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Vision correction surgeries (LASIK)

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بسم الله الرحمن الرحيم

(وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا)

صدق الله العلي العظيم

الإهداء

نحمد الله وهو المشكور الأول على ما أتانا من فضله .

يبهجني في إهداء هذا البحث لوالدي اللذان كانوا داعمين لنا في المسيرة الدراسية وتثمين لجهودهم في ذلك ثم

الى رفاق الأيام الجميلة والشاقّة .

وفي ذلك نقدم الشكر والتقدير إلى من أرشدنا ووجهنا في أعداد هذا البحث تتسابق عبارات الحُب و

يَتَبارى الكلام الرقيق لنقول لكَ شكراً وإن شكرتكَ لن يوفيكَ ذلك .

وفي الختام نحمد الله سبحانه وتعالى الذي منَ علينا بنعمة العقل

الشكر والتقدير

أولا وقبل كل شيء، نود أن نعرب عن خالص امتناننا لله على كل توجيهاته وبركاته وقوته التي قدمها لنا خلال مسيرتنا الأكاديمية.

نحن ممتنون للغاية كلية الحلة الجامعة لتوفيرها بيئة تدعم الدراسة الأكاديمية والاكتشاف. أحد الأسباب الرئيسية لنجاح هذه الدراسة هو التزام الجامعة بالجودة.

ونتقدم بخالص امتناننا للأستاذة رهام خالد على قيادتها المتميزة ودعمها المستمر ومراقبتها الملتزمة. لقد ساهمت معرفته في تطوير فهمنا بشكل كبير ورفعت مستوى دراستنا.

يجب أن نقدر بصدق عائلاتنا وأصدقائنا على صبرهم وإلهامهم و تشجيعهم المستمر. لقد كان تصميمهم و ثقتهم في جهودنا بمثابة الحافز لنا.

نحن نقدر مساهمات الجميع في جعل هذه الرحلة المشتركة ممكنة للبحث. لقد كانت كل مساهمة ضرورية لإنجاز هذا البحث

List of contents

Abstract

Laser vision correction (LVC) revolutionized ophthalmic practice by offering precise and effective solutions for refractive errors. This abstract explores the principles, techniques, outcomes, and advancements in LVC procedures, focusing on its widespread adoption and continuous refinement. Laser vision correction encompasses several techniques, including LASIK (Laser-Assisted In Situ Keratomileusis), PRK (Photorefractive Keratectomy), and SMILE (Small Incision Lenticule Extraction).

These procedures aim to reshape the cornea, thereby correcting refractive errors such as myopia, hyperopia, and astigmatism. Each technique has its unique advantages and considerations, catering to diverse patient needs and ocular conditions. The success of LVC procedures relies on precise preoperative assessment, where patient suitability and expectations are carefully evaluated. Advanced diagnostic tools, such as corneal topography and wavefront analysis, aid in optimizing surgical outcomes and minimizing postoperative complications.

Clinical studies have demonstrated the safety, efficacy, and predictability of LVC, with high patient satisfaction rates reported worldwide. Rapid visual recovery, reduced dependence on corrective lenses, and improved quality of life are among the notable benefits observed postoperatively. Recent advancements in LVC technology continue to enhance surgical precision and safety. Innovations such as femtosecond lasers, customized wavefront-guided treatments, and topography-guided ablations optimize visual outcomes and minimize aberrations. Despite its remarkable advancements, LVC is not devoid of risks and limitations. Potential complications include dry eye syndrome, night vision disturbances, and under correction or overcorrection of refractive errors.

Chapter One
Introduction

1.1 Introduction

In the twenty-five years since the US Food and Drug Administration (FDA) approval for laser vision correction (LVC) to treat myopia and hyperopia with astigmatism there has been a progression of technological improvements from unilateral Photorefractive Keratectomy (PRK), to bilateral Laser-assisted in situ keratomileusis (LASIK) with wavefront or topographical guided treatments.Citation1–Citation10 The flap initially created by a mechanical microkeratome now uses a femtosecond laser [1].

Laser vision correction has revolutionized the field of ophthalmology, offering millions of individuals worldwide a path to clearer, more precise vision without the dependence on glasses or contact lenses. This transformative procedure utilizes advanced laser technology to reshape the cornea, correcting refractive errors such as nearsightedness (myopia), farsightedness (hyperopia), and astigmatism[2].

The goal of laser vision correction is to decrease dependence on glasses and contact lenses by focusing light more effectively on the retina [3].

Laser vision correction is regarded as highly effective with studies showing 94% of patients achieving uncorrected visual acuity of 20/40 or better at 12 months [4], which is the visual acuity needed to drive without corrective lenses in most states. Smaller studies have shown that up to 93% of patients with lower refractive errors can obtain 20/20 vision without correction [5]. A meta- analysis completed in 2008 revealed that 95% of LASIK patients are satisfied with their improved vision [6].

techniques like LASIK (Laser-Assisted in Situ Keratomileusis) and PRK (Photorefractive Keratectomy) becoming prominent methods for vision enhancement. LASIK, in particular, has gained widespread popularity due to its quick recovery time and remarkable efficacy in correcting vision[7]

The procedure involves creating a thin flap in the cornea, which is then lifted to allow the laser to reshape the underlying tissue, correcting the refractive error. The flap is carefully repositioned after the laser treatment, promoting rapid healing and minimal discomfort for the patient[8].

Laser vision correction offers numerous benefits beyond visual clarity, including enhanced quality of life, increased convenience, and freedom to engage in various activities without the hindrance of corrective eyewear. While not everyone may be a candidate for laser vision correction, advancements in technology and surgical techniques continue to expand the pool of eligible candidates, making this procedure a viable option for a growing number of individuals seeking permanent vision correction[9].

1.2 Literature Review:

In this section ,Laser vision correction will be reviewed:

1- In 2012 Ming Chen study Purpose: To search evidence and determine whether PRK (Photo Refractive Keratectomy) or LASIK (Laser in Situ Keratomileusis) produce a better outcome of laser vision correction for patients with atypical topography of cornea. The best in corrected vision was obtained for those eyes with atypical topography that were treated with either PRK or LASIK. However, in the comparison of the outcomes of vision and ectasia, PRK outperformed LASIK.

2- In 2015 Leopoldo Spadea , et.al studied of the excimer laser for keratorefractive surgery has changed the treatment landscape for correcting refractive errors, such as myopia, hyperopia, and astigmatism. In recent years, with the increased understanding of the basic science of refractive errors, higher-order aberrations, biomechanics, and the biology of corneal wound

healing, a reduction in the surgical complications of keratorefractive surgery has been achieved. The understanding of the cascade of events involved in the corneal wound healing process and the examination of how corneal wound healing influences corneal biomechanics and optics are crucial to improving the efficacy and safety of laser vision correction.

3- In 2016 Ehlke, et.al studied Laser vision correction for myopia. Topographic and tomographic screening indices have been implemented clinically, but there is still much to learn about corneal biomechanics. A more recently developed procedure for myopia correction is small-incision lenticule extraction, in which a lenticule is created in the cornea's stroma with a femtosecond laser and extracted through a small corneal incision. Long-term outcomes and new complication risks need to be better understood as this procedure develop.

4- In 2017 Qi Wan, et.al The aim of this study was to review the safety and stability of cornea cross-linking (CXL) for the treatment of keratectasia after Excimer Laser Refractive Surgery. Methods Eligible studies were identified by systematically searching PubMed, Embase, Web of Science and reference lists. Meta-analysis was performed using Stata 12.1 software. The primary outcome parameters included the changes of corrected distant visual acuity (CDVA), uncorrected visual acuity (UCVA), the maximum keratometry value (Kmax) and minimum keratometry value (Kmin), the surface regularity index (SRI), the surface asymmetry index (SAI), the keratoconus prediction index (KPI), corneal thickness, and endothelial cell count. Efficacy estimates were evaluated by weighted mean difference (WMD) and 95% confidence interval (CI) for absolute changes of the interested outcomes.

5- In 2019 Elizabeth Wen Ling Lim studied Laser in-situ keratomileusis (LASIK), photorefractive keratectomy (PRK) and small-incision lenticule

extraction (SMILE) are safe and effective refractive surgical procedures. However, complications include regression of treatment and iatrogenic keratectasia which can be severe and sight-threatening. In order to reduce these complications, simultaneous corneal cross-linking (CXL) is currently being added to these refractive procedures. This review analyses current long-term literature (≥ 1 year follow-up) on refractive surgery and simultaneous CXL (LASIK Xtra, PRK Xtra and SMILE Xtra) to determine its overall safety and efficacy.

6- In 2020 Victoria Barnett & Allon Barsam were studied the current surgical options for refractive error and presbyopia, including laser refractive surgery and intraocular lens surgery.

7- In 2022 Zofia Pniakowska studied Laser vision correction (LCV) is a common corneal surgery for the treatment of refractive errors. The rapid development of LVC techniques make this procedures safe and efficient. Despite the high safety profile of corneal refractive surgery, there are however some clinical conditions that constitute absolute or relative contraindication for this procedures. The aim of the paper was to overview and summarise the currently known systemic contraindications for LVC.

8- in 2023 Hongyuan Zhang , et.al studied characterize focal biomechanical differences between normal, keratoconic, and post–laser vision correction (LVC) corneas using motion-tracking Brillouin microscopy.

9- in 2023 David Smadja, et.al studied postoperative impact of laser vision correction for myopia on the optical quality and stability of functional vision using a double-pass aberrometer. Retinal image quality and visual function stability were assessed preoperatively, one and three months after myopic laser in situ keratomileuses (LASIK) and photorefractive keratectomy (PRK) using double-pass aberrometry (HD Analyzer, Visiometrics S.L, Terrassa,

Spain). The parameters analyzed included vision break-up time (VBUT), objective scattering index (OSI), modulation transfer function (MTF), and Strehl ratio (SR).

1.3 Research aims :

The aims of study are:

1-Learn about Laser vision correction procedures.

2-Learn about the types of Laser vision correction operations.

3-studingthe method Lasik operations.

Chapter Two
Theoretical Part

2.1 introduction

Laser vision correction procedures have seen several advancements in past decades, either due to the improvements in the clinical techniques being utilized or due to the technical advancements in the laser systems [10]. Laser vision correction is a group of refractive surgery procedures for the correction of refractive errors. The corneal surgery methods such as laser-assisted in situ keratomileusis (LASIK), small incision lenticule extraction and surface ablation (LASEK or PRK) are characterised by a high safety and efficacy profile, providing good visual outcomes. Although the procedures are the most commonly performed ophthalmic surgeries worldwide, there are some systemic clinical factors that constitute the contraindications for LVC due to the increased risk of postoperative corneal complications[11].

