



## Correction of refractive error by using Excimer laser

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<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>ABSTRACT</b></p>	<p>Correction of refractive errors of the eye by reshaping the cornea using a number of techniques such as surface laser or LASIK and others. Less than (40-50) seconds and with high accuracy. In this project we found Myopia was more common than hyperopia, treatment of refractive error by excimer laser was slightly higher in females than in males and refractive errors were more common among the students.</p>
	<p><b>Keywords:</b> Excimer laser , hyperopia, treatment</p>

### 1.1 Introduction

Laser excimer is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation [1]

Some laser refractive surgical procedures have been used to modify the shape of the cornea and correct myopia, hyperopia and astigmatism.[2]

Introduction of the excimer laser to reshape the cornea has resulted in remarkable developments in the correction of these refractive errors. Combined with other advanced ophthalmological instruments, laser refractive eye surgery has resulted in a substantial rise in the safety, efficacy, and predictability of surgical outcomes. Despite these advances, certain limitations and complications persist. In this study, we describe the most important tests preparation of LASIK operation and the LASIK technique[3]. The laser has become one of the most powerful tools for the scientists in physics, chemistry, biology, medicine, research and many other field of life.

#### 1.1.1 Aim of the project:

To evaluate the effect of 193 nm excimer laser in the correction of refractive errors (Myopia, Hyperopia and Astigmatism) and to get rid of glasses and contact lenses with non return of the refractive error to the eye.<sup>[3]</sup>

This procedure occurs in the time is less than (40-50) s and with high accuracy.

### 1.2 Refractive errors:

An eye that has no refractive error when viewing distant objects is said to have *emmetropia* or be *emmetropic*. The eye can focus parallel rays of light (light from distant objects) on the retina, without using any accommodation.<sup>[4]</sup>

An eye that has refractive error when viewing distant objects is said to have *ametropia* or be *ametropic*. This eye, when not using accommodation, cannot focus parallel rays of light (light from distant objects) on the retina. The word "ametropia" can be used interchangeably with "refractive error" as they refer to the same thing. Types of ametropia include myopia, hyperopia and astigmatism. They are frequently categorized as spherical errors and cylindrical errors<sup>[9]</sup>, Spherical errors occur when the optical power of the eye is either too large or too small to focus light on the retina. People with refraction error frequently have blurry vision. Myopia: When the optics are too powerful for the length of the eyeball one has myopia or nearsightedness. This can arise from a cornea with too much curvature (refractive myopia) or an eyeball that is too long (axial myopia).

Hyperopia: When the optics are too weak for the length of the eyeball, one has hyperopia or farsightedness. This can arise from a cornea with not enough curvature (refractive hyperopia) or an eyeball that is too short (axial hyperopia).<sup>[5]</sup>

Cylindrical errors occur when the optical power of the eye is too powerful or too weak across one meridian. It is as if the overall lens tends towards a cylindrical shape along that meridian. The angle along which the cylinder is placed is known as the axis of the cylinder, while 90 degrees away from the axis is known as the meridian of the cylinder<sup>[5]</sup>.

Astigmatism: People with a simple astigmatic refractive error see contours of a particular orientation as blurred, but see contours with orientations at right angles as clear. When one has a cylindrical error, one has astigmatism.

#### 1.3.1 Treatment of refractive errors:

Refractive errors can be corrected with eyeglasses, contact lenses, or surgery.

- 1- **Eyeglasses:** - are the simplest and safest way to correct refractive errors. Your eye care professional can prescribe appropriate lenses to correct your refractive error and give you optimal vision.
- 2- **Contact Lenses:** - work by becoming the first refractive surface for light rays entering the eye, causing a more precise refraction or focus. In many cases, contact lenses provide clearer vision, a wider field of vision, and greater comfort.
- 3- **Refractive Surgery:** - aims to change the shape of the cornea permanently. This change in eye shape restores the focusing power of the eye by allowing the light rays to focus precisely on the retina for improved vision.

