Capsular Tension Ring in Subluxated Cataractous Lens; A Safer Technique in Phacoemulsification

Tarek T. Mohamed, MD;* Ashraf A. El Shayeb, MD;* Mostafa A. Haikel, MD;* and Haidham Faik, MD.

Purpose: To evaluate the effect of capsular tension ring on the shape of the capsular bag and safety of phacoemulsification in subluxated lenses.

Methods: 12 cataractous eyes were involved in this study (8 males and 4 females), with a mean age of 42 years, the lens was subluxated in all with partial loss of zonular integrity. All the cases underwent phacoemulsification through clear corneal incision using the stop and chop technique. The capsular ring was introduced after capsulorhexis through the corneal incision and a hydrophobic acrylic IOL was implanted. The cases were followed up for 12 months.

Results: We did not meet any capsular collapse during surgery in any case nor intraoperative zonular separation. Rupture of posterior capsule occurred in one eye (the capsular ring was removed, vitrectomy and anterior chamber IOL was implanted).

Conclusion: The capsular tension ring is useful for the management of cataractous eyes with partial loss of zonular integrity. It improves the reliability of the various stages of surgery and allows surgeons to perform safer surgeries in such cases.

Cataract surgery in the presence of zonular integrity loss has been associated with an increased incidence of intraoperative complications (1,2). The rotational and anterior-posterior forces created during nucleus emulsification may lead to total separation of these weakened zonules, resulting in vitreous loss (3).

The capsular tension ring (CTR) was first reported in 1991 by Hara and coauthors (4) who used it as a useful adjunct procedure to maintain the capsular bag and to prevent its shrinkage and shrinkage of the capsular opening which occurs relatively frequently after cataract surgery. Such complications lead to intraocular lens (IOL) decentration, tilting, and deformation.

The C.T.R (Fig. 1) is an open, band-shaped ring, made of PMMA, and is roughly semicircular in shape with a locating hole. The ring is produced in three diameters, 10mm for the normal eye, and 11mm and 12mm for shortsighted and myopic eyes, in which capsular bags are generally more distended. It has a thickness of 0.2mm and 0.7mm width. The ring is polished minimally to keep the edges sharp and rectangular, facilitating the creation of a sharp, discontinuous bend in the equatorial capsule. A crooked is located at both ring ends to prevent spearing of the capsular fornix and facilitate manipulation during insertion (5).

The ring may be introduced through the side port incision, or through the corneal incision with a special introducer which allows it to be inserted into the bag more gradually (6).

In this study, we evaluated the effect of implanting a capsular tension ring (CTR) after capsulorhexis and hydrodissection on intraoperative complications during phacoemulsification of the cataractous lenses associated with zonular weakness.

Patients and Methods

Table 1: shows the patients characteristics. 12 eyes were included in this study, 8 were males (66.6%) and 4 females (33.3%). All had cataractous subluxated lenses. Eyes with zonular dialysis > 90 degrees were not included in this study. Past history of trauma was present in 5 eyes (41.6%). The ages of the patients ranged from 32 to 55 years with mean age of 42 ± 12.6. All the eyes underwent complete ophthalmic examination, slit lamp and applanation tonometry. 4 eyes (33.3%) had white mature cataract, three of them had past history of trauma.
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those patients underwent ultrasonography of the globe to exclude any posterior segment lesion. Preoperatively, a dilated fundus examination was performed except in those eyes with very dense white cataract.

Eyes with uncontrolled glaucoma were not enrolled in this study. However, 2 cases (16.7%) with medically controlled glaucoma were enrolled. The mean preoperative IOP was 17.2 mmHg ± 2.5 (SD). Pseudoexfoliation was recorded in 3 eyes (25%). All the surgeries were done in the ophthalmic department of Benha Faculty of Medicine.

Table (1): Preoperative patient characteristics.

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<th>Preoperative characteristic</th>
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<tr>
<td>Mean age (years)</td>
<td>42 ± 12.6</td>
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<tr>
<td>Sex, n (%)</td>
<td>Male 8 (66.6)</td>
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<td>Past history of trauma, n (%)</td>
<td>5 (41.6)</td>
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<td>White cataract, n (%)</td>
<td>4 (33.3)</td>
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<tr>
<td>Pseudoexfoliation syndrome, n (%)</td>
<td>3 (25)</td>
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<tr>
<td>Mean IOP (mmHg)</td>
<td>17.2 ± 2.5</td>
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<td>Mean axial length (mm)</td>
<td>23.1 ± 2.1</td>
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Surgical technique:

The operation was done under general anesthesia in 3 cases (25%) and under local retrobulbar anesthesia and akesia in 9 cases (75%), 2 side port incisions were made using microvitreoretinal blade (20 G). The anterior chamber was filled with sodium hyaluronate 1%. Then a 3.2 mm clear corneal incision was made with a 3.2 mm Keratome. Capsulorhexis was performed with a Utrata forceps. In eyes with white cataract, trypan blue vital dye staining was used to visualize the anterior lens capsule. All capsulocortical attachments were loosened by careful, thorough hydrodissection. Then, a preloaded CTR was implanted through the main incision using an injector (Fig 2).

