Surgical Management of Angle Closure

Medical therapies are helpful, but surgery remains the definitive treatment.

BY MOLLY M. WALSH, MD, MPH, AND PAUL P. LEE, MD, JD

A n epidemiological review of the World Health Organization’s Global Data Bank on Blindness indicated that 2 million people are blind due to primary angle-closure glaucoma (ACG) compared with 3 million from primary open-angle glaucoma. In China alone, 9.1 million people have closed angles. Of these individuals, glaucoma has blinded 5.2 million adults unilaterally and 1.7 million adults bilaterally. ACG can be managed with laser peripheral iridotomy or incisional surgery.

BACKGROUND

Typically, acute angle closure presents suddenly with symptoms such as blurred vision, pain, and headache. Clinical observations may include conjunctival injection, corneal clouding, and a partially dilated pupil. In chronic angle closure, the angle closes over time, and patients are likely asymptomatic or have episodic symptoms. Clinicians diagnose chronic angle closure by the presence of peripheral anterior synechiae. The differential diagnosis for acute angle closure includes primary open-angle glaucoma with a narrow angle on gonioscopy, neovascular glaucoma, uveitis, nanophthalmos, and the causes of secondary ACG (including panretinal photoacoagulation, central retinal vein occlusion, ciliary body swelling, malignant glaucoma, previous vitreoretinal surgery, and posterior segment tumors).

The terminology for discussing angle closure and ACG can be confusing. Angle-closure suspects characteristically have bilateral, narrow angles. Angle closure is defined by the presence of narrow angles, which are accompanied by (1) an IOP greater than or equal to the 97.5th percentile for the population, (2) peripheral anterior synechiae, or (3) a past acute attack. Patients with ACG have bilateral, narrow angles and optic nerve changes consistent with glaucoma—specifically, cup-to-disc ratios greater than or equal to the 97.5th percentile for the population and defects on an automated visual field.

THE MECHANISMS OF ANGLE CLOSURE

All mechanisms of angle closure involve the apposition of the peripheral iris and the trabecular meshwork’s surface, which creates a barrier and reduces aqueous drainage through the outflow pathways. In angle closure, the trabecular meshwork has no intrinsic defects. There are both traditional and emerging concepts to explain the causes of the apposition of the iris and the trabecular meshwork.

Traditionally, ophthalmologists have believed that pupillary block (Figure 1) accounts for almost all cases...
of primary angle closure. Curran initially proposed that performing a peripheral iridectomy was effective because the flow of aqueous humor from the posterior to the anterior chamber was impaired in eyes with pupillary block.

In the rare cases in which pupillary block was not the mechanism of angle closure, ophthalmologists classically cited plateau iris, lens-induced phacomorphic glaucoma, and malignant glaucoma (ciliary block) as causative. For patients with plateau iris, iridotomy is insufficient to resolve an angle-closure episode, because pupillary block is not etiologically responsible. For that reason, other techniques become important such as argon laser peripheral iridoplasty, which surgeons can use to cause contraction burns in the iris’ periphery in order to pull the iris away from the angle.

Recent evidence suggests another potential mechanism for angle closure, however. Quigley et al showed that choroidal expansion may be involved in angle closure in many patients. With greater choroidal expansion, pressure differentials increase across the vitreous, and the vitreous loses its ability to transmit fluid. This ultimately causes the pressure in the posterior globe to become higher than that in the anterior chamber, a disparity that prompts the iridolenticular diaphragm to shift anteriorly. As the iris convexity increases, angle closure becomes likelier. Friedman et al have provided support for the theory of choroidal expansion. They showed differences between the lenticular position in eyes with primary angle closure compared with anatomic controls. Thus, more etiologies of angle closure may exist than have been traditionally recognized.

INITIAL MEDICAL THERAPY

Patients receive medical therapy upon presenting with acute angle closure. The combination of topical β-adrenergic antagonists, carbonic anhydrase inhibitors, hypotensive agents, and steroids remains the mainstay of initial treatment, because it is preferable to break the attack before performing laser or incisional peripheral iridotomy.

