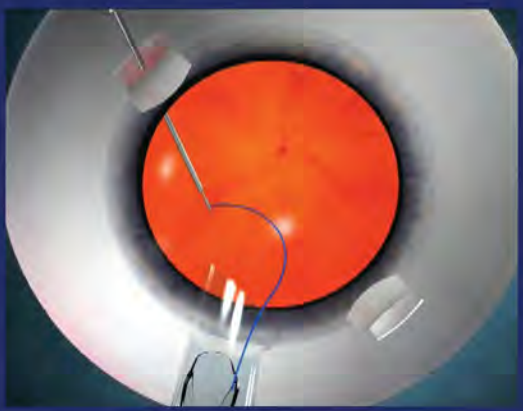
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CHAPTER

4

Phaco in Subluxated Cataracts

Amar Agarwal, Priya Narang

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INTRODUCTION

The surgical management of cataract associated with zonular dialysis is a real challenge for the ophthalmic surgeon. Due to recent advances in equipment and instrumentation, better surgical techniques and understanding of the fluidics, the surgeon is able to perform relatively safe cataract surgery in presence of compromised zonules. Implantation of a capsular tension ring can stabilize a loose lens and allow the surgeon to complete phacoemulsification and IOL implantation.

HISTORY

Insertion of a ring into the capsular bag fornix (equator) to support the zonular apparatus was first described by Hara and coauthors in 1991.[1] Hara et al. introduced the concept of "equator ring", "endocapsular ring" or "capsular tension ring (CTR)". In 1993, the first capsular tension ring (CTR) for use in humans was designed.[2] In 1994, Nagamato and Bissen-Miyajima[3] suggested using an open polymethyl methacrylate (PMMA) ring to provide adaptability.

ADVANTAGES

This technique offers four main advantages:

1. The capsular zonular anatomical barrier is partially reformed, so that vitreous herniation to the anterior chamber during surgery is reduced or even avoided.
2. A taut capsular equator offers counter traction for all traction maneuvers, making them easier to perform and decreasing the risk of extending the zonular dialysis. The great advantage of using the capsular ring during the phacoemulsification rather than after, just to center the lens is a great deal safer. Any force that is transmitted to the capsule is not applied directly to the adjacent zonules, but rather distributed circumferentially to the entire zonular apparatus.
3. The necessary capsular support for an in the bag, centered implant is obtained.
4. The capsular bag maintains its shape and does not collapse, which can lead to proliferation and migration of epithelial cells, development of capsular fibrosis syndrome and late IOP decentration.

DESIGNS AND DESCRIPTIONS

The capsular tension ring is made of one piece polymethyl methacrylate (PMMA) and is available in different sizes depending on their use in patients with emmetropia, low or high myopia. An injector is also present for loading the ring. The original capsular tension ring, with characteristic eyelets on both ends is marketed by Morcher company in co-operation with Dr Mitchel Morcher. Meanwhile, various similar products are being marketed (e.g. by ophtec physiol, corneal, IOL tech, Acrimed, Rayner, Hanita, Lens Tec.) As a standard capsular tension ring, 12.0/10.0 mm diameter ring (Morcher type 14) and the 13.0/11.0 mm diameter ring (ophtec 13/11) are the most commonly used by surgeons. Morcher type 14 are for normal axial length eyes, while type 14A and 14C are for myopic eyes.

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The modifications used, by Morcher, include two types of capsular tension rings with iris shields (Type L and G, with integrated iris shields of 60 and 90 degrees, respectively) and two types of capsular bending rings (CBRs) designed to prevent capsule opacification (type E and F).These modified versions incorporate fixation elements that allow the surgeon to suture the ring to the scleral wall, through the ciliary sulcus, without violating the capsular ring.[4]

Special Designs for Suturing in Severe Zonular Dehiscence

In cases where severe or progressive zonular dehiscence is present implantation of the capsular tension ring alone may not be adequate. This may lead to severe postoperative capsular bag shrinkage as well as IOL decentration and pseudophakodonesis.[5] Also complete luxation of the bag along with the capsular tension ring and the IOL cannot be excluded.

A modified design developed by Cionni with a fixation hook for severe or progressive cases of zonular deficiency[6] solves this problem. The hook is kept opposite to the meridian of decentration and is pulled peripherally using a transscleral fixation suture, to counteract capsular bag decentration and tilt. In severe cases two such rings or the two hooked model can be used. However the Cionni ring has its limitations like difficulty to implant if the capsulorhexis is small and in such cases the hook may even drag on the edge of the anterior capsule, and as the fixation plane is anterior to the anterior capsule, it may lead to iris chafing leading to pigment dispersion and chronic uveitis.

