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Intraocular Pressure Variation After Laser Refractive Surgery

A Dissertation Submitted to the Institute of Laser for Postgraduate Studies, University of Baghdad, in Partial Fulfillments of the Requirements for the Degree of Higher Diploma in Laser in Medicine – Ophthalmology

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Dedication

To my parents souls, for all your love and creating the foundation on which my present and professional life is built up on and for always being witting to sacrifice other things for teaching me throughout schooling, for support and reminding me of what really matters in life.

And for all my family members.

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Abstract

Purpose:

The aim of this study is to determine the effect of refractive surgery (RS) [(photorefractive keratectomy) PRK and LASIK (Laser in situ Keratomileusis] on intraocular pressure (IOP) change for correction of myopia, myopic astigmatism and hyperopia with prospectively reviewed preoperative, intraoperative and 3 months postoperative medical records in 92 eyes of 52 Iraqi patients who underwent LASIK and PRK for correction of myopic, myopic astigmatism and hypermetropia.

Data were extracted such as preoperative age, sex, IOP, manifest spherical equivalent (MSE), CCK, Central Corneal Keratometry, CCT (Central Corneal Thickness) and intended flap thickness and post-operative IOP at 1 week, 1 month and 3 months.

The preoperative CCT Central Corneal Thickness and ablation depth had significant effects on predicting IOP changes in photorefractive surgery groups.

Patients and Methods

92 consecutive eyes of 52 patients that underwent photorefractive surgeries (LASIK and PRK) with flying spot beam Laser were reviewed. Manifest refraction, uncorrected and Best Corrected Visual Acuity (BCVA), corneal topography and Central Corneal Thickness (CCT) were recorded before treatment.

Intraocular pressure (IOP) measurement is a routine procedure and fundament in ophthalmological examination. Goldmann Applanation Tonometer (GAT) is the standard method. GAT is affected by corneal properties, e.g Central Corneal Thickness (CCT), and Corneal Curvature (C.C). Refractive surgery change these properties. This has put focus on how corneal biomechanics translate into tonometric errors. To investigate

if Laser Refractive Surgery (LRS) (LASIK, PRK) affects tonometry, a study was performed where measurements with GAT, non-contact tonometry, (air puff tonometer) were obtained before, 1 week, 1 month, 3 months and 6 months after (PRS). The result showed a statistically significant reduction of measured IOP 3 months after (PRS) for all tonometry methods. Change in visual acuity (VA) and (IOP) between 1-3 months suggested a prolonged postop. process.

Results:

We prospectively reviewed pre-operative, intraoperative, and 3 months postoperative. Medical records for 92 eyes of 52 patients who underwent LASIK, PRK for myopia and myopic astigmatism and hyperopia. After excluding patients who did not return for follow up 1 month after the operation and the ones with missing data, we observed that the average IOP (GAT and NCT) non-contact tonometer at 3 months after PRS (LASIK and PRK) was lower than 1 week and 1 month and before laser refractive surgery (LRS) (LASIK and PRK).

The reduction of central corneal thickness (CCT) by LASIK was the cause or responsible for the lower IOP measurements by GAT and NCT (air puff tonometer).

At 3 months 83 eyes (90%) were examined, compared to preoperative values, IOP decreased in 79 eyes (95%) when measured with applanation tonometer. It decreased in all eyes when measured with air puff tonometry. Mean change in IOP was $-4.3 \pm 2.1\ mm\ Hg$ (range $-8.00\ to + 1.00\ mm\ Hg$) with the applanation and $(-1.00 \pm 2.00\ mm\ Hg)$ (range $-1.00\ \rightarrow +1.00\ mm\ Hg$) with air puff tonometry.

Conclusions:

Laser refractive surgery (LASIK and PRK) reduce intra ocular pressure (IOP) readings by Goldmann Applanation Tonometer(GAT) and Non –contact Tonometer(NCT) (air puff tonometer). So the cornea becomes less resistant after LASIK (PRS) in consequence, the GAT falsely underestimates the IOP. IOP evaluation by (NCT) or surface tonometer is more accurate than that by Goldmann Applanation Tonometer (GAT).

So Central Corneal Thickness (CCT) is an important variable in the evaluation of applanation IOP and should be included in the assessment of any case of potential glaucoma or ocular hypertension particularly in eyes with previous photorefractive surgery or photo ablative refractive surgery.

Recommendation:

So IOP decreased significantly after (LRS) LASIK and PRK when measured with either Goldmann (mean 4-3 mm Hg) or air puff (1-2 mm Hg) tonometer. This decrease may delay the diagnosis or effect of management of future glaucoma that may develop in a myopic eye that received PRS (LASIK, PRK) surgeries.

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List of Abbreviations

abbreviation	Page No.
LASIK	Laser Assisted in Situ Keratomileusis
PRK	Photo Refractive Keratectomy
LRS	Laser Refractive Surgery
PRS	Photo Refractive Surgery
BSCVA	Best Spectacle Corrected Visual Acuity
K1	1^{st} Keratometry Reading
K2	2^{nd} Keratometry Reading
LASEK	Laser Assisted Sub epithelial Keratomileusis
CCT	Central Corneal Thickness
D	Dioptre
IOP	Intra Ocular Pressure
GAT	Goldmann Applanation Tonometer
NCT	Non-Contact Tonometer
CC	Corneal curvature

Glossary of Terms

1. Cornea:

It provides most of the focusing power when light enters the eye. The cornea is composed of six layers of tissue. This is the part of the eye reshaped by laser vision correction[(1)].

2. Corneal Epithelium:

The outer layer of the cornea that serves as the eye's protective layer[(1)].

3. Lens:

The lens is the clear structure located behind the pupil. It's primary function is to provide fine-tuning for focusing and reading, which is accomplishes by altering its shape[(1)].

4. Refractive errors:

Also called Lower-Order Aberrations, include myopia, hyperopia and astigmatism[(2)].

5. Myopia (Near sightness):

A refractive error is which the patient sees better close up than from a distance. Myopia is caused by an eyeball that is too long to focus light on the retina or a cornea which is too steeply curved[(2)].

6. Hyperopia (Far sightness):

A refractive error in which you see better from a distance than close up. Hyperopia is caused by an eyeball that is too short to focus light on the retina[(2)].

7. Diopter:

A measurement of the degree to which light converges or diverges also a measurement of lens refractive power[(2)].

8. Astigmatism:

Astigmatism is blurry vision produced by foot ball-shaped cornea that's too steep in one meridian and too flat in another. Astigmatic corneas focus light in two different meridians in the eye, making both near and distance vision a problem[2].

9. Best corrected visual activity:

The best possible vision which can be achieved with corrective lenses measured in terms on Snellen lines on an eye chart[2].

Chapter One
Introduction

1.1 Introduction:

Intraocular pressure (IOP) is the fluid pressure inside the eye which play a central role throughout ophthalmology. It is part of routine ophthalmologic examinations and important in the management and follow up of glaucoma patients.

Tonometry is the method of which eye care professionals use to determine this IOP, and it is important aspect in the evaluation of patients at risk of glaucoma. Most tonometers are calibrated to measure pressure in millimeters of mercury (mm Hg)[(1)].

Laser refractive surgery (Laser in situ, Keratomileusis, (LASIK)), (photorefractive keratectomy (PRK)) is the most popular corneal refractive surgical procedure for myopia, hyperopia and astigmatism corrections in this decade. In LASIK procedure, corneal flaps are created and lifted to expose the corneal stroma for ablation. The method for flap creation has evolved from a mechanical microkeratome (MK) to a femtosecond (FS) laser over these years in consideration of safety, particularly for patients with thin corneas or small orbits. Moreover, with a superior performance in visual quality, the FS laser has gained popularity. Patients with myopia have higher risk of glaucoma. LASIK surgery involves flap dissection and central corneal thickness (CCT) reduction, which subsequently cause under estimation of the postop. IOP. Moreover, after LASIK, topical steriod is usually used to reduce postop. Inflammation, which might predispose patients to IOP elevation and glaucoma, if we don’t know the normal range of post-operative IOP, the iatrogenic low IOP might delay early detection of steroid responders or glaucoma[2].

However, non-contact tonometry (NCT) remains the most widely used technique because it has a low cost is easy to use, exhibits a high correlation with the Goldmann applanation tonometry (GAT) and involves no direct contact with corneal flaps. We therefore developed the statistical models of NCT, which might be helpful for early detection of ocular HTN, and delineate the interplay among factors to determine the IOP change after LASIK surgery with microkeratome (MK) and PRK. Previous studies have reported that preoperative age, IOP, CCT and MSE are factors influencing IOP underestimation after LASIK performed using an MK. Some studies demonstrated that the flap dissection also influence the IOP change after LASIK surgery(2).

Besides, the flap created by an FS laser has a planar configuration and better thickness predictability than that of traditional microkeratome (MK), Hence, we assumed that the flap difference would be significant in predicting the IOP change, and compared the predication of IOP change after LASIK surgery(2).

1.1.1 Aim of Study:

To evaluate the change in intraocular pressure (IOP) measurement by Goldmann applanation tonometer and non-contact tonometer (air puff tonometer) after photorefractive laser surgeries PRK and LASIK (laser in situ keratomileusis) for correction of myopia, Astigmatism and hypermetrepia and to assess the correlation between the changes of IOP reading and the reduction of central corneal thickness (CCT) after PRS (photorefractive surgery) in Iraqi patients.

1.2 Refractive Errors (How the Eye Works):

1.2.1 Normal eye (Accommodative)

- In order to see clearly, objects need to be brought to a focus point precisely on the retina of the eye. The retina can be compared to the film in a camera. The light is brought to a focus point by the cornea and lens of the eye. The cornea's curvature is ideally matched to it's length in the normal eye. As the normal eye ages, the lens loses the ability to focus for reading due to loss accommodation and will require the help of reading glasses. This usually begins to affect most people after the age of 40[2].

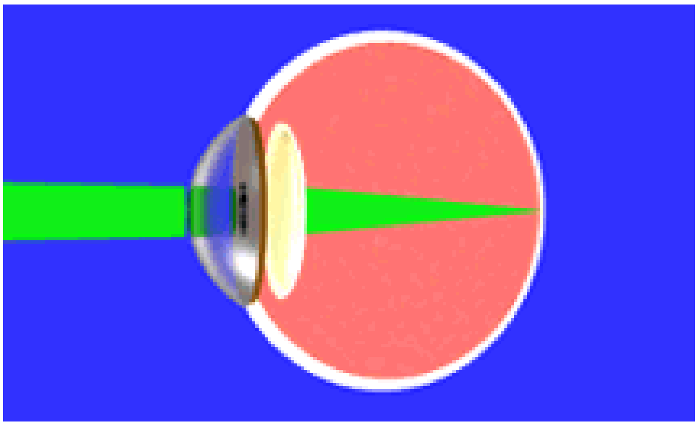


Fig. (1.1)

Normal eye

1.2.2 The near-sighted eye

- If you are nearsighted, the cornea of your eye is overly curved or your eyeball is too long (lenticule axial). This combination brings images of distant objects (street signs) to a focus point in front of the retina. When the light reaches the retina, a blurred image is seen since the light rays spread apart after the focus point[2].

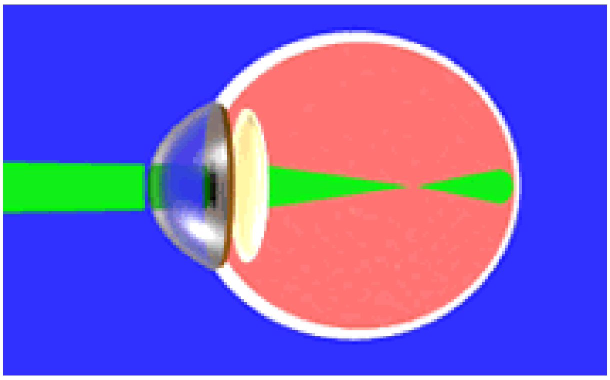


Fig. (1.2)

The near-sighted eye

1.2.3 The far-sighted eye

- If you are farsighted, the cornea of your eye is not curved enough or your eyeball is too short. This combination of factors causes the focus point of the eye to be located behind the retina. When light reaches the retina, a blurred image is seen since the light rays have not been brought to focus prior to reaching the retina[2].

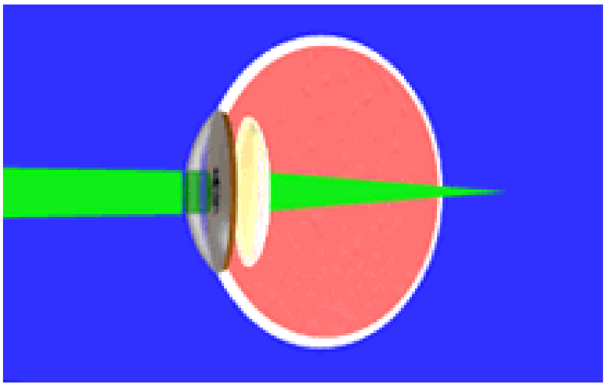


Fig. (1.3)

The far-sighted eye

1.2.4 Astigmatic eye

- If you have astigmatism, the cornea of your eye has a non-spherical shape (like American football) and does not bring light to focus at a single point. Instead, it focuses images over a range of points producing a blurred image. Both nearsighted and farsighted eyes can also have astigmatism[2].

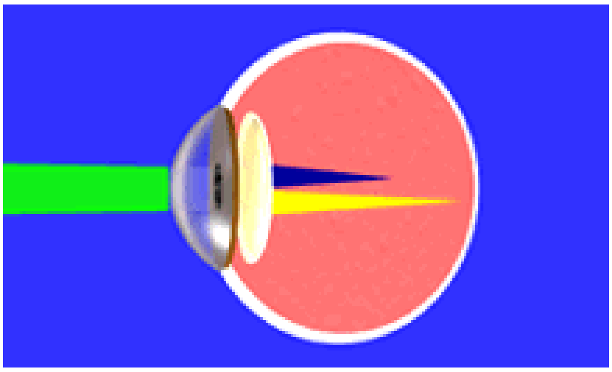


Fig. (1.4)

Astigmatic eye

1.3 Review of Ocular Anatomy:

- The cornea is a transparent tissue in the front part of the eye. It is a curved spherical structure that is responsible for focusing the light onto the inside of the eye together with crystalline lens[3].
- The iris is the colored part of the eye. It opens up in dark rooms and at night to let more light into the eye. Conversely, in bright lights the iris constricts to decrease the amount of light that enters the back of the eye.
- The pupil is the black spot in the center of the iris. Actually, the pupil is the name given to the opening in the iris through which light passes.
- The lens is responsible for helping to fine adjust the focus of the eye. The lens changes shape to allow clear vision both in the distance and for reading.

- The vitreous is a clear jelly-like material which fills the inside of the eyeball. Light passes through the vitreous on its way to being focused onto the retina.
- The retina is a thin film of tissue (like film in a camera) where images are brought into focus. The retina lines the inside surface of the eyeball. The retina is connected to the brain where the visual signals are processed.
- Between the cornea and the iris is a space called the anterior chamber. This space is filled with a clear water-like solution called aqueous humor[3].

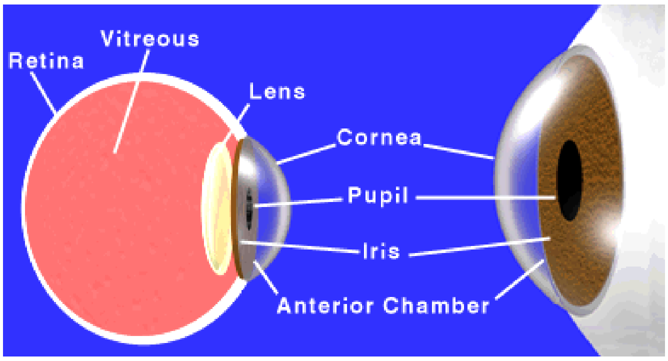


Fig. (1.5)

Ocular Anatomy

1.3.1 Anatomy of the Cornea:

It is transparent front part of the eye that covers the iris, pupil and anterior chamber. Together with the lens, the cornea refracts light. The cornea according for approximately 2/3 of the eye's total optical power.

In humans, the refractive power of the cornea is approximately 43 diopters. While the cornea contributes most of the eye's focusing power. Its focus is fixed. The curvature of the lens, on the other hand, can be adjusted to 'tune' the focus depending up on the object's distance[3].

Structure:

Its composed of 6 layers with average total thickness 540 µm. it's a vascular and the most densely innervated tissue in the body[3].

The cornea is a transparent avascular structure. Its average horizontal diameter (11.7 mm) is greater than it's vertical diameter (10.6 mm). The radius of curvature of anterior surface is approximately 7.8 mm where as that of posterior surface is 6.5 mm. The corneal thickness is 1.1 mm at periphery and thins to 0.5 mm centrally. The refractive index of the cornea is 1.37. The anterior corneal surface has a refractive power of +48.8 Diopter (D), and the posterior surface -5.8 Dioptre, and the total Dioptric power is +43D (D is a unit for measuring the effectiveness of an optical surface). Its accounts for 70% of refractive power of the eye. The anterior surface is steepest centrally and flatters peripherally. The cornea is composed of 75-80% of water(3).

