

# Long-term follow-up of neodymium: YAG laser anterior capsulotomy for the treatment of anterior capsular phimosis

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Hehua Ye<sup>1</sup>, Jiming Zhang<sup>2</sup> and Yiyong Qian<sup>2,3</sup>

## Abstract

**Objective:** To investigate the long-term safety and efficacy of Nd:YAG laser anterior capsulotomy for the treatment of anterior capsular phimosis.

**Methods:** We retrospectively analyzed a consecutive case series of Nd:YAG laser anterior capsulotomy in patients with anterior capsular phimosis, who were treated between November 2012 and April 2014. Data collected included risk factors, interval between surgery and capsulotomy, best-corrected visual acuity (BCVA), and diameter of anterior capsule opening before and after Nd:YAG laser anterior capsulotomy.

**Results:** Eleven eyes of 11 patients were included in the study. The mean follow-up time was  $30.1 \pm 4.5$  months (range: 26–42 months). At the last follow-up, the mean diameter of the anterior capsule opening was  $5.1 \pm 0.2$  mm, which was significantly greater than the diameter before laser capsulotomy ( $2.2 \pm 0.8$  mm). BCVA remained stable or improved in nine eyes (81.8%) following capsulotomy. No patients experienced recurrence of phimosis.

**Conclusions:** In a long-term study of >2 years, we found that Nd:YAG laser anterior capsulotomy is safe and effective for the treatment of anterior capsule phimosis.

<sup>3</sup>Department of Ophthalmology, Shanghai Tenth People's Hospital, Tongji University School of Medicine, Shanghai, P. R. China

## Corresponding author:

Yiyong Qian, Department of Ophthalmology, Shanghai Tenth People's Hospital, Tongji University School of Medicine, 301 Middle Yan Chang Road, Shanghai 200072, P. R. China.

Email: [tsien@suda.edu.cn](mailto:tsien@suda.edu.cn)

<sup>1</sup>Department of Ophthalmology, Xinhua Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, P. R. China

<sup>2</sup>Department of Ophthalmology, The First Affiliated Hospital of Soochow University, Suzhou, P. R. China



## Keywords

Anterior capsule phimosis, capsular opacification, Nd:YAG laser, capsulotomy, laser therapy, follow-up studies, phimosis

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## Introduction

Anterior capsular phimosis (or anterior capsule contraction syndrome) is a complication associated with continuous curvilinear capsulorhexis (CCC) following cataract surgery.<sup>1,2</sup> Rapid proliferation of residual anterior lens epithelial cells, followed by fibrous metaplasia, is suspected to result in eventual capsule contraction.<sup>1,3</sup> Opacification and severe contraction of the anterior capsule can cause a reduction in visual quality, as well as intraocular lens (IOL) decentration and/or tilt.<sup>4-6</sup> In extreme cases, zonular traction may lead to IOL dislocation and retinal detachment.<sup>7</sup>

Since Davison first advocated the use of neodymium:YAG (Nd:YAG) laser anterior capsulotomy for disrupting the contraction forces without further surgical intervention, Nd:YAG laser radial anterior capsulotomies have typically been performed to enlarge the opening area when capsular phimosis develops.<sup>1</sup> Previous studies have shown that Nd:YAG laser anterior capsulotomy is generally safe and effective for anterior capsule phimosis.<sup>1,8-11</sup> However, to our knowledge, there have been no reports regarding the long-term outcomes of Nd:YAG laser anterior capsulotomy. The purpose of this study was to investigate the long-term safety and efficacy of Nd:YAG laser anterior capsulotomy for the treatment of anterior capsule phimosis. We assessed anterior capsule opening and possible adverse effects of capsulotomy, including ocular inflammation, intraocular pressure elevation, and IOL dislocation.

## Patients and methods

We retrospectively reviewed consecutive cases of patients with anterior capsular phimosis who underwent Nd:YAG laser anterior capsulotomy between November 2012 and April 2014.

Anterior capsular phimosis was defined as the presence of contraction of the anterior capsular aperture within the undilated pupillary aperture, combined with any of the following findings: anterior capsule aperture decentration, IOL decentration and/or tilt, or visual disturbance and difficulty in examining the fundus.<sup>10</sup> Exclusion criteria included apparent posterior capsule opacification (PCO), a history of ocular surgery other than cataract phacoemulsification, a pupil diameter smaller than 5.0 mm after mydriasis, and patient refusal to participate in the study.

The study followed the tenets of the Declaration of Helsinki, and the Ethics Committee of the First Affiliated Hospital of Soochow University approved the protocol. Written informed consent was obtained from each patient.