LASER PERIPHERAL IRIDOTOMY

Purpose and Laser

Laser peripheral iridotomy eliminates pupillary block by allowing aqueous to flow between the anterior and posterior chambers. Performed with an Nd:YAG laser, an argon laser, or both, laser peripheral iridotomy remains the definitive treatment for acute ACG.

Research has shown that these lasers are equally effective in treating angle closure. Certain characteristics of the patient may influence the surgeon’s choice of a laser, however. In cases of acute angle closure, the argon laser may be preferable because it reduces bleeding, which is typical in inflamed eyes. In addition, blue-eyed patients respond more favorably to the Nd:YAG laser, whereas patients with darker irides respond better to argon or combination lasers.

Pretreatment

Patients should receive pilocarpine 1% to 2% and topical anesthesia before treatment. Research has shown that perioperative apraclonidine or brimonidine reduces the incidence of IOP spikes after laser therapy. Regardless of the laser used, the surgeon performs the laser peripheral iridotomy with a magnifying lens (eg, Abraham) equipped to provide magnification without a loss of depth perception. Such a lens effectively reduces a 50-µm spot to 30 µm, thereby providing higher energy per unit of area. To minimize glare and other postoperative visual distortions, the iridotomy should be performed between the 11- and 1-o’clock positions and away from the tear meniscus level.

Combined Nd:YAG and Argon Laser Iridotomy

When using both argon and Nd:YAG lasers in one session, the surgeon creates a coagulated base with the argon laser first in order to thin the iris and facilitate the iridotomy with the Nd:YAG laser. The combined technique may use less total energy and decreases the incidence of hyphema after laser therapy. Pretreatment with the argon laser is best with laser settings to maximize the iris stroma’s contraction. The ideal parameters for the argon laser are low power (200 to 400 mW), a large spot size (500 µm), and a long duration (0.5 seconds).

Nd:YAG Laser

Whether pretreatment with the argon laser is used or not, the surgeon can create an iridotomy with an Nd:YAG laser. Optimal settings are a preliminary energy of 1.5 to 3.0 mJ, which can then be titrated depending on the response of the iris. In most patients, 4.0 to 6.0 mJ is required to penetrate the iridic stroma. Typically, when...
an effective opening has been created, a plume of aqueous enters the anterior chamber, the iridic stroma moves posteriorly, and the peripheral anterior chamber deepens.

**Argon Laser**

To create penetrating burns for an iridotomy with an argon laser alone, the best combination is high power (600 to 1,200 mW), a small spot size (50 µm), and a short duration (0.02 to 0.05 seconds).^{14}

**Complications and Postoperative Care**

Although rare, the complications of laser peripheral iridotomy include diplopia, visual distortions, bleeding/hyphema, IOP spikes, closure of the peripheral iridotomy due to pigmentary proliferation, and, theoretically, retinal detachment (using an Nd:YAG laser). A discussion of these potential complications should be a part of the informed consent (Table 1).

If bleeding does occur at the time of iridotomy, compressing the lens can tamponade and stop the bleeding. After surgery, patients should receive topical apraclonidine or brimonidine. Their IOP should be checked 1 hour after treatment. Patients should use weaker topical steroids or NSAIDs for up to 1 week postoperatively.

Follow-up should occur 7 to 10 days after the procedure. During the visit, the physician should measure the patient’s IOP and perform gonioscopy. If pupillary block caused the angle to close and the laser peripheral iridotomy was successful, the iris’ contour should no longer be occludable. If the iris remains convex and the angle remains narrow, the physician must determine whether another mechanism such as plateau iris is present. A mydriatic provocative test with either 2.5% or 5.0% phenylephrine may then be indicated. If the IOP then becomes markedly elevated and gonioscopy reveals an occluded angle, plateau iris is the diagnosis and should be treated accordingly.^{3}

**OTHER TREATMENT OPTIONS**

Gonioplasty and Goniosynechialysis

A recent study showed that, although it is not currently a widespread practice, laser gonioplasty or surgical goniosynechialysis can effectively treat eyes with...

