Intraoperative Gonioscopy: Past, Present, and Future

Two clinicians review the options for visualizing the anterior chamber angle during angle surgery.

BY STEVEN D. VOLD, MD, AND IQBAL IKE K. AHMED, MD

With the growing popularity of newer angle procedures for the treatment of glaucoma, the use of gonioscopic lenses and other angle-imaging technologies in ophthalmic surgery has increased significantly. Efforts are underway to enhance the angle's visualization, improve angle surgery techniques, and achieve better surgical outcomes. This article reviews well-established and novel gonioscopic and anterior angle imaging technologies that may be useful in surgery.

HISTORICAL BACKGROUND

In 1900, Alexios Trantas described visualization of anterior chamber angle structures in a living eye with keratoglobus. In 1918, he coined the term *gonioscopy* for examining the anterior chamber angle. Another pioneer in the development of modern gonioscopy, Maximilian Salzmann, became the first to use a corneal lens and indirect ophthalmoscope to examine angle structures in 1915. Koeppe improved upon Salzmann's goniolens shortly thereafter by designing a steeper model. Curran is credited with being the first to observe that angle closure caused the IOP to rise. In the 1930s, Otto Barkan classified glaucoma using direct gonioscopy and a Koeppe lens. These significant contributions remain relevant today.[1]

PRINCIPLE OF GONIOSCOPY

The challenge of visualizing the anterior chamber angle structures lies with the critical angle. When light passes from a medium with a higher index of refraction to one with a lower index of refraction, the angle of refraction is larger than the angle of incidence, leading to internal reflection of light. The critical angle for the cornea-air interface is approximately 46°. Corneal lenses or mirrors are needed to overcome the internal reflection of light. In direct gonioscopy, the anterior curve of the contact lens is such that the critical angle is not reached, and the light rays are refracted at the contact lens-air interface. In indirect gonioscopy, the light rays are reflected by a mirror in the contact lens and leave the lens at nearly a right angle to the contact lens-air interface (Figure 1).

(Courtesy of Steven D. Vold, MD.)

Figure 1. Goldmann three-mirror, Sussman, Latina, modified Swann-Jacob, Zeiss, and Posner goniolenses.

INDIRECT GONIOLENSES

Zeiss and Posner Goniolenses

The Zeiss and Posner four-mirror lenses (Ocular Instruments, Inc., Bellevue, WA) are the most commonly used type of goniolenses in the clinical setting. The Zeiss version of the lens is no longer manufactured and has largely been replaced by the Posner goniolens.

The mirrors are tilted at 64° for evaluation of the angle, which eliminates the need to rotate the lens. The Zeiss

(Courtesy of Steven D. Vold, MD.)

Figure 2. Positioning of the operating microscope and patient's head during angle surgery using a modified Swann-Jacob goniolens.

and Posner goniolenses have an attached holding rod, which improves control at the slit lamp. This style of lens is convenient to use in the clinic, and it does not need a coupling agent such as methylcellulose. In addition, it enables clinicians to differentiate appositional from synechial angle closure. Learning to use this style of lens for gonioscopy is difficult, however, and it is possible to artificially open up the angle on examination.

Both of these four-mirror lenses can be used effectively in angle surgery (eg, goniosynechialysis). It is important to keep in mind, however, that they must be disinfected in glutaraldehyde or bleach and cannot be sterilized in an autoclave or heat disinfectant system.

Sussman and Khaw Goniolenses

With little-to-no rotation needed, both Sussman and Khaw four-mirror goniolenses (Ocular Instruments, Inc.) combine 360º of anterior chamber angle visualization. These lenses have many similar characteristics to both Zeiss and Posner goniolenses, but the former do not use a rod for stabilization and are held directly on the eye with the clinician's fingers.

Goldmann, Ritch, and Latina Goniolenses

The Goldmann single-mirror lens is the prototypical gonioprism. The mirror in this lens has a height of 12 mm and a tilt of 62º from the plano front surface. This lens has superior clarity and functionality for angle laser procedures. The Goldmann three-mirror lens provides two mirrors for the examination of the peripheral retina and one (tilted at 59º) for the anterior chamber angle. A viscous agent for coupling is necessary to obtain good visualization. Firm pressure on the eye with this goniolens can artificially close the angle.

(Courtesy of Iqbal Ike K. Ahmed, MD.)

