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Lasik update as treatment modality for refractive error



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Cokorda Istri Dewiyani^{1*}

ABSTRACT

Refractive error is one of the most common cause of avoidable blindness in the world. The prevalence of refractive error occurs in the worldwide were increasing every years, including in the Asian regions. This condition influenced by many risk factors, which are both modifiable and non-modifiable risk factors. There are three types of refractive errors: myopia, hypermetropia, and astigmatism

with low vision condition as the impact of the untreated refractive disorder. Two types of refractive disorder therapies was surgical and non-surgical therapy. Non-surgical therapy including spectacles, contact lenses, and optical low vision devices. The proper management of the refractive error can improving patient's quality of life.

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¹Departement of Ophthalmology
Bali Mandara Eye Hospital,
Denpasar, Bali, Indonesia

INTRODUCTION

The prevalence of refractive error has been increasing in the last decade. Its management has also undergone vast development, in line with the development of science and knowledge. Treatment of refractive error is aimed to increase patient's visual acuity, visual function, and patient's comfort, tailored to the patient's own needs and medical condition. The choice of treatment for refractive error includes spectacles, contact lenses, and refractive surgery.¹

Refractive surgery is based on the principle of corneal curvature modification to change the eye's refractive power. LASIK is a refractive surgery technique aimed to correct myopia, hypermetropia, and astigmatism with corneal tissue ablation and to flatten off the central anterior corneal surface. The radius of the corneal surface will increase, and the eye's refractive error will decrease, which can be adjusted to the degree of refractive error.^{2,3}

LASIK has undergone significant improvement in the last two decades after its development. More than 16 million LASIK procedure has been done all over the world. Currently, LASIK is one of the most frequent surgical procedures done, and so far it has been the most successful one. This technology has high safety and effectivity as a treatment for refractive error. However, the result is still unsteady.^{2,4} The LASIK procedure can be done when there are indications in preoperative and postoperative.

HISTORY OF REFRACTIVE SURGERY

Since Father Waslaw Szuniewicz researched the corneal manipulation technique in 1948, refractive surgery has improved significantly. Prof. Barraquer introduced the keratomileusis' method, which freezing the anterior corneal disc and removing stromal tissue in the year of 1964. In 1970, Fyodorov developed calculated radial keratotomy. Excimer laser (excited dimer), which is a mixture of reactive and inert gases, had been researched by Blum, Srinivasan dan Wynne since 1973, and found to induce a photoablation effect without thermal injury.^{2,5}

Steven Trokel developed *photorefractive keratectomy (PRK)* in the 1980s. He worked with Blum, Srinivasan dan Wynne to discover the first laser refractive surgery on the human eye in the year of 1987. The PRK involves the application of laser directly on the cornea, without making the flap. Hence, the healing process took a long time. Slade and Brint developed *laser in situ keratomileusis (LASIK)* in early 1990. This technique involves flap creation, microkeratome, and laser excimer. The application of laser excimer was direct to the stromal tissue to generate intrastromal lenticule and ease the modification of corneal shape. The flap then positioned back and functioned as a natural bandage to hasten healing process.^{2,5,6}

LASIK DEVELOPMENT

LASIK has complications, such as post-surgical

*Corresponding to :
Cokorda Istri Dewiyani;
Departement of Ophthalmology
Bali Mandara Eye Hospital,
Denpasar, Bali, Indonesia

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pain, flap dehiscence, edema, and corneal haziness, and the rare, most feared corneal ectasia. Complications mainly occurred when LASIK is done on the eye with inadequate corneal thickness, irregular astigmatism, dry eye, history of eye surface abnormality, and glaucoma. The researchers and ophthalmologists have developed various methods to decrease complications. LASEK (*Laser-Assisted Subepithelial Keratectomy*) technique was developed by Camellin in 1999, using alcohol to separate the corneal epithelium from the stroma. This method was developed again as *Butterfly* LASEK by Vinciguerra and Camesasca, LASEK *cruciform* by Amolis, and *gel* LASEK by McDonald. However, LASEK has been abandoned as the alcohol spoils the corneal tissue.^{6,7}

