

LASIK

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Pallikaris in 1990

Indications

Stable refraction
(no change over a period of 2 years)
Age ≥ 21 years
Adequate central corneal thickness
Myopia $\leq -10.00D$
Hyperopia $\leq +4.00$ to $5.00D$
Astigmatism $\leq 6D$

Absolute contraindications

Keratoconus
Central corneal thickness $< 410\mu m$
Unstable refraction
Deep corneal dystrophy
Previous corneal melt (or systemic conditions predisposing to corneal melt)
History of herpetic keratitis
Amblyopia

Relative contraindications

Cataract
Selected occupations (e.g., commercial pilots)
Obsessive personality

The excimer laser is used to ablate the corneal stromal tissue to achieve the desired refractive change

Surgical procedure

The patient lies on a couch with the excimer laser .delivery system above the patient's head
The cornea of the eye to be operated is anaesthetized .with topical anaesthetic drops
A lid speculum is inserted after instilling topical .anaesthesia to prevent blinking during the treatment
The patient is asked to fixate on the laser beam and the cornea is marked with gentian violet to .help realign the flap
A suction ring is applied to the limbus and the pressure increased to more than 65mmHg to ensure a regular cut. transient loss of vision may occur An automated microkeratome is fitted on the track and activated to pass across the cornea to create stromal flap. The vacuum is released and the epithelial flap is reflected back to expose the stromal bed. The hinge of the flap is made, either nasally or at the 12 .o'clock position

.excimer laser ablation is carried out on the corneal stroma. usually takes less than 90 seconds
The patients are warned that they might experience a pungent smell during laser ablation.
.The flap is washed with balanced salt solution and replaced
Centration is checked and the edges are smoothed down. The endothelial pump mechanism
.keeps it in place. After checking the adhesion, the speculum is removed
.Topical antibiotics and topical corticosteroid are prescribed for 1 week

Post-operative care

The patient is directed to avoid swimming, dust or smoke and any contact sport for about 1 month after the surgery.

clear eye shield is worn during sleep for 2 week to avoid trauma while sleeping. s

.The patient is examined after 1 day, 1 week, 1 month, 3 months, 6 months and 1 year

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Complications

Non-refractive

Flap related complications

The intra-operative flap complications include incomplete or free (completely cut) flap, lost flap, .decentred flap, irregular flap and flap stria

Late complications are epithelial ingrowth (epithelium within the stromal interface, one of the most common cause of reduced visual acuity wrinkles or striae, interface infection and flap dislocations. Central islands Interface debris

Infectious keratitis (rare) Diffuse interstitial keratitis (sands of Sahara) Endothelial cell loss

Haze Glare and haloes Night-vision problems Reduction in corneal sensitivity Dry eye

Posterior ectasia

Refractive complications

under- or overcorrection, regression, decentred ablation and induced irregular astigmatism caused by folds or microstriae of flaps

Laser *in-situ* keratomileusis

early post-operative period

Immediately after LASIK , a slit lamp should be used to **check the flap position** and look for **wrinkles, striae or significant interface debris** that may require the flap to be re-floated by the surgeon. Failure to do so could result in a compromised visual performance because of

.significant corneal irregularity over the pupil

.**corticosteroids** can be used to prevent or at least limit interface inflammation

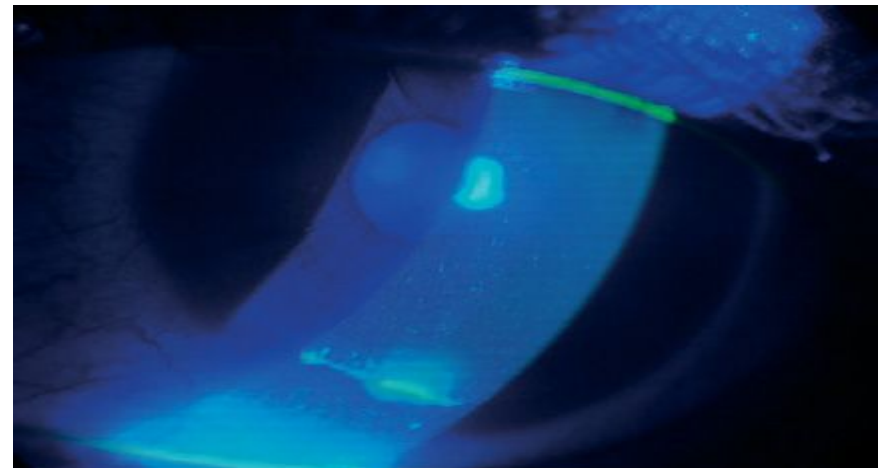
In the majority of cases, **functional vision returns** within a few hours of surgery, with 80% achieving a level of vision within one line of their preoperative BCVA by 3 days after LASIK

