

# Current approaches to the management of acute primary angle closure

Dennis S.C. Lam<sup>a</sup>, Clement C.Y. Tham<sup>a</sup>, Jimmy S.M. Lai<sup>a,b</sup>  
and Dexter Y.L. Leung<sup>a,c</sup>

## Purpose of review

Recent advances in the management of acute primary angle closure include argon laser peripheral iridoplasty, immediate anterior chamber paracentesis, and cataract or lens extraction by phacoemulsification. This review summarizes current thoughts on the role of these treatment modalities.

## Recent findings

Argon laser peripheral iridoplasty has been shown to be superior to treatments using combined topical and systemic medications in controlling intraocular pressure in acute primary angle closure. Immediate paracentesis has been shown to be very effective for aborting the condition. This is a good alternative for suitable cases and especially in settings in which laser equipment is not readily available. Cataract or lens extraction by phacoemulsification appears to be promising in preventing progression to chronic angle closure glaucoma after acute primary angle closure.

## Summary

Surgical trials are underway to examine the role of cataract/lens extraction in post-acute primary angle closure. This technique has the potential to prevent recurrence of the condition and progression to chronic angle closure glaucoma. With existing and upcoming new data on managing acute primary angle closure, it is hopeful that a more optimal treatment algorithm will be established soon.

## Keywords

angle closure, glaucoma, iridoplasty, laser, paracentesis, phacoemulsification

## Abbreviations

<b>ALPI</b>	argon laser peripheral iridoplasty
<b>APAC</b>	acute primary angle closure
<b>CACG</b>	chronic angle closure glaucoma
<b>IOP</b>	intraocular pressure

© 2007 Lippincott Williams & Wilkins  
1040-8738

## Introduction

The treatment for acute primary angle closure (APAC) has conventionally been the use of both topical and systemic intraocular pressure (IOP)-lowering medications. As soon as IOP is controlled and sufficient corneal clarity is re-established, laser peripheral iridotomy has been the next step in treatment, with the aim of preventing recurrence of the acute disease, and also to prevent progression to chronic angle closure glaucoma (CACG).

This conventional management algorithm has many limitations, and it is because of these limitations that a number of trials have been undertaken in recent years, with the hope of moving one step closer to the ideal treatment algorithm for APAC.

## Intraocular pressure control in acute primary angle closure: limitations of conventional systemic medications

The initial treatment for APAC aims at rapidly reducing IOP, so as to relieve excruciating symptoms and prevent further irreversible ocular tissue damage [1], before the definitive treatment of laser peripheral iridotomy can be safely performed. The initial treatment may involve one or more of the following IOP-lowering drugs: topical  $\beta$ -blocker, for example, timolol; topical miotic agent, for example, pilocarpine; systemic (oral/intravenous) carbonic anhydrase inhibitor, for example, acetazolamide; oral hyperosmotic agent, for example, glycerol; intravenous hyperosmotic agent, for example, mannitol. Topical steroids may also be used to control inflammation before surgery.

These treatments may fail to reduce IOP in a significant proportion of APAC patients. Even when they are effective, they may take hours, or even days, to reduce IOP to a safe and symptom-free level. The longer the duration of IOP rise, the more irreversible damage

Curr Opin Ophthalmol 18:146–151. © 2007 Lippincott Williams & Wilkins.

<sup>a</sup>Department of Ophthalmology and Visual Sciences, The Chinese University of Hong Kong, <sup>b</sup>Department of Ophthalmology, United Christian Hospital, Kowloon and <sup>c</sup>Hong Kong Eye Hospital, Hong Kong, People's Republic of China

Correspondence to Prof. Dennis S.C. Lam, MD, FRCS, FRCOphth, Professor and Chairman, Department of Ophthalmology and Visual Sciences, The Chinese University of Hong Kong, University Eye Center, Hong Kong Eye Hospital, 147K Argyle Street, Kowloon, Hong Kong, People's Republic of China  
Tel: +852 2762 3157; fax: +852 2194 1369;  
e-mail: dennislam\_pub@cuhk.edu.hk

