Where Are My Zonules, and Why Are They Slacking?

Technical advice for cataract surgery on eyes with compromised zonules.

BY MICHAEL E. SNYDER, MD

During the last decade, the intraoperative use of various devices—including those for the short- and long-term support of the pupil, capsule, and zonules—has revolutionized the treatment of eyes with zonular laxity or focal zonular absence. Intraoperatively, surgeons use both temporary and permanent implantable devices as well as ophthalmic viscosurgical devices (OVDs). The combination of these techniques, tailored to the specific situation, can achieve outstanding results in even the most complex cases.

MILD ZONULAR WEAKNESS

When the zonules are compromised, removing lenticular material can be among the greatest challenges, particularly if the hyaloid face is exposed or broken or has prolapsed into the anterior chamber. Eyes with mild (1-2 clock hours) zonular damage can sometimes be handled with "routine" techniques, although the supplemental placement of a dispersive OVD in the area of weakness remains prudent. Whether to use a capsular tension ring (CTR) or not in these eyes remains controversial. In a case of a mild dehiscence originating from trauma or surgical misadventure, a CTR may be unnecessary. When I anticipate progressive zonulopathy (eg, retinitis pigmentosa or pseudoexfoliation), I prefer to place a CTR even if the capsular bag appears stable, because refixation of that bag later in the case is infinitely more facile when a ring is in the equator.

Often (eg, after trauma or with pseudoexfoliation), the zonular defect may be evident on clinical examination. Alternatively, the first sign of zonular deficiency may be a "pincushioning" of the anterior capsule upon attempted puncture with a cystotome (Figure 1) or instability of the lens during the capsulorhexis or subsequent intraoperative maneuvers.

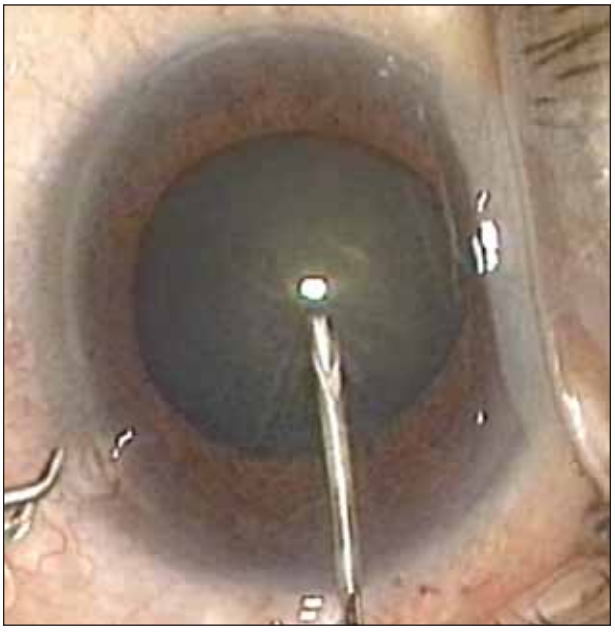


Figure 1. The anterior capsule exhibits a "pincushioning" effect demonstrating diffuse zonular laxity.

SEVERE ZONULAR WEAKNESS

When large degrees of zonular damage are present, the task of extracting the lens becomes increasingly complex. First, any vitreous present in the anterior chamber should be removed before manipulation of the lenticular material. Some surgeons have advocated partitioning smaller knuckles of vitreous in the periphery by use of dispersive OVD. My preference is to remove the offending vitreous material from the anterior segment via a pars plana approach. I complete this step before initiating the sometimes unpredictable fluidic shifts inherent in phacoemulsification and cortical aspiration.

