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Management for Angle Closure Glaucoma: Review Article

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Abstract:

Angle closure glaucoma (ACG) is a potentially blinding ocular condition caused by obstruction of aqueous humor outflow due to closure of the anterior chamber angle. This obstruction leads to elevated intraocular pressure (IOP), optic nerve damage, and progressive visual field loss if not promptly treated. ACG can present as primary or secondary disease and may manifest acutely with severe symptoms or chronically with subtle progression. Early recognition and appropriate management are crucial, as timely intervention can prevent irreversible vision loss.

Keywords: Angle closure glaucoma; intraocular pressure; laser peripheral iridotomy; gonioscopy; optic neuropathy; aqueous humor.

Introduction:

Angle closure glaucoma (ACG) is a major cause of irreversible blindness worldwide and is characterized by obstruction of aqueous humor outflow due to closure of the anterior chamber angle, resulting in elevated intraocular pressure and progressive optic nerve damage. The disease is particularly prevalent in Asian and Middle Eastern populations and may present as acute, intermittent, or chronic forms, with acute attacks constituting an ophthalmic emergency requiring prompt management. Based on gonioscopic findings and the presence of intraocular pressure elevation, peripheral anterior synechiae, and glaucomatous optic neuropathy, angle closure disease is classified into primary angle closure suspect, primary angle closure, and primary angle closure glaucoma. Early diagnosis and appropriate management are essential to prevent permanent visual loss and reduce the global burden of glaucoma **(1).**

Angle-closure glaucoma treatment options are medical, laser, and surgical. Treatment in all types of angle-closure glaucoma should be directed towards the reduction of IOP, reopening the angle, and preventing and/or stopping optic nerve damage **(2).**

a) Medical management

The primary role of medical therapy in PACG is in the immediate management of the acute attack of angle closure. IOP-lowering medications such as topical β-blockers, α-2 agonists, and prostaglandin analogs, as well as systemic (intravenous followed by oral) carbonic anhydrase inhibitors or hyperosmotic agents (e.g. intravenous mannitol or oral glycerol/isosorbide), are commenced as soon as possible to reduce IOP and hasten the resolution of corneal edema **(3).**

Once the IOP is sufficiently reduced and iris reperfusion is present, pilocarpine is instilled to induce miosis in an attempt to widen the ACA and reestablish aqueous outflow, and to facilitate LPI (It is important to remember that pilocarpine should be avoided when AC is secondary to lens-induced or retrolenticular mechanisms, such as in pseudoexfoliation, phacomorphic glaucoma, and aqueous misdirection) **(3).**

Topical steroids help reduce intraocular inflammation, while analgesics and antiemetics help make the patient more comfortable until LPI can be performed **(3).**

In patients with chronic PACG, long-term medical treatment consisting of topical β-blockers, α-2 agonists, or carbonic anhydrase inhibitors may be used if IOP control remains suboptimal after the patient has been treated with LPI. Prostaglandin analogs such as latanoprost, bimatoprost, and travoprost have been demonstrated to be effective in lowering the IOP in PACG patients, even when 360° of PAS is present **(3).**

Medical treatment plays an adjunctive role in patients at risk of AC (i.e.PACS). Parasympathomimetic agents such as pilocarpine are used to induce pupil miosis so that the laser procedure may be more easily performed. α-2 agonists such as brimonidine act quickly to lower the IOP and may be instilled before and after LPI to prevent a post-laser IOP spike. Topical steroids instilled for a week after LPI are beneficial in reducing post-laser intraocular inflammation **(3).**

b) Laser peripheral iridotomy (LPI)

LPI replaced surgical iridectomy as the first-line treatment of PACG in the late 1970s with the advent of argon and then neodymium yttrium-aluminum-garnet (Nd: YAG) laser technology. The Nd: YAG laser was shown in prospective studies to be as effective as surgical iridectomy and argon laser iridotomy **(4**). It has the advantage of using less total energy than argon laser and is theoretically less likely to cause damage to the lens and retina **(5).**

LPI eliminates the pressure differential between the anterior and posterior chambers and is the current standard treatment to correct pupillary block in the initial approach to angle closure. Iridotomy should be performed in all types of primary angle-closure glaucoma to alleviate pupillary block, avoid future acute attacks, and lower IOP **(4, 5).** It is also a safe and effective prophylaxis in suspect eyes with occludable angles secondary to pupillary block, including fellow eyes of acute primary angle closure (APAC) patients at risk for bilateral angle closure **(6).**

