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The effect of posterior capsulotomy size on refraction and anterior chamber parameters following Nd:YAG laser treatment

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Abstract

To investigate the effect of capsulotomy size on refraction and anterior chamber parameters following Nd:YAG laser treatment. Fifty-six eyes of 56 pseudophakic patients with posterior capsular opacification (PCO) were reviewed. Patients were divided into two groups according to the capsulotomy size. Changes in best corrected visual acuity (BCVA), spherical equivalent (SE), anterior chamber depth (ACD), anterior chamber volume (ACV) and anterior chamber angle (ACA) were compared between groups. A hyperopic shift was remarkable in the 1st week in both groups but SE declined about to preoperative levels at 1 month after laser capsulotomy in both groups (p=0,056). In both groups, ACD decreased 1 week after laser capsulotomy (p<0,001). There was not a significant change in ACV in both groups by time (p=0,583). It was found a statistically significant interaction between the capsulotomy size and ACA (p=0029). While the ACA decreased in small capsulotomy group by time, it increased in large capsulotomy group. Capsulotomy size was correlated with ACA. However, it did not have an effect on BCVA, SE, ACD and ACV.

Keywords: Posterior capsular opacification, Nd:YAG laser, spherical equivalent, anterior chamber parameters

Introduction

Posterior capsular opacification (PCO) is still one of the most common complications of cataract surgery despite the developments in surgical instruments, intraocular lens (IOL) designs and surgical techniques [1]. It results in decreased visual acuity, reduced contrast sensitivity, glare and monocular diplopia [2]. The proliferation of the lens epithelial cell remnants in the intracapsular area plays an essential role in the pathogenesis of PCO [3]. Continuous curvilinear capsulorhexis, successful hydrodissection, excellent removal of cortex and lenticular epithelial cells, in-the bag IOL placement and using a single-piece, acrylic sharp edges IOLs can be listed among the factors in the prevention of PCO. Anti-metabolites such as 5 fluorouracil and mitomycin C may also be used intraoperatively for this purpose [4].

Neodymium:yttrium-aluminum-garnet (Nd:YAG) laser capsulotomy is the standard treatment for PCO [5]. However, several side effects including intraocular pressure (IOP) elevation, cystoid macular edema, retinal detachment and IOL subluxations were reported [2,6,7]. It is the preferred treatment method in PCO with its economical, rapid and non-invasive aspects [8].

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There are conflicting results in the literature about the effect of Nd:YAG laser treatment on refraction and anterior chamber parameters [9-14]. Several studies have reported the relation between the capsulotomy size and visual acuity, refraction and posterior segment complications [15-19]. However, to the best of our knowledge this is the first study investigating the relation between capsulotomy size and anterior chamber parameters.

Materials and Methods

Fifty-six eyes of 56 pseudophakic patients with PCO were enrolled in this observational cross-sectional study. The medical records of the patients who underwent Nd:YAG laser posterior capsulotomy in a single session by the same surgeon (BA) were received. Inclusion criteria was a previous routine phacoemulsification surgery with in-the-bag intraocular single-piece lens placement. The patients with any pathology of the anterior segment and chronic ocular diseases such as glaucoma, keratoconus and uveitis were excluded from the study. Written informed consent had been obtained from all the patients. The study was carried out in accordance with the tenets of the Declaration of Helsinki and was approved by local institutional Ethical Committee.

All patients underwent a detailed ophthalmic examination including best-corrected visual acuity (BCVA), refraction-spherical equivalent (SE), Goldman applanation tonometry, biomicroscopy, indirect fundoscopy, axial length measurement

and the Scheimpflug anterior segment analysis before Nd:YAG laser capsulotomy. The measurements were repeated 1 week and 1 month after the capsulotomy procedure.

Refraction measurements were performed with Canon RK-F1 Auto Ref-Keratometer (Canon Inc., Japan). IOL Master 500 (Carl Zeiss Meditec, Jena, Germany) was used to measure axial length.

Anterior chamber parameters (ACV, ACD and ACA) were all measured by the Sirius 3D Rotating Scheimpflug camera topography system (Costruzione Strumenti Oftalmici, Florence, Italy). The Sirius system is based on the combination of two rotating Scheimpflug cameras and a Placido disc with 22 rings. It provides a 3-dimensional model of the anterior segment and supplies with precise diagnostic data on the entire anterior eye segment within a few second. The topography and pachymetry of the entire cornea, anterior chamber angle, anterior chamber volume and depth are automatically calculated (Figure 1).

