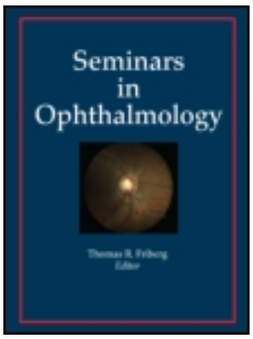

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ORIGINAL ARTICLE

Comparison of Two Laser Capsulotomy Techniques: Cruciate Versus Circular

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ABSTRACT

Purpose: To compare the safety and efficacy of two Nd: YAG laser capsulotomy techniques. *Methods*: In this prospective comparative interventional case series, 60 eyes of 57 patients with posterior capsular opacification were enrolled. Thirty eyes were selected to undergo a cruciate capsulotomy (Cross group) and the other 30 eyes were selected to undergo a circular capsulotomy (Circular group). Main outcome measures were best-corrected visual acuity (BCVA), intraocular pressure (IOP), amount of energy used, mean macular thickness (MMT), and floater symptoms. *Results*: The amount of energy used was significantly higher in the Circular group than in the Cross group ($p < 0.001$). BCVA and IOP were not significantly different between the two groups at baseline or follow-up. MMT was significantly higher in the Circular group than in the Cross group at one day after the laser procedure ($p = 0.032$). MMT was not significantly different between groups at one week, one month, and three months ($p > 0.05$). The number of patients with floater symptoms was significantly higher in the Circular group than in the Cross group at one week and one month ($p < 0.05$). *Conclusion*: Both the cross-like and circular Nd:YAG laser capsulotomy techniques induce similar visual and IOP changes. The circular technique is associated with a higher amount of energy used, more floater symptoms, and has a greater effect on macular thickness at one day after laser capsulotomy.

Keywords: Circular, cruciate, floater, Nd:YAG laser capsulotomy, posterior capsular opacification

INTRODUCTION

Posterior capsular opacification (PCO) is still the most common complication of modern-day cataract surgery, despite continuing advances in intraocular lens technology, surgical instrumentation, and surgical technique. PCO may compromise visual acuity and contrast sensitivity, and may produce excessive glare. The adequacy of visualization of the posterior segment for diagnostic and/or therapeutic purposes may also be compromised.

Neodymium: YAG (Nd: YAG) laser posterior capsulotomy is routinely used to treat posterior capsule opacification. Although Nd:YAG laser posterior capsulotomy improves visual functions, adverse effects of the Nd:YAG capsulotomy, such as a rise in intraocular pressure (IOP), IOL damage, subluxation of the intraocular lens, cystoid macular edema uveitis, macular hole, or retinal detachment, tend to occur.[1–9]

Several Nd: YAG laser techniques have been described for posterior capsulotomy in patients with PCO. Currently, two posterior YAG capsulotomy techniques, including cruciate technique and circular technique, are used. The effects of factors such as capsulotomy size and applied laser energy on the results of Nd: YAG laser capsulotomy have been reported previously, but the effect of capsulotomy techniques has not been investigated before. This study compared the efficacy and safety of two YAG capsulotomy techniques (cruciate technique and circular technique).

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PATIENTS AND METHODS

Design and Study Population

This prospective and interventional study was performed at the Department of Ophthalmology of the Bakirkoy Sadikonuk Research and Training Hospital. The study protocol was approved by the local ethics committee. An informed consent was obtained before the Nd: YAG laser capsulotomy.

Study participants had a PCO following an uneventful phacoemulsification and intraocular lens implantation. Eligible patients were assigned to one of the two capsulotomy opening techniques. The two groups were matched in terms of age, gender, and PCO score. The patients were excluded from the study if they had a history of previous ocular surgery except cataract surgery, eye trauma, uveitis, glaucoma, or systemic disease such as diabetes mellitus.

All of the patients underwent a complete examination that included Snellen best-corrected visual acuity (BCVA), biomicroscopy, IOP measured by Goldmann applanation tonometry, and dilated fundus examination. Also, macular thickness measurement was performed using spectral optical coherence tomography.

Posterior capsular opacification was diagnosed using slit-lamp examination under cycloplegia induced by instilling tropicamide 1% and phenylephrine 2.5% every 10 minutes over 30 minutes. PCO grading was performed based on dilated slit-lamp findings and fundus red reflex as follows: grade 1 (no or slight PCO), grade 2 (mild PCO), grade 3 (moderate PCO), and grade 4 (severe PCO).[10]

Techniques of Laser Capsulotomy

A Nd:YAG laser capsulotomy was performed on patients who had subjective visual disturbance that appeared to have been caused by PCO. All Nd: YAG laser capsulotomy procedures were performed under topical anesthesia using proparacaine by the same surgeon (NK) to reduce operator bias. A 3– to 4-mm posterior capsulotomy was performed using the ophthalmic Nd:YAG laser (LightMed®, LightMed Corporation, California, USA) with Abraham capsulotomy contact lenses. The single bursts were performed starting at 0.8 mJ and gradually increased in power until a 3-4-mm capsular opening was created.

