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ORIGINAL ARTICLE

MyoRing for Central and Noncentral Keratoconus

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ABSTRACT

Purpose: To demonstrate treatment options for keratoconus using MyoRing intracorneal implant in central and noncentral cones.

Materials and methods: Five eyes with central and noncentral cones were compared in a retrospective study.

Results: In central cones the maximum of the flattening effect is in the corneal center while in noncentral cones the maximum of the flattening is in area of the cone.

Conclusion: No matter where the cone location is the implantation of MyoRing intracorneal implants always results in a regularization of the central cornea.

Keywords: Cornea, Intrastromal corneal rings, Keratoconus, MyoRings.

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INTRODUCTION

The implantation of intracorneal ring segments (ICRS) into circular intracorneal tunnels is established for low to moderate grades of myopia, keratoconus and post-LASEK keratectasia.[1-5] The technique has several limitations including complicated nomograms, difficulties to create a concentric tunnel configuration without femtosecond laser technology, the need of a radial incission, sutures and complications, such as extrusions resulting from the non-equilibrium state as a result of constant pressure of the implants against the surrounding tissue.[6,7] Early experiments with intracorneal continous rings (ICCR) in the 1980s were performed by Binder without acceptable clinical results.[8] The development of a new technology and a new surgical approach (corneal intrastromal implantation system – CISIS), consisting of a safe and very easy to use high precission microkeratome for the creation of corneal pockets (PocketMaker microkeratome, Dioptex GmbH, Austria) and a new kind of continous ring implant (MyoRing, Dioptex GmbH, Austria) having two a-priori conflicting features, such as rigidity and flexibility allows, however, a safe and effective treatment of myopia, keratoconus and post-LASIK keratectasia.[9-12] The PocketMaker microkeratome consists of an ultrathin micron-guided diamond blade with extremely high cutting precission which exceeds that of a femtosecond laser, in particular if the cutting is performed in the deep cornea (i.e. 300 microns and more). The PocketMaker surgeon has full visual and interventional control during the entire cutting procedure. Pockets for CISIS at 300 microns depth can, however, also be performed by Ziemer LDV femtosecond laser (Ziemer, Switzerland) as well as by IntraLase (AMO, USA).[12,13] It is still a discussion whether noncentral cones respond as well to MyoRing treatment as central cones. I shall present here a series of central and noncentral keratoconus cases treated by CISIS using the PocketMaker microkeratome and the MyoRing intracorneal implant.

MATERIALS AND METHODS

Five eyes suffering from keratoconus with central cones and five eyes suffering from keratoconus with noncentral cones were compared in a retrospective comparative study. Both groups consisted of advanced cases with preoperative central K-readings ranging from 58.4 diopters (D) to 68.8 D [mean 63.16 ± 4.6 D (SD)] in the central cone group and 55.75 to 65.8 D (60.44 ± 4.6 D) in the noncentral cone group. The difference in preoperative K was not statistically significant ($p = 0.38$) and the groups could, therefore, be considered roughly of equal grade. All five central cone cases were female but four of five noncentral cone cases were male. All 10 cases are central Europeans without any evidence of genetic predisposition or positive family history. Both groups have also comparable age structure.

The surgery was performed using the PocketMaker microkeratome (Dioptex, Austria) and the MyoRing intracorneal implant (Dioptex GmbH, Austria) to be implanted into the 9 mm diameter corneal pocket created by the PocketMaker at 300 microns depth. The nomogram for the selection of the right implant diameter and implant thickness depends only on the central average K-reading (Sim K of the central 3 mm zone). In contrast to the ICRS nomograms the CISIS nomogram is very simple and does neither consider cone type nor cone location or astigmatic axis, etc. The only important inclusion criteria is a corneal thickness at the thinnest point of more than 350 micons, if the pocket is created by the PockerMaker and more than 400 microns if the pocket is created by the femtosecond laser. The access to the pocket is self-sealing and does not require suturing.

