Contact Lens Fitting for Keratoconic Patient with Intrastromal Corneal Ring Segments (Intacs)

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Abstract

A 25-year-old Hispanic male with keratoconus complained of inadequate vision improvement after Intacs surgery. Treatment with rigid gas permeable contact lenses improved his vision, but also resulted in corneal epithelial erosion over the segments. Intacs can improve vision in patients with mild to moderate keratoconus, but visual outcome is often not functional for patients with moderate to severe keratoconus. Rigid gas permeable fitting can be more challenging after Intacs surgery, but a piggyback system can be considered as an alternative fitting method.

I. Case History

The patient G.U. is a 25-year-old Hispanic male who presented for a routine eye exam with a chief complaint of blurry vision in both eyes. He has keratoconus in both eyes diagnosed approximately five years ago and had undergone Intacs surgery approximately three years ago. Surgery resulted in mild vision improvement in his right eye and minimal to no noticeable improvement in the left. Aside from keratoconus, the patient was healthy and was not taking any medication.

II. Pertinent Findings

G.U. did not wear any spectacles. Uncorrected visual acuity was 20/40 in the right eye and 20/80 in the left. Best spectacle corrected visual acuity was 20/25- in the right eye and 20/50- in the left with the following refractive findings:
However, G.U. desired to see better and more symmetrically between the two eyes. He was a law student and his daily activity was composed of heavy and prolonged reading tasks.

Anterior segment examination revealed mild inferior corneal thinning in the right eye and moderate-severe inferior temporal thinning in the left. He had a Flesicher ring at the base of the cone in the left eye with absence of Vogt striae, corneal scarring, hydrops and Munson sign. Two vertical symmetric arc-shaped clear ring segments were implanted at the peri-pupillary nasal and temporal cornea in the right eye (Figure 1), and only one vertical ring segment was implanted at the temporal cornea in the left eye (Figure 2).

Keratometry revealed egg-shaped mires with grade two distortion in the right eye and grade three distortion in the left eye. Retinoscopy showed irregular corneal reflex and confirmed the location of the inferior temporally displaced apex in the left eye.

Preoperative findings could not be obtained, but G.U. reported that he was diagnosed with more severe keratoconus in his left eye compared to his right eye. Keratometric readings from post-operative topography was 42.75/098 and 39.12/008 with asymmetric bow-tie corneal steepening along the vertical meridian in the right eye, and 49.62/066 and 42.12/156 with inferior temporal corneal steepening in the left (Figure 3).

Orbscan revealed corneal ectasia in both eyes with an apex of approximately 480 µm in the right eye and 380 µm in the left eye (Figure 4 and 5).

The other anterior segment findings, intraocular pressure, and dilated fundus evaluation were unremarkable in both eyes.

**III. Diagnosis and Discussion**

G.U. has mild keratoconus in his right eye and moderate-severe keratoconus in the left eye. However, the keratometric readings from the post-operative topography and Orbscan may be underestimated when compared to the patient's pre-operative readings. Intacs were implanted to flatten the localized corneal steepening and correct for keratoconus in both eyes.

Keratoconus is a non-inflammatory ocular condition that typically begins in adolescence. It can lead to progressive decreased vision and corneal ectasia bilaterally, although the severity of the condition is often asymmetric between the two eyes. Approximately 0.15% to 0.6% of the general population has keratoconus.1,2, 3

Intacs or Intrastromal Corneal Ring Segments (ICRS) were originally manufactured by KeraVision. In 1999, Intacs received FDA approval for myopia treatment ranging from -1.00 to -3.00 diopters.3,4,5 However, patients who had undergone Intacs surgery had longer recovery time and less precise visual outcome compared to subtraction procedures, such as laser-assisted in situ keratomileusis (LASIK). Therefore, Intacs were not commonly performed.3,4 In 2004, Addition Technology received FDA approval for treating keratoconus with Intacs.3,4
These arc-shaped 150 degrees corneal ring segments are made up of polymethylmethacrylate (PMMA). They come in different ring thicknesses: 0.25, 0.275, 0.3, 0.325, 0.35, 0.4 and 0.45 mm with the thickest ring designed to correct up to three to four diopters of myopia as shown in several research papers.\textsuperscript{6-10}

In addition to treating keratoconus, Intacs can be used to delay or eliminate the need for a corneal transplant for keratoconic patients who are contact lenses intolerant and desire better vision.\textsuperscript{11} According to the National Workshop on Corneal Blindness and Eye Banking, only 10\% of the required number of corneal grafts were procured in the United States.\textsuperscript{10} Therefore, Intacs can be used as an alternative treatment for keratoconic patients who are not able to obtain donor corneas.

