

Nonpenetrating Deep Sclerectomy

Steps to perform this procedure with mitomycin C.

BY WILLIAM E. SPONSEL, MD; ALMIRA CHABI, MD;
GRACE LINDHORST, MD; AND STEVEN CHALFIN, MD

The nonpenetrating deep sclerectomy has become an increasingly popular alternative to standard trabeculectomy throughout the world, largely because of the former's lower risk of early postoperative morbidity. Regardless of one's personal preference for routine filtering cases, the nonpenetrating deep sclerectomy is a procedure with which all glaucoma surgeons should become familiar for special cases in which its unique merits are undeniable. In our unit, we use the procedure routinely in all cases in which the operative eye is the only one with viable macular function. The nonpenetrating deep sclerectomy is also our procedure of choice in posttraumatic eyes in which even a brief period of peri- or postoperative anterior chamber collapse might be calamitous. This article describes our general surgical approach and provides a case example.

OUR APPROACH

Conjunctival Incision and Dissection of the Episclera

After using a blunt Westcott scissors and a non-toothed Bishop-Harmon forceps to create a buttonhole incision over the superior rectus bridle suture, we extend the conjunctival incision 6 mm laterally and medially, parallel to the lid margin. The Tenon's capsule is similarly opened 1.5 mm internally beyond the apices of the conjunctival incision. With a Weck-Cel sponge (Medtronic Xomed Ophthalmics, Inc., Minneapolis, MN) and a No. 67 Beaver blade (Becton, Dickson, and Company, Franklin Lakes, NJ), we dissect the episclera and the adherent Tenon's down to the limbus to expose 2 mm of the blue corneoscleral junction.

Deep Dissection

Following debridement of adherent Tenon's and episclera and 23-gauge cautery hemostasis, we make single or multiple applications of 0.4 µg/mL mitomycin C

(MMC) with a Weck-Cel sponge between the Tenon's capsule and the sclera for one to three 1-minute intervals (titration according to age/gender/race/scarring). Next, we irrigate the area with 10 mL of BSS. Using an NPGS diamond step knife (Huco Vision SA, St. Blaise, Switzerland), we inscribe a one-third thickness, external scleral flap (6.5 X 5.0 mm), which we then elevate to the limbus using a Mermoud crystal red sclerectomy knife (Huco Vision SA). With a Mermoud 25° diamond NPGS knife (Huco Vision SA), we inscribe a large internal sclerostomy (4.5 X 4.0 mm) into the deep scleral bed, the margins approximately 1 mm internal to those of the external block bed. The Mermoud sclerectomy knife is again used to excise the internal scleral block until a thin layer of scleral connective tissue remains over the ciliary body.

We carry the dissection 1.5 mm anteriorly into the cornea but leave Descemet's membrane as a window to



Figure 1. The anterior chamber is viewed through the slit lamp preoperatively.

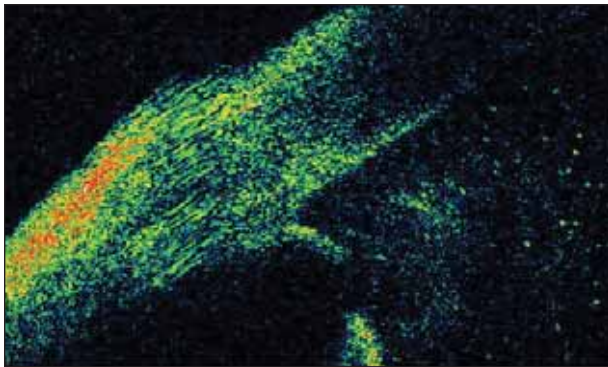


Figure 2. The authors performed axial offset ocular coherence tomography (OCT) of the inferior peripheral iris rupture, vitreous prolapse, tractional trauma, and remodeling of the adjacent corneoscleral junction.

the peripheral lens. We then expose the external trabeculum, situated circumferentially just outside the corneoscleral junction. Finally, we apply MMC beneath the scleral flap for 1 minute and again rinse with BSS.

