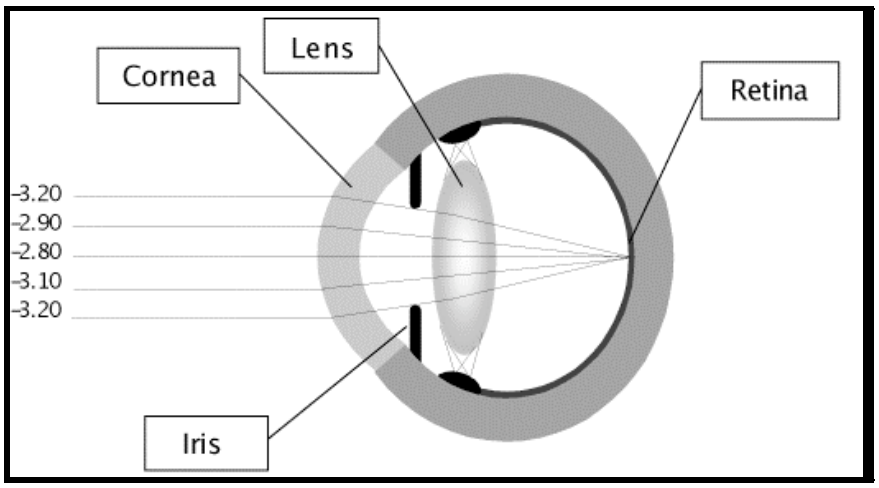
Wavefront guided laser refractive surgery - 2014

Laser refractive surgery is a way of reshaping of the cornea to correct myopia, hypermetropia ('long-sightedness') and astigmatism. The re-shaping of the cornea is performed by the excimer laser. There are broadly two kinds of laser surgery. LASIK, whereby a flap is cut in the cornea and the laser treatment delivered to the underlying cornea, and 'surface treatments'. In the latter, the outer layer of the cornea is removed (the epithelium) and the laser treatment is then delivered to the cornea directly. This has various similar sounding names such as LASEK, epiLASIK and the more old fashioned term PRK. LASIK tends to be the more commonly performed procedure whilst the differing surface treatments are reserved for those people whose corneas are too thin to have a flap cut into it, or whose treatments are not suitable for LASIK. During the last 20 years there has been enormous progress, resulting in more accurate corneal incisions, with advanced microkeratomes (the mechanical instrument used to cut corneal flaps) and the recent introduction of the Intralase femtosecond laser to cut the flaps, as well as more efficient and reliable laser technology.

Wavefront Scanning

Wavefront scanning aims to take account of the higher order optical aberrations that are present in the eye. Such higher order aberrations are present in all lens systems, whether a microscope or a modern astronomer's telescope and of course in the eye. These higher order aberrations are best understood by thinking of your spectacle prescription as an average of the focussing requirements for light rays entering the eye through different points on the eye surface.



If your refraction is, for example, -3.00D, this may be an average of -2.80D for rays entering through the centre of the cornea and -3.20D for rays entering around the edge. A wavefront scan produces a map of the focussing requirement at each point. Information from this scan can be programmed into the excimer laser with the aim of reshaping the cornea to produce sharper vision than spectacles. Whilst this is a seductive concept, there are several practical difficulties. Limitations in the mathematics used to summarise wavefront scanning information, and integral elements of refractive surgery, such as variation in individual healing responses, may have an unpredictable effect on the wavefront map. Current wavefront guided laser treatments do not routinely produce better vision than spectacles and contact lenses. But they have two benefits over laser refractive treatments based soley on spectacle prescriptions:

- Wavefront guided treatments are less likely to result in surgically induced increases in higher order aberrations (ie the corneal shape produced by a wavefront guided treatment is closer to the ideal natural shape of the eye).

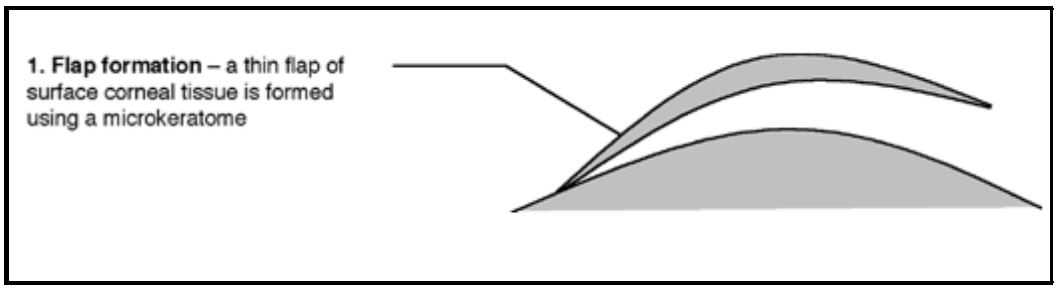
- Wavefront guided surgery is less likely to cause night vision problems or degradations of other elements of visual performance. Night vision is improved in the majority of patients after wavefront guided treatment.