The cornea is composed of 6 layers histologically as shown in Figure (1.6) cross section of human cornea.

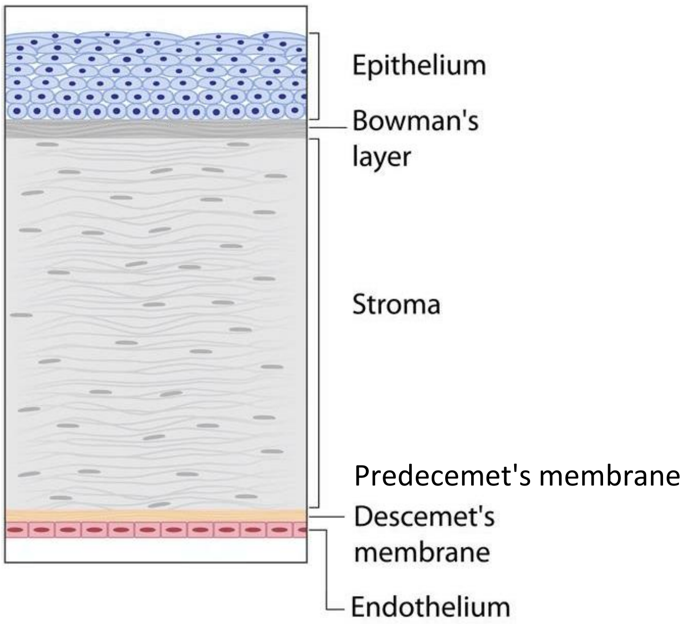


Fig. (1.6)

cross section of human cornea(3)

1. Epithelium:

It's about 50 µm in thickness and constitutes 10% of total corneal thickness. It's composed of 5-6 layers, which include 1-2 layers of superficial squamous cells, 2-3 layers of broad wing cells and the inner most layer of columnar basal cells[3].

2. Bowman's layer:

It's 12 µm thick and is composed of randomly packed type 1 and type V collagen fibers. It doesn’t regenerate when damaged. During PRK the Bowman's layer along with a small portion of anterior stromal tissue is removed by Excimer laser[3].

3. Stroma:

It makes up 90% of corneal thickness. It's composed of extracellular matrix formed of collagen and proteoglycans. Type I and type V fibrillar collagens are interwind by filaments of type VI collagen. The major corneal proteoglycans are decorin and lumican. The stromal cells are known as keratocytes. The stroma is made up of roughly of 200 layers lamellae which are 1.5-2.5 µm in thickness and are constituted of collagen fibrils enmeshed in a matrix consisting of proteoglycan, protein and glycoproteins[3].

The narrow and uniform diameter of collagen fibrils and the regular arrangement are characteristic of collagen of corneal stroma and are necessary for transparency of the cornea. Type I collagen is major collagen of corneal stroma. It constitutes approximately 70% of total stromal dry weight. Glycoprotein constitute 10% of dry weight cornea. The lattice arrangement of collagen fibrils embedded in the extra cellular matrix is partly responsible for corneal transparency[3].

4. Predescemets membrane.

5. Descemet's membrane:

10 µm thick and is secreted by endothelium. Type IV collagen is most abundant collagen in it. It consist of anterior banded protein and posterior not banded protein[3].

6. Endothelium:

Is a single layer of polygonal cells 20 µm in diameter. In young adult, the normal endothelial count is approximately 3000 cell/mm^3. The number decrease with aging. It acts as a barrier between aqueous and stroma. Tight junction between endothelium are essential for controlling corneal hydration[(3)].

1.4 Physiology of intraocular Pressure (IOP):

IOP is a result of a fluid system in the human eye where balance between in and out flow determines the level of IOP. It is maintained by the production of aqueous humor in the ciliary body in the posterior chamber and the outflow through the trabecular meshwork or the uveoscleral pathway originating in the anterior chambers. The flow of aqueous humor against resistance in a healthy eye creates an IOP of approximately 16$\pm$5 mm Hg. IOP plays a central role throughout ophthalmology. It is part of routine ophthalmologic examinations and important in the management and follow up of glaucoma patients.

Goldmann Applanation Tonometer (GAT) has been shown, in numerous studies, to be dependent on corneal properties such as central corneal thickness (CCT) and corneal curvature (CC). So IOP is measured with a tonometer as a part of comprehensive eye examination. Measured values of IOP are influenced by corneal thickness and rigidity. As a result, some forms of refractive surgery (such as PRK) can cause traditional IOP measurements to appear normal when in fact the pressure may be abnormally high. A newer trans palpebral and trans scleral tonometry method is not influence by corneal biomechanics and does not need to be adjusted for corneal irregularities as measurements is done over upper eyelid and sclera[(4)].

In order to measure IOP with GAT a drop of anesthetic and fluorescein is instilled in the eye. Through an optical prism the examiner sees two semicircles and adjusts the force until the inner edges of the semicircles connect GAT is mounted an a biomicroscope and thus requires the patient to be in a sitting position. Perkins and Draeger are handheld versions of GAT.

The applanation principle is also used by the Tono-pen after applanating the cornea with this handheld tonometer, it presents an average IOP of several measurements. The Tonopen is especially useful in irregular corneas and in patients who cannot sit at the biomicroscope(4).

1.5 Tonometry Methods Measurements:

Can be divided into 4 different categories according to their principles of measurements: Applanation, indentation, contour matching and rebound tonometry(4).

1.5.1 Applanation Tonometry:

The gold standard for tonometry methods is the Goldmann Applanation Tonometer (GAT) Fig. (1.7) Goldmann and Schmidt based their novel tonometer on the law of Imbert-Fick (Eq. 1) which states that the IOP is proportional to the force (F) needed to applanate apre-defined area (A) (Goldmann, 1957)(4).

$$IOP = \frac{F}{A}$$

Eq. 1. Imbert – Fick's Law

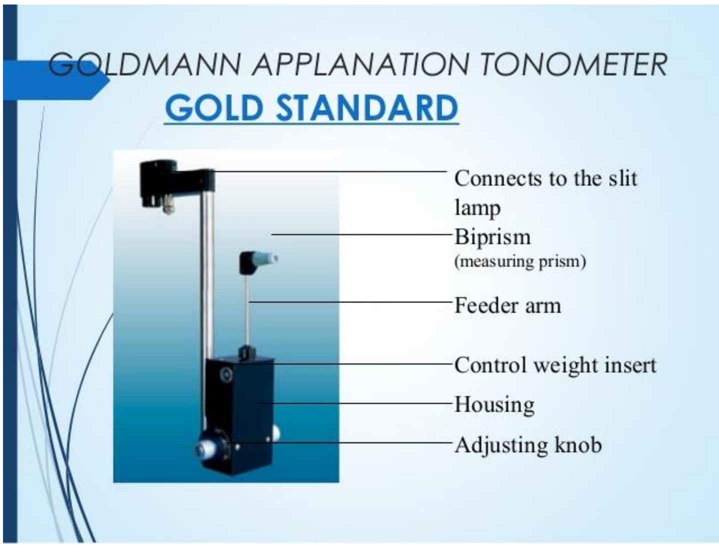


Fig. (1.7)

Goldmann Applanation Tonometer (GAT)

However, Eq. 1 is only applicable to an infinitely thin membrane with perfect elasticity and a dry surface (Goldmann, 1957). Since the cornea meets none of these conditions. Goldmann and Schmidt compensated for potential errors by presuming that the corneal thickness would be approximately 500 µm in most healthy eyes. Furthermore, they recognized that the influence of the tear fluid and the rigidity of the cornea would cancel out each other at a contact area with a diameter of approximately 3.06 mm(4).

1.5.2 Non-contact Tonometry (NCT):

Works with the applanation principle an air pulse applanates a predefined area of the cornea. An optical sensor registers when the applanation is complete and IOP is calculated depending on the force needed to applanate the cornea. The NCT technology has been further developed into the (ocular response analyzer) (ORA) that has the advantage of being able to measure a parameter believed to describe the visco-elastic dampening of the cornea, corneal hysteresis (rigidity)(4).

Applanation Resource Tonometry (ART) is a tonometry under development, it's based on the same principle, as GAT, i.e Imbert-Fick's law, but instead of a single reading of contact force and area as with GAT, it samples information continuous[4].

1.5.3 Indentation Tonometry:

The Schiotz tonometer was widely used before GAT was presented. It is still used in many regions in the world. The technique based on assessing how much indentation of the cornea that is caused by a particular weight (Schiotz, 1905).

1.5.4 Rebound Tonometry:

(I care) is a recently launched tonometry method based on a rebound technique. I care require no anaesthetics and is user-friendly, thus the field of application include children and disabled people[4].

1.5.5 Contour Tonometry:

The photodynamic Contour Tonometry (PDCT) is also recently launched. The method is based on direct trans-corneal IOP measurements many studies have shown PDCT to be less dependent or even independent of corneal biomechanics. The device has a concave sensor tip which enables the cornea to take the contour of the tip at contact. The IOP is then measured through a piezo resistive pressure sensor in the centre of the probe similar to GAT it's mounted on a biomicroscope and requires anesthestics[4].

1.6 Corneal Properties:

Corneal properties measured in these studies comprise CCT and CC. The normal CCT is estimated to be 534 µm. It's now recognized that the variation in the normal population is approximately 470 to 600 µm. a significant relationship between CCT and IOP measured with GAT is established. A thick cornea may give a false too high IOP reading and vice versa for a thin cornea. However, there is an ongoing debate or how much of the IOP measurement variance can be explained by CCT alone[4].

Normal CC is often in the range of $7.7 - 7.9\ mm$. True IOP may be overestimated when measured with applanation tonometry on steep corneas and under estimated in eyes with flat corneas. As for CCT, only a small portion of IOP measurement various can be explained by variance of CC[4].

Geometrical properties such as CCT and CC together with elastic properties of the cornea will have potential to affect IOP measurement due to corneal rigidity. Capillary forces due to tear fluid will also act on the applanation probe. These properties influence the tonometry in opposite directions. When a tonometer comes in contact with the eye, the tear fluid acts as an adhesive and can therefore theoretically facilitate the applanation[4].

Corneal rigidity, on the contrary, offers resistance to the tonometer and thereby potentially affects the IOP measurement toward a falsely high IOP (Goldmann, 1957)[4].

Mechanics can be applied to the analysis of dynamics systems and when applied to Biology it is termed biomechanics (Fungs, 1993). CCT and CC are examples of structural attributes that give rise to biomechanical properties of the cornea. Corneal thickness may be measured by (pachymetry) by optical and ultrasonic methods. Average corneal thickness, determined by optical and ultrasonic pachymetry is approximately $530 - 545\ \mu m$ in eyes without glaucoma[4].

1.7 Refractive Surgery:

Improvements in terms of increased safety and predictable results have been made in the field of refractive surgery during the last two decades. Refractive surgery has become increasingly popular in recent years[5].

The structural modification of corneal properties, e. g. CCT and CC, by refractive surgery, has augmented the risk for measurement error of IOP and consequently brought attention to the IOP measurement[5].

Generally, pre-operative examinations include a thorough ocular examinations, refraction, pupillometry, tonometry and measurements of corneal properties. Based on these variables and individual needs, the surgical technique is chosen. The techniques can mainly be classified into lamellar (e.g laser-in-situ Keratectomy) (LASIK) and Surface (e.g Laser assisted subepithelial Keratectomy) (LASEK) and photorefractive Keratectomy (PRK) ablation. LASIK is a subgroup in which the effect on IOP measurement has been sparsely investigated[5].

The fundamental difference between lamellar and surface ablation is the site of laser treatment in the corneal stroma and the indications for surgery. In lamellar ablation, a flap is created in the corneal stroma with a keratome and ablation carried out deep in the stroma. The patient experience a rapid increase in the V.A and few discomforting symptoms. During surface ablation only the epithelium is loosened and moved a side followed by external treatment of the stroma. The postoperative discomfort is greater and V.A improvement slower than with lamellar surgery. A general advantage with lamellar ablation is that patients with larger myopia, hyperopia and / or astigmatism can be treated compared to surface ablation[5].

1.8 Physical principles of photorefractive surgery:

1.8.1 Laser vision correction

- **Photorefractive Keratectomy (PRK)** utilizes a type of laser called an excimer laser to decrease nearsightedness. This form of laser vision correction removes a precise amount of tissue using a "cold" ultraviolet laser. The laser utilizes a sophisticated computer program that calculates and removes a precise amount of tissue from the center of one's cornea to decrease its curvature. This change in the cornea brings the focal point of the eye closer to the retina and improves one's distance vision[5].

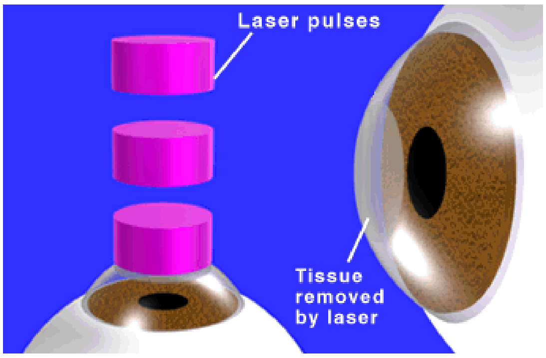


Fig. (1.8)

Photorefractive Keratectomy (PRK)

1.8.2 Astigmatism correction

- The excimer laser can be used to reduce astigmatism when performing LASIK or PRK surgery. The degree of astigmatism currently approved for correction is 0.75 D to 4.0 D. Astigmatism measurements describe to what degree the cornea is "non-spherical". As an example, the surface of a basketball is spherical and would have **no** astigmatism. The surface of a football, on the otherhand, would be highly non-spherical and would have **high** astigmatism. The excimer laser reduces the degree of astigmatism by removing corneal tissue in an asymetric manner. This is accomplished by utilizing an oval-shaped laser beam[5].

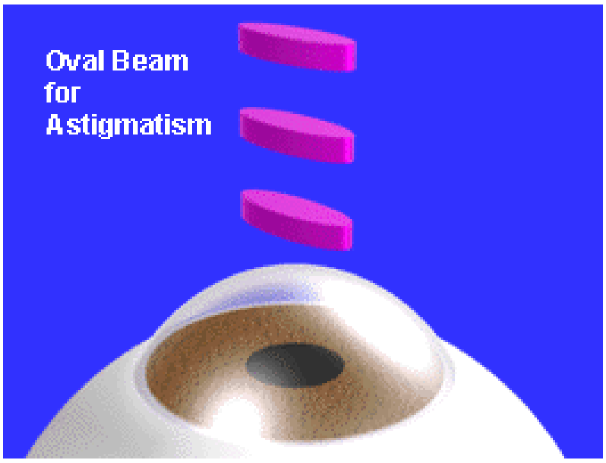


Fig. (1.9)

Astigmatism correction

1.8.3 Hyperopic Correction

The excimer laser can be used to reshape the cornea to correct farsightedness. If your eye is farsighted (hyperopic) the cornea is flatter than is required given the length of your eye. Hyperopic excimer laser surgery can improve your vision without glasses by reshaping the front surface of the eye and making it more curved[5].

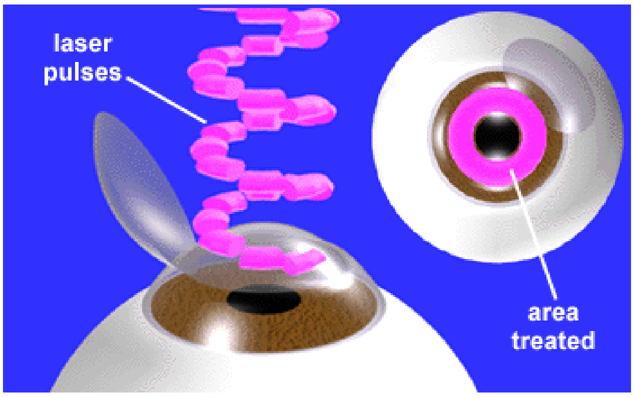


Fig. (1.10)

Hyperopic Correction

- In hyperopic (farsighted) treatment, a "donut" of tissue is removed from the mid-periphery of the cornea as shown in the picture above. This changes the profile of the cornea to steepen the central curvature as pictured below(5).

