

# Short-term effect of Nd:YAG laser capsulotomy on refraction, central macular thickness and retinal nerve fiber layer thickness

## *Efeito de curto prazo da nd: capsulotomia laser de YAG na refração, espessura macular central e espessura da camada de fibra nervosa da retina*

Selim Cevher<sup>1</sup>, Yusuf Koçluk<sup>2</sup>, Sava Çetinkaya<sup>2</sup>, Fikret Ünal<sup>2</sup>, Mehmet Çubuk<sup>2</sup>

### ABSTRACT

**Objective:** The aim of this study is to examine the effect of Nd:YAG laser capsulotomy on refraction, central macular thickness (CMT) and retinal nerve fiber layer (RNFL) thickness. **Methods:** 42 eyes of 42 patients who treated with Nd:YAG laser capsulotomy were included in this prospective study. Spherical equivalent (SE), cylindrical power refraction, CMT and RNFL thickness were evaluated preoperatively and at postoperative first day, first week and postoperative first month. **Results:** Spherical equivalent values and central macular thickness values did not significantly change in the first month after treatment. Average and nasal retinal nerve fiber layer thickness values significantly increase and cylindrical power refraction significantly decreased during the visits. **Conclusion:** Nd:YAG laser capsulotomy is confident and reliable treatment option of the posterior capsula opacification (PCO). After Nd:YAG laser capsulotomy cylindrical power refraction and RNFL thickness values significantly change.

**Keywords:** Tomography, optical coherence; Refraction; Nerve fiber

### RESUMO

**Objetivo:** O objetivo deste estudo é examinar o efeito da capsulotomia de laser Nd:YAG na refração, espessura macular central (CMT) e espessura da camada de fibra nervosa retiniana (RNFL). **Métodos:** 42 olhos de 42 pacientes que trataram com capsulotomia laser Nd:YAG foram incluídos neste estudo prospectivo. O equivalente esférico (SE), a refração de potência cíclica, a espessura CMT e RNFL foram avaliados pré-operatório e no primeiro dia pós-operatório, primeira semana e primeiro mês pós-operatório. **Resultados:** valores equivalentes esféricos e valores de espessura macular central não alteraram significativamente no primeiro mês após o tratamento. Os valores médios e da espessura da camada de fibra nervosa nasal da retina aumentaram significativamente e a refração do poder cíclico diminuiu significativamente durante as visitas. **Conclusão:** Nd:YAG capsulotomia laser YAG é uma opção de tratamento confiável e confiável da opacificação da cápsula posterior (PCO). Após Nd:YAG capsulotomia do laser YAG, a refração do poder cíclico e os valores da espessura do RNFL mudam significativamente.

**Descritores:** Tomografia de coerência óptica; Refração; Fibras nervosas

<sup>1</sup> Department of Ophthalmology, Ereğli State Hospital, Turkey.

<sup>2</sup> Department of Ophthalmology, Adana Numune Research and Training Hospital, Department of Turkey.

The authors declare no conflicts of interests.

Received for publication 14/02/2017 - Accepted for publication 26/06/2017.

## INTRODUCTION

One of the most common long-term postoperative complication of the cataract surgery is posterior capsule opacification (PCO). PCO causes several problems such as low visual acuity, contrast sensitivity and unocular diplopia. The main reason of PCO is remaining lens epithelial cells. These cells proliferate and migrate into the optic axis between intraocular lens and posterior capsule. Some factors associated with PCO, these are; patient age, intraocular lens (IOL) type, surgery technique, any ocular or systemic disease. For example, PCO rate is higher in children or young patients than in geriatric patients. Any patient who has diabetes mellitus or uveitis, PCO development rate increases. In recent years, the introduction of sharp-edge optic IOL and the development of the modern phacoemulsification technique have resulted in reduced rates of PCO.<sup>(1-3)</sup>

Standard treatment of the PCO is neodymium-doped yttrium aluminium garnet (Nd:YAG) laser capsulotomy. This procedure is effective but it has several complications such as postoperative intraocular pressure (IOP) elevation, IOL damage, inflammation, cystoid macular edema, and retinal detachment.<sup>(4,5)</sup> Macular edema is caused by inflammatory mediators due to the damage of blood-aqueous barrier; elevated IOP is associated with an increased amount of aqueous particles following Nd:YAG laser capsulotomy.<sup>(6,7)</sup> Elevated IOP can affect retinal nerve fiber layer (RNFL) thickness. If IOP elevation does not detect, RNFL and visual field damaging may occur. But the IOP elevation is usually transient. We can easily measure macular and RNFL thickness with optical coherence tomography (OCT). Nd:YAG laser capsulotomy may affect refraction. There is no consensus about the effect on refractive status. Some authors claimed that large capsulotomy size may cause posterior movement of the IOL and result in hyperopic shift.<sup>(8)</sup> On the other hand, some authors said that Nd:YAG laser capsulotomy does not affect spherical equivalent (SE).<sup>(9)</sup>

This study aims to examine the short-term effects of Nd:YAG laser capsulotomy on refraction status, macular and RNFL thickness.