All Nd:YAG laser capsulotomies were performed by using Ellex Ultra Q Nd:YAG laser (Ellex Medical Lasers Limited, Adelaide, Australia) after 25 minutes instillation of 1% tropicamide ophthalmic solution. The capsulotomy size was determined according to the scotopic pupil diameter. The scotopic pupil size was measured automatically by the pupillometry system embedded in the Sirius system. Nepafenac 0.1% solution four times a day and a brimonidine tartrate solution two times daily for 1 week were administered to all patients after the procedure.

The capsulotomy sizes were calculated at the control visit on the first week. It was determined with respect to the vertical and horizontal diameters of the posterior capsular opening by using the reticule on the slit-lamp. The averaged of the vertical and horizontal diameters were taken into consideration. The patients were divided into two groups according to the capsulotomy size. Thirty patients with capsulotomy size equal or smaller than 4 mm constituted the group 1 and twenty-six patients with a > 4mm capsulotomy size constituted the group 2.

Statistical analysis was carried out using SPSS 17.0 (SPSS, Chicago, Illinois, USA). Descriptive analyses were presented using means and standard deviations for normally distributed variables. One-way ANOVA was used to compare the intra-group parameters. Levene test was used to assess the homogeneity of variances. When an overall significance was observed, pairwise post-hoc tests were performed using Tukey's test. Independent samples t test was used to compare the inter-group parameters. The effect of capsulotomy size on the change in visual acuity, SE, ACD, ACV and ACA by time was investigated using repeated measures analysis of variance. Greenhouse-Geisser correction was used when the sphericity assumption was violated. P value of less than 0.05 was considered to be statistically significant.

Results

Both groups were similar in terms of age, gender, intraocular pressure, spherical equivalent, total energy used in capsulotomy and ACD before laser treatment. However, the pre-laser mean ACV and ACA values were found to be statistically higher in group 1 than group 2 (p=0.002, p=0,019, respectively). The initial (before laser treatment) demographic and clinical characteristics of both groups were summarized in Table 1. Inter-intra group comparisons of BCVA, SE, ACD, ACV and ACA before Nd:YAG laser capsulotomy and 1 week and 1 month after laser procedure is shown in Table 2.

Table 1. The demographic and clinical characteristics of groups before laser treatment

	Group 1 (capsulotomy size ≤4mm), n=30	Group 2 (capsulotomy size >4mm), n=26	P value
Age	72,3±5,6	71,8±6,6	0,751
Gender (male[%])	43,3%	56,7%	0,509
Intraocular pressure	15,8±1,9	15,4±2,4	0,532
Spherical equivalent	-0,41±0,92	-0,82±0,89	0,099
Total energy used in capsulotomy	55,2±20,7	45,8±19,6	0,090
Best-corrected visual acuity (logmar)	0,27±0,11	0,32±0,11	0,086
Anterior chamber Depth	3,76±0,32	3,66±0,53	0,394
Anterior chamber volume	177,06±17,47	161±19,37	0,002
Anterior chamber angle	54,76±5,76	50,84±6,39	0,019

*p value represents the comparisons of the groups; **p value represents the change in the intragroup parameters by time

Table 2. Inter-intra group comparisons of BCVA, SE, ACD, ACV and ACA before Nd:YAG laser capsulotomy and 1 week-1 month after laser treatment.

	Group 1 (capsulotomy size ≤4mm), n=30	Group 2 (capsulotomy size >4mm), n=26	*P value
BCVA (Logmar)			
Pre-laser	0,27±0,11	0,32±0,11	
1 week	0,07±0,05	0,10±0,05	0,646
1 month	0,04±0,05	0,06±0,05	
		**p<0,001	
SE			
Pre-laser	-0,41±0,92	-0,82±0,89	
1 week	-0,30±0,89	-0,63±0,78	0,419
1 month	-0,49±0,79	-0,73±0,81	
		**p=0,056	
ACD			
Pre-laser	3,76±0,32	3,66±0,53	
1 week	3,58±0,20	3,49±0,36	0,891
1 month	3,60±0,17	3,51±0,34	
		**p<0,001	
ACV			
Pre-laser	177,06±17,4	161,0±19,3	
1 week	175,56±12,7	163,0±17,8	0,097
1 month	174,16±12,9	162,5±17,9	
		**p=0,583	
ACA			
Pre-laser	54,76±5,7	50,84±6,3	
1 week	53,40±5,4	51,50±6,5	0,029
1 month	53,33±5,5	51,73±6,03	
		**p=0,612	

BCVA improvement at 1 week and 1 month was statistically significant in both groups (p< 0,001). However, there was no interaction between the capsulotomy size and BCVA improvement (p=0,646) (Figure 1).