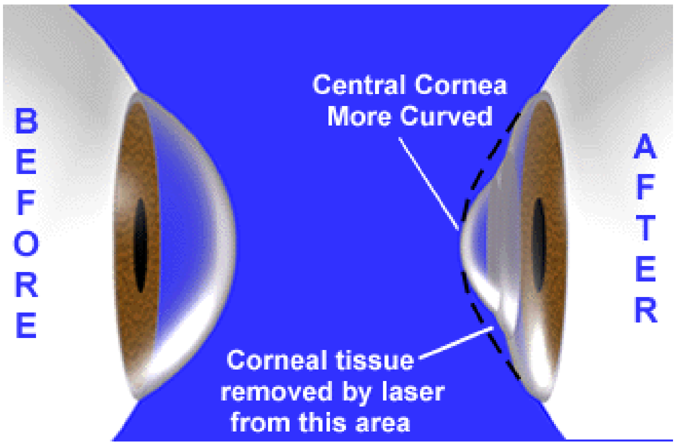


Fig. (1.11)

Hyperopic Correction

1.8.4 LASIK

- LASIK is a shortened term standing for "Laser in Situ keratomileusis". This correction procedure utilizes two devices to alter the degree of near-sightedness in an eye. These two devices are the excimer laser and the microkeratome(5).
- After anesthetic eyedrops are put on the eye, a suction ring is centered over the cornea of the eye. This suction ring stabilizes the position of your eye and increases the pressure to a level that is needed for proper functioning of the microkeratome. The guide tracks on this suction ring are used to provide a precise path for the microkeratome(5).

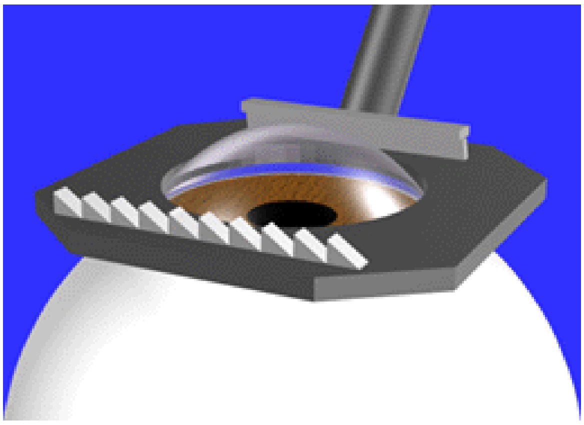


Fig. (1.12)

LASIK

- The microkeratome is a very precise instrument that is the "keystone" in the LASIK procedure. This device is a mechanical shaver that contains a sharp blade that moves back and forth at high speed. This shaver is placed in the guide tracks of the suction ring and is advanced across the cornea using gears at a controlled speed. This process creates a partial flap in the cornea of uniform thickness. The flap is created with a portion of the cornea left uncut to provide a hinge[5].

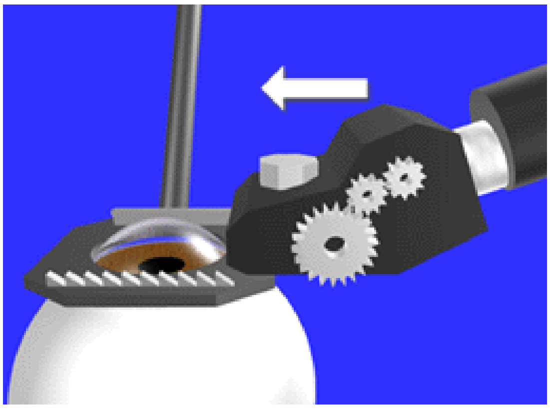


Fig. (1.13)

LASIK

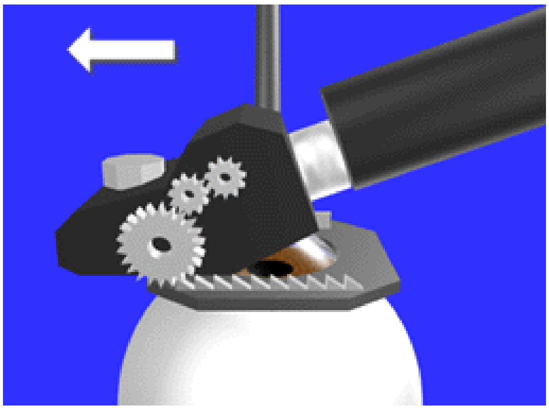


Fig. (1.14)

LASIK

- After the suction ring and microkeratome have been removed, the corneal flap is folded back on the hinge exposing the middle portion of the cornea[5].

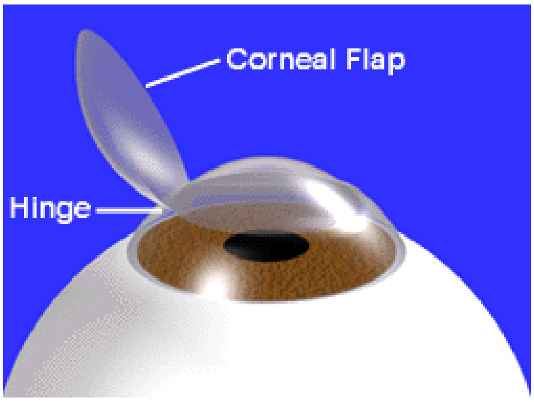


Fig. (1.15)

LASIK

- The excimer laser is then used to remove tissue and reshape the center of the cornea. The amount of tissue removed is dependent upon the degree of near-sightedness that is being corrected. This portion of the LASIK procedure is almost identical to the PRK procedure, except that in the PRK the surface of the cornea is treated **without** the creation of the corneal flap[5].

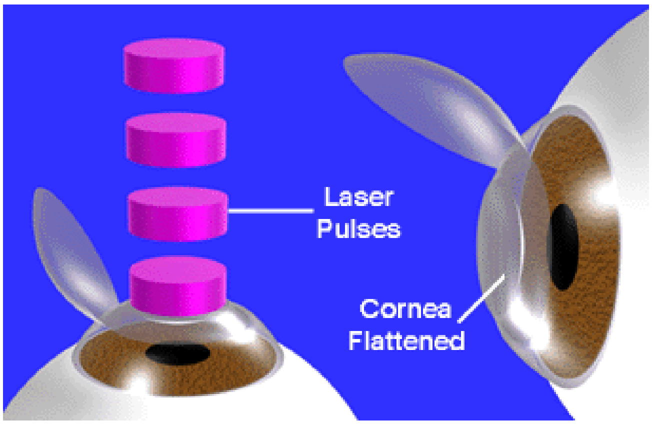


Fig. (1.16)

LASIK

- In the final step, the hinged flap is folded back into its original position. The front surface of the eye is now flatter since the flap conforms to the underlying surface. In effect, the change made in the middle of the cornea is translated to the front surface of the cornea[5].

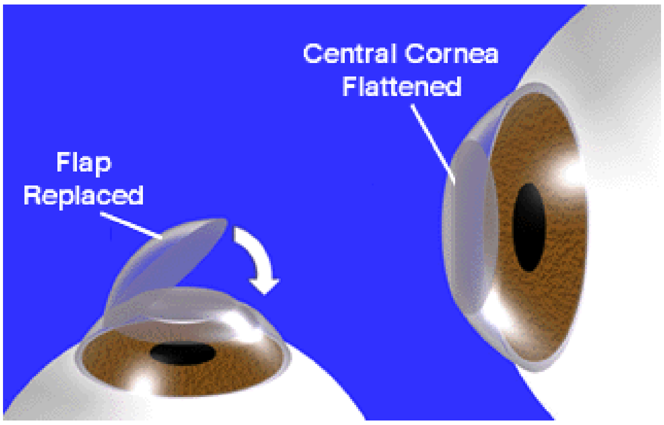


Fig. (1.17)

LASIK

PRS or Laser vision correction surgery alters the curvature of the cornea. The clear shield of the front of the eye, changing the power of the eye similar to the way a contact lens changes the power of the surface of the eye. A contact lens creates an artificially flatter, steeper or more aspheric (oblong) front surface of the eye based on the patients prescriptive needs[6].

1.9 Laser Parameters

Early studies of the potential use of Excimer laser focused on determining the best laser parameters (optimal ablation rates, fluence and wave length) to deliver smooth surfaces with no thermal damage to surrounding tissue. It was soon discovered that the 193 nm wave length of the ArF laser produced the best results and predictable ablations, with no variation in threshold energy at different laser pulse rates. Irradiance is a term that describes amount of energy per unit area. Another term fluence is more frequently used when describing energy in milli Joules (mJ) per unit area (cm^2). The minimum fluence required to ablate human corneal tissue is 50 mJ/cm^2 with the 193 nm Excimer laser, and this does not vary considerably with ablation rates. Additionally, fluence correlates directly with ablation depth per pulse, with a greater efficiency over a range of 150 to 400 mJ/cm^2. Ablation depth varies in different tissues for the same fluence, so scarred tissue can be lead to an irregular ablation rate. Fluence must be calibrated daily in most devices to precisely adjust the ablation depth per pulse expected(6).

1.10 Laser Tissue Interaction:

The effect of laser on biological tissue can be divided into two categories:

Wave length dependent and wave length independent.

1.10.1 Wave Length Dependent:

The interaction here depends largely on the laser wave length that has impacted the tissue since it's a very important parameter that determines the index of refraction as well as the absorption and scattering coefficient(6).

1.10.1.1 Photochemical Interaction:

Photochemical interactions take place at very low power densities (typically $1W/cm^2$) and long exposure times ranging from seconds to continuous wave[6].

1.10.1.2 Photo Thermal Interaction:

In biological tissue, photo energy changed to heat when 2 condition exist:

1. Absorption of photon by biological molecule to produce an excited molecule.
2. Collisions with other molecules lead to gradual deactivation of the excited one and increase in kinetic energy (increase tissue temperature)[6].

1.10.1.3 Photo Ablation:

Under effect of direct laser radiation of certain wave length and intensity, each monomer unit undergo excitation from an attractive to repulsive state. This promotion is associated with volume change and tissue dissociation leading to tissue ablation with minimal thermal effect[6].

1.10.2 Wave Length Independent:

These interaction mechanisms rely on plasma generation at high power density $10^{11} - 10^{16}$ W/cm^2 associated with lasers operating in short pulse duration (nanosecond, picosecond). At high intensities, the electric field strength of radiation is also very large, which is sufficient to cause dielectric breakdown in the tissue. The generation of plasma with laser pulses in the nanosecond range in thermionic emission and in the picoseconds or femtoseconds range in multi-photon ionization[6].

1.10.2.1 Plasma Induced Ablation:

Optical breakdown can be induced when obtaining power densities exceeding 10^{11} W/cm^2 in solids and liquids in picoseconds time. Ablation is obtained by ionizing plasma formation with an end results of very clean ablation associated with an audible report and bluish plasma sparking[(6)].

1.10.2.2 Photo Disruption:

In this type of interaction, in addition to plasma formation, shock wave is generated (leading to cavitation and jet formation). This ends up with fragmentation and cutting of tissue by these mechanical forces. Pulse durations in nanosecond usually induce photo disruption. Power densities may reach up to 10^{16} W/cm^2[(6)].

1.10.3 Optical Breakdown and Plasma Formation

Optical breakdown and plasma formation are the two critical events central to photo disruption. Optical breackdown is a sudden event with a drastic change to the target. When irradiated with laser the electrons gain enough power to completely dissociate from their atoms and the total area become ionized. Light energy can create this ionized state a "plasma"[(6)].

Table (1.1)

Key differences between flap surgery and surface surgery[5]

	Flap surgery (LASIK)	**Surface surgery (PRK, LASEK, Epi LASIK)**
Eye pain after surgery	Minimal (may last up to 12 hrs after surgery)	Moderate to serve (may last up to 72 hrs after surgery)
Functional vision recovery	Earlier (less than 24 hrs)	Later (3 to 7 days)
Corneal scarring risk	Minimal (<1%)	Greater > 1 to 2%
Dry eye symptoms	More risk (may last more than 6 months)	Less risk (last for 1 to several weeks)
Risk of complications	More risk Flap issue: flap wrinkles, epithelial ingrowth, flap melt	Less risk In general, safer than LASIK
Best for	Most patients	Patient with thin corneas or large pupils, contact sport (sportman, militaryman)

1.11 Laser Safety (precaution):

In safe design, use and implementation of lasers to minimize the risk of laser accidents, especially those involving eye injuries. Since even relatively small amounts of laser light can lead to permanent eye injuries, the sale and usage of lasers is typically subject to government regulation moderate and high-power lasers are potentially hazardous because they can burn the retina of the eye, even the skin. To control the risk of injury, various specifications, for e. g ANSIZ 136 in the US and IEC 60825 internationally, define "classes" of laser depending on their power and wave length. The regulations also prescribe required safety measures, such as labeling lasers with specific warnings and wearing safety goggles when operating lasers[7].

1.12 Laser Radiation Hazards:

Laser radiation predominantly causes injury via thermal effects. Even moderately powered lasers can cause injury to the eye-high power lasers can also burn the skin. Some lasers are so powerful that even the diffuse reflection from a surface can be hazardous to the eye. The coherence, the low divergence angle of laser light and the focusing mechanism of the eye means that laser light can be concentrated into an extremely small spot on the retina. A transient increase of only 10C^o can destroy retinal photo receptor cells. If the laser is sufficiently powerful, permanent damage can occur within a fraction of second, literally faster than the blink of an eye. Sufficiently powerful in the visible to near, infrared laser radiation $(400 - 1400\ nm)$ will penetrate the eye ball, and may cause heating of the retina, whereas exposure to laser radiation with wave length less than 400 nm and greater than 1400 nm are largely absorbed by the cornea and lens, leading the development of cataracts or burn injuries. Infrared lasers and particularly hazardous, since the body's protective "blink reflex" response is triggered only by visible light. For example some people exposed to high power Nd: YAG laser emitting invisible 1064 nm radiation, may not feel pain or notice immediate damage to their eye sight. A pop or click noise emanating from the eye ball may be the only indication that retinal damage has occurred i.e the retina was heated to over 100C^o resulting in localized explosive boiling accompanied by the immediate creation of a permanent blind spot[8].

Chapter Two

Materials and methods

2.1 Patients and Methods:

In this prospective study, we reviewed the medical records of patients who underwent myopic, hyperopic and astigmatic LASIK with flap created using MK and PRK from (July 1st 2018) to (October 17th 2018) at the department of ophthalmology in Laser Institute for Postgraduate Studies and in LASIK department in an Ibn Al-Haithem Teaching Hospital for ophthalmology. The patient records information was an anonymized and deidentified prior to analysis. The minimum age of the patients was 18 years old and they consider suitable for laser refractive surgery (LRS) (LASIK and PRK) after detailed screening examinations. Patients were excluded if they had a history of ocular disease, trauma, surgery, diabetes mellitus or other systemic diseases known to affect the eyes. Patients who developed a new ocular illness that interfered with the outcomes during the follow-up were excluded from the study.

2.2 Patients:

52 patients with ages running from 18-50 years old (average 34.5 $\pm$ 7.5) were scheduled for PRS (LASIK and PRK) to treat myopia, hypermetropia and astigmatism. Patients were subjected to a complete surgical ophthalmic examination that includes the IOP tests for this study.

The IOP tests were repeated 1 wk 1-3 months after surgery. The study was conducted in compliance with good clinical practice guidelines informed consent regulations. All the subjects enrolled in the study were adults older than 18 years who were able to give informed consent and they could leave the study at any time.

2.3 Clinical Measures:

Before and after LASIK surgery, spherical equivalent refraction (SER), corneal curvature (CC) and central corneal thickness (CCT) were obtained. IOP values pre and post-surgery measured using different technique: Goldmann applanation tonometer (GAT) and NCT (air puff tonometer).

2.4 Vision Correction Technique:

Wave light Allegretto wave eye-Q laser technical data and references.

