APPLICATIONS OF INTRA CORNEAL RINGS IN OPHTHALMOLOGY

Essay

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CONTENTS

TOPIC	PAGE
LIST OF ABBREVIATIONS	I
LIST OF FIGURES	II
LIST OF TABLES	IV
INTRODUCTION AND AIM OF THE WORK	1
(1): HISTORY OF INTRA CORNEAL RINGS	5
(2):TYPES OF INTRA CORNEAL RINGS	8
(3): INDICATIONS OF INTRA CORNEAL RINGS	30
(4): SURGICAL PROCEDURES	58
(5):CONTRAINDICATIONS AND COMPLICATIONS OF	70
INTRA CORNEAL RINGS	
SUMMARY	77
REFERENCES	79
ARABIC SUMMARY	91

LIST OF ABBREVIATIONS

BCVA	Best corrected visual acuity
СН	Corneal hysteresis
CQ	Clinical Quality
CRF	Corneal resistance factor
CXL	Collagen crosslinking
D	Diopter
FDA	Food and Drug Administration
HDA	Humanitarian Device Approval
ICR	Intrastromal corneal ring
ICRS	Intrastroma corneal ring segments
INTACs	Intracorneal Ring Segments
IOLs	Intraocular lens
K	keratometry
LASIK	laser-assisted in situ keratomileusis
LKP	Lamellar Keratoplasty
ORA	Ocular Response Analyzer
PKP	Penetrating Keratoplasty
PMD	Pellucid marginal degeneration
PMMA	Polymethylmethacrylate
PRK	photorefractive keratectomy
RK	Refractive keratotomy
SE	Spherical equivalent
UCVA	Uncorrected visual acuity
UV	Ultraviolet
VCG	Vacuum Centering Guide

List of figures

NO	Figure	page
1	ICR flatten the central cornea.	10
2	ICRS	11
3	Current design 150- degree Intacs [®] segments	12
4	The two 150-degree ring segments	13
5	An implanted Intacs [®] .The cross-section is hexagonal	13
6	The polymethyl methacrylate segments come 2 per pack	14
7	Slit-lamp photograph shows implanted Intacs SK ® segments	17
8	Ferrara ® ring segments	20
9	The Ferrara ® ring segment thickness varies from 0.15 to 0.35 mm.	20
10	Drawing shows ferrara ® prism format	21
11	Photograph of an implanted 210° Ferrara rings ®	22
<i>12</i>	Keraring [®] system".	25
13	An implanted Keraring [®] .The cross-section is triangular.	26
14	The Keraring [®] triangular cross-sectional shape produces a prismatic effect.	26
15	The SI-6 Keraring [®] has a wide base, scalene triangular crosssection.	27
16	A- uniform corneal thickness produces uniform stress distribution.	33
17	The mires appear as narrow rings in the steep cornea	35
18	The 3 forms of keratoconus: nipple, oval and globus	36
19	The nipple-shaped form of keratoconus	36
20	oval-form keratoconus	37
21	Globus-Shaped Keratoconus	37
22	Pellucid marginal degeneration	48
23	(a) Pellucid marginal degeneration (b) topography shows severe astigmatism and diffuse steepening of the inferior cornea	49
<i>24</i>	Pellucid marginal corneal degeneration with implanted	<i>51</i>

	single 210-degree arc length KeraRings.	
25	central keratectasia with an anterior corneal steepening from the side.	53
26	Incision location and placement of Intacs [®] inserts for treating keratoconus.	60
27	The geometric centre of the cornea marked with an inked Sinskey hook.	61
28	The 1-mm radial incision is made with a diamond knife	<i>62</i>
29	Rotation of the dissectors create the tunnels in the peripheral cornea into which inserts will be placed.	63
<i>30</i>	The first segment is placed in the tunnel	<i>64</i>
31	Inserts in place	64
32	Single and double curved spatula	65
33	Channels for ICRS created by femtosecond laser	66
34	The surgeon used the FS laser to carve channels for implanting the Ferrara ® Ring	69
35	Sterile infiltration of the channel	<i>73</i>
36	Lamellar Infiltrates following INTACS	74
37	Microbial keratitis following intracorneal ring segment implantation	75

List of tables

<i>NO</i>	Table	page
1	Comparison of Several Intracorneal Segments.	28
2	Clinical trial Follow-Up of Intrastromal Corneal Ring in Management of Myopia	30
3	Intacs [®] thickness and its nominal correction	32
4	Colin nomogram for keratoconus, based on spherical Equivalent	41
5	Intacs [®] nomogram, based on the corneal topographic pattern of the inferior or central cone (axial or sagittal map)	42
6	Nomogram for Intacs sk ® selection based on keratometry.	43
7	Nomogram for Intacs sk ® selection based on SE.	43
8	Miranda Nomogram for Intrastromal Ring Segments.	44
9	Nomogram for KeraRings [®] implantation proposed by the manufacturer.	45
10	Segment thickness choice in symmetric bow-tie keratoconus	46
<i>11</i>	Single 210°-Segment thickness choice in central cones.	47
12	Segment Thickness by Spherical Equivalent Values for a Single 210-Degree Arc Length KeraRings ® Implantation in PMD	52
<i>13</i>	ICRS indications and contraindications	57

INTRODUCTION AND AIM OF THE WORK

Introduction

Options for visual rehabilitation include spectacle correction, contact lens fitting, refractive keratotomy (RK), photorefractive keratectomy (PRK), laser-assisted in situ keratomileusis (LASIK), and intracorneal rings or Intacs. Currently, nonsurgical approaches are still the least expensive and safest. For the subset of patients who desire freedom from glasses and lenses, refractive surgery is an option. The ideal refractive surgery procedure is the one that is effective, predictable, safe, and potentially reversible (*Shetty et al, 2008*).

