SURGICAL MANEUVERS

Asymmetrical base intracorneal ring segment can be used for keratoconus treatment

The device is used to customize treatment for each unique keratoconic cornea.

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Keratoconus is a noninflammatory, progressive, bilateral ectatic corneal disease with corneal stromal thinning that results in weakening and surface distortion of the cornea. The onset of this disease process is often between the ages of 10 and 25 years. Blurred vision is usually secondary to irregular astigmatism, myopia and corneal scarring. The ectatic cornea often takes the shape of a cone. Risk factors for keratoconus include a family history of keratoconus, excessive eye rubbing, atopic disorder, obstructive sleep apnea, connective tissue afflictions such as Marfan syndrome, osteogenesis imperfecta, Ehlers-Danlos syndrome, and other conditions such as Down syndrome, floppy eyelid syndrome, aniridia, Leber's congenital amaurosis and retinopathy of prematurity.

While keratoconus is initially corrected with glasses, contact lenses provide better quality of vision and visual correction. Advanced keratoconus with extensive, irregular astigmatism can make contact lens fitting challenging even for an experienced practitioner. Corneal transplant surgery, either partial thickness as in lamellar keratoplasty or full-thickness penetrating keratoplasty, becomes a therapeutic necessity to consider in an attempt to visually rehabilitate the distorted cornea, especially when contact lenses are inadequate or no longer tolerated, or a visually significant corneal scar is evident. Other therapeutic modalities such as corneal cross-linking stiffens the cornea and inhibits progressive corneal thinning in keratoconus. Use of intracorneal ring segments can assist in reshaping the cornea, allowing refitting of the cornea with a contact lens and hence delaying or even preventing the need for surgical intervention such as corneal transplantation.

In this column, Drs. Gordillo, Grandin and Lotfi describe their use of asymmetrical base intracorneal ring segment in the treatment of keratoconus.

Thomas “TJ” John, MD
OSN Surgical Maneuvers Editor

The treatment of irregular astigmatism is a constant and dynamic challenge for the corneal surgeon. To enhance visual acuity and quality, it is necessary to achieve a regular corneal surface. Classification of keratoconus is the first step to disease treatment because severity, grade and stage at the moment of surgery have everything to do with the decisions and final results. Rabinowitz classified keratoconus according to the morphology of the cone and the pattern of corneal topography. Amsler described the classification for different stages using a Placido disc; as a conclusion, he described the keratoconus, classifying it in association with slit lamp evaluation outcomes and Placido ring analysis. Belin and colleagues proposed a keratoconus staging that incorporates anterior and posterior curvature, thinnest pachymetric values and distance visual acuity, and it consists of five stages that describe an ABCD classification system and conveys both anatomical and functional data. Fernández-Vega also proposed a classification using pachymetry maps, the thinnest point of the cornea location and the distance from the center of the pupil. This measurement was used to classify the keratoconus as central, paracentral or pericentral.

Considering the paracentral type, we propose the surgical technique of intracorneal ring segments (ICRS) with asymmetric base implantation, as it is a minimally invasive and reversible surgical procedure that improves visual acuity by reshaping the cornea and also acting by an “arc-shortening effect” on the corneal lamellae and flattening the central cornea, as described by Alfonso and colleagues. The inferiorly placed ICRS pushes the protrusion area of the cornea from the inferotemporal quadrant toward a more central cornea. The changes in corneal structure induced by ICRS are mainly the result of the segment implanted in the flatter meridian. As previously suggested, this type of ICRS implantation in keratoconus that meets the morphological characteristics of the sample under study is a stable procedure. Considering this concept, we are able to describe the new asymmetric base ICRS as a necessity to personalize keratoconus treatment.

