Customized Versus Conventional Laser in situ Keratomileusis

Essay

Submitted for Partial Fulfillment of Master Degree In Ophthalmology

By

Radwan Mohsen Mohammed AL-Esayi

(M.B.,B.Ch.)

Aden University –

Supervised by

Prof .Dr .Mervat Salah Mohammed Mourad

Professor of Ophthalmology

Faculty of Medicine

Ain Shams University

Dr .Mohammed Hanafi Hashem

Lecturer of Ophthalmology

Faculty of Medicine

Ain Shams University

Faculty of Medicine

Ain Shams University

Cairo, 2011

الليزك المخصص مقابل الليزك التقليدي

مقال مقدم
تمهيدا للحصول على درجة الماجستير في طب و جراحة العيون

من

الطبيب/ رضوان محسن محمد العيسائي
بكالوريوس الطب و الجراحة
كلية طب عدن

تحت اشراف

الأستاذه الدكتوره/ مرفت صلاح محمد مراد
أستاذ طب و جراحة العيون
كلية طب عين شمس

الدكتور/ محمد حنفي هاشم
مدرس طب و جراحة العيون
كلية طب عين شمس

كلية الطب
جامعة عين شمس
2011

CONTENTS

ABLE OF ABBREVIATIONS

µm	Micrometer
BCVA	Best corrected visual acuity.
CATz	Customized aspheric treatment zone
CCD	Charge couple device.
CS	Contrast sensitivity.
CXL	Collagen crosslinking
FC	Fractional clearance.
FDA	Food and drug administration.
HOA	Higher order aberrations
LASIK	LASER in situ keratomileusis.
LOA	Lower order aberrations.
MTF	Modulation transfer function.
nm **OATz**	Nanometer Optimized aspheric transition zone
OZ	Optical zone.
PD	Pupil diameter.
PRK	Photorefractive keratectomy
PSF	Point spread function.
RMS	Root mean square.
RMSH	High order Root-Mean-Square.
SRR	Spatial resolved refractometer
UCVA	Uncorrected visual acuity.
WFG Lasik	Wavefront guided Lasik
ZAR	Zyoptix ablation refinement software.

TABLE OF FIGURES

LIST OF TABLES

INTRODUCTION

Laser in situ keratomileusis (LASIK) was initially reported by Pallikaris et al in 1990 and has become an efficient and commonly performed procedure in refractive surgery. However, a decrement of visual performance after the surgery has been reported, such as glare and halo under dim conditions, poor night vision and decrease of contrast sensitivity values (***Pallikaris et al, 1990)***.

Therefore wavefront-guided LASIK were introduced to provide a solution of low vision quality related to laser ablations ***(McDonald, 2000)***.

This technique tended to facilitate better visual outcome by reducing or eliminating existing ocular aberrations. The worldwide application of conventional ablation in LASIK aroused general concern on whether there are differences in visual outcome and high order aberration when comparing conventional ablation LASIK with customized ablation ***(Phusitphoykai et al., 2003)***.

Wavefront technology can measure most of the lower- and higher-order aberrations of the eye ***(Liang, 1994)***.

Wavefront-guided (WFG) LASIK, also called custom LASIK, is a variation of the surgery in which the excimer laser is instructed to ablate a sophisticated pattern based on measurements from an aberrometer.

This is distinct from 3 other basic types of excimer laser treatment profiles: conventional, wavefront optimized, and topography guided.

Wavefront-guided

Ablation offers the potential advantage of better visual quality because of treatment of higher-order aberrations. When compared with conventional excimer laser ablation, wavefront-guided ablation appears to offer better contrast acuity and less induction of postoperative higher-order aberrations. However, patients undergoing wavefront-guided ablation may still have more higher-order aberrations postoperatively than they did preoperatively ***(American Academy of Ophthalmology, 2008)***.

Conventional LASIK

Also called standard LASIK, was the first profile to receive Food and Drug Administration (FDA) approval and still is used commonly today. Conventional LASIK applies a simple spherocylindrical correction based on the removal of tissue using Munnerlyn's equation ***(Munnerlyn, 1988)***.

Conventional excimer laser ablation treats lower-order or spherocylindrical aberrations such as myopia, hyperopia, and astigmatism. These lower-order aberrations comprise approximately 90% of all aberrations, with higher-order aberrations making up the remainder. Higher-order aberrations are also a by-product of excimer laser ablation. Some higher-order aberrations can cause symptoms such as loss of contrast sensitivity and nighttime haloes and glare, decreasing the quality of vision ***(American Academy of Ophthalmology, 2008)***.

Wavefront-optimized

LASIK is a treatment profile designed to reduce or eliminate the induced spherical aberration of conventional LASIK ***(El-Danasoury, 2005)***. The wavefront-optimized treatment is based on a spherocylindrical correction that is adjusted by an internal algorithm to remove additional tissue in the periphery of the ablation zone, thereby creating a more prolate corneal shape.

Topography-guided

LASIK uses information from both the corneal shape and the spherocylindrical correction to determine the excimer laser ablation profile ***(Knorz, 2000)***.

Topography-guided LASIK is investigational in the United States because there are no FDA approved indications.

Wavefront-guided excimer laser ablations may provide improved quality of vision under dim lighting conditions relative to conventional excimer laser ablations ***(Netto, 2006)***.

Wavefront-guided ablation is not suitable for all patients. Wavefront data may be impossible to obtain in very irregular corneas or with smaller pupillary diameters. The treatment is more costly than conventional excimer laser ablation because of the time required to collect the wavefront data that are needed to program the excimer laser **(*Nuijts et al., 2002*)**.

