Corneal topography changes after Femtosecond assisted Intracorneal rings in treatment of moderate keratoconus

Thesis

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Abstract

Purpose:

To evaluate changes in corneal topography indices after intracorneal rings implantation by means of femtosecond laser technology in eyes with moderate keratoconus and analyze associations of these changes with visual acuity.

Design:

Retrospective, non-randomized.

Patients and methods:

A total of 40 eyes of 30 patients with a mean age of 33.23 years ±4.45 (SD) were included; 15 patients were males (50%) and 15 patients were females (50%). All cases were diagnosed as keratoconus according to the standard criteria.
All cases presented with reduced best spectacle-corrected visual acuity, contact lens intolerance or discomfort, and pachy apex of more than 400 μm. Ferrara Rings were implanted in all cases into an intrastromal corneal tunnel created by means of femtosecond technology.

Main Outcome Measures:

Uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), average keratometric value (K- value) and spherical equivalent (SE).

Results:

A significant improvement in UCVA & BCVA was observed after surgery at 1 day, 3m and 6m postoperatively.
The mean UCVA (LogMAR) increased from 1.03 ± 0.51 preoperatively to 0.56 ± 0.17, 0.47 ± 0.16 and 0.44 ± 0.12 at 1day, 3m and 6m postoperatively, respectively. And there is also increase of the mean BCVA (LogMAR) from 0.49 ± 0.14 preoperatively to 0.37 ± 0.11, 0.33 ± 0.12 and 0.29 ± 0.14 at 1day, 3m and 6m postoperatively, respectively. This was consistent with the significant reduction in spherical equivalent from -5.62 ± 3.61 diopters (D) Preoperatively to -2.53 ± 2.49 D , -2.23 ± 2.47 D and -2.45 ± 2.32 D at 1day,3m and 6m postoperatively respectively.
Furthermore, a significant improvement in average K from 48.12 ± 2.86D preoperatively to 45.41 ± 2.93D , 45.48 ± 2.96D and 45.48 ± 2.98D after 1day,3m and 6m postoperatively, respectively.

Conclusion:

The implantation of Intracorneal rings (FerraraRings) has proven to be a safe and feasible alternative procedure for the treatment of mild-moderate keratoconus especially for patients with contact lenses intolerance and it delays or eliminates the need for PKP.

Key Words:

Keratoconus – Femtosecond - Implantation of FerraraRings.

List of abbreviations

Abbreviation	Full name
AB	Asymmetric Bowtie
AB/SRAX	Asymmetric bow tie with skewed radial axes pattern.
BCVA	best corrected visual acuity
BFS	best fit sphere
BFTE	best fit toric ellipsoid
CISIS	corneal intrastromal implantation system
CXL	Corneal crosslinking
DLK	Deep Lamellar Keratoplasty
FFKC	Forme Fruste Keratoconus
Fig	Figure.
FS	Femtosecond
ICRS	Intracorneal ring segments.
Intacs	Intrastromal Corneal Ring Segments.
IS	Inferior Steep
KC	keratoconus
K-value	Keratometric value
OCT	Optical coherence tomography
PKP	penetrating keratoplasty
PMD	pellucid marginal degeneration
PMMA	polymethyl methacrylate
PRK	Photorefractive keratectomy
SB	Symmetric bowtie
SD	Standard deviation from the mean
SE	spherical equivalent
SS	Superior Steep
UCVA	uncorrected visual acuity
UV	ultraviolet

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Introduction

Keratoconus is a degeneration of the cornea; 84% of all cases begin between the ages of 20 and 49 years, usually (80-85%) with bilateral cone-shaped corneal bulging and stromal thinning.(1)

Disease manifestation is highly variable. It can vary from slightly irregular astigmatism to severe visual impairment because of increased corneal protrusion and subepithelial scarring. Because of the young age of the patients, this disease often has a dramatic effect on quality of life and life planning.(2,3)

Keratoconus is slowly progressive with gradual loss in visual acuity, especially low-contrast visual acuity, even with best visual correction in place (4). Likewise, the corneal curvature worsens, gradually steepening, in association with decreasing best-corrected visual acuity. Younger age at onset is generally believed to be associated with faster progression and worse outcomes. (5)

Intracorneal ring segments (ICR) are thin semicircular inserts made of polymethylmethacrylate that are implanted in the corneal stroma to shorten the arc length of the central corneal surface and result in corneal surface flattening. Intracorneal ring segments have been used to treat corneal ectatic disorders such as keratoconus and post-LASIK ectasia, as well as myopia.(6)

The femtosecond laser may be programmed to create tunnels for ICR implantation.This technique has been shown to be comparable to manual tunnel dissection in terms of visual and refractive outcomes.The consistency of depth, uniformity of cut, and the minimal trauma induced when creating the channels using the femtosecond laser can make insertion of the ICR easier and minimize the duration of the procedure.(7)

Aim of work

To evaluate changes in corneal topography indices after intracorneal rings implantation in patients with moderate keratoconus and analyze associations of these changes with visual acuity.

Anatomy of the cornea

The human cornea, like those of other primates, has five layers (Fig.1). [8] From the anterior to posterior the five layers of the human cornea are:

1. **Corneal epithelium**:

   An exceedingly thin multicellular epithelial tissue layer (non-keratinized stratified squamous epithelium) of fast-growing and easily regenerated cells, kept moist with tears. Irregularity or edema of the corneal epithelium disrupts the smoothness of the air/tear-film interface. [9]

2. **Bowman's layer:**

   Also known as the anterior limiting membrane, when in fact it is not a membrane but a condensed layer of collagen

3. **Corneal stroma (substantia propria)**:

   A thick, transparent middle layer, consisting of regularly arranged collagen fibers along with sparsely distributed interconnected keratocytes, which are the cells for general repair and maintenance.[10]

4. Descemet's membrane (posterior limiting membrane):

A thin acellular layer that serves as the modified basement membrane of the corneal endothelium, from which the cells are derived. This layer is composed mainly of collagen type IV fibrils, less rigid than collagen type I fibrils, and is around 5-20μm thick. [(11)]

5. Corneal endothelium:

A simple squamous or low cuboidal monolayer, approximately 5μm thick, of mitochondria-rich cells. These cells are responsible for regulating fluid and solute transport between the aqueous and corneal stromal compartments. Unlike the corneal epithelium the cells of the endothelium do not regenerate. Instead, they stretch to compensate for dead cells which reduce the overall cell density of the endothelium, which has an impact on fluid regulation. If the endothelium can no longer maintain a proper fluid balance, stromal swelling due to excess fluids and subsequent loss of transparency will occur and this may cause corneal edema and interference with the transparency of the cornea and thus impairing the image formed.[(11)]