

What Forces Act on the Capsular Bag?

Capsular tension rings may be an appropriate option for managing loose zonules.

BY CHRISTOPHER LIU, FRCOPHTH

Recently, my colleagues and I performed a systematic theoretical analysis of the pre- and postoperative forces that act on the lens capsular bag. If such forces could be counteracted, we reasoned that the risk of complications could be reduced, especially in high-risk patients. It is important for every surgeon to understand the forces that act on the capsular bag, as well as the devices that will help achieve successful and stable postoperative outcomes. We have found that the use of capsular tension rings (CTRs) is an appropriate option for lowering the amount of force on the capsular bag and managing loose zonules.

Our findings indicated that such forces acting on the capsular bag, both perioperatively and postoperatively, include (1) the trampoline effect during collapse and re-inflation of the anterior chamber, (2) the capsulorrhexis, which also exerts force on the zonules, (3) phaco probes and second instruments during phacoemulsification, (4) I/A of soft lens matter, (5) insertion of the IOL and dialing it to a position, which may stretch the anterior lens capsule as well as exert forces on the zonules, and (6) long-term contraction of the capsular bag from lens epithelial cell transdifferentiation. This occurs in cases of zonular weakness if the anterior capsulorrhexis is inadequately sized, particularly when silicone IOLs are used.

Several techniques and tricks may counteract the forces exerted onto the capsular bag. First, gentle tissue handling—especially in the case of zonular weakness—is important. Second, try to reduce the long-term bag contraction by only opening the anterior capsular cut to an adequate diameter. Further tricks to reduce the force include supporting the lens capsular bag by using iris retraction hooks and the Mackool Cataract Support System (Duckworth & Kent, Hertfordshire, England);

applying the Ahmed Capsular Tension Segment (Morcher, Stuttgart, Germany) to provide pre- and postoperative sectorial capsular support; and using single or multiple CTRs to prevent capsular contraction and capsular bag decentration.

If loose zonules—caused by Marfan's syndrome, pseudoexfoliation, trauma, and iatrogenic causes—are present, then it is more likely that the patient will experience vitreous loss, a dropped nucleus, unopposed capsular bag shrinkage, anterior capsular fibrosis and phimosis, and bag-IOL decentration-subluxation. Surgeons should proceed with caution in these high-risk cases. Their first action must be to ask themselves two questions: (1) In severe cases with few remaining zonules, should the case be referred to a vitreoretinal surgeon? and (2) Should the case be referred to a cataract specialist who is experienced in dealing with complex cases? If you are to proceed with the surgery, aim for long-term centration of the IOL, the absence of anterior capsular phimosis, and no continuing zonular loss, which may lead to subluxation or dislocation of the capsular bag. There are several devices that may help you to reach these goals.

DEVICES

Iris Retraction Hooks

These flexible nylon hooks usually have a colored body so that they may be easily identified. Two popular models are the Grieshaber Iris Retractor (Grieshaber and Co. AG, Kennesaw, Georgia) and the MicroVision Iris Retractor (MicroVision, Inc., Seabrook, New Hampshire). Iris hooks offer many benefits compared with other mechanical methods of pupil dilation, including excellent and stable pupil size. It is also possible to transfer iris hooks to the anterior capsulorrhexis rim. On the



Figure 1. Bimanual insertion of a CTR after hydrodissection.

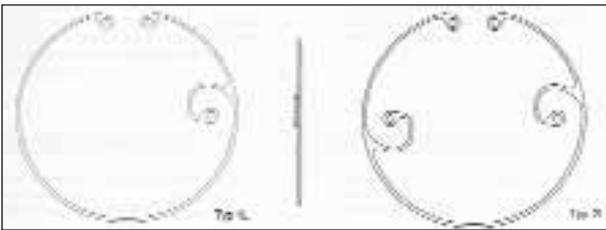


Figure 2. Two of the five available Cionni Modified CTR models.

