratio values. The distribution of variables was assessed using the Kolmogorov-Smirnov test. The Wilcoxon test was utilized to analyze dependent quantitative data. Additionally, Spearman correlation analysis was employed to examine correlations between variables. The analysis was conducted using SPSS version 28.0 software (SPSS Inc., Chicago, Illinois, USA).

RESULTS

Initially, a total of 60 participants were enrolled in the study. However, during the research, 36 participants were lost to follow-up, and their data were subsequently excluded from the final analysis. As a result, the analysis was conducted on the data from 24 participants (12 females and 12 males). In this study, patients were selected from a group of individuals who had undergone uneventful phacoemulsification surgery in the past. Moreover, all of the selected patients had been implanted with a single piece of hydrophobic IOL placed in the lens bag. For

a single point, the average energy utilization was 0.7 mJ, with an average total of 13.4 shots (range: 7-30) and a total energy level of 11.6 mJ (range: 5.9-27.3 mJ). The time between phacoemulsification and Nd:YAG laser posterior capsulotomy was 12.71±0.5 months.

The changes in visual acuity, refraction values based on SE, astigmatism axis, and mean intraocular pressure before the procedure are presented in Table 1. After the procedure, a significant increase in corrected distance visual acuity (CDVA) was observed (0.48±0.67 to 0.05±0.85 logMAR, p=0.002). In addition, there was a minimal improvement in SE refraction values, but this change was not found to be statistically significant (0.05±1.83 to 0.05±0.97, p=0.479). Vector analysis was conducted using the Alpins method. Figure 2 illustrates a vector analysis of the refractive astigmatism in patients during the last visit. The vector mean of target-induced astigmatism (TIA) was 0.55 D at 95°, while surgically induced astigmatism (SIA) was 0.29 D at 105°. The difference vector (DV), representing the disparity between TIA and SIA, was measured at 0.30 D at 85°. The correction index (CI), calculated by dividing SIA by TIA, was 0.94 (CI<1.0 indicates under-correction, CI>1.0 indicates overcorrection) (Figure 2). The post-procedure intraocular pressure showed no significant difference, although such a difference was noted at the 1-week follow-up.

Table 2 presents a comprehensive summary of parameter results derived from anterior segment optical coherence tomography evaluations conducted both before capsulotomy and one week after the procedure. Comparisons revealed that ACD and ACV did not display any significant differences before and after the Nd:YAG capsulotomy (p>0.05). The IOL position showed backward movement in 20 patients and anterior movement in 4 patients. However, there was a significant increase in LR in comparison to the pre-procedural measurements (-1.21±0.46 to -0.68±0.63, p=0.023). Regarding horizontal anterior chamber distance and ICA, there were no significant changes after the procedure (p>0.05). In the Spearman correlation test, a noteworthy positive correlation (p<0.05) was identified between the capsular opening and the change in refraction following the ND:YAG laser procedure.

TABLE 1: Pre-Nd:YAG capsulotomy descriptive Sirius topography measurements.

	Minimum-Maximum	Median	$\bar{X}$±SD/n-%
Age	52.0-81.0	69.5	69.0±6.9
Gender			
Female			12 50.0%
Male			12 50.0%
CDVA (logMAR)	1.0-0.15	0.52	0.48±0.67
SE	-3.00-4.75	-0.19	0.05±1.83
Astigmatism Axis	7.0-180.0	86.0	82.0±48.5
ACD (mm)	3.39-5.09	4.11	4.20±0.51
Lens Rise	-2.22--0.48	-1.12	-1.21±0.46
HACtilt	4.20-8.20	5.15	5.75±1.57
ACV (mL)	168.4-265.8	234.0	229.1±29.3
HACD (mm)	11.10-12.55	12.12	12.07±0.45
Iridocorneal angle (degree)	39.30-65.80	59.15	58.28±6.85
IOP (mmHg)	10.00-25.00	14.50	15.17±4.71

CDVA: Corrected distance visual acuity; SE: Spherical equivalent; ACD: Anterior chamber depth; HACtilt: Horizontal anterior chamber tilt; ACV: Anterior chamber volume; HACD: Horizontal anterior chamber distance; IOP: Intraocular pressure; SD: Standard deviation.