2.2 Laser

Lasers, as the source of light or radiation energy, were described by Theodore Meimann in 1960.[12] Laser devices produce electromagnetic radiation that is relatively uniform in wavelength, phase, and polarization. Different kinds of lasers are used for medical treatments. Laser therapy is a form of medicine that applies laser radiation to the surface of the body. While lasers are used to cut or remove tissue, relieve pain, reduce inflammation and edema, promote wounds, prevent tissue damage, and heal deeper tissues and nerves in medicine, they stimulate and enhance cell and tissue function. The effects of lasers are confined to the special set of wavelengths. The main tissue chromophores including hemoglobin and melanin have high absorption bands during shorter waves. Also, water strongly absorbs infrared photons at wavelengths above 1100 nm. Therefore, using low-level lasers in medicine is known as a suitable tool. Low-Level Lasers such as ruby, Argone, HeNe, and Krypton are types of lasers that affect biological systems through non-

thermal means.[13] In order to influence the visible light exposure to a living biological system, it can absorb photons by using electron capture bands belonging to some molecular photo-receptors. When the tissue chromophores, often hemoglobin, water or melanin, are affected by laser energy, the photon is absorbed, so it causes the target material to heat up and inflicts localized damage. In addition, laser energy is absorbed more rapidly and intensively through the skin and then causes localized damage.[14] Furthermore, the person who directs the laser must be fully trained and skilled because lasers of an unspecified purpose can burn or destroy healthy tissue. Treatment complications of laser therapy may occur following the application of different types of laser devices and must be anticipated. In this article, we explain and evaluate several effects of lasers on cell functions, tissue, and the body [15].

Laser surgery is a kind of surgery which makes use of the laser beam cutting power to obtain bloodless cuts in tissue or eliminate a superficial lesion such as a skin tumor. Today there is an increased interest in minimally invasive surgery. In other surgery areas, the techniques have been refined, in which no or smaller incisions are required. There are many types of lasers that are different in emitted light wavelengths and their power and ability to clot, cut or vaporize tissue. Lasers are used to relieve bleeding or obstruction of some diseases. Sometimes, laser therapy is used alone, but it is often associated with surgery, chemotherapy, or radiation therapy. [16]As it is shown in Table 1, among the commonly used lasers are the erbium-doped yttrium aluminium garnet (Er:YAG) laser,3 the diode laser, the argon laser, the neodymium-doped yttrium-aluminum-garnet (Nd:YAG) solid state laser,4 and the CO2-gas laser.5 These lasers penetrate only at short distances in the tissue and result in fine and precise cuts in surgery. Laser technology was introduced by an Austrian neurosurgeon in 1976 [17] .

Table 1

The Various Types of Lasers Used in Surgery

Laser	Wavelength (nm)	Absorption Chromophore
Er:YAG	2940	Water
Diode	630–980	Pigment, water (range)
Argon	350–514	Pigment, hemoglobin
Nd:YAG	1064	Pigment, proteins
CO_2	10600	Water

A laser system sends regular feedback to the calibration device, which measures the deviation with respect to the expected signal. This regular feedback can be laser pulses directed on to the calibration device (for example, in case of energy measurement) at regular intervals or simply a prompt to use the calibration device and perform a system calibration (for example, in case of plastic ablations requiring user interaction)[18]. The deviation of the achieved signal from the expected signal acts as calibration data, which is interpreted either objectively or subjectively. The resulting adjustment factor is fed to the laser system for calibrating the system performance closer to the expectation. This cycle is repeated at different frequencies depending on the frequency of the regular feedback, with different methods. With several calibration materials, methods, and devices either commercially available or under research and development, there is a need to review the accuracy introduced by each of these aspects and to find a configuration that reflects an optimum to achieve better outcomes after laser vision correction [19].

2.3 Anatomy

In order to see clearly, the cornea and lens must bend (refract) light rays to focus an image on the retina. The cornea is responsible for roughly 2/3 of the eye's total 60 diopters of refractive power. Unlike the lens, which is able to change its refractive power through accommodation, the cornea's curvature is fixed. The cornea is composed of 5 layers that provide a clear window and refractive power to the eye. These layers are shown in Figure 1. The stroma provides the cornea with structural shape and thus its refractive power. Laser vision correction removes stromal tissue in order to change the shape of the cornea, making it flatter or steeper. Laser vision correction is most commonly used to treat myopia (nearsightedness), hyperopia (farsightedness), and astigmatism. Figures 2, 3, and 4 illustrate these refractive errors. Depending on the refractive error, the cornea is made flatter or steeper to focus light on the retina.

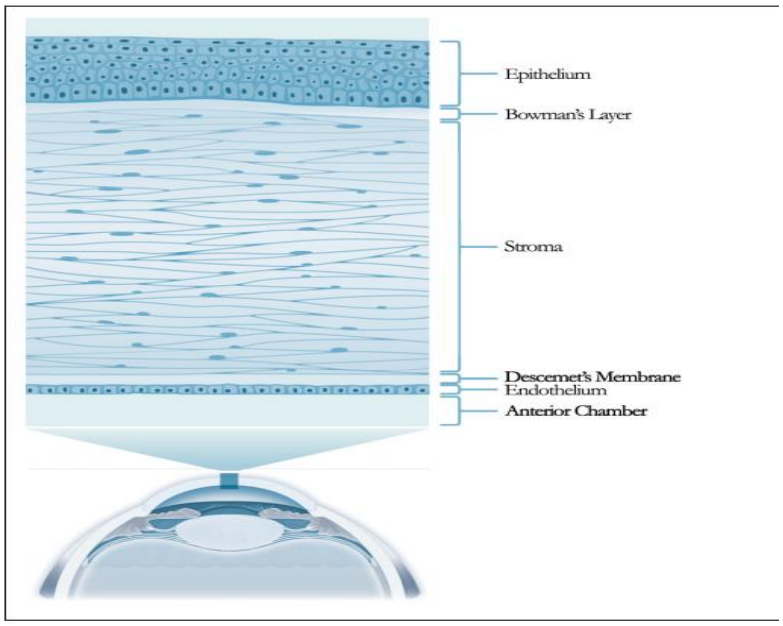


Figure 1: The cornea has an average central thickness of 540 micrometers. Layers from anterior to posterior: the epithelium, Bowman's layer, stroma, C Descemet's endothelium. membrane, and

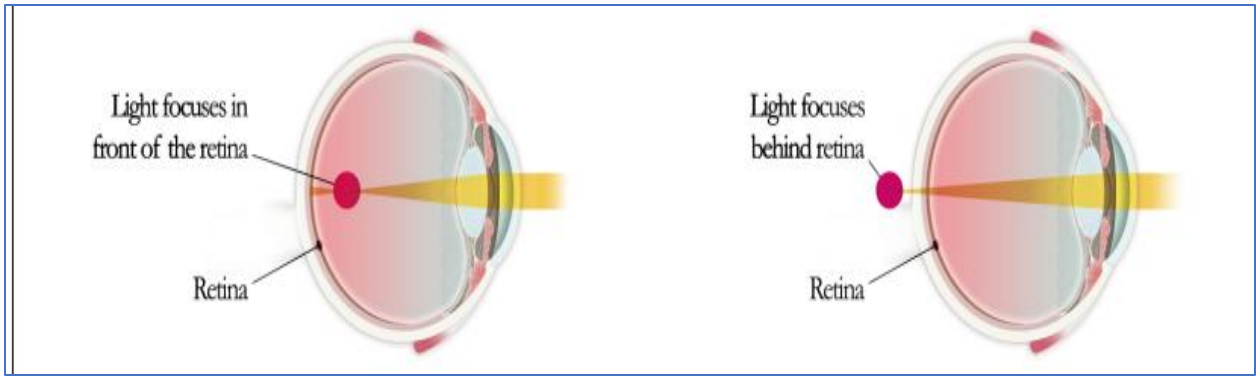


Figure 2: In myopia, the eye is too long or the cornea is too steep. Distant objects appear blurry because images are focused in front of the retina.

Figure 3: In hyperopia, the eye is too short or the cornea is too flat. As a generalization, close objects appear blurry because images are focused behind the retina.

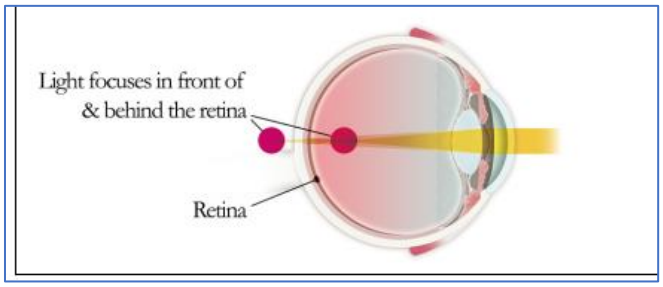


Figure 4: An astigmatic eye has an unevenly shaped cornea, like a football shape instead of a basketball, causing both close and distant objects to appear blurry.

In addition to corneal refractive errors, surgeons must account for presbyopia in patients who are middle aged or older. Presbyopia is the inability to focus on objects at near range due to loss of accommodation. Younger patients can accommodate, meaning they can make their relatively soft lens “thicker” to focus at near and “thinner” for distance. Presbyopia is a normal condition that typically occurs after the age of 40 and is caused by decreased lens compliance over time. With aging, the lens loses the ability to accommodate to see at near. Presbyopic patients have two options for laser vision correction:

(1) Correct both eyes for distance and use reading glasses for intermediate/near work

(2) Correct one eye for distance and one eye for near (i.e., monovision) to decrease the dependence on glasses.

2.4 Laser eye surgery and lens surgery

Surgery to improve your eyesight is known as refractive surgery or vision correction. There are 2 different types: laser eye surgery and lens surgery. Both types of surgery can make you less dependent on glasses or contact lenses. Research shows that both are safe and effective. What type of refractive surgery will suit you best depends on a range of things, including your eyesight, eye health, age, budget and lifestyle. Your surgeon will examine your eyes, assess your needs and help you decide on the best option for you. When weighing up the risks and benefits of refractive surgery bear in mind that wearing contact lenses also carries some risks for your eye health. Refractive surgery is not available on the NHS for people who just want to improve their eyesight. Most people have it done at a private clinic. Costs vary according to what kind of surgery you're having.