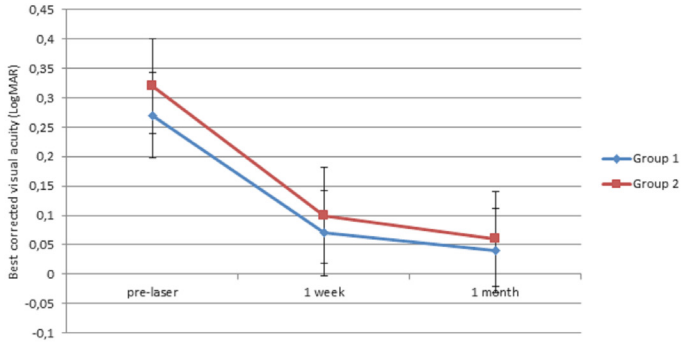

Figure 1. Repeated measurements of BCVA (Logmar) in both groups before Nd:YAG laser capsulotomy and 1 week-1month after procedure. The trends of two lines are parallel.

A hyperopic shift was remarkable in the 1st week in both groups but SE declined about to preoperative levels at 1 month after laser capsulotomy in both groups (p=0,056) (Figure 2). Besides, there was no difference between the two groups (p=0,419).

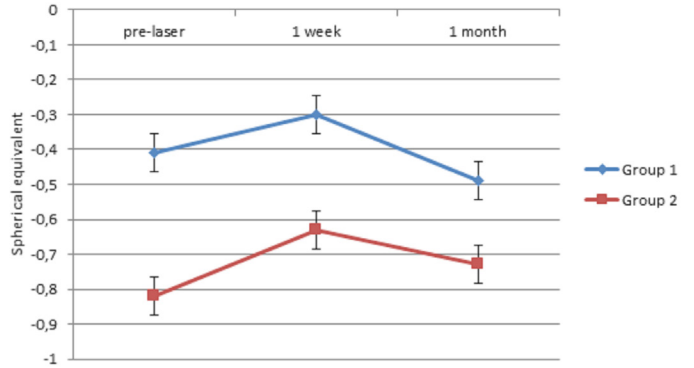

Figure 2. Repeated measurements of SE in both groups before Nd:YAG laser capsulotomy and 1 week-1month after procedure. Hyperopic shift can be seen in the 1st week in both groups. The trends of two lines are parallel.

In both groups, ACD decreased 1 week after laser capsulotomy, but subsequently a slight increase was observed in the 1-month follow-up period. This trend in ACD was statistically significant (p<0,001), nevertheless there was no difference between the groups (p=0,891) (Figure 3).

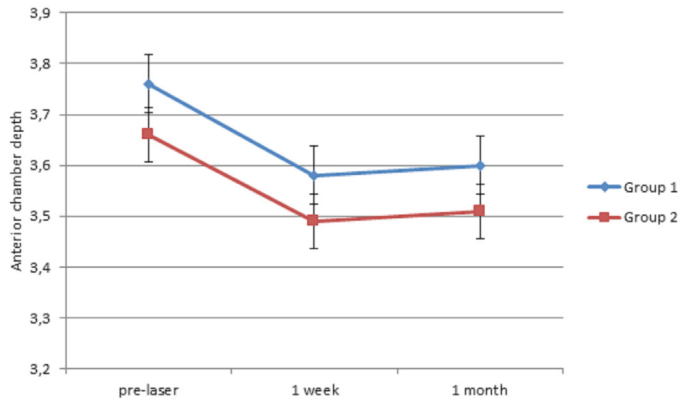

Figure 3. Repeated measurements of ACD in both groups before Nd:YAG laser capsulotomy and 1 week-1month after procedure. The trends of two lines are parallel

There was not a meaningful change in ACV values in both groups by time (p=0,583), likewise, no interaction between the capsulotomy size and ACV was observed (p=0,097) (Figure 4).

It was found a statistically significant interaction between the capsulotomy size and ACA (p=0.029). While the ACA values decreased in group 1(small capsulotomy group) by time, those increased in group 2 (Figure 5).

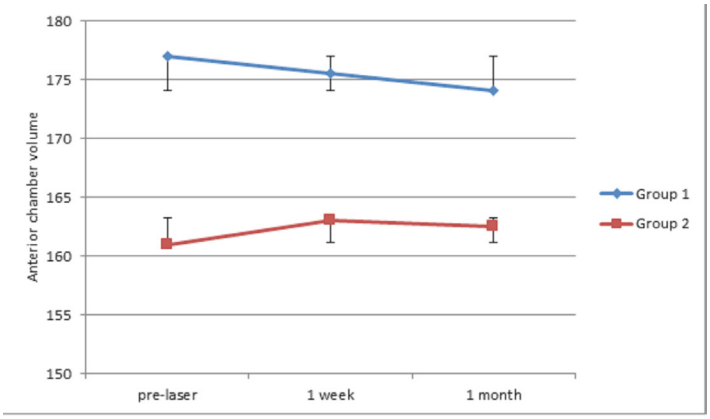

Figure 4. Repeated measurements of ACV in both groups before Nd:YAG laser capsulotomy and 1 week-1month after procedure. The trends of two lines are almost parallel.