An alternative is to fix the ring by guiding the needle of the scleral suture through the equator of the capsular bag, just inside the capsular tension ring.[7] This technique has to be completed as a one step procedure because the suture may cheese-wire through both capsules leaving along the equator.

Another alternative in cases of severe decentration is to make a small equatorial capsulorhexis through which a standard capsular tension ring can be inserted. A scleral suture can then be passed

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around the exposed capsular tension ring which is then used to center the lens before capsulorhexis.

INDICATIONS

The indication for use of capsular tension ring is in all cases of subluxation of lens (Table 4.1) ranging from the common ones like traumatic displacement (mechanical or surgical), Marfan's syndrome, pseudoexfoliation syndrome and hypermature cataract to the rare ones like aniridia and intraocular tumors.

APPLICATIONS

Zonular Dehiscence

The efficacy of the capsular tension ring in managing zonular dialysis has been demonstrated in vitro[8,9] depending on where the zonular defect presents. The capsular tension ring may be inserted at any stage of cataract procedure. By reestablishing the capsules contour, the capsular tension ring protects the capsular fornix from being aspirated, avoiding consecutive zonular dialysis extension, irrigation fluid running behind the capsular diaphragm with the posterior capsule bulging, and vitreous prolapse into the anterior chamber with possible aspiration. With pre-existing zonular defects such as those caused by blunt trauma, the capsular tension ring is inserted before phacoemulsification is started.

Zonular Weakness

Ocular and systemic conditions may result in a zonular weakness that may be profound and progressive. Pseudoexfoliation syndrome with or without glaucoma and Marfan's syndrome are the most common causes. If zonular weakness is profound the capsular tension ring is implanted before the cataract is emulsified and a 10-0 nylon anchoring suture may be temporarily threaded through the eyelets so as to remove the capsular tension ring if the zonules fail during surgery.

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TABLE 4.1 Etiology of subluxated lenses

- Isolated ocular abnormality
  - Simple ectopia lentis
  - Simple microspherophakia
  - Spontaneous, late subluxation of lens
- Associated with other ocular abnormality
  - Aniridia
  - Ectopia lentis et pupillae
  - Uveal coloboma
  - Cornea plana
- Associated with heritable systemic syndromes
  - Marfan's syndrome
  - Homocystinuria
  - Weill-Marchesani syndrome
  - Ehler-Danlos syndrome
  - Rieger's syndrome
  - Hyperlysinemia
  - Sulfite oxidase deficiency
  - Sturge-Weber syndrome
  - Pflander's syndrome
  - Crouzon's syndrome
  - Sprengel's anomaly
  - Oxycephaly
- Associated with other ocular conditions
  - Mature or hypermature cataract
  - Mechanical stretching of zonules
    - Buphthalmos
    - Staphylomas
    - Ectasias of globe
    - High myopia
    - Perforation of large central corneal ulcer
  - Pull on zonules
    - Cyclytic inflammatory adhesions
    - Eales disease
    - Persistent hyperplastic primary vitreous
    - Intraocular tumors
    - Retinal detachment
  - Degeneration of zonules
    - Uveitis
    - Retinitis pigmentosa
    - Chalcosis
    - Prolonged silicone oil tamponade
    - High myopia
    - Hypermature cataract
- Traumatic subluxation/dislocation and surgical trauma

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In pseudoexfoliation syndrome, the anterior capsule may contract excessively after in the bag IOL placement (capsular phimosis). This can be prevented by providing a locking mechanism that would prevent the eyelets from overlapping, suturing together the two eyelets together or by using two larger implants. This can be supplemented by meticulously polishing the anterior capsule leaf overlapping the implant.

In case of Marfan's syndrome the zonules may be disintegrated or elongated while the remaining may be still functional, giving rise to lens decentration, which may be progressive. In case of Weill-Marchesani syndrome, microspherophakia and zonular degeneration may occur. Secondary scleral suturing to remedy IOL decentration and tilt may be useful in such cases.[7]

Use of prolonged silicone oil tamponade may lead to progressive zonular atrophy and emulsified oil or oil bubble gaining access into the anterior chamber spontaneously or during the cataract surgery. In such cases a large capsular tension ring should be implanted before phacoemulsification is done.