Fig. (2.1)

Wave light Allegretto wave eye-Q laser device

Table (2.1)

Laser technical data of the wave light Allegretto device

Technical Data	
Laser class	Class 4 (IEC + 21 CFR)
Laser type	ArF-excimer laser (Argon Fluoride)
Wavelength	193 nm
Pulse duration	12 ns
Repetition rate	400 Hz
Treatment time	2 s/D at a fully corrected OZ of 6.5 mm
Aiming beam diodes	635 nm Laser class 2 (IEC 60825), class II (21 CFR 1040)
Focusing beam diodes	635 nm Laser class 2 (IEC 60825), class II (21 CFR 1040)
Spot characteristics	Diameter 0.95 mm Gaussian beam profile
Ablation profiles	*Wavefront*® *Optimized*® ablation profiles
Working principle	Flying spot laser system 2 mirrors on closed-loop galvo scanners
Eye-tracking system	Active IR eye-tracking system Eye-tracking and laser trigger synchronized Centered on the optical center of the pupil Center manually adjustable
Microscope	Zeiss Pico*
Magnification steps	5; 7.5; 12.5; 20; 31 .25
Working distance	20 cm (7.9 inches)
Patient adjustment	Z- and xy-adjustment for exact positioning of patients' eye
Applications	*Wavefront*® *Optimized*® refractive treatments Wavefront-Guided (A-CAT) treatments in conjunction with the Analyzer Diagnostic Device (optional)
Refraction increments	0.25 D (0.01 D)
Calibration	Fluence on PMMA and eye-tracking system on test targets once a day
Energy control	Closed-loop energy control
Laser control	Membrane key pad, joystick
Gas supply	1 ArF premix gas cylinder (20 I integrated) 1 nitrogen gas cylinder (20 I integrated or 50 I external) Nitrogen grade 4.0 or higher
Cooling	Air cooled, low noise
Weight	Laser with standard bed: 444 kg (979 pounds) (excl. gas) Laser with swiveling bed: 476 kg (1,050 pounds) (excl. gas)

ZEIS MEL 80 Excimer Laser

Fig. (2.2)

ZEIS MEL 80 Excimer Laser

Table (2.2)

Product Information, Technical Data and Laser Data

Type	ArF excimer laser
Wavelength	193 nm
Frequency	250 Hz
Aiming beam diode	650 nm (laser class 1)
Device Data	
Weight of MEL® 80	290 kg incl. gas cylinder
Weight of patient supporting system	232 kg
Dimensions (Laser, W * D * H)	800 * 1550 * 1490 mm
Dimensions including patient	1800 * 3140 *
Phototherapeutic keratectomy	
Area ablation	Programmable PTK shaping

Type	ArF excimer laser
Treatment range	
According to CE guidelines	-12 D to +3 D (up to 3.0 D cyl)
Active eye tracker	Infrared, pupil and limbus tracking. 1050 frames per second (fps)
CCA+(plume removal system)	Integrated in device
Spot scanning-parameters	
Beam dimensions	0.7 mm FWHM (Full width at half maximum), Gaussian beam profile
Area ablation	Programmed PTK shaping
CCA+(plume removal system)	Integrated into the device, automatic adaptation 250 Hz / 500 Hz operation
Optional	Monitor with touch screen, keyboard, printer, CRS-Master, PRESBYOND® Laser Blended Vision
Spot scanning parameters	
Beam dimensions	0.7 mm FWHM (full width at half maximum), Gaussian beam profile
Phototherapeutic keratectomy	
Dimensions including patient supporting system (w * D * H)	1800 * 3140 * 1490 mm
Power supply	100 V AC; 50/60 Hz; 17.5 A 120 V AC; 50/60 Hz; 14.6 A 208, 220, 230, 240V AC; 50/60 Hz; 7.9A
Gas supply	Integrated ArF-Premix cylinder 10 I
Equipment	
Surgical microscope	OPMI® pico with integrated video

2.4.1 LASIK & PRK Technique:

Surgery was performed by two experienced surgeons, performed all PRS (LASIK and PRK) procedures, using flying spot Excimer laser system, version (zeiss and allegretto). Laser parameters included the following: wave length of 193 nm, radiant exposure (fluence) of 160 mJ/cm^2, pulse repetition rate of 50 Hz, average ablation depth/pulse of 0.25 µm on the cornea, and an ablation zone diameter from 6.5-7 mm with transition zone of 0.5 mm. all flaps had a superior hinge, and the intended thickness ranged from 100 to 120 µm. the MK (microkeratome) flap were created using Moria M2 (Moria, Antony, France) with superior hinge, and the intended thickness were 110 µm and 130 µm. all stromal beds ablated using S4 Excimer laser. Emmetropia was attempted in all cases by using on ablation zone 6.5-7 mm for spherical and astigmatic corrections. The postop topical medication regimen consist of ciprofloxacin (Nor-floxacin) 4 times/day, Tobradex (Alcon) every 2 hrs and artificial tears (Refresh, Allergan, USA or Hyfresh) every 1 hr for 1 day, and 0.1% flouro methalone (FML) was subsequently administrated 4 times per day at a dose that tapered to the end of the month for all eyes, presurgical manifest refraction was selected as the target correction.

2.4.2 Outcome Measures:

Both eyes were recruited in patients who underwent bilateral PRS (LASIK and PRK). The preoperative variables were age, sex, MSE, ablation depth, CCT (Ultrasound U/S pachymetry), CCK measured using (Kerato Auto Refractometer), IOP and flap thickness. The flap thickness was recorded as the intended flap setting in surgery. After the operation, the patients were followed up to 1 week, and at 1, 3 months. Patients who did not return for follow up at 1 week and 1 month were excluded.

2.5 Methods for Measurement IOP:

All IOP values were measured using NCT (Topcon computerized tonometer, Japan) and CT (GAT). IOP measurements was first reviewed a 1 week, before LASIK (PRS) and then a day before the surgery, and at 1 wk and 1, 3 months after PRS (LASIK and PRK). At each visit, IOP was examined 3 times in each eye. The mean IOP obtained during average IOP measurements was used in analysis.

2.6 Methods for Assessment of Corneal Properties:

Several methods were used for documentation of the anterior segment. Orban scan (CCT orb scan) is scanning slit (light) base optical reflectance method that requires no anesthesia. This procedure enables the apparatus to topographically map the cornea. CCT was measured within a central sector with a diameter of 3.06 mm.

The pachymeter SP-100 is an ultrasound instrument that measures CCT (CCT pachymeter) through a contact probe placed perpendicular to the central cornea. A mean of 3 measurements was registered according to the instrument manual. The anterior segment was photographed using a penta cam. It is a scheim camera that rotates while it photographs and captured detailed formation of the anterior segment including CC and CCT penta cam.

Chapter Three

Results and Discussions

3.1 Statistical Analysis:

To compared the predictability of IOP change (post IOP – pre IOP), the statistical analysis was performed using the statistical package for the social sciences software version 15.0, continuous variables were analyzed using the two-tailed student's t-test. Pearson collerations were used to assess the relationship between preoperative and postoperative (GAT and NCT (air puff tonometer) IOP measurements. There is a high postoperative difference in measurement obtained by Goldmann applanation versus NCT (air puff tonometer). Both eyes (92 eyes) of 52 patients were included in this study, sixty four (64) underwent PRK and twenty nine (28) underwent LASIK. The patient range in age from 18-50 years (mean 26.5 ± 5.5 years). The mean spherical equivalent prior to surgery was -5,25 + 1,5 diopters (D), mean preoperative central corneal thickness was 560 ± 22,5 µm overall, 553 ± 25.1 µm in PRK group, and 565 ± 19.3 µm in the LASIK group, mean postop. CCT was 471.7 ± 38.1 µm overall, 456 ± 49 µm for PRK group and 482.5 ± 23.1 µm for the LASIK group.

Table (3.1)

Patient characteristics

	LASIK (mean ± SD)	**PRK (mean ± SD)**
Age (years)	27.5 ± 6.3	25.4 ± 5.0
Preoperative spherical equivalent (D)	±5.25 ± 1.2	±3.8 ± 1.7
Pre op. CCT (µm)	553 ± 25.1	565 ± 19.3
Post op. CCT (µm)	456.1 ± 49	482.5 ± 23.1
Pre op. corneal curvature (D)	45.0 ± 1.5	43.66 ± 1.2
Post op. corneal curvature (D)	40.25 ± 1.75	39.5 ± 1.4
Pre op. GAT (mm Hg)	16.4 ± 2.0	15.9 ± 2.0
Post op. GAT (mm Hg)	10.9 ± 1.4	10.7 ± 1.5
Pre op. NCT (air puff)	16.2 ± 1.7	15.5 ± 2.5
Post op. NCT (air puff)	16.3 ± 1.8	15.6 ± 2.6

Note: Statistically significant (P < 0.05)

The mean preoperative IOP reading was 16.2 ± 1.9 mmHg for GAT and 15.9±2.0 mmHg for NCT, the difference in pre op. IOP measurements between the two devices was found to be statistically significant for PRK and LASIK (MK) groups combined (P < 0.04), IOP value measured by NCT tend to be lower than those measured by GAT by 0.3 ± 1.0 mmHg, while (post op. NCT) reading tended to be higher than GAT readings. Mean NCT readings were 16.1 ± 2.3 mmHg and mean GAT readings were 10.8 ± 1.5 mmHg with differences between measurements of 5.2 ± 1.9 mmHg (P < 0.001).

Note: All eyes were included (PRK and LASIK groups combined) when comparing the difference between pre op. and post op. measurements obtained by GAT, IOP readings where higher prior to surgery by 5.3 ± 1.8 mmHg ($P < 0.01$), with NCT post op. measurements where higher by 0.2 ± 0.5 mmHg ($P < 0.01$).

We compared the effect of modality of surgery on IOP measurements obtained by GAT and NCT prior to and after surgery. For that purpose, we compared the preop. And postop. difference in measurements between the two modalities of surgery. Mean IOP for LASIK measured by GAT was 16,4 ± 2 mmHg pre op. and 10.9 ± 1.5 mmHg post op. for PRK, the mean pre op. measurement was 15.8 ± 2.0 mmHg versus 10.7 ± 1.5 mmHg post op. Thus there was no statistically significant difference in the amplitude of change in preoperative versus postoperative GAT IOP measurement between LASIK and PRK. The mean NCT pre op. IOP measurement for LASIK eyes was 16.2 ± 1.5 mmHg versus 16.3 ± 2.0 mmHg post op. The mean NCT pre op. reading for PRK eyes was 15.5 ± 2.5 mmHg versus 15.6 ± 2.6 mmHg postop. Therefore was also unaffected by modality of surgery.

3.2 Results:

Table (3.2)

Result after 1 week Post Op. IOP

Case No.	Pre op. IOP (mm Hg)		1 wk Post op. (mm Hg)		Pre op. CCT (µm)	Expected ablation depth (µm)	Post op. CCT (µm)
	OD	OS	OD	OS			
Case 1 LASIK	14	14	10	11	548	-127	421
Case 2 LASIK	14	14	10	11	539	-115	424
Case 3 PRK	14	12	13	11	519	-35	484
Case 4 PRK	14	12	13	11	518	-39	479
Case 5 PRK	15	15	7	8	518	-84	424
Case 6 PRK	15	15	7	8	509	-89	420
Case 7 PRK	11	15	11	12	614	-47	567
Case 8 PRK	11	15	11	12	602	-46	556
Case 9 PRK	6	7	10	10	513	-28	485
Case 10 PRK	6	7	10	10	513	-32	481
Case 11 PRK	17	17	16	14	542	-34	508
Case 12	17	17	16	14	564	-33	531

Case No.	Pre op. IOP (mm Hg)		1 wk Post op. (mm Hg)		Pre op. CCT (µm)	Expected ablation depth (µm)	Post op. CCT (µm)
	OD	OS	OD	OS			
PRK							
Case 13 PRK	17	17	13	12	543	-19	527
Case 14 PRK	17	17	18	12	544	-53	491
Case 15 PRK	14	15	10	13	553	-37	516
Case 16 PRK	14	15	10	13	556	-32	524
Case 17 PRK	15	15	10	12	547	-37	510
Case 18 PRK	15	15	10	12	560	-30	530
Case 19 PRK	13	14	10	11	536	-71	465
Case 20 PRK	13	14	10	11	529	No correction -10.0s/ -1.50c/180	
Case 21 PRK	15	14	13	13	562	-36	526
Case 22 PRK	15	14	13	13	556	-33	523
Case 23 LASIK	16	17	7	8	509	-89 mm (flap thickness -120 µm)	420
Case 24 LASIK	16	17	7	8	509	-89 mm (flap thickness -120	424

Case No.	Pre op. IOP (mm Hg)		1 wk Post op. (mm Hg)		Pre op. CCT (µm)	Expected ablation depth (µm)	Post op. CCT (µm)
	OD	OS	OD	OS			
						µm)	
Case 25 PRK	14	18	13	14	522	-41	481
Case 26 PRK	14	18	13	14	542	-37	508
Case 27 PRK	14	14	11	12	537	-49	488
Case 28 PRK	14	14	11	12	539	-49	490
Case 29 PRK	16	14	13	12	520	-23	497
Case 30 PRK	16	14	13	13	529	-19	510
Case 31 LASIK	18	18	12	14	565	-89 mm (flap thickness -120 µm)	483
Case 32 LASIK	18	18	12	14	554	-65	489
Case 33 PRK	14	14	12	12	565	-27	528
Case 34 PRK	14	14	12	15	563	-44	519
Case 35 LASIK	13	14	10	11	507	-16 µm (flap thickness -120 µm)	491 371
Case 36	13	14	10	11	504	-26	478

Case No.	Pre op. IOP (mm Hg)		1 wk Post op. (mm Hg)		Pre op. CCT (µm)	Expected ablation depth (µm)	Post op. CCT (µm)
	OD	OS	OD	OS			
PRK							
Case 37 LASIK	16	17	12	13	547	-58 µm	491
						Flap thickness 120 µm	Stroma 731
Case 38 LASIK	16	17	12	13	528	-48 µm	480
						Flap thickness 120 µm	Stroma 360
Case 39 PRK	12	15	10	13	565	-27	538
Case 40 PRK	12	15	10	13	563	-44	519
Case 41 PRK	15	15	13	13	617	-59	563
Case 42 PRK	15	15	13	13	626	-56	570
Case 43 PRK	17	18	13	18	555	-83	472
Case 44 PRK	17	18	13	18	550	-71	479
Case 45 PRK	14	15	13	13	561	-60	501
Case 46 PRK	14	15	13	13	550	-55	495
Case 47 LASIK	15	14	12	11	551	-79 µm	472
						Flap thickness 120 µm	Stroma 372

Case No.	Pre op. IOP (mm Hg)		1 wk Post op. (mm Hg)		Pre op. CCT (µm)	Expected ablation depth (µm)	Post op. CCT (µm)
	OD	OS	OD	OS			
Case 48 LASIK	15	14	12	11	567	-78 µm	489
						Flap thickness 120 µm	Stroma 369
Case 49 PRK	11	12	10	10	543	-29	514
Case 51 PRK	11	12	10	10	545	-38	507
Case 51 LASIK	18	18	13	13	576	-52 µm	524
						Flap thickness 120 µm	Stroma 404
Case 52 LASIK	12	13	13	13	566	-95 µm	461
						Flap thickness 120 µm	Stroma 341

Table (3.3)

Post Op. IOP (mm Hg) 1 month, 3 months after PRS (Photorefractive Surgery)

Case No.	**Post Op. 1 month**		**Post Op. 3 months**	
	OD	**OS**	**OD**	**OS**
Case 1	9.5	105	9.5	10.5
Case 2	9.5	105	9.5	10.5
Case 3	12.5	10.5	11.5	9.5
Case 4	12.5	10.5	11.5	9.5
Case 5	7	8	6.5	7.5
Case 6	7	8	6.5	7.5
Case 7	10.5	11.5	10.0	11.0
Case 8	10.5	11.5	10.0	11.0
Case 9	9.5	9.5	9.0	9.0
Case 10	9.5	9.5	9.0	9.0
Case 11	15.5	13.5	14.5	13.0
Case 12	15.5	13.5	14.5	13.0
Case 13	12.5	11.5	11.5	11.0
Case 14	12.5	11.5	11.5	11.0
Case 15	9.5	12.5	9.0	11.5
Case 16	9.5	12.5	9.0	11.5
Case 17	9.5	11.5	9.0	11.0
Case 18	9.5	11.5	9.0	11.0
Case 19	9.5	10.5	9.0	10.0
Case 20	9.5	10.5	9.0	10.0
Case 21	11.0	11.0	10.5	10.0
Case 22	11.0	11.0	10.5	10.0

Case No.	Post Op. 1 month		Post Op. 3 months	
	OD	OS	OD	OS
Case 23	7	8	7.8	8.5
Case 24	7	8	7.8	8.5
Case 25	10.5	11.5	9.5	10.5
Case 26	10.5	11.5	9.5	10.5
Case 27	10.0	11.0	9.5	11.0
Case 28	10.0	11.0	9.5	11.0
Case 29	12.0	12.0	11.5	11.5
Case 30	12.0	12.0	11.5	11.5
Case 31	11.0	13.0	10.5	12.0
Case 32	11.0	13.0	10.5	12.0
Case 33	11.0	11.0	10.0	10.0
Case 34	11.5	14.0	11.0	13.5
Case 35	9.5	10.0	9.0	9.5
Case 36	9.5	10.0	9.0	9.5
Case 37	11.0	12.0	10.7	11.5
Case 38	11.0	12.0	10.7	11.5
Case 39	9.0	12.0	8.5	11.5
Case 40	9.0	12.0	8.5	11.5
Case 41	12.5	12.5	12.0	12.0
Case 42	12.5	12.5	12.0	12.0
Case 43	12	16	11.5	15.0
Case 44	12	16	11.5	15.0
Case 45	12.5	12.5	12.0	12.0
Case 46	12.5	12.5	12.0	12.0
Case 47	11.0	10.5	10.5	10.0

Case No.	Post Op. 1 month		Post Op. 3 months	
	OD	OS	OD	OS
Case 48	11.0	10.5	10.5	10.0
Case 49	9.0	9.0	8.5	8.5
Case 50	9.0	9.0	8.5	8.5
Case 51	12.0	12.0	11.5	11.5
Case 52	12.0	12.0	11.5	11.5

We prospectively revised preoperative intraoperative and 1-3 postoperative medical records for 92 eyes of 52 patients who underwent photorefractive surgery (PRS) include LASIK and PRK for myopia, hyperopia and astigmatism. After excluding patient who did not return to follow up 1 month after operation, we evaluate these patients in LASIK and PRK groups. While selecting variables, we observed a highly negative correlation Between preoperative MSE (manifest spherical equivalent) and ablation depth. Therefore we only included the ablation depth for analysis. Correlation coefficient between flap thickness and CCT was 0.30 and the correlation coefficient between flap thickness and MSE was 0.12. Ultimately age, sex, ablation depth, flap thickness, CCT and CCK (central corneal keratometry) were processed for further analysis. Table (3.1) lists the descriptive data of LASIK with MK group. The mean age was 27.5 $\pm$ 6.3 years, and for PRK group 25.4 $\pm$ 5.0 years. The average MSE was 5.25 $\pm$ 1.2 diopters for LASIK and -3.8 $\pm$ 1.7 diopters in the PRK group. The mean CCT was 553 $\pm$ 25.1 µm and 565 $\pm$ 19.3 µm in LASIK and PRK groups, respectively.