Patient selection

This asymmetric base ICRS was designed for the treatment of keratoconus in the corneas of patients with a diagnosis of the previously described phenotype identified as “duck”. For the correct selection of appropriate patients, it is important to consider the topographic parameters of the cornea. Inclusion criteria were a diagnosis of keratoconus, disabling visual acuity in association with a decentered ectatic area of the cornea, pachymetry greater than 400 μm in the proposed zone for the ICRS

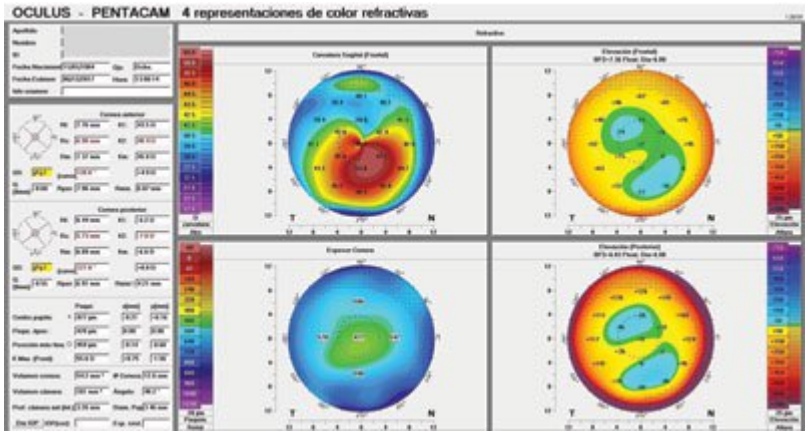

Figure 1. Right eye corneal topography (Pentacam, Oculus) showing paracentral inferior decentered ectatic area in a preoperative case.

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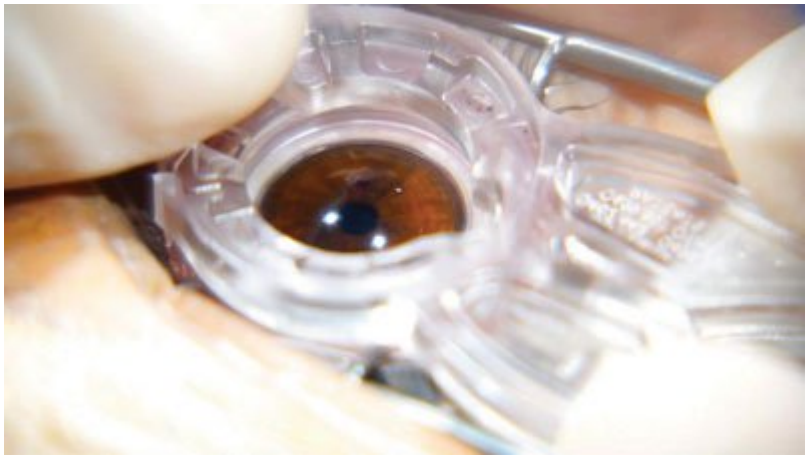

Figure 2. After speculum is inserted, a disposable suction ring is placed.

Figure 3. Femtosecond laser applanation cone is set.

implantation, ectatic area identified as paracentral and inferior (Figure 1, page 5), with a mild sphere defect and mild to moderate cylinder defect. Exclusion criteria for this procedure included patients with pachymetry less than 400 µm in the zone of ICRS implantation, post hydrops, corneal scarring, glaucoma, retinal diseases, severe atopic disease, local active infection, severe dry eye, autoimmune disease or immunodeficiency syndrome, recurrent corneal erosion syndrome, corneal dystrophy, history of herpetic keratitis and/or central corneal opacities.

Preoperative evaluations

Complete ophthalmological examination was performed and included documentation of ocular laterality (right or left), uncorrected distance visual acuity, corrected distance visual acuity, manifest refraction, slit lamp examination, IOP measurement with applanation tonometer, endothelial cell count evaluation and fundus examination. These examinations were performed to identify the topographic pattern, keratometric values, mean keratometry and, if

possible, asphericity. Ultrasonic pachymetry to detect thinner corneal point, apex corneal thickness, upper pachymetry and inferior within the central 6 mm of the cornea was also performed.

Intracorneal ring segment

The cornea department of Zaldivar Institute designed this novel ICRS, called the Intraseg (Gamma Vision). The asymmetric base is made of PMMA, as are all ICRS devices already commercially available. The Intraseg has an arc of 6 mm and an asymmetric-based diameter from 150 µm to 250 µm with 25 µm steps.

Surgical technique

The procedure can be performed using topical anesthesia. Topical proparacaine 0.5% is used, followed by pilocarpine drops. Ultrasonic pachymetry must be measured, and the cornea should be marked in the center with the pupil as a reference.