LENS COLOBOMA

A colobomatous lens (Fig. 4.1) is due to defective or absent segment of zonules resulting in a notch in the lens. It is a misnomer in that there is no actual lenticular substance missing. There is just a retraction of a crystalline area due to localized loss of tension on the lens capsule. Intact zonules are often seen in this area and therefore a localized area of defective ciliary body or zonules may lead to localized loss of traction on the lens capsule. It may occur along with a ciliary body coloboma. Lens coloboma is, therefore, more accurately referred to as *coloboma of the zonule and/or ciliary body.*

Surgery in Lens Coloboma

Surgery is done using a capsular tension ring (CTR) which forms the capsular fornix (Figs 4.2 to 4.4). The CTR which was first started by T Hara protects against capsular fornix aspiration, consecutive

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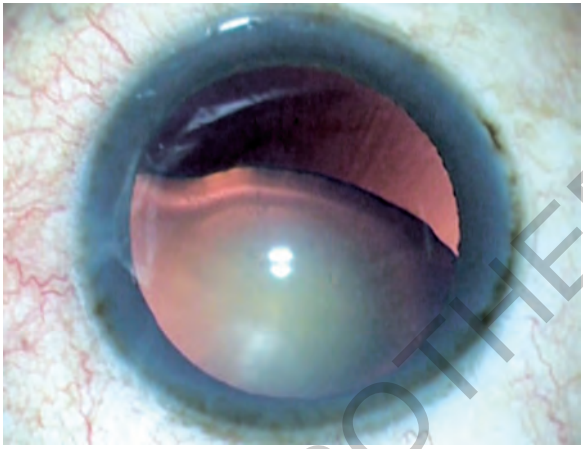


Figure 4.1 Lens coloboma

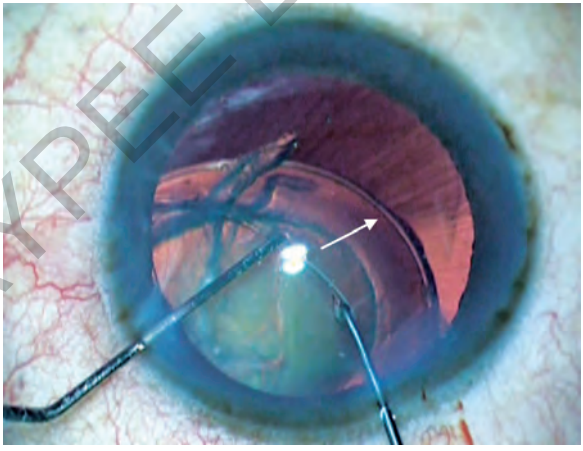


Figure 4.2 Endocapsular ring implantation

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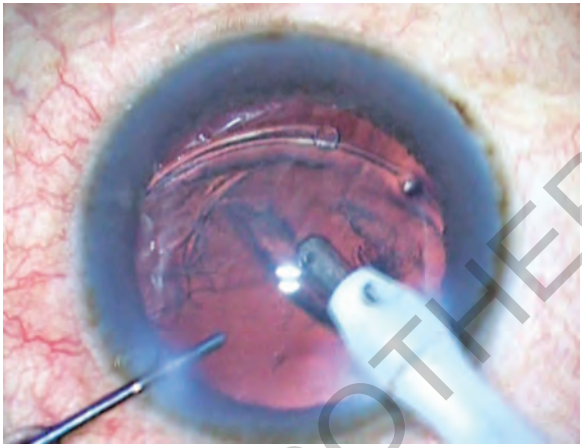


Figure 4.3 Cortical aspiration

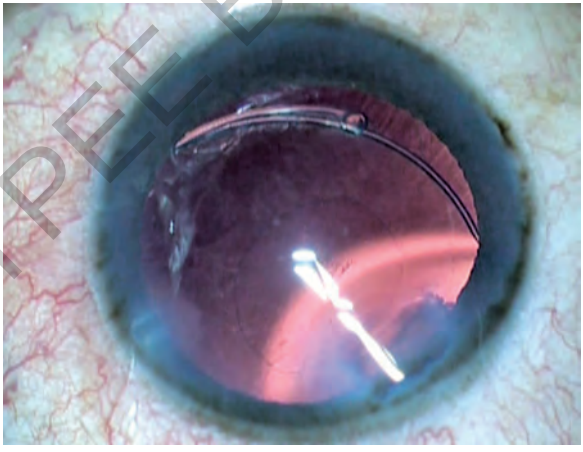


Figure 4.4 Cortex removed. (*Note:* The lens coloboma and endocapsular ring. At this stage one can implant the foldable IOL comfortably)