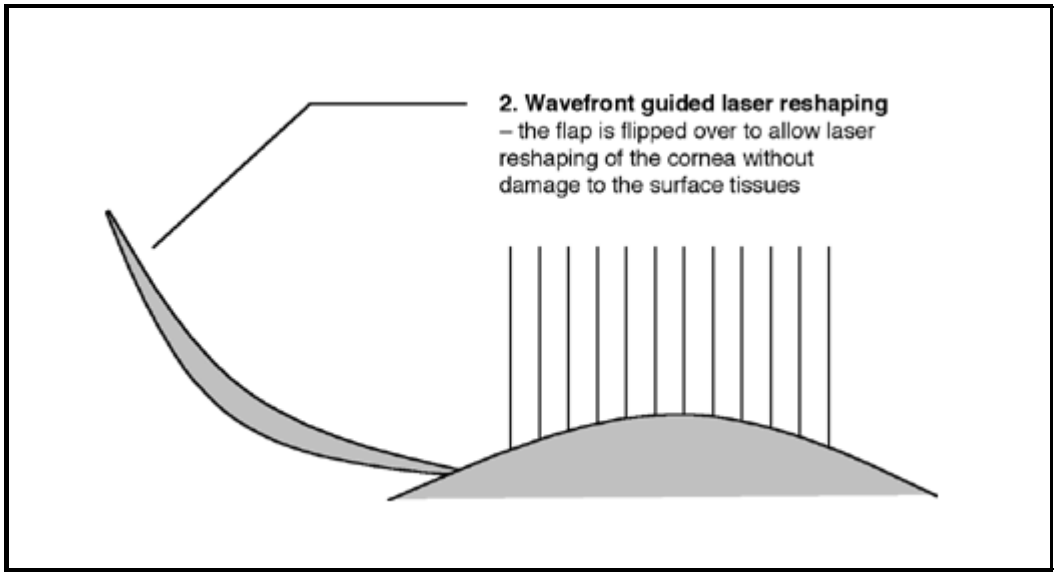
The wavefront scanning and excimer laser refractive surgical system used at Moorfields Eye Hospital is the latest generation AMO CustomVue System (www.VISX.com).

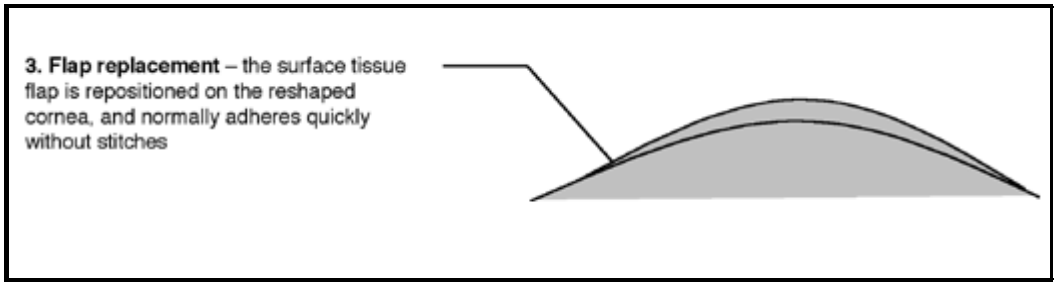
LASIK

LASIK (laser in situ keratomileusis) is the dominant operation in contemporary refractive surgery. Around 100,000 LASIK procedures are performed per year in the UK, and over 12 million have been performed worldwide since the introduction of LASIK in 1993.

In LASIK, an automated surgical instrument (the Baush and Lomb Hansatome XP) or a femtosecond laser (the Intralase FS60) is used to create a standard size hinged flap of surface corneal tissue. The tissues beneath are then reshaped using a computer-controlled excimer laser before the protective flap is replaced. In essence, the cornea is reshaped without surface damage.







Why is a Corneal Flap used in LASIK?

Scarring responses throughout the body are driven by damage to surface tissues. Many plastic surgical procedures are based on the idea that if undamaged skin can be replaced or grafted

onto a wound, scarring and tissue contraction will be minimized. LASIK is also based on this principle, using a thin protective corneal flap to avoid surface tissue damage and subsequent scarring responses. This provides a rapid, virtually painless recovery and fast stabilisation of the visual result.