Current Opinion in Ophthalmology 2007, 18:146–151

there is to the optic nerve head, iris, lens, endothelium and drainage pathways [1]. Patients may suffer prolonged periods of excruciating symptoms. Furthermore, the systemic drugs may cause systemic side effects, such as paraesthesiae, drowsiness, confusion, loss of appetite, polydipsia and polyuria. More serious systemic side effects may also occur with carbonic anhydrase inhibitors, such as metabolic acidosis and electrolyte disturbance [2,3], respiratory failure [4], Stevens-Johnson syndrome [5], and blood dyscrasias [6]. Systemic hyperosmotic agents can cause metabolic disturbance such as acidosis, pulmonary edema and congestive heart failure, acute renal failure, and even intracranial hemorrhage and anaphylactic reaction [7,8]. For these reasons, current medical regimens to control IOP in APAC patients are not optimal.

### **Argon laser peripheral iridoplasty: a new role for an old procedure in acute primary angle closure**

Argon laser peripheral iridoplasty (ALPI) [9] has long been used to mechanically open up the angle in medically resistant APAC. It involves the placement of a ring of contraction burns on the peripheral iris to contract the iris stroma near the angle. This mechanically pulls open the angle and lowers the IOP, allowing the eye to become quiet before the definitive treatment of laser peripheral iridotomy in APAC. The usual practice was to perform ALPI after maximal medications fail to control the IOP in APAC [9,10].

If ALPI can reduce IOP rapidly in almost all cases of medically resistant APAC, why can it not be used in other cases of APAC as well? The potential advantages of immediate ALPI are shortening the period of high IOP, and thus minimizing the extent of ocular tissue damage, especially optic nerve head damage; replacing the use of systemic carbonic anhydrase inhibitor and hyperosmotic agents, so that patients are spared the risk of any systemic side effects [11]. The idea of employing ALPI as the immediate first-line treatment for APAC was conceived in 1997.

### **Surgical trials establishing a role for argon laser peripheral iridoplasty as first-line treatment for acute primary angle closure**

A series of preliminary studies were initiated in Hong Kong in 1997 to test the hypothesis of ALPI being an effective and safe immediate first-line treatment for APAC in place of conventional systemic IOP-lowering medications.

The first pilot project [12] involved 10 consecutive patients with APAC. After administration of topical timolol and pilocarpine, ALPI was performed on the attack eye with no systemic IOP-lowering medications. The mean IOP of the 10 APAC eyes was very

rapidly reduced from a pretreatment level of 59.5 to 21.7 mmHg at 30 min after ALPI, and 16 mmHg at 1 h after ALPI. Symptoms were rapidly relieved. ALPI was effective in every one of the 10 recruited patients, and no serious complications had arisen from the laser procedure.

A follow-up study confirmed that the IOP reduction was predominantly due to the ALPI, and not the topical timolol and pilocarpine [13]. It was also later shown that treatment of only 180° of the peripheral iris with ALPI may be sufficient to reduce IOP in the majority of APAC cases, and so partial optical obstruction of the peripheral iris by corneal opacities need not be a contraindication for ALPI treatment [14]. Apart from argon laser, diode laser was also demonstrated to be effective for peripheral iridoplasty in APAC, with inherent advantages [15]. The safety of laser peripheral iridoplasty was confirmed by all these preliminary studies.