Patients may experience **grittiness, photophobia and perhaps burning for the first 24 hours** until the epithelium around the flap margin has healed, but discomfort can generally be controlled using anti-inflammatory drops (e.g., 0.5% diclofenac sodium extended release) rather than a bandage contact lens

period, **Eye rubbing or squeezing** can dislodge, or distort the flap during the early post-operative . so the patient is usually fitted with a **transparent eye shield** to minimize this



Striae post-LASIK



Flap-edge defect post-LASIK

At 1 week

.The epithelium should fully cover the flap margin by 1 week post-LASIK

Epithelial defects should be monitored carefully, since they increase the risk of **epithelial ingrowth and diffuse lamellar keratitis (DLK)**

Interface debris should also be watched as it may lead to focal infiltrates that require flap re-floatation

At 1 month

.By this stage, the vision tends to be very good

some patients start to notice visual problems such as reduced-quality night vision and haloes around lights

The refractive error may have stabilized in those treated for lower degrees of myopia (<6.00DS), although regression of approximately 15% of the pre-operative error is not uncommon²⁰ (e.g., -0.25D after LASIK for -1.50D, and -1.50D after LASIK for -10.00D), and is associated with an increase in corneal thickness and central corneal steepening

If epithelial ingrowth is going to develop it tends to do so within the first month. The clinician must then decide whether the location and extent of the ingrowth warrant intervention

At 3 months

After LASIK, healing is limited to the region around the lamellar interface and haze occurs around the flap margin only

Most LASIK patients demonstrate a stable refractive error by 3 months, with the exception of those treated for very high myopia. The possibility of an enhancement procedure can be discussed if the refractive outcome is poor, (error is greater than 1.00DS.) usually performed between 3 and 6 months after the first procedure, both the refraction and corneal topography must be stable and there must be sufficient residual corneal thickness. cycloplegic refraction is essential to minimize the risk of overcorrection

At 6 months and beyond

of eyes achieve $\pm 1.00D$ of emmetropia at 6 months post-LASIK for corrections of 100%–90%–8.00D or less. Hyperopic LASIK has proved slightly more successful than hyperopic PRK, but the stabilization rate is approximately four times longer than for myopic treatments

Complications specific to LASIK

Non-refractive

Flap related complications

The intra-operative flap complications include incomplete or free (completely cut) flap, lost flap, decentred flap, irregular flap and flap stria

Late complications are epithelial ingrowth (epithelium within the stromal interface, one of the most common cause of reduced visual acuity wrinkles or striae, interface infection and flap dislocations. Central islands Interface debris

Infectious keratitis (rare) Diffuse interstitial keratitis (sands of Sahara) Endothelial cell loss

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under- or overcorrection, regression, decentred ablation and induced irregular astigmatism caused by folds or microstriae of flaps

The

.vast majority of complications manifest themselves within 6–8 weeks of LASIK surgery

Most can be treated and have a minimal effect on the final outcome after surgery, if managed properly. Serious adverse complications that lead to a significant permanent visual loss, such as infections and corneal ectasia, are very rare, but side effects such as dry eyes, night-time

