CLINICAL STUDY

Limited argon laser peripheral iridoplasty as immediate treatment for an acute attack of primary angle closure glaucoma: a preliminary study

JIMMY S.M. LAI, CLEMENT C.Y. THAM, DENNIS S.C. LAM

Abstract

Purpose **To study the efficacy and safety of limited (180°) argon laser peripheral iridoplasty (ALPI) as a first-line treatment for acute primary angle closure glaucoma (PACG) without the use of systemic anti-glaucomatous medications.**

Methods **Ten consecutive patients with PACG were recruited into the study. Each patient received topical pilocarpine (4%) and timolol (0.5%), and immediate limited ALPI as primary treatment. The intraocular pressures at 15, 30 and 60 min after ALPI were documented by Goldmann applanation tonometry.**

Results **The mean intraocular pressure (IOP) of this group of patients was reduced from 57.9 ± 10.6 mmHg to 39.0 ± 10.9 mmHg at 15 min, 28.3 ± 9.1 mmHg at 30 min and 20.4 ± 9.0 mmHg at 60 min after ALPI. No complications were encountered. In 8 of the 10 patients the corneal oedema cleared 1 h after ALPI. In the remaining 2 patients the corneal oedema cleared 2 h after ALPI.**

Conclusion **Immediate limited ALPI, without adjunctive systemic anti-glaucomatous medications, appeared to be effective and safe in controlling the IOP in treating acute PACG with a duration of attack ≤ 48 h. It may be as effective as 360° ALPI, and therefore has a role in those patients in whom 360° treatment is not possible.**

Key words Acute angle closure glaucoma, Laser peripheral iridoplasty

J.S.M. Lai
C.C.Y. Tham
D.S.C. Lam
Eye Unit
Prince of Wales Hospital
Department of Ophthalmology & Visual Sciences
The Chinese University of Hong Kong
Shatin, N.T.
Hong Kong

Jimmy S.M. Lai, FRCS, FRCOphth ✉
Eye Unit
Prince of Wales Hospital
Department of Ophthalmology and Visual Sciences
The Chinese University of Hong Kong
Shatin, N.T.
Hong Kong
Tel: (852) 2632 2878
Fax: (852) 2648 2943
e-mail: jsmlai@netvigator.com

Supported in part by the Mr W.K. Lee Eye Foundation, Hong Kong

Received: 9 July 1998
Accepted in revised form: 23 October 1998

Primary angle closure glaucoma (PACG) is characterised by an abrupt rise in the intraocular pressure (IOP) caused by iris apposition to the trabecular meshwork. The eye suffering from PACG has elevated IOP, a shallow peripheral anterior chamber and corneal oedema.[1] Laser iridotomy is the treatment of choice when there is a component of pupillary block.[2] However, when the eye is acutely inflamed and in the presence of corneal oedema, laser iridotomy may not be possible. Traditionally, treatment involves lowering the IOP with both systemic and topical medications, and subsequently relieving the pupillary block by laser peripheral iridotomy when the cornea is clear.[3]

Systemic medications for PACG include intravenous or oral carbonic anhydrase inhibitors and hyperosmotic agents. Topical medications include pilocarpine and beta-blockers.[4] Systemic carbonic anhydrase inhibitors cause loss of appetite, paraesthesia and drowsiness in most patients. They can also cause potentially serious side effects, such as metabolic acidosis, Stevens–Johnson syndrome and blood dyscrasias.[5–8] They are contraindicated in patients with hypokalaemia, hyponatraemia, renal and hepatic failure, sulphonamide sensitivity and pregnancy. Systemic hyperosmotic agents may also cause rare but potentially life-threatening complications such as electrolyte disturbance, pulmonary oedema and congestive heart failure, especially in patients with pre-existing cardiovascular diseases.[9]

Systemic medications, together with topical anti-glaucomatous eyedrops, take time to act. They sometimes fail to control the IOP. If the IOP remains high, the definitive treatment of laser peripheral iridotomy may not be achievable because of corneal oedema, shallow anterior chamber, and thick iris resulting from the semi-dilated pupil.

