LASIK – An Overview

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ABSTRACT

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Among the different refractive surgical procedures, LASIK [Laser in situ keratomileusis] is presently the most popular one with millions of procedures performed worldwide. Its predictability is better than other procedures, even in re-treatments. LASIK does not require removal of epithelium, respects Bowman's membrane and thereby causes minimal keratocyte activation. Hence tissue reaction and disorganization of stromal collagen fibrils is minimal compared to older ablational procedures using the same laser like photorefractive keratectomy [PRK].

This article describes the rationale behind the procedure, its indications, contra indications, the operative technique and the after care needed.

Keywords: LASIK, Microkeratome

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Among the different refractive surgical procedures, LASIK [Laser in situ keratomileusis] is presently the most popular one with millions of procedures performed worldwide.[1,2] Its predictability is better than other procedures, even in re-treatments.[8,9,10] LASIK does not require removal of epithelium, respects Bowman's membrane and thereby causes minimal keratocyte activation.[1,3,4] Hence tissue reaction and disorganization of stromal collagen fibrils is minimal compared to older ablational procedures using the same laser like photorefractive keratectomy [PRK].[3,4.5,6] This translates into greater refractive stability and almost nonexistent corneal haze. As there is no epithelial removal, patient comfort is much better and visual rehabilitation is rapid.[5,6,7]

The Excimer Laser is composed of

- A laser cavity and a condenser to generate an electric discharge
- Gas reservoir
- Optical path for transmission of the laser beam
- Focusing system
- Laser beam delivery system
- Computer
- Working area including an operating table, surgical microscope and console

Cavity – The cavity houses the module where the high voltage discharge takes place and the laser radiation is generated.

Dimer is a molecule created by the mixture of a rare gas [like Argon] with a halogen [like fluorine]; they are subjected to an electric field transforming them to an excited state characterized by a higher energy, hence the term 'excimer' [excited dimer]. Upon return to their original state energy release in the form of photons occurs which is conveyed to laser resonance cavity where a series of mirrors multiplies the effect giving rise to an amplified and monochromatic radiation with high fluence and intensity ranging from 180 and 200 mJ / sq.cm. The photons emerging from the laser are absorbed entirely by the surface of cornea and have an energy of 6.4 eV much more than the 3.5 eV required to break intermolecular bonds. Among the various wavelengths studied, Argon fluoride [ArF] emitting193nm is found to be the most suitable due to [1] high photon energy [2] reduced penetration in the surrounding tissue [3] minimal thermal damage, limited to about 1 micron [4] regular impact [5] absence of mutagenicity, being away from DNA absorption spectrum and[6] strong water absorption.

Apart from wavelength, the other important parameters are number of pulses, repetition frequency and fluence. The number of pulses emitted is measured in hertz. The quickest laser [with maximum repetition frequency] to perform the procedure in the shortest time give the best results as it minimizes corneal hydration. Hence ablation with a 400 Hz machine will

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be more predictable than a10 or a 50 Hz one. Fluence represents the quantity of energy a laser beam has when leaving the cavity. It is a measure of energy per pulse and per surface unit of ablated tissue expressed as mJ/sq.cm.

Gas reservoir: Some laser systems have a reservoir where readied gaseous mixture is kept while some systems have two distinct reservoirs to be blended later. The gas bottles can be lodged either inside or outside the laser frame.

Optic path: It is the route the laser beam travels before hitting the corneal tissue. Along this path the laser beam passes through a series of mirrors, prisms and lenses which is different among manufacturers and changes in homogenicity and shape of the profile. Also here the He-Ne red laser is added making it visible.

Focusing system: Every laser in the market has different strategy to focus the laser working plane before starting the ablation.

Laser beam delivery system: is another important consideration. *Flying spot* technique in which a small tile of tissue is removed with every pulse is presently employed by all laser manufacturers.

Computer: The computer monitors all functions connected with the excimer laser ranging from gas mixing, monitoring of released energy, data entry and interfacing with external devices.

Working area: The microscope, operating table and console are ergonomically designed to suit the needs of both the patient and surgeon and vary with the manufacturer.

A fast and stable **eye-tracking system** is important to ensure accurate laser delivery even if there is an eye movement during the procedure.

Eye-tracking is done conventionally with an infrared video camera.

Microkeratome or a motorised blade is used for flap creation, the most important step in LASIK procedure. The different features of a microkeratome that influence the flap cut are motor, oscillation, fixation, vaccum, applanation, advance, view, diameter control, thickness control, power back-up and audible feedback. Broadly there are two types of microkeratomes – linear system and pivotal system. Linear type is based on Barraquer's principle, ie cornea is applanated first and in the flattened state cornea is cut. Here the power vectors do not change at all from beginning to end. Eg: Barraquer's, Nidek, Ruiz, ACS microkeratome, Moria . In the pivotal system applanation is done while cutting and the horizontal power vector increases considerably while cutting the middle of the cornea. Eg: Carriazo-Barraquer's, Hansatome.

Before performing a definitive procedure like LASIK proper patient selection is of paramount importance to achieve consistently good results.

