

Surgical treatment for primary angle closure glaucoma

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Abstract

Primary angle closure glaucoma is one of the leading causes of blindness in Asia. Surgical intervention is often needed to control the intraocular pressure for patients with advanced glaucoma. The current surgical modalities include laser peripheral iridoplasty, lens extraction, trabeculectomy, goniosynechialysis, combined procedures, glaucoma implants, and cyclo-destruction. The choice of surgical treatment depends on the surgeon's experience and the stage of the disease.

Key words: Primary angle closure glaucoma, Surgical treatment

Introduction

Primary angle closure glaucoma (PACG), a category of chronic angle closure glaucoma (CACG), is a major cause of blindness in Asia and South Africa.^{1,2} It is an anatomical disorder of the anterior segment, characterized by persistent closure of the filtration angle as a result of iris apposition to the trabecular meshwork due to pupillary block or angle crowding. Primary angle closure glaucoma can be defined as an intraocular pressure (IOP) of greater than 21 mm Hg, with either the presence of pathological cupping or glaucomatous visual field defects in an eye with a persistently closed angle (**Figure 1**). Most eyes with PACG have peripheral anterior synechiae (PAS) resulting in permanent closure of the angle (**Figure 2**). If a large proportion of the



Figure 1. Gonioscopy to show a closed angle.

angle is closed, medical therapy may be ineffective for controlling the IOP and surgical intervention becomes necessary (**Figure 3**).³ This paper reviews the current surgical techniques for PACG.

Laser peripheral iridotomy

Laser peripheral iridotomy is the definitive treatment for acute angle closure due to pupillary block.⁴ In pupillary block, aqueous movement from the posterior chamber to the anterior chamber is blocked in the region of iridolenticular contact. By creating a hole on the peripheral iris, the pressure differential between the posterior chamber and the anterior chamber is equalized. Pupillary block is the most



Figure 2. Early peripheral anterior synechiae formation.



Figure 3. Extensive peripheral anterior synechiae angle closure.

common cause of angle closure and virtually all eyes with angle closure probably have the component of pupillary block. Studies in Caucasian eyes have shown that laser peripheral iridotomy is effective for controlling IOP after acute primary angle closure in the long term.^{5,6} However, Aung et al reported that a high proportion of patients with acute primary angle closure developed an increase in IOP despite a patent laser peripheral iridotomy.⁷ Nevertheless in eyes with PACG where the angle is closed, with or without PAS, laser peripheral iridotomy has a role in eliminating progressive synechial closure from recurrent pupillary block.⁸

Laser peripheral iridoplasty

Argon laser peripheral iridoplasty (ALPI) has been used for the treatment of an acute attack of angle closure.⁹⁻¹¹ The technique involves the use of lower energy, long duration, and large spot size contraction burns placed at the periphery



Figure 4. Laser peripheral iridoplasty markings. The peripheral iris configuration is altered by the laser burns.

of the iris to pull open the appositionally closed angle by mechanical effect (**Figure 4**). Both argon laser and diode laser have been reported to have a high success rate as the initial treatment for acute primary angle closure.¹²⁻¹⁵ Argon laser peripheral iridoplasty has also been used to treat CACG.¹⁶⁻¹⁸ In one study by Chew and Yeo, ALPI was able to open at least half the closed angle in all the studied eyes, with good IOP control for up to 6 months.¹⁶ In another study, Agarwal et al achieved 100% success in IOP control, with the rate of success directly related to the extent of the closure, optic disc cupping, and the presence of visual field changes.¹⁹ Laser peripheral iridoplasty has also been used following surgical goniosynechialysis to alter the iris configuration to maintain an open angle.²⁰ Despite high success rates in the treatment of acute attacks of angle closure, the efficacy of ALPI in the treatment of PACG has yet to be proven. The duration of the angle opening effect of laser peripheral iridoplasty depends on the mechanism of the block. Eyes with plateau iris configuration rarely require retreatment. However, the angle can still gradually close due to progressive lens enlargement. In one study of 30 patients with acute angle closure treated with laser peripheral iridoplasty followed by laser peripheral iridotomy, 30% of patients developed increased IOP with PAS closure of the angle with a mean follow-up of 33.0 ± 9.3 months. (JSM Lai, unpublished data.)