The mean ablation depth was 87.5 $\pm$ 21.5 µm in LASIK group, and 82.5 $\pm$ 24.5 µm in PRK group. The mean intended flap thickness was 126 $\pm$ 6.0 µm in LASIK group (MK) which ranged from 100 – 130 µm.

The mean pre op. IOP was 16.4 ± 2.0 mmHg LASIK group, and 15.9 ± 2.0 mmHg in PRK group. mean post op. IOP (in LASIK group) was 10.9 ± 1.4 mmHg 1 week post op. and mean post op. IOP (in PRK group) was 10.7 ± 1.5 mmHg 1 week post op. at 1 month was 10.4 ± 1.4 mmHg, at 3 month was 10.4 ± 2.4 mmHg, at 6 months was 10.5 ± 2.5 mmHg (in LASIK group).

In PRK, at 1, month was 10.2 ± 1.5 mmHg, at 3 months was 9.00 ± 2.4 mmHg, at 6 months 8.8 ± 2.4 mmHg. Accordingly we included the post op. IOP at 1 week, 2 months and 3 months for predication of IOP changes.

Table (3.4) showed the factors influencing IOP changes in subjects undergoing PRK and LASIK. The significant predictors in the both groups are CCT, ablation depth and flap thickness.

Table (3.4)

Clinical characteristics of the LASIK group and PRK group

Variable	**LASIK group**	**PRK group**
Number of patients	23	29
Age at operation	27.5 ± 6.3	25.4 ± 5.0
Mean keratometric (dioptre)	45.0 ± 1.5	43.66 ± 1.2
CCT (μm)	553 ± 25.1	565 ± 19.3
Flap thickness (μm)	126 ± 8.2	-
Ablation depth	82.5 ± 24.5	85.5 ± 21.5
MSE (dioptre)	5.25 ± 1.5	3.8 ± 1.7
(NCT) pre op. IOP (mmHg)	16.2 ± 1.7	15.5 ± 2.5
(NCT) post op. IOP (mmHg)	16.3 ± 1.8	15.6 ± 2.6
(GAT) pre op. IOP (mmHg)	16.4 ± 2	15.9 ± 2.0
(GAT) post op. IOP (mmHg)	10.9 ± 1.4	10.7 ± 1.5

Fig 3.2, the mean IOP after LASIK and PRK. Data presented as mean ± standard deviation at 1 week, 1 month, 3 months after surgery. In both methods the flap dissection of MK (LASIK) and PRK post operation

at 1 month, 3 months were all significantly lower than post IOP at 1 week (the indicates P < 0.0001). The MK group showed greater post op. IOP from 1 week to 1 month than those of PRK laser group.

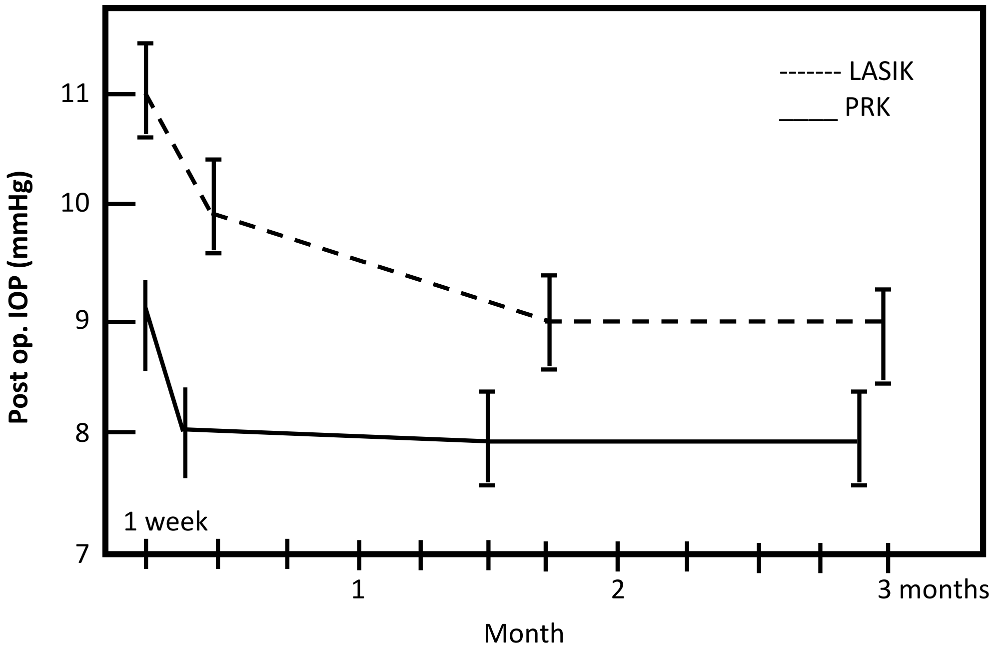


Figure (3.1)

Relation between Post Op. IOP and flap dissection of (LASIK) and PRK

3.3 Discussion:

Laser refractive surgery (LRS) (PRK or LASIK) is a safe procedure with good visual outcome. The aim of both types of LRS is to correct a metropias through the reduction of CCT(13,14).

Some authors have reported complications of LRS that occurred in consequence of ocular trauma. However, since the beginning of the LRS, initially PRK and further LASIK, there is no consensus if the eyes that underwent these surgeries remain with the same resistant (CRF) (Corneal Resistance Factor) or if they become less resistant to surgical trauma. In these words, could these kinds of surgery change E (ocular rigidity)(15,16).

Another question that arises is why the values of IOP (GAT) measurements are lower after LRS than before it? One point to be emphasized is that because of the reduction of CCT and also of the corneal curvature change, the artificial reduction of IOP measurement can occur with any kind of applanation tonometer, mainly with GAT which is still consider the gold standard(16). For statistical analysis, both eyes of the same patient were considered because:

1. Both eyes of some patients did not have the same pre op. dioptric value.
2. The amount of corneal ablation and resulting fragmentation or rupture of Bowman's membrane were not the same in both eyes.
3. Each eye of a patient could have a different post op. behaviours(17).

Our results showed an average artificial reduction of IOP measurement equal to 2.5 mmHg at 1-3 months in both eyes after LASIK. The difference were not statistically significant at 1-3 months. However, they were statistically significant after 3 months. Some authors have reported that the refractive stabilization after LASIK and PRK occurs up to 90 days(18). Its important to emphasize that the lowest averages of IOP (GAT) were found at 3 months with statistical difference highly significant (Table 1). So after 3 months (not 1 month) there was stabilization of the measured values (IOP, VC volume of corneal indentation, ocular rigidity(E) and tonometric pressure(Pt)(18).

It's obvious that the real IOP doesn’t change in consequence of LRS (LASIK). Therefore its' necessary to be very careful in selecting the patients who are candidates to LRS (Laser refractive surgery). Moreover for all above mentioned reasons LRS is not recommended in suspected or glaucomatous patients(19).

Corneal hysteresis (CH) and corneal resistance factor (CRF) measured by the ocular response analyzer (ORA) are novel methods of analyzing corneal elasticity. According to some papers, hysteresis of the cornea is also reduced after LRS. Therefore its' possible that after LASIK (reducing CCT), E is also diminished in consequence of the reduction CH and CRF(20,21).

3.4 Conclusions:

The cornea becomes less resistant after LRS (LASIK and PRK) and in consequence the GAT falsely underestimates the IOP. The IOP evaluation by NCT (air puff tonometer) is more accurate than that by GAT.

So, in conclusion, in this study of 92 eyes undergoing LRS (PRK and LASIK (MK)) for correction of ammetropia, measurements of IOP obtained by GAT and NCT were significantly different, with significant under estimations of postoperative IOP were using GAT. The type of surgery did not affect IOP measurement using either instrument. NCT was unaffected by CCT. Therefore NCT may be more appropriate for the measurement of IOP after ammertopic LRS (Laser Refractive Surgery).

The preoperative CCT and ablation depth had significant effect on predicting IOP changes in photorefractive surgery groups. In the LASIK group and PRK groups explain 47% and 18,9% respectively of the variation of post-operative IOP underestimation.

3.5 Future Direction and Recommendation:

Modern tonometry techniques such as pressure prosphene tonometry, rebound tonometry, dynamic contour tonometry and ocular response analyser (ORA) have been employed to obviate IOP under estimation after Laser Refractive Surgery (LRS).

References:

1. Changes in corneal biomechanics intraocular pressure following LASIK using static, dynamic and noncontact tonometry. Has S. Pepose, MD, PHD, American journal of ophthalmology, volume 143,issue 1,January 2007, P.39-47
2. Intraocular pressure change measured by Goldmann tonometry after laser in situ Keratomileusis. Annrik V. Fournier, MD, American society of cataract and refractive surgery and European society of cataract and refractive surgeon S. July 1998, volume 24, issue 7, p. 905-910.
3. Effect of photo refractive keratectomy nystagmus and visual functions in myopic patients with infantile nystagmus syndrome, Abbas Baghen, Hamid Abbasi, February 2016, volume 162, p. 167-172.
4. Intraocular pressure (clinical aspects and new measurement methods), Ganti Johannesson, Dept. of clinical sciences, ophthalmology Dept. of radiation sciences, Biomedical engineering and informatics, Umea university 2011.
5. Effect of laser in situ Keratomileusis on rebound tonometry and Goldmann applanation tonometry, Andrew K.C. Lam, PHD, FAAO, Journal of cataract and refractive surgery, volume 36, Issue 4, April 2010, p. 631-636.
6. Markolf H 2007 interaction mechanisms, In laser tissue interaction ,1st edition,3; 46-147.

7. Tonometry after laser in situ Keratomileusis treatment: a preliminary study in Thai patients, Ruang Voravate, Thuangtong A, Kosriruk Vongs P, I med assoc. Thai, 2005, 88(3): p. 340-344.
8. Effect of Excimer LASER photo refractive keratectomy on intraocular pressure measurements using the Goldmann applanation tonometer, 1997, American academy of ophthalmology .
9. Change in intraocular pressure in eyes measured with contact and non-contact tonometers after laser in situ Keratomileusis, M Aloa El Dansoury, MD, FRCS, Journal of refractive surgery, 2001, 17(2), p. 97-99.
10. Correlation of intraocular pressure and central corneal thickness in normal myopic eyes and after laser in situ Keratomileusis. Barry Emara, MD, Louis E. Probst, MD, Journal of cataract and refractive surgery, October 1998, volume 24, issue 10, p. 1320-1325.
11. Intraocular pressure after LASIK for hyperopia, David MD, David Lardoo, MD, ophthalmology, volume 109, issue 9, September 2002, p. 1659-1661.
12. Change in intraocular pressure measurements after LASIK: The effect of refractive correction and the lamellar flap, Daniel H. Chang, MD, R. Doyle Stutling, MD, PHD. Ophthalmology, volume 112, issue 6, June 2005, p. 1009-1016.
13. Factors influence intraocular pressure changes after LASER in situ Keratomileusis with flaps created by femtosecond laser or mechanical keratotome, Meng-Yin Lin, Dep. Of ophthalmology, January 29, 2016, Shuang Ho hospital, Taipei medical university, Taiwan.

14. The effect of corneal refractive surgery on glaucoma, Vassilios Karobolis, University of eye clinic, Journal of ophthalmology, volume 2017, Article and D 8915623, 8 pages, April 2017.
15. Intraocular pressure and ocular rigidity after LASIK, Department of ophthalmology, Faculty of medicine, UFMG- Belo Horizonte (MG), Brasil, Sebasti Cronemberrger, 12,05,1009.
16. Comparison of intraocular pressure before and after laser in situ Keratomileusis refractive surgery measured with Perkins tonometry, non-contact tonometry and trans palpebral tonometry, ophthalmology, volume 2015, Article ID 683895, 6 pages, Isabel Cacho, Juan Sanchez, Instituto Balearv deoftalmologia, palmade mallorca, Spain, March 2015.
17. Intraocular pressure measurements with Goldmann applanation tonometry and dynamic control tonometry in eyes after intra LASIK or LASEK, Gabi Shemesh, Uri Soiberman, Dept. of ophthalmology, Faculty of medicine, clinical ophthalmology, 2012.
18. Intraocular pressure measurements using dynamic contour tonometry after laser in situ Keratomileusis, IOVS (Investigative Ophthalmology and Visual Science), September 2003, volume 44, Issue 9, Claude Kaufmann.
19. Human corneal thickness and its impact on intraocular pressure measures, a review and meta-analysis approach and surv-ophthalmology, April 2004, volume 45, p. 367-408, Doughty Mj., Zaman ML.
20. Changes in corneal biomechanics and intraocular pressure following LASIK using static, dynamic and non-contact tonometry, American ophthalmological society thesis, 2007, Tat S Pepose, MD, PHD, volume 143, issue 1, p. 39-47.

21. The relationship between corvis ST tonometry measured corneal parameters and intraocular pressure, corneal thickness and corneal curvature Ryo Asaoka, Shun Suka Naka Kura, Pedro Gonzalez, Duke university, United States, October 20, 2015.

Appendix

Case 1

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	20/6	21y	44.9	45.6	7.52	7.41	574
LE			45.1	45.8	7.48	7.37	570

Refraction		Sph.	Cyl.	Axis
	RE	-2.00	-	-
	LE	-2.25	-0.25	10

Pre op. IOP 13/12 mmHg

Treatment report	OZ	TZ	AZ
	6.50mm	1.25 mm	9.00 mm

Ablation profile		Max depth	Corneal thick	Stroma
	RE	30.69 µm	572 µm	541 µm
	LE	38.13 µm	573 µm	534 µm

Case 2

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	24/6/2018	25y	43.30	44.0	7.79	7.67	578
LE			43.3	44.1	7.8	7.65	581

Refraction		Sph.	Cyl.	Axis
	RE	-1.25	-0.50	85
	LE	-1.25	-	-

Pre op. IOP 15/14 mmHg

BCSVA R 6/18 → 6/6

L 6/12 → 6/6

Ablation profile		Max depth	Corneal thick	Stroma
	RE	26.92 µm	577 µm	550 µm
	LE	19.35 µm	579 µm	559 µm

Treatment report	OZ	TZ	AZ
	6.5 mm	1.25 mm	9.0 mm

Case 3

LASIK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	24/6/2018	25y	44.8	45.7	7.53	7.39	525
LE			44.5	45.4	7.58	7.44	534

Refraction		Sph.	Cyl.	Axis
	RE	-4.75	-0.75	20
	LE	-3.75	-0.75	160

Pre op. IOP 17/16 mmHg

BCSVA R 6/18 → 6/6

L 6/12 → 6/6

Ablation profile		Max depth	Corneal thick	Stroma
	RE	80.92 µm	522 µm	455 µm
	LE	66.94 µm	513 µm	432 µm

Treatment report	OZ	TZ	AZ
	6.5 mm	1.25 mm	9.0 mm

Case 4

LASIK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	27/6	22y	45.3	46.2	7.45	7.30	532
LE			45.4	45.9	7.43	7.35	530

Refraction		Sph.	Cyl.	Axis
	RE	-2.00	-0.50	130
	LE	-1.50	-1.75	80

Treatment report	OZ	TZ	AZ
	6.50mm	1.25 mm	9.00 mm

(b)

Ablation profile		Max depth	Corneal thick	Stroma
	RE	38.11 µm	529 µm	490 µm
	LE	49.1 µm	530 µm	480 µm

Case 5

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	30/6/2018	24y	43.2	44.0	7.81	7.68	500
LE			42.2	43.7	7.99	7.72	506

Refraction		Sph.	Cyl.	Axis
	RE	-4.00	-0.75	30
	LE	-4.5	-1.75	165

Pre op. IOP 16/15 mmHg

BCSVA R CF 3 m → 6/9

L CF 2m → 6/9

Ablation profile		Max depth	Corneal thick	Stroma
	RE	7.62 µm	492 µm	421µm
	LE	91.28 µm	509 µm	417 µm

Treatment report		OZ	TZ	AZ
	RE	6.5 mm	1.25 mm	9.0 mm
	LE	6.5 mm	1.25 mm	9.0 mm

Case 6

RE → PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	30/6	30y	43.9	46.8	7.69	7.21	551
LE			44.3	45.9	7.62	7.36	552