Traditionally, argon laser peripheral iridoplasty (ALPI) has been used to open the appositionally closed angle mechanically in PACG when medical treatment fails to control the IOP. It is effective in situations when laser iridotomy cannot be performed because of

corneal oedema secondary to high IOP. A ring of contraction burns (low power, long duration and large spot size) is placed on all 360° of the peripheral iris to contract the iris stroma near the angle. The contraction pulls the iris tissue away from the trabecular meshwork thus opening up the angle and lowering the IOP. This will allow the cornea to become clear and inflammation to subside before definitive treatment is performed.[10–13] The usual practice is to perform ALPI 3–6 h after maximal medications fail to control the IOP.[11]

The current practice of using ALPI only after maximal anti-glaucomatous medications fail may not be optimal. For those who fail to respond to the medical treatment, increased optic nerve damage and permanent closure of the angle with damage to the trabecular meshwork may result from the prolonged elevated IOP.[14] Moreover, whether they respond to the medical treatment or not, patients may also suffer from the side effects of the systemic medications.

For the above reasons we have undertaken a preliminary study in which PACG patients were treated with topical anti-glaucomatous therapy and immediate ALPI, in the conventional 360° manner.[15] ALPI without the use of systemic anti-glaucomatous therapy in PACG patients with a duration of attack ≤ 48 h was found to be both effective and safe in controlling the IOP. Corneal clarity returned early, facilitating the definitive treatment of laser iridotomy without delay.

We have experienced uncooperative patients and patients who developed nausea and vomiting during the laser treatment. Under those circumstances, less than 360° of the peripheral iris were treated. However, the IOPs were still successfully lowered to safe levels. We therefore postulate that treatment of 360° of the peripheral iris may not be needed to lower the IOP. As long as the effective burns successfully open up part of the angle, the vicious cycle will be broken and pupillary block will be relieved. Moreover, fewer laser burns should decrease the chance of laser-related complications. There are conditions in which 360° ALPI may not be feasible, for example in uncooperative patients, or patients with media opacities such as corneal opacities, pannus and pterygium obscuring part of the peripheral iris. The question of whether one should still attempt ALPI on such patients remains to be answered. There has been no documentation in the literature as to how much ALPI is enough to abort an attack of PACG. This study aimed at evaluating the effectiveness and safety of 180° ALPI.

Materials and methods

All patients were recruited from the Eye Unit, Prince of Wales Hospital. Inclusion criteria were: (1) a first episode of PACG; (2) IOP ≥ 40 mmHg (by applanation tonometry); (3) duration of attack ≤ 48 h; (4) no other previous ophthalmic disorders that may have had a persistent effect on the structure or function of the drainage angle. Exclusion criteria were: (1) anti-glaucomatous treatment prior to the patient's presentation to the authors; (2) media opacities that obstructed laser access to more than 180° of the peripheral iris. The study period was from September 1997 to April 1998.

Informed consent was obtained from each participating patient. The involved eye of these patients was given 1 drop of 4% pilocarpine and 1 drop of 0.5% timolol. Neither carbonic anhydrase inhibitors nor hyperosmotic agents were used. ALPI was performed under topical anaesthesia with amethocaine eye drops (1%). The Alcon Biophysic laser machine (Model 532; Alcon Laboratories, Fort Worth, TX) was used. The laser was initially set at an energy level of 300 mW. The duration of each laser pulse was 0.3 s, with a spot size of 500 μm. The laser beam was focused onto the peripheral iris as close to the limbus as possible with the Abraham laser iridotomy contact lens (Ocular Instruments, Bellevue, WA). A 180° segment of the peripheral iris was treated. The site most amenable to laser treatment was chosen. If no part of the iris was obscured, the inferior 180° of the peripheral iris was treated. The end-point was reached when localised iris contraction at the treated area became visible. The laser energy level was reduced if any of the following were observed: (1) charring of the iris; (2) formation of gas bubbles; (3) production of a 'pop', indicating a minute explosion. The laser energy level was increased if there was no contraction response from the iris. One drop of topical apraclonidine (1%) was given after ALPI as prophylaxis against the post-laser IOP spike.