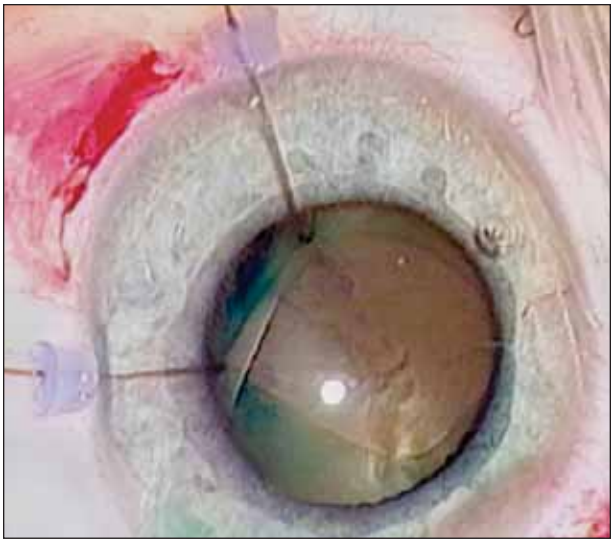


Figure 2. Flexible retractors placed along the margin of the capsulorhexis can stabilize the capsular bag complex.

Maintaining maximal integrity of any remaining zonular structure is the surgeon's first goal in addressing these cases. Hydrodissection should be careful and complete and the use of OVDs judicious.

UNSTABLE CAPSULAR BAG

When the bag is highly unstable, the initial capsular puncture may be difficult with limited countertraction. The crossed sword, capsule pinch maneuver can facilitate this step.[1] A 25-gauge forceps placed through a paracentesis can aid in the capsulorhexis when a decentered lens is far from the main wound.

Upon achieving an intact capsulorhexis, the surgeon can stabilize the very loose bag by hooking the capsulorhexis' margin with flexible retractors placed through the limbus (Figure 2). It is important to tighten the retractors only enough for stabilization. Attempts to recenter the lens with these retractors can break the margin of the capsulorhexis. Thorough hydrodissection and thoughtful viscodissection with a dispersive OVD can reduce inadvertent tractional forces on the bag's equator and remaining zonules. The periodic instillation of more dispersive viscoelastic can also be extremely helpful in moving lenticular fragments toward the central safe zone. This precaution diminishes the potential for aspiration of the bag's equator, which can migrate centrally in the absence of zonules, even if hooks are in place.

I like to remove as much lenticular material as possible before placing a CTR, because visualization of the capsulorhexis will be greatest while the trapping of cortical fibers in the periphery is minimized. This follows

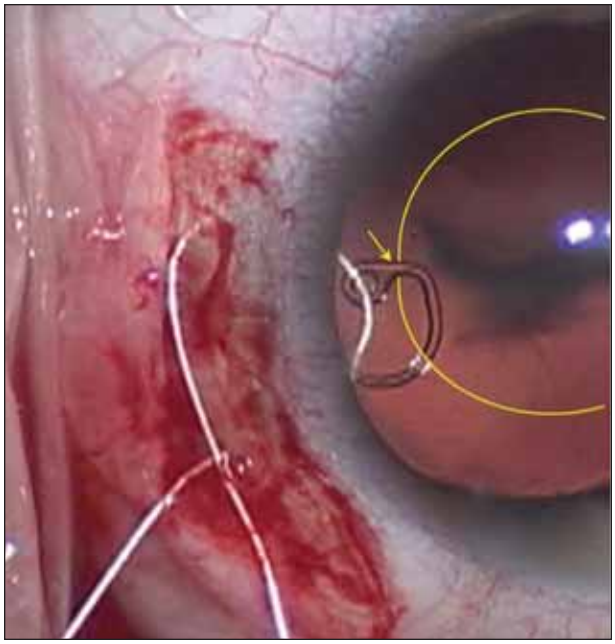


Figure 3. A Cionni Ring for Sclera Fixation in situ within the capsular bag shows the fixation element coursing around the capsulorhexis' margin (digitally outlined, arrow added for better view) from posterior to anterior to the anterior capsule. The Gore-Tex suture passes through the eyelet and the scleral wall, with all components of this suture in front of the capsular complex.

the maxim set forth by Kenneth Rosenthal, MD: insert the ring as late as you can but as soon as you must. A CTR expands the capsular bag and gives it a rigid perimeter, redistributing tension to the remaining intact zonules.

