The skill of intraoperative gonioscopy is not a simple task of docking a surgical goniolens onto the corneal surface. Here is my advice on how to optimize outcomes while minimizing complications during microinvasive glaucoma surgery (MIGS).

**OR SETUP**

Prior to starting angle surgery, raise both the stretcher and the surgical stool while maintaining an upright posture (Figure 1A). With head and microscope tilt, an increased working distance between the oculars and the nasally displaced surgical field will result. To maintain focus, lower both the chair and microscope while keeping a straight back, and raise the eyepiece to maintain primary gaze (Figure 1B). Initially setting the stool in its lowest position will cause unnecessary strain from both neck and back flexion.

Avoid using the foot pedal to refocus on the ocular surface and subsequently in the angle under gonioscopic view. Instead, manually lower the microscope each time to bring the target tissue plane into view, thereby preserving the range of focus during angle surgery. It is essential to find the right balance during head and...
microscope rotations to ensure that surgical instruments approach the target tissue en face parallel to the iris plane. With the patient in a supine position (Figure 1A), the optical axis of the surgical microscope is perpendicular to the eye, denoted by a vertical bar aligned with a horizontal line on the carrier arm in the Zeiss Opmi Lumera 700 system (Carl Zeiss Meditec; Figure 2A). To facilitate surgical flow and minimize awkward body positioning that may cause stress or injury, place a mark or adhesive tape on the carrier arm (Figure 2A and B) to serve as a reference point for your preferred angle tilt. You can quantify the exact rotation of the microscope head in degrees from the vertical using the iOS Compass on the iPhone (Apple; Figure 2C). This will enable OR personnel to rotate the knob on the carrier arm clockwise to bring the microscope into position for optimal viewing of angle structures when coupled with nasal head rotation of approximately 30º to 35º until the coaxial light is aligned along the iris plane.

**PHACOEMULSIFICATION VERSUS MIGS**

There are fundamental differences between MIGS and cataract surgery (Table 1). In the primary phaco position (Figure 1A), the elbows are straddling the flanks. After head and microscope tilt, the increased working distance anteriorly displaces the elbow of the nondominant hand when the goniolens is docked onto the corneal surface (Figure 1B and see Watch It Now). MIGS requires simultaneous extra- and intraocular coordination of the goniolens and instruments, respectively, making it essentially a one-handed surgery. Angle surgery is confined anterior to the iris plane with a trabecular space approximately one-third (0.7-mm width)$^1$ of a standard keratome incision (2.2-2.4 mm).

The cornea is a highly innervated structure with multiple subepithelial nerve endings.$^2$ During cataract surgery, keratome and sideport incisions induce minimal corneal stimulation. In contrast, there is maximal stimulation of the ocular surface and perilimbal area after goniolens docking (Figure 1B), with potential risk for intraocular complications (iris trauma, bleeding) from involuntary saccades under topical anesthesia.$^3$ Additionally, the absence of a red reflex requires maximizing illumination with appropriate magnification to identify the target tissue.

**KERATOME INCISION**

Keep in mind two important factors when creating a temporal corneal incision: (1) eccentricity and (2) location (see Keratome Wound Construction and Watch It Now). I highly recommend using a fixation ring in all cataract surgery cases, not only to gain familiarity with holding the handle of a surgical goniolens but also to access the

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**TABLE 1. FUNDAMENTAL DIFFERENCES BETWEEN CATARACT SURGERY AND MIGS**

<table>
<thead>
<tr>
<th>Anatomy</th>
<th>Cataract Surgery</th>
<th>MIGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbows</td>
<td>Aligned with flanks</td>
<td>Increased working distance between oculars and surgical field with elbow extension</td>
</tr>
<tr>
<td>Hands</td>
<td>Bimanual intraocular</td>
<td>Simultaneous extra/ intraocular coordination</td>
</tr>
<tr>
<td>Cornea</td>
<td>Impact limited to keratome and sideport incisions</td>
<td>Maximal stimulation of ocular surface with docking of goniolens</td>
</tr>
<tr>
<td>Red reflex</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Iris plane</td>
<td>Posterior, full access</td>
<td>Anterior, confined to 0.7-mm TM space</td>
</tr>
</tbody>
</table>

*Abbreviations: MIGS, microinvasive glaucoma surgery; TM, trabecular meshwork.*
peripheral cornea by rotating the globe nasally. A leading eye surgeon has recommended initiating the corneal incision at the limbal arcade. With MIGS, however, there is a potential risk of microbleeds as the keratome advances into the corneal stroma. In such cases, blood subsequently occupies the interface between the goniolens and cornea, obscuring angle viewing. On the other hand, inward displacement of femtosecond laser arcuate incisions from the limbus may cause surgical instruments to interfere with the overlying goniolens at the wound entry site during angle surgery.

Manual entry just inside the limbus can avoid these two extremes. As a standalone procedure or when MIGS precedes cataract surgery in combined cases, you can create small keratome incisions ($\leq$ 2 mm) with minimal alteration of ocular integrity while maintaining a pristine, uninterrupted view of the angle structures. After angle surgery, reset the surgical microscope to its initial settings prior to proceeding with phacoemulsification. In contrast, if lens extraction precedes angle surgery, certain conditions such as complex or prolonged cataract surgery and vitrectomy can make performing MIGS challenging owing to poor angle visualization.