Indications of LPI:

1. Prevention of acute angle closure: **Lowe (7) and Snow (8)** reported that iridectomy was effective in preventing a subsequent episode of angle closure in fellow eyes of cases with acute angle closure. Left untreated these eyes had a 50% risk of an attackof angle closure over five years. According to the same principle, fellow eyes of PAC/PACG affected eyes should be treated with LPI. The exception to this is in cases where the fellow eye is pseudophakic **(5).**
2. Long-term IOP control: In patients presenting with PAC/PACG who have elevated IOP one of the aims of LPI treatment is to try and achieve target IOP levels by treating the reversible component of the disease, i.e. appositional angle closure **(5).**
3. Prevention of PAS formation and progressive glaucomatous optic nerve damage: By eliminating appositional closure due to pupillary block and thereby removing the principal causal mechanism underlying PAS development, and by relievingappositional closure, therefore theoretically either lowering co-existing raised IOP or preventing future IOP rises which lead on to development or progression of glaucomatous optic neuropathy **(5).**

Techniques for performing Laser Peripheral Iridotomy

Optimal size and location of LPI: While some recommend that the LPI (Fig. 1) should be positioned in the peripheral one-third of the iris between 11:00 and 1:00 o'clock, in order to minimize visual symptoms that patients may suffer if the LPI is placed at the lid margin or in the interpalpebral region, others routinely place the LPI at the 3 and 9 o'clock positions **(9).**Where iris crypts are present, the iris will be thinner and these sites, if in a suitable position, should be used for LPI **(5).**

Fleck (10) calculated that an iridotomy should be a minimum size of 15 microns in order to prevent pupillary block but suggested aiming for a size of 150-200 microns. One of the factors incorporated into the model he used for the calculations was the iris thickness. As brown Asian irides are thicker and more bulky than blue ones they probably require a larger iridotomy **(5).**

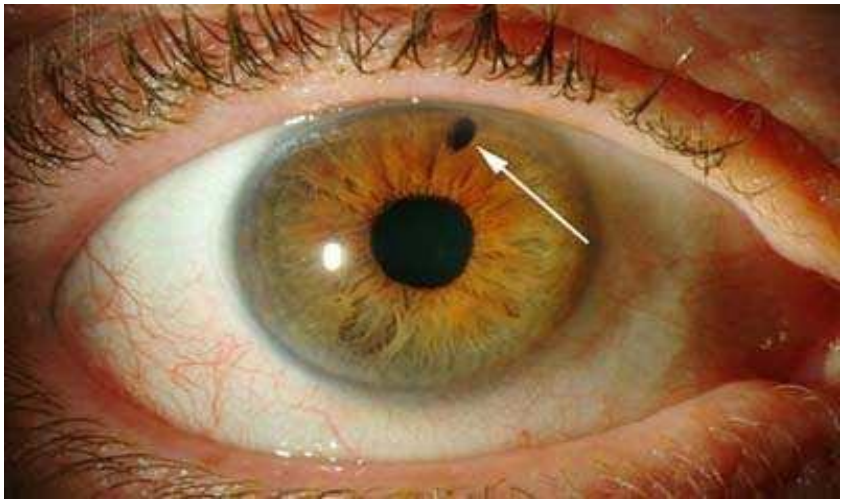

Fig. 1: Laser peripheral iridotomy **(11).**

Laser Peripheral Iridotomy methods.

1. Argon laser Peripheral Iridotomy:

Argon laser began to replace surgical iridectomy as a safer non-invasive method of making an iridotomy in the late 1970s. It was demonstrated to be safe and effective but required melanin for tissue absorption of the energy, making it less easy to penetrate lightly pigmented blue irides **(5).**

2. Nd: YAG laser Peripheral Iridotomy:

The Nd: YAG laser replaced argon as the most common means of performing LPI in the late 1980s. The Q-switched mode of the Nd: YAG laser causes photo disruption of tissues by the formation of high-energy ionic plasma at the location of the focus of very intense energy. It has the advantage of not requiring the presence of melanin pigment for iris absorption. The overall energy required to produce an iridotomy is lower than that required with argon laser. Nd: YAG lasers are usually smaller and portable which can be useful where treatment of patients in the community is necessary. The Nd: YAG LPI is the method of choice for Caucasian angle closure patients with blue or light brown irides **(5).**