Anterior capsulotomy was performed by using the method described by Hayashi et al.,<sup>11</sup> in which a Q-switched Nd:YAG laser (YC-1600; NIDEK, Gamagori, Japan) was used. Following dilation of the pupil and administration of topical anesthesia, a contact lens was applied to enhance the power density at the anterior capsule level. Either four or five relaxing incisions were made, beginning at the margin of the anterior capsule opening

and extending peripherally to the edge of the IOL optic. The incisions were made by emitting laser energy on the anterior capsular rim. The energy levels were 1.5–2.5 mJ; single pulse mode and 15  $\mu$ m spot size settings were used. Care was taken not to pit the IOL optic. The patient was treated with a schedule of pranopufen 0.1% eye drops (Pranopulin, Senju, Japan) that were tapered over 4 weeks after capsulotomy.

All patients underwent complete ophthalmologic evaluations, including best-corrected visual acuity (BCVA), intraocular pressure (IOP), diameter of the anterior capsule opening (recorded as the mean of the longest and shortest diameter values), and IOL centration before and after Nd:YAG laser anterior capsulotomy. Follow-up examinations were performed at 1, 3, and 6 months after capsulotomy; thereafter, the patients were checked at 6-month intervals. All cases had a minimum follow-up of 24 months.

A paired-sample T test was used to compare the diameters of the anterior capsule opening, before and after laser capsulotomy. Statistical analysis was performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA).  $P < 0.05$  was considered statistically significant.

## Results

Included in the study were 11 eyes of 11 patients (Table 1), six (54.5%) of whom were women. The mean age of the patients was  $68.1 \pm 8.5$  years (range 54–81 years). Four cases in our series had type 2 diabetes mellitus, three cases had high myopia, two cases had retinitis pigmentosa, and one case had undergone prior implantation of a silicon IOL. The mean interval between the phacemulsification surgery and Nd:YAG laser anterior capsulotomy was  $4.4 \pm 1.4$  months (range 2.6–6.2 months). The mean energy used in capsulotomy was  $1.8 \pm 0.3$  mJ with a mean of  $20.0 \pm 6.4$  laser shots. The mean

**Table 1.** Demographic and clinical characteristics of patients who underwent Nd:YAG laser anterior capsulotomy

Patient	Gender/ Age		Interval between cataract surgery and laser (months)	At time of capsulotomy			At last follow-up	
	Age	Risk factors		Diameter of anterior capsule opening (mm)	BCVA	Follow-up time (months)	Diameter of anterior capsule opening (mm)	BCVA
1	M/57	DM	5.7	2.5	0.4	42	5.2	0.3
2	F/81	NA	6.1	2.6	0.4	33	5.0	0.5
3	F/72	NA	5.6	3.0	0.5	31	5.1	0.5
4	M/64	DM	3.6	2.3	0.4	31	5.1	0.4
5	M/63	High myopia	3.2	2.7	0.2	30	4.8	0.2
6	M/79	NA	4.2	3.0	0.6	29	5.3	0.6
7 <sup>†</sup>	F/67	Silicon IOL, DM	6.2	Complete occlusion	0.1	28	5.0	0.5
8	F/76	High myopia	3.0	2.2	0.5	28	5.5	0.6
9 <sup>‡</sup>	F/67	RP	3.1	2.3	FC	27	5.0	FC
10 <sup>‡</sup>	M/54	RP, high myopia	2.6	2.1	0.3	26	5.0	0.1
11 <sup>†</sup>	F/69	DM	5.3	1.5	0.3	26	4.9	0.5

<sup>†</sup>Mild IOL decentration was observed before Nd:YAG laser anterior capsulotomy and did not progress after capsulotomy.

<sup>‡</sup>Progressive zonular weakness was observed after Nd:YAG laser anterior capsulotomy.

BCVA = best corrected visual acuity; DM = diabetes mellitus; NA = not available; IOL = intraocular lens; RP = retinitis pigmentosa; FC = finger counting.

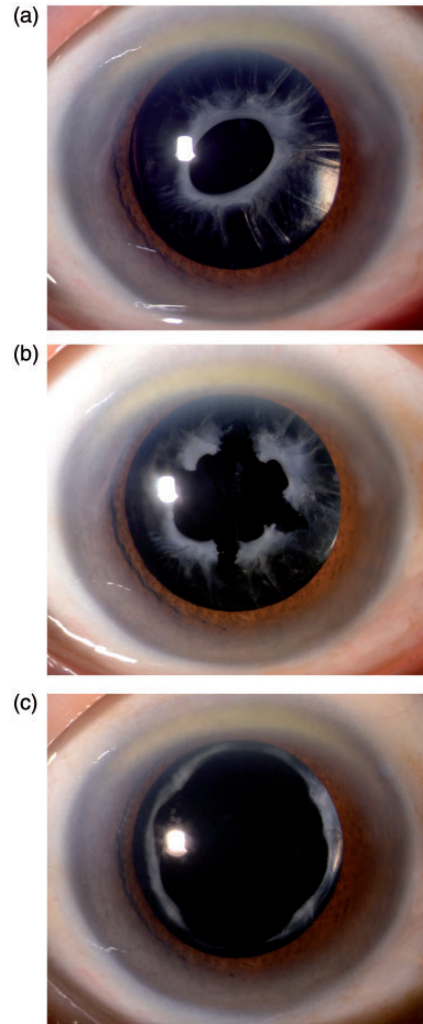
follow-up time was  $30.1 \pm 4.5$  months (range 26–42 months) (Table 1).