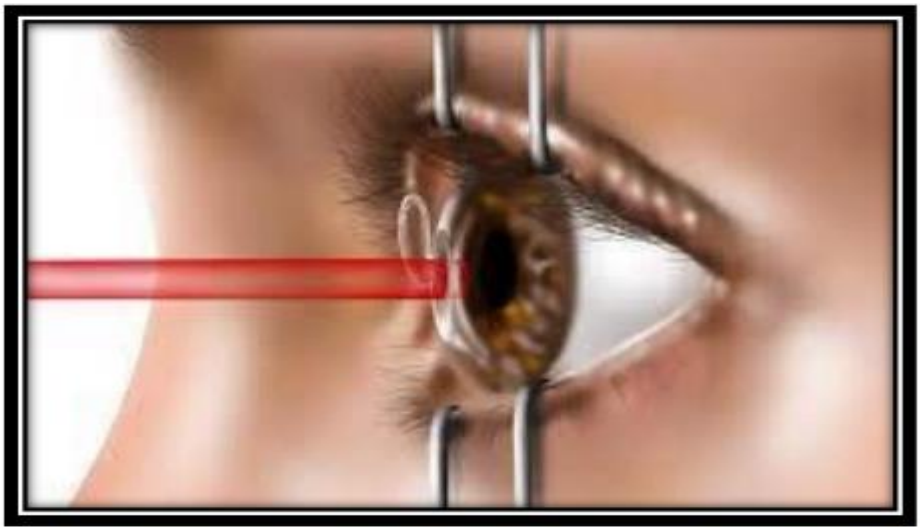


Figure 5: Laser eye surgery

2.4.1 Laser eye surgery What is it?

Laser eye surgery, or laser vision correction, involves using lasers to reshape the front surface (cornea) of your eyes so that you can focus better. It can correct short-sightedness, long-sightedness and astigmatism.

2.4.2 Who is it suitable for?

Laser eye surgery is suitable for most people over 18. Ideally your eye prescription will have stayed more or less the same for about 2 years. Lens surgery may be more suitable if you have a high spectacle prescription or later in life.

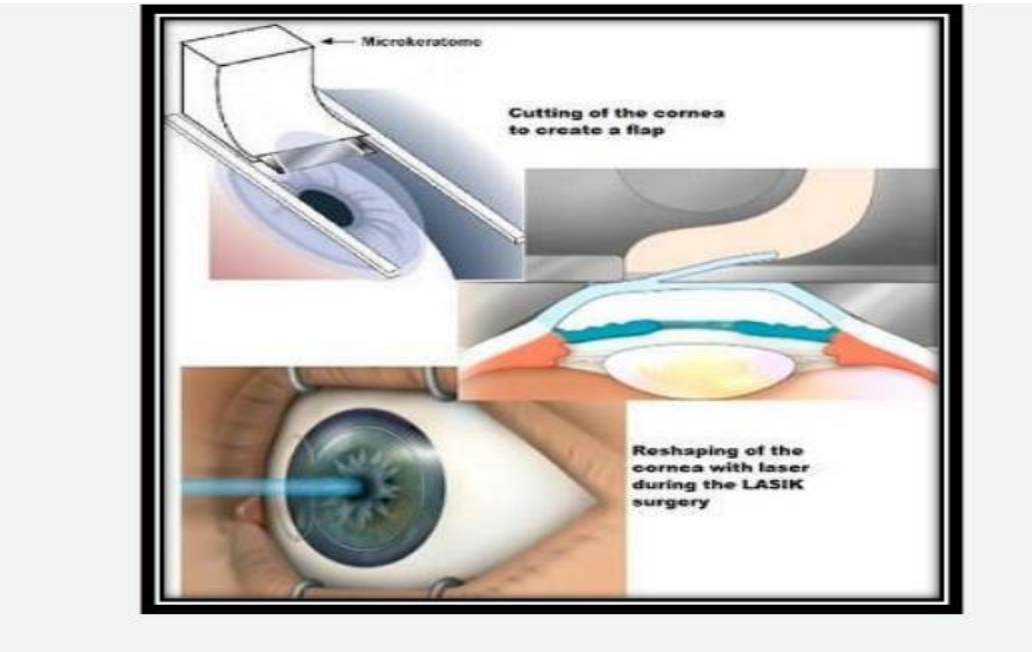


Figure 6: Lens surgery

2.4.3 Are there any risks?

About 1 in 10 people who have laser eye surgery need more surgery to get the best possible results. There's usually no extra cost for this. Common side effects include:

• Mild, gritty discomfort – artificial tears can help with this and your eyes will usually feel comfortable again in about 3 to 6 months

• Visual disturbances (such as glare from oncoming headlights when driving at night) – this usually resolves or can be treated successfully

• Red marks on the white of your eye – these always fade away in about a month.

Severe loss of vision is very rare.

2.5 LASIK Eye Surgery

LASIK is the most commonly performed laser eye surgery to treat myopia (nearsightedness), hyperopia (farsightedness) and astigmatism. Like other types of refractive surgery, the LASIK procedure reshapes the cornea to enable light entering the eye to be properly focused onto the retina for clearer vision[20].

The word "LASIK" is an acronym for "laser-assisted in situ keratomileusis."

LASIK surgery is essentially pain-free and takes only about 15 minutes for both eyes. The results — improved vision without eyeglasses or contact lenses — begin immediately after the procedure and vision usually continues to improve and stabilize over a few days.

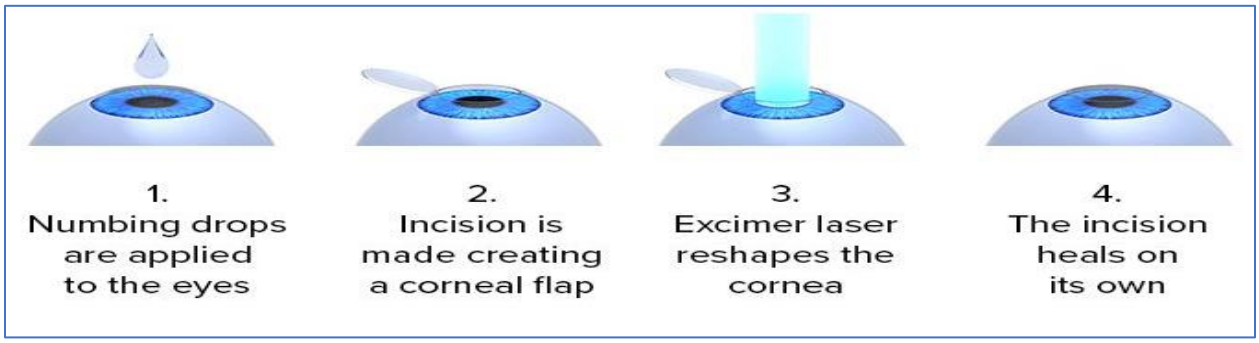


Figure 7:Lasik surgery steps

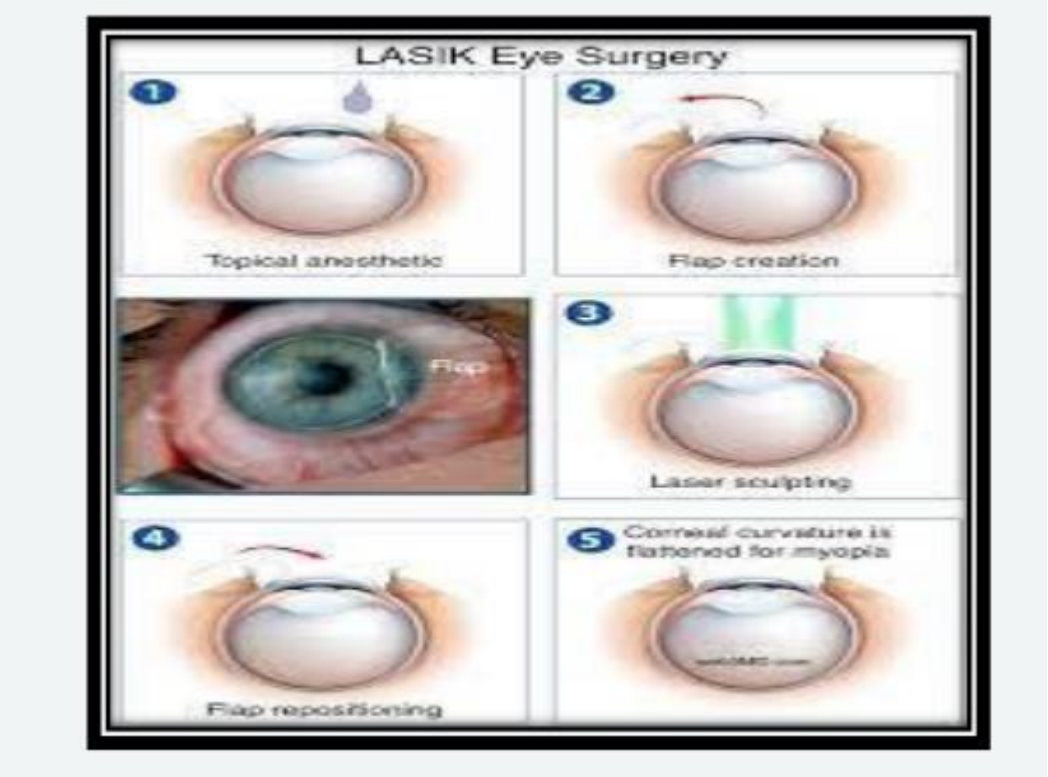


Figure 8:Lasik surgery steps in surgery

In LASIK, an ophthalmologist uses a laser to reshape the cornea (clear front part of the eye). A small flap is made in the upper cornea with either a small blade or a laser. The flap is lifted up and the laser is then used to reshape the deeper cornea by removing precise amounts of tissue. The goal of the surgery varies depending on the type of vision problem. If a patient is nearsighted, the goal is to flatten the cornea by removing tissue from the central cornea. If a patient is farsighted, the goal is to make the cornea steeper by removing tissue from the peripheral cornea. LASIK can also correct astigmatism by reshaping the cornea into a more symmetrical, spherical shape. It is a quick procedure (often less than 15 minutes) that requires only numbing drops, with no need for general anesthesia, stitches, or bandaging[21].

2.6 Types of LASIK

1- LASIK which stands for Laser Assisted In-Situ Keratomileusis is one of the most popular refractive surgeries available. This is because it has the quickest recovery and the least discomfort in the recovery period of all the laser eye surgery methods. More than 90% of patients would choose or have recommended LASIK for their laser eye surgery[22]. The majority of people would have 20/20 vision the next day. It is now blade-free and uses two lasers to reshape the cornea. It can treat myopia, hyperopia, astigmatism and presbyopia. The first laser used in this method is a femtosecond laser and creates a flap in the superficial cornea at 105um deep. The average cornea is 550um. The femtosecond laser uses light to create multiple (millions) of small gas bubbles that all join together to the shape of the superficial flap. This laser is an infrared laser using a wavelength of 1053nm. The laser is silent and takes less than 15 seconds to complete the flap[23].