3. Sequential argon/Nd YAG LPI

In patients with brown irides, large amounts of energy may be required to achieve a patent Pl when using the Nd: YAG laser. This is of particular relevance in Asian and African populations but also applies to some Caucasian individuals. Argon laser pre-treatment to thin the iris results in the need for less energy with the Nd: YAG laser which is then used to penetrate the iris and create an iridotomy. The coagulative effect of the argon laser reduces the risk of hemorrhage from the iridotomy site. With this sequential technique, the total mean energy used has been reported to be as little as one-third of the energy used in pure argon or pure Nd: YAG iridotomies. Frequency-doubling continuous wave Nd: YAG lasers can be used for the same purpose as the argon laser **(3, 12).**

Guidelines for performing Laser Peripheral Iridotomy

- Patients presenting with newly diagnosed PAC or PACG with markedly elevated IOP should be treated with topical and systemic medications to achieve a safe IOP level (<30 mmHg) prior to undergoing LPI.
- Pre-treat the eye with one drop of pilocarpine to constrict the pupil and use an alpha-agonist (brimonidine or apraclonidine) before and after laser treatment to minimize the risk of post-laser IOP spikes **(13).**
- Topical anesthesia.
- Lens: Abraham lens or Wise lens with coupling fluid. **(5).**

Nd: YAG Laser Peripheral Iridotomy (suggested settings)

Check that the defocus is set to zero. Some surgeons start with relatively low power (1-3 mJ) to thin the iris, and others start with higher power (5-8 mJ) to quickly penetrate the iris. A gush of pigment from the posterior chamber signals patency of the iridotomy. Once a hole has been made in the iris, it should be enlarged horizontally to achieve an adequate-sized iridotomy (If possible, the energy should be lowered for enlarging the iridotomy) **(5).**

Sequential argon / Nd: YAG PI (suggested settings)

1. Argon laser settings:

Stage 1: (optional): 50-micron spot size, 100 MW, and 0.05 seconds duration. Thirty shots in a rosette pattern to thin the iris. This helps avoid large, adherent bubbles with higher power.

Stage 2: Increase power to 750 MW and duration to 0.1s. 10-15 shots (more if not employing stage 1) to form a deep central crater.

2. Nd: YAG laser settings:

1-3 mJ and increase the power required to penetrate the iris in the argon laser pre-treated area. Enlarge as for Nd: YAG PI.

- Following LPI, administer an alpha-agonist. Alternatively, oral acetazolamide can be given in cases where there is concern of post-laser IOP spike, e.g., in cases with raised IOP or advanced PACG.
- Check IOP 45-60 minutes after L.PI.
- Post-laser treatment: Topical steroids should be administered to reduce inflammation and tapered according to the clinical response **(5).**

Complications of laser treatment

Early/immediate:

- **Iris hemorrhage from LPI site:**

Bleeding from the iris occurs during the procedure when the iris vessels are hit by the Nd: YAG laser. Pressure on the globe from the laser lens will usually stop thebleeding **(5).**

- **Cornea:**

Direct injury to the corneal epithelium or endothelium was reported in the past with argon laser when high energy was used to create iridotomies **(14).** A publication in which specular microscopy was used to examine the corneal endothelium following Nd: YAG laser procedures (including iridotomies) demonstrated that dark areas appeared in the endothelium and were related to the amount of Nd: YAG energy used. However, at six months post-iridotomy, there was no statistically significant loss of corneal endothelial cells **(15).**

- **Anterior lens capsule**

This rare complication of LPI can be avoided by placing the iridotomy in the peripheral iris away from the lens and by ensuring that the laser defocus is set to zero before starting treatment **(5).**

- **IOP Elevation:**

The incidence of acute IOP rise following LPI is low due to the routine pre-treatmentof eyes with topical alpha-agonists **(16).** The patients, in whom an IOP spike is more likely to occur, are those with advanced PACG and extensive synechial closure of the angle. The small amount of trabecular meshwork that is not closed by PAS is likely to have compromised outflow function and become blocked by the iris pigment and tissue generated by the PI. The result is an acute rise in IOP. A course of oralacetazolamide starting immediately following

