“IntraLase Femtosecond Laser “
As a New Technique for Intrastromal Corneal Ring Segments Implants

An Essay
Submitted for partial fulfillment of M.Sc.
Degree of ophthalmology

By
Maged Samuel Ishak Gergis
M B, B Ch.

Supervised by

Prof. Dr. Bahaa El Deen Abdallah Ali
Professor of Ophthalmology
Faculty of Medicine
Ain Shams University

Dr. Mohammed Moghazi
Lecturer of Ophthalmology
Faculty of Medicine
Ain Shams University

Faculty of Medicine,
Ain Shams University,
2008

AKNOWLEDGMENT

First and foremost I thank God who gave me the strength to fulfill this work.

I would like to express my sincere gratitude to ***PROF. DR. Bahaa El Deen Abdallah Ali, Professor of ophthalmology, Faculty of Medicine, Ain Shams University,*** *for his generous supervision, keen interest and precious time he offered me throughout this work.*

*I wish also to express my deep gratitude to****DR. Mohamed Moghazi, lecturer of ophthalmology, Faculty of Medicine, Ain Shams university,*** *for his continuous support, guidance and for offering much of his time and effort throughout this work.*

List of contents

List of abbreviations

ACD	Anterior chamber depth
BCVA	Best corrected visual acuity
BDD	Beam delivery device
D	Diopters
DALK	Deep anterior lamellar keratoplasty
DM	Descemet's membrane
DNA	Deoxyribonucleic acid
FDA	Food and drug administration
Fs	femtosecond
GAG	Glycosaminoglycans
ICR	Intrastromal corneal rings
ICRS or INTACS	Intrastromal corneal ring segments
IgG	Immunoglobulin G
IOP	Intra ocular pressure
KC	Keratoconus
LASIK	Laser assisted in situ keratomileusis
LED	Light-emitting diodes
MEM	Modified Eagle's medium
MW	Molecular weight
NAD	Nicotinamide adenine dinucleotide
NADP	Nicotinamide adenine dinucleotide phosphate
OCT	Optical coherence tomography
PK	Penetrating keratoplasty
PMD	Pellucid marginal degeneration
PMMA	Polymethyl methacrylate
PRK	Photorefractive keratectomy
Ps	picosecond
RGP	Rigid gas permeable
SRA	Suction ring assembly
UCVA	Uncorrected visual acuity
UVA	Ultra violet-A
VHF	Very high frequency

List of figures

List of tables

INTRODUCTION

In 1978 Reynolds hypothesized that a ring shaped implants 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 ***(Chan et al, 2002).***

In April 1999, the U.S.Food and Drug Administration (FDA) granted the first-ever approval for an implant to be permanently placed into the human cornea for the purpose of altering its curvature. The Keravision intrastromal corneal ring (ICR) segment or "íntacs" are now an exciting addition to the refractive surgeons ***(Linebarger et al, 2000)*****.**

Intracorneal ring segments (Intacs), first used for the correction of low myopia, are increasingly being used to treat mild to moderate keratoconus**.** ***(Levinger&Alio, 2005)*****.**

Although the preliminary success of Intacs was overshadowed and overtaken by LASIK surgery, the utility of this technology to enhance or restore corneal rigidity was subsequently adopted for the treatment of ectatic disease such as keratoconus & iatrogenic post-LASIK keratectasia. ***(Colin et al, 2007).***

Colin and Coworkers executed the first Intacs implantation into keratoconus eyes in June 1997. The surgery was performed in patient with clear central cornea and contact lens intolerance.The goal of using Intacs inserts for treating keratoconus is not to eliminate the corneal disease but to decrease corneal abnormality associated with it and improve visual acuity in affected patient to a satisfactory levels. A principle benefit of treating keratoconus with Intacs inserts is to delay or eliminate the need for a corneal graft but it is not alternative to it. ***(Colin et al, 2000).***

The intrastromal ring segments, or ICRS, are a recent design modification of intrastromal corneal ring that splits the ring into tow segment, each have an arc length of 150 degrees and a hexagonal cross-section. ***(Twa et al, 1999).***

Intacs act as passive spacing elements that shorten the arc length of the anterior corneal surface, thereby flattening the cornea.***(Burris, 1993-Wagoner, 2001).***