Refraction		Sph.	Cyl.	Axis
	RE	X	-1.75	170

Pre op. IOP 16/15 mmHg

BCSVA R 6/18 → 6/6 with glasses

Ablation profile		Max depth	Corneal thick	Stroma
	RE	26.9 µm	544 µm	517µm

Treatment report		OZ	TZ	AZ
	RE	6.5 mm	1.25 mm	9.0 mm

Case 7

LASIK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	4/7/2018	19y	43.1	44.4	7.83	7.61	491
LE			43.1	44.1	7.83	7.66	487

Refraction		Sph.	Cyl.	Axis
	RE	-5.25	-1.25	145
	LE	-1.50	-1.25	15

Pre op. IOP 14/13 mmHg

BCSVA RE CF 3m → 6/9P

LE 6/18P → 6/6

Ablation profile		Max depth	Corneal thick	Stroma
	RE	80.62 µm	492 µm	411 µm
	LE	30.64 µm	479 µm	443 µm

Treatment report	OZ	TZ	AZ
	6.0 mm	1.25 mm	8.50 mm

Case 8

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	20/8/2016	31y	43.9	44.6	7.68	7.57	569
LE			44.3	44.3	7.62	7.62	576

Refraction		Sph.	Cyl.	Axis
	RE	-1.25	-0.75	70
	LE	-1.25	-0.75	90

Pre op. IOP 16/15 mmHg

BCSVA R 6/18 → 6/6

L 6/18 → 6/6

(d)

Ablation profile		Max depth	Corneal thick	Stroma
	RE	31.61 µm	574 µm	543 µm
	LE	30.50 µm	576 µm	545 µm

Treatment report		OZ	TZ	AZ
	RE	6.5 mm	1.25 mm	9.0 mm
	LE	6.5 mm	1.25 mm	9.0 mm

Case 9

LASIK

Date	Age		K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
27/9	21y	LE	42.5	44.0	7.94	7.56	512
		RE	42.6 D	44.9	7.93	7.52	524

RE refraction	Sph.	Cyl.	Axis
27/9	-4.50 s	-1.7 sc	170

Pre op. 14/14 mmHg

BCSVA R CF 3m → 6/6 P

L CF 6m → 6/6 P

Case 10

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	27/9	28y	44.0	45.2	7.67	7.47	584
LE			44.3	45.5	7.62	7.43	598

Refraction		Sph.	Cyl.	Axis
	RE	-1.25 s	-0.50 C	177
	LE	-0.75 s	-0.25 C	5

Case 11

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	27/9	21y	43.3	41.2	7.79	6.63	537
LE			43.2	41.0	7.81	7.67	641

Refraction		Sph.	Cyl.	Axis
	RE	-2.00s	-0.50 C	45^{o}
RE	BCVA 6/60 → 6/6		LE	6/60 → 6/6
	LE	-2.75 s	-0.25 C	85

Case 12

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	27/9	18y	42.4	43.8	7.96	7.71	528
LE			42.6	43.8	7.92	7.71	536

Refraction		Sph.	Cyl.	Axis
	RE	-3.25 Ds	-0.25 C	25
	LE	-3.75 Ds	-0.50 C	120

BCSVA CF 3m → 6/6 P. BE

Laser Setting	OZ	TZ	depth
OD (RE)	9	1.5	52
OD (LE)	9	1.5	6

Case 13

LASIK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	27/9	23y	43.25	42.75	7.92	7.91	
LE							

Refraction		Sph.	Cyl.	Axis
	RE	-6.00	X	-
	LE	-5.00	X	-

Pre op. 16/17 mmHg BCVA CF 3m → 6/16 BE

Case 14

LASIK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	13/9	23y	40.8	44.4	8.27	7.61	607
LE			41.8	43.1	8.07	7.84	597

Refraction		Sph.	Cyl.	Axis
	RE	-4.75	-3.75	16
	LE	-4.50	-0.75	46

Pre op. 15/18 mmHg

BCSVA R 3m → 6/6

L 6/60 → 6/6

Flap thickness: R 110 μm L 110 μm

Depth R 108 L 70.5

Case 15

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy μm
RE	27/6	33y	42.9	45.0	7.86	7.51	525
LE			43.6	44.7	7.74	7.55	530

BCSVA 6/6 BE

Pre op. IOP 13/12 mmHg

Refraction		Sph.	Cyl.	Axis
	RE	-3.00	-1.75	10
	LE	-2.50	-0.50	10

Pre op. IOP 13/12 mmHg

Ablation profile		Max depth	Corneal thick	Stroma
	RE	45.49 μm	525 μm	479 μm
	LE	70.56 μm	523 μm	452 μm

Treatment report	OZ	TZ	AZ
	6.5 mm	1.25 mm	9.00 mm

Case 16

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy μm
RE	22/9	19y	44.6	45.4	7.56	7.44	537
LE			44.6	45.0	7.57	7.50	537

Refraction		Sph.	Cyl.	Axis
	RE	-1.75	-0.50	160
	LE	-1.75	-	-

Pre op. IOP 18/17 mmHg

BCSVA R 6/36 → 6/6

L 6/24 → 6/6

Case 17

LASIK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	6/9/2018	22y	41.0	43.4	8.23	7.78	543
LE			41.8	42.5	8.07	7.94	533

Refraction		Sph.	Cyl.	Axis
	RE	-5.50	-4.50	75
	LE	-7.50	-0.50	140

Pre op. IOP 14/13 mmHg

BCSVA RE 6/60 → 6/9

L 6/60 → 6/6P

Case 18

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	6/9/2018	28y	41.8	42.2	8.08	8.00	509
LE			41.4	42.5	8.15	7.94	517

Refraction		Sph.	Cyl.	Axis
	RE	-3.75	-0.25	100
	LE	-4.25	-0.75	15

Pre op. IOP 13/12 mmHg

BCSVA R 6/60 → 6/6P

L CF 3m → 6/9

Ablation profile		Max depth	Corneal thick	Stroma
	RE	59.97 µm	502 µm	442 µm
	LE	74.06 µm	514 µm	439 µm

Treatment report		OZ	TZ	AZ
	RE	6.5 mm	1.25 mm	9.0 mm
	LE	6.5 mm	1.25 mm	9.0 mm

BCSVA → (Best corrected spectacle visual acuity)

Case 19

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	30y	RE	45.0	45.8	7.51	7.30	539
		LE	44.7	45.4			527

Refraction		Sph.	Cyl.	Axis
	RE	-2.75	-0.50	40
	LE	-2.75	-0.50	110

Treatment data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK	250 Hz	6.5 mm	40 µm (OD)
				49 µm (OS)

Pre op. IOP 14/19 mmHg

Case 20

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018		RE	43.0	43.50	7.86	7.78	520
		LE	43.1	43.50			525

Refraction		Sph.	Cyl.	Axis
	RE	-0.75	-0.50	30
	LE	-0.50	-0.50	25

Pre op. IOP 16/14 mmHg

BCSVA RE 6/12P → 6/6

LE 6/12 → 6/6

Case 21

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	31y	OD	43.60	45.10	7.74	7.48	565
		OS	43.70	44.80	7.72	7.53	554

Treatment data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK	250 Hz	6.5 mm	82 µm (OD)
				65 µm (OS)

Refraction		Sph.	Cyl.	Axis
	OD	-4.00	-1.75	180
	OS	-3.50	-1.00	180

Flap thickness
120 µm

Pre op. IOP 18/18 mmHg

BCSVA RE 6/60 → 6/6P

LE 6/36 → 6/6

Case 22

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	18y	OD	42.6	44.9	7.8	8.1	565
		OS	42.6	44.7	7.5	8.1	563

R/ data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK	250 Hz	6.5 mm	27 µm (OD)
				44 µm (OS)

Refraction		Sph.	Cyl.	Axis
	OD	-0.50	-1.00	155
	OS	-1.25	-1.50	30

Pre op. IOP 12/15 mmHg

BCSVA 6/6 BE

Case 23

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy μm
26/9/2018	24y	OD	43.6	43.9	7.77	7.69	507
		OS	43.3	44.4	7.76	7.68	504

R/ data	Type	Laser frequency	Optical Z	Expected ablation depth
	LASIK	250 Hz	6.5 mm	16 μm (OD)
				26 μm (OS)

Refraction		Sph.	Cyl.	Axis
	OD	-0.75	-0.75	160
	OS	-0.75	-	

Pre op. IOP 13/14 mmHg

Flap data	Diameter	Thickness
	8.9 mm	120 μm

Case 24

LASIK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy μm
26/9/2018	23y	OD	41.5	44.7	7.65	8.1	547
		OS	41.6	44.0	7.6	7.67	528

Treatment data	Laser frequency	Optical Z	Expected ablation depth
	250 Hz	6.5 mm	58 μm (OD)
			48 μm (OS)

Refraction		Sph.	Cyl.	Axis
	OD	X	-3.75	10
	OS	X	-3.00	5

Flap data	Diameter	Thickness
	8.90 mm	120 μm

OD 6/36	BCSVA	6/6
OS 6/36		6/6

Case 25

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	24y	OD	43.4	44.4	7.77	7.61	504
		OS	43.5	44.0	7.76	7.68	507

R/ data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK BE	250 Hz	6.5 mm	26 µm (OD)

Refraction		Sph.	Cyl.	Axis
	OD	-0.75	-0.75	160
	OS	-0.75	-	

Pre op. IOP 13/14 mmHg

BCSVA OD 6/12P → 6/6

OS 6/9P → 6/6

Case 26

PRK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	19y	OS	40.3	41.0	8.37	8.23	617
		OD	40.0	40.9	8.44	8.25	626

R/ data	Type	Laser frequency	Optical Z
	PRK	250 Hz	6.5 mm

Refraction		Sph.	Cyl.	Axis
	OS	-3.75	-	-
	OD	-2.75	-1.00	140

Expected ablation depth	Thickness	Diameter
54 µm (OS)	(OS) 536 µm	(OS) 7.65 mm
56 µm (OD)	(OD) 570 µm	(OD) 8.00 mm

Pre op. IOP 15/15 mmHg

BCSVA OS 6/60 → 6/6

OD CF 6m → 6/6

Case 27

PRK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	25y	OD	42.0	43.3	8.04	7.8	550
		OS	41.1	43.6	8.1	7.71	555

R/ data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK	250 Hz	6.5 mm	(OS) 83 µm
				(OD) 61 µm

Refraction		Sph.	Cyl.	Axis
	OS	-3.50	-2.25	170
	OD	-4.00	-1.00	10

Thickness	Diameter
(OD) 479 µm	8.01 mm
(OS) 472 µm	

Pre op. IOP 17/18 mmHg

BCSVA OD CF 6m → 6/6P

OS CF 6m → 6/6P

Case 28

LASIK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	21y	OD	43.8	45.5	7.71	7.42	567
		OS	44.0	44.8			551

Refraction correction		Sph.	Cyl.	Axis
	OD	-4.00	-1.00	180
	OS	-4.50	-0.50	180

Flap data	Diameter	Thickness
	8.90 mm	120 µm

Ablation diameter	Laser frequency	Optical Z	Expected ablation depth
8.01 mm	250 Hz	6.5 mm	(OS) 79 µm
			(OD) 78 µm

Residual Stromal Thickness
(OD) 369 µm

Pre op. IOP 14/15 mmHg

BCSVA OD 6/60 → 6/6

OS 6/60 → 6/6

Case 29

PRK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	19y	OD	44.3	45.3	7.88	7.47	533
		OS	41.0	46.0	7.00	7.30	523

Refraction correction		Sph.	Cyl.	Axis
	OD	-4.50	-1.25	75
	OS	-3.25	-2.00	125

Pre op. IOP 14/16 mmHg

BCSVA OD 6/6P

OS 6/12

Case 30

LASIK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	28y	OD	42.7	45.7	7.9	7.39	550
		OS	42.7	45.5	7.9		561

R/ data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK	250 Hz	6.5 mm	(OD) 55 µm
				(OS) 60 µm

Refraction correction		Sph.	Cyl.	Axis
	OD	-1.00	-2.50	5
	OS	-0.50	-3.25	40

Residual Stromal Thickness
(OD) 369 µm
(OS) 499 µm

Pre op. IOP 14/15 mmHg

BCSVA BE 6/6

Case 31

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	43y	OD	41.9	43.5	8.05	7.76	543
		OS	41.4	44.1	8.1	7.65	545

Treatment data	Type	Laser frequency	Optical Z	Expected ablation depth
	PRK	250 Hz	6.5 mm	(OD) 29 µm
				(OS) 38 µm

Refraction correction		Sph.	Cyl.	Axis
	OD	-1.25	-0.50	180
	OS	-0.50	-1.75	180

Residual Stromal Thickness
(OD) 369 µm
(OS) 499 µm

Pre op. IOP 11/12 mmHg

BCSVA OD 6/24P → 6/6

OS 6/24 → 6/6

Case 32

LASIK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	18y	OD	41.5	44.4	8.13	7.64	576
		OS	41.8	43.9	8.09	7.75	566

R/ data	Type	Laser frequency	Optical Z	Expected ablation depth
BE	LASIK	250 Hz	6.5 mm	(OD) 52 µm
				(OS) 95 µm

Refraction correction		Sph.	Cyl.	Axis
	OD	-5.00	-2.75	10
	OS	-4.50	-1.75	170

Flap data	Diameter	Thickness
	8.90 mm	120 µm

Pre op. IOP 18/18 mmHg

BCSVA OD CF 3m → 6/6P

OS CF 3m → 6/6P

Case 33

LASIK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
30/9/2018	24y	OD	45.4	48.6	7.40	6.92	491
		OS	45.6	48.9	7.50	6.92	482

Refraction correction		Sph.	Cyl.	Axis
	OD	-3.00	-3.50	10
	OS	-6.50	-4.00	175

Pre op. IOP 11/11 mmHg

BCSVA OD CF 4m → 6/6

OS CF 2m → 6/9P

Case 34

PRK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
26/9/2018	22y	OD	42.25	43.50	8.01	7.75	543
		OS	41.75	44.0	8.09	7.65	545

Refraction correction		Sph.	Cyl.	Axis
	OD	-7.00	-0.50	180
	OS	-0.50	-1.75	5

Pre op. IOP 11/12 mmHg

BCSVA BE 6/6

Case 35

PRK BE

	Date	Age	K_1 (D)	Axis	K_2 (D)	Axis	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	24y	42.10	170	44.0	80	8.02	7.49	548

R/ report (Flap data) Flap diameter (mm) 8.9

Specification flap thickness (µm) 120

R/ data: Type LASIK

Profile → Tripple A

Laser frequency (Hz) → 500

Correction	Sph.	Cyl.	Axis
	-6.00	-4.50	165

Optical zone → 6.00 mm

Expected ablation depth → 127 µm

LE	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachymetry µm
	42.4	44.2	7.96	7.64	539

Pre op. IOP 14/14 mmHg

BCSVA 6/9

R/ report (Flap data) Flap diameter (mm) 8.90

Specification flap thickness (μm) 120

R/ data: Type LASIK

Profile → Tripple A

Laser frequency (Hz) → 500

Optical Z (mm) Expected ablation depth: 115 μm

Correction	Sph.	Cyl.	Axis
	-7.00	-2.25	5

Case 36

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy μm
RE	3/10/2018	26y	44.0	45.8	7.37	7.67	519
LE			42.5	44.9	7.94	7.52	518

Refraction		Sph.	Cyl.	Axis
	RE	X	-2.25	85
	LE	X	-2.0	80

Pre op. IOP 14/12 mmHg

Optical Z (mm) 6.5 Expected ablation depth: R → 39 μm

L → 39 μm

Ablation depth → 39 μmAblation diameter: R → 8.0 mm

L → 8.0 mm

Residual stroma thickness:R → 484 μm

L → 479 μm

Case 37

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy μm
RE (OD)	3/10/2018	20y	43.8	46.2	7.70	7.38	518
LE (OS)			43.8	46.1	7.71	7.32	509

Refraction		Sph.	Cyl.	Axis
	RE	-3.75	-2.50	40
	LE	-2.75	-3.00	145

Pre op. IOP 15/15 mmHg

BCSVA R CF 4m → 6/6P

L 6/60 → 6/6P

R/ data Type PRK, laser frequency (250 Hz)

Optical zone (mm) 6.50 Expected ablation 89 µm

Ablation depth	Ablation diameter	Residual stromal thickness
89 µm	8.04 mm	420µm

Case 38

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE (OD)	3/10/2018	31y	42.6	44.50	7.88	7.63	602
LE (OS)			41.9	44.4	7.87	7.57	614

Refraction		Sph.	Cyl.	Axis
	RE	X	-2.75	95
	LE	X	-2.75	80

Pre op. IOP 11/15 mmHg

BCSVA R 6/18 P → 6/6

L 6/18P → 6/6

R/ data Type PRK, laser frequency (250 Hz)

Optical zone (mm) 6.50 Expected ablation 46 µm

Ablation depth	Ablation diameter	Residual stromal thickness
47 µm	8.04 mm	567µm

Case 39

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE (OD)	3/10/2018	27y	43.9	45.0	7.96	7.50	513
LE (OS)			43.9	45.4	7.96	7.5	513