Peeling the External Trabecular Meshwork

We use the Mermoud pre-Descemet spatula (Huco Vision SA) and stainless steel Mermoud NPGS forceps (Huco Vision SA) under high magnification to elevate the external trabeculum, and we free its edges with a diamond knife and Galand Corneal Scissors (Huco Vision SA). Peeling the underlying trabecular meshwork exposes the semihollow, internal trabeculodescemet membrane. The active percolation of clear aqueous humor into the operative field indicates proper fluid drainage without penetration of the innermost connective layer of tissue. We then reapply the external flap with two 10–0 nylon corner sutures to its original posterior bed margin and cut flush the knots with a super-sharp blade. Finally, a 25-gauge needle paracentesis tract is formed tangentially in the corneal periphery to facilitate later elevation of the anterior chamber and bleb.

Closing the Tenon's Capsule

We close the Tenon's capsule with an 8–0 braided Vicryl polyglycan suture (Ethicon, Inc., Somerville, NJ) on a tapered blood vessel needle using a series of continuous locking bites from right to left. We then run the same suture with a watertight, continuous closure in the opposite direction. We pull up on the conjunctiva curtain-rod style every five to six bites so that no Vicryl remains visible to the left. A bleb typically forms spontaneously and can be further elevated with slow injections of BSS through the paracentesis tract via a 30-gauge cannula until the IOP is approximately 8 mm Hg.

CASE EXAMPLE

Presentation

A 15-year-old female presented to her local, rural eye clinic with a 1-week history of left frontal headache. She had no significant medical history, but she complained of decreased vision and sharp pain in her left eye. Strands of vitreous were visible inferiorly in the anterior chamber of her left eye. Her visual acuity was 20/25 OD and 20/50 OS, and her IOP measured 17 mm Hg OD and 60 mm Hg OS. A dilated fundus examination revealed correspondingly asymmetric cup-to-disc ratios of 0.3 OD and 0.9 OS. The full spectrum of ocular hypotensive medications reduced the IOP in her left eye to 46 mm Hg in the clinic, and she was permitted to return home. Five days later, however, the visual acuity in her left eye had not improved, and the IOP remained at 34 mm Hg. Gonioscopy documented that the angle was normal and open 360°.

The patient's family opted to drive 5 hours to our ER for a second opinion. Our initial examination yielded UCVA's of 20/25 OD and 20/125 OS and IOP levels of 15 mm Hg OD and 40 mm Hg OS. Although the chamber of her left eye was deep and quiet, a profusion of dense strands of pigment-laden vitreous protruded vertically from a hole in the inferior iris. The mobile free ends wafted intermittently across the pupillary axis. Neither the cornea nor the lens appeared to be adversely affected by this obviously long-standing vitreous prolapse.

A gonioscopic examination revealed multiple peripheral opercular holes in the iris, associated with an inferior zonular breach and extensive medial and lateral

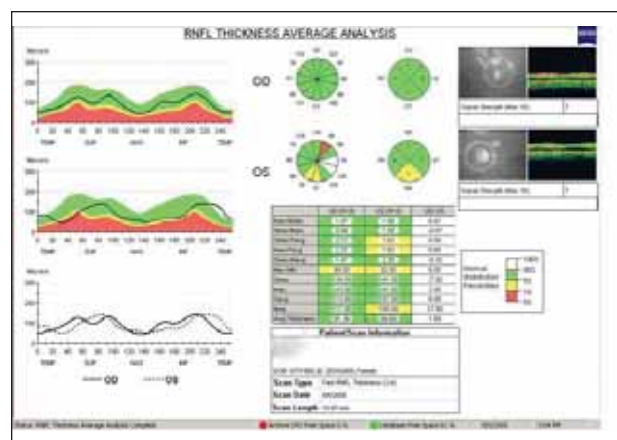


Figure 3. This standard OCT printout shows the posterior segment findings. The nerve fiber layer's profile shows focal loss in the superotemporal peripapillary zone. A fundus examination confirms asymmetric cupping (vertical cup-to-disc ratios of 0.35 OD and 0.95 OS) and evidence of an old, diffuse chorioretinal injury in the left superotemporal periphery.