DEVICES

A standard CTR may not recenter a bag completely and will not augment total zonular strength. Accordingly, in cases of profound instability, the surgeon may wish to consider three alternate devices. The first is a Cionni Ring for Sclera Fixation (Morcher GmbH, Stuttgart, Germany; distributed in the United States by FCI Ophthalmics, Inc., Marshfield Hills, MA), which contains a fixation element. The second is an Ahmed Capsular Tension Segment (CTS; Morcher GmbH, distributed in the United States by FCI Ophthalmics, Inc.). The third is the AssiAnchor (not FDA approved; Hanita Lenses, Kibbutz Hanita, Israel) fixated to the scleral wall as either a temporary or permanent measure.

The Cionni device is a CTR with one (or two) fixation element(s) that courses around and anterior to the capsulorhexis' margin. The ring has an eyelet to which a suture can be affixed and passed through the scleral

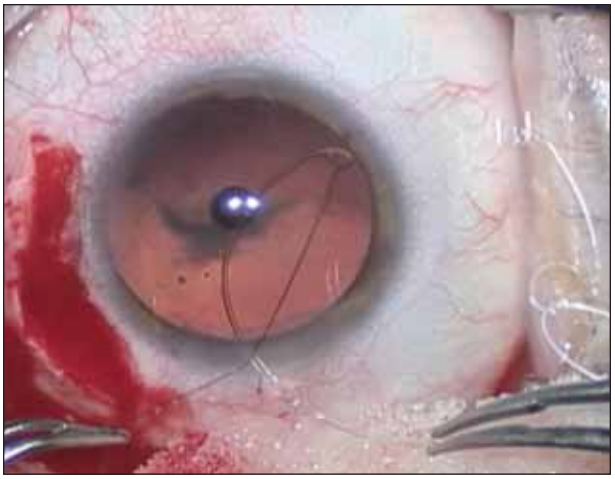
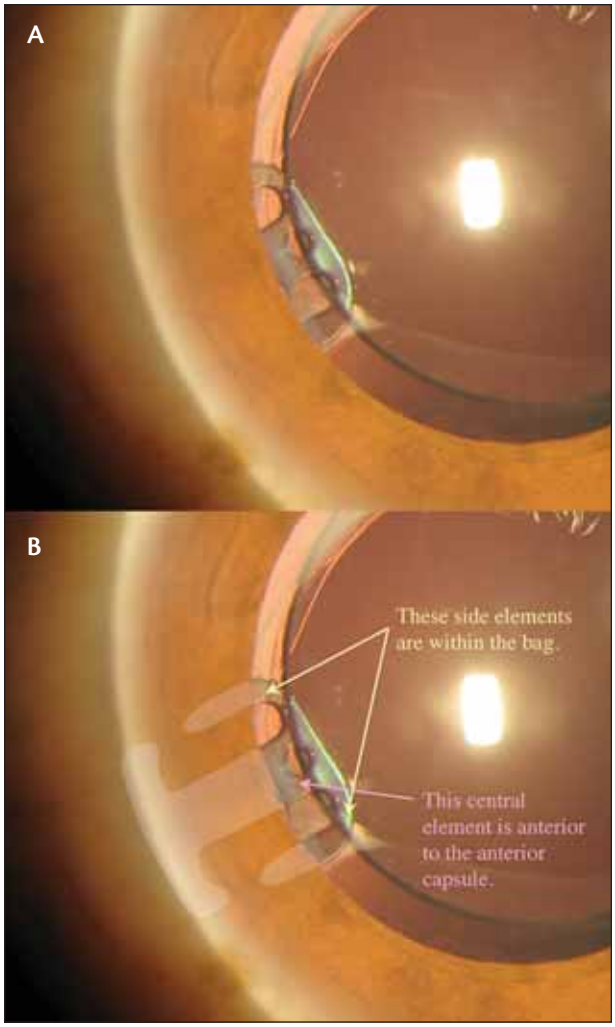