In 2000, a randomized controlled interventional trial comparing ALPI against conventional systemic IOP-lowering medications in the first-line treatment of APAC was commenced in Hong Kong [11]. Seventy-three eyes of 64 consecutive patients with their first presentation of APAC, with IOP greater than 40 mmHg, were recruited into the study. The APAC eye of each consenting patient received topical pilocarpine (4%) and topical timolol (0.5%). The patients were then randomized into one of two treatment groups. The ALPI group received immediate ALPI under topical anesthesia. The laser was initially set at an energy level of 200 mW, and titrated according to response. The duration of each laser pulse was 0.5 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 Iridectomy Laser Lens (Ocular Instruments, Inc., Bellevue, USA). All four quadrants (360°) were treated whenever possible. The endpoint was reached when localized iris contraction at the treated area became visible. The Medical Treatment group was given 500 mg of intravenous acetazolamide, followed by oral acetazolamide 250 mg four times a day, and oral potassium supplement, until IOP normalized. Intravenous mannitol would also be administered to the latter group if the presenting IOP was higher than 60 mmHg. The APAC eye of both groups continued to receive topical pilocarpine (1%) until peripheral iridotomy could be performed.

In the end, 33 APAC eyes of 32 patients were randomized to receive immediate ALPI, while 40 APAC eyes of 32 patients had conventional systemic medical therapy. Both treatment groups were matched for age, duration of attack, and IOP at presentation. The ALPI-treated group had lower IOP than the medically treated group, at 15 min, 30 min, and 1 h after the start of treatment

(Fig. 1). The differences were statistically significant. The differences in IOP became statistically insignificant from 2 h onwards. The duration of attack did not affect the efficacy of ALPI in reducing IOP in APAC. No serious laser complications occurred.

From this study, the authors concluded that ALPI is significantly more effective than conventional systemic medications in reducing IOP in APAC not suitable for immediate laser peripheral iridotomy, within the first 2 h from the initiation of treatment. ALPI is a safe and more effective alternative to conventional systemic medications in the management of APAC.

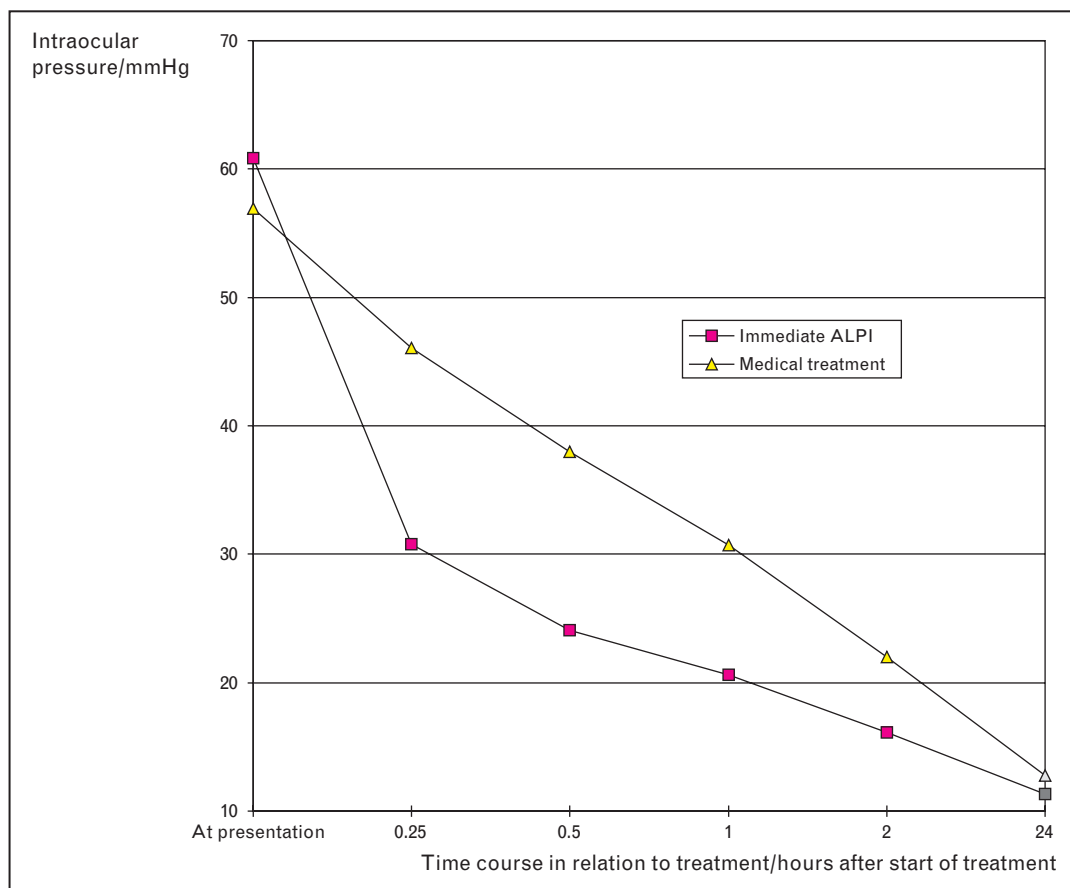
It is believed that ALPI mechanically pulls open the closed drainage angle, thereby allowing aqueous to escape through the trabecular meshwork. This hypothesis was supported by an ultrasound biomicroscopy study [12]. Since the appositional closure of the drainage angle in a grossly inflamed eye during an acute attack may conceptually predispose to peripheral anterior synechiae formation, ALPI may, at least in theory, reduce the

