Intacs Followed by MyoRing Implantation in Severe Keratoconus

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ABSTRACT

PURPOSE: To describe the outcome of complete intrastromal ring (MyoRing, DIOPTEX GmBH, Linz, Austria) implantation following intrastromal corneal ring segment (Intacs, Addition Technology, Inc., Sunnyvale, CA) implantation for severe keratoconus.

METHODS: Case report.

RESULTS: A MyoRing was implanted in a keratoconic patient who had undergone a previous Intacs implantation surgery 4 years previously without Intacs explantation and had residual refractive error. There were no intraoperative or postoperative complications. After 1 year; mean keratometric power decreased from 50.3 to 43.6 diopters, uncorrected distance visual acuity improved from 20/400 to 20/50, and corrected distance visual acuity improved from 20/200 to 20/30.

CONCLUSIONS: In selected severe keratoconus cases with high myopia and steep keratometry previously treated with Intacs implantation, if significant residual refractive error is observed, secondary implantation of MyoRing over Intacs may improve vision and refraction.

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Keratoconus is an uncommon disease affecting the young population. Intrastromal corneal rings have proved to be a safe and effective treatment choice for keratoconus.[1-5] The MyoRing (DIOPTEX GmbH, Linz, Austria), a flexible full-ring implant designed to be inserted into a corneal pocket, has been shown to be safe and effective in high myopia and advanced keratoconus.[4,5] To our knowledge, there is only one previous report of refining the results of previously implanted intrastromal ring with implantation of another ring.[6] We report secondary implantation of the MyoRing in a keratoconic eye with a previous history of Intacs implantation (Addition Technology, Inc., Sunnyvale, CA).

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CASE REPORT

A 31-year-old keratoconic man with a history of Intacs implantation 4 years previously in his right eye was referred to our clinic. Central corneal thickness was 406 microns. There were two Intacs segments placed in the inferonasal and supranasal positions (**Figures 1A** and **1B**). The patient had mild keratoconus in his left eye. He was contact lens intolerant and was unable to use glasses due to anisometropia.

Intacs ring segments have an internal diameter of 6.77 mm and an external diameter of 8.10 mm. Reports indicate that the range of its myopia correction is between -1.00 and -4.10 diopters (D).[2] Due to residual high keratometry and myopia, we planned to correct his refractive error with a secondary complete intrastromal ring. We did not explant segments because removing segments might cause significant trauma to the cornea and it could be done at any time after MyoRing implantation.

A 5-mm long arcuate keratotomy was performed temporally using a diamond knife at a 9-mm optical zone, followed by creating an intrastromal pocket with a diameter of 6 mm using crescent knife and Melles instruments. The depth of the pocket was set for 300 microns. We placed the arcuate keratotomy inferotemporally (the center of the keratotomy was placed at 195 degrees, between the two Intacs segments). After creation of the pocket, the MyoRing was introduced into the corneal pocket through the tunnel (**Figures 1B** and **1C**). According to the Daxer nomogram,[3] a ring diameter of 5 mm and a thickness of 280 microns were selected.

Total aberrometric analysis with the iTrace (Tracey Technologies, Houston, TX), pachymetery (SP3000; Tomey, Nagoya, Japan), anterior segment OCT (Carl Zeiss Meditec, Jena, Germany), ocular response analysis (ORA; Reichert Technologies, Depew, NY), and Pentacam imaging (Oculus Optikgeräte GmbH, Wetzlar, Germany) were performed at all visits preoperatively and postoperatively. Preoperative and postoperative patient data are shown in **Table 1**. Both corneal hysteresis and corneal resistance factor increased after MyoRing implantation. After 1 month, the patient became glasses tolerant due to reduced anisometropia (**Figure 1D**).

DISCUSSION

Numerous reports have confirmed Intacs implantation as a safe and effective treatment in keratoconus.[2] Alio et al.[7] reported that Intacs insertion provides good outcomes in keratoconic eyes with mean keratometric

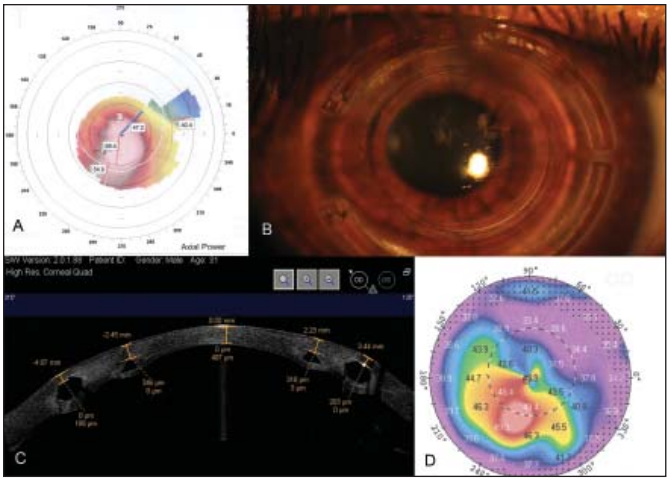

Figure 1. (A) Preoperative topographic map of the right eye of the patient with only a pair of Intacs segments (Addition Technology, Inc., Sunnyvale, CA). (B) A 6-month postoperative photograph of the right eye of the patient with both Intacs and MyoRing (DIOPTEX GmBH, Linz, Austria) implanted. (C) 6-month postoperative anterior segment optical coherence tomography of the right eye of the patient with both Intacs and MyoRing implanted. (D) 6-month postoperative topographic map of the right eye of the patient with both Intacs and MyoRing implanted.