Figure 3. Angle view with the Ahmed 1.5X Surgical Goniolens.

The Ritch trabeculoplasty lens (Ocular Instruments, Inc.) has four gonioscopic mirrors, with two inclined at 59º and 62º and a convex lens over one mirror in each set. The Latina SLT goniolens (Ocular Instruments, Inc.) features a 63º mirror and is popular for laser trabeculoplasty.

DIRECT GONIOLENSES

Koeppe/Barkan Goniolens

The Koeppe lens (Ocular Instruments, Inc.) is the prototypical diagnostic goniolens used in children. It is available in different diameters and radii of posterior curvature. A handheld biomicroscope or tilted operating microscope is required for adequate visualization of the angle. The Barkan goniolens (Ocular Instruments, Inc.) has served as the prototypical surgical goniolens. Neither of these lenses is moved by a rod.

Swan-Jacob Goniolens

The Swan-Jacob goniolens (Ocular Instruments, Inc.) has been modified for goniosurgery and is now one of the more popular models for angle surgery. Clinicians use an attached rod to manipulate the lens for improved visualization. The lens provides excellent visualization for goniotomy, ab interno trabeculotomy using the Trabectome (NeoMedix Corporation, Tustin, CA), trabecular micro-bypass iStent surgery (not FDA approved; Glaukos Corp., Laguna Hills, CA), and placement of the CyPass suprachoroidal device (not FDA approved; Transcend Medical, Inc., Menlo Park, CA). Use of the lens requires tilting the patient's head and operating microscope as well as a viscoelastic coupling agent (Figure 2). The Khaw, Hill, and Ritch surgical gonioprisms (all from Ocular Instruments, Inc.) are competing products that feature modifications of this lens.

RECENT ADVANCES

The Volk G-6 Goniolens

The new Volk G-6 goniolens (Volk Optical, Inc., Mentor, OH) uses six rather than four mirrors potentially to provide true panoramic 360º visualization (see "Volk's New Gonio Lens Is First With Six Mirrors").

Volk's New Gonio Lens Is First With Six Mirrors

BY MALAIKA DAVID, ASSOCIATE EDITOR

Early this year, Volk Optical (Mentor, OH) introduced the G-6 Gonio Lens—the first six-mirrored goniolens (Figure 1). With these mirrors equally aligned at 63°, the goniolens is designed to provide a complete 360° view of the anterior segment during glaucoma screenings with minimal manipulation of the lens. The G-6's mirrors are placed more closely together than a traditional four-mirror lens, which reportedly reduces examination times by allowing fast scanning and nearly eliminating the need to maneuver the lens. It has a tall, tapered profile and is designed to be used without any viscous interface solutions.

In an interview with *Glaucoma Today*, Jonathan Eisengart, MD, shared his experience with the G-6.

"The major benefit I've noticed when using a six-mirror lens, as compared to a four-mirror lens, is that I can visualize the vast majority of the angle without rotating the lens," Dr. Eisengart said. "Using a four-mirror lens leaves blank areas that are not visualized between the mirrors. The six-mirror lens eliminates those blank areas. Although this is the most obvious advantage, there are also other benefits to using the G-6."

Dr. Eisengart continued, "There is less distance to move from one mirror to the next, and although that does not sound important, it does make performing gonioscopy significantly quicker. I perform gonioscopy at least 10 times a day. If this lens saves me 30 or 60 seconds from each examination, that time adds up by the end of the day. Its smaller contact area also allows the G-6 to sit easily between the eyelids, especially if the patient is squeezing. It increases patients' comfort and is easier to get on the eye."

For clinicians interested in trying the new goniolens, Dr. Eisengart had some advice. "One pearl I recommend for using the G-6 is to hold the lens in the same orientation every time," he said. "I advise holding it so that you have a horizontal mirror at the 12-o'clock and 6-o'clock positions. That way, you can use a superior mirror to look at the inferior angle easily. For gonioscopy, you really want to start in the inferior angle because the structures are usually most obvious inferiorly. Also, because of the smaller contact area and longer length of the lens, it can be a little less stable on the eye and more likely to move on the eye's surface. You want to be careful not to apply any pressure and inadvertently indent the cornea, which can make the angles look open when they are not."

Figure 1. Volk Optical's G-6 Gonio Lens.