The intrastromal corneal ring (ICR) is a device designed to correct mild-to-moderate myopia by flattening the anterior corneal curvature without encroaching on the visual axis. The device is an openended PMMA transparent ring with an outer diameter (R1) of 8.1 mm and an inner diameter (R2) of 6.8 mm, and the curvature conforms to that of the cornea. It is inserted through a peripheral radial incision made with a diamond knife at two-thirds corneal depth in to a 360° peripheral intrastromal channel created with specially designed instruments. The anterior corneal curvature is changed by using rings of different thicknesses (*Ertan et al, 2007*).

Intrastromal corneal ring segments (Intacsmicrothin prescription inserts), or ICRS, are a more recent design modification of the ICR. The ring segments split the ring into two 150° arcs. The use of ring segments simplifies the implantation procedure (*Shabayek & Alio JL*, 2007).

Another type of Intrastromal corneal ring segments (ICRS) are the Ferrara rings introduced by Pablo Ferrara in 1986. It had proved to be effective in correcting keratoconus as it implanted at 5 mm diameter. The closer the implantation to the visual axis the more effective the segment in correcting Keratoconus (*Ertan et al*, 2007).

Several benefits of using Intacsmicrothin inserts exist. It is a minimally invasive outpatient procedure. Since the surgery is completed in the peripheral cornea, the central optical zone is not disturbed. Results are rapid and predictable. There is a reduced risk of visual adverse effects and a long-term convenient refractive correction. It is removable and exchangeable (*Fontana et al*, 2009).

INTACS are intended for the reduction or elimination of mild myopia (-1.00 to -3.00 D spherical equivalent at the spectacle plane) in patients who are aged 21 years or older, in patients with documented stability of refraction as demonstrated by a change of less than or equal to 0.50 D for at least 12 months prior to the preoperative examination, and in patients where the astigmatic component is 1.00 D or less (*Alio Jl et al, 2005*).

In 2004, INTACS was given humanitarian device approval by the FDA for use in patients with keratoconus who are no longer able to achieve adequate vision using contact lenses or glasses and for whom corneal transplantation is the only remaining option (Aylin&Joseph,2007).

INTACS are contraindicated in high degrees of myopia, hyperopia, or astigmatism, Patients with existing collagen vascular, autoimmune, or immunodeficiency disease, Pregnancy, Patients with previous anterior segment trauma, In the presence of existing ocular conditions, such as recurrent corneal erosion syndrome, corneal dystrophy, or other corneal pathology that may predispose the patient to future complications (*Alio Jl et al, 2005*).

AIM OF THE WORK

To review literature about the role of Intra Corneal Rings in correction of myopia and its role in ectatic corneal disorders.

HISTORY OF INTRA CORNEAL RINGS

History of Intracorneal Rings

Near sighted people have thought ways to get rid of their glasses for centuries. Tradition says that ancient Chinese slept with sandbags on their eyes to flatten their corneas. It's certain Purkinje tried the same thing in 1820s with only temporary improvement of his 5D of myopia. In the mid 1800s, a Dr. J. Ball advertised a small mallet mounted on a spring in an eye cup that struck the cornea through the closed eyelid, pounding it flat. "It restores your eyesight and renders spectacles useless," he claimed. Professor Charles Tyrell claimed a similar effect from the use of his ideal SightRestorer at the turn of the same century (*Ferry AP*, 1986).

Intracorneal implants started in the 1950s when Barraquer proposed the use of implants for a refractive purpose. Polymethylmethacrylate (PMMA) biocompatibility was confirmed and reasonable predictability of these implants was reported(*Barraquer*, 1966).

In 1978, **Reynolds** hypothesized that a ring-shaped implant could be introduced through a single peripheral radial incision in the cornea. **Reynolds** reasoned that this implant would alter the anterior corneal curvature through expansion or constriction in the diameter of the device as needed to correct myopia or hyperopa (**Khann et al, 2000**)...

Reynolds began looking at the possibility of actually implanting a 360-degree ring into the cornea to alter its shape. By the mid-1980s, after many early prototype refinements, the first animal studies began looking at the feasibility and biocompatability of implanting a plastic ring into physiologically active tissue (**Fleming et al,1987**).

By 1991, the first ICR had been implanted in nonsighted human eyes in Brazil and would be followed that same year by the initiation of phase I FDA(Food and Drug Administration) studies in the United States. In this phase, ten nonsighted human eyes received the early 360-degree prototype, with a variety of ring thicknesses. These initial studies were undertaken to demonstrate the safety of both the insertion and removal of the rings and that their effect was intended to flatten the central corneal curvature. Using streak retinoscopy and keratometry (Assil et al,1995).

Nose′ found that a 0.30 mm ring thickness produced approximately 2.5 D of central flattening in corneal curvature. As part of the FDA protocol, the rings were removed at the 1-year mark in 5 of the 10 eyes. Surprisingly, these eyes demonstrated a prompt and nearly complete return to their normal preoperative curvatures, suggesting that ring removal may provide a return to a preoperative state (**Nose**′ et al 1996).

In 1993, phase II FDA trials began using the 360-degree ring in sighted human eyes. Coincidentally, a group of researchers in Brazil began altering the ring circumference to small (40- and 60-degree) arcs in an attempt simultaneously to correct astigmatism. Interestingly, these researchers found that altering the original 360-degree design into two equal 180-degree segments resulted in little overall change in the refractive effect (**Krueger&Burris,1996**).

Based on the idea that intrastromal corneal rings can flatten the cornea, providing a potential new method of keratorefractive surgery, the effect of implanting various ring sizes of a given thickness in intrastromal channels dissected in human eye bank corneas was investigated. They concluded that new ring designs should take ring thickness into