IOP was measured by Goldmann applanation tonometry immediately before, and at 15, 30 and 60 min after ALPI. If the IOP remained above 22 mmHg at 60 min it was rechecked at 90 min after ALPI. The involved eye was given 1 drop of 1% pilocarpine 4 times a day, and 1 drop of 0.5% timolol twice a day, after ALPI until the definitive treatment of laser iridotomy was performed. Topical prednisolone acetate (1%) was also given six times a day for 7 days after ALPI. Patients were followed up for any complications arising from the laser procedure.

Results

Ten consecutive patients with their first acute PACG and duration of attack ≤ 48 h were recruited into the study. Pupillary block was clinically the mechanism underlying the acute PACG in all patients. There were 6 men and 4 women, ranging in age from 63 to 83 years (mean 71.9 years) (Table 1). All 10 patients were of Chinese ethnic origin, with dark brown irides. No patient had a previous history of glaucoma or other eye treatment.

The duration of attack prior to presentation, as determined by the onset of ocular pain and decreased vision of the affected eye, ranged from 2 to 48 h (mean 20.3 h). The visual acuity at presentation ranged from 20/100 to light perception (LP). Ninety per cent (9/10) of the patients had a visual acuity of 20/200 or less at the

Table 1. *Patients' data and results of immediate 180° ALPI for acute attacks of PACG*

Patient no.	Age/Sex	Duration of attack (h)	Pre-ALPI VA	Pupillary size (mm)	Laser settings for ALPI	IOP (mmHg) At presentation	IOP (mmHg) At 15 min after ALPI	IOP (mmHg) At 30 min after ALPI	IOP (mmHg) At 1 h after ALPI	Corneal status 1 h after ALPI	VA at 1 day after ALPI
1	78/F	18	20/200	5	#97, 400 mW, 0.3 s, 500 μm	56	39	28	17	Clear	20/200[a]
2	83/F	48	FC	5	#57, 325 mW, 0.3 s, 500 μm	70	58	40	30 (18 at 1.5 h)	Clear	20/200[a]
3	65/M	24	FC	5	#100, 400 mW, 0.3 s, 500 μm	50	45	30	29 (20 at 1.5 h)	Clear	20/200[a]
4	82/F	18	FC	5	#136, 400 mW, 0.3 s, 500 μm	60	52	45	38 (20 at 1.5 h)	Oedema(+)	20/70
5	66/M	24	20/200	5	#90, 400 mW, 0.3 s, 200 μm	50	36	20	16	Oedema (++)	20/200
6	66/M	2	20/100	4	#57, 350 mW, 0.3 s, 500 μm	42	25	20	17	Clear	20/40
7	82/M	12	LP	5	#81, 360 mW, 0.3 s, 300 μm	60	23	15	8	Clear	LP[a]
8	65/F	16	10/200	5	#38, 300 mW, 0.3 s, 500 μm	72	42	27	18	Clear	20/70
9	69/M	26	20/200	6	#63, 400 mW, 0.3 s, 300 μm	48	33	28	17	Oedema (++)	20/50
10	63/M	15	20/200	6	#52, 420 mW, 0.3 s, 300 μm	71	37	30	14	Clear	20/30

ALPI, argon laser peripheral iridoplasty; PACG, primary angle closure glaucoma; VA, visual acuity; IOP, intraocular pressure; F, female; M, male; LP, light perception; HM, hand movement; FC, finger counting.
[a]Dense cataract pending extraction.

time of presentation. All patients had corneal oedema at presentation. All patients had a fixed, mid-dilated pupil of 4–6 mm (Table 1).

At presentation, the IOP ranged from 42 to 72 mmHg (mean 57.9 ± 10.6 mmHg) (Table 1). Immediate ALPI was performed once the clinical diagnosis of PACG was made. The laser contraction burns were placed in the far periphery in 180° of the iris. The mean number of contraction burns placed was 77.0 (range 38–136 burns). The mean energy level was 376 mW (range 325–420 mW). The exposure time was 0.30 s and spot size used was 500 μm in all patients (Table 1). All ALPIs were completed within 10 min.

