ORIGINAL ARTICLE

The Long-term Effect of Nd:YAG Laser Iridotomy on Intraocular Pressure in Taiwanese Eyes with Primary Angle-closure Glaucoma

Mei-Ju Chen*, Ching-Yu Cheng, Ching-Kuang Chou, Catherine J.L. Liu, Wen-Ming Hsu

Department of Ophthalmology, Taipei Veterans General Hospital, and National Yang-Ming University School of Medicine, Taipei, Taiwan, R.O.C.

Background: To investigate the long-term effect of Nd:YAG laser iridotomy on intraocular pressure (IOP) in Taiwanese eyes with primary angle-closure glaucoma (PACG).

Methods: The medical records of 81 patients (130 eyes) who were diagnosed with PACG and who had undergone Nd:YAG laser iridotomy between 1998 and 2002 were reviewed. According to the presence of symptomatic glaucoma attack, eyes were divided into an acute angle-closure glaucoma (AACG) group and chronic angle-closure glaucoma (CACG) group. In the AACG group, the acute episode was treated and resolved after Nd:YAG laser iridotomy. These eyes were diagnosed to have or developed glaucoma during the follow-up period. All patients were followed-up for at least 24 months. The presenting features, treatment and IOP during the follow-up period were analyzed.

Results: The mean follow-up period was 44.1 ± 17.8 months (median, 36 months). There were 27 eyes (from 25 patients) in the AACG group. Only 2 eyes (7.4%) did not require any treatment after Nd:YAG laser iridotomy. Eleven eyes (40.7%) eventually underwent filtering surgery at a mean of 3.2 months (median, 3 months) after Nd:YAG laser iridotomy. There were 103 eyes (from 56 patients) in the CACG group. Eighty-five eyes (82.5%) required further medical treatment, of which 21 eyes (20.4%) eventually received filtering surgery at a mean of 9.8 months (median, 5 months) after Nd:YAG laser iridotomy.

Conclusion: For most Taiwanese eyes with PACG after Nd:YAG laser iridotomy, additional medicine and surgery are required in the long term. Eyes in the AACG group needed more surgical intervention than those in the CACG group. [*J Chin Med Assoc* 2008;71(6):300–304]

Key Words: intraocular pressure, laser iridotomy, primary angle-closure glaucoma

Introduction

Primary angle-closure glaucoma (PACG) is a major form of glaucoma in Asia.[1,2] Nd:YAG laser iridotomy to relieve pupillary block is safe and effective in treating or preventing angle-closure glaucoma.[3–6] However, recent studies showed that the long-term follow-up of laser peripheral iridotomy might not be satisfactory.[7,8] The aims of this study were to evaluate the long-term effect of Nd:YAG laser iridotomy on intraocular pressure (IOP) in Taiwanese patients with PACG and to compare the results of chronic angle-closure glaucoma (CACG) and acute angle-closure glaucoma (AACG).

Methods

We reviewed the medical records of all Taiwanese patients who had been diagnosed with PACG and who had undergone Nd:YAG laser iridotomy at Taipei Veterans General Hospital between 1998 and 2002. PACG was defined as an elevated IOP of more than 21 mmHg, glaucomatous optic disc changes and compatible visual field loss in the eye with occludable angle. Glaucomatous optic disc change was defined as a cup-to-disc ratio > 0.5. Visual field loss was defined as an automatic Humphrey visual field (program 24-2, Swedish interactive thresholding algorithm standard) showing

*Correspondence to: Dr Mei-Ju Chen, Department of Ophthalmology, Taipei Veterans General Hospital, 201, Section 2, Shih-Pai Road, Taipei 112, Taiwan, R.O.C.
E-mail: mj_chen@vghtpe.gov.tw • Received: September 13, 2007 • Accepted: April 16, 2008

a glaucoma hemifield test "outside normal limits" and a cluster of 4 contiguous points on the pattern deviation plot depressed at $p < 5\%$ level not crossing the horizontal meridian. Occludable angle was defined as an angle in which the trabecular meshwork was not visible for at least 180 degrees without indentation on gonioscopy.[9] There were 2 groups of patients. Patients with an acute symptomatic episode of angle-closure were in the AACG group. In all such patients, the acute episode was treated and resolved after Nd:YAG laser iridotomy. These eyes were diagnosed to have or developed glaucoma during the follow-up period. Those without previous acute episode were in the CACG group. Patients with secondary angle-closure or less than 24 months of follow-up were excluded. Demographic characteristics, ophthalmic history, dates and onset of symptoms, details of laser iridotomy, presenting IOP, IOP during the follow-up period, and the treatment required were all recorded.