Cruciate Technique. The laser treatment was initiated off-axis in a horizontal line across the center, followed by a line in the vertical axis to form a cross.

Circular Technique. Nd: YAG laser capsulotomy was performed using a circular pattern of laser treatment. A topical steroid was administered for a week after the laser capsulotomy.

Evaluation of Patients

Clinical examination and measurements were repeated at one day, one week, one month, and three months after the procedures. Capsulotomy size (axis for cruciate technique and diameter for circular technique) was measured using the light length of the slit-lamp. Main outcomes measures: best-corrected visual acuity, intraocular pressure, used amount of energy, macular thickness, and floater symptoms related to posterior capsule remnants.

Data Analyses

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) Version 16. The normality of the data was confirmed using the Shapiro-Wilk Test ($p > 0.05$). An independent sample t test and Chi-square test for paired data were used to assess the differences between the groups. Pre-laser and post-laser measurements were compared using paired t test. A p value of less than 0.05 was considered significant.

RESULTS

This study included 60 eyes of 57 patients on whom Nd: YAG laser capsulotomy for the PCO was performed. The demographic and clinical characteristics of the two groups of subjects are shown in Table 1. No statistically significant differences were observed between the two groups in terms of age, gender distributions, or PCO grading. Mean capsulotomy size was 3.8 ± 0.2 mm in the cruciate group and 3.9 ± 0.3 mm in the circular group ($p = 0.512$)

The mean interval between the cataract surgery and Nd: YAG laser capsulotomy was 50.1 ± 13.0 months (range 26 to 72) in the cruciate group and 47.7 ± 24.3 months (range 14 to 96) in the circular group ($p = 0.737$). The mean applied laser energy in the cruciate and circular groups was 54.9 ± 19.0 (range 21 to 90) milijoules (mj) and 104.7 ± 37.3 (range 39 to.160) mj, respectively ($p < 0.001$). The mean applied shot was 38.8 ± 8.9 (range 26 to 60) in the cruciate group and 58.7 ± 24.3 (range 33 to 100) in the circular group ($p = 0.004$).

The mean BCVA before Nd-YAG laser posterior capsulotomy was 0.40 ± 0.15 (range 0.2 to 0.6) in the cruciate group and 0.31 ± 0.16 (range 0.10 to 0.60) in the circular group ($p = 0.120$). The BCVA improved 0.95 ± 0.11 (range 0.70 to 1.0) in the cruciate group and 0.93 ± 0.13 (range 0.60 to 1.0) in the circular group three months after capsulotomy.

The mean IOP before capsulotomy was 16.7 ± 2.9 mmHg in the cruciate group and 15.6 ± 1.4 mm Hg in the circular group ($p = 0.137$). The mean

TABLE 1. Demographics and baseline characteristics of patients.

	Cruciate technique	Circular technique	p
Number of Eyes/Patients	30/29	30/28	
Gender			
Female/Male	19/10	21/7	0.564[a]
Age			
Mean ± SD	56.8 ± 19.2	57.3 ± 15.4	0.932[b]
Range	33–78	39–82	
Interval Between Cataract and Laser Procedures			
Mean ± SD	50.1 ± 13.0	47.7 ± 24.3	0.737[b]
Range	26 to 72	14 to 96	
PCO Grade			
Mean ± SD	2.7 ± 0.5	2.9 ± 0.7	0.127[b]
Range	2 to 4	2 to 4	

PCO: Posterior capsular opacification
[a]: chi-square test, [b]: independent–t test

TABLE 2. Mean central macular thickness at baseline and at various time points up to one month.

	Cruciate technique	Circular technique	p^a
Baseline	266 ± 34	271 ± 17	0.679
	204 to 316	248 to 291	
1 day	257 ± 30	281 ± 37	0.032
	214 to 315	250 to 426	
1 week	257 ± 27	280 ± 48	0.088
	211 to 315	241 to 438	
1 month	253 ± 30	281 ± 53	0.083
	203 to 312	255 to 433	
3 months	258 ± 30	277 ± 43	0.125
	214 to 316	251 to 403	

[a]: independent–t test

post-laser IOP in the cruciate group and in the circular group was 15.9 ± 2.1 and 15.3 ± 2.0 on the first day ($p = 0.330$), 16.0 ± 2.2 and 15.2 ± 2.1 in the first week ($p = 0.305$), and 15.7 ± 2.9 and 14.4 ± 2.2 after the first month ($p = 0.168$).

The mean preoperative and postoperative macular thicknesses are shown in Table 2. No statistically significant differences were observed between the two groups in terms of mean preoperative macular thickness ($p = 0.679$). On the first postoperative day, mean macular thickness was significantly higher in the circular group than the cruciate group ($p = 0.032$); however, in the first week, first month, and third month, no significant difference was observed between the groups ($p > 0.05$).