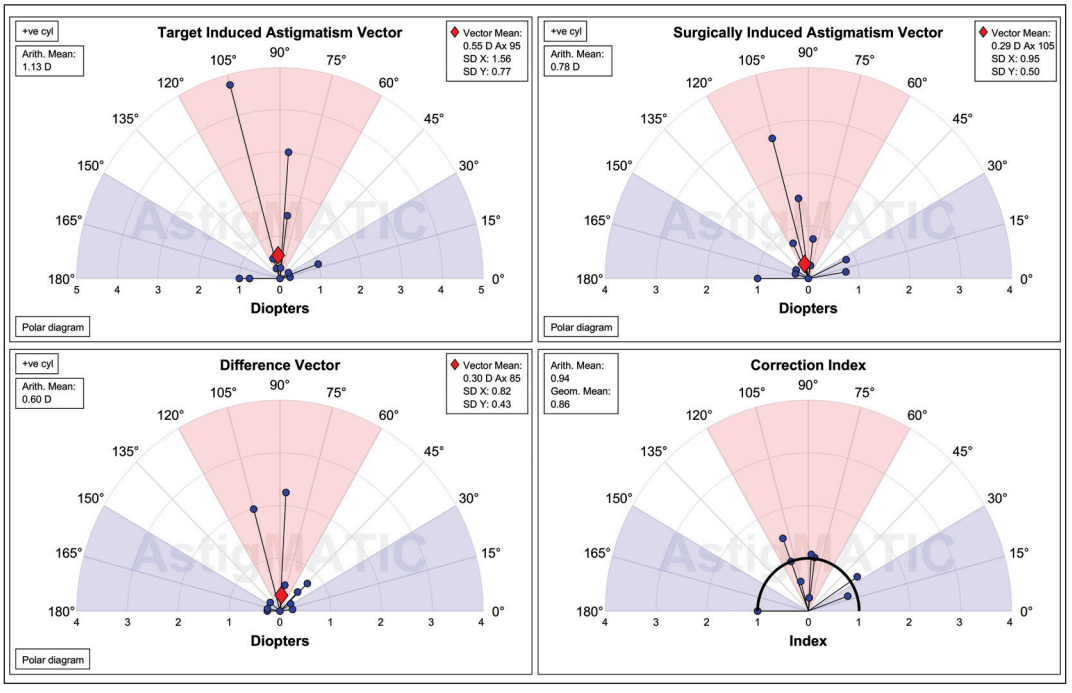

FIGURE 2: Vector analysis of refractive astigmatism of patients at one week after Nd:YAG capsulotomy. The analysis was including target induced astigmatism **(a)**, surgically induced astigmatism difference vector **(c)** (which is the difference between target induced astigmatism and surgically induced astigmatism), and correction index **(d)**.

TABLE 2: Comparison of Sirius topography measurements before and after Nd:YAG capsulotomy.

	Pre-capsulotomy		Post-capsulotomy		
	X̄±SD	Median	X̄±SD	Median	p value
CDVA (logMAR)	0.48±0.67	0.52	0.05±0.85	0.02	0.002[w]
SE	0.05±1.83	-0.19	0.05±0.97	0.00	0.479[w]
Astigmatism axis	82.00±48.50	86.00	82.64±49.97	80.00	0.484[w]
ACD (mm)	4.20±0.51	4.11	3.92±0.50	3.95	0.182[w]
Lens rise	-1.21±0.46	-1.12	-0.68±0.63	-0.83	0.023[w]
HACtilt	5.75±1.57	5.15	7.40±3.36	7.05	0.074[w]
ACV (mL)	229.1±29.3	234.0	223.4±22.6	218.2	0.308[w]
HACD (mm)	12.07±0.45	12.12	12.05±0.59	12.03	0.929[w]
Iridocorneal angle (degree)	58.28±6.85	59.15	58.83±4.74	59.30	0.556[w]
IOP (mmHg)	15.17±4.71	14.50	14.00±4.07	13.50	0.151[w]
Capsular opening			6.81±3.24	5.93	

[w]Wilcoxon test;

CDVA: Corrected distance viusal acuity; SE: Spherical eqiuvalent; ACD: Anterior chamber depth; HACtilt: Horizontal anterior chamber tilt; ACV: Anterior chamber volume; HACD: Horizontal anterior chamber distance; IOP: Intraocular pressure; SD: Standard deviation.