After insertion of the ring, the capsular bag expanded and tautened, and this enabled us to proceed with phacoemulsification safely within a stretched bag.

In eyes with axial lengths longer than 25.0 mm (n = 2), a 12.0 mm CTR was implanted. In the other eyes, an 11.0 mm CTR was used.

Phacoemulsification was performed using a stop-and-chop technique in all cases. After the cortex was removed, the capsular bag was filled with sodium hyaluronate 1% and the incision was enlarged using 4.1mm Keratome. Then, a foldable hydrophobic acrylic intraocular lens was implanted in the bag. The sodium hyaluronate was removed, followed by hydration of the wound edges.

In one case the posterior capsule was ruptured after implantation of the CTR and during phacoemulsification of the last piece of the nucleus, so we removed the CTR using the Kelman/Macpherson forceps, anterior vitrectomy was done, and an anterior chamber IOL was implanted after widening the wound to accommodate it.

Results

Patients were followed up for 12 months. The mean follow-up was 310.2 ± 40.0 days.

The primary outcome measures were the rate of intraoperative zonular separation (zonular dialysis) and in-the-bag fixation of a foldable IOL. Other parameters included posterior capsule rupture without zonular separation, vitreous loss, postoperative corneal edema, Thin reaction in the anterior chamber, and IOP.

Anterior capsule fibrosis, anterior capsule shrinkage, posterior capsule folds, and PCO were evaluated through the follow-up period at the slitlamp.

Intraoperative zonular separation was defined as zonular dialysis > 90 degrees with or without lens drop into the vitreous cavity. No eye in this study had zonular separation during surgery.

The exact IOL placement was verified by intraoperative assessment and a postoperative biomicroscopic examination performed through a dilated pupil. Placement was classified as bag, sulcus, anterior chamber, or null. In-the-bag fixation of a foldable IOL was achieved in 11 eyes (91.7%) and anterior chamber IOL was implanted in one eye (8.3%), in which posterior capsule rupture without zonular separation had occurred and managed by

Fig. (1): The capsular tension ring.
CTR removal, anterior vitrectomy and anterior chamber IOL implantation.

Corneal edema, (striate keratitis with or without accompanying stromal thickening) in the early postoperative period, was graded on a 4-point scale: 0 = no edema, it was achieved in 5 eyes (41.6%); 1 = minimal edema with no reduction in V.A., achieved in 3 eyes (25%); 2 = mild corneal edema with reduction in V.A. achieved in 2 eyes (16.8%); 3 = moderate corneal edema with reduction in V.A. achieved in one eye (8.3%) and 4 = severe corneal edema with reduction in V.A. recorded in one eye (8.3%). Corneal edema resolved in 2 to 15 days in all eyes.

Fibrin reaction chamber in the anterior was determined by a biomicroscopic examination 1 day postoperatively. It was seen in one eye (8.3%). Intensive topical corticosteroid therapy dissolved the membrane without sequela in this case.

Intraocular pressure was measured by applanation tonometry at all visits. During the first postoperative examination, transient IOP spikes were observed in 3 eyes (25%). It was > 25 mmHg but returned to normal level < 17 mmHg within few days. At the last follow-up visit there is no significant difference between the mean postoperative and preoperative IOP.

Examination the anterior and posterior capsule at slitlamp showed that; in 9 eyes (75%) there is no anterior capsule fibrosis up to one year follow up. In general, anterior capsule shrinkage was minimal. Posterior capsule folds were seen in only 1 eye (8.3%) and it resolved by 1 year postoperatively.

Posterior capsule opacification was evaluated by analyzing its intensity and extent on the posterior capsule within the IOL optic and its effect on the VA. The number of the patients who had significant
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PCO and Nd: YAG laser capsulotomy was one at 1 year follow up (8.3%).

Discussion

Cataract surgery can be very challenging in patients with weak or ruptured zonules. The Capsular Tension Ring, effectively solves several procedural difficulties encountered in performing cataract surgery in these patients (7).

Capsular tension ring implantation was described by Legler and Witscel in 1993 (8). When a (hydroxy methyl methacrylate) ring is inserted in the capsular bag, it stretches the capsule equator and distributes the forces equally over all zonules. In the cases in which zonular support is absent or inadequate, the ring supports the capsular bag and facilitates surgery (6).

The capsular ring provides a simple way to stretch the posterior capsule and re-establish the shape of the bag. In eyes where the zonules have been damaged through trauma or pseudo-exfoliation, it allows dependable high quality intracapsular surgery and forestalls both capsular fibrosis and ciliary retraction (10).