Lens extraction

Extracapsular cataract extraction (ECCE) has been shown to lower IOP in CACG.²¹⁻²⁴ Phacoemulsification alone has also been shown to normalize IOP in CACG.^{25,26} Lens removal is associated with deepening of the anterior chamber and widening of the angle.^{27,28} It has been postulated that removal of a large cataractous lens from an eye with a crowded anterior segment may improve the aqueous outflow.²⁹ It has also been postulated that during phacoemulsification, the positive fluid current flushes out cellular debris from the trabecular meshwork, making the trabecular meshwork less resistant to the aqueous outflow.³⁰ Other hypotheses include pressure from the haptics of the intraocular lens (IOL) on the ciliary body causing a decrease

in aqueous production;³¹⁻³⁴ stretching of the trabecular meshwork by the IOL, enhancing the outflow facility;³¹⁻³⁴ traction of the ciliary body via the zonules, preventing the collapse of Schlemm's canal;^{25,33} and biochemical or blood-aqueous barrier alterations.³⁵

Trabeculectomy

Trabeculectomy, which is the surgical treatment of choice for primary open angle glaucoma (POAG), is also effective for PACG.³⁶ However, this approach may result in a shallow anterior chamber, choroidal detachment, malignant glaucoma, or endophthalmitis.^{37,38} Trabeculectomy has been shown to have an overall success rate of 68% in terms of IOP control.^{36,39} Most patients with PACG may have a single episode or recurrent attacks of acute angle closure, and may have been treated with laser peripheral iridoplasty and peripheral iridotomy. These eyes may be in an acute or chronic state of intraocular inflammation. If the inflammation is not adequately controlled, the use of adjunctive therapy with 5-fluorouracil⁴⁰ or mitomycin-C⁴¹ may improve the surgical result. However, the use of antifibrotic agents increases the risk of persistent hypotony, late-onset bleb-related endophthalmitis, and cataract progression.⁴²⁻⁴⁴ Trabeculectomy, with or without adjunctive therapy, has the disadvantage that future cataract extraction may result in loss of the functioning filter. It has been reported that 30 to 100% of previously functioning blebs required anti-glaucoma medications to control the IOP after ECCE or phacoemulsification.⁴⁵⁻⁴⁸

Goniosynechialysis

Goniosynechialysis (GSL) is a surgical technique performed to strip the peripheral anterior synechiae from the angle so that aqueous can flow through the trabecular meshwork. In the past, ophthalmologists have tried to sweep open a closed angle without direct visualization. This has often failed since correct instrument placement cannot be certain. In 1984, Campbell introduced a modified GSL technique using direct intraoperative visualization of the angle and chamber deepening with viscoelastic agents.⁴⁹ Visualization has been further improved with the use of the Swan-Jacob lens. This specially designed lens has a handle attached to a small diameter prism so that it will not obstruct the spatula from entering the anterior chamber at the limbus (**Figure 5**). Various surgeons have published their results on GSL and the general success rate for IOP control for patients with angle closure of less than 1 year's duration is approximately 80%.⁵⁰⁻⁵² Irreversible damage to the trabecular meshwork often occurs in areas of PAS closure with a proliferation of iris tissue into the intertrabecular space, which may explain why GSL fails in angle closure of long duration. In order for GSL to be effective, it must be performed before there is irreversible histologic change in the trabeculum, and the mechanism causing the angle closure must be eliminated by performing peripheral iridotomy, ALPI, or lens extraction, either alone or in combination, to minimize the possibility of reclosure. Tanihara and Nagata reported success using



Figure 5. Spatula stripping open the closed angle in goniosynechialysis.