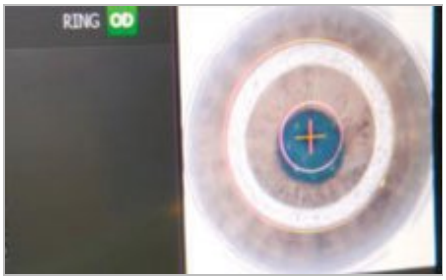

Figure 4. The tunnel is created by femtosecond laser.

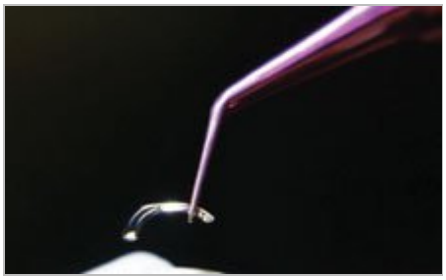

Figure 5. The asymmetric base PMMA intracorneal ring held by forceps.

Figures 6 and 7. Intracorneal ring implantation with the axis of the incision in the steepest axis of topography.

This procedure utilizes the IntraLase FS (Johnson & Johnson Vision) for tunnel and incision creation. The laser settings should be personalized, depending on white-to-white distance, corneal thickness and selected segment; for that, the automatic software designed by the cornea department of Zaldivar Institute is utilized to give the surgeon specific calculation for the tunnel creation. The depth of the tunnel must be set at 80% of the value of the thinnest pachymetry reading in the implantation zone. The tunnel settings for the ICRS with a base diameter of 200 µm or more must be 8 mm for the outer tunnel diameter and 5.8 mm for the inner tunnel diameter. The last parameter to consider is the axis position, which should be placed depending on the corneal topography, as the ICRS must be implanted with the axis of the incision in the steepest axis of topography, so that the flattening effect will be at the ectatic area. Once the parameters are set in the IntraLase and the speculum is

inserted, a disposable suction ring is placed and laser applanation cone is set (Figures 2 and 3). The tunnel is then created by the IntraLase (Figure 4) followed by the incision. The Intraseg is held by forceps and implanted (Figures 5 to 7), and the ICRS is rotated from at least 2 mm from the entrance incision using a Sinskey hook, holding the segment through the holes in the extreme. The base of the ICRS will be coincident with the area of major ectasia.

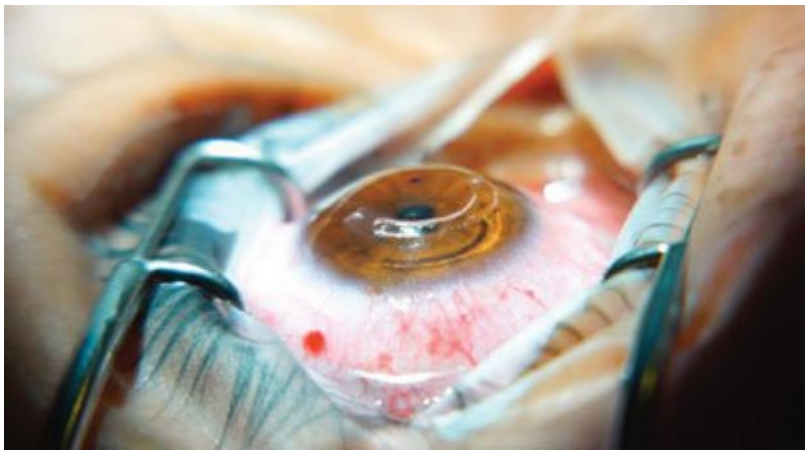

Figure 8. Intraoperative image after asymmetric ICRS implantation.