Intacs are FDA approved for patients 21 years old or older, who cannot achieve functional vision with contact lenses or spectacles. These patients need to have a clear central cornea and a corneal thickness $\geq 450$ µm.\textsuperscript{3,4} Implanting Intacs in thin corneas can increase the risk of corneal ulceration and ring perforation. The intrastromal ring segments are implanted at 70\% of the corneal thickness to prevent corneal melting and segment perforation. When the corneal ring segments are implanted at a depth greater than 50\% of total corneal thickness, corneal collagen is still capable of diffusing glucose from the aqueous, thus reducing the risk of corneal melting or ulceration.\textsuperscript{9} Progressive eye conditions, herpetic keratitis, autoimmune or connective tissue diseases, and/or a corneal curvature greater than 53 diopters are contraindications for Intacs surgery.\textsuperscript{7}

Several studies have shown that Intacs used for keratoconus treatment resulted in good visual outcome. Uncorrected visual acuity was found to improve zero to three lines, best corrected visual acuity was found to improve one to eight lines, corneal curvature was found to reduce 1.5 to 4.5 diopters.\textsuperscript{6,7} These changes were also found to be stable according to the one and five year follow-up studies.\textsuperscript{8,12}

Intacs can be implanted into the cornea either vertically or horizontally. A study by Alió, et al. suggested that if the keratoconic corneal steepening did not cross the 180 meridian by more than 1 mm, then it was equally effective to place only one inferior segment horizontally versus two asymmetric ones placed at the superior and inferior cornea.\textsuperscript{13} Patients with keratoconus often have inferior corneal steepening. Thus, a thicker ring segment is frequently implanted inferiorly to flatten that part of the cornea. For G.U., he has a more localized temporally displaced apex in the left eye, which corresponds with the temporally placed vertical segment (Figure 6). However, a temporally displaced cone is a very rare condition in keratoconus. The majority of patients with keratoconus have asymmetric bow-tie (47\%), inferior, inferior temporal or inferior nasal corneal steepening.\textsuperscript{14}

Intacs were initially promoted as a reversible procedure. After explantation or removal of the ring segments, the refractive endpoint often would return to where it was pre-operatively.\textsuperscript{15,16} Unlike many subtraction procedures, such as LASIK, the corneal tissue is not removed from the central cornea to produce the desired visual outcome. These ring segments are implanted within the stroma away from the visual axis with an outer diameter of approximately 8.1 mm and an inner diameter of approximately 6.9 mm.\textsuperscript{9} Therefore, the cornea remains prolate in shape after the Intacs surgery and is not subjected to increased spherical aberration as some patients experience post-refractive surgery.\textsuperscript{3,4} However, Intacs have a small magnitude of correction with a limit of correcting up to three to four diopters. The cornea also becomes irregular after Intacs...
insertion, especially in areas above the corneal ring segments. This induced corneal irregularity can make the contact lens fitting more difficult.\textsuperscript{17-21}

Complications from the Intacs surgery include anterior chamber perforation during the procedure, implant extrusion or decentration, ocular infection, corneal neovascularization and stromal deposits along ring segments.\textsuperscript{3,4} Corneal neovascularization puts patients at a higher risk of having a graft failure when they undergo corneal transplant.\textsuperscript{22} Although most patients develop stromal deposits along the segments, these deposits are not visually significant since the segments are implanted away from the visual axis. These deposits are made up of intracellular lipid accumulations and collagen, which are synthesized in response to the corneal injury secondary to the segment implant.\textsuperscript{12} After Intacs explantation, these deposits remain at the stroma.\textsuperscript{15,16}

The majority of patients with mild to moderate keratoconus do not develop ocular complications from Intacs surgery.\textsuperscript{6-8,12} Patients with moderate to severe keratoconus, as defined by a corneal curvature greater than 55 diopters, have a 40\% complication rate from anterior chamber perforation, bacterial keratitis, ring perforation and/or decentration.\textsuperscript{13}

\textbf{IV. Treatment and Management}

Some of the treatment options for addressing our patient’s chief complaint of blurry vision included glasses, Intacs explantation and contact lenses. Spectacles improved G.U.’s visual acuity, but he desired to see more symmetrically between the two eyes. Intacs can be removed, but G.U. reported that his surgeon had recommended against the explantation procedure. Indications for Intacs explantation include poor visual outcome and visual disturbance, such as seeing glare and halos, after the surgery.\textsuperscript{11} Ocular complications, such as bacterial keratitis, neovascularization, anterior chamber perforation, segment decentration or extrusion, are also good indications for Intacs removal.\textsuperscript{11}

Two separate studies by Asbell and Chan showed good refractive reversibility after Intacs removal in myopic patients.\textsuperscript{15,23} Asbell and Ucakhan found that 86\% of patients had uncorrected visual acuity and best corrected visual acuity returning to ± 0.50 D of the original refractive error, and 91\% of the patients had uncorrected visual acuity and best corrected visual acuity returning to ± 1.00 D of original refractive error in three months.\textsuperscript{23} Chan and Khan found that 100\% of the patients had uncorrected visual acuity and best corrected visual acuity returning to ± 0.25 D of original refractive error in four weeks.\textsuperscript{15} However, these studies were done in healthy myopic patients. Visual outcome after Intacs removal is likely to be more unpredictable for patients with keratoconus due to impaired corneal integrity. After Intacs explantation, corneal haze, stromal deposits along the segments and channels created for segment insertion all remain. As a result, Intacs surgery is not a completely reversible procedure from an anatomical point of view.\textsuperscript{11,15,23}

G.U. was fitted with keratoconic rigid gas permeable contact lenses to improve his visual acuity. Parameters are listed in Table 1.