He found the transition to the six-mirrored goniolens easy but said that clinicians who use a one-mirror goniolens will face a learning curve. "However, if you are already comfortable using a standard four-mirror goniolens that does not use a contact gel, there is just about no learning curve," he noted. "You should be able to comfortably move to the six-mirror goniolens after performing three to five examinations."

For more information about the G-6 Gonio Lens, visit http://www.volk.com.

Jonathan Eisengart, MD, is a staff glaucoma specialist at the Cleveland Clinic Cole Eye Institute. He acknowledged no financial interest in the product or company mentioned herein. Dr. Eisengart may be reached at (216) 445-9429; eisengj@ccf.org.

(Courtesy of Iqbal Ike K. Ahmed, MD.)

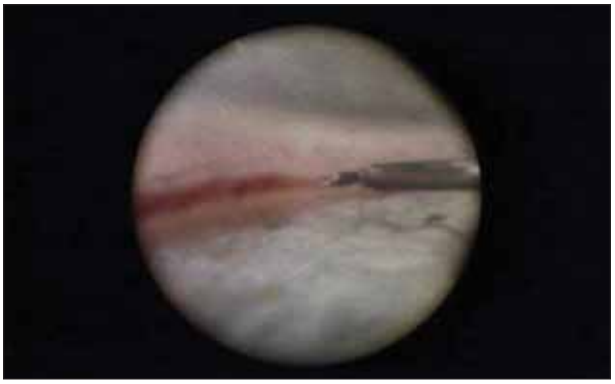

Figure 4. Endoscopic view of angle during the iStent's implantation.

(Courtesy of Iqbal Ike K. Ahmed, MD.)

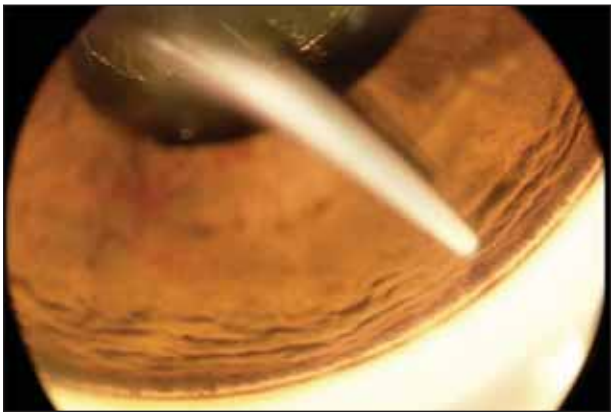

Figure 6. View of the angle using the EyeCam angle imaging technique.

Ahmed 1.5X Surgical Goniolens

The Ahmed 1.5X Surgical Goniolens (Ocular Instruments, Inc.) is an indirect goniolens with enhanced magnification, field of view, and brightness. It is designed of low-index, low-dispersive optical glass with a curved anterior surface to give a 1.5X magnification of the angle structures, which is offset to reduce aberrations. This lens is specially designed for surgical procedures and is steam sterilizable (Figure 3).

Endoscopic Angle Visualization

Endoscopic visualization of the angle using an endoscopic probe (Endo Optiks, Little Silver, NJ) can allow physicians to examine the angle with an endoscopic camera and light source attached to a viewing monitor. An additional incision is required to place a straight or curved probe into the anterior chamber (Figure 4).

EyeCam Fiber Optic Visualization of the Angle

Clinicians can view the angle on a monitor when using an external, fiber optic, high-resolution camera system (Clarity Medical Systems, Inc., Pleasanton, CA) and a coupling medium placed on the cornea. The EyeCam or RetCam has been used in clinical settings for retinopathy of prematurity and angle visualization, and these units can be adapted to an OR setting. They also enable physicians to document angle structures with video or photographs (Figures 5 and 6).

(Courtesy of Iqbal Ike K. Ahmed, MD.)

Figure 5. EyeCam setup for visualization of the angle .

CONCLUSION

The trend toward more minimally invasive glaucoma surgery has encouraged the development of improved techniques for visualizing the anterior chamber angle. Newer goniolenses and imaging technologies enhance ophthalmologists' ability to perform angle surgery. Future technological advances will be driven by the need to improve visualization of the angle, reduce manipulation of the patient and operating microscope during surgery, provide better control of the eye, and facilitate easier surgical maneuvers inside the anterior chamber. Ultimately, these innovations will likely allow ophthalmologists to improve long-term surgical outcomes for their glaucoma patients. ❑

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