Contraindications for LASIK can be ocular or systemic

1. *Keratoconjunctivitis sicca*- Severe dry eye as in Sjogren's disease is an absolute contraindication. LASIK can indeed worsen the condition. In normal patients a mild form of dry eye is seen after LASIK, more so with the superior hinge. Hence tear substitutes are routinely prescribed for a period of three months after the procedure. If patients with dry eye undergo LASIK they need to be on frequent preservative free tear substitutes or on lacrimal plugs.
2. *Herpetic eye disease*- can be reactivated after LASIK.
3. *Corneal scars*–ablation on a scar is unpredictable which can lead to irregular astigmatism.
4. *Corneal ectasias*– Keratoconus is considered an absolute contraindication. Ectasia can be worsened after LASIK.
5. *Thin corneas* – It is not advisable to perform LASIK if central pachymetry value is less than460 – 470 microns.
6. *Other ocular pathology* like glaucoma or retinal breaks/ degenerations [detailed later] need to be addressed. If active blepharitis is present it is better deferred.
7. *Pregnancy/ Lactation / Oral Contraceptive Pill use* – due to hormonal changes refraction is unstable. OCPs usually cause a myopic shift in refraction. Also, during pregnancy steroids / antibiotics cannot be used if need be.
8. *Collagen vascular diseases* like rheumatoid arthritis or SLE may be a relative contra indication. The disease needs to be under god control before contemplating the procedure.
9. *Diabetes* is another important relative contraindication. Diabetics have delayed epithelial healing, unstable refraction due to osmotic effect on the crystalline lens and can have early cataract. The few reported cases of cataract after LASIK [with Summit laser] occurred in diabetics after postoperative topical steroid therapy.

Requisites - A soft contact lens wearer need to be off lenses for a week. For a RGP [Rigid Gas Permeable] lens wearer two week abstinence is recommended. Jobs requiring high contrast sensitivity like pilots need to be explained about the gain in uncorrected visual acuity at the expense of small possible loss in contrast sensitivity.

Examination - It is needless to state that examination has to be comprehensive.

Visual acuity: Uncorrected visual acuity for distance and near must be well documented. Near acuity is an indicator of macular status. Best Corrected Visual Acuity need to assessed after cycloplegic refraction.

Stability of refraction: Refraction need to be stable for a year and the candidate must be past 18 years of age. A history of frequent change of spectacles should make one wary of corneal ectasia. The discrepancy between manifest and cycloplegic refraction needs to be 0.25 or less, and never more than 0.5 D. The treatment is usually based on manifest refractive error. Though FDA approved treatment range varies between manufacturers, LASIK may be done for upto -12 D of myopia, +6 D of hypermetropia and 6 D of astigmatism/ cylindrical power.

Slit lamp examination: Thorough slit lamp examination is done to assess corneal clarity, to rule out infection, inflammation, scars, corneal ectasia and superficial vascularisation. Scotopic pupil size needs to be noted.

Corneal thickness / Pachymertry: Any cornea less than 460 microns centrally is not suitable for LASIK. The residual stromal bed thickness needs to be at least 250 microns to prevent corneal ectasia.

Topography: needs to be studied carefully for abnormally steep areas to rule out ectasia. Steep corneas are predisposed for button hole formation while flap creation.

Glaucoma: IOP measurement is difficult after LASIK and is underestimated by applanation tonometry. Glaucoma, being a sight–threatening disease it is better to avoid LASIK in ocular hypertensives.

Retina evaluation: It is imperative to treat predisposing retinal degenerations or breaks with prophylactic photocoagulation before LASIK. Or else, the high IOP produced during placement of suction ring can cause retinal detachment. Any macular pathology need to be documented.

Ocular motility & ptosis: Preoperative photographs need to be taken for documentation if there is any disturbance in ocular motility or ptosis. The patient, with his thick glasses may not have noticed it and can possibly blame the surgeon later.

Informed consent need to be elaborate explaining the predicted outcome, nature of the procedure, possible complications like under / over correction , glare, haloes, decrease in BCVA and driving problems It is important for the patient to realize that correction is only optical not anatomical. Women need to declare that they are not pregnant or lactating.

Procedure: It is important to maintain room humidity [around 40 - 50%] and temperature [18-22 degrees C]. These factors can influence the amount of tissue ablated, though most laser systems presently in the market have built-in system to give necessary warning. Early in practice it is better to avoid deep set eyes as the suction ring placement can be difficult.

Topical anesthetic drops need to be put only twice; too frequent an application can damage the epithelium and predispose for epithelial defect. Eye lashes need to be away from the operating field. Before keeping the suction ring the keratome need to be checked under microscope. Marks are made at 5 and 7 'o clock positions with a marker pen and suction ring is applied after wetting the cornea, centered on the pupil.

After ensuring the suction, cut is made with Microkeratome. Both the surgeon and patient can relax now, before lifting the flap. The patient's head and microscope need to be realigned and the flap is lifted. Laser shots are then applied to the stromal bed. Delay in this part can cause tissue dehydration and consequent over-ablation.

Flap is repositioned after putting a drop of BSS in the stromal bed and irrigation is done underneath the flap. Excess irrigation can cause hydration of the flap. The flap is ironed out with a wet Weck-cell sponge and proper alignment of markings is ensured. The edges of the flap are then dried. It is important to wait for a minute to ensure adequate apposition of the flap to the stromal bed. The microscope lights can be kept off during that period. The speculum is gently taken out after making sure that flap is properly adherent.

The flap needs to be re-checked after removing the surgical drape. Topical antibiotic and steroid drops are instilled and the patient seen after 30 minutes to ensure proper flap alignment.

It is better to avoid patching the eye, but dark glasses

or shield need to be worn. Patient is prescribed topical antibiotics, mild steroids and lubricant eye drops 4 times a day for a period of one week. The patient is seen the next day, when near complete intended correction can be expected unless there is a complication.

Thus, if adequate precautions are taken LASIK is a simple procedure with high level of patient satisfaction. Detailed preoperative work-up, proper patient counseling and adherence to scientific principles are imperative to ensure a successful outcome.

END NOTE

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