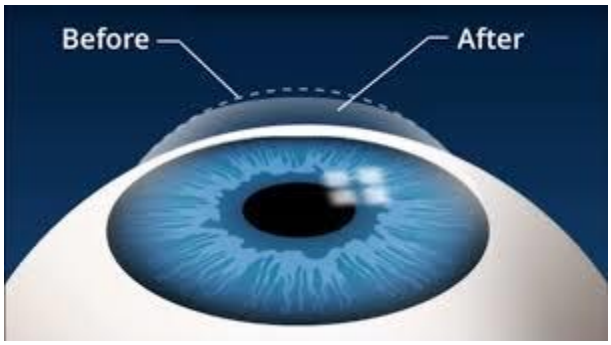


Figure 9 :Lasik surgery after and before

The second laser used is an excimer laser which reshapes the cornea under the flap. In myopia the excimer laser is flattening the curvature of the cornea and in hyperopia the laser is steepening the cornea. The higher the treatment prescription of your glasses or contact lenses the more corneal tissue is reshaped. This laser ablates the corneal tissue. The excimer laser emits a cool beam of ultraviolet light of 193nm. This laser you can hear during the treatment and the treatment can take from 5

seconds to 25 seconds to complete depending on your prescription. You are in the laser room for 10-15minutes.[24]

2- PRK which stands for Photo Refractive Keratectomy is the original laser eye surgery technique. It has now mainly been replaced by LASIK but still has a place to treat some people with thin corneas. It is also a blade-free technique and can successfully treat and correct myopia (nearsightedness) and astigmatism [25]. PRK is not suitable for moderate to high hyperopia (longsightedness). PRK was the first type of laser eye surgery for vision correction and is the predecessor to the popular LASIK procedure. PRK works by reshaping the cornea in the same way as LASIK but the reshaping is done on the surface once the epithelial cells are removed. At the end of the laser treatment a bandage contact lens is used. The exact same excimer laser used in LASIK is used for PRK. PRK recovery takes a bit longer than recovery from LASIK. Where as LASIK recovery takes only 4-5 hours, PRK can take 4-5 days to settle and the final improvement occurs over 3-4 weeks. PRK has been available since 1988 and was FDA approved in 1995.[26]

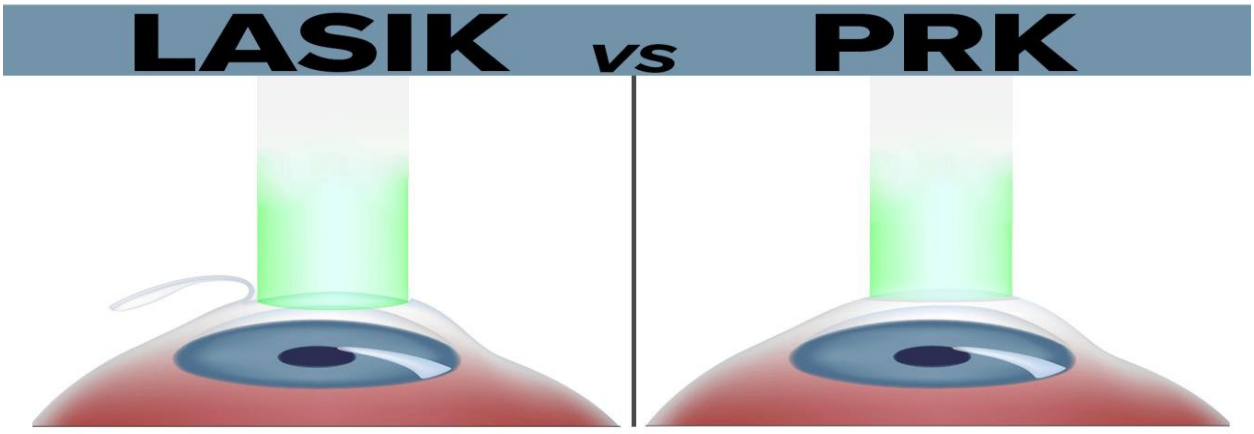


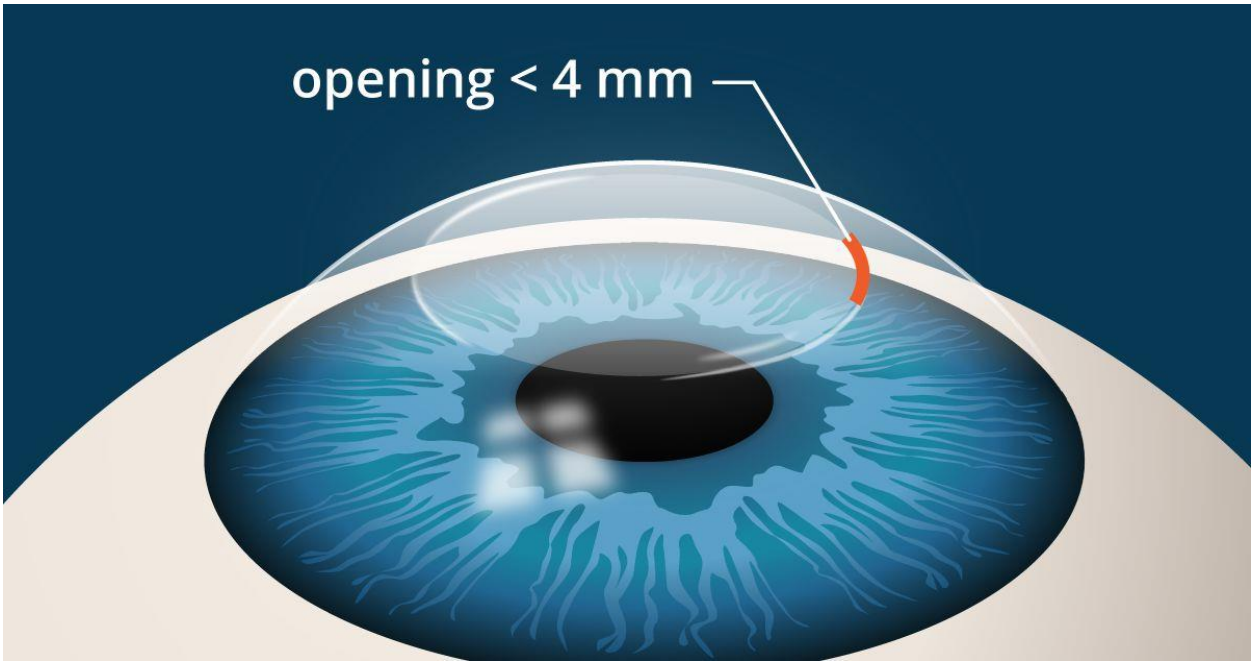
Figure 10 : Lasik vs PRK

3- EPI-LASIK is another variation to the PRK procedure. The epi-lasik flap is very similar to the thin flap created in LASEK surgery. In both procedures, the flap contains only cells from the very thin outer layer of the cornea, called the epithelium. The difference is how the epi-LASIK and LASEK flaps are produced. A LASEK flap is created with a tool that has a sharp blade[27]. In epi-LASIK, the flap is separated from the underlying corneal layer (the stroma) with an instrument called an epithelial separator that has an oscillating plastic blade that has a thin blunt edge.And unlike in LASEK, an alcohol solution typically is not applied to the eye in epi-LASIK to loosen epithelial cells from the underlying corneal stroma. The Epi-LASIK refractive surgery has been around since the early 2000s. People that would be most suitable for this type of surgery include those who have thin corneas, with insufficient tissue for LASIK. As with PRK the visual recovery is delayed and more discomfort is experienced during the recovery. In three days many patients do have 20:40 or even 20:20 but others take longer, possibly three or six months to reach their final result. Usually you can drive within a week after surgery. [28]

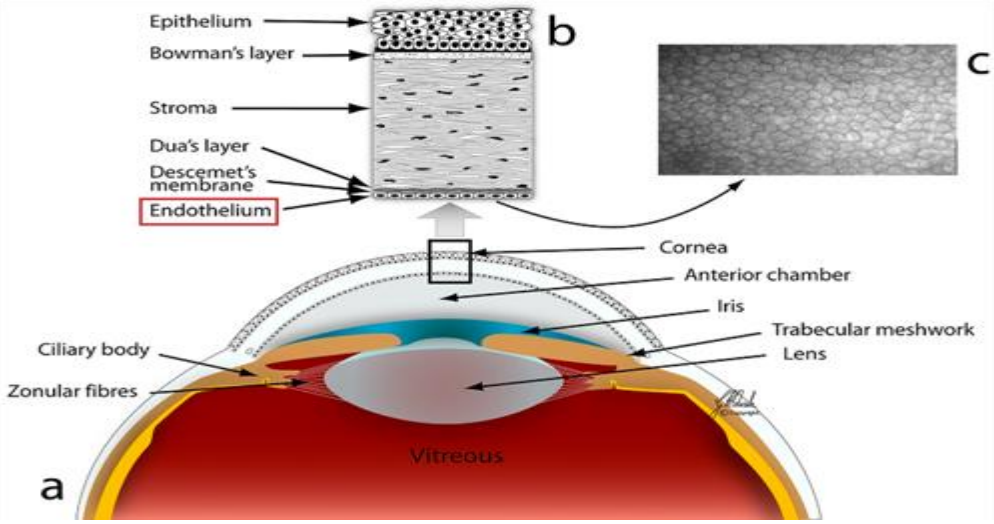
Figure 11: Epi - LASIK

4- LBV which stands for Laser Blended Vision is a laser technique to give over 45 year olds distance and reading vision. It uses mono-vision with the dominant eye treated for distance and the non dominant eye treated for near. It commonly uses LASIK but the PRK techniques can also be used in myopic patients.[29]

