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Has LASEK superseded LASIK?

LASIK has not only become the most popular refractive procedure performed worldwide but has now become the most commonly performed surgical procedure in the USA. Although this has been driven by the common belief that LASIK provides rapid recovery and consistent results, the procedure is not risk free. The rise in numbers of treatment performed has also meant a rise in the number of complications specific to LASIK.

The quest for a procedure which not only provides consistent results and has a better safety profile than LASIK, and overcomes some of the problems with PRK, has led to the development of laser-assisted subepithelial keratectomy (LASEK).

LASEK combines aspects of both PRK and LASIK but would appear to have the advantage of reducing the complications inherent to both procedures. Shah et al[1] have previously demonstrated in eyes undergoing PRK to one eye and LASEK to the other, that results are superior in LASEK. Similar studies comparing LASEK to LASIK are emerging.

This article compares and contrasts the two procedures.

Surgery

The key steps of LASEK and LASIK are highlighted in **Table 1**. There are two basic types of LASEK flap – one with a superior hinge and the other with nasal and temporal hinges (the butterfly technique, recently described by Paolo Vinciguerra). The epithelial basement membrane is delaminated using ethanol (typically 18%) placed in an alcohol well for 30 seconds and then washed off with balanced salt solution. The alcohol well needs to be at least 1mm larger than the intended ablation diameter. Deep circular corneal ring markers or specially designed alcohol wells for LASEK can be used.

For LASEK, the set up is easy and there are no specialist sterilisation requirements as there are no areas on the instrumentation that may potentially require higher temperatures/vacuum to sterilise. In contrast, LASIK usually requires the help of an assistant because of the specialised set up, cleaning and sterilisation requirements. Surgical time is short for LASEK and for beginners, it is an easier procedure to learn with a gentler learning curve in comparison to LASIK.

Both procedures require the creation of a flap, but flap failure has much greater significance for LASIK. If the flap fails in LASEK, the surgeon can still proceed as for PRK. However, flap failure in LASIK would at best mean postponement of treatment and could possibly lead to poor visual outcome in cases with significant flap complications, e.g. transection, button-hole, partial flap.

Table 2 shows a comparison of the two procedures.

Suitable refractions

Refractions of +4.00D to -8.00D are generally accepted to be suitable for LASEK. Although most authors would agree that slightly higher degrees of both hyperopia and myopia could be treated with LASIK, the procedure is limited by corneal thickness and keratometric readings for individual patients. Some surgeons use topical application of mitomycin C 0.02% for two minutes to prevent haze formation, typically in eyes with over 6.00D of myopia, and then are happy to use LASEK for refractions up to -12.00D or -13.00D, depending on the corneal thickness. Hence, the possible treatable refractions are much greater with LASEK than with LASIK.

Table 1
Key steps for LASEK

LASEK	LASIK
Anaesthetise cornea	Anaesthetise cornea
Prep, drape and speculum	Prep, drape and speculum
Alcohol well	Corneal marker and suction ring
18% ethanol solution for 30 seconds	Microkeratome
Alcohol delamination of epithelial basement membrane	Occlude central retinal artery
Create epithelial flap with superior hinge or butterfly technique	Flap cut with microkeratome (superior or nasal hinge)
Excimer laser treatment	Excimer laser treatment
Flap repositioned	Flap repositioned
Bandage contact lens	

LASIK with flap being cut and lifted

Suitable patients

All patients are potentially suitable for LASEK and it can be performed in patients where LASIK may be contraindicated. Examples include patients with epithelial basement membrane dystrophy, deep-set eyes, narrow palbebral apertures, glaucoma filtering blebs and large pupils. Recent cases that the author has treated which were felt to be unsuitable for LASIK, but suitable for LASEK, include Von Hippel Lindau disease with an angioma which had previously bled, and a case of partial non-arteritic ischaemic optic neuropathy. In both cases, it was felt to be an unacceptable risk to block the central retinal artery. Obviously, the risks and benefits of LASEK have to be individually discussed in these cases.