LPI and continued for two to three days may be considered in patients with advanced PACG undergoing LPI **(5).**

Sustained rises in IOP can occur following LPI. These patients need to be monitored closely and treated with topical and systemic IOP-lowering medications. The use of topical steroids may be a factor contributing to sustained elevation of IOP post-LPI. Topical non-steroidal anti-inflammatory agents can be used as an alternative to steroids in these patients. **(5).**

Late complications of LPI:

- Posterior synechiae: The development of posterior synechiae following LPI can result in a permanently miotic pupil. Possible factors that may contribute to posterior synechiae formation include increased contact between the posterior iris and the anterior lens surface after LPI, the use of miotic agents, and AC inflammation.
- Accelerated cataract formation (possible late complication): There is concern that LPI may stimulate cataract formation or accelerate the progression of existing lens opacities. **(17).**

c) Argon Laser iridoplasty (ALI)

ALI is often indicated when mechanisms other than pupil block, such as plateau iris configuration (in which the cross-section of the peripheral iris is seen to have a plateau shape), plateau iris syndrome (in which underlying ciliary body rotation can be demonstrated), or thick peripheral iris roll, are believed to be responsible for the angle closure. In such cases, LPI alone is usually inadequate for achieving the opening of the ACA, and adjunctive ALI can be highly effective. By applying multiple surface photocoagulation burns to the peripheral iris, ALI works by causing peripheral iris contraction away from the trabecular meshwork, thereby reducing appositional contact with the trabecular meshwork.

ALI may also be used in acute attacks of angle closure in which medical therapy has failed to lower IOP sufficiently for corneal edema to resolve, thereby precluding LPI. In such cases, ALI can aid in faster resolution of this attack, facilitating the more definitive treatment of laser iridotomy. ALI may also be used to facilitate access to the trabecular meshwork for laser trabeculoplasty to be performed **(5).**

d) Surgical management

Surgical treatment is often indicated in patients in whom IOP control is suboptimal with persistent progression of optic nerve and/ or visual field damage despite a successful laser iridotomy, and maximal medical therapy. Early intervention with lens extraction has also been advocated, particularly when angle closure is primarily the result of a large cataract. Other indications for early surgical intervention include poor compliance with or intolerance of medical treatment, inability to cooperate with laser treatment or difficulty with follow-up **(3, 18).**

Surgical management includes the following:

- **Iridectomy:**

Since the advent of laser iridotomy, surgical peripheral iridectomy is now seldom performed. However, it may still be useful occasionally where the cornea fails to clear sufficiently for laser iridotomy to be performed, or in the case of a patient who is unable to cooperate with the laser procedure. **(3).**

- **Lens extraction**

Lens extraction is highly effective when either lens thickness or its anterior position is the primary mechanism underlying the angle closure (Fig. 2). Where possible, medical therapy should be commenced to lower IOP prior to lens extraction in order to minimize intraoperative complications. In the acute setting, these eyes are usually associated with extremely high IOPs, shallow AC, cloudy corneas, floppy iris due to iris ischemia, reduced corneal endothelial cell counts, posterior synechiae, lens zonular laxity, and a high risk of malignant glaucoma **(3, 19).**

- **Goniosynechialysis**

This is usually performed in combination with lens extraction and involves mechanical stripping of PAS away from the trabecular meshwork **(3, 20).**

Fig. 2: AS-OCT images are taken pre and post-phacoemulsification. **(21)**

- **Trabeculectomy:**

Trabeculectomy in ACG is performed similarly to for open-angle glaucoma. The use of antimetabolites should be considered. Trabeculectomy, either alone or in combination with lens extraction, should be considered after the acute attack of AC, if the IOP control remains suboptimal despite laser and medical treatment, especially in more advanced cases of ACG which are already associated with PAS, optic nerve, or visual field damage. In acutely inflamed eyes, trabeculectomy has been reported to have low success rates **(3, 22).**

- **Glaucoma drainage implant**

This may be considered in chronic ACG where trabeculectomy has failed to control the IOP, or in eyes that are deemed to be at high risk of failure with trabeculectomy **(3).**

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