Managing Zonular Deficiency

Endocapsular devices can facilitate cataract removal in patients with weak or missing zonules.

BY BORIS Malyugin, MD, PhD

The past couple of decades have witnessed significant technological progress in cataract surgery, leading to a variety of vacuum-driven, ultrasound- and laser-assisted microincisional approaches. The forces applied to the capsular bag and zonules during lens fragmentation and aspiration, nucleus rotation, and IOL implantation parameters can generally be used to characterize these approaches. Accordingly, the condition of the capsular bag and zonular apparatus determine how smooth the performance of the surgical procedure will be. Compromised zonules can present a significant challenge and increase the risk of intra- and postoperative complications.

DIAGNOSIS AND ASSESSMENT

Local or generalized zonular weakness is mostly seen in eyes with trauma, pseudoexfoliation syndrome, glaucoma, high myopia, or hereditary systemic diseases (Marfan syndrome, homocystinuria, Weill-Marchesani syndrome, etc.; Figure 1). In these patients, one can expect an increased risk of capsular tear, vitreous prolapse, and IOL instability early and late postoperatively.

In many cases, zonular weakness can be diagnosed preoperatively by observing crystalline lens displacement, phacodonesis, or iridodonesis. The other most frequent indirect signs of weakened or ruptured zonules include irregular depth of the anterior chamber, monolateral shallowing or deepening of the anterior chamber, pupil abnormalities, presence of vitreous strands in the anterior chamber, pseudoexfoliative material, and presence of a filtering bleb. While formulating the surgical plan, it is necessary to assess the extent and localization of zonular weakness or dialysis (usually in clock hours) as well as the status of the rest of the zonules, including the severity of generalized zonular instability.

In addition to conventional biomicroscopy, ultrasound biomicroscopy is helpful to directly visualize and explore the zonular status. The characteristic signs one can expect to find in these patients include localized zonular defect, overstretched and elongated zonules (in the area contralateral to the meridian of lens displacement), lens tilt, hyperprolate shape of the anterior lens capsule, and spherophakia (Figure 2).

DEVICES TO FACILITATE SURGERY

Capsular tension rings. There are several types of devices designed to facilitate cataract surgery in patients with compromised zonules. Capsular tension rings (CTRs) are most effective in patients with generalized zonular
weakness and patients with localized zonular defects not exceeding 3 clock hours (or 90°).

CTRs are useful for stabilizing the crystalline lens during cataract surgery and reducing the likelihood of intraoperative complications. These devices are utilized to maintain the circular contour of the capsular equator during surgery through stretching of the capsular bag. A CTR can also prevent collapse and aspiration of the capsule, distribute forces equally over all zonules, and prevent vitreous prolapse into the anterior chamber.

In the postoperative period, one benefit of a CTR is that it counters progressive contractile centripetal forces and resists capsulorrhexis shrinkage as the capsular bag contracts. This is a very likely scenario in pseudoexfoliation syndrome, in which the entire capsular bag can dislocate years after the initial surgery.

The downside of CTR use is the technical complication of the irrigation and aspiration phase of surgery. Entrapped cortical material at the equator of the capsular bag makes the aspiration process challenging. However, using bimanual I/A systems and stripping the cortex in a tangential direction can overcome this challenge.

Capsular supporting devices. Several devices have been designed to facilitate cataract surgery in patients with zonular weakness (Figure 3). For instance, flexible iris hooks can be used to support the capsular bag in the presence of extremely loose zonules. As a result of having relatively short curved portions, conventional iris retractors tend to slip off and, in some cases, tear the anterior capsulorrhexis.

Specially designed capsule retractors made of titanium or plastic, including the Mackool Cataract Support System (Duckworth & Kent Ltd.) and MST Capsule Retractors (MicroSurgical Technology), have elongated ends to support the peripheral capsular fornix without damaging the capsulorrhexis. These devices function as temporary artificial zonules, fixating the whole capsular bag to the limbal area (Figure 4).

More permanent capsular support can be achieved with Ahmed Capsular Tension Segments, the Assia Anchor...
M-shaped capsular segments developed by Sergienko, and the suture with a T-shaped ending developed by Yamaguchi. These devices minimize surgical trauma and provide permanent zonular replacement, not only during surgery but also in the long term postoperatively. The main disadvantage of these devices is that they can provide only focal support of the capsular bag and do not totally restore its equatorial shape. Therefore, in many cases, combination with a conventional or modified CTR is mandatory.

**Modified capsular tension rings.** To address moderate and profound zonular weakness, Robert Cionni, MD, modified the standard CTR by adding a fixation eyelet to the central portion of the ring. This eyelet allows the ring to be sutured to the sclera to provide intraoperative support during phacoemulsification. The Cionni Modified CTR (Morcher GmbH) is useful for patients with zonular dialysis exceeding 3 clock hours. The ring is manufactured with one or two fixation elements (Figure 5). Most surgeons implant the device manually through the main cataract corneal incision using forceps. The use of injectors is much less common, as the fixation element attached to the ring does not allow the device to be fully retracted inside an injector tube.

The Malyugin Modified CTR (Morcher Type 10G, Morcher GmbH) is a new endocapsular supporting device. The idea behind its development was to make the device injector-friendly. This is achieved by moving the fixation element to the ring’s tip (Figure 6). As a result, the modified CTR is completely retractable into an injector tube, allowing it to be used through a 2-mm incision (Figure 7). The Malyugin CTR addresses the difficulties of microincisional cataract surgery in patients with a large zonular dialysis or zonular weakness by centering the subluxated lens and allowing it to be secured to the scleral wall (Figure 8). During implantation, the curved portion of the Malyugin CTR slides easily along the equator of the capsular bag. Thus, the risk of perforating the capsular fornix with the tip of the CTR is minimized.

Based on my personal experience, use of the Malyugin CTR is advantageous in patients with severe acquired and hereditary lens subluxations. It has proved to be safe and effective, providing long-term IOL stability postoperatively (Figure 9).

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CONCLUSION

Endocapsular devices enable cataract removal in complicated cases with weak or absent zonules and can provide fixation of the capsular bag to the sclera. Conventional and modified CTRs offer numerous benefits to surgeons managing challenging cataracts. The surgeon’s choice of device should be based on the extent of the zonular defect, the status of the remaining zonular apparatus, and the necessity of restoring the full circular contour of the capsular bag equator.

One issue that remains unclear relates to the material of the suture used to fixate capsular supporting devices to the scleral wall. The discussion surrounding this subject started after multiple reports described late dislocation of the bag-IOL-CTR complex due to lysis of supporting 10-0 polypropylene sutures. Some surgeons have switched to 9-0 polypropylene, while others prefer 7-0 polytetrafluoroethylene (Gore-Tex; W.L. Gore & Associates, Inc.) sutures.

The optimal suture material for scleral fixation is a major topic that must be explored in detail in the future.

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