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zonular dialysis, irrigation fluid flowing behind the capsule, vitreous herniating into the anterior chamber, IOL decentration, and capsular phimosis. Minimal mydriasis or reactive miosis may be a problem. Conventional approaches to deal with normally positioned small pupils and cataract surgery may be used, such as mechanical stretching, iris retractors, or multiple sphincterotomies. Vitreous loss may occur secondary to prolapse through the coloboma in the presence of an intact capsule. Giant retinal tears also occur with isolated lens coloboma. A large optic IOL is advisable for better visualization of the posterior segment, which is at greater risk of potential retinal detachment and also for optimal centration of the optic relative to the ectopic pupil. Aberration free or aspheric IOLs may also be preferable in these eyes to decrease the effect of lens decentration on vision. A silicone IOL is not advised in case a complex retinal detachment occurs that requires the use of silicone oil.

Technique

Anesthesia

Both general and peribulbar anesthesia are suitable for creation of scleral windows and transscleral suturing of the capsular ring or of the IOL if necessary. Special mention is required about 1% intracameral lidocaine. There is a risk of its passage through the zones lacking zonular fibers, and transitory loss of sight resulting from retinal toxicity, as described in cases of capsular ruptures.[10]

Incisions

The first step is to make an incision in the eye which has a subluxated cataract. A needle with viscoelastic is injected inside the eye in the area where the second site is made. This will distend the eye so that when you make a clear corneal incision, the eye will be tense and one can create a good valve. Now use a straight rod to stabilize the eye with the left hand. With the right hand make the clear corneal incision.

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Capsulorhexis

Commencing capsulorhexis is difficult because of capsular instability. It is better to begin the capsulorhexis in the area where the zonules is whole and where the capsule offers sufficient resistance. If vitreous is present in the anterior chamber, the gel must be first isolated and vitrectomy should be performed if required. After the vitreous has been removed from the anterior chamber, a viscoelastic preferably dispersive is inserted by first covering the zone. Capsulorhexis can be performed after the zone of zonular dehiscence and iridocrystalline diaphragm have been stabilized. Do not use trypan blue in such cases as the trypan blue will go into the vitreous cavity through the zonular dehiscence and make the whole vitreous cavity blue. This will make visualization difficult in surgery. Completion of rhexis can be done using an intraocular rhexis forceps.

Hydrodissection and Hydrodelineation

Hydromaneuvers should be performed meticulously to ensure correct freeing of the lens nucleus. The hydrodissection cannula should be inserted in the direction of the zone of disinsertion rather than in the opposite direction, which would enlarge the disinsertion. Viscoelastic may be required to separate the nucleus and cortical material and also to separate the cortex from the lens capsule.

Implantation of Capsular Ring

Mostly capsular tension rings can be easily inserted in the capsular bag if it is well expanded with viscoelastic. The instruments used to implant a capsular tension ring include Kelman-McPherson type forceps special injectors (marketed by Ophtec and Geuder suitable for both Ophtec and Morcher CTRs and the one developed by Menapace and Nishi for use with CBR, Geuder Co.) and last but not the least a guiding suture.

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Phacoemulsification

Nuclear phacoemulsificaton can be performed using coaxial phaco or bimanual phaco/phakonit in the bag or out of the bag, depending on the surgeon's preference. In general, phacoemulsification in these situations may be considered a safe proposition if performed in a proper way.

Cortical Aspiration

When performing automated aspiration, movements of the tip should not be radial because of the risk of traction on the ring and the capsular bag.

Implantation of the Intraocular Lens

It is desirable to implant a larger diameter lens to minimize symptoms if lens decentration were to occur. The foldable lens is loaded and implanted in the capsular bag followed by viscoelastic removal. In either case, rotational maneuvers must be avoided or minimized.[11]

CIONNI'S RING

If the lens continues to remain decentered after CTR insertion, a flexible nylon iris hook is used to engage the rhexis margin through a paracentesis opposite to the direction of subluxation. This gives capsular support till the end of surgery at which time a transscleral fixation of one haptic of the IOL can be done for its centration.