## METHODS

Approval was obtained from the local ethics committee for the study. The study conformed to the tenets of the Declaration of Helsinki.

This prospective study enrolled 42 patients with PCO. All patients treated with Nd:YAG laser capsulotomy between August 2014 and July 2015. The minimum period between the cataract surgery and Nd:YAG capsulotomy was 6 months. The inclusion criteria were previous uncomplicated phacoemulsification, presence of PCO, visual loss (at least two lines compared to the last visit) and a capsulotomy opening approximately 4.0 mm in diameter. The exclusion criteria were glaucoma, corneal or retinal disease, a history of ocular inflammation, previous laser treatments, ocular trauma, or surgery during the follow-up period, anterior capsule contraction and implantation of a toric or multifocal IOL.

All subjects underwent a comprehensive eye examination including refraction and best corrected visual acuity (BCVA), slit-lamp biomicroscopy, intraocular pressure measured using Goldman tonometry, and fundus examination. Refraction power was measured using a Topcon KR-8100 autorefractor (Topcon Corp, Nagoya, Japan). The spherical equivalent RE values were calculated as the sum of the sphere plus half the cylindrical power.

All measurements were repeated 3 times. VA was measured with an office-based Snellen system. The VA values were converted to logMAR units for statistical analysis.

All patients underwent OCT measurements preoperatively and postoperatively (at 1 and 7 days and 1 month). Before OCT measurement, full mydriasis was obtained with topical tropicamide 1% and phenylephrine hydrochloride 2.5%. Data on retinal nerve fiber layer (RNFL) thickness and macular thickness were obtained using the OCT (Spectral OCT SLO; Opko/OTI, Miami, FL). We also divided patients into 2 groups according to the energy levels. Group A was lower than 60 joules, group B was higher than 60 joules and we compared the OCT values. Signal strength was rated on a ten-point scale; signal strength values of  $\geq$  six were considered acceptable. Multiple images were taken from each eye by an experienced operator and the scan with the best signal was chosen for the study.

Tropicamide 1% and phenylephrine 2.5% were administered for pupillary dilatation prior to the procedure. A standard contact lens was used to enhance power density at the level of the posterior capsule and an approximately 4.0 to 4.5 mm diameter circular area of the central posterior capsule was cleared by emitting laser energy on the capsule. Energy levels starting from 1.0 mJ and up to 2.5 mJ were applied to the capsule. The Nd:YAG laser was posterior defocused by 0.50 mm in every eye. The energy level, total spot count, and total energy use of each patient were recorded. After capsulotomy, prednisolone acetate 1% four times daily and brimonidine tartrate 0.2% two times daily for 1 week were prescribed. All the procedures were performed by one ophthalmologist (S.C) and using an ophthalmic Nd:YAG laser (Visulas YAG II, Zeiss, Germany) with an Abraham capsulotomy lens (Ocular Instruments Inc, Bellevue, Washington).

Data analysis was performed using Statistical Package for Social Sciences for Windows software (SPSS version 16.0, SPSS Inc. Chicago, USA). Normality distribution of variables was tested by Kolmogorov-Smirnov test. Mean  $\pm$  standard deviations (SD) were used in the presentation of the data. Variables distributed normally were compared using Student's T test and variables distributed abnormally were compared using Mann-Whitney U test. Comparison of the parameters before and after the surgery between groups was performed using general linear model (repeated measure). Categorical variables were presented as frequency (%) and compared between the groups using chi-square test and Fisher's exact test. Differences were considered statistically significant when p value was  $<0.05$ .

## RESULTS

42 eyes of 42 patient were evaluated (19 men and 23 women). Mean age was  $63.7 \pm 1.06$  (range:35-83). The mean time between cataract surgery and Nd:YAG capsulotomy was  $45.36 \pm 33.72$  months.