Nd:YAG laser iridotomy was performed for all eyes. The AACG group received medication first, and then Nd:YAG laser iridotomy when the IOP was lowered or corneal edema decreased. All patients were treated with topical 2% pilocarpine and proparacaine preoperatively. Laser energy setting was between 2.0 mJ and 4.5 mJ. The iridotomy site was in the supernasal or supertemporal quadrant of the peripheral iris. Topical steroid drops were used 4 times daily for 1 week after Nd:YAG laser iridotomy. Patients continued their antiglaucoma medication until the clinician evaluated the IOP change and gonioscopy.

The long-term outcome was evaluated in terms of IOP and the requirement for additional therapy. After Nd:YAG laser iridotomy, eyes that developed a rise in IOP were started on medication first, followed by filtering surgery. Trabeculectomy combined with extracapsular cataract extraction and intraocular lens implantation were indicated if there was coexisting dense cataract. To evaluate the effect of Nd:YAG laser iridotomy on IOP in eyes with PACG, a rise in IOP during follow-up was defined as IOP > 21 mmHg or additional medicine or surgery required.

The χ^2 test or Fisher's exact test was used to compare the proportions of patients successfully treated by Nd:YAG laser iridotomy between groups. Mann-Whitney *U* test was used to compare the mean interval after Nd:YAG laser iridotomy for a rise in IOP and initiation of medicine, as well as the time interval to surgery in the two groups. Kaplan-Meier survival analysis was performed to assess the survival time of the 2 groups. The time to failure was defined as the need for further surgery. The log-rank test was applied to compare the difference in survival times between groups. Statistical significance was set at $p < 0.05$. All data analyses were performed using a commercial statistical software package, Stata (Stata Corp., College Station, TX, USA).

Results

A total of 81 PACG patients (130 eyes) treated with Nd:YAG laser iridotomy met the inclusion criteria. There were 51 men and 30 women. The mean age of the patients was 71.8 ± 6.8 years. The mean follow-up period was 44.1 ± 17.8 months (median, 36 months). There were 27 eyes in the AACG group and 103 eyes in the CACG group. The mean presenting IOP was 44.6 ± 12.0 mmHg in the AACG group and 23.1 ± 4.7 mmHg in the CACG group. The mean cup-to-disc ratio was 0.71 ± 0.17 in the AACG group and 0.68 ± 0.16 in the CACG group. In the AACG group, most cases presented at the first symptomatic attack, with 4 cases at the second episode. The duration of symptoms before consultation was from 3 to 48 hours. The number of applications for Nd:YAG laser iridotomy ranged from 8 to 52 spots. The short-term complications included transient iris bleeding and post-laser iridotomy IOP spike. IOP increased in approximately 20% of eyes after laser iridotomy. Antiglaucoma medication and oral acetazolamide were given if IOP was more than 30 mmHg. The IOP spike resolved by the first week postoperatively.

Twenty-five eyes (92.6%) in the AACG group and 85 eyes (82.5%) in the CACG group developed a subsequent rise in IOP during follow-up after Nd:YAG laser iridotomy. Only 2 eyes (7.4%) in the AACG group and 18 eyes (17.5%) in the CACG group were treated with Nd:YAG laser iridotomy alone without long-term rise in IOP. Fourteen eyes (51.9%) in the AACG group and 64 eyes (62.1%) in the CACG group required further medical treatment to control IOP. There was no significant difference in the proportion of eyes successfully controlled with Nd:YAG laser iridotomy alone ($p = 0.245$) or requiring medication ($p = 0.332$) in the 2 groups. In the AACG group, 11 eyes (40.7%) required filtering surgery because of poorly controlled IOP. Ten eyes underwent trabeculectomy, and 1 eye underwent combined trabeculectomy with cataract extraction and lens implantation. In the CACG group, surgical intervention was required in 21 eyes (20.4%) to control IOP. Thirteen eyes underwent trabeculectomy, and 8 eyes underwent combined trabeculectomy with cataract extraction and lens implantation. The difference in the proportion of eyes requiring surgery in the 2 groups was statistically significant ($p = 0.029$).