### 1.4 Excimer laser:

The first excimer laser was produced in 1975 and since then it has witnessed a rapid technological development and developed into new types that have [ the power of excimer laser (200w) with (250 or 500)HZ frequency and (1.00 mJ) energy and a pulse width of (4-7) ns]. The Excimer laser has some properties such as:

- The Excimer laser is a "cool" laser, does not generate heat in the cornea.
- The laser energy destroys intermolecular bonds in the corneal tissue resulting in tissue removal by a process termed "photo ablative decomposition". The exquisite precision with which the tissue can be removed, and the absence of thermal damage. The precision of treatment with the 193-nm ArF excimer laser and, more important, the lack of damage to surrounding tissue, characterized a new mechanism of interaction called ablative photodecomposition, later named photoablation. This was due

to the absorption of ultraviolet (UV) photons by the cornea with sufficient energy to break organic molecular bonds in the tissue [10].

#### **1.4.1 Development:**

1. First Generations Excimer Laser systems:

Broad beam lasers were first generation machines. They projected beam in concentric circles of different sizes on to the cornea. They are prone to inhomogeneity of energy across the treatment area, and the problems grow more significant as the laser attempts to treat high refractive errors. It led to night vision problems especially in patients with large night pupil diameters. The results had also been hampered with corneal haze and halos.[11]

2. Second Generation Excimer Laser systems: Broad beam lasers gave way to second generation slit scanning lasers. A narrow slit like beam of laser is scanned in the direction perpendicular to the axis of the slit, hence a "Slit-scanning" laser. This method can, to a certain extent, improve the problem in inhomogeneity. Nevertheless, its flexibility in treating other vision problems is still inadequate. It has its limits in difficult situations.[8]

3. Third Generation Excimer Laser systems: Third generation excimer lasers use a computer controlled scanning mirrors to scan a small spot (2mm) of laser energy over the treatment area, hence "small-spot scanning" or "Flying-spot" lasers. These lasers produce smooth surfaces. The spot can be scanned to cover an area as large as 12mm in diameter. Thus night vision problems are rare with these lasers. The scanning mirrors are controlled by software, thus enables third generation lasers to create any treatment profile to correct any refractive error.

4. Fourth Generation Excimer laser system: The latest State of the Art, fourth generation excimer lasers have made improvements in spot size, tracking ability, speed of treatment and stability of laser beam. Fourth Generation Lasers create a "perfect" optical system that can yield better than 6/6 vision and at the same time reduce, or eliminate, the risk of low-light vision problems like glare and haloes at night. This type of laser regarded such most recent scientific technology in treating refractive error of the eyes where low-wave ultraviolet laser rays are used to adjust corneal surface therapy changing its refractive power as shown in figure(2.3).This ray remove layers from corneal tissue in high accuracy and with very accurately determininal length and depth

#### **1.4.2 Advantages of excimer laser for eyes**

Excimer laser technology is characterized by the following:[8]

1. Safe and effective technique: only about 10-20% of the thickness of the corneal tissue is removed.
2. Cornea protection from heat: Excimer laser protects the cornea; It is a cold laser and does not generate heat, which ensures the safety of the cornea from burning.
3. Accuracy: Excimer laser removes the amount of tissue according to specific measurements and settings very precisely.

#### **1.4.3 Side effects of EXPI Laser:**

Some side effects may occur for a few days only after Eyezimer's Eye Laser procedure, namely: [9]

1. Eye dryness.
2. Feeling of pain for lightness or itching.
3. Eye sensitivity towards light.
4. The appearance of glow or auras around the light.

#### **1.4.4 Individuals who are eligible for Eye Laser :**

include individuals who are qualified to correct eye surgery with laser surgery: [1]

1. The patient is over 18 years old.
2. That the patient reaches a constant measure of eye degrees, so that they do not change.
3. That the thickness of the cornea is sufficient to make the laser on it.
4. My nearsightedness reaches -10.0 degrees.
5. The farsightedness reaches +6.0 degrees.
6. The astigmatism reaches 6.0 degrees.