None of the cases showed any signs of retinal detachment, cystoid macular edema, IOL damage due to pit, or glaucoma crisis following ND:YAG laser capsulotomy. Additionally, there were no instances of IOL decentralization and tilt in either the vertical or horizontal plane among any of the cases.

DISCUSSION

Decentralization and improper positioning of the IOL following cataract surgery can lead to reduced visual quality, heightened high-order aberrations (depending on the IOL type used), and the occurrence of photic phenomena.[3,19,20] Changes in the axial position of the IOL may result in a myopic or hyperopic shift, depending on the direction of displacement.[10,14] In the literature, various studies have explored the effects of Nd:YAG laser capsulotomy on intraocular pressure, refraction, and ACD parameters. In a study conducted by Parajuli et al., they demonstrated that the SE remained stable during the first week and first month after Nd:YAG laser capsulotomy. However, the ACD showed a gradual increase over time.[21] In the research conducted by Thornval and Naeser, the results indicated that the SE and intraocular pressure remained stable, while the ACD significantly increased.[13] In our study, no significant change was observed in the ACD value. Also, we observed that the lenses of 20 patients shifted posteriorly, while in 4 patients, the lenses shifted anteriorly.

Lens epithelial cells persisting post-cataract surgery undergo proliferation and generate microfilament aggregates, exhibiting characteristics of myofibroblastic cells. This process leads to fibrosis, opacification, and the development of a membrane and capsular striae. Tensile forces within the posterior capsule arise from the contractile nature of microfilaments and metaplastic lens epithelial cells.[13] These morphological alterations may account for the posterior displacement of the IOL implanted in the bag observed after YAG laser capsulotomy. Theoretically, as the posterior displacement of the IOL may induce a hyperopic shift, the negative correlation between horizontal anterior chamber tilt and the SE, as found in our study, approaching the emmetropic value, can be elucidated. However, we did not identify any significant change in SE. Additionally, the study demonstrated that the hyperopic shift varied depending on the size of the capsular opening.[22] The extent of posterior displacement of the lens is influenced by factors such as the material and structure of the IOL and the size of the capsulotomy. Previous observations indicate that the posterior orientation and ACD increased is more pronounced in single-piece and 3-piece lenses compared to plate haptics.[22,23] Even though the IOL material used in our study was similar, no significant change was observed in IOL tilt parameters. In our study, no significant correlation was identified between the size of the capsulotomy and the posterior orientation of the lens. However, it is crucial to perform an appropriately sized capsulotomy based on the optic axis and pupil size. Avoiding capsulotomies that are too small or too large is essential for optimal outcomes.

Upon reviewing the literature, no study investigating LR in patients who underwent Nd:YAG capsulotomy could be located. Previous studies assessing LR have typically focused on the crystalline lens and often involved patients with implantable collamer lenses.[24,25] Consistent with the definition provided here, the LR involves measuring the vertical separation between the apex of the horizontal ICA and the apex of the anterior surface of the IOL (Figure 3).[17] A negative value means that the crystalline lens is above the iridocorneal plane.[26] It is a parameter automatically measured by the Sirius tomography device as standard. The term post-capsulotomy "IOL rise" was assigned to refer to crystalline LR. The study demonstrates that, as the IOL approaches positive values, it undergoes displacement from the horizontal plane towards the posterior. In our investigation, the posterior displacement of the IOL following capsulotomy supports the reduction in the negative value of LR. An IOL rise parameter can also be measured in patients with an IOL implanted after cataract surgery, without the need for any manual measurement. Un-

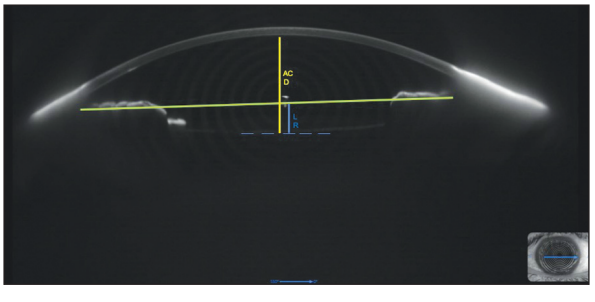

FIGURE 3: Lens rise was defined as the anteroposterior distance between the anterior-lens surface and the angle recess to angle recess line (green line). The solid yellow line is anterior chamber depth, the solid blue line is lens rise, and the dashed blue line is anterior surface of intraocular lens.

like manual measurement using devices like optical coherence tomography, Sirius topography provides direct measurements of the IOL rise.