GSL followed by argon laser peripheral iridoplasty.⁵² Lai et al reported 5 patients with an 80% success rate using limited GSL followed by diode laser peripheral iridoplasty.⁵³ The most common complication of GSL is intraoperative hemorrhage. Other complications include iridodialysis, cyclodialysis, and lens damage.⁵⁴ Both GSL and trabeculectomy have advantages and disadvantages. **Table 1** compares the potential risks of both operations.

The exact mechanism of GSL is unknown. Reopening the angle to re-establish the aqueous outflow channel is one of the possible mechanisms. We postulated that postoperative inflammation and cyclodialysis resulting in decreased aqueous production may contribute to the lowering of the IOP.

Combined lens extraction and glaucoma procedures

Many patients with PACG have coexisting cataract. Surgical treatment of PACG is therefore often combined with lens extraction with IOL implantation. Since it has been shown that removal of the lens is associated with deepening of the anterior chamber and a long-term decrease in IOP,³⁴ glaucoma surgery combined with lens extraction should have a more profound IOP lowering effect. In addition, removal of the cataract will improve patients' visual acuity. Unfortunately, there is no data available on the exact amount of additional IOP lowering of glaucoma procedures combined with lens extraction.

Table 1. Potential advantages and disadvantages of goniosynechialysis and trabeculectomy.

	Goniosynechialysis	Trabeculectomy
Postoperative intraocular pressure spike	+	—
Iridodialysis	+	—
Flat anterior chamber	—	+
Hypotony	—	+
Malignant glaucoma	—	+
Bleb related infection	—	+
Late endophthalmitis	—	+

Lens extraction with trabeculectomy

Trabeculectomy has been combined with extracapsular cataract extraction and posterior chamber intraocular lens implantation (PCIOL) in the treatment of POAG and cataract. Recently, trabeculectomy has been combined with phacoemulsification and is reported to have an improved outcome because of the decreased surgical trauma from using a small incision. In Wedrich et al's series of 3 patients with CACG, there was a 100% success rate in IOP control, with and without medications, after combined phacotrabeculectomy (mean follow-up, 13.3 months).⁵⁵ As mentioned previously, trabeculectomy alone has disadvantages for the management of PACG. It is therefore recommended that the lens be removed at the time of trabeculectomy, even with early cataract.

Lens extraction with goniosynechialysis

Teekhasaene and Ritch have reported success with phacoemulsification combined with GSL⁵⁶ and Lai et al have been successful with combined phacoemulsification and limited GSL followed by diode laser peripheral iridoplasty for PACG.⁵⁷ In Lai et al's case report, it was shown that the effect of lens removal in PACG would only deepen without actually opening up the angle, while GSL opened up the angle.⁵⁷ Nevertheless, both lens extraction and GSL performed alone have been shown to lower the IOP, although the mechanisms are uncertain and may or may not be common to both procedures. GSL combined with lens extraction has the following potential advantages:

- visual improvement after removal of cataract
- removal of the lens may decrease the possibility of reclosure of the angle
- additive IOP lowering effect of the 2 procedures.

Glaucoma implant

The use of a glaucoma implant for difficult-to-treat glaucoma is not new and ranges from the early Molteno implant to the currently popular valve-equipped variety such as the Ahmed glaucoma valve (**Figure 6**). Overall, the success rates for controlling IOP for complicated cases ranges from 70 to 90%.⁵⁸⁻⁶² However, because it is a technically more difficult procedure and because of the potentially serious complications, the use of a glaucoma implant for CACG has been mainly confined to those patients in whom previous, multiple, filtering procedures have failed. Of the studies that included CACG, the proportion of patients with CACG ranged from 1.7 to 9%.⁵⁸⁻⁶² Aside from the small number of patients, the major problem with these studies is that only 2 published the results of the subgroup with CACG.^{58,63} One had only a single non-Asian patient who ended up with no light perception at 6 months,⁶⁴ while the other included 10 patients (of non-specified race), 7 of whom had successful surgery.⁵⁸ In Krishna et al's series, there were 15 eyes (23%) with the diagnosis of CACG, iridocorneal endotheliopathy, and juvenile open angle glaucoma treated with the 350 mm² Baerveldt glaucoma implant.⁶³