The average total spot count was  $28.8 \pm 9.87$  (range:15-58). The total energy level was  $69.75 \pm 3.36$  joule (range:27.4-190).

The mean preoperative BCVA for logMar was  $0.72 \pm 0.55$  and postoperative logMar was  $0.17 \pm 0.23$  at 1 day,  $0.12 \pm 0.17$  at 1 week and  $0.09 \pm 0.18$  at 1 month. We found significant improvement at all visits when we compared preoperative values (p value  $<0.001$ ).

The mean intraocular pressure was  $13.6 \pm 3.14$  mmHg preoperatively. Postoperative IOP was  $12.4 \pm 4.14$  mmHg at 1 day,  $13.42 \pm 3.63$  mmHg at 1 week,  $13.9 \pm 3.18$  mmHg at 1 month. The IOP did not significantly increase or decrease at all visits (p value:0.29).

The mean preoperative spherical equivalent was  $0.16 \pm 1.29$  diopter (D). Postoperative values were;  $0.25 \pm 0.96$  D at 1 day,

0.20±0.99D at 1 week and 0.05±0.87D 1 month. There was not found any significant change in SE (p value:0.28).

The mean preoperative cylindrical power refraction was -1.6±1.57D. Postoperative first day was -0.83±1.15D, first week was -0.77±1.14D and first month was -0.70±1.03D. Cylindrical power refractions significantly decrease during the first month (p value:0.007).

The mean foveal thickness was 214.10 ±30.67µm preoperatively, 217±33.9µm at 1 day, 217.67 ±34.17µm at 1 week and 218.26±32.44µm at 1 month, postoperatively. There was not found any statistically significant difference between preoperatively and postoperatively foveal thickness (p value:0.769). We also compared foveal thickness according to the energy levels in two group (Group A was lower than 60 joules, group B was higher than 60 joules), there was not any significant difference (p value: 0.259).

In RNFL analysis, the mean average RNFL thickness was 99.66 ±10.56µm preoperatively, postoperative values were 103.1±9.76µm at 1 day, 102.67 ±9.48µm at 1 week, 104 ±9.93µm at 1 month. There was significant increase in RNFL thickness when we compared preoperative and postoperative average RNFL thickness (p value: < 0.001). Between group A and group B, there was not significant difference (p value:0.96). The mean superior quadrant RNFL thickness was 118.81±16.44µm preoperatively, 123.14±14.29µm at 1 day, 122.4±14.18µm at 1 week and 123.4±14.58µm at 1 month after laser treatment. We did not find any significant difference in superior quadrant analysis of RNFL thickness (p value:0.089). We also did not find any difference between the group A and B (p value:0.527). The mean inferior quadrant RNFL thickness was 125.86±15.25µm preoperatively, 129.86±18.09µm at 1 day, 128.57±16.39µm at 1 week and 131.67±18.66µm at 1 month, postoperatively. Either general analysis or group analysis there was not significant difference (p value:0.06, p value:0.065). The mean nasal quadrant RNFL thickness was 81.07±12.86µm preoperatively, 87.4±14.84µm at 1 day, 84.76±13.43µm at 1 week and 85.42 ±12.27µm at 1 month, postoperatively. We found statistically significant increase nasal quadrant of RNFL thickness (p value: 0.01) but we did not found any difference between group A and group B (p value:0.4). The mean temporal quadrant RNFL thickness was 73.38±16.09µm preoperatively, 73.92±12.98µm at 1 day, 74.16±11.69µm at 1 week and 74.95±10.88µm at 1 month, postoperatively. We did not find significant difference temporal quadrant of RNFL thickness either general analysis or group analysis (p value:0.86, p value:0.13).

## DISCUSSION

Standard treatment of the PCO is Nd:YAG laser capsulotomy. This method is reliable but it has several complications such as IOP changes, IOL damage and dislocation, iridocyclitis, vitreous hemorrhage and vitritis, retinal detachment, macular edema and refraction change. In our study, we did not find significant change in spherical equivalent but we detected that cylindrical power refractions significantly decrease during the first month. Our results are similar to the study of Khambhaphant et al. They analyzed 47 eyes and they found no significant change in SE but they found significant decrease cylindrical change after 3 months<sup>(10)</sup>. In 2014, Oztas et al. found significant decrease in cylindrical power refraction<sup>(11)</sup>. Vrijman et al. reported that Nd:YAG laser capsulotomy resulted in unchanged refraction for 93% of eyes.<sup>(12)</sup> They did not find significant change in either SE or cylindrical power refraction. Ozkurt et al. and Hu et al. also reported no

significant change in SE after treatment.<sup>(13,14)</sup> Zaidi et al. found hyperopic shift in SE.<sup>(15)</sup> They found that yag laser capsulotomy causes anterior movement of the IOL. For the satisfaction of the patient, it is important to prescribe the optimal corrective lenses after the yag laser capsulotomy. Because of the decreasing cylindrical refraction, we suggest the prescription after 1 month.