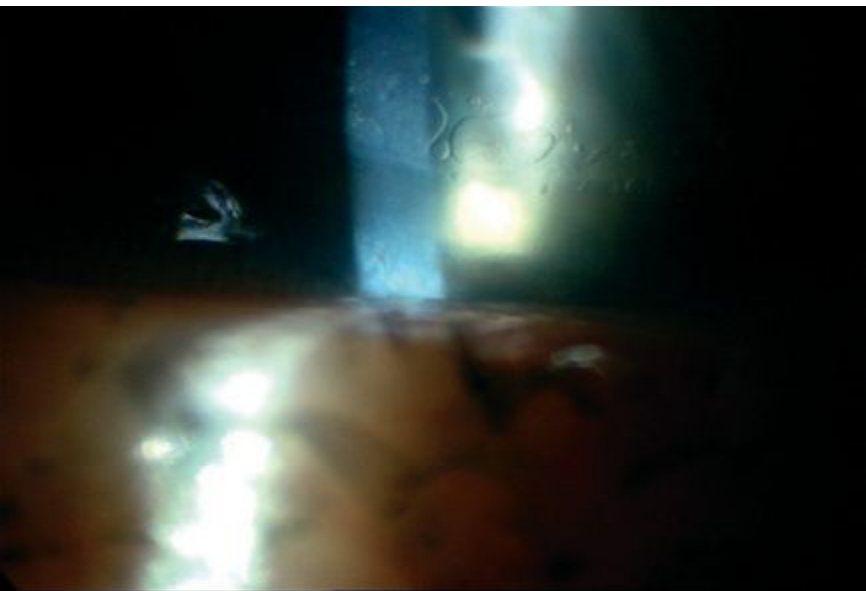
.starbursts and reduced contrast sensitivity are relatively common for the first few months

Epithelial ingrowth

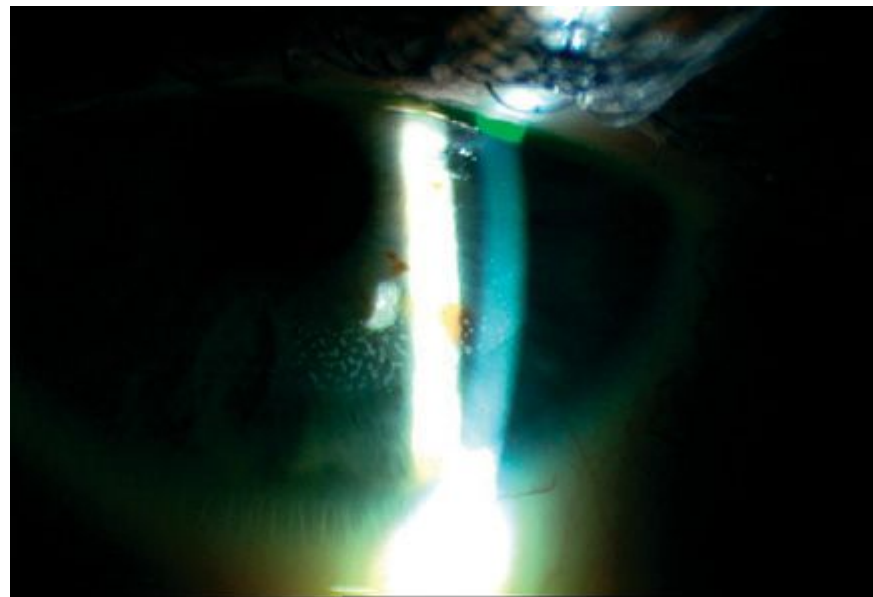
Epithelial ingrowth occurs when nests of epithelial cells trapped beneath the flap begin to proliferate. *Ingrowth* presents as a milky deposit in the interface *and is more common after* enhancement than after the initial procedure.

The extent should be measured since growth less than 1.0mm from the flap margin is acceptable, as it is usually self-limiting.

Ingrowth greater than 1.0mm, invading the visual axis or progressing rapidly requires surgical management, particularly if the flap margin is rolled or eroded, as it can lead to significant irregularity and flap melt. Although a small degree of ingrowth is common (approximately 15% of eyes), few cases require management. Untreated ingrowth can lead to corneal irregularity, glare, and very occasionally to corneal melt.