Our study has some limitations. Firstly, patients in our sample received single-piece IOLs from different brands, potentially introducing variability in pre- and post-Nd:YAG capsulotomy measurements. Although all IOLs had a hydrophobic acrylic structure, differences in their propensity for PCO and positioning within the bag may exist. Additionally, the reported increase in ACD after Nd:YAG laser, observed in previous studies, did not reach significance in our study, likely due to the small number of patients. The absence of a control group and another methods in the study limits the comparison of changes in IOL tilt and LR, necessitating exploration with a larger patient cohort.

CONCLUSION

In conclusion, our findings revealed no alteration in the SE following Nd:YAG laser posterior capsulotomy. However, we did observe changes in the axial position of the IOL and the measured LR value using anterior segment topography. This non-invasive, user-friendly, and effective measurement method can be employed to determine the presence and extent of IOL tilt after Nd:YAG capsulotomy.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Yaşar Dağ;* ***Design:*** *Yaşar Dağ, İrem Önal;* ***Control/Supervision:*** *Yaşar Dağ;* ***Data Collection and/or Processing:*** *Yaşar Dağ, İrem Önal;* ***Analysis and/or Interpretation:*** *Yaşar Dağ, İrem Önal;* ***Literature Review:*** *Yaşar Dağ, İrem Önal, İdil Çelen;* ***Writing the Article:*** *Yaşar Dağ, İrem Önal;* ***Critical Review:*** *Yaşar Dağ, İrem Önal;* ***References and Fundings:*** *Yaşar Dağ, İrem Önal, İdil Çelen.*

REFERENCES

1. Wormstone IM. Posterior capsule opacification: a cell biological perspective. Exp Eye Res. 2002;74(3):337-47. [Crossref] [PubMed]
2. Billotte C, Berdeaux G. Adverse clinical consequences of neodymium:YAG laser treatment of posterior capsule opacification. J Cataract Refract Surg. 2004;30(10):2064-71. [Crossref] [PubMed]
3. Woodward MA, Randleman JB, Stulting RD. Dissatisfaction after multifocal intraocular lens implantation. J Cataract Refract Surg. 2009;35(6):992-7. [Crossref] [PubMed] [PMC]
4. Sunderraj P, Villada JR, Joyce PW, Watson A. Glare testing in pseudophakes with posterior capsule opacification. Eye (Lond). 1992;6 (Pt 4):411-3. [Crossref] [PubMed]
5. Aslam TM, Devlin H, Dhillon B. Use of Nd:YAG laser capsulotomy. Surv Ophthalmol. 2003;48(6):594-612. [Crossref] [PubMed]
6. Fus M, Pitrova S, Maresova K, Lestak J. Changes of intraocular lens position induced by Nd:YAG capsulotomy. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2022;166(2):211-6. [Crossref] [PubMed]
7. Aron-Rosa D, Aron JJ, Griesemann M, Thyzel R. Use of the neodymium-YAG laser to open the posterior capsule after lens implant surgery: a preliminary report. J Am Intraocul Implant Soc. 1980;6(4):352-4. [PubMed]
8. Bath PE, Fankhauser F. Long-term results of Nd:YAG laser posterior capsulotomy with the Swiss laser. J Cataract Refract Surg. 1986;12(2):150-3. [Crossref] [PubMed]
9. Bhargava R, Kumar P, Prakash A, Chaudhary KP. Estimation of mean ND: Yag laser capsulotomy energy levels for membranous and fibrous posterior capsular opacification. Nepal J Ophthalmol. 2012;4(1):108-13. [Crossref] [PubMed]
10. João MD, Costa JV, Monteiro T, Franqueira N, Faria Correia F, Vaz F. Intraocular lens position and anterior chamber parameters evaluation after Nd:YAG laser posterior capsulotomy for posterior capsular opacification using anterior segment swept-source optical coherence tomography. Clin Ophthalmol. 2022;16:153-9. [Crossref] [PubMed] [PMC]
11. Eleiwa T, Khedr NE, Fayek H, Bayoumy A. Short-term anterior segment changes after Nd-YAG laser posterior capsulotomy in pseudophakic eyes with fuchs' endothelial dystrophy. Clin Ophthalmol. 2021 30;15:1819-25. [Crossref] [PubMed] [PMC]
12. Monteiro T, Soares A, Leite RD, Franqueira N, Faria-Correia F, Vaz F. Comparative study of induced changes in effective lens position and refraction after Nd:YAG laser capsulotomy according to intraocular lens design. Clin Ophthalmol. 2018;12:533-7. [PubMed] [PMC]