chance of peripheral anterior synechiae formation by reducing the duration of appositional angle closure. This may potentially help reduce the chance of subsequent progression to CACG. A recent study has provided evidence in support of this hypothesis, though the differences have not reached statistical significance with a mean follow up of around 16 months [16<sup>\*</sup>].

### Immediate anterior chamber paracentesis: a safe and effective adjunct to systemic medications?

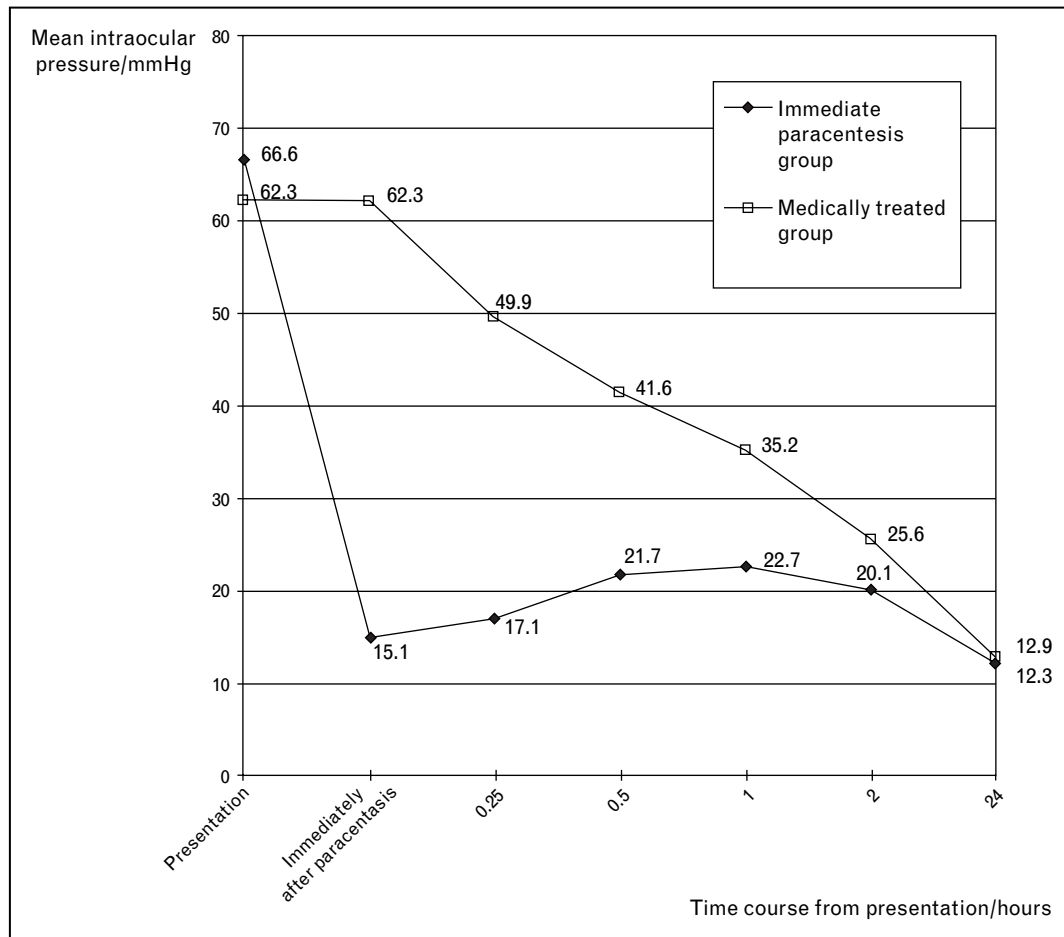
In cases when laser iridoplasty is not possible, immediate paracentesis has been proposed as an alternative procedure to rapidly lower the IOP in APAC [17]. The unique advantage of immediate anterior chamber paracentesis lies in the rapidity of IOP control (Fig. 2) and almost instantaneous relief of the severe symptoms [17]. Rapid IOP control limits the extent of ocular tissue damage from high IOP. For a sustained pressure reduction, it appears that conventional medications are still necessary when paracentesis has been performed [17]. Furthermore, laser iridotomy is also necessary after paracentesis to