In general, yag laser capsulotomy improve visual functions. We found a statistically significant improvement in BCVA. Sometimes BCVA can not increase as we expect. One of the reasons of the worse BCVA is cystoid macular edema. Yag laser capsulotomy damage the vitreous and cause increasing inflammatory mediators. These mediators increase permeability of the perifoveal capillaries and result in cystoid macular edema. Karahan et al. examined patients according to the yag laser capsulotomy size (group 1<3.9mm, group 2>3.9mm). They found that CMT thickness increased 1 week after treatment but 4 weeks after treatment CMT decreased to preoperative levels in both groups.<sup>(16)</sup> Ari et al. who examined 30 patients according to the energy levels, they found significant increase in CMT in high energy group.<sup>(17)</sup> Another study from Turkey, Yilmaz et al. studied about long term changes in macular thickness, they did not find significant change in CMT.<sup>(18)</sup> Casas et al. found insignificant change in CMT at 3 months after treatment.<sup>(19)</sup> Steinert et al. found that the rate of cystoid macular edema was 1.23% in 897 patients.<sup>(20)</sup> In our study, we evaluated 42 eyes, we did not find significant change in CMT during the first month. We also compared CMT according to the energy levels, we did not detect any significant difference in short follow-up period. We did not observe cystoid macular edema in any patient.

The other complication of the yag laser capsulotomy is IOP change. Brimonidine tartrate was used after yag laser capsulotomy two times daily for 1 week. We checked IOP every visit during the follow-up period and we did not find significant increase. The RNFL measurement is a helpful diagnostic method in optic disc diseases especially in glaucoma. After yag laser capsulotomy glaucoma may become. In glaucoma, RNFL thickness get thinner. In the analysis of RNFL, we found increase in average RNFL and nasal quadrant of RNFL thickness. Our findings is correlated to study of Kara et al. They found statistically significant increase in average RNFL thickness which was measured 90.24± 15.9 µm preoperatively and 98.27±14.1 µm postoperatively.<sup>(21)</sup> Although we find statistically significant increase in RNLF thickness, the result is not clinically significant. We think that preoperative RNFL thickness was measured low because of the influence of PCO on OCT image quality so we think that preoperative RNFL thickness is of low reliability. After the yag laser capsulotomy image quality improves and reliability of the RNFL scans increase. This differentiation may affect the measuring of the CMT. In our study we took multiple images from each eye and the scan with the best signal was chosen for the study. Gonzales et al. showed that yag laser capsulotomy improve signal strength, but they did not find significant difference in CMT between preoperative and postoperative measurements.<sup>(22)</sup> Further evaluation about this issue is needed.

## CONCLUSION

We searched the short time effect of the yag laser capsulotomy on spherical equivalent, cylindrical power refraction, central macular thickness and retinal nerve fiber layer thickness. Nd: YAG capsulotomy is a safe procedure and produces a statistically small increase in average RNFL thickness that is not clinically significant and leads to an improvement in BCVA and reduction in cylindrical power.