Epi-LASEK was then developed with a blunt-edged microkeratome to create an epithelial flap. However, the flap often does not adhere well, and in the end, LASEK and Epi-LASEK failed to prove themselves superior to PRK in reducing post-surgical complications.^{8,9}

Various researches regarding LASIK has been done since its development. Moreover, LASIK has been proven to be safe and effective to treat refractive error. However, the refractive outcome was found to increase in a higher refractive error degree. Few factors that have been found to affect the outcome predictability of LASIK those are: age, optical zone diameter, epithelial hyperplasia and preoperative keratometry.³

Juhasz has researched the use of femtosecond laser for medical purposes in 1997, which opened to the possibility of doing LASIK without a surgical knife.⁵ Laser *femtosecond* is an infrared laser that works within the pulsating duration of *femtosecond* (10-15 seconds), creating bubbles of microgames inside the tissue, forming a gap that creates the LASIK flap. This technique reduces flap complication, allows the operator to control the size and thickness of fold, better precision for higher degree refractive error. The procedure is popular as Femto-LASIK, which is the second generation of LASIK.¹⁰

In the year of 2007, Carl-Zeiss Meditec introduced *femtosecond* laser VisuMax for ReLEx (Refractive Lenticule Extraction) technique. *Femtosecond Lenticular Extraction* (FLEx) is the first of the third generation of LASIK. FLEx involved making flap incision, leaving a 500 intact epithelium without reposition, reducing flap complication, and removal of a whole lenticular, thus reducing the need for photoablation. The technique was followed by the development of SMILE (*Small Incision Lenticular Extraction*) which creates a small incision of 2-3 mm to insert a

surgical device to separate lenticular and remove it, eliminating the need to develop flap.^{5,7}

INDICATION AND CONTRAINDICATION OF LASIK

LASIK is mainly intended for patients who wear spectacles but wish to be free from glasses as well as contact lenses. LASIK candidates should have personal characteristics of a relaxed, positive, manageable personality, comfortable wearing spectacles that are not made for maximum refractive correction, and have the awareness to use glasses when reading or driving. LASIK candidates must be 18 years or older (SMILE), have stable refraction in the last 12 months, or refractive fluctuations up to 0.5 Dioptri. In hypermetropia, refractive changes during manifest should be a maximum of 0.75 Dioptri. LASIK can be performed on myopia at a maximum -14.00 Dioptri, hyperopia ≤ 4.00 Dioptri to 5.00 Dioptri, and astigmatism of 6 Dioptri. Biometric measurements need to be carried out to ensure the candidate has sufficient corneal thickness.^{7,11}

LASIK has relative and absolute contraindications. Relative contraindications are:^{1,11,12}

- Monocular vision
- Certain condition that limits the visual functions (aside from refractive error), stromal or corneal dystrophy
- Too steep or flat cornea may increase the risk of complications from microkeratome
- Abnormal corneal topography, which increases the risk for corneal ectasia, including keratoconus
- Significant irregular astigmatism
- History of keratitis HSV or VZV
- Uncontrolled dry eye
- Glaucoma, history of uveitis
- Pregnancy, DM, autoimmune disease
- Systemic medications (such as amiodarone, isotretinoin, sumatriptan, levonorgestrel implant, colchicine, etc.)
- Age below 21 years old

Absolute contraindications of LASIK are:^{1,11,12}

- Unstable refractive error
- Corneal abnormality (keratoconus and other corneal ectasia, thinning, edema, interstitial keratitis or neurotropic, extensive vascularization)
- Inadequate corneal thickness for the needed ablation depth (post LASIK stromal thickness minimum 250 μ m)
- Significant cataract, uncontrolled glaucoma,

- uncontrolled surface eye disease (blepharitis, DES, atopy/allergy, etc.)
- Uncontrolled autoimmune disease
- Unreasonable expectations