Biomechanical effect

It is postulated that making a stromal lamellar cut reduces the biomechanical strength of the cornea[2]. The reported cases of keratectasia following LASIK, but lack of them following PRK, lend support to this theory[3,4]. As no stromal lamellar flap is cut

LASEK alcohol well

Table 2
LASIK versus LASEK – suitability, procedures and outcomes

	LASEK	LASIK
Suitable refractions	+4.00D to -8.00D Some say all CCT not an issue Thin corneas Flat Ks Steep Ks, i.e. all Ks Large pupils	+5.00D to -12.00D Limited by CCT Limited by Ks Limited by large pupils
Suitable patients	All Older and caucasian	Better for young and some ethnic groups
Surgery	Easy set up No requirement for special sterilisation because of lumen Short surgical time Easy to learn No steep learning curve If fails, becomes PRK	More specialised set-up Assistant required Special cleaning and sterilisation Moderate learning curve If fails, flap complication Possible significant flap complication
Biomechanical effect	Minimal	Refractive effect of flap Central flattening with suction and pass and no cut
Stromal effects	Minimal	Elongation lamellae
Pain	Minimal (like sleeping with CLs in) to severe Most mild to moderate Topical NSAID for 2/7 Oral compound analgesia Sleeping tablets for two nights Bandage contact lens 3-4/7	Usually minimal More if epithelial defect or dislodged flap No pain killers routinely required
Visual recovery	Typically three days Full range 30 minutes to 3/52 Typically better VA than LASIK patients in first few hours Poor vision for more than a week if high hyperope as some myopic shift	Typically one day Longer if complicated or affected by dry eyes, etc On-going changes for 3-6/12
Epithelial recovery	3/7 butterfly technique 4/7 superior hinge Majority of epithelium viable Not just dead epithelium as 'natural CL' Some punctuate epitheliopathy possible for few days	One day Epitheliopathy possible (dry eyes/preservative sensitivity)
Stability	Early instability in high corrections Myopic shift in hyperopes Hyperopic shift in myopes Smaller than with PRK Epithelial remodelling	Typically stable within a few days More variation in large ablations and large optical zones Epithelial remodelling

for LASEK, the biomechanical stability may be maintained as with PRK.

The microkeratome pass over the cornea elongates the stromal lamellae. Hence, when the excimer laser ablation is applied, the cornea is no longer in a natural state, i.e. not only has the cornea been cut and its structural integrity destroyed, the remaining stroma is longer than it was at the start of the procedure.

Given that LASIK flaps can be lifted many years after surgery (seven years is the longest that the author is aware of), it is clear that a cornea that has undergone LASIK will probably be permanently weakened. Whereas this may be an acceptable risk in most patients, it can not be acceptable for all patients, e.g. those who are at risk of ocular trauma. For example, fighter pilots who have become too myopic for their occupation, and are looking at refractive surgery, may be counselled that the extreme forces applied to their bodies in the event of ejection from an airplane may mean that a LASIK flap is far too risky for them and that LASEK is by far the most sensible solution.

Pain

One of the main reasons for the growth in popularity of LASIK over PRK was the marked reduction in pain following LASIK compared with PRK. Patients do, however, experience pain after LASIK if there is an epithelial defect or the flap is displaced. Routinely analgesics are usually not required.

Pain after LASEK is variable from minimal to severe, with most patients complaining of mild to moderate pain. Topical non-steroidal anti-inflammatory drugs (two days), oral analgesics (as required), sleeping tablets (two nights) and bandage contact lens (three to four days) are all used to maximise patient comfort after LASEK.

An average patient will complain of discomfort more than pain. It is very rare to get complaints of severe pain as used to be the case following PRK.

Visual recovery

Patients having LASIK typically make an excellent recovery within 24 hours. Recovery may be delayed in complicated cases or affected by dry eyes.

LASEK patients have a slower recovery time of approximately three days (range two days to five weeks). However, initially, patients can be seeing very well as they sit up following surgery. It is not uncommon to measure an acuity of 6/6 within 30 minutes of the procedure. Most patients attain better vision than LASIK in the first few hours after treatment, but the trend is reversed within 24 hours.