**Figure 1 Randomized controlled trial comparing argon laser peripheral iridoplasty (ALPI) with conventional systemic intraocular pressure (IOP)-lowering medications as first-line treatment of acute primary angle closure**



Profiles of mean IOP before and at various time points after commencement of treatment in the two treatment groups. Reproduced with permission from Lam *et al.* [11].

**Figure 2 Profiles of mean intraocular pressure in acute primary angle closure eyes treated with immediate anterior chamber paracentesis and systemic medications compared with those treated with systemic medications in a conventional fashion**



Reproduced with permission from Lam *et al.* [17].

eliminate pupil block. Since paracentesis reduces IOP and clears corneal edema so rapidly, it may allow laser peripheral iridotomy to be performed earlier than is conventionally possible.

The performance of anterior chamber paracentesis in an eye with APAC appears to pose many unique technical difficulties. First of all, the patient is in severe pain and may be photophobic. The patient may not cooperate fully at the slit lamp, and eyelid speculum is often, if not always, required for a safe procedure. The patient may be nauseated, or even vomiting. The patient may thus not be able to stay entirely still on the chin rest at the slit lamp. An APAC eye has a shallow anterior chamber, and thus the risk of iris or lens damage from the paracentesis slit knife is present. In our experience, the additional discomfort arising from the paracentesis is minimal compared with what has been caused by APAC. The time required for the procedure is also very short, usually taking a few seconds only. The key is to encourage and explain

the procedure adequately to the patient. We have encountered no difficulties in finishing the procedures. It goes without saying that we do not perform paracentesis in patients who cannot cooperate and in eyes that have a very shallow anterior chamber depth. Most of the cases that we encounter do not have very shallow anterior chambers. One practical tip is to enter the anterior chamber with only a short section of the fine tip of the slit knife, thereby limiting the risk of lens/iris damage. A slight twist of the slit knife after entering the anterior chamber will open up the small slit wound, allowing aqueous to come out easily. We do not drain the aqueous in one go. We twist back the slit knife after a little bit of aqueous has come out so that the drainage will be stopped. We wait for a few seconds and then repeat the procedure once or twice to complete the decompression. This manner of controlled and stepwise reduction of IOP will minimize the risk of decompression retinopathy. Last but not least, as this is an intraocular procedure, it is important that aseptic techniques are practiced.

