Fate of anterior capsule tears during cataract surgery

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PURPOSE: To determine the incidence of anterior capsule tears, at what stage of surgery they occurred, and their intraoperative behavior.

SETTING: Ambulatory surgery center, Cincinnati Eye Institute, Cincinnati, Ohio, USA.

METHODS: This 5-year retrospective study was of patients having phacoemulsification with posterior chamber intraocular lens (IOL) implantation complicated by unplanned peripheral extension of the capsulorhexis tear or a radial anterior capsule tear. The operative notes and a videotape of the surgery were reviewed. The stage at which the tear was initially observed and when it extended were identified, as was whether the tear extended to the posterior capsule. Anterior vitrectomy and the design and location of the IOL implanted were also analyzed.

RESULTS: A discontinuous anterior capsulorhexis or a break in the anterior capsule rim was observed in 21 eyes of 2646 cases, for an overall incidence of 0.79%. Anterior capsule tears were identified during ophthalmic viscosurgical device injection in 1 eye, capsulorhexis in 13 eyes, hydrodissection in 2 eyes, phacoemulsification in 3 eyes, irrigation/aspiration (I/A) in 1 eye, and implantation of a prosthetic iris device in 1 eye. Seven of the 13 tears identified during the capsulorhexis were managed by redirecting the second edge of the ''safety'' capsulorhexis to incorporate the tear. In 14 eyes, the tear in the anterior capsule extended into the zonules; 4 of these tears were limited. Ten tears extended around the equator and through the posterior capsule, occurring during the hydrodissection in 1 eye, phacoemulsification in 2 eyes, I/A in 1 eye, and IOL implantation in 6 eyes. An anterior vitrectomy was required in 4 eyes that had posterior capsule involvement. Endocapsular fixation of a 1-piece acrylic IOL was achieved in 18 eyes. Three eyes required implantation of a 3-piece acrylic IOL in the ciliary sulcus.

CONCLUSIONS: Extension of an anterior capsule tear can complicate cataract surgery at any stage. Extension of the tear through the posterior capsule occurred in almost half the eyes with an anterior capsule tear, often requiring an anterior vitrectomy. Managing an anterior capsule tear can be challenging yet compatible with implantation of a posterior chamber IOL.

J Cataract Refract Surg 2006; 32:1638–1642 © 2006 ASCRS and ESCRS

The importance of an intact capsulorhexis for safe phacoemulsification with intraocular lens implantation (IOL) is well recognized.[1] A discontinuous anterior capsule edge that occurs during the capsulorhexis or at any stage of the procedure may result in complications including extension through the posterior capsule, vitreous loss, posterior dislocation of lens fragments, and alteration of the intended type and location of the IOL.[2] This study was done to determine the incidence, origination, and behavior of torn anterior capsules complicating cataract surgery.

PATIENTS AND METHODS

A retrospective study was designed in which surgical videotapes and intraoperative reports specifying anterior capsule tears were reviewed. The review comprised cataract procedures performed by the same surgeon (R.H.O.) between January 2000 and December 2004. The stage at which the anterior capsule tear was identified, whether it could be salvaged, whether it extended into the zonules, and whether it continued around the equator into the posterior capsule were recorded. In the group of eyes further complicated by a posterior capsule tear, the stage of recognition, and the need for anterior vitrectomy were analyzed, as was the design and placement of the IOL.

0886-3350/06/$-see front matter
doi:10.1016/j.jcrs.2006.05.013

RESULTS

Twenty-one cases in which a break or an extension of the anterior capsule edge occurred were identified. During the review, 2646 procedures were performed, yielding an incidence of 0.79% for this complication.

The anterior capsule tear was most frequently identified during the capsulorhexis (13 eyes). However, it was unexpected to find that the tear was first recognized during the initial injection of the ophthalmic viscosurgical device (OVD) (1 eye), hydrodissection (2 eyes), phacoemulsification (3 eyes), irrigation/aspiration (I/A) (1 eye), and implantation of a prosthetic iris device (1 eye). The tear was rescued by redirecting the second or "safety" edge of the capsule in 7 of the 13 eyes in which the tear was noticed during the capsulorhexis. In the remaining 6 eyes and in an additional 8 eyes in which the tear occurred at stages other than the capsulorhexis, the tear extended into the zonules. Peripheral extension was limited in 4 of these eyes, while in 10 the tear extended around the equator and through the posterior capsule.

This more serious complication in which the posterior capsule was involved occurred during hydrodissection in 1 eye, phacoemulsification in 2 eyes, I/A in 1 eye, and IOL implantation in 6 eyes. In 4 cases of posterior capsule tears, an anterior vitrectomy was necessary. A 1-piece acrylic IOL (Alcon) was placed in the capsule bag in all but 3 eyes. In the 3 eyes in which the capsule bag was severely damaged, a 3-piece acrylic IOL was placed in the ciliary sulcus.