Figure 4. Traction on the nylon suture (placed through the leading eyelet element) reduces centrifugal tension on the capsular bag during the early stages of the CTR's insertion. This precaution lessens damage to the remaining zonules and eases placement of the ring. Note that the fixation suture is preloaded through the eyelet on the fixation element (right side of image).

wall to recenter and secure the CTR-bag complex (Figure 3). By definition, the bag will be quite loose before the placement of a Cionni CTR. Threading a 10–0 nylon suture through the leading eyelet can be extremely helpful in reducing stress on the bag's equator during the device's insertion. Gentle traction on the suture will make the end of the ring more centripetal for this step (Figure 4). Boris Malyugin, MD, has described a modification of the Cionni ring that has the fixation element at the leading end of the ring.[2] This difference may obviate the need for a second traction suture. (The Malyugin variant on the Cionni ring is not FDA approved.)

The Ahmed CTS has a fixation element similar to that of the Cionni CTR. Instead of a complete ring, the segment has an arc of approximately 120º (varying by the size of the bag and CTS). The CTS can be placed more easily when the nucleus remains in the capsular bag. One or more segments may be placed as needed, depending on the degree to which support is lacking. Typically, a standard CTR is placed in conjunction with the CTS(s).

The AssiAnchor is a flat PMMA device that resembles a paper clip slipped onto the edge of the capsulorhexis (Figure 5). The capsule is supported both by the internal elbow of the device on the capsular edge and by the end of the device at the fornix of the bag. An eyelet permits a fixation suture. As with the CTS, multiple anchors may be placed for large areas of dehiscence.



(Courtesy of Ehud Assia, MD.)

Figure 5. The AssiAnchor is seen in situ (A). Shading by the author (B) estimates the approximate location of the portions of the device covered by the iris in the image. Yellow arrows indicate the outer clip-like portions within the capsular bag, while the pink arrow identifies the central portion coursing anterior to the bag complex.

SUTURES

Suture material for fixating any of the described devices remains a topic of discussion. When used in these cases, 10–0 polypropylene sutures seem to have a relatively short (5-10 years) duration, at which point they break and require refixation. Whether the sutures break from hydrolysis or mechanical stress has not been fully established. A number of clinicians use 9–0 polypropylene, which has a thicker caliber and thus may last appreciably longer. One might presume, however, that 9–0 polypropylene will be susceptible to the same factors as its more dainty 10–0 cousin. Polyester sutures may be less vulnerable to either mechanical or enzymat-

ic degradation. Gore-Tex (W. L. Gore & Associates, Inc., Newark, DE) is a more robust material with a long intracorporeal history precluding enzymatic degradation. Although the ophthalmic use of this material is off label, its strength and longevity make it my material of choice for cases in which I place a stabilizing device. The site of the scleral suture should be scrutinized at every visit for the long term, regardless of the suture material chosen.

I prefer to pass the fixation suture through the eyelet and to make two scleral passes, separated by 3 to 5 mm. Once tied externally, the knot can be rotated into the scleral wall's opening, and the fixation element can be slid slightly back or forth along the suspended suture loop to further refine the final centration.

After the capsular bag has been evacuated of lenticular material, re-expanded by a CTR, and refixated by the passage of a suture, the IOL may be placed. Usually, I prefer to only gently snug the ring/device fixation suture externally without completing the knot until the IOL is in the bag. At that point, I can adjust the tension on the suture to fine-tune the IOL's centration. This point is particularly important for multifocal lenses. It is equally important that the globe be brought to a normal IOP before this step occurs. If the suture is tied before full inflation of the globe, hypotension can promote an inaccurate perception of where the capsular complex will end up. This can result in a decentration of the bag-IOL complex toward the meridian where the suture is tied.

When the knots are internal to the scleral wall, erosion of the suture through the overlying conjunctiva is extraordinarily rare in the setting of a normal ocular surface. Nevertheless, it remains prudent to inspect the area covering the suture at each clinical visit. ■

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