7. The eye does not have diseases such as keratoconus or high intraocular pressure.

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### **2.1 Introduction:**

There are two types of excimer lasers *Surgeries*:

1. Surface Laser Process (PRK)
2. LASIK
3. FemtoLASIK

#### **2.1.1 Surface Laser Process (PRK)**

The surface laser process PRK is a type of laser vision repair surgery, in which the excimer laser is used to modify the shape of the cornea and the degree of its convexity and then correct the size of the vision such as LASIK, but without the need to lift a layer or crust of the cornea as happens with LASIK.<sup>[1]</sup>

Unlike LASIK, during the surface laser PRK, we only remove the epithelial cells lining the surface of the cornea,<sup>[2]</sup> then the excimer beam is shipped laser on the corneal bark to correct the strength of vision, then the corneal brightness is covered with a special contact lens for only three days until the epithelial membrane heals again, leaving the cornea without any wound or trace of the operation. has a success rate of 95 percent for patients.

#### **2.1.1.2 Indications for using the surface laser:**

1. Treatment of myopia or astigmatism less than 4 degrees.
2. If the thickness of the cornea does not allow LASIK to be performed.
3. In patients who practice violent sports or team sports where they are prone to eye collision.
4. In patients who prefer a degree of 100% safety and are not very concerned with the temporary side effects that occur after surface laser and disappear completely within several days after the operation.
5. To improve vision before corneal fixation in cases of simple and medium keratoconus.

#### **2.1.1.3 Advantage of PRK surface laser process:**

Advantages of the surface laser process include:<sup>[4]</sup>

- . An improvement in vision by at least 50% after the surface laser operation, and the improvement may reach 95%
- . after the procedure, no need to use the glasses but you may need them to read or to see more clearly at night
- . For the same surface laser process

The results of the LASIK process are in the long term, but the surface laser process is safer to keep the corneal structure close to the cornea, which increases the risk to normal, while the LASIK process includes placing a flap on complications<sup>[7]</sup>

#### **2.1.1.4 Disadvantages of PRK surface laser process:**

Despite the advantages of the surface laser process, its safety and its high success rate, it has a number of disadvantages that make many people prefer the LASIK process for vision correction, as the defects of the surface laser process include<sup>[3]</sup>

- The recovery period is relatively long Annoyingly, the recovery period can be up to 30 days
- The process is required after completion Putting bandages, you need to see a doctor in order to remove them
- Discomfort from the effect of the operation lasts for several weeks after it is performed<sup>[4]</sup>
- Surface laser surgery has a number of complications, including scar formation, infection, clouding of the cornea, and a halo effect around the light.
- In rare cases, vision may worsen after the operation<sup>[5]</sup>
- The procedure can be done with under correction or overcorrection of the refractive error, which means you may need to continue we under correction

#### 2.1.1.5 Candidates for laser surgeries Surfactant

The criteria that a patient must meet in order to be eligible for PRK surgery include <sup>[7]</sup>

1. Age greater than 21 years • The degree of vision has not changed significantly in the last year before The operation
2. The rate of improvement in irrigation should be at least 50 percent after the operation
3. .Myopia cases with a prescription ranging from 100 to 12

#### A diopter is the one that measures the power of a lens<sup>[2]</sup>

4. The woman should not be pregnant or breast-feeding at the time of the surface laser procedure
5. The average pupil size is about 6 mm when the room is dark.

#### 2.1.1.6 Side effects after surface laser surgery:

All the side effects of the surface laser operation are temporary, and the patient rarely complains of any of them after a month of the operation, as follows:

1. Shaking, burning and tears in the eyes for only three days after the operation.
2. A slight haze of vision that gradually decreases over a period of two weeks after the operation.
3. Mild dry eyes.