Fifteen minutes after ALPI the mean IOP dropped to a mean of 39.0 ± 10.9 mmHg (range 23–58 mmHg) (Table 1). This represented a 32.6% reduction in mean IOP within 15 min after ALPI. Thirty minutes after ALPI the mean IOP was 28.3 ± 9.1 mmHg (range 15–45 mmHg) (Table 1). This represented a further 27.4% reduction in IOP, compared with the IOP at 15 min after ALPI. This total reduction in IOP 30 min after ALPI was 51.1%.

One hour after ALPI the mean IOP dropped to 20.4 ± 9.0 mmHg (range 8–38 mmHg) (Table 1). In 70% (7/10) of the patients the IOP was ≤ 18 mmHg, which was well within the normal limit. Patients 2, 3 and 4 had IOPs of 30, 29 and 38 mmHg respectively. At 1.5 h after ALPI the IOPs of patients 2, 3 and 4 dropped to 18, 20 and 20 mmHg, respectively (Table 1). By 1 h after ALPI 8 of the 10 corneas had clarity re-established, allowing early laser iridotomy as definitive treatment. The corneas of patients 4 and 9 became clear by 2 h.

The visual acuity of the involved eye 1 day after ALPI ranged from 20/30 to light perception (LP), with 5 of the 10 patients having a visual acuity of 20/70 or better. Patients 1, 2, 3 and 7 had visual acuities of only 20/200 to light perception, even when their corneas cleared after ALPI. This was due to the presence of dense cataracts. At the time of writing, patients 1, 2, 3 and 7 are still awaiting their cataract extraction.

Fig. 1 shows the IOP profiles in the 10 patients recruited into this study.

Discussion

ALPI has a well-established role in the management of patients with PACG resistant to conventional topical and systemic anti-glaucomatous medications.[10–13] To avoid the potential side effects of systemic medications, which can be particularly serious in frail elderly patients, and also the unnecessary delay in the control of the IOP, we have previously proposed applying ALPI, alongside topical anti-glaucomatous medications, as the first-line treatment for PACG, without the use of systemic medications from the start.[15] A preliminary study suggested that this alternative regime is safe and as effective as systemic medications in lowering the IOP, but without the potentially serious side effects.

ALPI is traditionally applied to all 360° of the peripheral iris. We have, however, come across patients in whom it was not possible to complete ALPI in all 360° of the peripheral iris. These were mostly patients who were not able to cooperate or to tolerate the procedure right through to the end. It was noted that in many of