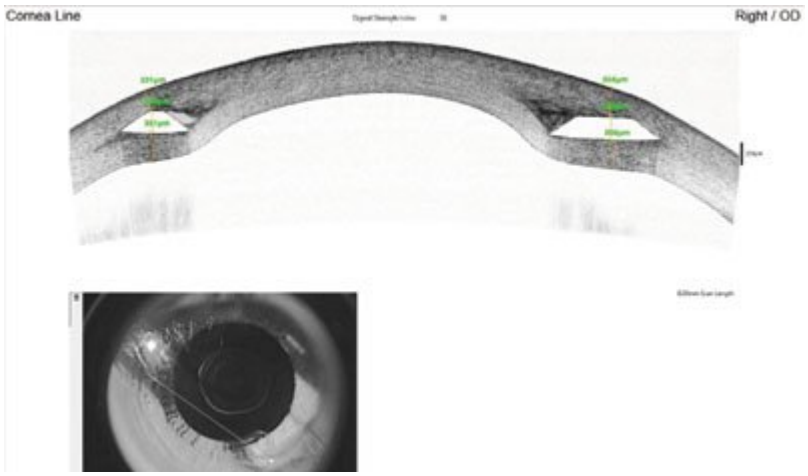

Figure 9. Asymmetrical base ICRS is shown with OCT.

Postoperative control

Immediate postoperative evaluation using the slit lamp can show the changes in the corneal shape. It is recommended that a corneal OCT be obtained 24 hours after surgery to confirm the ICRS depth of implantation. Postoperative evaluation should focus on the inner tunnel, the depth of the ICRS and the presence of any possible complications (Figures 8 to 10).

Postoperative medications include a combination of antibiotic and dexamethasone eye drops every 4 hours for 2 weeks and eye drops as needed. Follow-up examination is recommended at 30 days and 3, 6 and 12 months postoperatively, with a corresponding topography evaluation at each follow-up (Figure 11).

Conclusions

The ICRS was designed based on the need to customize the treatment of each unique keratoconic cornea, with optimization of corneal topography as the main objective. Both refractive and topographical changes can be observed after treatment with asymmetric base ICRS, with reductions in cylinder and substantial improvements in corneal surface regularity. The identification of the corneal keratoconic type and

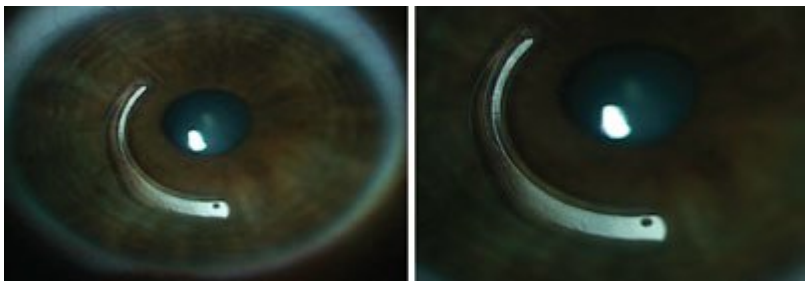

Figure 10. Postoperative slit lamp evaluation.

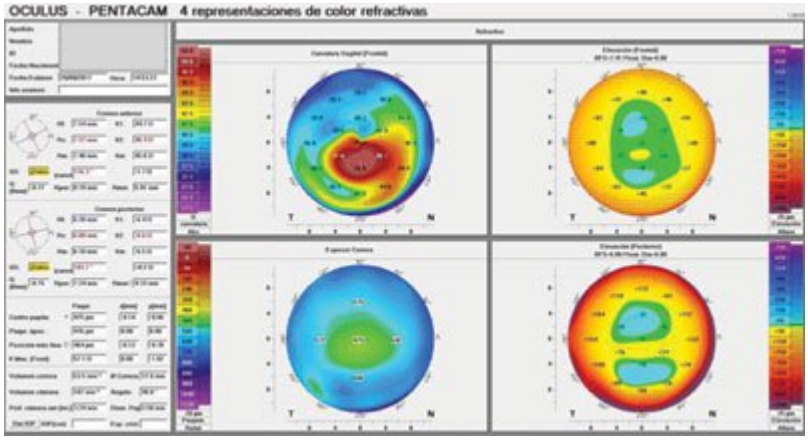

Figure 11. Postoperative topographic image.

classification is mandatory, and a topographic image is required to identify the pattern for achieving the correct selection of ICRS as well as the number and position for each ectatic cornea. Implantation of the asymmetrical base ICRS is an option, allowing a customized treatment for keratoconus that is safe and reproducible.

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