PRE-OPERATIVE LASIK ASSESSMENT

Anamnesis, which is including the history of disease, surgery, especially in the eyes, and contact lens wear, need to be done. Patients who use contact lenses must stop using them for two weeks before the procedure, while the toric lenses and RGP should be stopped for at least three weeks.¹³ A visual examination should be done as accurate as possible, with more than one examination method available. In myopia patients, the pupils tend to be broad, so, vision problems can occur at night after LASIK surgery. Posterior segment examination is essential, especially in myopia patients to detect lattice degeneration that indicates retinal thinning, the presence of tears or holes in the retina that requires first treatment with a laser.^{13,14}

Corneal topography can detect corneal pathology (e.g., keratoconus, pellucid marginal degeneration, or PMD), which can increase the risk of postoperative corneal ectasia, as well as overall regularity of corneal contours. This technology can also be useful in postoperative examinations.¹¹ Optical Coherence Tomography (OCT) can help detect corneal abnormalities such as diffuse lamellar keratitis (DLK) and pressure-induced stromal keratitis (PISC).¹⁴

COMPLICATIONS AND POST-OPERATIVE MANAGEMENT OF LASIK

Conventional LASIK has proven its safety; however, long-term complications can occur, although in general, it does not threaten vision.¹⁵ Photoablation with a large number of excimer lasers can cause a decrease in the intrinsic corneal optical characteristics. Corneal photoablation and flap can cause weakening of corneal biomechanics and corneal structural changes in the long term, which triggers myopic shift due to increased corneal curvature.^{1,16,17} The SMILE technique is a technique that has been proven to be better in terms of the predictability of refractive outcomes and minimal biomechanical complications. SMILE can produce normal visual acuity in more than 90% of patients, and Femto-LASIK in more than 70% of patients.¹⁸⁻²⁰

The initial postoperative examination aims to identify and treat acute problems such as infection, removal of the corneal flap, striae on the fold, epithelial ingrowth (proliferation of epithelial cells trapped under the flap that appear as milk-

like deposits on the front surface), and so forth. Epithelial ingrowth of more than 1.0 mm can affect vision and must be treated with immediate surgery. Otherwise, significant corneal irregularities can occur, even corneal melting. Postoperative acute complications generally occur within 6-8 weeks. Severe complications, such as infection and corneal ectasia, are infrequent. Dry eyes, glowing eyes, and reduced contrast sensitivity are common side effects in the first few months after surgery, which are generally less common after SMILE. Additional refractive corrections are sometimes needed and are typically done with PRK. The long-term examination includes refraction and topographic stability, handling any ocular problems and referring if necessary.^{1,7,20-22}

SUMMARY

LASIK is one of the refractive errors management that has rapid growth in the last decade. One of the latest development is in the SMILE technique, which has a high level of success. Despite having proven safe, LASIK also has varying complications and outcome predictability, especially in high-grade refractive disorders.

Ophthalmologists have developed various LASIK techniques to minimize complications and produce better outcomes. LASEK and Epi-LASEK are examples of techniques that are developed to deal with LASIK complications related to flaps. Otherwise, the results failed to be proven superior compared to PRK. The invention of femtosecond laser brings a new possibility in LASIK technology, which enables LASIK without the use of a surgical knife. The latest technique, SMILE, even allows LASIK without flaps.

LASIK has indications and contraindications that must be fulfilled by each candidate. Eligible LASIK candidates must undergo preoperative examinations, such as a thorough eye examination, posterior segment examination, tonometry, gonioscopy, biometry measurements, corneal topography, OCT. It is done to ensure optimal conditions so that complications can be predicted and minimized.^{1,12,14}

Postoperative management of LASIK includes an initial examination to detect short-term complications that generally occur within 6-8 weeks postoperatively, for example, infections, flap problems, epithelial ingrowth. The long-term postoperative examination includes an examination of refraction stability, topography, handling of all ocular problems and referral to relevant specialists when needed.

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