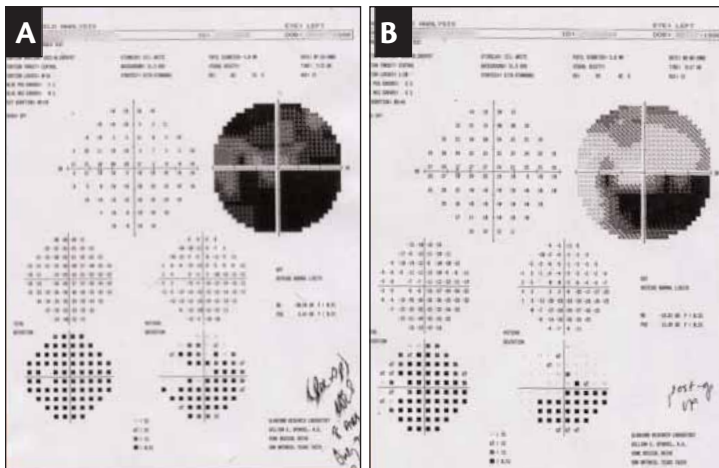


Figure 4. A preoperative Humphrey 30-2 visual field of the patient's left eye shows subtotal concentric loss with limited sparing of pericentral visual function (A). The fellow eye, tested first, produced a completely normal visual field. The postoperative Humphrey visual field (B) showed recovery of normal function in all areas not already manifesting a loss of nerve fiber layer at the time of the preoperative OCT assessment (see Figure 3).

recession of the angle. Figure 1 shows the slit-lamp view, and Figure 2 shows an axial OCT image of the inferior angle, the iris breach, and the protruding vitreous, with posttraumatic remodeling of the corneoscleral junction.

Standard OCT of the posterior pole demonstrated no evidence of macular traction, but it confirmed a loss of the superonasal nerve fiber layer in the patient's left eye (Figure 3). Humphrey 30-2 automated perimetry (Carl Zeiss Meditec Inc., Dublin, CA) revealed severe concentric visual loss sparing limited nasal and superior pericentral visual function in her left eye (Figure 4A).

Given the patient's multiple peripheral irideal ruptures with tenuous vitreous incarceration, angle recession, advanced optic neuropathy, and uncontrolled IOP, we were concerned that standard surgical fistulation (via either a trabeculectomy or a tube shunt) might risk unpredictable hyaloid traction after the procedure and thus endanger the entire lens diaphragm and retina. Primary anterior vitrectomy would have risked enlarging the zonular breach with no tangible benefit. Our initial goal was thus to lower the patient's IOP aggressively without destabilizing the otherwise benignly incarcerated vitreous. We therefore elected to perform a nonpenetrating deep sclerectomy with MMC.

Surgical Course and Outcome

We performed a nonpenetrating deep sclerectomy in the manner described earlier with one exception. As usual, we dissected the episclera and the adherent Tenon's down to the limbus and exposed the blue corneoscleral junction. We also, however, removed densely scarred Tenon's capsule in this layer from between the 11- and 1-o'clock positions, which was infiltrated with blackened material (possibly carbon from a projectile firework or pencil).

One week postoperatively, the acuity in the patient's left eye had improved to 20/30, and her IOP was 4 mm Hg. The broad, low-profile bleb was minimally vascularized, and the anterior chamber's contents were undisturbed. One month later, the patient had discontinued all antiglaucoma medications, and her IOP remained 6 mm Hg. The results of the Humphrey visual field test perimetry (Carl Zeiss Meditec Inc., Dublin, CA) dramatically improved (Figure 4B). Remarkably, the optic

nerve cupping in this young adult had largely disappeared (confirmed by OCT) with the restoration of the inferior disc vasculature's normal anatomy (Figure 5).

Discussion

The patient in this case appeared to have experienced severe ocular trauma years earlier. She suffered chronic angle-recession glaucoma with associated inferior zonular and irideal breach, which we attributed to the anterior rotational force of the inferior formed vitreous displaced by the superior impact of a carbon-laden, blunt projectile. Once her IOP was normalized by the nonpenetrating deep sclerectomy with MMC, we observed further upward displacement of the free vitreous strands and very slow migration of formed vitreous

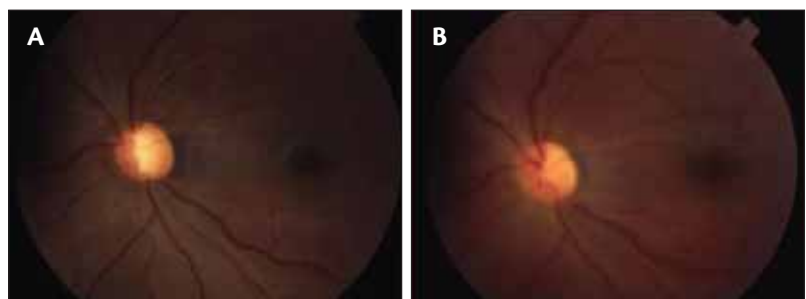


Figure 5. This preoperative disc photograph shows severe cupping in the patient's left eye (A). In this postoperative disc photograph, the cupping of the optic nerve has almost disappeared, and the normal anatomy of the inferior disc vasculature has been restored (B).