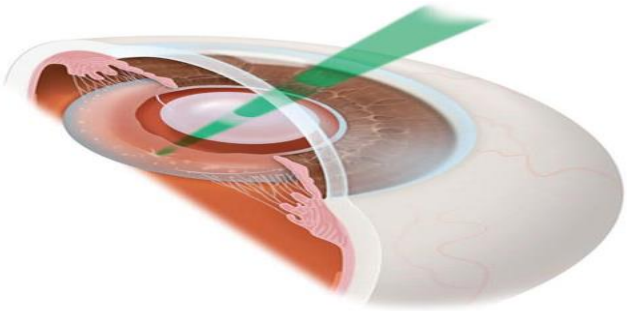
5- SMILE which stands for Small Incision Lenticule Extraction, is a new technique. It is blade free and uses one laser. SMILE uses a femtosecond laser to create a lens-shaped disc of tissue within the cornea. This disc of tissue is called a 'lenticule' because it is lenticular in shape, this is removable. The lenticule size and shape is adjusted to the refractive error of the patient[30]. The laser eye surgeon removes the lenticule through a 4-5mm incision on the cornea. The removal reshapes and flattens the cornea and therefore corrects vision. The visual recovery is slower than LASIK. Any enhancements required are more difficult needing either PRK or LASIK to fix any residual refractive error. SMILE is not FDA approved for myopia <1.0D nor astigmatism nor hyperopia (long sightedness).[31]



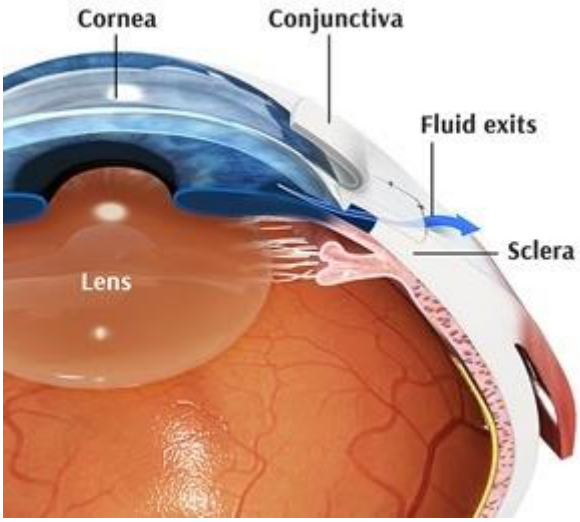
6- PTK stands for Photo Therapeutic Keratectomy. This laser treatment uses the excimer laser to polish the corneal surface and removes any irregular tissue. In some cases a refractive error treatment such as PRK can be used at the same time.[32]



7- YAG stands for neodymium-Yttrium Aluminium Garnet. This laser provides fast, effective and painless treatment for posterior capsule opacity (PCO), also known as 'secondary cataracts'. The procedure is called YAG laser posterior capsulotomy. In a cataract operation, the cloudy lens from your eye is replaced with an artificial lens. In about 10% of cataract surgery patients, the thin membrane behind the lens (called the posterior capsule) can become hazy[33]. This causes blurred vision, much like a cataract, which is why posterior capsule opacity is often called a 'secondary cataract'. A YAG laser capsulotomy procedure is extremely fast, simple and effective. It can be performed in the consulting room, so there's no need for you to go into surgery, and it's completely painless. [34]



8- SLT stands for Selective Laser Trabeculoplasty, is a form of laser surgery that is used to lower intraocular pressure in glaucoma. It is used when eye drop medications are not lowering the eye pressure enough or are causing significant side effects. It may sometimes be used as initial treatment in glaucoma[35]. People who have open-angle glaucoma (the drainage system in the front part of the eye is open) and are in need of lowering of their intraocular pressure (IOP) are eligible for the procedure. How SLT works is that the Laser energy is applied to the drainage tissue in the eye. This starts a chemical and biological change in the tissue that results in better drainage of fluid through the drain and out of the eye. This eventually results in lowering of IOP. It may take 1-3 months for the results to appear.[36]



9- PRP stands for Pan Retinal Photocoagulation. This laser does not improve eye sight but is used to prevent further visual loss. Normally used in diabetic eye disease or eye conditions where the blood supply has been compromised. The laser causes a small photocoagulation in the retina and decreases the overall oxygen demand for the eye. The original laser used for PRP was an Argon laser and uses light in the 488nm and 532nm green spectrum. Newer lasers used in PRP include double frequency Nd-YAG, Dye Yellow and Diode lasers.[37]

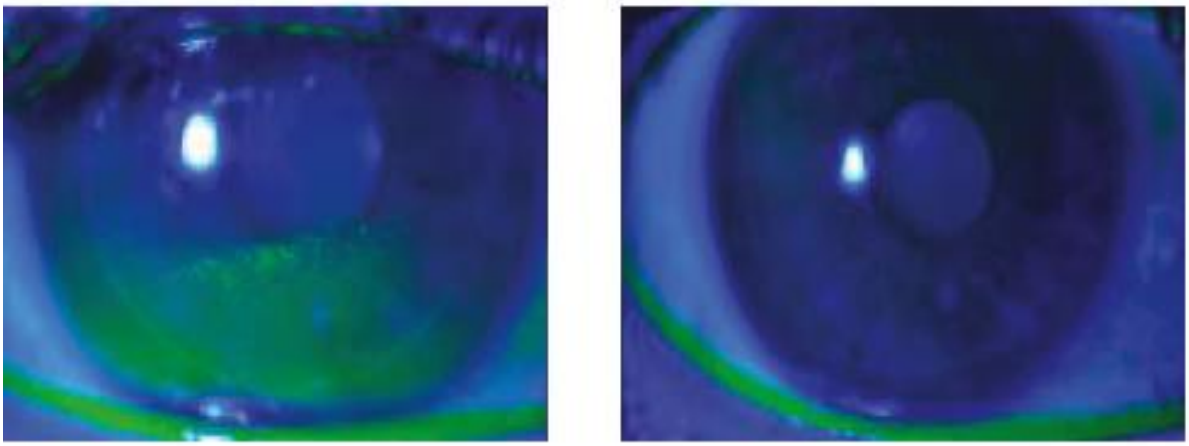


Figure 12 : Dye Yellow and Diode lasers

Chapter three

3.1 Types Of Lasik Surgery

some common types of LASIK surgery options:

3.1.1LASIK

It is the most popular form of laser eye surgery which involves creating a hinged flap in the eye cornea with the help of a sterile blade. Your surgeon then uses a laser to remove very thin layers from the cornea.[38]

3.1.2 Intra-LASIK

In this procedure, your surgeon uses the laser instead of the blade to cut and reshape the cornea.[39]

3.1.3 Wavefront LASIK

One of the most modern and advanced technique is Wavefront LASIK. During this procedure, a map of the cornea by a 3-dimensional scan is produced. This surgery is more accurate, and the chances of gaining 20/20 vision improve after this procedure.[40]

3.2 Lasik Procedure

LASIK surgery is painless and hence much more comfortable than other eye surgeries. the detailed LASIK procedure:

3.2.1 Before Lasik Surgery:

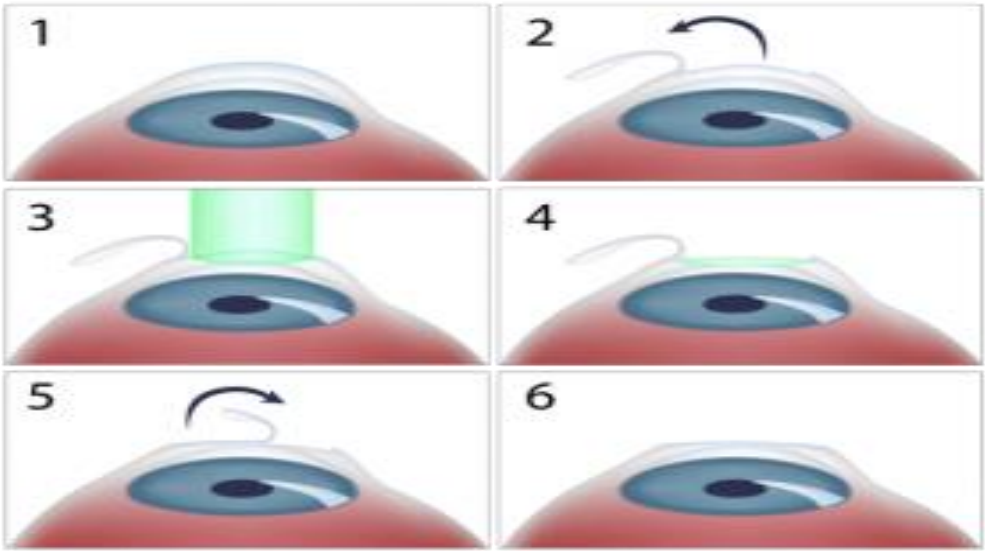
Before the surgery, surgeon will carry out a thorough eye screening . The eye doctor will evaluate the following things:

- Size of the pupil.
- The shape of the cornea.
- The thickness of the eye cornea.

- Refractive errors such as myopia, hyperopia, astigmatism, etc.
- Moistness in the eyes.
- Condition of the posterior segment of the eye, especially the retina.
- Any other eye conditions.[41]

3.2.2 During Lasik Procedure

To prevent any kind of discomfort, surgeon will give local anesthesia or can give medication before the surgery. eyes will be accurately positioned under the laser, and with the help of a lid speculum instrument, the eyelids will be kept open.surgeon may use an ink marker to mark the eye cornea before creating a thin flap. Then, with the help of another instrument called microkeratome, thin flap is created in the cornea. A suction ring may be used to prevent movement of the eye that could affect the quality of the flap.[42] Once the flap is created and painlessly peeled back, your eye surgeon will use a computer to adjust the laser as per the refractive need. the light for a small duration and the surgeon will observe the eye through a microscope when the laser sends light pulses into the cornea. Through this step, the corneal tissue is reshaped with the help of laser and the flap is put back in place. This surgery only takes 5-10 minutes for each eye.[43]

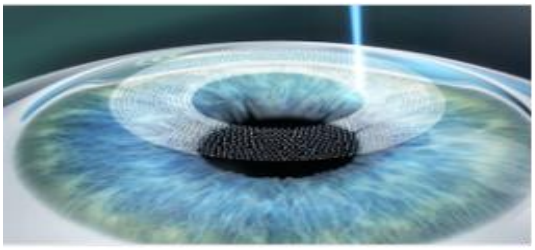


Lasik Eye Surgery

3.2.3 Immediately After Lasik Surgery

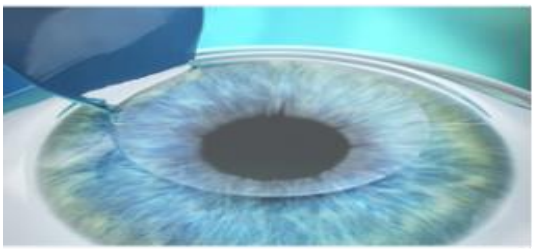
LASIK surgery is completed, the present a little blurring of vision, eye pressure or temporary burning and/or itching sensation.[44]

The treatment steps

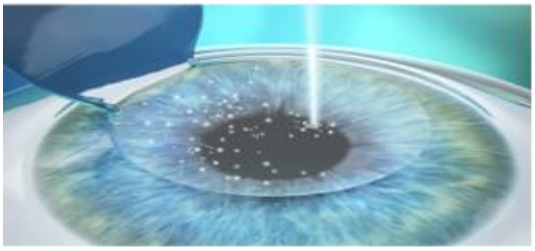


Step 1
Flap creation
The eye is anesthetized with special drops. Femtosecond laser pulses are used to create a flap on the surface of the cornea.