Fig(2.1) shows the cornea is normal

Permanent side effects (such as continued opacity for long periods) do not occur unless the surgeon exceeds the scientific rules that must be followed in the case of using surface lasers as a result of either the surgeon's lack of knowledge or experience in this particular type of.<sup>[3]</sup>

#### 2.1.2 LASIK :

**LASIK: Laser- Assised In Situ Keratomileusis.** Is a type of refractive laser eye surgery performed by ophthalmologist for refractive error, laser refractive surgery in which the excimer laser ablation is done under a partial-thickness corneal flap<sup>[4]</sup> Until recently, the flap could only be made with a microkeratome. The microkeratome uses an oscillating blade to cut the flap after immobilization of the cornea with a suction ring. Microkeratomes can cut to depths of (100–200)  $\mu\text{m}$ . A femtosecond laser has been developed that can etch flaps within the cornea stroma at a desired corneal depth. The femtosecond laser provides more accuracy in flap thickness than previous methods; the microkeratome cuts can vary widely in depth, even with the same preset thickness.<sup>[9]</sup> Femtosecond laser flap creation is less dependent on the corneal curvature and might be more reliable in cases of steep or flat corneas, which can be at greater risk for irregular corneal cuts. Increased cost and surgical time <sup>[6]</sup>.

##### 2.1.2.1 The LASIK procedure:

Once anesthetic eye drops 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.<sup>[5]</sup>

The microkeratome 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 has been created, it is reflected at its hinge away from the corneal stroma.

The patient is asked to fixate on a centration light, an eye-tracker is engaged to adjust for any eye movements during the ablation, and a preprogrammed excimer ablation is done. Variables such as refractive target, treatment diameter, and treatment blend zone can be altered for most laser platforms. Excimer laser pulses are applied. The ablation might either correct sphere and cylinder error, the amount of tissue removed is dependent upon the degree of refractive error that is being corrected.<sup>[6]</sup>

After the ablation has been completed, the stromal bed is irrigated and the corneal flap is repositioned <sup>[5]</sup>.

#### 2.1.2.2 Lasik Advantage:

A better vision in the next day after the operation thereby the quick return to normal life without glasses <sup>[6]</sup>

- No pains are suffered after the operation.
- In most cases a contact lenses are not required at all after the operation.
- The operation is under taken with topical anesthetic the patient dose not need to stay in the hospital.
- The operation can be done for both eyes simultaneously.
- The refractive error dose not happen again because the LASIK result are stable and certain.

Despite these advantages, certain limitations and complications persis , such as Changes made to the cornea cannot be reversed after LASIK, Problems may occur when the doctor creates the flap, which can permanently affect vision and LASIK can rarely cause a loss of "best" vision. Your best vision is the highest degree of vision that you achieved while wearing your contacts or eyeglasses.<sup>[9]</sup>

#### 4.1 Results & Discussion:

The results of LASIK are affected by age, in this chapter will compare between age & type of refraction, age & Gender and between the age & occupation By collection of 100 eyes that underwent LASIK.<sup>[1]</sup>

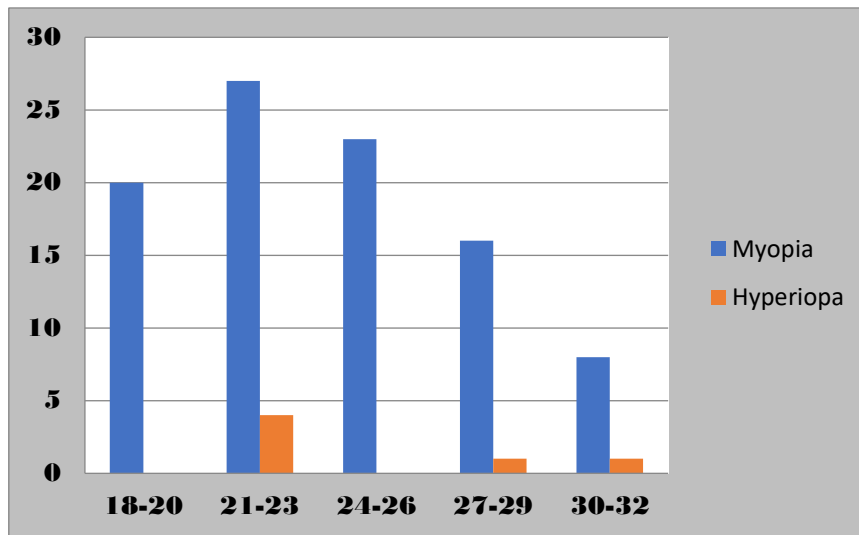
The data of 100 eyes that underwent LASIK treatment for simple myopia & hyperopia with or without astigmatism re summarized in tables (4.1), (4.2) ,(4-3) and more explanation included in figures (4.1),(4.2) and (4-3).