## REFERENCES

1. Buehl W, Findl O, Menapace R, Sacu S, Kriechbaum K, Koepl C, et al. Long-term effect of optic edge design in an acrylic intraocular lens on posterior capsule opacification. *Journal of Cataract and Refractive Surgery*. 2005;31(5):954-61.
2. Buehl W, Menapace R, Sacu S, Kriechbaum K, Koepl C, Wirtitsch M, et al. Effect of a silicone intraocular lens with a sharp posterior optic edge on posterior capsule opacification. *Journal of Cataract and Refractive Surgery*. 2004;30(8):1661-7.
3. G. Cleary, D. J. Spalton, and D. D. Koch. Effect of square-edged intraocular lenses on neodymium: YAG laser capsulotomy rates in the United States. *Journal of Cataract and Refractive Surgery*. 2007;33(11):1899-906.
4. Billotte C, Berdeaux G. Adverse clinical consequences of neodymium:YAG laser treatment of posterior capsule opacification. *Journal of Cataract and Refractive Surgery*. 2004;30(10):2064-71.
5. Ranta P, Tommila P, Kivela T. Retinal breaks and detachment after neodymium: YAG laser posterior capsulotomy: five-year incidence in a prospective cohort. *Journal of Cataract and Refractive Surgery*. 2004;30(1):58-66.
6. Lee MS, Lass JH. Rapid response of cystoid macular edema related to Nd : YAG laser capsulotomy to 0.5% Ketorolac. *Ophthalmic Surgery, Lasers and Imaging Retina*. 2004;35(2):162-4.
7. Altamirano D, Mermoud A, Pittet N, van Melle G, Herbort CP. Aqueous humor analysis after Nd : YAG laser capsulotomy with the laser flare-cell meter. *Journal of Cataract and Refractive Surgery*. 1992;18(6):554-8.
8. Findl O, Drexler W, Menapace R, Georgopoulos M, Rainer G, Hitzinger CK, et al. "Changes in intraocular lens position after neodymium: YAG capsulotomy," *Journal of Cataract and Refractive Surgery*. 1999;25(5):659-62. V .
9. Chua, C. N., A. Gibson, and D. C. Kazakos. "Refractive changes following Nd: YAG capsulotomy." *Eye* 15.3 (2001): 304-305.
10. Khambhant 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.
11. Oztas Z, Palamar M, Afrashi F, Yagci A. The effects of Nd:YAG laser capsulotomy on anterior segment parameters in patients with posterior capsular opacification. *Clinical and Experimental Optometry*. 2015;98(2):168-71.
12. 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. *Journal of Refractive Surgery*. 2012;28(8):545-50.
13. Ozkurt YB, Sengör T, Evciman T, Habolu M. Refraction, intraocular pressure and anterior chamber depth changes after Nd:YAG laser treatment for posterior capsular opacification in pseudophakic eyes. *Clinical and Experimental Optometry*. 2009;92(5):412-5.
14. Hu CY, Woung LC, Wang MC, Jian JH. Influence of laser posterior capsulotomy on anterior chamber depth, refraction, and intraocular pressure. *Journal of Cataract and Refractive Surgery*. 2000;26(8):1183-9.
15. Zaidi M, Askari SN. Effect of Nd:YAG laser posterior capsulotomy on anterior chamber depth, intraocular pressure, and refractive status. *Asian J Ophthalmol*. 2003;5(4):2-5.
16. Karahan E, Tuncer I, Zengin MO. The effect of ND:YAG Laser posterior capsulotomy size on refraction, intraocular pressure, and macular thickness. *Journal of Ophthalmol*. 2014;2014: Article ID:846385.
17. Ari S, Cingü AK, Sahin A, Çinar Y, Çaça I. The effects of Nd : YAG laser posterior capsulotomy on macular thickness, intraocular pressure, and visual acuity. *Ophthalmic Surg Lasers Imaging*. 2012;43(5):395-400.
18. Yilmaz, T., and A. Yilmaz. "Long-term changes in subfoveal choroidal thickness and central macula thickness after Nd: YAG laser capsulotomy" *Int Ophthalmol*. 2016 Oct 3. [Epub ahead of print]
19. Ruiz-Casas D, Barrancos C, Alio JL, Ruiz-Guerrero M, Muñoz-Negrete FJ. Effect of posterior neodymium: YAG capsulotomy. Safety evaluation of macular foveal thickness, intraocular pressure and endothelial cell loss in pseudophakic patients with posterior capsule opacification. *Arch Soc Esp Ophthalmol*. 2013; 88:415-22.
20. Steinert RF, Puliafito CA, Kumar SR, Dudak SD, Patel S. Cystoid macular edema, retinal detachment, and glaucoma after Nd:YAG laser posterior capsulotomy. *Am J Ophthalmol*. 1991; 112(4):373-80.
21. Kara N, Altinkaynak H, Yuksel K, Kurt T, Demirok A. Effects of posterior capsular opacification on the evaluation of retinal nerve fiber layer as measured by stratus optical coherence tomography. *Canadian Journal of Ophthalmol*. 2012; 47(2):176-80.
22. Gonzalez-Ocampo-Dorta S, Garcia-Medina JJ, Feliciano-Sanchez A, Scalerandi G. Effect of posterior capsular opacification removal on macular optical coherence tomography. *Eur J Ophthalmol*. 2008; 18(3):435-41.

---

### Corresponding Author

Selim Cevher  
 Department of Ophthalmology, Eregli State Hospital, 42010  
 Konia, Turkey.