The hyperopic shift after myopic PRK, and the myopic shift after hyperopic PRK, is emulated by LASEK to some extent. In particular, high hyperopes can experience poor vision for a week or more because of the myopic shift after LASEK.

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Epithelial recovery

Complete epithelial recovery following LASEK takes three to four days depending on the type of flap. Recent studies have shown that more than 50% of epithelial cells in the flap remain viable after exposure to diluted alcohol for up to 30 seconds. This supports the belief that the epithelial flap is more than just a 'natural contact lens'[5,6]. LASIK causes minimal disturbance of the epithelium in uncomplicated cases and recovery is complete within 24 hours, but can vary depending on the type of microkeratome. However, epitheliopathy is possible following LASIK, in association with dry eyes or preservative sensitivity.

Stability

LASEK patients with high corrections have unstable refraction in the early phase with myopic shift in hyperopes and hyperopic shift in myopes. The vast majority of patients are stable within one week with LASEK. LASIK patients, however, usually have stable refraction within a few days but may vary more in large ablations and large optical zones.

Short-term risks

Table 3 compares the short-term risks of both procedures.

Retreatment

Lifting the epithelial flap after LASEK for retreatment is more difficult than lifting a virgin LASEK flap, with a slightly higher risk of haze following retreatment. It is, however, possible to perform LASIK on these patients. Although LASIK flaps are easier to lift, flap complications including flap melt can occur. Performing LASEK on these patients is an alternative.

Table 3
LASEK versus LASIK – short-term risks

LASEK	LASIK
Epithelial loss/death	Flap complications
Infection	Infection
Debris under flap	Interface debris
Soft lens-related infiltrates	DLK
Side effects of oral analgesia	Dry eyes
Epithelial non-healing	

Table 4
LASEK versus LASIK – long-term risks

LASEK	LASIK
Haze (rarely worse than grade 1)	Late DLK
Epithelial remodelling	Epithelial in-growth
Regression (rare)	Regression
	Ectasia
	Flap dislocation
	Halos

Wavefront guided treatment

Wavefront guided treatment is possible with both LASEK and LASIK. LASIK patients have variable amounts of induced higher order aberrations by cutting the flap (largely spherical) and the treatment does not take into account the induced aberrations. There is only a small effect on original higher order aberrations by epithelial remodelling in LASEK patients. If wavefront guided treatment is going to be used, it does not make any sense to use it on an eye which has had additional aberration induced on it by making a flap. The logical step would be to use this modality of treatment on eyes undergoing LASEK. In time, nomograms may allow for some of the induced aberrations in LASIK but they will never be able to predict the induced aberration in each individual eye.

Results

Table 5 shows some of the recently published results for LASEK.

Summary

LASEK has no significant surgical risks and is universally suitable for a large range of corrections, unlike LASIK. Initial results are as good as LASIK with few of the problems associated with either LASIK or PRK. In the

Table 5
Some of the recently published results for LASEK

Authors	Pre-op myopia or hyperopia	Follow up	Unaided 6/12 or better	Unaided 6/6 or better	Accuracy ±1.00D	Loss of corrected visual acuity	Comments
(*Claringbold*, 2002)[7] 222 eyes	Pre-op MSE -1.25 to -11.25D	Four days Two weeks 12 months	84% 98% -	- - 6/4.5 – 19% 6/6 – 63% 6/7.5 – 18%	- - -	- - 0%	
(Shahinian Jr, 2002)[8] 146 eyes	-1.25 to -14.38D	12 months (55 eyes)	96%	56%	84% ±0.50D 93% ±1.00D	0% two lines 16% one line	18% gained One line of BSCVA
(Anderson et al, 2002)[9] 343 eyes	-1.00 to -14.00D astigmatism 0 to 4.75D	Six months (122 eyes)	98%	84%	85% ±0.50D 94% ±1.00D		

authors' opinion, it should be the choice of procedure unless the risk of surgical cut and related flap problems are exceeded by perceived individual benefit from speed of recovery.

About the authors

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