Table 3 shows the number of patients who had symptoms of floaters related to a posterior capsule remnant after the laser capsulotomy. The rate of patients who have had floaters symptom was higher in the circular technique than the cruciate technique at one day ($p < 0.001$), one week, ($p < 0.001$), one month ($p = 0.001$), and three months after the procedure ($p = 0.495$).

TABLE 3. Number of patients with floater symptoms after laser capsulotomy.

	Cruciate technique	Circular technique	p^a
Baseline	0 (0)	0 (0)	<0.001
1 day	0 (0)	16 (53.3)	<0.001
1 week	0 (0)	12 (40)	<0.001
1 month	0 (0)	6 (20)	0.023
3 months	0 (0)	2 (6.6)	0.495

[a]: chi-square test

DISCUSSION

Nd: YAG laser posterior capsulotomy is a well-established treatment modality for posterior capsular opacification. Although Nd:YAG laser capsulotomy improves visual acuity, contrast sensitivity, and fundus visualization, it has some complications, such as damage to intraocular lenses, post-laser intraocular pressure increases, cystoid macular edema, disruption of the anterior vitreous face, increased incidence of retinal detachment, and re-closure of the capsulotomy.[11–17]

Several techniques for Nd: YAG laser delivery have been described.[18] These include cruciate, circular, horseshoe, or spiral delivery. Each technique has its own advantages and disadvantages. However, there is still a lack of consensus regarding Nd: YAG laser capsulotomy techniques. Currently, Nd: YAG laser capsulotomy is performed using two main techniques: cruciate and continuous curvilinear capsulotomy. According to a survey by Gomaa et al., 47% of the ophthalmologists apply the Nd:YAG laser procedure in a cruciate pattern, 27.3% use a circular technique, 23.5% use both techniques, and 2.3% prefer other techniques.[19] However, there have been no studies that report the effect of YAG laser capsulotomy techniques on the results of a capsulotomy.

There is significant improvement in visual acuity, stereoacuity, and contrast sensitivity after Nd: YAG capsulotomy.[20–24] Improvement in visual acuity after Nd:YAG capsulotomy in patients with significant PCO has been well documented.[9,25–27] A previous study found no effect of capsulotomy size on changes of visual acuity and changes of spherical equivalent refraction.[28] Hayashi et al. indicated that both small and large capsulotomies have shown no significant correlation between the opening area created by the capsulotomy and BCVA, and between the opening area and the contrast sensitivity or glare.[29] In this study, we created 3- to 4-mm (for vertical and horizontal diameters) posterior capsulotomy in both groups, which produced similar resultant capsulotomy openings. The current study showed that no differences were found in terms of visual acuity. Intraocular pressure changes following Nd:YAG laser capsulotomy have been reported in many studies.[30,31]

Different explanations that have been given for the pressure rise following Nd: YAG laser treatment include the deposition of debris in the trabecular meshwork, pupillary block, and inflammatory swelling of the ciliary body or iris root associated with angle closure.[32–36] In our study, we found no statistical difference in terms of IOP between the cruciate and circular group.

Previous studies have investigated changes of macular thickness after Nd: YAG laser capsulotomy. Although some of the previous studies have reported cystoid macular edema, many of them found no significant changes in macular thickness following Nd: YAG laser capsulotomy.[37–42] This study showed that macular thickness was significantly higher in the circular group than in the cruciate group on the first day after the procedure. However, no significant difference was seen in terms of macular thickness between the two groups at one week, one month, and three months after capsulotomy. Although the possible mechanism of CME is still unclear, it is suggested that, in response to the YAG laser, mediator agents such as prostaglandins are released from the anterior segment and traverse the vitreous to reach the retina, where they may cause leakage of perifoveal capillaries. This can lead to accumulation of fluid in the macula.[43,44]

Nd:YAG capsulotomy, in addition to causing photodisruption of the posterior capsule, causes disruption of the anterior vitreous face in approximately 33% of cases.[45] It is likely that, in many cases where isolated remnants of the posterior capsule remain, these fragments settle into the vitreous cavity and they lead to complaints of floaters. Our study indicated that circular YAG laser capsulotomy leads to floaters related to posterior capsule remnants. On the other hand, cruciate laser capsulotomy was not associated with floaters. A circular application of the laser could leave a remnant of the posterior capsule that could result in symtoms of floaters during head movement. However, a cruciate laser application causes a contraction of the capsule or leads to the lasered portion ''flopping'' out of the visual axis. Vella et al. reported a case with persistent floaters following circular YAG laser application.[46]

Although this study is the first in terms of comparison of two Nd:YAG capsulotomy techniques, it has some limitations. The small sample size precludes firm conclusions; further investigation would be required in a larger study population. Moreover, the PCO grading is subjective and may lead to bias. However, PCO scores were significantly associated with signal strength and visual acuity. This correlation may increase the reliability of the PCO grading process.

In summary, the circular and cruciate Nd: YAG laser capsulotomy applications are two of the most common laser capsulotomy techniques. Although visual results and IOP values were similar in both groups, cruciate laser applications have advantages such as fewer energy applications and a lower rate of floater symptoms.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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