DISCUSSION

An anterior capsule tear is an accepted complication of phacoemulsification surgery. Before the mid-1980s, when a can-opener capsulectomy was standard, radial tears[3] were common. These tears often would extend and be contained by the anterior zonules.[4] Capsulorhexis reduced the incidence of anterior capsule tears,[5] but this complication remained potentially serious because the tear could extend around the equator into the posterior capsule, compromising the integrity of the capsular bag. Vitreous loss, residual nucleus or cortex, and suboptimal IOL location and stability were unfavorable consequences.[2]

The incidence of an anterior capsule tear in our study was 0.79%. Every anterior capsule tear was recorded on the surgical video label, and all labels were reviewed. Although unlikely, it is possible that a small number of videotapes were misplaced, damaged, or miscoded. The surgeon was experienced with a practice limited to referral adult cataract surgery. The elasticity of the pediatric capsule would have increased the incidence of anterior capsule tear. We believe the incidence would have been higher if the surgeon had not used Healon5 (sodium hyaluronate 2.3%) before it was approved in the United States. This OVD flattens the convex anterior surface of the crystalline lens, reducing peripheral extension of the capsulorhexis edge and keeping it under the surgeon's control. Another reason the incidence of tears was not higher was the use of trypan blue to enhance visualization of the capsulorhexis in eyes with a white or brunescent cataract. Although unapproved in the U.S., we found the dye invaluable and worth using since first described by Melles et al.[6]

Anterior capsule tears occurred during the capsulorhexis as the surgeon was creating a clockwise tear with a bent 22-gauge needle. The surgeon immediately injected additional Healon5 to "freeze" the intraocular environment, at which point the safety edge remote from the tear was maneuvered with the 22-gauge needle or microforceps in a counterclockwise direction, attempting to surround or incorporate the errant or broken edge. A rescued capsulorhexis was achieved in 7 of the 13 escaped capsulorhexes.

The safety capsulorhexis (developed by R.H.O.)[7] is performed by creating a midperipheral puncture left-to-right slash with the bent tip of the 22-gauge needle, which raises a "<" shaped flap (Figure 1). Turning around the proximal edge with the needle (essentially a U-turn) makes the edge point to the left (Figure 2), where it remains as the safety edge. Then, the distal edge is directed clockwise 360 degrees and the capsulorhexis is completed outside the proximal safety edge (Figure 3). If the distal edge begins to tear outward, the proximal safety edge can be directed counterclockwise to incorporate the tear (Figure 4). The resulting notch at the initial puncture site can be managed by a scissors snip. The notch is incorporated and then excised with a forceps (Figure 5).

The size of the continuous curvilinear capsulorhexis (CCC) may contribute to an anterior capsule break. An opening that is too small could be more conducive to striking the edge of the capsulorhexis with the ultrasound tip or snagging the edge with the chopper. An opening that is too large could involve more proximal zonules.[8]

Accepted for publication May 7, 2006.

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No author has a financial or proprietary interest in any material or method mentioned.

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Figure 1. The surgeon makes a slash from *A* to *B* with a needle to create a "<" shaped capsule opening.

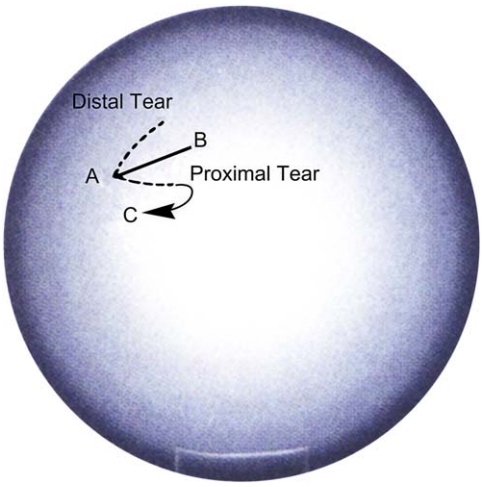

Figure 2. After the proximal tear is redirected to create *C*, the safety edge, the surgeon uses the distal tear for the leading edge of the capsulorhexis.

Regardless of the size of the capsulorhexis, when a tear occurred, the surgeon never intentionally made a relaxing incision in the capsule, an approach that has been advocated.[9]

It was also unexpected to find such a variation in the stage of the operation during which the anterior capsule tear was identified. For example, the tear in the anterior capsule was caused by the injection of the OVD in a patient with aniridia, a condition in which an unusually thin and fragile anterior capsule has been reported.[10] In 1 patient with a history of severe blunt trauma, gentle hydrodissection with a 27-gauge cannula ruptured the anterior capsule rim, which immediately extended around the equator and through the posterior capsule. In another patient with microphthalmia and iris colobomata, the tear through the anterior capsule was dramatic because a sector prosthetic iris device was being compressed through a small CCC.