13. Thornval P, Naeser K. Refraction and anterior chamber depth before and after neodymium: YAG laser treatment for posterior capsule opacification in pseudophakic eyes: a prospective study. J Cataract Refract Surg. 1995;21(4):457-60. [Crossref] [PubMed]
14. Khambhiphant B, Liumsirijarern C, Saehout P. The effect of Nd:YAG laser treatment of posterior capsule opacification on anterior chamber depth and refraction in pseudophakic eyes. Clin Ophthalmol. 2015;9:557-61. [Crossref] [PubMed] [PMC]
15. Uzel MM, Ozates S, Koc M, Taslipinar Uzel AG, Yılmazbaş P. Decentration and tilt of intraocular lens after posterior capsulotomy. Semin Ophthalmol. 2018;33(6):766-71. [Crossref] [PubMed]
16. Vrijman V, van der Linden JW, Nieuwendaal CP, van der Meulen IJ, Mourits MP, Lapid-Gortzak R. Effect of Nd:YAG laser capsulotomy on refraction in multifocal apodized diffractive pseudophakia. J Refract Surg. 2012;28(8):545-50. [Crossref] [PubMed]
17. Wu H, Zhong DJ, Luo DQ, Zhang LY, Liu J, Wang H. Improvement in the ideal range of vault after implantable collamer lens implantation: a new vault prediction formula. Front Med (Lausanne). 2023;10:1132102. [Crossref] [PubMed] [PMC]
18. Gauvin M, Wallerstein A. AstigMATIC: an automatic tool for standard astigmatism vector analysis. BMC Ophthalmol. 2018;18(1):255. [Crossref] [PubMed] [PMC]
19. Levy J, Lifshitz T, Klemperer I, Knyazer B, Ashkenazy Z, Kratz A, et al. The effect of Nd:YAG laser posterior capsulotomy on ocular wave front aberrations. Can J Ophthalmol. 2009;44(5):529-33. [Crossref] [PubMed]
20. Cinar E, Yuce B, Aslan F, Erbakan G. Comparison of wavefront aberrations in eyes with multifocal and monofocal iols before and after Nd:YAG laser capsulotomy for posterior capsule opacification. Int Ophthalmol. 2020;40(9):2169-78. [Crossref] [PubMed]
21. Parajuli A, Joshi P, Subedi P, Pradhan C. Effect of Nd:YAG laser posterior capsulotomy on intraocular pressure, refraction, anterior chamber depth, and macular thickness. Clin Ophthalmol. 2019;13:945-52. [Crossref] [PubMed] [PMC]
22. Karahan E, Tuncer I, Zengin MO. The Effect of ND:YAG Laser Posterior Capsulotomy Size on Refraction, Intraocular Pressure, and Macular Thickness. J Ophthalmol. 2014;2014:846385. [Crossref] [PubMed] [PMC]
23. Findl O, Drexler W, Menapace R, Georgopoulos M, Rainer G, Hitzenberger CK, Fercher AF. Changes in intraocular lens position after neodymium: YAG capsulotomy. J Cataract Refract Surg. 1999;25(5):659-62. [Crossref] [PubMed]
24. Lin F, Wang Y, Liu Y, Qu X, Zhou X. The influence of 0.5% tropicamide on anterior segment parameters with CASIA2 in emmetropic, myopic, and hyperopic eyes. Front Physiol. 2022;13:957097. [Crossref] [PubMed] [PMC]
25. Yang J, Li H, Wu M, He R, Nong Y, Zou Z, Zhang C, Zhou S. A vault-prediction formula for implantable collamer lens based on preoperative parameters: a retrospective clinical study. BMC Ophthalmol. 2023;23(1):350. [Crossref] [PubMed] [PMC]
26. Wang Z, Ma H, Zhang Y, Yuan Y, Liu Y, Chen Y. Changes in anterior chamber after myopic and hyperopic FS-LASIK. Ophthalmol Ther. 2022;11(6):2243-57. [Crossref] [PubMed] [PMC]