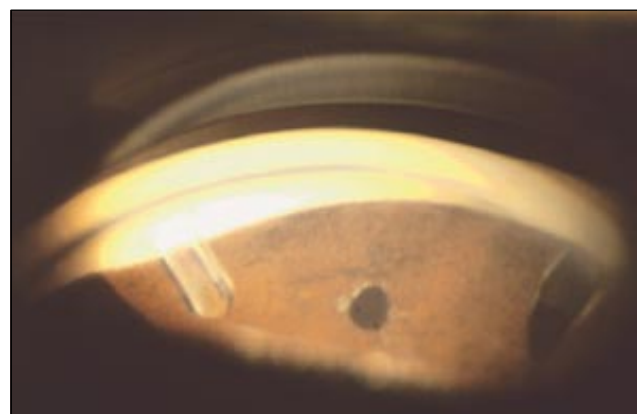


Figure 6. Ahmed glaucoma implant tube in an eye with primary angle closure glaucoma.

The immediate-term failure rate in this sub-group was 47%, compared with 19% in the group with POAG. Given the limited number of patients and amount of information currently available, further studies are needed before a firm conclusion on the relative success of glaucoma implants for patients with PACG can be attained.

Cyclodestruction

In 1950, Bietti introduced cyclocryotherapy⁶⁴ to destroy the ciliary body epithelium, stroma, and vasculature by applying a temperature of -80°C via a cryoprobe.⁶⁵ The clinical usefulness of cyclocryodestruction is limited by its complications — the most serious one being hypotony and phthisis.⁶⁶⁻⁶⁸ Others include hyphema and choroidal and retinal detachment. In the past 10 years, cyclocryotherapy has been replaced by laser cyclophotocoagulation. Trans-scleral diode laser cyclodestruction using the G-probe is becoming more popular and is used to treat many types of glaucoma (**Figure 7**).^{69,70} The semiconductor diode laser emits light of wavelength 810 nm, near the infrared spectrum. It is absorbed by melanin and is transmitted through the sclera.⁷¹⁻⁷³ The success rates of cyclodestruction vary among different types of procedures and glaucomas. Diode laser cyclophotocoagulation was reported to be effective in



Figure 7. Diode laser trans-scleral cyclophotocoagulation using the G-probe.