Table (4.1) Represent the relationship between Age (years) & Gende

Age	Type of refractor	
	Myopia	Hyperopia
(18-20)	20	0
(21-23)	27	4
(24-26)	23	0
(27-29)	16	1

(30-32)	8	1
<b>Total</b>	<b>94</b>	<b>6</b>

This table shows the relationship between age(year) and type of refractor , this table state Myopia was more common than hyperopia [2] , which in age(21-23) years were (31) cases , (27) myopia and (4) hyperopia because mainly young peoples are effected with this defect, But hyperopia occurs to mainly peoples of 40 age. As during this the muscles become less flexible..

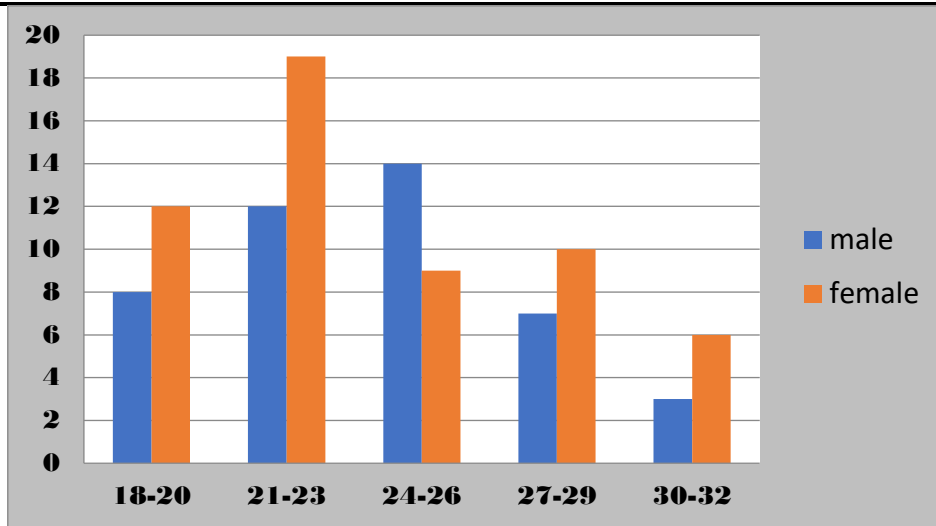


Figure(4.1) Histogram representing the relationship between Age & Type of refractor

Table (4.2) Represent the relationship between Age (years) & Gender

Age	Gender	
	Male	Female
(18-20)	8	12
(21-23)	12	19
(24-26)	9	14
(27-29)	7	10
(30-32)	3	6
<b>Total</b>	<b>39</b>	<b>61</b>

In this table The treatment of refractive error by excimer laser (LASIK) was slightly higher in female[3], which [ age(21-23) were (31)cases ,(12)male and (19)female] because women are more interested with cosmetology than men.