The intervals for the subsequent rise in IOP after Nd:YAG laser iridotomy for the 110 eyes are shown in Table 1. Twenty-four eyes (96.0%) in the AACG group and 73 eyes (85.9%) in the CACG group developed a rise in IOP requiring medication in the first month after Nd:YAG laser iridotomy. The mean duration after Nd:YAG laser iridotomy was 1.1 months (median, 1 month) in the AACG group and 1.8 months (median, 1 month) in the CACG group. This difference was not statistically significant ($p = 0.69$).

The intervals for requiring filtering surgery after Nd:YAG laser iridotomy for the 32 eyes are shown in Table 2. In the AACG group, all eyes underwent surgery within 6 months, while in the CACG group most eyes required surgery within 1 year. The mean duration after Nd:YAG laser iridotomy was longer in the CACG group (9.8 months; median, 5 months) than in the AACG group (3.2 months; median, 3 months), but the difference was not statistically significant ($p = 0.098$). At the time of surgery, the mean IOP was 29.91 ± 5.84 mmHg in the AACG group and 25.14 ± 2.85 mmHg in the CACG group. The most frequent topical medications were beta-blockers and cholinergics, followed by alpha-agonists, carbonic anhydrase and prostaglandins. A few patients were treated with oral acetazolamide.

Kaplan-Meier survival curves of the 2 groups after Nd:YAG laser iridotomy to the introduction of filtering surgery are shown in Figure 1. In the AACG group, the 1-year survival rate was 59.3%, and the rate remained the same at 3 years. In the CACG group, the 1-year, 2-year and 3-year survival rates were 85.4%, 81.5% and 78.8%, respectively. This difference was statistically significant ($p = 0.013$).

Discussion

Pupillary block is a significant mechanism causing angle-closure glaucoma. Nd:YAG laser iridotomy is effective in widening the drainage angle[7,10,11] and reducing IOP in eyes with primary angle-closure. Primary angle-closure is conventionally treated with laser peripheral iridotomy, followed by antiglaucoma medication,

Table 1. Time interval for rise in intraocular pressure requiring further treatment after Nd:YAG laser iridotomy

Duration (mo)	AACG ($n = 25$)	CACG ($n = 85$)	p*
≤1	24 (96.0%)	73 (85.9%)	
>1 to 6	1 (4.0%)	7 (8.2%)	
>6 to 12	0 (0%)	3 (3.5%)	
>12	0 (0%)	2 (2.4%)	
Mean	1.1	1.8	0.69
Median	1.0	1.0	

Mann-Whitney U test was used for statistical analysis. AACG = acute angle-closure glaucoma; CACG = chronic angle-closure glaucoma.

Table 2. Time interval for rise in intraocular pressure requiring surgical treatment after Nd:YAG laser iridotomy

Duration (mo)	AACG ($n = 11$)	CACG ($n = 21$)	p*
≤1	5 (45.5%)	5 (23.8%)	
>1 to 6	6 (54.5%)	6 (28.6%)	
>6 to 12	0 (0%)	4 (19.0%)	
>12	0 (0%)	6 (28.6%)	
Mean	3.2	9.8	0.098
Median	3.0	5.0	

Mann-Whitney U test was used for statistical analysis. AACG = acute angle-closure glaucoma; CACG = chronic angle-closure glaucoma.

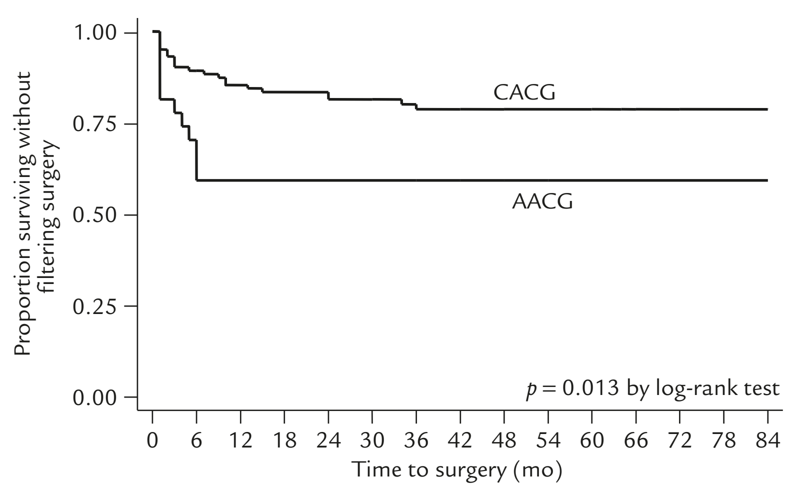

Figure 1. Kaplan-Meier survival curves of the 2 groups after laser iridotomy to the introduction of filtering surgery. AACG = acute angle-closure glaucoma; CACG = chronic angle-closure glaucoma.