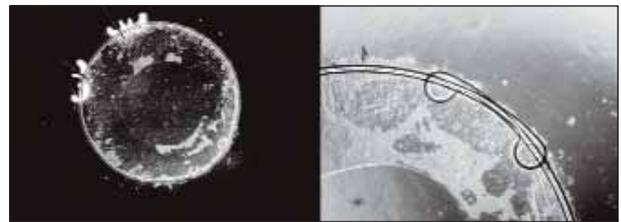


Figure 4. Low-power images of capsular bags following a sham cataract operation and ring insertion.



Figure 3. The Ahmed capsular tension segment.

other hand, iris hooks require making four extra incisions, and the process is time consuming. Another disadvantage is the expense of the iris hooks.

CTRs

These rings are usually PMMA C-shaped open rings that are designed for in-the-bag implantation. Whether inserted bimanually (Figure 1) or with an injector system, this device maintains the circular shape of the capsular bag. Its function is to help reduce zonular dehiscence and vitreous loss, prevent shrinkage of the capsular bag, and reduce anterior capsular phimosis as well as post-operative IOL decentration and tilt. Several manufacturers offer CTR models. Those that have a square edge also have the added benefit of preventing posterior capsular opacification.

CTRs should be placed as soon as zonular dehiscence or weakness is detected. First, insert iris hooks as necessary onto the intact capsulorrhexis rim. A CTR may be inserted before phacoemulsification of the nucleus or either before or after I/A of soft lens matter. CTRs are especially useful for high-risk cases. Consider using multiple and possibly large-diameter rings for patients with high myopia, pseudoexfoliation, and larger clock hours of zonular dehiscence. If very extensive zonular dehiscence is noted, however, do not insert the CTRs if they do not allow scleral fixation (see the *Variants of the CTR* section for the Cionni Modified CTR). These devices should also be avoided if there is a posterior capsular tear, a subluxated crystalline lens, or if the anterior capsulorrhexis is not intact. If you are planning to use an accommodating IOL, CTRs are contraindicated, because these IOLs require capsular movement.

Several complications may arise with the use of CTRs, including capsular bag decentration or tilt and dislocation of the ring. Furthermore, the capsular tear may be extended if the patient has an imperfect anterior capsulorrhexis, posterior capsular tear, or if the surgeon attempts (1) to enlarge the anterior capsulorrhexis or (2) a primary posterior capsulorrhexis. Use caution when placing the CTR, because inadvertent placement into the sulcus or anterior chamber angle will cause additional complications.

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Variants of the CTR

In addition to standard CTRs, there are several variant models on the market, including the Cionni Modified Capsular Tension Ring (Morcher, Stuttgart, Germany) (Figure 2) and the Ahmed capsular tension segment (Figure 3). The last variant has a 5-mm radius of curvature and a third eyelet for an iris hook or suture fixation. It may even be used in the event of a rhexis tear or posterior capsular rent. Some CTRs have a rectangular profile. As previously mentioned, these models prevent posterior capsular opacification. Some models are also foldable and offer a sharp edge and a closed ring.

In conclusion, the importance of counteracting the forces that act on the capsular bag must not be underestimated. Try using a large rhexis. In the presence of zonular weakness, avoid using a silicone IOL. Instead, use one made from materials with low propensity for causing capsular contraction (eg, AcrySof acrylic material [Alcon Laboratories, Inc., Fort Worth, Texas]). Additionally, consider employing a device such as iris retraction hooks, capsular tension segment, or CTRs to prevent further complications. CTRs are a wonderful tool to maintain the circular shape of the capsular bag and prevent capsular bag decentration and contraction (Figure 4). ■

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Christopher Liu, FRCOphth, is a Consultant Ophthalmic Surgeon at the Sussex Eye Hospital, in Brighton, UK, and Honorary Clinical Senior Lecturer at the Brighton and Sussex Medical School, in Brighton. He is also Director of the Tongdean Eye Clinic, in Hove, UK. Dr. Liu states that he has no financial interest in the products or companies mentioned. He may be reached at CSCLiu@aol.com.