Refraction		Sph.	Cyl.	Axis
	RE	-1.75	-	-
	LE	-1.50	-0.50	20

Treatment data		Optical Z	Ablation depth	Laser frequency
	R	6.5 mm	28 µm	250 Hz
	L	6.5 mm	32 µm	250 Hz

Pre op. IOP 16/17 mmHg

Ablation diameter 7.61 mm

Residual stromal thickness 485 µm

Case 40

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	25y	42.6	44.7	7.90	7.62	542
LE			43.3	45.3	7.77	7.47	564

Refraction		Sph.	Cyl.	Axis
	RE	-1.00	-1.00	180
	LE	-0.50	-1050	180

Pre op. IOP 11/15 mmHg

BCSVA Be 6/18P → 6/6

R/ data	Optical z	Expected ablation depth µm
R	6.5 mm	34 µm
L	6.5 mm	33 µm

Case 41

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	25y	42.6	44.7			542
LE			43.3	45.3			564

Refraction		Sph.	Cyl.	Axis
	RE	-1.00	-1.00	180
	LE	-0.50	-1.50	180

BCSVA R 6/18P → 6/6

L 6/18P → 6/6

R/ data	Optical z	Expected ablation depth µm
R	6.5 mm	33 µm

Case 42

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	23y	40.5	41.5		8.12	543
LE			40.4	41.6	8.35	8.11	544

Refraction		Sph.	Cyl.	Axis
	L	-0.50	-0.50	120
	R	-2.50	-1.00	40

BCSVA R 6/18P → 6/6

L 6/18P → 6/6

R/ data		Optical Z	Ablation depth	Laser frequency
	R	6.5 mm	19 µm	250 Hz
	L	6.5 mm	53 µm	250 Hz

R/ Parameters	Optical Z	Ablation depth	Ablation diameter	Residual stromal thickness
	6.5 mm	53 µm	8.01 mm	491 µm

Case 43

PRK BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	34y	40.5	40.3	8.27		556
LE			40.1	41.50	8.42	8.11	553

Refraction		Sph.	Cyl.	Axis
	L	-1.50	-0.50	30
	R	-1.25	-1.00	180

Pre op. IOP 14/15 mmHg

BCSVA R 6/24P → 6/6

L 6/36 → 6/6

R/ parameters		Optical Z	Ablation Z	Laser frequency	Type
	R	6.5 mm	32 µm	250 Hz	PRK
	L	6.5 mm	37 µm	250 Hz	PRK

Case 44

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	21y	43.0	44.1	7.76	7.66	547
LE			43.5	43.7	7.74	7.70	560

R/ data	Refraction		Sph.	Cyl.	Axis
		L	-1.25	-1.00	70
		R	-0.75	-1.00	110

Pre op. IOP 15/15 mmHg

BCSVA R 6/18P → 6/6

L 6/12 → 6/6

R/ parameters		Optical Z	Ablation Z	Laser frequency	Type
	R	6.5 mm	37 µm	250 Hz	PRK
	L	6.5 mm	30 µm	250 Hz	PRK

Case 45

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	26y	41.1	42.6	8.21	7.92	536
LE			41.3	42.3		7.98	529

Treatment data	Type	Laser frequency	Optical Z	Expected ablation depth
RE	PRK	250 Hz	6.5 mm	71 µm

Refraction		Sph.	Cyl.	Axis	Type
	LE	-4.00	-1.00	165	PRK
	RE	-10.0	-1.50	150	

Pre op. IOP 13/14 mmHg

BCSVA R CF 1 m → 6/6P

L CF 1 m → 6/18

Case 46

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	24y	42.3	43.2	7.98	7.87	556
LE			42.20	42.70	7.98	7.90	562

Treatment data	Type	Laser frequency	Optical Z	Expected ablation depth
RE	PRK	250 Hz	6.5 mm	28 µm

Refraction		Sph.	Cyl.	Axis	Type
	RE	-1.75	-050	75	PRK
	LE	-1.75	-0.50	105	PRK

Pre op. IOP 14/15 mmHg

BCSVA R 6/36 → 6/6

L 6/36 → 6/6

Case 47

PRK

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	30y	44.6	50.9	7.50	6.60	447
LE			39.5	41.7			594

Refraction		Sph.	Cyl.	Axis
	RE	-2.50	-5.00	20
	LE	+3.50	-2.00	175

R/ data CXL RE

BCSVA RE CF 6m → 6/12

LE 6/24P → 6/9P

Case 48

PRK (LASIK) BE

	Date	Age	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
RE	3/10/2018	20y	43.80	46.10	7.71	7.32	509
LE			43.8	46.20	7.71	7.31	518

	Flap diameter	Flap thickness	Optical Z
RE	8.9 mm	120 µm	6.50 mm
LE	8.9 mm	120 µm	6.50 mm

Refraction		Sph.	Cyl.	Axis
	RE	-3.75	2.50	40
	LE	-2.75	-3.00	145

Case 49

PRK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
3/10/2018	50y	RE	43.1	45.0	7.83	7.50	522
		LE	43.6	40.2	7.7	7.68	542

R/ data	Laser frequency	Optical Z
	250 Hz	6.5 mm

	Expected ablation depth
RE	41 µm
LE	37 µm

Refraction		Sph.	Cyl.	Axis
	RE	-1.00	-1.50	140
	LE	-1.00	-1.25	30

Pre op. IOP 14/18 mmHg

BCSVA RE 24P → 6/6

LE 24P → 6/6

Case 50

PRK BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
	34y	RE	43.1	45.0	7.83	7.50	522
		LE	43.6	44.2			545

Refraction		Sph.	Cyl.	Axis
	RE	-1.00	-1.25	30
	LE	X	-1.50	140

Pre op. IOP 14/18 mmHg

BCSVA RE 6/24 → 6/6

LE 6/18 → 6/6

Case 51

PRK (LASIK) BE

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
		RE	7.65	7.10	44.0	47.50	489
		LE	7.6	7.9	44.6	47.4	455

Refraction			Sph.	Cyl.	Axis
	CXL + PRK →	RE	-1.50	-3.75	35
	CXL →	LE	-5.00	-6.00	160

Pre op. IOP 9/19 mmHg

BCSVA RE 6/36 → 6/6

LE CF 3m → 6/9P

Case 52

PRK

Date	Age	K reading	K_1 (D)	K_2 (D)	K_1 (mm)	K_2 (mm)	Pachy µm
3/10/2018	23y	RE	40.4	41.6			544
		LE	40.5	41.5			543

Refraction		Sph.	Cyl.	Axis
	RE	-2.50	-1.00	110
	LE	-0.50	-0.50	120

Pre op. IOP 17/17 mmHg

BCSVA RE 6/24 → 6/6

LE 6/12P → 6/6

Case Sheet

جامعة بغداد
معهد الليزر للدراسات العليا
عيادات الليزر لطب العيون وجراحتها

تمـلأ من قبل قسم التسجيل	اسم المريض : مروة جواد كاظم	تاريخ الميلاد : ١٩٨٨/٩/٢
	الجنس : ذكر ـــ انثى ✓	اسم الام : وحيدة جودة
	الحالة الزوجية : متزوجة	المهنة : ربة بيت
	اقرب شخص : محمد ...	صلة القرابة : الزوج
	عنوان السكن : مدينة الصدر	رقم الهاتف : ٠٧٧٠٩٧٠٨٨٥٠
	تاريخ الدخول : ٢٠١٨/٩/٢٧	الطبيب الاختصاصي : د. محمد ...

الرقم الاحصائي او لاصق تعريف المريض
الحساسية الامراض العامة

تمـلأ من قبل الطبيب	التشخيص الاولي						
	العلاج المطلوب						
	تملا عند خروج المريض						
	التشخيص النهائي						
	تاريخ الخروج	/ / ٢٠١					
	حالة المريض عند الخروج						
	العلاج						
	العملية	تاريخها	/ / ٢٠١	نوعها :			
		درجتها	صغرى	متوسطة	كبرى	فوق الكبرى	خاصة
	الملاحظات						

توقيع وختم الطبيب الاختصاصي

Eye	Surgery	Notes

Operative Notes الوقت : التاريخ : / / ٢٠١

الطبيب الجراح :	مهندس ليزر الصيانة :
	مهندس تشغيل الليزر :
الممرض المساعد :	تقني الليزر :

Aneshesia Type	☐ Topical ☐	Sedatives	☐ None ☐ Diazepam

تملأ من قبل الكادر الجراحي

	OD (Right)	OS (Left)
Procdure	☐ PRK ☐ LASEK ☐ PTK ☐ LASIK ☐ CXL	☐ PRK ☐ LASEK ☐ PTK ☐ LASIK ☐ CXL
Epithelium removal	☐ Manual ☐ Laser ☐ Ethanol	☐ Manual ☐ Laser ☐ Ethanol
Microkeratomss	Blade	Blade ....
Flap thickness (Ultrsound-measured)	Pachymetry............ Bed thickness .... Flap Thick	Pachymetry............ Bed thickness .... Flap Thick ....
Laser Setting	SPH | CYL | AXIS | OZ | TZ | DEPTH	SPH | CYL | AXIS | OZ | TZ | DEPTH
Ptk	Diameter......... Depth......... Total.........	Diameter......... Depth......... Total.........
MMC	☐ No ☐ yes .... seconds	☐ No ☐ yes .... seconds
Events	☐ None ☐ Bleeding ☐ Epithelial Abrasion ☐ Flap Comp	☐ None ☐ Bleeding ☐ Epithelial Abrasion ☐ Flap Comp
BCL	☐ No ☐ yes	☐ No ☐ yes
	Immediate Postop Exam	
Flap Position	☐ No ☐ yes	☐ No ☐ yes
Interface	☐ Clean ☐ Debris ☐ Filament	☐ Clean ☐ Debris ☐ Filament
Notes		

توقيع مشغل الجهاز توقيع ممرض العمليات توقيع وختم الجراح

History

Motivation / Visual Coal ☐ Convenience ☐ Job requirement ☐ Poor vision

Past ocular History Haloes / Glare (Specs / CL) Yes o No ☐ Presbyopia ☐ Dry eyes

☐ Surgery

General Health : ☐ Diabetes ☐ joint disease

Medications :

Family history : ☐ keratoconus ☐ Others

Allerges

	OD			OS			
VA (Distance)							
VA P.H							
BCVA							
Manifest refraction	/ X			/ X			
Add For Near							
Cycloplegic ref Trop Cyclogyl	/ X			/ X			
VA Post Cyclo	Pupil			WTW		IOP	
Dominance	Photopic						
OD	Mesopic			ACD (center)		Pachymetry	
OS	Scotopic						

Ocular exam	o N o Abn	o N o Abn
Topography	o N o Abn	o N o Abn
Provisional DX	☐ Myopia ☐ Hyperoia ☐ Astigmatism ☐ Presbyopia ☐ Anisom ☐ Ambylopia ☐ Catarat ☐ Keratonus <u>Severity</u> : ☐ Corn opacity	
Investigations		
Plan Date / /201 Prognosis	☐ OFF ☐ موعد العملية PRK LASLK CXL متابعة .... ☐ Spacial risks explained Undercorrection / Enhancement Haloes Dry eyes Vison problems	

Date	V.A	B C V A	I.O.P	Cornea	Fundus	Treatment	Notes
			15/18				

- ما هي عملية تصحيح البصر بالليزر ؟ وما هي أنواعها -

عملية تصحيح البصر تتضمن إعادة تغيير انحناء القرنية الخارجي للتقليل أو التخلص من الأخطاء الانكسارية مثل قصر وبعد البصر والاستكماتزم وهنالك نوعان من هذه العمليات : (١) العمليات السطحية وفيها ترفع الطبقة الطلائية الخارجية ويستعمل شعاع الليزر بعد ذلك وتوضع عادة عدسة لاصقة في العين لمدة ٣ – ٧ أيام للمساعدة في التئام الطبقة الطلائية . (٢) العمليات الصفيحية (الليزك) وفيها يستعمل جهاز خاص لعمل شريحة من القرنية تطوى بعدها ثم يستعمل الليزر لتغيير شكل القرنية وتعاد بعدها الشريحة إلى مكانها .

لا تصحح هذه العمليات أمراض العين الأخرى مثل الحول ، الكسل الوظيفي ، الماء الأبيض أو ارتفاع ضغط العين .

- ما هي بدائل هذه العمليات -

تشمل البدائل غير الجراحية استعمال النظارات الطبية أو العدسات اللاصقة للحصول على الرؤية الجيدة في حالات الأخطاء الانكسارية أما البدائل الجراحية فتشمل زراعة الحلقات أو العدسات داخل مقلة العين .

- ما هي نتائج عمليات تصحيح البصر بالليزر -

معظم عمليات الليزر تؤدي إلى تحسن في قوة البصر وتقليل درجات الأخطاء الانكسارية وفي نسبة جيدة تؤدي إلى التخلص من النظارات الطبية تماما .

هذا مع العلم إن هذه العملية لا تؤدي إلى التخلص من نظارات القراءة التي يستعملها معظم الأشخاص بعد الأربعينات من العمر .

- ما نوع التخدير الذي سوف يستخدم في العملية ؟ وما هي مخاطره -

في معظم الحالات يستخدم التخدير السطحي بواسطة القطرات وفي حالات نادرة قد يحتاج المريض إلى مخدر العين أو عظلات الجفن أو الوجه .

قد يؤدي التخدير الموضعي بالحقن إلى حدوث نزف تحت الملتحمة أو نزف داخلي في العين مما قد يؤدي إلى تدهور النظر .

- ما هي مضاعفات ومخاطر عمليات تصحيح البصر بالليزر -

لا يمكن ضمان نتائج العملية وقد لا يتم تصحيح النظر كليا أو جزئيا بصورة عدم اكتمال التصحيح أو زيادة في كمية التصحيح مما قد يتطلب عمليات أخرى .

في معظم الحالات يكون هناك بعض الإشكالات مثل الحكة أو الألم أو كثر الدموع أو احمرار العين أو نزف تحت الملتحمة أو تذبذب في حدة الإبصار أو حساسية من الضوء الذي قد يستمر لعدة أيام أو أكثر .

عادة يحدث جفاف في العين يستمر لمدة أسابيع أو أشهر وفي حالات نادرة يكون دائميا .

بعد هذه العمليات قد يحدث اختلال في الرؤية الليلية مثل تكون الهالات حول مصادر الضوء أو الوهج وقد تختفي أو لا تختفي هذه الإعراض .

قد تحدث التهابات في القرنية مع عتامات وقد تؤدي إلى مشاكل بالنظر تحتاج إلى عمليات أخرى مثل تبديل القرنية .

في عمليات الليزك قد يحدث مشاكل أثناء عمل الشريحة السطحية مما قد يضطر الطبيب إلى إيقاف العملية وتأجيلها أو إلغائها تماما .

لا يمكن التنبؤ بمدة بقاء التصحيح عبر السنوات وقد يحدث تراجع حتى بعد عدة سنوات إما علاجا أو عملية أخرى .

يجب الأخذ بنظر الاعتبار في حالات ارتفاع ضغط العين فان تغيير شكل القرنية بواسطة هذه العمليات قد يؤدي إلى تغيير خاطئ في قياسات الضغط .

إي مريض تجرى له هذه العمليات يجب إن يتابع بصورة دورية مع الطبيب لتقليل أو اكتشاف المضاعفات بصورة مبكرة .

إني المريض .... أوافق على إجراء عملية .... للعين .... من قبل الطبيب المعالج الدكتور .... أو بإشرافه وتحت التخدير المناسب واقر باني قد قرأت المعلومات أعلاه (أو تم قراءتها لي) وناقشتها مع الطاقم الطبي وأتفهم بأنه من غير الممكن للطبيب أن يضمن النتائج المتوقعة سلفا أو إن يحيطني علما بكل المضاعفات التي يمكن أن تنتج من العملية وقد احتاج إلى عملية ثانية أو علاج إضافي .

كما اقر بان الطاقم الطبي قد أجاب على كل أسئلتي بخصوص هذه العملية وأتقبل مخاطر ونتائج العملية وأي خيارات قد يرتأيها الطبيب وأخوله طلب إي مساعدة أو مشورة جراحية قبل أو أثناء أو بعد إجراء العملية .