The segments are easily removed and do not affect later PKP, and visual acuity and refraction generally return to baseline within 1–7 weeks of removal.***(Chan et al,2002).***

Early studies, specifically those performed before Humanitarian Device Exemption approval, used the manual channel makers. This technique has a higher risk of perforation or need for removal of segments because of poor positioning. To avoid these issues, the lamellar channel can be created using a femtosecond laser.The principle of the IntraLase femtosecond laser (IntraLase, Irvine, Calif) is to accomplish surgery with little collateral damage. This ultrashort-pulsed laser allows for non-thermallaser tissue interaction, called photodisruption, through very small pulse energies. Tissue resection is achieved by precise placement of microphotodisruptions scanned at high repetition rates controlled by the computer. ***(CUOS Medical Research web site, 2006)***

We report on a retrospective case series comparison where Intacs were placed for the treatment of keratoconus and post-LASIK keratectasia by using either traditional mechanical dissection or a femtosecond laser (Intralase; IntraLase, Irvine, CA).

REFERENCES

- ***Alio JL, Artola A, Hassanein A, et al.*** One or 2 Intacs segments for the correction of keratoconus. J Cataract Refract Surg. 2005; 31:943–953.

- ***Burris TE, Baker PC, Ayer CT, et al.*** flattening of central corneal curvature with intrastromal corneal rings of increasing thickness: an eye bank eye study. J Cataract Refract Surg. 1993;19(Suppl):182–187

- ***Chan SM and Khanm HN.,*** Reversibility and exchangeability of intrastromal corneal ring segments. J Cataract Refract Surg. 2002;28:676–68

- ***Colin J, Cochener B, Savary G, et al.*** correcting keratoconus with intracorneal rings. J Cataract Refract Surg. 2000; 26:1117–1122.

- ***Colin J and Malet FJ.*** Intacs for the correction of keratoconus: Two-year follow-up. J Cataract Refract Surg 2007; 33:69–74.

- ***Levinger S and Pokroy R.,*** Keratoconus managed with Intacs. Arch Ophthalmol. 2005; 123:1308–1314.

- ***[CUOS Medical Research web site].*** Principles of Ultrafast Laser Surgery Available at: http://www.eecs.umich.edu/USL/Medical/Photodisruption.html. Accessed January 23, 2006.

- ***Twa MD, Karpecki PM, King BJ, Linn SH, Durrie DS and Schanzlin DJ.*** One year result from phase 3 investigation of the Intacs. J Amoptom Assoc 70(8):515-24, 1999.

- ***Wagoner MD, Smith SD, Rademaker WJ, et al.*** Penetrating keratoplasty vs. epikeratoplasty for the surgical treatment of keratoconus. J Refract Surg. 2001; 17:138–146.

Anatomy of the Cornea

The cornea is a transparent avascular tissue with a smooth, convex surface and concave inner surface, which resembles a small watch-glass. The main function of the cornea is optical; it forms the principal refractive surface, accounting for some 70% (40-45 dioptres) of the total refractive power of the eye. Refractive requirements are met by the regular anterior curvature of the cornea and the optically smooth quality of the overlying tear film. The resistance of the cornea, which provides a protective layer and resists the ocular pressure, is due to the collagenous components of the stroma. Transparency of the corneal stroma is achieved by the regularity and fineness of its collagen fibrils and the closeness and homogeneity of their packing. Water is constantly pumped out of the cornea by its posterior layer, the endothelium. This maintains the optical homogeneity of the corneal layers and prevents swelling and clouding. The cornea is thus an evolutionary compromise, being a multicomponent, thick, tough avascular tissue with a smooth surface and uniform curvature. ***(Bron et al, 1997).***

Dimensions:

In front the cornea appears elliptical, being 11.7 mm wide in the horizontal meridian and 10.6 mm in the vertical in adults. The posterior surface of the cornea appears circular, about 11.7 mm in diameter. This difference is due to the greater overlap of sclera and conjunctiva above and below than laterally. The axial thickness of the cornea is 0.52 mm with a peripheral thickness of 0.67 mm. In the anterior aspect the cornea is transversely ellipsoid, whereas its posterior aspect is circular. ***(Maurice et al, 1970)***