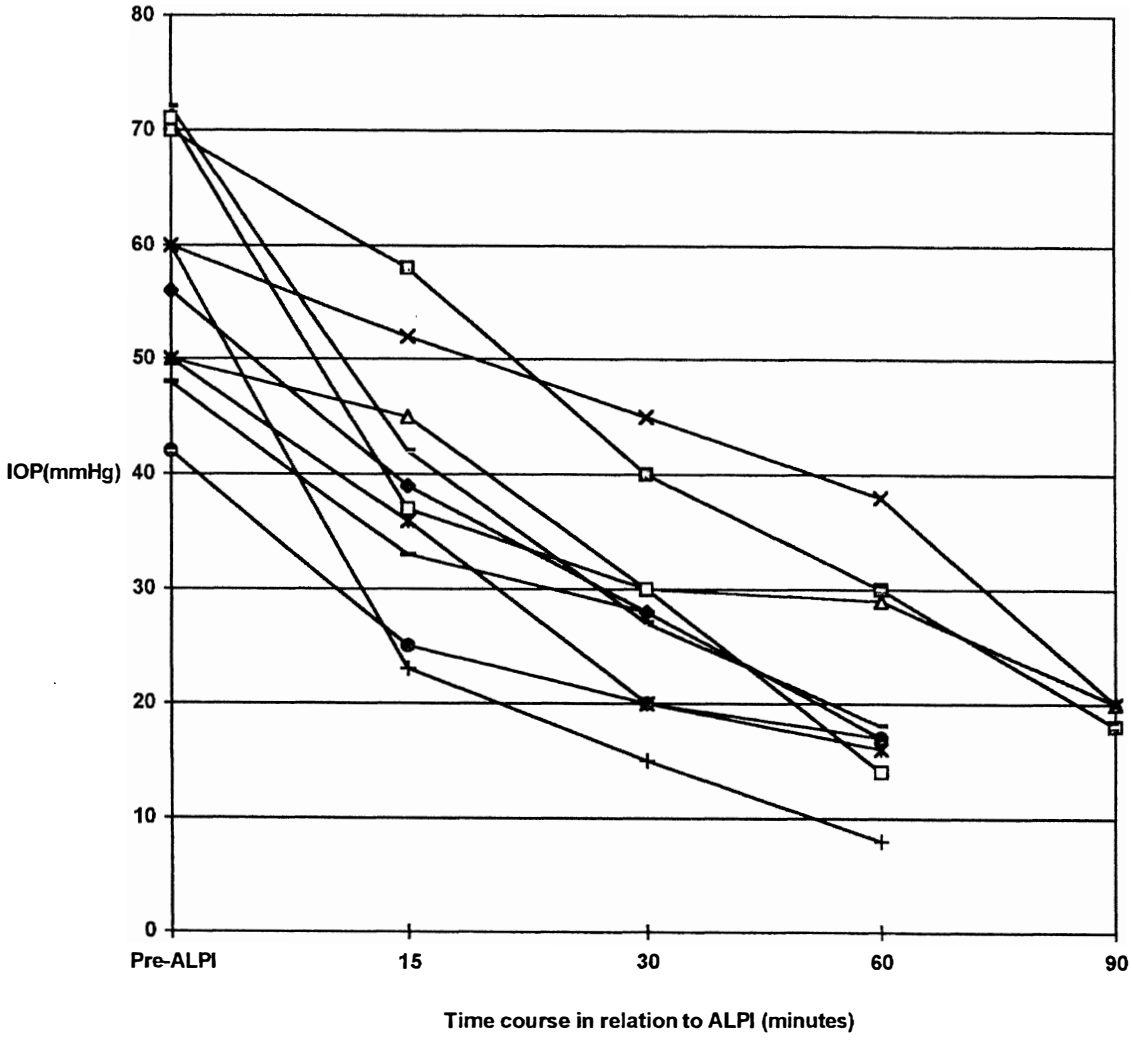

Fig. 1. *Profile of intraocular pressure (IOP) changes before and after argon laser peripheral iridoplasty (ALPI) in 10 patients.*

these patients we were able promptly to lower the IOP despite the fact that ALPI had been applied to only 180°, or sometimes even less, of the iris. We therefore hypothesised that it may not be necessary to complete 360° ALPI to achieve the reversal of an acute PACG attack, and that perhaps ALPI over 180° may be sufficient to abort an attack. It has not been documented in the scientific literature how much of the peripheral iris needs to be treated by ALPI to achieve prompt pressure control in PACG.

In our experience it is not always feasible to apply ALPI in all 360° of the peripheral iris. For example, a pannus encroaching onto the peripheral cornea can obscure part of the peripheral iris, as can a pterygium. Alternatively, any corneal scars, resulting from inflammatory conditions, or from mechanical or chemical trauma, can also obstruct laser access to the peripheral iris.

In this study we deliberately applied ALPI to only half the peripheral iris (180°) in 10 consecutive patients with their first attack of PACG. This pilot study was aimed at determining whether limited ALPI to only half the peripheral iris would be sufficient to abort an attack of PACG. The study was an attempt to address the question of whether one should apply immediate ALPI to those PACG patients with only part of their peripheral iris amenable to laser treatment.

