Review of Surgical Management for Closed-Angle Glaucoma

By Scott C. Kozarsky, BA | Faculty Reviewer: Reza Razeginejad, MD

Closed-angle glaucoma, also known as angle-closure glaucoma, is one of the major types of glaucoma. Glaucoma is a term used to describe a broad group of ocular diseases that damage the optic nerve. The type of angle closure with which the patient presents, whether acute, subacute, or chronic, will dictate their treatment. Management of these three presentations will be discussed at length later in this article. In the United States, closed-angle glaucoma is less common than open-angle glaucoma, which often has a gradual onset of intraocular pressure (IOP) elevation and optic nerve damage.

An anatomical narrow space between the cornea and iris in the anterior segment of the eye, commonly known as a narrow angle, is a major risk factor for developing closed-angle glaucoma. In a patient with narrow angles, dilating eye drops used to aid in the examination of the eyes may cause sudden blockage of the drainage system and IOP spikes, along with certain other medications such as antidepressants, cold medications, and antihistamines.[1]

When a patient with narrow angles presents for an eye exam, care must be taken in deciding whether it is safe to instill dilating drops for a dilated fundus exam. If the patient has previously undergone a treatment called laser peripheral iridotomy (LPI), it should be safe to administer dilating eye drops. If the anterior chamber is shallow in the periphery, gonioscopy should be performed to evaluate the angle prior to dilation. Gonioscopy is performed using angle-mirrored lenses during slit lamp biomicroscopy examination for visualization of the angle. If gonioscopy shows an open angle (**Figure 1**), it is safe to dilate the patient's eyes. However, if gonioscopy shows an occludable angle, this confirms that LPI must be performed prior to dilation.

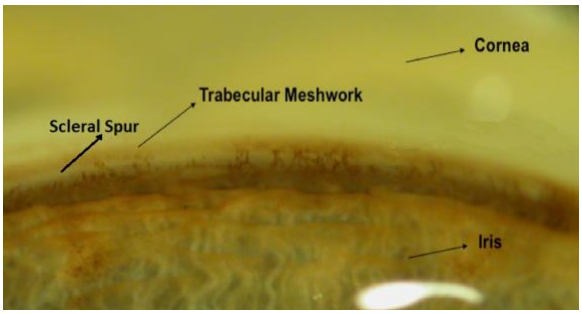

Figure 1. *Gonioscopic view of an open angle with key structures labeled.*[2]

LPI is the first-line procedure for treating closed-angle glaucoma, with roughly 60,000 to 80,000 cases performed in the United States each year.[3] The goal of this operation is to use a laser beam to create a small opening in the iris, allowing

pressure to equalize between the anterior and posterior chamber, thus flattening the anteriorly bowed iris. A patent iridotomy allows the iris to fall away from the angle, thus opening it and preventing or resolving an angle closure attack.[4] Historically, argon lasers were used to perform the iridotomy. However, since the 1980s, YAG lasers (**Figure 2**) have replaced argon lasers as they can create the opening using less energy.

Figure 2. *An example of a YAG laser used to perform LPI.*[5]

To perform the iridotomy, pilocarpine eye drops are first instilled to constrict the pupil and tighten the iris, facilitating perforation by the laser. Immediately prior to the procedure, a topical anesthetic is applied to prevent discomfort and enable the placement of a special iridotomy lens. This lens has many important functions, including holding the eyelids open, minimizing eye movement, and providing a magnified view for the surgeon. A suitable location such as a crypt or area of thinning is then selected on the superior or temporal iris, and the laser is focused on this point. The chance of ghost images following laser iridotomy seems to be lower with temporal LPIs compared to superior LPIs, another consideration when choosing a site.