Nests of proliferating epithelial cells trapped beneath the flap can result in epithelial ingrowth



Ingrowth often presents as a milky deposit in the interface

Microstriae

Fine grey lines that are related to crinkles in Bowman's membrane are not uncommon in those treated for moderate or high myopia, as the flap does not fit the remodelled stromal bed. Such cases are difficult to manage and are usually left alone unless vision is compromised

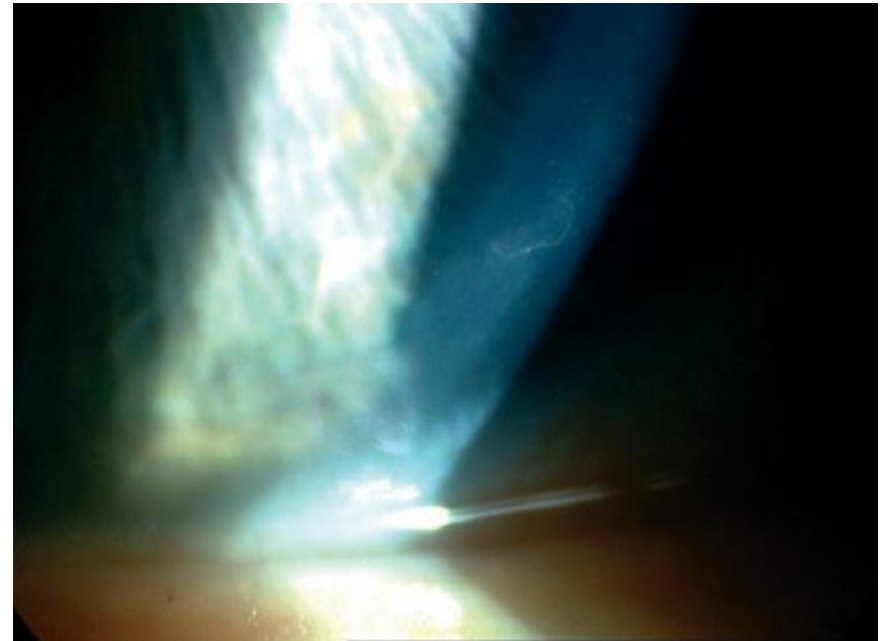
Interface debris

Some debris is seen in virtually all eyes post-LASIK. Sources include dust from the atmosphere, meibomian secretions (*Figure 5.5*), *metallic deposits and oils from the microkeratome blade* and *fibres (Figure 5.6)*

or Debris is usually inert and causes no problems, but it can be associated with stromal infiltrates .DLK, in which case it requires treatment with topical corticosteroids



.Post-LASIK interference debris



.Fibres trapped in the interface post-LASIK

Diffuse lamellar keratitis (Sands of the Sahara)

DLK is a sterile, diffuse inflammation at the level of the interface that may be accompanied by anterior chamber activity

.It looks a little like post-PRK haze, but is very obviously confined to the interface

.It is thought to be an immune response to interface debris or perhaps bacterial toxins

The onset tends to occur within a day or two of the LASIK procedure, with symptoms such as

.pain and photophobia, and additional signs of ciliary hyperaemia and lacrimation

Visual quality may be reduced because of the increase in forward light scatter, although Snellen

.acuity is unaffected generally

such Referral back to the operating surgeon is required for treatment with topical corticosteroids as fluorometholone, antibiotics and cycloplegics. The flap may be lifted and irrigated in some

.cases



A number of systems are used to grade DLK, including one that divides cases into one of four categories

	<i>No central involvement</i>	<i>Central involvement</i>
Sporadic case	Type IA	Type IIA
Case part of a cluster	Type IB	Type IIB

Cases with central involvement (type II) took significantly longer (12.1 days) to resolve than much cases with central sparing (type I – 3.5 days). Not surprisingly, central involvement carries a higher risk of a reduction in BCVA. The majority of cases were sporadic rather than part of a cluster

.DLK can also present many months after LASIK in association with an epithelial defect
White blood cells migrate from the limbal blood vessels into the interface, since it is the easiest path for them to take

.Central corneal sparing is much more likely if the DLK is related to an epithelial defect
There is also a reported case of DLK that occurred 10 months post-LASIK in association with acute iritis, 40 which suggests that DLK is a nonspecific corneal inflammatory response rather than a condition caused by a particular agent. Appropriate management of patients with DLK generally results in complete resolution of the condition