and then surgery if necessary. Previous studies have shown that laser iridotomy is effective for IOP control in Caucasians.[3,11] However, reports from Asian populations[7,8] showed that Nd:YAG laser iridotomy might be inadequate to maintain IOP control in the long term. Nolan et al[7] examined 164 eyes of 98 Mongolian subjects with primary angle-closure and found that iridotomy failed in 47% of eyes with established optic neuropathy. Alsagoff et al[8] studied 83 eyes with PACG of different Asian ethnicities (e.g. Chinese, Malay, Indian) and found that 53% of eyes became medically uncontrolled after laser iridotomy. We noted similar findings, that 40.7% of eyes with AACG and 20.4% eyes with CACG required filtering surgery because of poorly controlled IOP. Nd:YAG laser iridotomy alone may be ineffective for IOP control in most Taiwanese eyes with PACG.

Compared with Caucasians, Asian eyes are prone to develop angle-closure.[12,13] The biometry in different ethnicities may play a significant role. Shorter axial global length, shallower anterior chamber and greater than 2 diopters of hyperopia were significantly correlated with a diagnosis of PACG.[14] Clinically, lens swelling,[15] ciliary block[16] and plateau iris[17] may be involved in the pathogenesis of primary angle-closure. Plateau iris has been shown to be poorly responsive to laser iridotomy.[18] In addition to anatomical factors, laser iridotomy itself may cause progression of peripheral anterior synechiae in PACG eyes.[19] Also, a higher energy of Nd:YAG laser is necessary to penetrate thicker and heavily pigmented Asian irides than Caucasian irides. The pigment release and inflammation might account for the subsequent IOP rise after Nd:YAG laser iridotomy in Asians.

Our study showed that eyes with AACG needed more surgical intervention than eyes with CACG, which is consistent with earlier reports.[8,20] Eyes with AACG may have had some degree of permanent angle damage and diminished outflow after acute episode. Also, there is potentially increased angle crowding by progressive lens swelling. Although the mechanisms causing alterations in lens metabolism are unknown, more rapid cataract formation was noted after acute angle-closure.[21,22] Also, Asian eyes tended to have more severe attacks with longer duration.[23] These factors might contribute to the failure of IOP control and more surgery needed in AACG eyes.

The present study found that 88.2% of our patients experienced an IOP rise after Nd:YAG laser iridotomy within the first month. This is higher than in previous reports.[10,24] Lim et al[10] found that 6 eyes (31.6%) within the first month and 5 eyes (26.3%) between month 1 and 2 had a rise in IOP in 44 acute primary angle-closure eyes treated with Nd:YAG laser iridotomy. Their patients had acute primary angle-closure without documented optic neuropathy, while ours had established glaucomatous optic neuropathy and visual field loss. Nd:YAG laser iridotomy might worsen the damage in the trabecular meshwork for advanced glaucoma with compromised outflow. Another study of an American population[24] reported that 19 eyes (54.3%) in the AACG group and 18 eyes (45%) in the CACG group developed elevated IOP within 1 month after sequential Argon laser and Nd:YAG laser iridotomy. Elevated IOP shortly after laser warrants close monitoring of PACG patients to avoid further glaucomatous damage.

This study was limited by the retrospective design, modest number of cases and variable follow-up. There was difficulty in documenting standardized gonioscopy because multiple ophthalmologists were involved in the treatment of the patients. Also, post-laser iridotomy IOP spike, different kinds and dosing patterns of drugs and patient compliance may affect long-term outcome. However, our study demonstrated the clinical course of PACG after Nd:YAG laser iridotomy in Taiwanese eyes. In all patients, Nd:YAG laser iridotomy was performed first, followed by medication and filtering surgery. It seems that long-term IOP control might be inadequate by Nd:YAG laser iridotomy only, especially in eyes with AACG. Close monitoring of IOP at frequent intervals after Nd:YAG laser iridotomy is advised in the follow-up of PACG patients to avoid further glaucomatous damage.

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