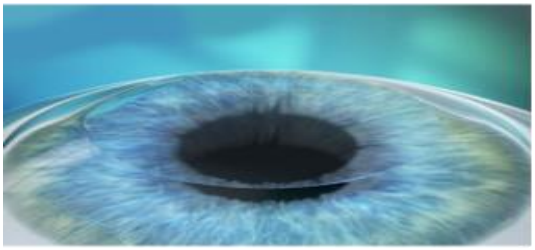
Step 2
Convenient interplay
With setups that have a pivoting patient supporting system, the patient is conveniently moved from the femtosecond laser to the excimer laser.



Step 3
Flap is folded back
The prepared flap is folded back like the page of a book, exposing the inner corneal tissue to be treated.



Step 4
Corneal sculpting
The excimer laser removes the corneal tissue point by point within a few seconds, thereby correcting the visual defect.



Step 5
Flap is repositioned
Afterward, the flap is returned to its original position, protecting the eye much like a natural bandage.

3.3 LASIK complications

3.3.1 Preoperative complications

3.3.1.1 Anesthesia

Corneal refractive procedures are performed with topical anesthetic drops (0.5% propacaine, 0.5% tetracaine, and 0.4% oxybuprocaine). Preoperative cleaning of the operative region consists of application of Iodine 5% in the conjunctival fornices for 15 seconds. Both the anesthetic and the iodine may cause epithelial weakening, punctate erosions, or irregular corneal surface. (238) Care about the amount of anesthetic and Iodine used prior to the procedure is essential for the protection of the epithelium. Use of viscous artificial tears during the procedure may interfere with the work of microkeratome and should be avoided [45].

3.3.1.2 Eyelashes, foil, speculum

Securing the operative surface with transparent adhesive foil over the eyelashes, selection of the appropriate speculum providing enough space for the microkeratome, and choice of the proper microkeratome for the given eye anatomy is very important in creating regular flaps [45].

3.1.1.3 Conjunctiva

Adequate examination of the whole anterior segment, conjunctiva, limbal region, and fornices is very important precondition for successful surgery. Irregularities in the limbal region, scleral elevations, nevus, and tumor prominence in the region of conjunctiva, limbus, or fornices may cause irregular vacuum suction, pseudosuction, and potential vacuum loss which may result in irregular flap due to improper lamellar incision [45].

3.3.2 Intraoperative complications

3.3.2.1 Microkeratome-related complications

Automated microkeratome creates a precise cut on the cornea which represents the flap. It consists of an oscillation blade attached to a head and both work with independent motors (one for the oscillation of the blade, other for the movement forward and backward). The surgeon chooses adequate rings for the different diameters and steepness of the cornea, the thickness of the flap (from 90 to 120 microns), hinge position, and its diameter [46].

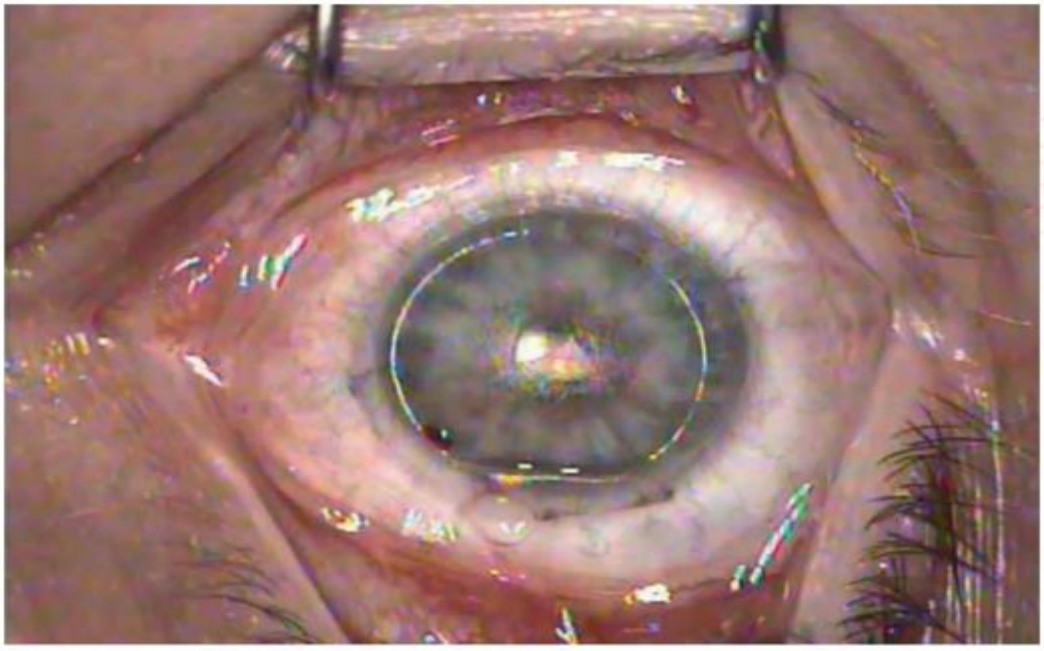
3.3.2.2 Incomplete or irregular corneal flap

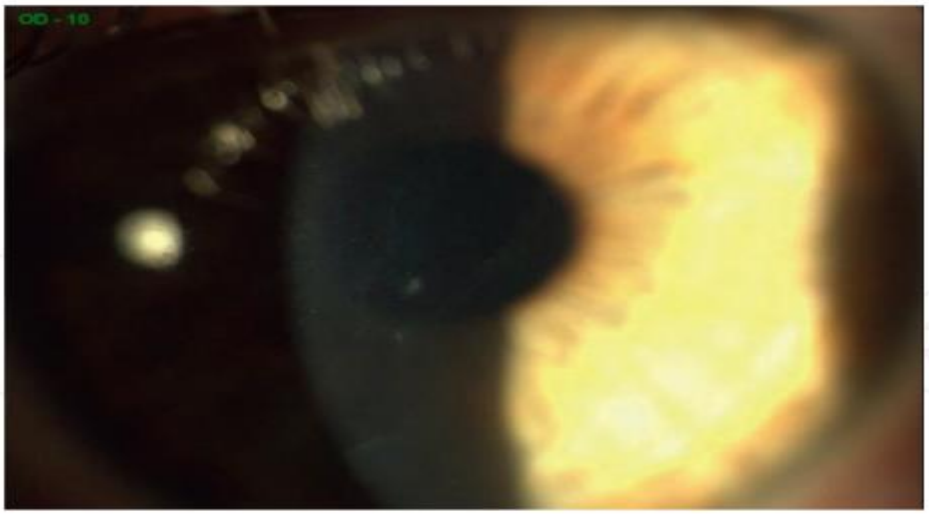
The incidence of incomplete flap is 0.3−1.2% [47]. Incomplete flap occurs when the microkeratome is stopped before the planned hinge position. Stopping of microkeratome most often occurs due to collisions with eyelids and eyelashes, speculum and/ or foil, and due to suction (vacuum) loss during passage. The cause can also be of a mechanical nature-a defect in the dissection head (knife) or in the motor unit of the microkeratome [48]. Irregular flaps often result in lack of enough space for laser ablation, also they carry the risk of profound epithelial ingrowth which can result in corneal scarring in the visual axis or even flap melting.

3.3.2.3 Perforated (buttonhole) flap

The incidence of perforated flap (buttonhole) is 0.1−0.6%, and for too thin flap 0.1−0.4% [49]. Flap perforation occurs when the blade of the microkeratome enters the corneal surface-Bowman membrane and epithelium during the passage, usually in the central part of the flap . Too thin flaps occur when the blade of the dissection head does not penetrate deep enough into the cornea but stays close to the surface. Perforated flaps are more common in steep corneas (>46.0 D), and inadequately achieved vacuum that causes poor adhesion of the cornea and microkeratome blade,

also in flat and small corneas where corneal suction puts cutting plane below the blade [50]. It can also be mechanical in nature due to uneven cutting speed in manual microkeratome, blunt blades, weak blade oscillations, and due to mechanical damage to the blade of the microkeratome dissection head. Perforated flaps are one with the worst visual outcome compared to other intraoperative complications, usually resulting in irregular astigmatism and epithelial ingrowth [51].





3.3.2.4 Free flap (free cap)

The incidence of free flaps is 0.1−1.0%. The size of the flap depends on the volume of the cornea protruding above the vacuum ring. In the case of protrusion of a small amount of tissue, a free flap is formed. Free flaps are more common in flat corneas with keratometric values <41.0 D, in an insufficient vacuum, when selecting a too small vacuum ring, or in inadequately adjusted microkeratome stoppers [45].

3.3.2.5 Corneal perforation

Penetration into the anterior chamber, that is, entry into the anterior chamber with full corneal thickness, may occur during lamellar dissection or even excimer laser photoablation. Perforations can range from simple corneal perforations to perforations with iris and lens damage with or without loss of vitreous. Perforation can occur on extremely thin corneas, in old corneal scars, ulcers, or after previous refractive surgery [45]. Cases with corneal perforation usually have poor visual outcomes due to scar formation and recurrent epithelial ingrowth in perforated plane [49].

3.3.2.6 Decentered flap

Thin and irregularly decentered flaps can occur during flap formation with both microkeratome or femtosecond laser. The causes are multifactorial and include poor positioning (centering) of the vacuum ring, too low achieved vacuum on the cornea, poor corneal lubrication, poor quality of the blade, pre-existing corneal pathology or microkeratome malfunction [50].