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**TABLE 1. COMMON ERRORS AND PROBLEMS IN LASER PERIPHERAL IRIDOTOMY**

<table>
<thead>
<tr>
<th>Error or Problem</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iridectomy not patent</td>
<td>Make sure lens capsule is visible through iridectomy site at conclusion of procedure. “Smoke signal” is not enough!</td>
</tr>
<tr>
<td>Pupil distorted at conclusion of LPI</td>
<td>Inadequate miosis prior to procedure. Much more common with argon or diode LPI than with Nd:YAG laser. Will likely resolve with time.</td>
</tr>
<tr>
<td>Diplopia/visual phenomenon</td>
<td>Iridectomy made in palpebral fissure or so peripheral that tear meniscus acts as prism, creating second image. If intolerable, patient can wear cosmetic contact lens, blocking light from LPI but not pupil.</td>
</tr>
<tr>
<td>Bleeding</td>
<td>Choose correct laser; use argon, diode or argon, or diode plus Nd:YAG in patients on anticoagulants, with iris neovascularization, etc.</td>
</tr>
<tr>
<td>Difficulty in perforating the iris</td>
<td>Use correct techniques for eye color and situation. Use adequate miotics to thin and stabilize target. Use contact lens.</td>
</tr>
<tr>
<td>Closure of initially patent iridectomy</td>
<td>Use argon or diode plus Nd:YAG or Nd:YAG to prevent closure and use Nd:YAG to reopen to prevent repeat occurrence.</td>
</tr>
<tr>
<td>Pressure spike</td>
<td>Use aggressive premedication to prevent pressure spikes, especially in eyes with compromised optic nerves and visual field deficits.</td>
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^LPI indicates laser peripheral iridotomy.
Persistently elevated IOP that have had angle closure and peripheral anterior synechiae for less than 6 months.\textsuperscript{15}

**Surgical Peripheral Iridectomy**

Lai et al\textsuperscript{16} noted an overall decrease in cases of acute angle closure requiring surgical peripheral iridotomy. Given the advances in laser technologies, laser peripheral iridotomies have replaced surgical peripheral iridectomies, except in rare instances.

“Laser gonioplasty or surgical goniosynechialysis can effectively treat eyes with persistently elevated IOP that have had angle closure and peripheral anterior synechiae for less than 6 months.”

**Paracentesis**

Anterior chamber paracentesis has also been used as an acute treatment for cases of ACG.\textsuperscript{17} In a study of eight patients with an IOP > 50 mm Hg, the patients’ discomfort resolved immediately after the paracentesis procedure, their mean IOP decreased to below 21 mm Hg just 2 hours after the surgery, and no complications were reported. The pilot study was small, however. Moreover the paracentesis procedure is only helpful in cases of acute angle closure, and it does not offer a long-term solution. The technique’s inherent theoretical complications include endophthalmitis and suprachoroidal hemorrhage, particularly as the IOP drops precipitously. Further studies are necessary to thoroughly evaluate the potential role of paracentesis procedures in the treatment of ACG.

**Cataract Surgery**

Of interest is the dispute about whether peripheral iridectomy is effective in the long-term control of IOP in Asian patients who have chronic, asymptomatic ACG.\textsuperscript{18} A controversial study by Nonaka et al\textsuperscript{19} provided evidence that cataract surgery effectively resolved residual angle closure and IOP elevations after iridotomy. Researchers confirmed these findings by ultrasound biomicroscopy measurements and the darkroom prone-position test.\textsuperscript{17} These findings provide additional support for the mechanisms proposed by Quigley et al.\textsuperscript{6}
CONCLUSION

When patients present with an acute attack of angle closure, the current treatment recommendations include initial medical therapy followed by laser peripheral iridotomy after the IOP has been lowered. It is important to remember to perform a prophylactic laser peripheral iridotomy in the patient’s fellow eye, after the episode of acute angle closure has resolved in the involved eye. These management techniques represent the current optimal treatments for angle closure.

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