Corneal integrity

healing does not appear to lead to the growth of collagen fibres between the corneal flap and the ablated stromal bed. The flap is attached to the underlying cornea only at its margins, the corneal epithelium, and therefore does not contribute significantly to the strength of the cornea. This can be attributed to the endothelial pump and the multiple layers of corneal epithelium that cover the flap margin

flap dislocation can occur at any time if the trauma is discrete and from such an angle that it catches the edge of the flap. Patient's who report with flap dislocation should be referred of urgently to the operating surgeon for irrigation and refloating of the flap, followed by a course topical antibiotics and corticosteroids, since DLK and epithelial ingrowth are common after such an occurrence

Keratectasia

Keratectasia is a rare condition in which surgically induced corneal thinning leads to protrusion of the corneal tissue, an increase in myopia and irregular astigmatism, and consequently to a reduction in visual performance. Some cases require a corneal graft to achieve functional vision This is a severe complication that may not present for a year or more post-surgery

Most cases of keratectasia can be attributed to miscalculation of the remaining corneal thickness. The general consensus is that keratectasia can be avoided by ensuring that the residual stromal bed after creation of the flap is at least 250µm in thickness
to Unless the thickness of the stromal bed is measured intra-operatively, it is not always possible ,ensure that adequate thickness remains because of the limited accuracy of microkeratomes .(standard deviation of $\pm 30\mu\text{m}$)

,Iatrogenic ectasia is most commonly associated with the treatment of high myopia ($> -15.00\text{DS}$) since a deeper ablation is required and residual corneal thickness calculations become much more critical. The risk of inducing a corneal ectasia is small if a minimum of 30% of the corneal

.A recent study of 2873 eyes reported ectasia in 0.66%

The authors noted that ectasia did not occur in those treated for **myope less than -8.00DS**
.those with a **residual corneal bed thickness of $325\mu\text{m}$ or more**

The anterior $100\text{--}120\mu\text{m}$ of the corneal stroma is known to have a more tightly interwoven anterior lamellae than the underlying stroma, which makes this part of the stroma stronger and
.more resistant to swelling than the deeper layers

Examination of the biomechanics of the cornea after severance of anterior lamellae during the creation of the flap and the reshaping of the underlying stroma **suggests** that the whole cornea,
.including the posterior surface, bows forwards as a result of surgery
This movement, which has also been implicated in the refractive regression seen post-LASIK,
.suggests that the anterior lamellae play an important structural role

Retinal complications

The risk of retinal detachment increases with increasing myopia above -3.00D , and highly myopic eyes (greater than -10D) also have an increased risk of primary open angle glaucoma,
.pigment dispersion syndrome, cataracts and myopic maculopathy
or In theory, creation of the corneal flap could lead to retinal complications, such as retinal tears
.rhegmatogenous retinal detachment, particularly in susceptible individuals

This highlights the importance both of a thorough retinal examination with scleral indentation (to allow the identification and treatment of retinal lesions prior to surgery) and of the
.education of all patients in the importance of regular eye examinations post-surgery

Complications common to all forms of excimer laser surgery

Undercorrection

Residual myopia is usually the result of an inaccurate pre-operative refraction or an insufficient period free of contact lenses prior to surgery. **Enhancement** can be considered once the refraction has stabilized

Overcorrection

An initial hyperopic result is to be expected after PRK, but if hyperopia greater than 1.00D with minimal haze formation is still present 6 weeks post-surgery, the patient may be an 'under-healer' and require a hyperopic enhancement. Hyperopic treatments are not as successful as myopic procedures, with a relatively high risk of regression, irregularity and a long stabilization period

Regression

Regression is the loss of refractive effect over time and is more common following larger refractive corrections, particularly after PRK. A degree of regression is expected during the first 6 weeks post-PRK and the first 3 weeks post-LASIK, and is associated with stromal remodelling, thickening of the epithelium and corneal biomechanics

Severe regression associated with intense haze is very rare now that PRK is limited to the treatment of low myopia. The risk of regression is much higher in all people exposed to high **Dry eye** of ultraviolet radiation (natural sunlight), and in females who take oral contraceptives. Grittiness and asthenopia associated with dry eye are relatively common during the first 6 months post-excimer laser surgery. A number of possible causes include damage to the conjunctival goblet cells by the lid speculum and impaired corneal sensitivity.