Once set up, the laser is used to deliver energy and create an opening approximately 200 microns in size. After the iridotomy has been performed and patency confirmed, the patient can go home with a postoperative topical corticosteroid. LPI is generally a safe and well-tolerated procedure. However, complications can include transient increases in IOP and hyphema. In anticipation of these complications, IOP-lowering eye drops are often given before and after the procedure to reduce the risk of a temporary IOP spike. Hyphema is prevented by avoiding iris vessels when selecting a site to perforate the iris.[6]

As mentioned previously, within the realm of closed-angle glaucoma, there are three common presentations for patients with narrow angles. The degree of intervention required to treat these patients depends on the severity and progression of their condition. The most urgent presentation is an acute angle closure attack when the angle is occluded, and IOPs can rise as high as 40 to 60 mmHg. An angle closure attack requires immediate intervention with LPI and medications to lower IOP before the optic nerve is damaged. The other eye should also receive an LPI to prevent an acute

angle closure attack. Once the attack has resolved, it is often advisable to perform cataract surgery. Because the lens is thicker when there is a closed angle, removal of the cataract and replacement with an intraocular lens (IOL) opens up space in the anterior chamber and will prevent a recurrent angle closure attack or formation of peripheral anterior synechiae (PAS), which are adhesions of the iris to the angle structures that compromise the trabecular meshwork's drainage functionality.

Another presentation of narrow angles is a subacute angle closure attack. In a subacute angle closure attack, the patient has an angle closure attack, but it breaks spontaneously without medical intervention, unlike a classic angle closure. These transient attacks are often mistaken for migraines as they cause a headache lasting a couple of hours, which then resolves, resulting in the risk of failing to identify patients with dangerously narrow angles. The treatment for a subacute angle closure attack is the same as for an acute angle closure attack: LPI, IOP-lowering medications, and cataract surgery if required.

The final presentation of narrow angles is chronic angle closure glaucoma, which is the result of long-standing, untreated narrow angles and IOP elevation leading to permanent damage of the optic nerve. One third of chronic angle closure glaucoma cases first present with an acute angle closure attack.[7] However, chronic angle closure glaucoma differs from acute or subacute angle closure in that damage has occurred to the optic nerve, thus making it a glaucomatous condition.

Chronic angle closure glaucoma is also characterized by the formation of PAS. These iris-to-angle adhesions that compromise the trabecular meshwork's drainage of the anterior chamber may render LPI and cataract surgery inadequate for IOP control. However, LPI and IOP-lowering medications are still the first-line treatment for chronic angle closure glaucoma. In cases when these two measures do not achieve the necessary IOP reduction, glaucoma surgery may be required in conjunction with, or after cataract surgery. If there is 360-degree PAS formation, LPI offers no benefit, and glaucoma surgery will be required to lower IOP, often performed simultaneously with cataract surgery.

The two main glaucoma surgeries for this scenario are trabeculectomy and tube shunt. In most cases, trabeculectomy is performed first, and a tube shunt is only used if trabeculectomy fails to adequately lower IOP. Trabeculectomy is a surgery in which an opening is created out of the anterior chamber to allow aqueous drainage into the subconjunctival space. The flow of aqueous into the space causes elevation of the conjunctiva, opening a filtering bleb or route for the aqueous out of the anterior chamber to relieve

pressure. The drained fluid is absorbed by either conjunctival veins or lymphatic vessels near the bleb.[8]

In contrast to trabeculectomy which opens a drainage route into the conjunctiva, tube shunt surgeries involve the placement of a tube, with its plate fixated to the sclera 8-10 mm posterior to the limbus to facilitate aqueous drainage. There are two main types of installed shunts: valved and non-valved. The Ahmed Valve (**Figure 3**) has a valve in its plate component that opens when IOP rises to 12 mmHg and closes when IOP falls to 6 mmHg. This mechanism results in effective modulation of IOP for the early postoperative period, reducing the risk of very low IOP which could be associated with sight-threatening complications such as suprachoroidal hemorrhage. Meanwhile, a Baerveldt shunt has no valve, instead allowing fluid to drain freely through the tube and out of the eye. Therefore, the tube needs to be tied off with absorbable sutures initially to prevent very low IOPs. However, by the time the sutures dissolve, about four to six weeks postoperatively, enough scar tissue has developed around the plate in most cases such that flow is sufficiently controlled and hypotony, or IOP less than 6 mmHg, is prevented.