الممرض المسؤول | توقيع المريض أو اقرب شخص له

تملأ من قبل المريض وبتوقيع المريض تحت إشراف الممرض

OCULUS - PENTACAM

LASIK f 234
IOP 17/16 mmHg

Last Name:	Salam Abed		
First Name:	Rana		
ID:	0510		
Date of Birth:	01/01/1995	Eye:	Right
Exam Date:	06/24/2018	Time:	15:28:33
Exam Info:			

Cornea Front

	Rf:	7.53 mm	K1:	44.8 D	
	Rs:	7.39 mm	K2:	45.7 D	
	Rm:	7.46 mm	Km:	45.2 D	
QS: Data Ga	Axis: (flat)	12.7 °	Astig:	0.9 D	
ecc: (6mm) 0.48	Rper:	7.76 mm	Rmin:	7.25 mm	

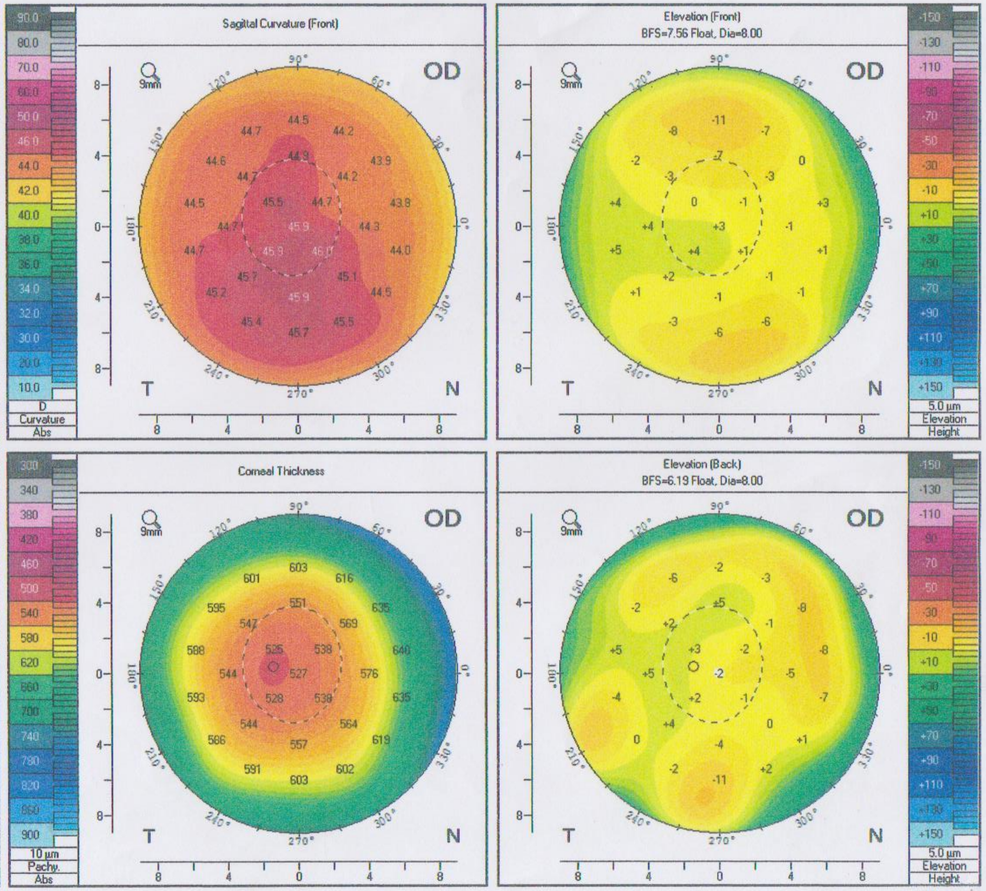
Cornea Back

	Rf:	6.23 mm	K1:	-6.4 D
	Rs:	6.21 mm	K2:	-6.4 D
	Rm:	6.22 mm	Km:	-6.4 D
QS: Data Ga	Axis: (flat)	100.2 °	Astig:	0.0 D
ecc: (6mm) 0.01	Rper:	6.40 mm	Rmin:	6.03 mm

	Pachy:	x[mm]	y[mm]
Pupil Center:	525 µm	-0.19	+0.25
Pachy Apex:	527 µm	0.00	0.00
Thinnest Locat.:	523 µm	-0.72	+0.20
K Max. (Front):	46.6 D	+0.13	-0.39

Cornea Volume:	60.2 mm³	Ø Cornea:	11.5 mm
Chamber Volume:	137 mm³	Angle:	39.3 °
A. C. Depth (Ext.):	3.30 mm	Pupil Dia:	3.02 mm
Enter IOP IOP(cor):		Lens Th.:	

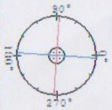
Refractive



OCULUS - PENTACAM

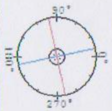
Last Name:	Salam Abed		
First Name:	Rana		
ID:	0510		
Date of Birth:	01/01/1995	Eye:	Left
Exam Date:	06/24/2018	Time:	15:26:12
Exam Info:			

Cornea Front



Rf:	7.58 mm	K1:	44.5 D
Rs:	7.44 mm	K2:	45.4 D
Rm:	7.51 mm	Km:	45.0 D
QS: Data Ga	Axis: (flat) 175.2 °	Astig:	0.8 D
ecc: (6mm) 0.45	Rper: 7.77 mm	Rmin:	7.35 mm

Cornea Back

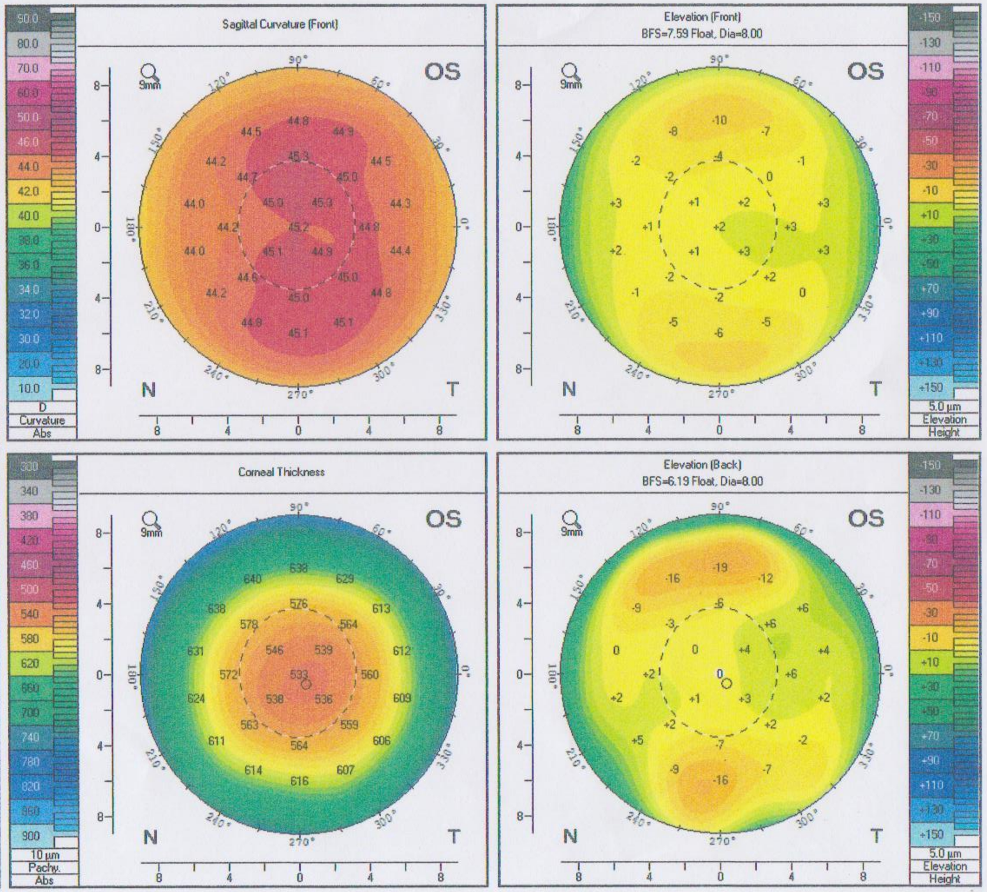


Rf:	6.27 mm	K1:	-6.4 D
Rs:	6.07 mm	K2:	-6.6 D
Rm:	6.17 mm	Km:	-6.5 D
QS: Seg.(Blin	Axis: (flat) 11.5 °	Astig:	0.2 D
ecc: (6mm) 0.11	Rper: 6.40 mm	Rmin:	5.95 mm

	Pachy:	x[mm]	y[mm]
Pupil Center: +	534 µm	-0.04	+0.04
Pachy Apex:	533 µm	0.00	0.00
Thinnest Locat.: ○	532 µm	+0.20	-0.27
K Max. (Front):	45.9 D	0.00	+0.07

Cornea Volume:	61.4 mm³	Ø Cornea:	11.5 mm
Chamber Volume:	158 mm³	Angle:	45.6 °
A. C. Depth (Ext.):	3.32 mm	Pupil Dia:	3.45 mm
Enter IOP IOP(cor):		Lens Th.:	

Refractive



ALLEGRETTO

WaveLight®

Treatment report

Salam Abd, Rana
01-01-1995
Female

OS

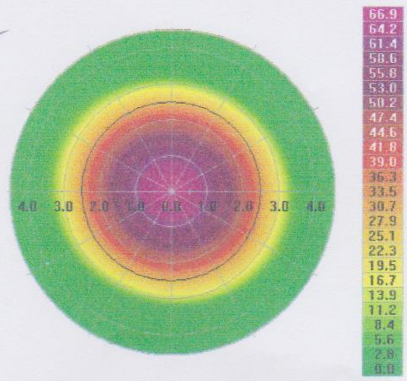
ID: 156200339 Status: Finished

Treatment

Type: ***WFoptimized*** S 001 Date: 27-06-2018

Correction:	***-3.75 D -0.75 D @ 160°***
Clinical:	-3.75 D ^ -0.75 D @ 160°
Target Ref.:	0.00 D ^ 0.00 D @ 160°
Optical Zone:	***6.50 mm***
Transition Zone:	1.25 mm
Ablation zone :	9.00 mm
Vertex Distance:	12.0 mm
K-reading (K1):	44.40 D @ 5°
K-reading (K2):	45.10 D @ 95°
Pupil Diameter:	5.00 mm
Applied Drugs:	0
Entry made by :	MOHAMED HAMZA
Surgeon:	MOHAMED HAMZA
Confirmed by:	MOHAMED HAMZA

Ablation Profile



Maximum Depth:	66.94 µm
Central Depth:	66.94 µm
Corneal Thickness:	522 µm
Device:	0
Flap Thickness:	0 µm
Stroma:	455 µm

Memo and postOP-Comments

WaveLight AG
Am Wolfsmantel 5
D-91058 Erlangen - Germany
Phone: ++49 (0)180 5526262

ALLEGRETTO

WaveLight®

Treatment report

Salam Abd, Rana
01-01-1995
Female

OD

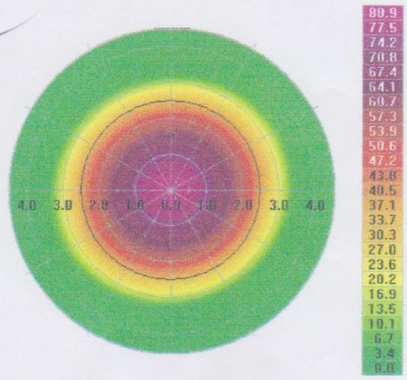
ID: 156200339 Status: Finished

Treatment

Type: ***WFoptimized*** S 001 Date: 27-06-2018

Correction:	***-4.75 D -0.75 D @ 20°***
Clinical:	-4.75 D ^ -0.75 D @ 20°
Target Ref.:	0.00 D ^ 0.00 D @ 20°
Optical Zone:	***6.50 mm***
Transition Zone:	1.25 mm
Ablation zone :	9.00 mm
Vertex Distance:	12.0 mm
K-reading (K1):	44.60 D @ 9°
K-reading (K2):	45.30 D @ 99°
Pupil Diameter:	5.00 mm
Applied Drugs:	0
Entry made by :	MOHAMED HAMZA
Surgeon:	MOHAMED HAMZA
Confirmed by:	MOHAMED HAMZA

Ablation Profile



Maximum Depth:	80.92 µm
Central Depth:	80.92 µm
Corneal Thickness:	513 µm
Device:	0
Flap Thickness:	0 µm
Stroma:	432 µm

Memo and postOP-Comments

IOP. 17/16 mmHg.

WaveLight AG
Am Wolfsmantel 5
D-91058 Erlangen - Germany
Phone: ++49 (0)180 5526262

الخلاصة

الهدف:

هدف هذه الدراسة هي وصف العوامل المؤثرة على قياس تغير ضغط العين الداخلي بعد عمليات تصحيح البصر بالليزر بواسطة PRK والليزك، لغرض تصحيح قصر البصر الاستكماتزمي، وبعد البصر، وبعد البصر الاستكماتزمي. وقد تمت متابعة المرضى بعد مرور شهر، ثلاثة أشهر من تاريخ معالجتهم لـ(92) عينة من اثنان وخمسين مريضاً. تم جمع الإحصاءات قبل العملية كالعمر، والجنس، وضغط العين، والأخطاء الانكسارية، وسمك القرنية، وطبوغرافية القرنية.

المرضى والطرق:

استخدمت في الدراسة (92) عينة من (52) مريضاً يعانون من قصر البصر، وقصر البصر الاستكماتزمي، وبعد البصر بعد أن تم إجراء لهم عمليات تصحيح البصر بالليزر (ليزك، PRK). تم حساب الأخطاء الانكسارية، وتصحيح البصر بالعوينات الطبية، ودرجة الرؤيا بعد التصحيح، وقياس ضغط العين لكل مريض، وقياس سمك القرنية وطبوغرافية القرنية قبل إجراء العملية.

تم قياس ضغط العين بواسطة جهاز كولدمان وجهاز أيربف قبل العملية، وبعد إجراء العملية، حيث تم ملاحظة تغيرات في قياس ضغط العين بجهاز الكولدمان نتيجة تغيرات في سمك القرنية، وتحدب القرنية بعد إجراء عملية التصحيح بالليزر، وهذا مما يعطي قراءات خاطئة (أقل من الطبيعي) في قياس ضغط العين.

تم قياس ضغط العين بعد إجراء تصحيح البصر بالليزر بأسبوع، وشهر، وثلاثة أشهر. وأثبتت النتائج هبوط ضغط العين بعد مرور ثلاثة أشهر وستة أشهر بعد إجراء عملية التصحيح مع تغيرات في حدة البصر.

النتائج:

تم جمع نتائج العينات للمرضى بعد مرور شهر، وثلاثة أشهر، بعد إجراء العملية، وعدد العينات الطبية هو (92) عينة لـ(52) مريضاً. تم إجراء عملية تصحيح البصر لهم لمعالجة قصر البصر، وبعد البصر الاستكماتزمي، والاستكماتزم، وتم استبعاد أي مريض

لم يراجع بعد شهر من إجراء العملية من الدراسة، وتم ملاحظة هبوط ضغط العين للمرضى بعد إجراء العملية بـ3 أشهر بالمقارنة مع ما قبل إجراء عملية التصحيح. والسبب هو انخفاض سمك القرنية بواسطة عملية الليزك مما تسبب بانخفاض قياس ضغط العين بعد إجراء عملية التصحيح.

الاستنتاج:

1. عمليات تصحيح البصر بالليزر تؤدي إلى انخفاض أو هبوط في قياس ضغط العين الداخلي بعد إجراء العملية بـ3 أشهر.
2. تغيرات في سمك القرنية وطبوغرافية القرنية وممانعة القرنية لأجهزة ضغط العين مما تسبب في الانخفاض الخاطئ لضغط العين بجهاز الكولدمان مما يعطي انطباعاً خاطئاً لضغط العين لمرضى الزرق وارتفاع ضغط العين مما يسبب مشاكل في معالجتهم مستقبلاً.
3. يوجد تأثيراً طفيفاً على ضغط العين الداخلي بعد إجراء عملية الليزك بواسطة جهاز الأيربف (air puff) Tonometer بالمقارنة مع جهاز الكولدمان Tonometer (Goldmann).
4. يتضح بأن هناك فرقاً في مقياس ضغط العين الداخلي بعد إجراء عملية التصحيح بالليزر لكل من جهاز (Goldmann) الأكثر تأثراً بتغيرات سمك القرنية وطوبوغرافيتها وخواصها وجهاز (NCT Non-contact tonometer) air puff ذي التأثير البسيط، مما يعطي انطباعاً خاطئاً عن انخفاض ضغط العين وعلاج مرضى الزرق مستقبلاً.
5. نحتاج إلى أجهزة حديثة لقياس ضغط العين مستقبلاً لا تتأثر بالتغيرات في سمك القرنية وتحدبها وخواصها بعد إجراء عمليات تصحيح البصر بالليزر.

وزارة التعليم العالي والبحث العلمي

جامعة بغداد

معهد الليزر للدراسات العليا

تغيرات ضغط العين بعد عمليات تصحيح البصر بالليزر

دراسة

مقدمة إلى معهد الليزر للدراسات العليا – جامعة بغداد كجزء من متطلبات نيل درجة الدبلوم العالي في الليزر في الطب/ طب العيون

من قبل

أنمار علوان حسين

بكالوريوس طب وجراحة عامة / دبلوم عالي في طب وجراحة العيون

بإشراف

الدكتور أحمد محمد حسن عبد العزيز

زميل المجلس العربي للاختصاصات الصحية- طب العيون وجراحتها

دبلوم عالي ليزر في الطب - عيون

معهد الليزر – جامعة بغداد

1440هـ 2018م