TABLE 1
Preoperative and Postoperative Variables

Variable	Preop	1 Month Postop	6 Months Postop	1 Year Postop
UDVA	20/400	20/100	20/50	20/50
CDVA	20/200	20/40	20/30	20/30
Km (D)	50.3	43.8	43.3	43.6
Sphere (D)	-8.00	-1.00	-1.00	-0.75
Cylinder (D)	-6.5	-2.5	-2.25	-2.25
HOA	4.6	5.1	4.7	4.3
Coma	4.1	4.1	3.4	3.5
Spherical aberration	-0.7	+1.2	+1.1	+1.1
CH	8.3	9.5	8.5	8
CRF	7	8.5	8.3	7.5
CCT	412	428	425	427

preop = preoperative; postop = postoperative; UDVA = uncorrected distance visual acuity; CDVA = corrected distance visual acuity; Km = mean keratometric power; D = diopters; HOA = higher-order aberration; CH = corneal hysteresis; CRF = corneal resistance factor; CCT = central corneal thickness

power of less than 53.0 D and poor outcomes in eyes with mean kerometric power greater than 55.0 D. There is only one study supporting the use of Intacs insertion in corneas steeper than 57 D.[8] Coskunseven et al.[6] reported favorable visual and refractive results in three keratoconic patients with Intacs segments in place after implantation of adjuvant single intrastromal corneal ring segment (KeraRing).

The degree of residual myopia (6 D) and post-Intacs keratometry (maximum 53 D) indicates that our patient was not a good candidate for Intacs implantation in the first place or at least the procedure was not aimed to induce emmetropia. If the Intacs segments were implanted precisely concentric, the inner diameter would be 6.77 mm, so the inner rim would have a distance of 3.38 mm from the corneal center. The MyoRing had an outer diameter of 5 mm (inner diameter of 4 mm and a thickness of 0.5 mm ring thickness), leaving a 0.88 mm distance between its outer edge and the inner edge of the Intacs segment. Risk of damaging previous Intacs segments forced us to place the tunnel deeper at the temporal side between the two temporal ends of the Intacs segments, and made it impossible to use a Pocket Maker microkeratome (DIOPTEX, GmBH) as proposed by Daxer et al.[3] to create an intracorneal pocket. We placed the incision on the steep axis aiming for astigmatism correcting effect.

Previous studies reported keratometric power reduction of 5.76 to 8 D and a reduction of 5.2 to 6 D and 1 to 2.2 D in spherical and cylindrical power, respectively, after MyoRing implantation in keratoconus.[3,4] In our case, the spherical equivalent decreased approximately 9 D and the mean spherical component of refractive error decreased approximately 7 D, which is comparable to previous reports of MyoRing implantation. The MyoRing size of 5/280 (Diameter_mm/Thickness_Microns) was selected according to the nomogram proposed by Daxer et al.[3] Although the nomogram is proposed for use only in virgin corneas and not corneas with previously implanted rings, we had acceptable refractive results. This may indicate that the previously implanted ring segments have no effects after MyoRing is implanted central to their location. The only way to clarify the effect of the previously implanted Intacs segments is to reevaluate the patient after removal of the Intacs segments. Because our patient was satisfied with the results and removing segments might have caused significant trauma to the cornea and we could do it at any time after MyoRing implantation, the previous segments were left in place.

Refraction remained stable during the 1-year follow-up period, but both corrected and uncorrected visual acuity improved during the 1 to 3 months of postoperative visits, which can be justified by reduction in higher-order aberrations and coma. A significant increase in spherical aberration was observed, probably due to the central flattening effect of the MyoRing. No progression of keratoconus was noted during the follow-up period. One reason may be the presence of MyoRing and Intacs segments, but because the patient

was 31 years old, the progression of the disease may have already halted.

We observed a 15-micron increase compared to preoperative values in central corneal thickness 1 year after surgery. This is consistent with previous reports of MyoRing implantation[5] and could be due to corneal tissue redistribution after surgery.

We conclude that in moderate to severe keratoconus, adjuvant MyoRing implantation may help to improve the results when the refractive error is highly myopic and if the previously implanted intrastromal segments were unable to correct the corneal shape.

AUTHOR CONTRIBUTIONS

Study concept and design (MJB, HH); data collection (HH, MK, ASR, MS); analysis and interpretation of data (MJB, HH, MK, ASR); drafting of the manuscript (MJB, HH, MK, ASR, MS); critical revision of the manuscript (MJB, HH, ASR); statistical expertise (HH, MK, MS); administrative, technical, or material support (MJB, HH, ASR); supervision (MJB, ASR)

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