It also prevents the concentration of forces on individual zonular fibres, thus spreading the forces to the entire capsule. It helps in preventing intraoperative posterior capsule rupture by keeping the posterior capsule taut, preventing its anterior bulging and protecting it from being aspirated by phaco or irrigation/aspiration tips during phacoemulsification and cortical aspiration (8).

In pseudoexfoliation syndrome the contraction of the bag is so high, so in using a foldable IOL in such a case, there is a rapid ovalisation of the anterior opening of the capsular bag (11,12). That is why foldable lenses, would ordinarily be contraindicated in such cases. The CTR provide another advantage as it allows such cases to be implanted with foldable IOL (12).

It also shows its value when used in combined surgery for glaucoma and cataract. In such cases there can be significant zonular relaxation and poor dilatation which would otherwise lead to considerable difficulty in cleaning the posterior capsule (13).

In a study by Bayraktar et al (2001) (12), phacoemulsification was done with CTR and without in pseudoexfoliation syndrome. Most eyes (94.9%) in CTR group had a foldable IOL implanted in the capsular bag; while in-the-bag fixation was possible in only 79.5% in the control group (without CTR). This indicates that by decreasing the rate of intraoperative zonular separation, the CTR increases the rate of primary in-the-bag IOL implantation.

In this study there were no instances of zonular lysis and only one case of posterior capsular rupture in 12 patients after placement of the capsular rings. By comparison, in another study (6) 43 patients, underwent phacoemulsification without the ring, there were seven cases of extensive zonular lysis and 11 cases of capsular rupture.

In our study, a fibrin reaction in the anterior chamber was seen in 8.3% of cases, more or less equal to 7.7% of cases in another work (12).

As regard PCO, it however, was not completely prevented by the ring, although PCO in eyes with a ring was not marked (14). This may be the result of several factors. The lens epithelial cells (LECs) most distal to the anterior capsule center could remain within the ring and later proliferate onto the posterior capsule. This occurrence may depend on the ring’s width. Another possibility is that the 2 ends of the open ring did not overlap or were not closely apposed within the capsular bag and that LECs migrated between the 2 ring ends onto the posterior capsule (14,15).

To prevent LEC migration between the 2 ring ends, Nishi and coauthors (16) modified the capsular bending ring. The eyelet at 1 end was eliminated and the end slightly elongated so that it can overlap the crooked eyelet of the other ring end in the capsular bag.

Although the capsular bending ring significantly inhibited PCO and ACO, its routine use may be questionable and could lead to complications. Implantation of the ring requires additional surgical time, and the expense is a concern (15).

Some authors advocate routine use of the capsular tension ring in high myopes or to prevent posterior capsular opacification (8). In a new attempt, new rings, being developed incorporate the anti-metabolite 5-fluorouracil which it delivers to the eye over a 10 day period following IOL implantation to decrease the rate of PCO (10).

We implanted the CTRs just after hydrodissection but before phacoemulsification. No attempt was done to rotate the nucleus before inserting the ring. Meridional and anterior-posterior forces that stretch the weakened zonules are created during nucleus manipulation (grooving, rotation). Therefore, the CTR should be inserted before this stage. Although the ring helps stability of capsular bag and helps the surgeon during nucleus manipulations, as shown in our current study, it actually, create difficulties for the surgeon during...
cortex aspiration especially if the cortex is not totally cleaved from the capsule. Thus, we believe that cortical cleaving by Hydrodissiction as described by Fine (17) should be performed in those cases and that the ring should be inserted just beneath the lens capsule, not between the cortical fibers.

In addition to meticulous cortical cleaving hydrodissection, a viscoelastic injection during the path of the ring may help separate the lens fibers from the cortex. Adequate hydrodissection is critical to prevent cortical material being trapped by the capsular tension ring as this significantly increases the time required for irrigation and aspiration (17).

Some authors believe that the ring could be inserted at any time, even during phacoemulsification. In fact, if there is significant instability, inserting the ring can make it easier to complete the phacoemulsification by supporting a very mobile capsular bag and reducing the risk of capsular rupture. Even with the ring in place, it is not difficult to rotate and fracture the lens adequately (9).

Conclusion

In conclusion, CTR implantation after capsulorhexis and hydrodissection in presence of weak zonules, reduced intraoperative complications caused by zonular separation, increased the rate of in-the-bag IOL fixation, decreased IOL decentration and decreased PCO leading to improvement of UCVA (7).

The recommended indications for CTR implantation are: zonular rupture or dehiscence after blunt or surgical trauma and inherent zonular weakness such as in cases of pseudoxefoliation, Marfan's syndrome, long-standing silicone tamponade in vitrectomized eyes, and in high myopic eyes as it provides a framework for restoring the anatomical integrity of the eye (6,7).

References