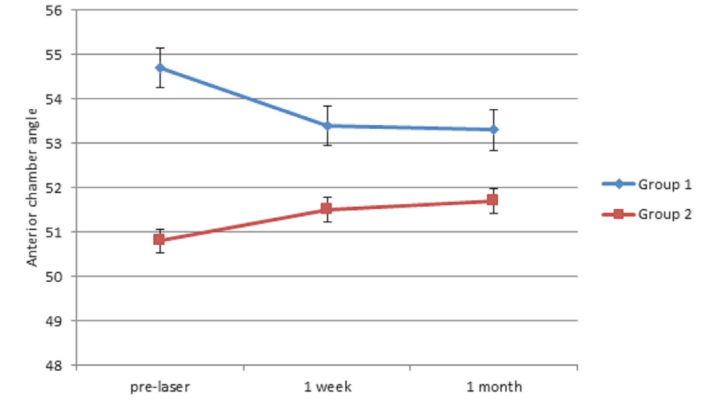

Figure 5. Repeated measurements of ACA in both groups before Nd:YAG laser capsulotomy and 1 week-1month after procedure. A decline in the ACA is remarkable in the small capsulotomy group (group 1), on the contrary an increase in ACA in large capsulotomy group (group 2) is seen.

Discussion

PCO remains the most common long-term complication after cataract surgery, despite continued refinement of surgical technique. The incidence of PCO was reported to be 20.7% at two years and 28.5% at 5 years after cataract surgery [20]. At present, Nd:YAG laser is the preferred method for correction of visual loss caused by capsular opacification and remains the gold standard for the treatment of PCO.

Although Nd:YAG laser capsulotomy has been found to be safe and effective, the procedure has potential to affect the position of the IOL. Theoretically, posterior movement of the IOL may cause a hyperopic shift. Some studies reported that [7,10,11] the change in SE after Nd:YAG laser capsulotomy was statistically insignificant. However, conflicting results were reported about the association between capsulotomy size and SE. For instance, Cetinkaya and colleagues found no significant changes in SE in any capsulotomy size groups in just the same way as Yilmaz et al. [15,18]. But Karahan et al. declared that patients who underwent a larger capsulotomy size equal or larger than 3.9mm have had a higher hyperopic shift [19]. In our study, we found a hyperopic shift in both small and large capsulotomy groups in the first week and there were no differences between the two groups. But after a month SE has declined about to preoperative levels.

Several studies have used different techniques to look at the effects of Nd:YAG laser capsulotomy on ACA morphology and no statistically significant difference was noted in ACA before and after Nd:YAG laser capsulotomy by three studies conducted between 1995 and 2009 [7,11,13]. Findl and associates [9] reported that Nd:YAG capsulotomy induced a backward movement of the IOL and this resulted in deepening of the anterior chamber. On the other side Smith RT and his colleagues have shown no significant changes in ACD [12]. Two distinct studies reported a significant decrease in mean ACD after Nd:YAG capsulotomy [4,14]. But none of the aforementioned studies investigated the effect of the capsulotomy size on ACD. In our study we observed that in both groups ACD decreased 1week

after laser capsulotomy, but subsequently a slight increase was seen after 1 month. No significant difference existed between the groups according to the capsulotomy sizes.

There was no study in the literature analyzing the association between the capsulotomy size and ACA. We found a statistically significant interaction between the capsulotomy size and ACA. While the ACA values decreased in small capsulotomy size group by time, those increased in larger capsulotomy size group. We believed that this may be a critical finding in the current study.

Conclusions

In conclusion, we found that there was no statistically significant changes between capsulotomy size and BCVA, SE, ACD, ACV. However, there was a statistically significant interaction between capsulotomy size and ACA. In small capsulotomy group ACA was decreased, on the contrary ACA was increased in larger capsulotomy group. Overall a larger capsulotomy size may be preferred in the patients with suspect narrow-angle.

Competing interests
The authors declare that they have no competing interest.

Financial Disclosure
The financial support for this study was provided by the investigators themselves.

Ethical approval
The study was carried out in accordance with the tenets of the Declaration of Helsinki and was approved by local institutional Ethical Committee.

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