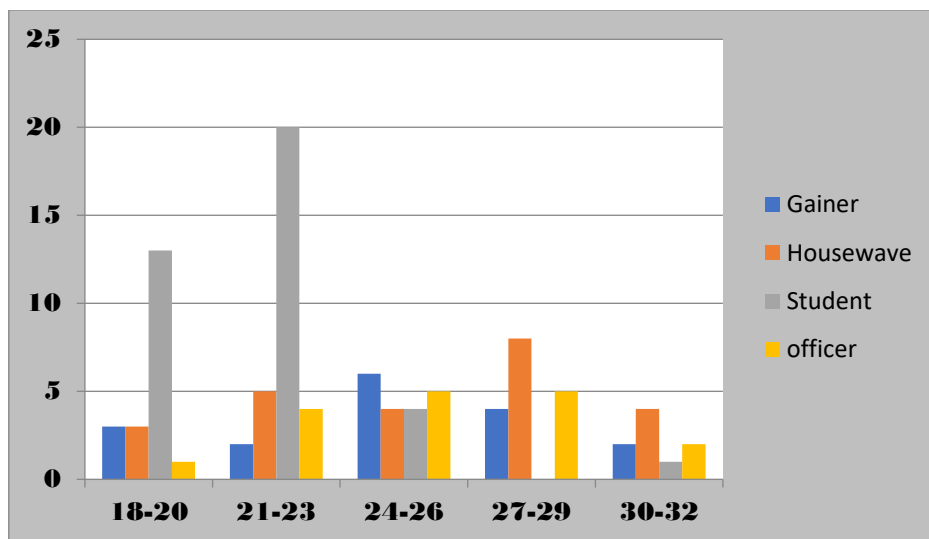
Figure(4.2) Histogram representing the relationship between Age(years) & Gender.

Table(4.3) Represent the relationship between Age (years) & Occupation

Age	Occupation			
	Gainer	Housewife	Student	Officer
(18-20)	3	3	13	1
(21-23)	2	5	20	4
(24-26)	6	4	4	5
(27-29)	4	8	0	5
(30-32)	2	4	1	2
Total	17	28	38	17

In this table show ( LASIK ) is common in student more than others .

In age (21-23) there was about(20) cases from student, refractive error was more common in student because mostly school going children this is caused to increase in technology children are always engaged in playing video games .<sup>[4]</sup>



Figure(4.3) Histogram representing the relationship between Age(years) & Occupation



As we know our eyes are relaxed when we see distant object it feels a little difficulty to see near object.<sup>[5]</sup> And when anyone is always doing near works the eyes are so much tired of seeing near object the muscles are continuously stretched and if anyone seems to have a routine of always doing near work his\her eyes adapt themselves so that they have less difficulty.<sup>[6]</sup> The eye balls become vertically elongated. So that the ciliary muscles have to be less stretched while doing the close work. But when anyone see distant object the image is blurred as after fully relaxing also the image does not get focused on the retina as the eye is vertically elongated.

#### 4.2 Conclusions:

The results of this thesis indicate that LASIK surgery has many advantages over other photorefractive procedure, including a relative lack of pain afterward and the fact that good vision usually is achieved by the very next day.<sup>[7]</sup>

Both nearsighted and farsighted people can benefit from the LASIK procedure. With nearsighted people, the goal is to flatten the too-steep cornea; with farsighted people, a steeper cornea is desired. Excimer lasers also can correct astigmatism by smoothing an irregular cornea into a more normal shape.<sup>[9]</sup>

- All of the persons who did the LASIK operation gave up the glasses or contact lenses. The correction of refractive errors by excimer laser can be done for both eyes simultaneously.
- The visual acuity after LASIK depending on the degree of visual acuity with glasses for the patient before the LASIK operation.<sup>[9]</sup>
- Advances in these procedures continue to make the procedures not
- only more effective, but also safer.

Femtolask has emerged as a new technology in the world of laser vision correction for the treatment of refractive defects<sup>[11]</sup>.

It can be considered as a modern and developed generation of the regular LASIK technique, as it is distinguished by being more accurate and more accurate The safety of the emergence of complications after surgery is less, period, and probability Also, it is less painful after convalescence as well<sup>[8]</sup>

Complications completely, but reduced them compared to less. However, it has some drawbacks as it has not been canceled with

LASIK process, so whoever wants to correct vision in this way should be fully aware of that<sup>[10]</sup>

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