3.4 Postoperative complications

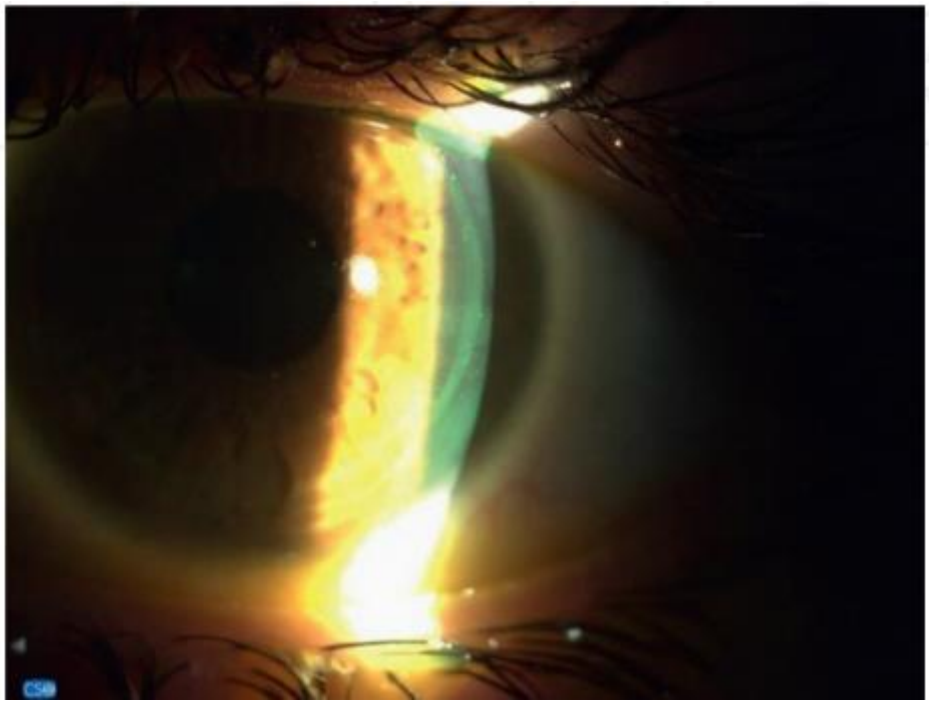
3.4.1 Early postoperative complications

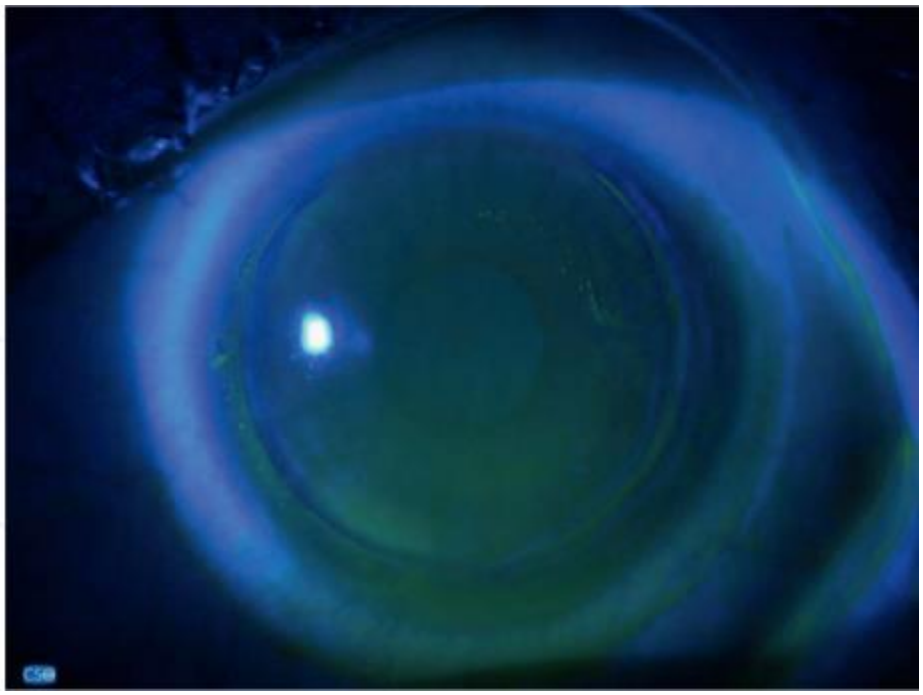
3.4.1.1 Flap striae

Flap striae occur in 0.03−3.5%, according to the literature [51] and are usually observed the next day after the surgery at the slit-lamp examination, best in retroillumination or with fluorescein staining at cobalt-blue light . In cases where flap is edematous, epithelial microstriae can present within 7 days postoperatively. Striae can be classified as micro- and macrostriae. Microstriae are irregularities in epithelial layer, where macrostriae result as full-thickness flap-folds. AT higher risk are cases with high refractive error (“tenting” effect due to the flap and stromal bed contour mismatch), misalignment during repositioning, excessive manipulation of the flap during surgery, and flap contracture [52].

3.4.1.2 Flap dislocation

Dislocation of the flap most commonly occurs in the first 24 hours after surgery before epithelial healing of the lamellar incision occurs . However, dislocations are possible several months after the procedure, usually after ocular trauma . Flap dislocation is considered an emergency and should be treated immediately to prevent folds and epithelial ingrowth. Patients present with sudden onset blurred vision, often associated with pain in the early postoperative period, the most common cause is mechanical due to lid squeezing, forceful blinking, and rubbing of eyes. Larger diameter flaps, thinner, and those with a small hinge are more susceptible to movement. In some cases, after repositioning the flap, DLK, interface haze, or epithelial ingrowth can occur [53].





3.4.1.3 Residual refractive error (under- or overcorrection)

Residual refractive error has been reported in up to 50% of LASIK cases [54]. Hypocorrection is the most common complication after primary LASIK and is usually diagnosed within the first few weeks after surgery. Hypercorrections are

more common after repeated procedures and in elderly patients due to slightly dehydrated cornea (>50 years). Hypo- and hypercorrections are associated with excimer laser ablation algorithm, inaccurate nomograms, age, height of refractive error [55], and even environmental factors can affect the amount of tissue ablation depth (temperature, humidity, and atmospheric pressure) [56]. Additionally, cyclotorsion from erect to supine position and poor centration of eye during laser ablation can cause postoperative astigmatism [57].

3.5 Lasik Surgery Outcome

Healing of the eyes after LASIK surgery occurs rapidly. Your vision may be slightly hazy or blurry for the first day. Majority of patients experience improved and clear vision within a few days of this surgery. Most people who undergo this surgery do not need glasses or contact lenses after the LASIK procedure. Generally, the outcome of LASIK surgery depends on the specific refractive error and some other factors. Patients with a low grade of nearsightedness show the most success with this surgery, while the ones with a high degree of farsightedness or nearsightedness or with astigmatism have a less predictable outcome.[58].

Chapter four
Result and Discussion

4.1 Result

All the data for the study were collected and processed in accordance with the norms and procedures of the Institutional Review Board, as well as the principles described in the Helsinki Declaration. Consecutive patients who underwent refractive surgery in a single private medical center ,PRK was preformed using an Allegretto Wave Eye-Q 400 Hz Laser (Alcon Inc., Fort Worth, TX, USA). The corneal epithelium was removed manually. The size of the ablation zone was 6 mm. The LASIK procedure was performed by a BAUSCH & LOMB microkeratome and following ablation with the Allegretto Wave Eye-Q 400 Hz Laser (Alcon Inc., Fort Worth, TX, USA). LASEK was performed using 20% alcohol for 20 s.

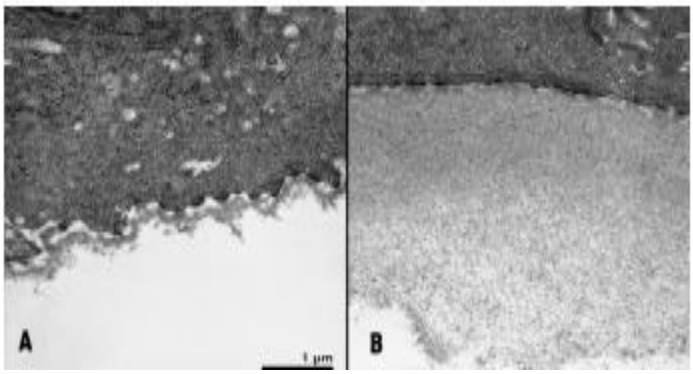


Figure 4.1 Transmission Electron Microscopy of human epithelium specimens obtained after PRK in a case with normal epithelium (A) and from a case whose contralateral eye had epithelial slough during LASIK (B). Note several hemidesmossomes present and a thin layer of basement membrane in A. In B, a multilaminated basement membrane is present, which is a characteristic of Anterior Basement Membrane (Cogan's) Dystrophy.

Patients were examined and graded for ocular surface disease according to the Dry Eye Workshop severity (DEWS) classification , and were examined 6 months following the refractive surgery. Severe DEWS score was defined as grades 3 and 4. This study included only patients with a peri-operative DEWS score of 0. This grading system was selected because of its broad acceptance and ongoing use in

recent studies in the field of ocular surface disease . The follow-up examinations with DEWS grading were performed by the same surgeon who performed the surgeries (J.P.). Table 2 shows the DEWS scores for the patients.

Table 2. Dry Eye Workshop severity (DEWS) scale

	Severity Grade				
Parameter	0	1	2	3	4
Schirmer test (mm/5 min)	35	7	5	2	0
TBUT (seconds)	45	7	5	3	0
Staining (NEI scale)	0	3	8	12	20
OSDI (%)	0	15	30	45	100
Meibomian grading	0	1	2	3	4
Osmolarity (mOsm/L)	275	308	324	364	400

In total, the analysis included 251 eyes of 137 patients: 64 eyes (36 patients) after LASEK, 90 eyes (48 patients) after PRK, and 97 eyes (53 patients) after LASIK. Considering all the patients included, the mean age was 27.8 ± 5.6 years. Of the 137 patients, 73 (53.2%) were male. Four patients were excluded from the analysis due to a complicated procedure. Of these, two underwent LASEK: one had an incomplete flap and one had a free flap. Two patients who underwent PRK were excluded from the analysis due to an eccentric treatment. The three groups did not differ according to age ($p = 0.34$), gender distribution ($p = 0.69$), or the mean myopic correction ($p = 0.97$) (Table 3).