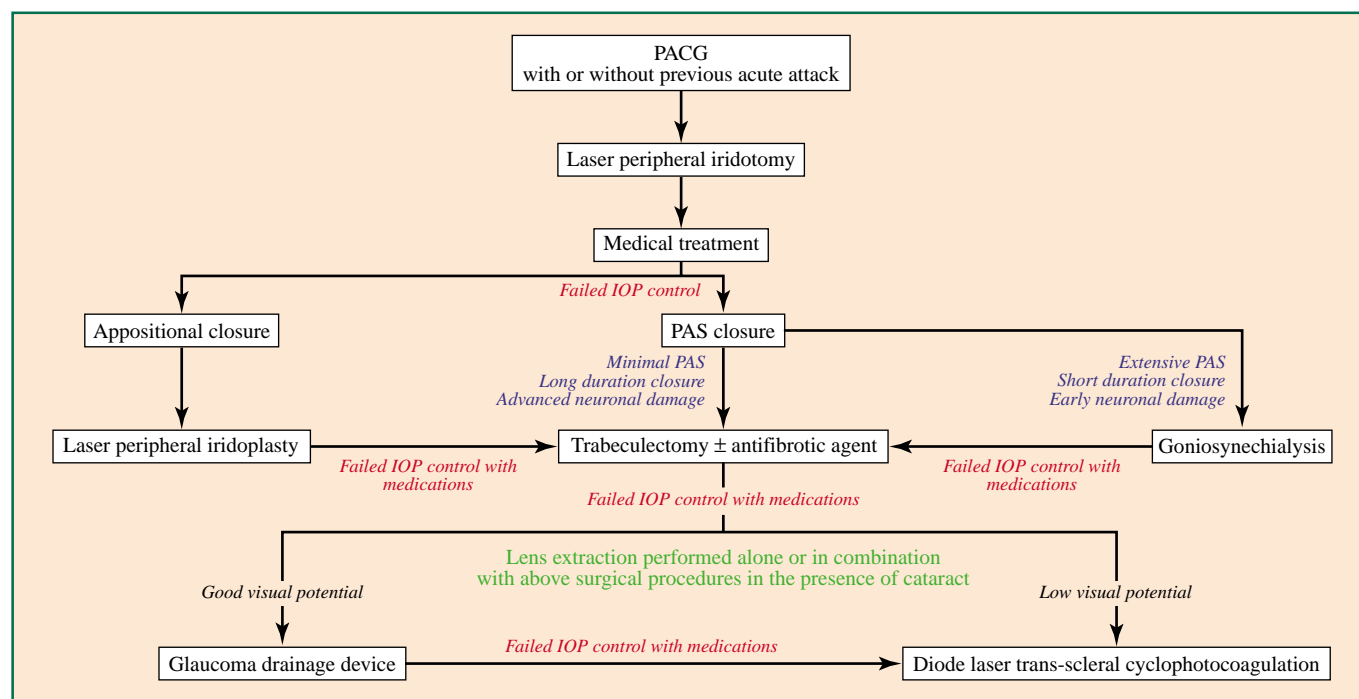


Figure 8. Suggested approach to treatment for primary angle closure glaucoma (PACG). *Abbreviations:* IOP = intraocular pressure; PAS = peripheral anterior synechiae.

controlling the IOP to below 21 mm Hg in 70 to 81% of pediatric and adult refractory glaucomas.⁷⁴⁻⁸¹ However, there has been no large-scale study on its efficacy in the treatment of PACG. Since it decreases the IOP by destroying the ciliary body epithelium, it should theoretically be effective even in eyes with 360° PAS angle closure. The development of diode laser cyclophotocoagulation opens new areas for the management of difficult-to-treat glaucoma such as for patients with a synechial type of PACG. The effectiveness, ease of transport, ease of learning, and speed of this technique make diode laser trans-scleral cycloablation a potential primary or secondary surgical procedure in the treatment of PACG.

Conclusion

Surgical treatment of PACG is difficult and complicated. There is no gold standard guideline to the choice of surgery and there is a lack of randomized clinical trials to compare different surgical modalities. In the absence of data from comparative

studies, the choice of surgical treatment depends on the surgeon's expertise and preference (**Figure 8**). The stage of the glaucoma should be taken into consideration in deciding which type of surgical modality is to be used.

Given the current evidence, the role of trabeculectomy alone is becoming obsolete for the surgical treatment of PACG. For PACG with recent PAS angle closure, GSL alone or combined phacoemulsification and GSL may be a logical approach. However, in the presence of substantial visual defects and/or advanced cupping that signifies a long duration of angle closure, irreversible structural changes in the trabeculum are expected. Performing GSL to open the angle to increase aqueous outflow in these patients may not be a sensible choice. Combined phacotrabeculectomy may be considered for extensive and longstanding PACG. Currently, glaucoma implants and cyclodestruction are reserved for patients with PACG who have undergone multiple filtering operations. Their role as initial surgical treatment for PACG has yet to be evaluated.

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