Immediate ALPI can lower IOP and relieve symptoms in APAC almost as rapidly, but the argon laser may not be readily available in most emergency settings. Furthermore, immediate laser iridoplasty also requires round-the-clock availability of such expertise, which may pose logistical difficulties. The equipment necessary for immediate anterior chamber paracentesis, however, is minimal, and can be made readily available in any emergency setting. Furthermore, it is envisaged that after proper training, on-call ophthalmology residents may also be competent enough to perform an effective and safe paracentesis. The role and benefits of paracentesis in the management of APAC have yet to be more clearly defined by prospective randomized clinical trials.

### Post-acute primary angle closure treatment

Once IOP has been controlled in APAC (post-APAC), the target of the next step in treatment is to prevent recurrence of the acute attack, and to avoid progression to CACG. The ideal treatment for APAC should, on the one hand, eliminate any pupillary block to prevent future attacks, and on the other, should widen the angle and eliminate any residual appositional closure as much as possible to prevent progression to CACG.

Traditionally, the treatment of choice has been laser peripheral iridotomy. The efficacy of laser peripheral iridotomy in preventing recurrence of acute angle closure in oriental eyes has not been well studied. Its ability to prevent progression to CACG has, however, been shown to be limited. In one study, 58.1% of APAC eyes treated with conventional medical regimes followed by laser peripheral iridotomy progressed to CACG after a mean follow up of 50.3 months [18]. An alternative treatment that can do better than this has to be found.

### The role of early lens extraction in post-acute primary angle closure

The thickness of the crystalline lens contributes to pupillary blockade in a predisposed eye. This may explain the incidence of APAC increasing with age. In APAC patients with coexisting visually significant cataract, cataract extraction and capsular implantation of an intraocular lens has the added advantage of deepening the anterior chamber and widening the drainage angle. We hypothesized that cataract extraction in APAC patients should effectively eliminate, or at least reduce, the risk of recurrence of acute angle re-closure. The widening effect this therapeutic regime has on the drainage angle may also reduce the risk of progression of peripheral anterior synechiae and development of CACG.

We are currently undertaking a randomized controlled trial comparing early phacoemulsification and conventional argon laser peripheral iridotomy on IOP rise after

APAC. The 6-month results have been very encouraging (authors' unpublished data) in terms of IOP rise. There are 31 eyes in each arm and the IOP rise rates were 3.2% and 28.3% for the phacoemulsification and iridotomy groups, respectively. We are preparing a manuscript to report the full details and results of the study.

In our study, we performed phacoemulsification about  $7 \pm 3$  days after aborting APAC but without peripheral laser iridotomy. The anterior chamber was often shallow. Posterior synechiae was not uncommon, and the pupil was often difficult to fully dilate. The iris was often atrophic and atonic. Epithelial corneal edema is common and the zonules were weaker than normal. All the above increase the risk of surgery. Regional instead of topical anesthesia is recommended as the eyes were very sensitive to pain and postoperative fibrinous reaction is common if intensive peri and postoperative anti-inflammatory treatments were not given. Our overall view is that phacoemulsification is doable soon after aborting APAC but this is skill dependent and not without risk. A better option is to perform the surgery about 4 weeks after APAC when the eye has settled down adequately and the IOP has not yet risen. It appears further studies to define the role and best timing of phacoemulsification in the prevention of CACG after APAC are warranted.

### Conclusions

Systemic IOP-lowering medications and laser peripheral iridotomy have, for decades, been the unchallenged treatment of choice in APAC. In light of recently available data, especially those from studies on oriental eyes, it has become increasingly clear that the conventional approach is still far from ideal.

ALPI has recently been shown to be superior to the conventional approach in IOP control. We highly recommend this method for treating APAC. Immediate anterior chamber paracentesis appears to be safe and very effective in IOP control for suitable cases. Surgical trials are on the way to examine the role of cataract/lens extraction in post-APAC. This method has the potential to prevent recurrence of APAC and progression to CACG. It is hoped that these clinical trials will result in better treatment algorithms for the management of APAC.