Table 3. Baseline peri-operative characteristics and DEWS scores according to refractive surgeries: LASEK, PRK, and LASIK

	LASEK	PRK	LASIK	*p* Value
Number of eyes (patients)	64 (36)	90 (48)	97 (53)	
Mean age years	27.5± 5.88	27.3 ± 5.40	28.4 ± 2.09	0.34 #
Male gender	55.3%	51.1%	49.4%	0.69 *
Mean myopic correction [D]	6.0 ± 2.23	6.2 ± 2.03	6.2 ± 2.09	0.97 #
DEWS score	0.82 ± 0.92	0.78 ± 0.83	1.07 ± 0.86	0.01 #

To our knowledge, this is the first study to compare dry eye symptoms after LASIK, LASEK, and PRK. We found a significantly increased risk of dry eye disease after LASIK than after the other procedures, as reflected in the higher mean DEWS score 6 months after surgery. The significance of this research is that complications from refractive surgery still include ocular surface disease as their most common cause . As patients' visual comfort and quality of life directly correlate with the degree of dry eye disease, post-refractive dry eye illness should be addressed properly .

Our findings support a prospective study by Lee et al. of 36 eyes following PRK and 39 eyes following LASIK . Tear production was more reduced 6 months after LASIK than after PRK. In our study, the patients who underwent the three procedures did not differ in age, gender, or the amount of refractive correction. This contrasts with a previous study that reported baseline differences between patients who underwent the compared procedures . Kim et al. reported that lamellar cutting of the cornea during LASIK affects corneal sensitivity, and noted that the cornea did not recover to its pre-operative level even after 6 months .

This could explain the greater severity of dry eye disease we observed following LASIK compared to other surgeries. A number of studies showed that corneal sensitivity decreased after PRK but rebounded to nearly normal levels after 3 months . These findings could perhaps explain the potential of more rapid corneal re-innervation following PRK and LASEK than following LASIK, and could explain

our results. Pe'rez-Santonja et al. found that corneal sensitivity in the ablated zone in the context of mild myopia is more decreased following LASIK than PRK, over the first 3 months post-surgery .

Corneal sensitivity values following the two procedures were only comparable after 6 months. In a study by Lee et al., tear secretion and tear film stability were less at 3 months after LASIK than after PRK. That study showed reduced tear secretion and tear film stability 6 months after LASIK, yet without statistical significance. These indices did not return to their pre-operative levels. In LASIK, the nerves of the central cornea are cut by the microkeratome, in addition to the laser ablation for myopia correction. Due to decreased ocular sensation, tear production could be decreased, and this could lead to increased tear osmolarity. Not previously having worn eyeglasses may cause an increase in tear film evaporation, which in turn may cause an increase in tear osmolarity .

In an analysis that included all our patients, female gender was correlated with a more severe score of dry eye. This relation was maintained in separate analyses of patients who underwent LASEK and LASIK. Previous retrospective studies found an association of female gender with chronic tear dysfunction following LASIK surgery. The greater risk of dry eyes in women has been linked to decreased levels of androgen hormones, which support tear secretion by the lacrimal glands .

Notably, a prospective study found no association of dry eye severity with gender. Our finding that age was not an important risk factor for ocular surface disease following LASIK corroborates other studies . Our study has several limitations. First, the number of eyes was 251, and a larger number of patients should be included in further studies, as well as more refractive laser procedures, and multiple medical facilities. Future research is required to confirm the validity and replicability of those conclusions. Secondly, the maximum follow-up was 6 months, and long-term

implications should be further examined and tested. Thirdly, the inevitable selection criteria for each procedure are a limitation of this study, which did not include randomization. Peri-operative DEWS scores were not collected; although this is similar to previous studies on this subject, it represents a limitation in our study. Additionally, this study utilized binocular data, though earlier studies had also presented this type of data analysis .

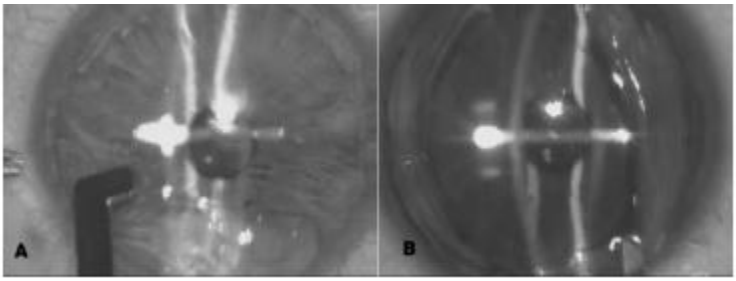


Figure 1. A. Superior hinged “U” shaped epithelial flap in classic LASEK. B. “Butterfly” LASEK. (Surgery done by Paolo Vinciguerra, MD).

Further, in the LASIK procedure, a manually operated microkeratome was used, rather than the more recently developed femtosecond flap formation method. Our findings suggest that careful monitoring and appropriate dry eye treatment are essential, especially in the early and late postoperative phases of LASIK. Additional factors that may impact tear secretion, though not explored in this study, should be examined. Careful selection of the best surgery for each patient is important. Possibly, LASIK may not be the best option for candidates for surgery who are at risk of developing a dry eye condition, such as programmers, or those who spend considerable time in front of screens. In summary, in this prospective large-scale study, dry eye disease was more common following LASIK than other procedures. Female gender was also associated with dry eye. Patients, particularly those with high myopia, should be counseled about the risk of developing dry eye after refractive surgeries.

4.2 LASIK: the most popular refractive procedure today

The concept of lamellar refractive keratoplasty was first introduced by Prof. Joaquim I. Barraquer in Bogotá, Colombia. Prof. Barraquer developed complex and technically demanding lamellar procedures for correction of refractive errors in the early 1960s. The combination of the lamellar surgery with the excimer laser ablation, first reported by Pallikaris and Burrato in the early 1990s, brought several advantages. Independently, Gholam A. Peyman also conceived of lamellar surgery combined with laser ablation and patented this concept in the United States. The greater accuracy and precision of the excimer laser facilitated the lenticular resection of tissue for the refractive correction.

In addition, preservation of the central epithelium increased patient comfort and allowed for more rapid visual recovery.

It also made bilateral surgery an attractive option for the patient. Less damage to the epithelium results in increased predictability of the surgery for high corrections. Thus, LASIK has emerged as the dominant refractive surgical procedure performed today.

The most significant advantages of LASIK are:

✓ Faster visual rehabilitation with earlier post-operative stabilization of visual acuity

✓ Less post-operative patient discomfort

✓ Attenuated wound healing and less stromal haze formation

✓ Possibly improved predictability, stability, and corneal clarity in higher correction groups

✓ Shorter duration of post-operative medications use

✓ Easier enhancement procedure.

Chapter five

5.1 Conclusion

1- laser vision correction (LVC) has revolutionized the field of ophthalmology, offering millions of people worldwide a chance to reduce or eliminate their dependence on glasses or contact lenses.

2-The advancements in technology, particularly with procedures like LASIK (Laser-Assisted In Situ Keratomileusis) and PRK (Photorefractive Keratectomy), have made LVC safer, more precise, and more accessible than ever before.

3-Patients often experience rapid recovery times and significant improvements in visual acuity, enhancing their quality of life and boosting their confidence.

4- it's crucial for individuals considering LVC to undergo a thorough evaluation by a qualified eye care professional to determine their candidacy and understand the potential risks and benefits.

5-While LVC offers remarkable results for many, it may not be suitable for everyone, and realistic expectations are vital.

6-Overall, LVC stands as a transformative option for vision correction, offering a clear path to clearer vision and improved daily living for countless individuals

5.2 Recommendation

1- It's essential to understand the various LVC procedures available, such as LASIK and PRK, and their suitability for individual eye conditions.

2- Potential candidates should carefully weigh the risks and benefits and have realistic expectations regarding outcomes.

3- choosing an experienced surgeon and with state-of-the-art technology can significantly enhance the safety and effectiveness of the procedure.

4- post-operative care and follow-up appointments are crucial for ensuring optimal healing and long-term success.

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الخلاصة

أحدث تصحيح الرؤية بالليزر (LVC) ثورة في ممارسة طب العيون من خلال تقديم حلول دقيقة وفعالة للأخطاء الانكسارية. يستكشف هذا الملخص المبادئ والتقنيات والنتائج والتطورات في إجراءات LVC، مع التركيز على اعتمادها على نطاق واسع وتحسينها المستمر.

يشمل تصحيح الرؤية بالليزر العديد من التقنيات، بما في ذلك الليزك (تصحيح تحدب القرنية بمساعدة الليزر)، وPRK (استئصال القرنية الانكساري الضوئي)، وSMILE (استخراج العدس بشق صغير). تهدف هذه الإجراءات إلى إعادة تشكيل القرنية، وبالتالي تصحيح الأخطاء الانكسارية مثل قصر النظر، مد البصر، والإستجماتزم. تتمتع كل تقنية بمزاياها واعتباراتها الفريدة، مما يلبي احتياجات المرضى وحالات العين المتنوعة.

يعتمد نجاح إجراءات LVC على التقييم الدقيق قبل الجراحة، حيث يتم تقييم مدى ملاءمة المريض وتوقعاته بعناية. تساعد أدوات التشخيص المتقدمة، مثل تضاريس القرنية وتحليل واجهة الموجة، في تحسين النتائج الجراحية وتقليل مضاعفات ما بعد الجراحة.

أثبتت الدراسات السريرية سلامة وفعالية وإمكانية التنبؤ بـ LVC، مع ارتفاع معدلات رضا المرضى في جميع أنحاء العالم. يعد التعافي البصري السريع وتقليل الاعتماد على العدسات التصحيحية وتحسين نوعية الحياة من بين الفوائد الملحوظة التي تمت ملاحظتها بعد العملية الجراحية.

تستمر التطورات الحديثة في تقنية LVC في تعزيز الدقة والسلامة الجراحية. تعمل الابتكارات مثل ليزر الفيمتو ثانية، والعلاجات المخصصة الموجهة بواجهة الموجة، و الاستئصالات الموجهة بالطبوغرافيا على تحسين النتائج البصرية وتقليل الانحرافات.

على الرغم من التقدم الملحوظ الذي حققته، إلا أن LVC لا تخلو من المخاطر والقيود. تشمل المضاعفات المحتملة متلازمة العين الجافة، واضطرابات الرؤية الليلية، ونقص التصحيح أو التصحيح الزائد للأخطاء الانكسارية. يعد تثقيف المرضى والتقنية الجراحية الدقيقة والرعاية الشاملة بعد العملية الجراحية أمرًا بالغ الأهمية للتخفيف من هذه المخاطر وتحسين النتائج البصرية.

جمهورية العراق وزارة التعليم العالي

والبحث العلمي

كلية الحلة الجامعة

كلية التقنيات والعلوم الطبية والصحية

قسم الفيزياء الطبية

جراحات تصحيح البصر ب(الليزك)

بحث مقدم إلى مجلس قسم الفيزياء الطبية ضمن متطلبات الحصول على درجة البكالوريوس في الفيزياء الطبية

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