Creating the temporal incision along the 3- to 9-o’clock axis offers several advantages, including equidistant access of the nasal angle and a pivot point facilitating angle surgery (see Keratome Wound Construction). Do not hesitate to create additional keratome incisions supero- or inferotemporally if the temporal view is obscured in order to directly access the inferior and superior nasal angle structures, respectively, or if additional clock hours of the angle require treatment based upon the intended MIGS procedure.

**GONIOSCOPY**

Several surgical goniolenses for MIGS are commercially available. They represent a modification of the Swan Jacob lens whereby the grasping handle is contiguous with
the viewing lens. These instruments vary by static field of view, extent of corneal contact, image magnification, and handle length—each with its pros and cons. A number of these goniolenses have been specifically designed to enhance globe control, including the disposable iPrism Clip view stabilizer (Glaukos; Figure 3). Recently, a two-mirror Ocular Upright 1.3× Surgical Gonioprism (Ocular Instruments) with a static 45º field of view was introduced that redirects the oblique gonio image to the coaxial “primary” phaco position (Figure 1A), eliminating the need for any head or microscope tilt.

As with a writing implement, when the surgical goniolens is held in the nondominant hand, the side of the palm plays two essential roles (Figure 4). First, it functions as a weight-bearing anchor point resting on the patient’s forehead or zygoma based upon laterality. Second, the side of the palm allows for pivoting to gently dock the lens onto the corneal surface with minimal force in order to avoid creating Descemet folds that will obscure angle viewing.

Although an ophthalmic viscosurgical device (OVD) may be used as a coupling medium between the cornea and lens, lidocaine gel not only serves as a topical analgesic but also decreases the sensation of tissue manipulation during surgery. Additionally, when I use only a cohesive OVD to deepen and stabilize the anterior chamber (AC), particularly in cases that take longer or require multiple manipulations during MIGS, I have found that the OVD tends to egress quickly, resulting in a shallow AC that requires reformulation. In my hands, Arshinoff’s softshell technique provides greater chamber stability with less need to deepen the AC.

If you cannot achieve adequate visualization of the angle, ask the patient to look nasally to bring the target tissue into view. Alternatively, use the surgical goniolens to rotate the globe farther nasally in a controlled manner before embarking on the MIGS procedure.

**IDENTIFICATION OF TRABECULAR MESHWORK FOR SCHLEMM CANAL-BASED SURGERY**

The scleral spur serves as the surgical landmark separating canal-based surgery via the trabecular meshwork (TM) anteriorly from suprachoroid-based surgery via the ciliary body band posteriorly. For surgery based in Schlemm canal (SC), it is critical to assess patients preoperatively with office-based gonioscopy in order to determine if the angle is open or closed (see Watch It Now). Moderate to heavy pigment within the TM can serve as a visual guide during MIGS. Areas of greater pigmentation have been reported to be in close proximity to collector channels, potentially enhancing aqueous outflow, but in patients with minimal to no pigment, other methods may be used intraoperatively (Table 2). In standalone MIGS or when the procedure precedes cataract surgery, gentle pressure with the edge of the surgical goniolens on the perilimbal episcleral vasculature nasally will induce regurgitation of blood into SC. Alternatively, gently
depressing the posterior lip of the keratome incision to cause the egress of small amounts of viscoelastic will induce a state of relative hypotony. Blood reflux into SC will result when viewed with gonioscopy. At this juncture, pressurizing the AC without overfilling will “freeze” the blood in SC and visually assist you in proceeding with targeted SC-based surgery.

After phacoemulsification, a diffuse red hue usually outlines SC and facilitates MIGS. Trypan blue has been used in ophthalmic surgery for a variety of indications, including cataract surgery, trabeculectomy, and corneal transplantation.14 Cultured human TM cells exposed to commercially available 0.06% trypan blue showed no evidence of toxicity with respect to cell viability after an exposure time of 60 seconds or less.15 At a Glaukos user meeting held on March 3, 2016, Reay Brown, MD, proposed the dye’s application to diffusely stain the TM landmark as a visual guide.

CONCLUSION

Safe, successful MIGS demands intraoperative gonioscopy, which itself requires a number of perioperative steps. Table 3 provides my recommendations for mastering this skill set. Try different goniolenses to identify which best meets your surgical needs, and remember that, on occasion, it may be necessary to use more than one type of surgical lens during MIGS. To learn intraoperative gonioscopy and build your surgical confidence, I recommend making use of educational resources available online12,16 and checking out the instructional course “Intraoperative Gonioscopy—a Key to Angle Surgery” at the upcoming annual meeting of the American Academy of Ophthalmology.

Figure 4. The side of the surgeon’s palm serves as both a weight-bearing anchor and as a pivot point resting on the patient’s forehead (A) or zygoma (B) to help the surgeon dock the goniolens onto the corneal surface with minimal force. Note that the surgeon’s fingers are parallel to the nasal bridge.