When zonular dehiscence is large in extent or progressive in nature, capsular bag shrinkage resulting in IOL decentration and pseudophakodonesis may occur even after a successful surgery with capsular ring. Complete luxation of the bag and its contents has also been reported. For such cases, Cionni's modified design with a fixation hook is a good solution (Fig. 4.5). The hook is kept in the area of dialysis and is pulled peripherally using a transscleral fixation suture, to counteract capsular bag decentration and tilt.

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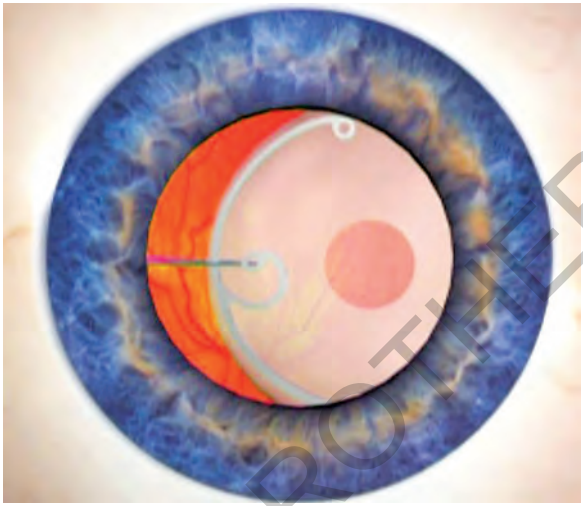


Figure 4.5 Cionni's ring

In severe cases, two such rings or the two hooked model can be used. If normal endocapsular ring is used the ring and the IOL might not be in the correct position (Fig. 4.6). An alternative in cases of severe decentration (Fig. 4.7) is to make a small equatorial capsulorhexis through which a standard capsular tension ring can be inserted. A scleral suture can then be passed around the exposed capsular tension ring which is then used to center the lens before capsulorhexis. Peribulbar anesthesia is suitable for creation of scleral windows and transscleral suturing of the capsular ring or of the IOL if necessary.

IKE SEGMENTS

Ike Ahmed designed the Ike segments which can be used for small segments.

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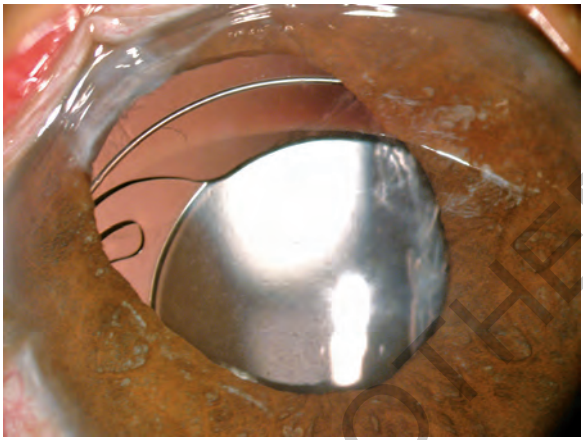


Figure 4.6 Endocapsular ring implanted without suturing to the sclera (*Note:* The ring and IOL are not in proper place)

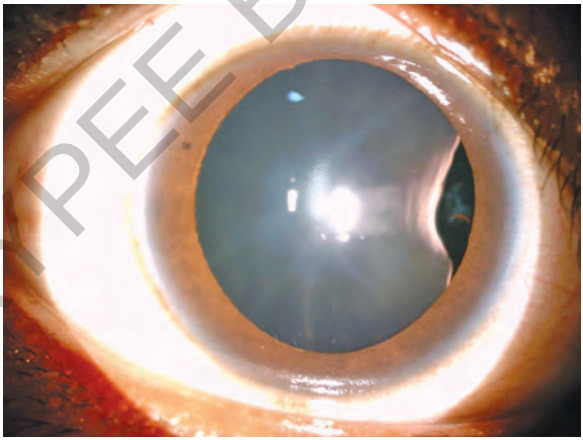


Figure 4.7 Lens coloboma

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She has authored some of the leading papers like Phakonit, Sleeveless phacotip-assisted levitation of dropped nucleus, sleeveless extrusion cannula-assisted levitation of dropped intraocular lens, IOL scaffold and pre-Descemet's endothelial keratoplasty (PDEK). She was awarded a Gold medal for her contribution to the field of ophthalmology by Indian Intraocular Implant and Refractive Society in Delhi.

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