Figure 6. Viewed through the slit lamp, the anterior chamber had this appearance after the nonpenetrating deep sclerectomy, inferior vitrectomy, and peripheral iridoplasty.

through the progressively growing traumatic iridotomies, but the nonpenetrating deep sclerectomy's filtration site remained clear.

Several months postoperatively, we were able to carry out a planned repair of the inferior iris through a 4-mm limbal, corneoscleral, stepped incision. After injecting viscoelastic and performing an initial, careful, manual anterior vitrectomy, we mobilized the margins of the irideal breach, sutured them to the posterior lip of the stepped incision, draped the intervening torn irideal margin into the lips of the wound, and closed with 10-0 nylon.

Postoperatively, we prescribed 1% pilocarpine q.i.d. to counteract pupillary distortion in the direction of the repair. Figure 6 shows the result 1 week later, when the visual acuity of her left eye was 20/25, and the IOP was 8 mm Hg. The residuum of old vitreous is visible at the inferior pupillary margin.

Despite the patient's severe cupping and subtotal visual field loss preoperatively, the nonpenetrating deep sclerectomy with MMC dramatically restored visual function to all perimetric zones that had not shown an actual loss of nerve fiber layer on her preliminary OCT assessment. The dense, inferonasal scotoma—corresponding to the zone of severe loss in the superotemporal nerve fiber layer shown on her preliminary OCT—persisted after surgical normalization of the IOP.

Although a reversal of the disc cupping commonly accompanies the reduction of IOP in infants under 6 months of age (before developmental cross-linking of collagen in the lamina cribrosa), such an extreme reversal is rarely seen in older individuals. To our knowledge, our patient appears to be among the oldest reported to

demonstrate such a dramatic morphological recovery of the optic nerve head.

CONCLUSION

Nonpenetrating deep sclerectomy is an elegant procedure with considerable practical utility, particularly in settings where any period of intraoperative or postoperative anterior chamber instability might compromise the long-term surgical outcome. In order to use this procedure effectively in the posttraumatic setting, it is advisable first to gain expertise in elective cases.

From our review at the University of Texas Health Science Center in San Antonio of filtering procedures with an antimetabolite, nonpenetrating deep sclerectomy with MMC seemingly achieves comparable long-term surgical success rates to full-thickness trabeculectomy. With the former procedure, the IOP levels are marginally higher, but the risk of hypotony, a collapsed chamber, hyphema, or choroidal effusion is significantly lower throughout the first several months postoperatively. For these reasons, we routinely employ nonpenetrating deep sclerectomy with MMC in all patients with unilateral macular function in the operative eye and in pediatric patients. We continue to rely on full-thickness, guarded trabeculectomy with MMC in other adults with progressive glaucoma. □

Almira Chabi, MD, is a resident ophthalmologist at the University of Texas Health Science Center in San Antonio. She acknowledged no financial interest in any of the products or companies mentioned herein. Dr. Chabi may be reached at (210) 722-5241; chabi@uthscsa.edu.

Steven Chalfin, MD, is Associate Professor of Ophthalmology at the University of Texas Health Science Center in San Antonio and Director of Ophthalmology at the Audie L. Murphy VAMC, also in San Antonio. He acknowledged no financial interest in any of the products or companies mentioned herein. Dr. Chalfin may be reached at (210) 567-8411; chalfin@uthscsa.edu.

Grace Lindhorst, MD, is a resident ophthalmologist at the University of Texas Health Science Center in San Antonio. She acknowledged no financial interest in any of the products or companies mentioned herein. Dr. Lindhorst may be reached at (210) 392-8897; lindhorst@uthscsa.edu.

William E. Sponsel, MD, is Professor and Director of Clinical Research in the Department of Ophthalmology and Director of Glaucoma Services at the University of Texas Health Science Center in San Antonio. He acknowledged no financial interest in any of the products or companies mentioned herein. Dr. Sponsel may be reached at (210) 567-8421; sponsel@uthscsa.edu.