The cornea forms part of what is almost a sphere, but it is usually more curved in the vertical than the horizontal meridian, giving rise to astigmatism 'with the rule'. In its central third, the optical zone, the radius of curvature of the anterior surface is about 7.8 mm and that of the posterior 6.5 mm, in adult males. The natural and normal cornea is generally prolate, with steeper curvature centrally and relatively flatters peripherally. ***(Bron et al. 1997).***

Surface zones of the cornea:

The corneal surface can be divided into four anatomical zones: the central (optical) zone, the paracentral zone, the peripheral zone and the limbal zone, (figure 1).

- **Central zone:** also called optical zone of the cornea. It is 2.4 mm in diameter and overlies the entrance of the pupil where it represents the most spherical area of the cornea and determines the high-resolution image formation on the fovea.
- **Paracentral zone**: also called mid, intermediate or mid peripheral zone. It is 6-8 mm in diameter.
- **Peripheral zone:** it is also called transitional zone. It is 7-11 mm in diameter.
- **Limbal zone**: it is 11.5-12 mm in diameter. It is the ring of cornea about 0.5 mm wide that contains the capillary arcade and stem cells. ***(Bores et al, 1993).***

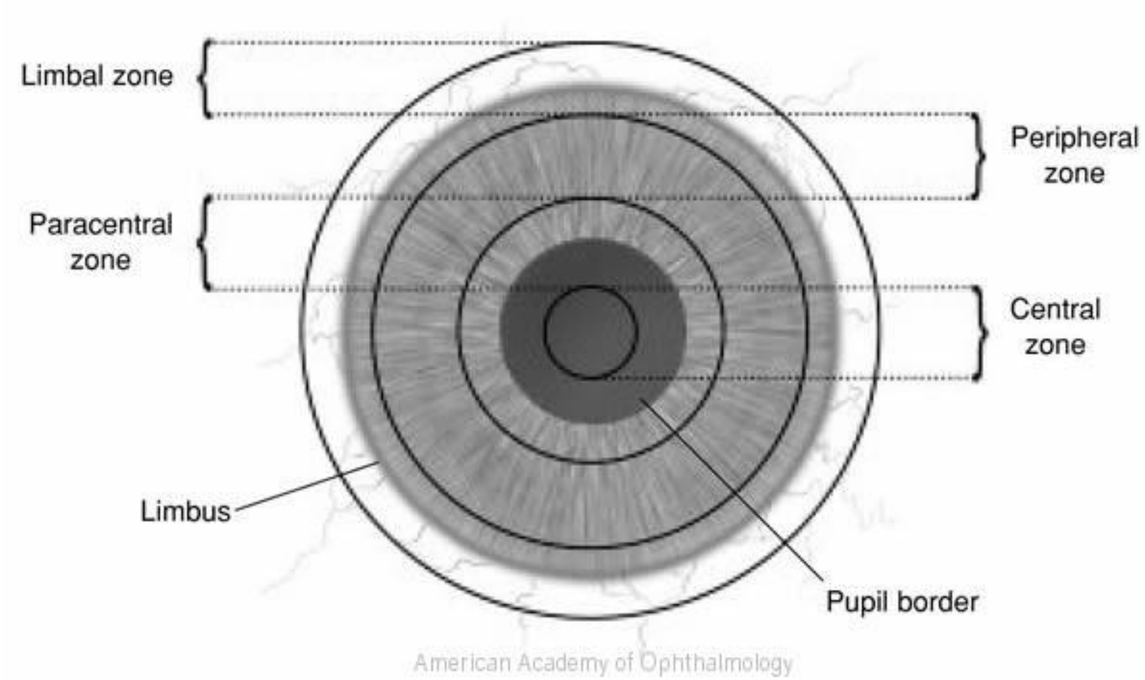

Figure 1**.** Surface zones of the cornea

Adopted by American Academy of Ophthalmology Basic and Clinical science course 2003 on CD ***(Liesegang et al., 2003).***

Structure:

Behind the precorneal tear film are five tissue layers:

1. Epithelium.
2. Bowman's layer.
3. Stroma.
4. Descemet's membrane.
5. Endothelium.