Zonuloplasty, a novel surgical treatment for zonular weakness in patients undergoing cataract surgery

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Abstract

Purpose: Patients with zonular weakness, undergoing cataract surgery, have a very high risk of the Intraocular Lens (IOL) dislocation during this operation. Strengthening the capsular bag is undeniably important in these patients. In this article, we suggest a novel surgical technique as a prospective treatment for zonular weakness in such patients.

Methods: A triangular capsular flap is cut from the anterior capsule with the base directed towards the zonular break area. Basal peripheral iridotomy (PI) is performed in the same zone through corneal paracentesis. The tip of the capsular flap is caught with capsular forceps which is guided through both PI and corneal paracentesis. The tip of the flap is fixed in corneal stroma with a full thickness 10/O suture. After the lens implantation, the triangular anterior capsular flap is sutured in 360 iris edges and residues of flap in the anterior chamber are cut along the iris plane. Sutures from cornea along with the cut part of the flap are removed. This technique may be more practical in ECCE but it is very difficult to perform in Phacoemulsification. In this condition, a very tiny iris clip can be used instead of suturing to grasp the capsular flap in PI site and suspend it from the iris.

Results: This flap prevents dislocation of bag contents into vitreous and the possibility of vitreous loss through zonular defect and is a reliable support for PC/IOL. We can perform zonuloplasty in one quadrant zonal defect or 2-4 quadrants in the cases like Marfan Syndrome.

Conclusion: Zonuloplasty is an innovative surgical procedure in cases with zonular instability more than 1/4 quadrant when CTR is ineffective.

Keywords
Zonuloplasty, Zonular weakness, Cataract surgery, Intraocular lens dislocation

Introduction

Zonular weakness can relatively easily be identified when a patient presents with one of its noticeable signs such as, iridodonesis, prolapse of vitreous, phacodonesis, or a significant lens subluxation. But the detection of zonular vulnerability sometimes requires a subtle examination aimed at discovering the specific and more delicate changes and signs [1].
Identifying the signs of zonular damage and weakness

Osher [2] has divided and described the main subtle signs indicating the zonular weakness as the following:

I. Iridolenticular gap

The diagnosis of the iridolenticular gap is achievable by detecting the space between the anterior lens capsule and the border of the iris at the pupil as a result of focal zonular loss. The lens is a little tilted backwards due to this zonular break.

As a result, the best way to detect the microsubluxation of the lens is to examine the anterior segment by means of a slit lamp.

II. Decentered nucleus

Having a detailed knowledge of the anatomy of the lens along with its careful examination by slit beam will enable the examiner to detect even the most delicate decentered nucleus.

In a normal eye, the forces are symmetrically distributed over the lens by zonules. In the presence of zonular weakness or break, this equilibrium of forces will no longer remain leading to the moving of the lens and its nucleus away from the weak spot. Alteration in the normal location of the lens nucleus is one of the important signs indicating zonular weakness or damage.

III. Focal iridodonesis

Zonules act as a barrier against vitreous gel to shift forward and contact the iris while the eye moves. Weak or damaged zonules are not able to properly operate this barrier role. Hence, vitreous gel contacts the iris when it vibrates due to eye movements and these results in pushing the iris to the fore in some specific areas. Bulged iris sparkles during eye movements and can be detected by a subtle eye examination.

IV. Vitreous tension

A precise eye examination may reveal the lines through the pupil, indicating vitreous tension. Ruptured zonules can resist against the forward herniation of the vitreous body. The vitreous lines can appear as a result of the tension and the consequential herniation.

V. Lens equator visibility

It is crucial for an examiner to scrutinize the lens not only in the primary position but also while the eyes are fixed on eccentric locations. The latter condition would facilitate the detection of the equator of the lens as a result of zonular weakness.

Spotting the lens equator in the presence of a subtle zonular weakness may require a very careful indirect ophthalmoscopic examination.

VI. Lens contour alterations

In normal eyes there is continuously a balance between the tensions symmetrically applied by zonules to the lens to expand and the natural tendency of the lens—due to its elasticity—to retract. This balance keeps the lens in its normal shape. Focal weakness or damage of zonules causes the lens retracting forces to overcome this battle, leading to the distortion of the normal lens contour. Normal lens contour alterations can be detected as a flattening or a partial retraction of the lens adjacent to the vulnerable zonules.

In order to confirm the integrity of zonules or detect zonular weakness, it is vital to perform a structured and subtle lens examination by having the zonules and the possibility of their disorders in mind.

The Idea: Zonuloplasty as a surgical treatment for zonular weakness

A triangular capsular flap is cut from the anterior capsule with the base directed towards the zonular break area. Basal PI is performed in the same zone through corneal paracentesis. The tip of the capsular flap is caught with capsular forcept which is guided through PI and corneal paracentesis and the tip of flap is fixed in corneal stroma with a full thickness 10/O suture.

After the lens implantation, the triangular anterior capsular flap is sutured in PI at iris edges and residues of flap in the anterior chamber are incised which then will be removed along with the sutures from cornea. Figure 1 illustrates the steps of our suggested surgical procedure.

Regarding suturing, it can be more practical in extracapsular cataract extraction (ECCE) but very difficult to perform in Phacoemulsification. In this condition, very tiny clip -iris clip (figure 2)- can be made and used instead of suturing to grasp the capsular flap in PI site and suspend it from iris. This flap prevents dislocation of bag contents into vitreous, the possibility of vitreous loss through zonular defect, and acts as a reliable support for PC/IOL. The anterior capsular flap functions as the natural continuation of posterior capsule in the area of zonular weakness and prevents the tears in the anterior capsule to be extended to the posterior.

In cases with traumatic lens subluxation accompanied with a more than 1/4 zonular break, cutting anterior capsule would be an obstacle due to the pliancy of capsular bag and lens mobility. In this condition, we can gently perforate anterior
capsule by a very sharp device and subsequently make a further extension using microsissor. Hydrodissection performed by utilizing a viscoelastic with low viscosity can push nucleus to A/C, if a small nucleous. Capsular bag tearing and vitreous loss happen mostly at this stage. During aspiration of cortical material the wrinkling and tearing of capsular bag may often occur in zonular weakness. To prevent this complication, we recommend removing the cortical material by forcing out the viscoelastic and then aspirating by cannula. Mass removal must begin from the area of preserved zonula moving slowly to the zone of defect.

Additionally, we can perform zonuloplasty in one quadrant in zonal defect or 2-4 quadrants in the cases like Marfan syndrome.

**Evaluation of the idea**

We suggest this surgical technique, as a proposal, for strengthening the capsular bag in patients with zonular weakness and a high risk for IOL dislocation, undergoing cataract surgery. Further investigations, experimental studies on animals and humans, and clinical trials are encouraged to enhance the advancement of this proposed technique to a practical surgical treatment for zonular weakness.

**Conclusion**

Zonuloplasty is an innovative surgical procedure in the cases with zonular instability more than 1/4 quadrant when other treatments are ineffective. Methods like Capsular Tension Ring (CTR) implantation can be used in zonular weakness, less than one quadrant, but our proposed technique is applicable in more than one quadrant weakness. Our suggested technique is a novel surgical treatment for zonular weakness in patients undergoing cataract surgery and compared to the current methods, it is less time-consuming and relatively simpler.
**Figure 1.** The steps of the procedures of zonuloplasty in patients with zonular weakness undergoing cataract surgery

**Figure 2.** An “iris clip”
Available at: http://www.charviinternational.com/img/umbcordclampreg.jpg

**References**