RESULTS

The preoperative and postoperative data for the manifest refraction are shown in Table 1 and for the visual data in

Table 1: Preoperative and postoperative refractive data (sphere and cylinder)

		Sphere (D)	*Cylinder (D)*
Preoperative	Central cone	–7.37 ± 4.93	–6.50 ± 2.35
	Noncentral cone	–7.05 ± 6.75	–3.55 ± 1.30
Postoperative	Central cone	–1.87 ± 3.27	–1.75 ± 2.36
	Noncentral one	–0.60 ± 3.60	–2.25 ± 2.10

Table 2: Preoperative and postoperative visual acuity

		UDVA (logMAR)	*CDVA (logMAR)*
Preoperative	Central cone	1.72 ± 0.40	0.90 ± 0.58
	Noncentral cone	1.30 ± 0.64	0.49 ± 0.27
Postoperative	Central cone	0.37 ± 0.14	0.31 ± 0.19
	Noncentral one	0.45 ± 0.31	0.22 ± 0.18

Table 2. Each group shows statistically significant improvement between preoperative and postoperative data ($p < 0.05$). The mean improvement in central K-reading was 10.78 D in the central group and 9.74 D in the non-central group. The difference between the central and non-central group was not statistically significant ($p = 0.75$). Neither was the mean preoperative uncorrected distance visual acuity (UDVA) statistically significant ($p = 0.247$) for both groups (–1.722 ± 0.181 logMAR for the central group *vs* –1.3 ± 0.286 logMAR for the noncentral group) nor the improvement in UDVA; (13 lines in the central and 9 line in the noncentral group) ($p = 0.32$). Figures 1 and 2 show typical situations in the treatment of a central cone and a noncentral cone. In both, Figures 1 and 2, the left pattern shows the postoperative sagital map after MyoRing implantation, the pattern in the middle shows the preoperative sagital map and the right pattern shows the postoperative-preoperatve difference. As expected, the treatment of the central cone results in a significant concentric flattening around the optical axis (Fig. 1). In the noncentral cone treatment, however, the maximum of the flattening effect is in the inferior cone region where the cone is located (Fig. 2).

DISCUSSION

The data show that there is no significant difference in the results between MyoRing treatment of central and non-central cones. In the central cone the corrective power of the implant acts mainly concentric around the optical axis with a central flattening effect of 10 D (Fig. 1). The situation in noncentral cones is qualitatively different. In the case of Figure 2 (noncentral inferior cone), the flattening in the steep inferior cone area is more than 11 D and still 5 D in the

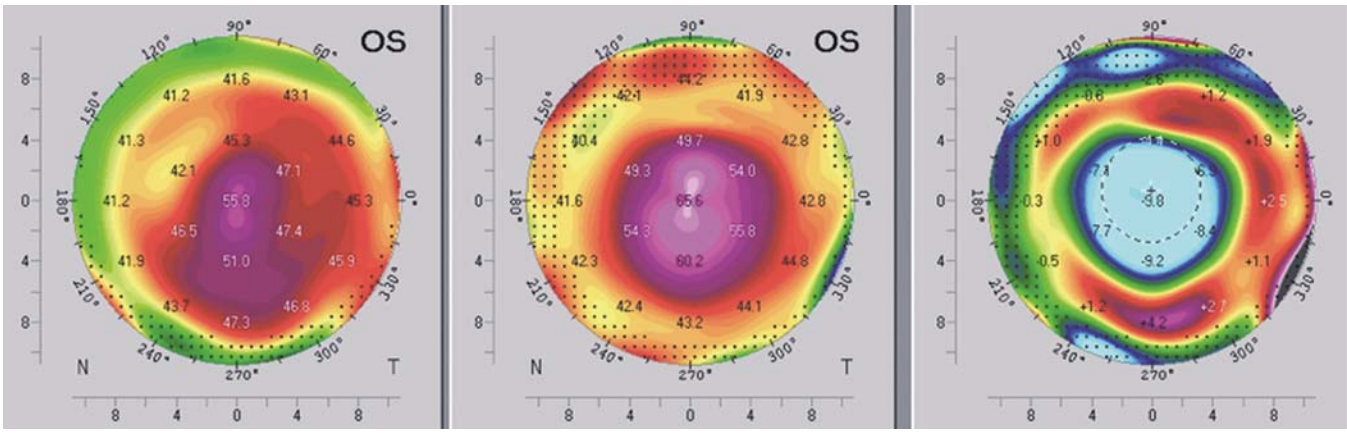

Fig. 1: The right image shows the difference between preoperative (middle) and postoperative (left) sagittal map of a central cone