Preservative-free ocular lubricants throughout the day and an ointment at night suffice.

. Punctal plugs can be useful in more severe cases

Intraocular pressure elevation

If corticosteroids are used to treat the intense haze of DLK, for example, a small proportion of patients will demonstrate a significant rise in intraocular pressure (IOP)

Steroid responders require immediate referral for cessation of topical corticosteroids and all possible beta-blocker treatment. When assessing IOP post-surgery, clinicians should note that excimer laser techniques lead to an artificially low IOP reading by about 2mmHg, which is related to the reduced thickness of the central cornea

Stromal infiltrates

Infiltrates, both sterile and infectious, can occur in the presence of a bandage contact lens (post-PRK or -LASEK) or interface debris (post-LASIK). Sterile infiltrates are also associated with the use of nonsteroidal anti-inflammatory eye drops

These must be assumed to be infectious until proved otherwise and the patient referred back to the surgeon for topical antibiotics (infectious) or topical corticosteroids (sterile)

Corneal infections

reported Cases of infectious keratitis are rare, but both fungal and bacterial infections have been in the early post-operative period

These can take the form of a corneal ulcer with epithelial staining, infiltrates and stromal oedema, or be confined to the interface (LASIK). Rapid referral is necessary to identify the cultures and for intensive treatment, but a penetrating keratoplasty may be the only solution

Excimer laser procedures have also been known to reactivate the herpes simplex virus, of which the classic dendritic pattern should be a warning. Those at risk should have been screened out prior to surgery

Visual outcome

Unaided vision

PRK

For low and medium degrees of myopia ($<-6.00D$), 88–99% achieve 6/12 or better (uncorrected vision), and 58–78% achieve 6/6 or better by 12 months post- PRK

LASIK

For eyes treated for $-9.50D$ or less, the percentage of eyes that achieve 6/6 or better has been quoted as 83%, with 6/12 vision or better achieved by 86–100% at 6 months post-LASIK

LASEK

For a range of myopia up to $-11.25D$, an unaided vision of 6/4.5 was achieved by 19% of eyes, 6/6 by 63% of eyes and 6/7.5 by 18% of eyes

Visual complications

or high percentage of patients (7.3%) treated for hypermetropia $>+4.00D$ were found to lose two or more lines of best-corrected acuity

spherical aberration and coma are highly dependent on pupil size and, on average, there is between a five- and seven-fold increase in total aberrations as the pupil dilates from 3 to 7mm

Coma is associated with decentration of the ablation zone in relation to the pupil centre and increases with increasing preoperative refractive error

night-vision problems were associated with high levels of stromal haze, which caused stray light, and with treatment zones significantly smaller than the average pupil, which led to extreme aberrations. Nowadays, haze is less common because high myopes are no longer treated with PRK. LASIK and LASEK cause little or no haze in the majority of cases and ablation zone diameters for all techniques have increased from around 4 or 5mm upto 6 or 6.5mm, which makes them larger than or the same size as the average pupil under low illumination

Assessment of corneal profile

Particular topographical features that may signal problems include central islands, decentred ablations and irregularities

A central island is defined as a 2–4mm area with 1.5–3.5D of corneal steepening associated with undercorrection, more common after treatment with a broad-beam laser

Decentrations of the ablation in the region of 0.5mm are very common and tend to cause a slight reduction in visual quality, related to an increase in higher order aberrations (coma), but rarely a reduction in high-contrast acuity

Larger decentration can cause monocular diplopia, irregular astigmatism and a loss of BCVA. Such cases require retreatment, ideally using a laser with a topographic or wavefront link. Decentrations may be symptom free if the pupil itself is slightly decentred

Slit-lamp examination

Retroillumination is particularly useful in revealing complications such as flap microstriae, interface debris and ectasia

Haloes

Haloes are more common in eyes that have undergone small-diameter ablations, and in patients with naturally large pupils (6.5–7.0mm in diameter)

Ablation diameters of 6.0mm or more have significantly reduced halo problems in the majority of patients