Trabeculectomy and tube shunt have similar early postoperative complication risks, including elevation of IOP or hypotony, but their long-term complication profiles are different. Each procedure has its own unique risks, making it difficult to directly compare the severity or degree of risk associated with these operations. Individual factors may drive decision-making toward one procedure over another. For example, since a Baerveldt

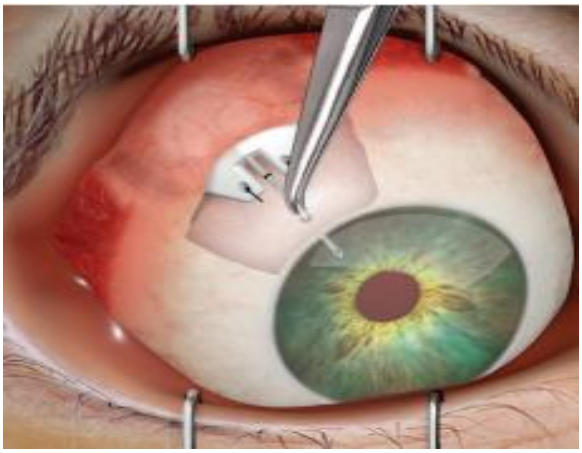

Figure 3. *An illustration of Ahmed Valve installation.*[9]

tube requires more postoperative monitoring than an Ahmed Valve, the Ahmed Valve is a better choice for patients who may be unable to attend multiple follow-up appointments. Though each technique has its pros and cons, what is clear is that both of these surgeries are significantly more invasive compared to laser and medical therapy, which accounts for why these glaucoma surgeries are only performed after failure of the mentioned interventions.

A more recent surgical development for IOP reduction is the Xen Stent, a 6 mm stent with a 45-micron lumen that works similarly to a trabeculectomy and allows aqueous to drain into the subconjunctival

space. However, there is risk of stent blockage with fibrin, pigment, or blood. Therefore, the general paradigm for treating chronic narrow-angle glaucoma continues to be LPI, medication, and cataract surgery with or without filtering glaucoma surgeries such as trabeculectomy or tube shunt surgeries. Ultimately, an individualized decision must be made for how to treat each patient considering a variety of factors from physical examination findings to personal circumstances.

References

1. Ellis R. What is acute angle closure glaucoma? 2022. Retrieved December 21, 2022. https://www.webmd.com/eye-health/acute-angle-closure-glaucoma.
2. Adapted from: World Glaucoma Association. How is gonioscopy done? 2022. Retrieved December 21, 2022. https://www.glaucomapatients.org/examination/how-is-gonioscopy-done/.
3. Wen JC, Rezaei KA, Lam DL. Laser peripheral iridotomy curriculum: Lecture and simulation practical. MedEdPORTAL. 2020;16:10903.
4. Ou, Y. Laser peripheral iridotomy: Surgery for narrow-angle glaucoma. 2021). Retrieved December 21, 2022. https://www.brightfocus.org/glaucoma/article/peripheral-iridotomy-laser-procedure-narrow-angles.
5. Herrett R. Ellex launch the ultra Q YAG lase with reflex technology. 2013. Retrieved December 21, 2022. https://www.prweb.com/releases/2013/2/prweb10432509.htm.
6. Silva AB, Miguel A, et al. Laser peripheral iridotomy. 2022. Retrieved December 21, 2022. https://eyewiki.aao.org/Laser_Peripheral_Iridotomy.
7. Porter D, McKinney JK. What is chronic angle-closure glaucoma? 2022. Retrieved December 21, 2022. https://www.aao.org/eye-health/diseases/what-is-chronic-angle-closure-glaucoma.
8. Piltz-Seymour J, Tania Tai TY, et al. Trabeculectomy. 2022. Retrieved December 21, 2022. https://eyewiki.aao.org/Trabeculectomy#Table1
9. New World Medical. The Ahmed glaucoma valve surgical procedure. Retrieved December 21, 2022. https://www.newworldmedical.com/wp-content/uploads/2020/07/55-0005-SurgicalStepsGDD.pdf.