This study has relevance also to patients with no anterior segment media opacities. Anterior segment laser procedures carry risks, even though the risks associated with immediate ALPI for PACG may be small. The basic principle remains that one should apply as little laser energy as possible to achieve the targeted end-point. Theoretically the more laser burns that are applied to the iris, the more the inflammation and the higher the risk of corneal burn and lens injury. If 180° treatment is equally effective, we may not need or want to treat 360°

From this study it appears that 180° ALPI may be effective in the control of IOP in PACG. It is able to lower the IOP from an initial, dangerous level of 57.9 mmHg (mean) to a much safer level of 20 mmHg or below in 70% of PACG patients in 60 min. This safer level of IOP was achieved in 100% of patients after 90 min. Topical apraclonidine was used in this study as prophylaxis against the post-laser IOP spike, and it may have contributed to the IOP reduction in addition to the effect of ALPI. In all patients their corneal oedema cleared in

2 h, allowing laser peripheral iridotomy to be performed. None of the patients in this study suffered any complications arising from the laser procedure.

Immediate ALPI appeared to be effective and safe, and free from the potential systemic side effects of the conventional systemic medications. We suggest that immediate ALPI may be considered as the first-line treatment of PACG. It is of particular value in those patients who are at risk from systemic complications. From the results of this study we do not believe that media opacities obstructing laser access to part of the peripheral iris, or lack of patient cooperation, should be absolute contraindications to ALPI. We would like to propose a large-scale prospective clinical trial to identify the minimum laser treatment required to abort an attack of PACG.

References

1. Fourmon S. Diagnosing acute angle closure glaucoma: a flow chart. Surv Ophthalmol 1989;33:491–4.
2. Robin AL, Pollack IP. Argon laser peripheral iridotomy in the treatment of primary angle closure glaucoma. Arch Ophthalmol 1982;100:919–23.
3. Ritch R, Podos SM. Argon laser treatment of angle closure glaucoma. Perspect Ophthalmol 1980;4:129.
4. Airaksinen PJ, Saari KM, Tiainen TJ, Jaanio EA. Management of acute closed-angle glaucoma with miotics and timolol. Br J Ophthalmol 1979;63:822–5.
5. Mogk K, Cyrlin MN. Blood dyscrasias and carbonic anhydrase inhibitors. Ophthalmology 1988;95:768–71.
6. Chapron DJ, Gomolin IH, Sweeney KR. Acetazolamide blood concentrations are excessive in the elderly: propensity for acidosis and relationship to renal function. J Clin Pharmacol 1989;29:348–53.
7. Cowan RA, Hartnell GG, Lowdell CP, Baird IM, Leak AM. Metabolic acidosis induced by carbonic anhydrase inhibitors and salicylates in patients with normal renal function. BMJ 1984;289:347–8.
8. Shirato S, Kagaya F, Suzuki Y, Joukou S. Stevens–Johnson syndrome induced by methazolamide treatment. Arch Ophthalmol 1997;115:550–3.
9. D'Alena P, Ferguson W. Adverse effects after glycerol orally and mannitol parenterally. Arch Ophthalmol 1966;75:201–3.
10. Ritch R. Argon laser peripheral iridoplasty: an overview. J Glaucoma 1992;1:206–13.
11. Ritch R. Argon laser treatment for medically unresponsive attacks of angle-closure glaucoma. Am J Ophthalmol 1982;94:197–204.
12. Sassani JW, Ritch R, McCormick S, *et al*. Histopathology of argon laser peripheral iridoplasty. Ophthalmic Surg 1993;24:740–5.
13. Lim AS, Tan A, Chew P, *et al*. Laser iridoplasty in the treatment of severe acute angle closure glaucoma. Int Ophthalmol 1993;17:33–6.
14. David R, Tessler Z, Yassur Y. Long term outcome of primary acute angle closure glaucoma. Br J Ophthalmol 1985;69:261–2.
15. Lam DSC, Lai JSM, Tham CCY. Immediate argon laser peripheral iridoplasty (ALPI) as treatment for acute attack of primary angle closure glaucoma (PACG): a preliminary study. Ophthalmology 1998;105:2231–6.