At the last follow-up, the mean diameter of the anterior capsule opening was  $5.1 \pm 0.2$  mm, which was significantly greater than the diameter before laser capsulotomy ( $2.2 \pm 0.8$  mm) (paired sample T test,  $t=11.594$ ,  $P<0.001$ ). BCVA remained stable or improved in nine eyes (81.8%) after capsulotomy (Table 1). No recurrence of phimosis was reported. Mild IOL decentration was observed in two cases and did not progress after capsulotomy. Other complications that have been reported in prior studies of anterior capsulotomy, including hyphema, uveitis, lens pitting and elevated IOP, were not observed in these 11 patients.

Figure 1 shows photographs of a representative eye that underwent Nd:YAG laser anterior capsulotomy. The anterior capsule opening was severely constricted, to a diameter of approximately 2.2 mm, at 3 months after cataract surgery (Figure 1a). Four relaxing incisions were made by using Nd:YAG laser shots directed from the margin of the anterior capsule opening to the edge of the IOL optic (Figure 1b). At 27 months after anterior capsulotomy, the eye remained quiescent with the IOL centered and an anterior capsule opening of 5.5 mm diameter (Figure 1c).

## Discussion

In this study, we investigated the long-term results in 11 eyes that underwent successful Nd:YAG laser anterior capsulotomy for the treatment of anterior capsule phimosis. With a mean follow-up of 30 months, we found that all 11 eyes maintained an enlarged anterior capsular aperture. None of those eyes showed recurrence of phimosis and or development of progressive IOL decentration after capsulotomy.



**Figure 1.** Photographs of a representative eye that underwent Nd:YAG laser anterior capsulotomy. (a) Slit lamp photograph showing anterior capsular phimosis and fibrosis with an anterior capsule opening diameter of 2.2 mm, 3 months after cataract surgery. (b) Appearance of anterior capsule immediately after four relaxing incisions were made by Nd:YAG laser. (c) At 27 months after anterior capsulotomy, the eye remained quiescent, with the intraocular lens centered and an anterior capsule opening diameter of 5.5 mm

Anterior capsular phimosis is more frequent in eyes of patients with comorbidities, such as pseudoexfoliation, uveitis, myotonic dystrophy, high myopia, retinitis pigmentosa, or small capsulorrhexis.<sup>1,12-14</sup> Anterior capsular shrinkage occurs rapidly in the first 6 weeks postoperatively, and may continue for several months.<sup>15</sup> This suggests the need for close postoperative observation of patients with risk factors, particularly in the first 3 months after cataract surgery. Once phimosis occurs, Nd:YAG laser anterior capsulotomy may prevent complete capsulorrhexis occlusion and further complications.

Our results showed that after four or five relaxing incisions were created with an Nd:YAG laser, the anterior capsule opening could be remodeled to a similar round shape with an enlarged aperture, without recurrence of phimosis during long-term follow-up. Ocular complications, such as hyphema, inflammation, and intraocular pressure elevation, can occur secondary to Nd:YAG laser anterior capsulotomy.<sup>3,7,16</sup> However, none of these complications occurred in our study. Our results suggest that Nd:YAG laser anterior capsulotomy may be safe and effective for the treatment of anterior capsule phimosis after cataract surgery, even if it is detected during long-term follow-up.

Importantly, anterior capsule contraction formed in eyes with zonular weakness, which can contribute to anterior capsular phimosis because weakened zonular fibers may be unable to counterbalance the increased strength of centrally directed contractile forces that are generated by capsular fibrosis.<sup>4,7</sup> However, capsular shrinkage or Nd:YAG laser anterior capsulotomy may break or weaken the zonules, and anterior capsulotomy cannot prevent the

progression of intrinsic zonular weakness. In our study, progressive zonular weakness after Nd:YAG laser anterior capsulotomy was observed in two patients with retinitis pigmentosa. Spontaneous dislocation of the IOL-capsular bag complex has been previously reported.<sup>17-19</sup> In such cases, the patient must be closely monitored, even after laser anterior capsulotomy.

Limitations of this study include its small sample size and the retrospective study design. Furthermore, Nd:YAG laser anterior capsulotomy was performed >3 months after cataract surgery in almost all cases. However, previous studies have reported that a preventive anterior capsulotomy with low-energy laser emission in the early postoperative period was effective and safe for preventing anterior capsule contraction in high-risk eyes.<sup>9,11</sup> Further prospective studies should be performed to determine the appropriate timing and settings of Nd:YAG laser anterior capsulotomy for the treatment of anterior capsular contraction.

In conclusion, our long-term follow-up study showed that Nd:YAG laser anterior capsulotomy is safe and effective for the treatment of anterior capsule phimosis.

### **Declaration of conflicting interests**

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