When the tear is identified early and rescue is not possible, many surgical techniques may be helpful. Stabilizing

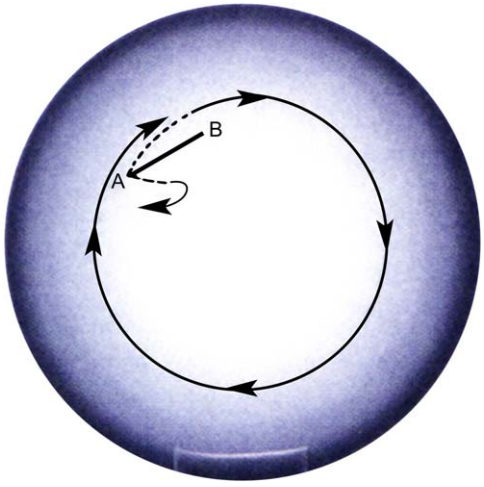

Figure 3. The capsulorhexis is completed in a clockwise fashion.

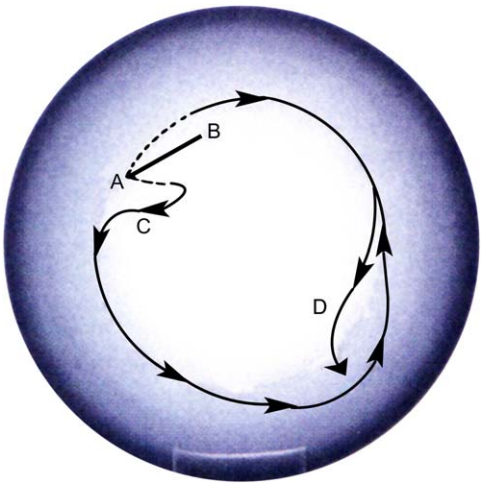

Figure 4. If the anterior capsule tear begins to extend peripherally (*D*), the proximal safety edge (*C*) is engaged and directed counterclockwise to rescue the capsulorhexis.

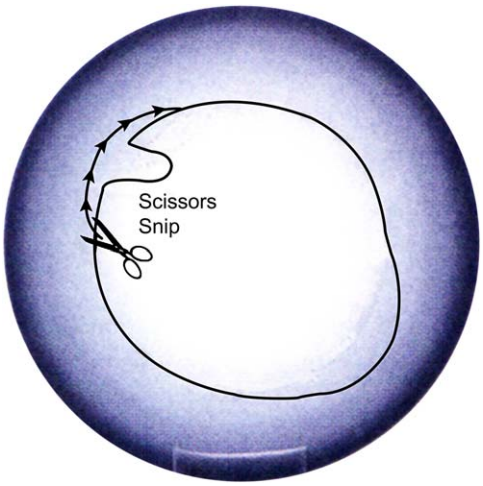

Figure 5. A scissors snip creates a new edge that can be grasped with a forceps and directed clockwise, excising the notch.

the anterior chamber with OVD before withdrawing the ultrasound or I/A tip prevents chamber shallowing, which could extend the tear. Completing the nucleus removal by slow-motion phacoemulsification with lowered parameters and a chopping technique is recommended, taking care to avoid decentering or excessive nucleus manipulation.[11] During cortical removal, the I/A tip should not engage the tear's edge and the cortex should be stripped toward the tear, leaving the cortex adjacent to the tear for last. Dry cortical removal with Healon5 is effective. Residual nuclear and cortical material was entirely removed from all eyes in this series.

The IOL design, insertion technique, and choice of the IOL location are important. When a radial tear is present, any force against the capsule bag can extend the tear around the equator and through the posterior capsule. We prefer a 1-piece acrylic IOL because the haptics are soft and pliable. Moreover, when this IOL is injected into a capsular bag filled with Healon5, the haptics remain folded and do not fully open until the OVD is removed and exchanged for a balanced salt solution. The small profile of the injected IOL and its behavior in Healon5 allow the surgeon to maneuver the IOL away from the axis of the tear. Alternatively, the IOL can be inserted in the anterior chamber and rotated, after which each haptic can be individually repositioned in the capsular bag.

A 3-piece IOL may more easily extend the tear. Placement in the anterior chamber followed by haptic repositioning into the capsular bag is a reasonable approach. We do not recommend using a silicone plate IOL in the capsular bag or a 1-piece acrylic IOL in the sulcus. An appropriate power change should be considered when the IOL is implanted in the sulcus.[12]

The surgeon must be familiar with bimanual, dry, and pars plana anterior vitrectomy techniques to manage tears that extend into the posterior capsule. In this series, vitreous management was required in 4 cases (19%) and the anterior capsule tear extended during IOL insertion in 6 patients, primarily because the surgeon's strategy for managing this complication was evolving. If the capsular bag is reasonably intact, we use a 1-piece acrylic IOL for endocapsular fixation. Although the soft haptic behavior in Healon5 is advantageous, the rapid fibronectin response, which creates an adhesion between the acrylic optic and the capsule, may stabilize the IOL after surgery. When the surgeon is uncertain whether to attempt endocapsular fixation, ciliary sulcus, iris, or anterior chamber fixation is acceptable.

CONCLUSION

Anterior capsule tears may complicate cataract surgery. The surgeon must recognize the gravity of this complication because approximately 67% of the tears extend to the zonules, 48% extend around the equator through the posterior capsule, and 19% require a vitrectomy. Anterior capsule tears, whether limited to the zonules or extending into the posterior capsule, are usually compatible with posterior chamber IOL implantation.

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