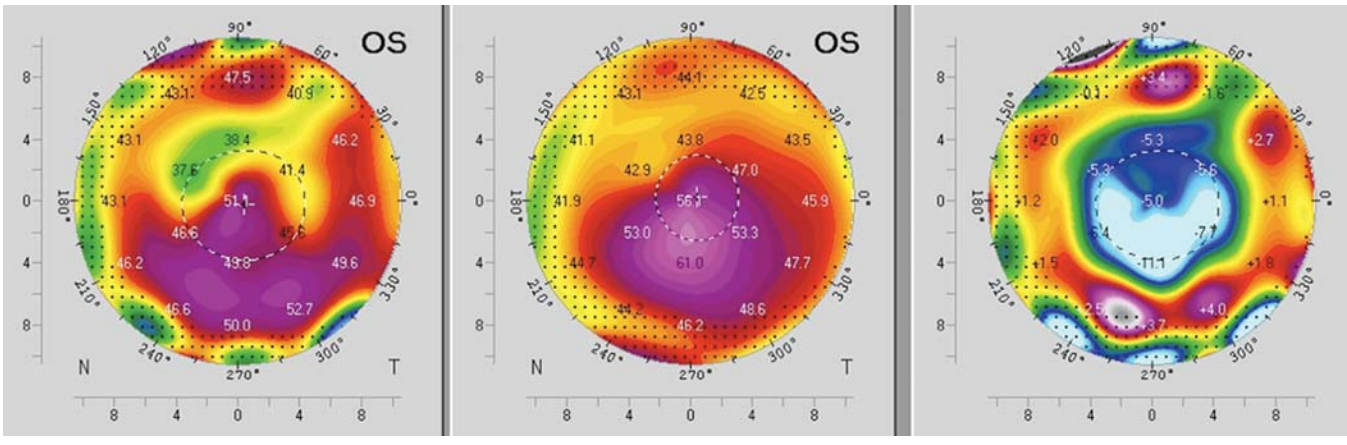

Fig. 2: The right image shows the difference between preoperative (middle) and postoperative (left) sagittal map of a noncentral cone

central, superior, nasal and temporal area. It seems, therefore, from the analysis of the preoperative *vs* postoperative patterns that the correction of irregularities in MyoRing therapy is done 'automatically' there where it is needed (Figs 1 and 2), i.e. where the cone is. This results in a regularization of the central cornea no matter where the cone is located. Considering the concept of keratoconus therapy using intracorneal segments it may seem surprising on a first view that treatment of keratoconus with the MyoRing is effective independent of the type and location of the cone. While in segment therapy the implant has to be choosen in numbers (one or two segments), segment arc length and implant positioning within the cornea according to the type and location of the cone; this is not required in MyoRing treatment. The MyoRing is a flexible but nevertheless rigid implant which on one hand allows implantation into a corneal pocket via a small entrance and on the other hand the stabilitation of the cornea in a new biomechanical equilibrium with a regularized central corneal shape. The concept of MyoRing treatment in comparison to that of segments is shown in Figure 3. The structure on the top schematically represents the irregular cornea in the preoperative state. While the therapy with segments roughly consider the individual irregularities and select the implant arc length, implant number and implant position according to the type and position of the irregularities; this is not neccessary in the case of MyoRing treatment. Since, the MyoRing is rigid enough to force the irregular cornea to the regular shape of the implant (Fig. 3) the result is always a very regular postoperative corneal surface, no matter how the preoperative irregularities looked like. In other words, the type and kind of cone in keratoconus treatment does not affect the therapeutic strategy and need not to be considered in the treatment.

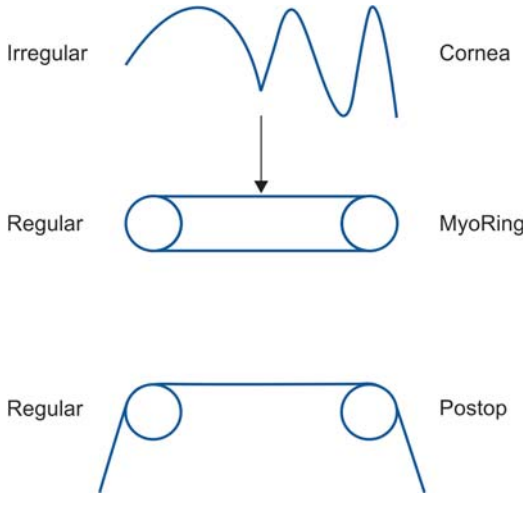

Fig. 3: Schematic drawing of the mechanism of action of the MyoRing. The irregular cornea (top) schematically represented by the irregular course of the line (top) is 'stretched' by the regular (circular) shaped MyoRing (middle) to a regular-shaped cornea (bottom)

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