Factors that may cause an increase of optical aberrations postoperatively are variables in the LASIK procedure including creation of the corneal flap, corneal lamellar ablation resulting in asymmetric anterior surface flattening, mild decentration of the laser ablation, and wound healing effects such as epithelial hyperplasia and forward shifting of the posterior cornea. Other factors may include accommodation, aging, and pupil size ***(Wilson et al., 2001)***.

AIM OF THE ESSAY

The purpose of the study is to know and review the results of the customized LASIK and conventional LASIK.

OCULAR ABERRATIONS

The perfect eye would image every point in the scene to a corresponding small point on the retina. In other words, no blurring would occur for any point in the scene ***(MacRae, 2000)***.

Anything other than the ideal image is called "optical aberrations". One of them is *lower order aberrations (LOAs)* that include spherical errors (myopia and hyperopia) and regular astigmatism and have more devastating effects on quality of image which is not dependant on pupil size and easily corrected by glasses, contact lenses and conventional Lasik. The other is *higher order aberrations (HOAs)* which are the refractive errors beyond spherocylinder errors formerly known as "irregular astigmatism", their effect is less than LOAs (the higher the order the less the effect), they affect contrast more than resolution of image and affected by the pupil size; affect mesopic vision more than day vision ***(MacRae, 2000)***.

Aberrations are either: ***(Schwiegerling, 2000)***

I. Chromatic aberrations.

II. Monochromatic aberrations; which are studied as:

- Ray aberrations.
- Wavefront aberrations.

I. CHROMATIC ABERRATIONS

The eye suffers from chromatic aberrations, that are the result of dispersion in optical elements of the eye. The index of refraction of the various components of the eye depends on the wavelength of light, and, thus, white light entering the eye is spread into a spectrum of colors, just as a prism disperses white light into a rainbow. For longitudinal chromatic aberration, a wavefront of green light will converge to a point on the retina. Red wavefronts will suffer from hyperopic spherical refractive error and converge to a point behind the retina, whereas blue wavefronts will suffer from myopic spherical refractive error and converge to a point in front of the retina. Thus, chromatic aberration is simply spherical refractive error that depends on wavelength. Figure 5; shows the effects of chromatic aberration on the wavefronts converging in the eye ***(Schwiegerling, 2000)***.

In general, the wavefronts formed by the eye will take on complex non-spherical shapes, and different wavelengths will have different wavefront shapes. To push the eye to its theoretical limits of performance, all of the monochromatic and chromatic aberrations would need to be corrected. In other words, the wavefronts converging toward the retina need to be perfectly spherical, regardless of wavelength, and all of them must converge to a perfect point on the retina. In this manner, a point of white light out in the world is imaged to a point of white light on the retina ***(Schwiegerling, 2000)***.

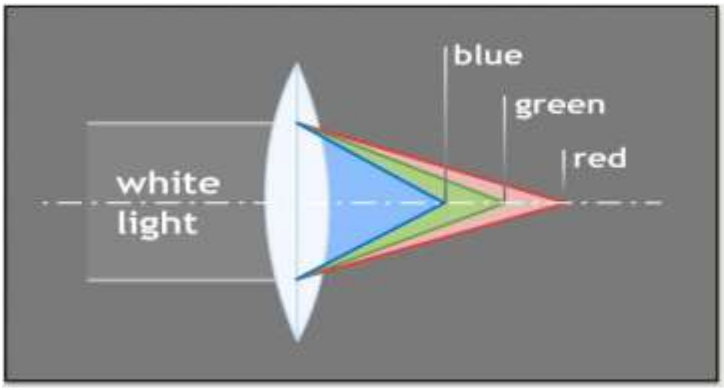

Figure (1): Chromatic aberration .

II. *MONOCHROMATIC ABERRATIONS*

A- Ray aberrations:

1- <u>Spherical Aberration:</u>

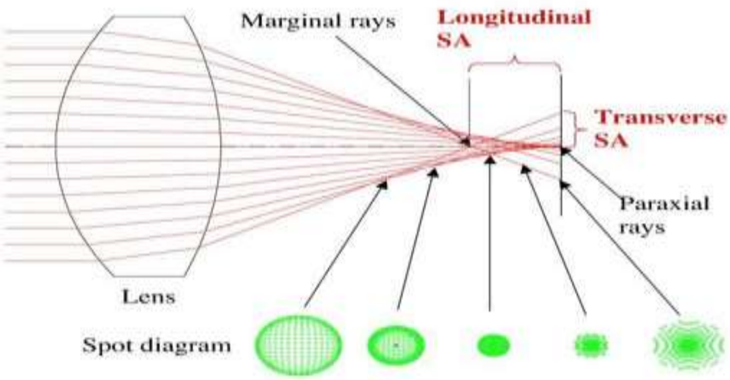

Figure (2): Spherical aberrations ***(Yoon. 2002)***.

Spherical lenses do not bring all rays to a perfect focus point. For a plus spherical lens, there is increasing converging power as the lateral distance from the central ray is increased. Thus, spherical aberration causes rays at the edge of the lens to be focused anterior to the focus of the central ray. Instead of all of the rays of light coming to a concise point of focus, they are distributed over a small region of the image, and there is no single sharp point of focus. Spherical aberration in humans is due to the anterior surface of the cornea and the anterior and posterior surfaces of the crystalline lens. The cornea compensates somewhat for this by its natural prolate shape or flatter paracentral and peripheral curve than centrally. As we ablate for myopia and flatten the center, we reduce prolateness and actually increase spherical aberration. At night, pupil dilation increases spherical aberration, which causes a slight (0.5 to 1.0 D) increase in myopia. Hence, the root cause for "night myopia" is the principle of spherical aberration ***(Doane et al., 2003)***.