### References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 177–178).

- 1 David R, Tessler Z, Yassur Y. Long-term outcome of primary acute angle-closure glaucoma. *Br J Ophthalmol* 1985; 69:261–262.
- 2 Chaparon DJ, Gomolin IH, Sweeney KR. Acetazolamide blood concentrations are excessive in the elderly: propensity for acidosis and relationship to renal function. *Clin Pharmacol* 1989; 29:348–353.

- 3 Cowan RA, Hartnell GG, Lowdell CP, *et al.* Metabolic acidosis induced by carbonic anhydrase inhibitors and salicylates in patients with normal renal function. *BMJ (Clin Res Ed)* 1984; 289:347–348.
  - 4 Coudon WL, Block AJ. Acute respiratory failure precipitated by a carbonic anhydrase inhibitor. *Chest* 1976; 69:112–113.
  - 5 Shirato S, Kagaya F, Suzuki Y, Joukou S. Stevens-Johnson syndrome induced by methazolamide treatment. *Arch Ophthalmol* 1997; 115:550–553.
  - 6 Mogk LG, Cyrlin MN. Blood dyscrasias and carbonic anhydrase inhibitors. *Ophthalmology* 1988; 95:768–771.
  - 7 D'Alena P, Ferguson W. Adverse effects after glycerol orally and mannitol parenterally. *Arch Ophthalmol* 1966; 75:201–203.
  - 8 Spaeth GL, Spaeth EB, Spaeth PG, Lucier AC. Anaphylactic reaction to mannitol. *Arch Ophthalmol* 1967; 78:583–584.
  - 9 Ritch R, Liebmann JM. Argon laser peripheral iridoplasty. *Ophthalmic Surg Lasers* 1996; 27:289–300.
  - 10 Ritch R. Argon laser treatment for medically unresponsive attacks of angle-closure glaucoma. *Am J Ophthalmol* 1982; 94:197–204.
  - 11 Lam DS, Lai JS, Tham CC, *et al.* Argon laser peripheral iridoplasty versus conventional systemic medical therapy in treatment of acute primary angle-closure glaucoma: a prospective, randomized, controlled trial. *Ophthalmology* 2002; 109:1591–1596.
  - 12 Lam DS, Lai JS, Tham CC. Immediate argon laser peripheral iridoplasty as treatment for acute attack of primary angle-closure glaucoma: a preliminary study. *Ophthalmology* 1998; 105:2231–2236.
  - 13 Tham CC, Lai JS, Lam DS. Immediate argon laser peripheral iridoplasty for acute attack of PACG (addendum to previous report). *Ophthalmology* 1999; 106:1042–1043.
  - 14 Lai JS, Tham CC, Lam DS. Limited argon laser peripheral iridoplasty as immediate treatment for an acute attack of primary angle closure glaucoma: a preliminary study. *Eye* 1999; 13 (Pt 1):26–30.
  - 15 Lai JS, Tham CC, Chua JK, Lam DS. Immediate diode laser peripheral iridoplasty as treatment of acute attack of primary angle closure glaucoma: a preliminary study. *J Glaucoma* 2001; 10:89–94.
  - 16 Lai JS, Tham CC, Chua JK, *et al.* To compare argon laser peripheral iridoplasty • (ALPI) against systemic medications in treatment of acute primary angle-closure; mid-term results. *Eye* 2006; 20:309–314.
- In this cohort of 38 eyes with APAC, we showed that the beneficial effects of ALPI (in terms of IOP control and number of glaucoma medications required) are maintained up to a mean follow-up of  $15.7 \pm 5.8$  months after laser.
- 17 Lam DS, Chua JK, Tham CC, Lai JS. Efficacy and safety of immediate anterior chamber paracentesis in the treatment of acute primary angle-closure glaucoma: a pilot study. *Ophthalmology* 2002; 109:64–70.
  - 18 Aung T, Ang LP, Chan SP, Chew PT. Acute primary angle-closure: long-term intraocular pressure outcome in Asian eyes. *Am J Ophthalmol* 2001; 131:7–12.