Contact lenses were ordered with Boston XO materials to increase oxygen permeability, plus lenticulation to reduce edge thickness and overall mass, and heavy blend to enhance tear film exchange. G.U. was able to see 20/25- in the right and left eyes with these lenses. However, due to the constant rubbing of the rigid gas permeable contact lenses against the irregular corneal surface above the segments, the corneal epithelium eroded in both eyes after contact lenses fitting (\textbf{Figure 7 and 8}). G.U. was treated with
tobramycin ophthalmic eye drops 1gtt qid for 4 days. The corneal epithelial defects resolved with treatment.

The next step would be to fit G.U. with a piggyback system. The soft contact lens would act as a cushion to avoid mechanical trauma from the rigid gas permeable. Corneal irregularity, central and peripheral superficial punctuate keratitis are often reduced with a piggyback system. Patients often have increased comfort and wearing time while maintaining visual acuity. However, these patients can develop some of the following complications: giant papillary conjunctivitis, corneal hypoxia and edema. Enzyme cleaner or one-day disposable soft contact lenses can be prescribed to resolve papillae. Choosing high Dk hard and soft contact lenses can minimize corneal hypoxia and edema. The soft lenses more prone to wear and tear due to the constant movement of rigid gas permeable above the soft lenses. Lastly, the use of two lens modalities can be inconvenient and costly for patients to maintain.

V. Conclusions

Several papers had suggested good visual outcome with Intacs for treating patients with mild to moderate keratoconus. However, Intacs do not stop the progression of keratoconus. For patients with moderate to severe keratoconus, Intacs also resulted similar vision improvement, but these patients often did not appreciate a change in functional vision and the complication rate from the Intacs surgery was much higher. Before considering Intacs as a treatment for keratoconus, it is important to differentiate patients who are truly contact lenses intolerant from patients who have been fitted improperly due to incorrectly chosen contact lenses parameters. For patients who had received Intacs surgery for keratoconus correction, the contact lens fitting process can become more challenging due to the increased incidence of corneal epithelial erosion over the ring segments and the need for a piggyback system.

VI. Acknowledgements

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VII. References and Resources


VIII. Addendum

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Table 1. Keratoconic rigid gas permeable parameters
Figure 1. Vertical intrastormal corneal ring segments implanted at the nasal and temporal cornea in the right eye

Figure 2. Vertical intrastromal corneal ring segment implanted at the temporal cornea in the left eye
Figure 3. Topography shows asymmetric bow-tie corneal steepening in the right eye and inferior temporal corneal steepening in the left eye.
Figure 4. Asymmetric bow-tie corneal steepening and mild-moderate inferior-central ectasia in the right eye as illustrated by the Orbscan
Figure 5. Inferior temporal corneal steepening and moderate-severe ectasia in the left eye as illustrated by the Orbscan.

Figure 6. Temporally placed Intacs for correction of a temporally displaced cone in the patient’s left eye.
Figure 7. Corneal epithelium erosion in the right eye s/p RGP fitting

Figure 8. Corneal epithelium erosion in the left eye s/p RGP fitting
CE Questions:
1. Before using Intacs to treat keratoconus, what were they used to correct?
   a. Myopia
   b. Hyperopia
   c. Presbyopia
   d. Fuch’s dystrophy

2. For patient with Intacs, it is better to go with a ______ diameter RGP.
   a. Larger
   b. Smaller

3. Intacs is completely reversible from an anatomical point of view.
   a. True
   b. False

4. Prescription often returns to the baseline after Intacs removal.
   a. True
   b. False

5. Intacs can slow down the progression of keratoconus and myopia.
   a. True
   b. False

6. What are some common signs of keratoconus?
   a. Flesicher ring at the base of the cone
   b. Vogt striae
   c. Corneal scarring
   d. Hydrops
   e. All of the above.

7. 0.45 mm thickness Intacs can correct up to ____ diopters of myopia.
   a. 5
   b. 2
   c. 3
   d. 4

8. Piggyback can be considered to avoid mechanical rubbing between the RGP and Intacs.
   a. True
   b. False

9. Intacs can be considered to eliminate or delay the need for ______ for patients with keratoconus.
   a. Hydrops treatment
   b. Glasses
   c. Corneal transplant

10. Complications from the Intacs surgery include ____________.
    a. Anterior chamber perforation during the procedure
    b. Implant extrusion or decentration
    c. Ocular infection
    d. Corneal neovascularization
    e. All of the above
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