Intralase LASIK –
Continued efforts at increasing safety in LASIK have led to the development the Intralase FS60 femtosecond laser. Concentrating laser energy within a very short pulse duration (a femtosecond is 1/100,000th of a second) allows the creation of a microscopic gas bubble in the target tissues. A rapid train of closely spaced femtosecond laser pulses is scanned through the cornea in by the Intralase laser, separating the target tissues by joining a 3D pattern of microscopic gas bubbles together to create a LASIK flap quickly, painlessly and accurately. Contemporary automated cutting instruments (microkeratomes such as the Hansatome XP) also work well and are still widely used; but the newer generation, faster pulsed FS60 Intralase laser matches these alternative methods for speed and lack of thermal tissue damage, and helps to avoid some complications that can occasionally occur with microkeratomes. Flap complications can still occur in intralase LASIK, but they can usually be treated without detriment to the visual result. More information about the Intralase approach can be found at www.intralase.com

Wavefront surface treatment
Reshaping beneath the corneal surface rather than removing the corneal skin layer and reshaping the surface directly (as in the longer established excimer laser technique - photorefractive keratectomy or PRK) has several advantages. LASIK is less painful than PRK, visual recovery is quicker, and the new corneal surface shape stabilises faster. The downside for LASIK is that flap creation is an additional surgical step, and this introduces a new set of complications. These are minimised with approaches such as Intralase LASIK, and contemporary methods allow thinner corneal flaps to be created safely, expanding the range of patients that can be treated with LASIK. Nonetheless, patients are quite commonly found to have a relatively thin cornea at their initial consultation. For these patients surface laser treatments such as PRK, or newer variations such as EpiLASIK and LASEK, are often the safest option.

In EpiLASIK, an automated surgical device similar to a LASIK microkeratome is used to remove the skin layer (epithelium) quickly and painlessly from the central corneal surface prior to wavefront guided excimer laser reshaping. In LASEK this is achieved by applying an alcohol solution that helps to remove the epithelium. An anti-scarring drug, mitomycin C, is then applied to the corneal surface to reduce haze (loss of corneal clarity) and regression (corneal shape changes during healing which can dilute the effect of treatment). A bandage contact lens is then applied to protect the operated area for a few days whilst the skin layer heals. Eye drops are used to minimise discomfort, but approximately 5-7 days in which the eyes are relatively sore, light sensitive and watery is normal. Vision returns over the next few weeks whilst the new skin layer remodels. Although the recovery is slower after EpiLASIK than after LASIK, final visual results are normally equally good.

Risks and Benefits

- Over 97% of wavefront LASIK patients in the range treated at Moorfields Eye Hospital are able to see the driving standard or better without glasses after one treatment. Results for surface treatments (eg EpiLASIK, LASEK or PRK) are similar.

- Enhancement treatment (retreatment) is highly effective in correcting significant residual refractive errors (>1.00D). Retreatment is carried out in approximately 5% of cases. There is no additional charge for retreatments carried out within a year of primary treatment (the need for any retreatment can normally be determined within 6 months of surgery).

- Common side effects such as mild dryness or light scatter during night driving normally resolve within 6 to 9 months of treatment.

- Realistic expectations are important. Laser refractive surgery is highly effective in reducing spectacle dependence. At minimum, you should expect to be able to play sport and socialise comfortably without glasses after treatment; but some patients may still prefer to wear thin glasses for selected distance vision tasks.

- Wavefront laser refractive surgery of any type does not routinely deliver above normal vision. Most patients have low-level residual refractive errors after surgery. These refractive errors are at a similar level to those normally found in non-spectacle wearers, and do not usually require retreatment.

- Progressive increasing reliance on reading glasses for near vision is normal from around age 45 for anyone with good uncorrected distance vision. This is not altered by laser refractive surgery.

- Vision should otherwise remain stable and good permanently after treatment. Your risk for developing other eye problems should not be altered. Natural variations in the distance spectacle prescription can occur at any age. These are usually small, but can be large enough to warrant further treatment in a small percentage of patients (less than 2% in the first 5 years after treatment).

- The overall complication rate for LASIK is about 5% (figures for EpiLASIK and LASEK are similar). Most problems are minor, and almost all complications can be corrected safely without affecting the final visual result. Additional consultations and treatments may be required. There is no charge for any additional treatment required for the correction of complications.

- Less than 1 in 1000 patients are left with significant scarring or corneal irregularity requiring a corneal graft or hard contact lens wear for visual rehabilitation. This level of risk is similar to the cumulative risk of corneal scarring resulting from infection in 5-10 years of contact lens wear.

- Most complications occur within 1 month of LASIK or EpiLASIK. The risk of long-term loss of corneal shape stability (keratectasia) after LASIK has recently been estimated at less than 1/1000 in a systematic review of the medical literature commissioned by NICE (the national institute of clinical excellence). Current patient selection strategies further reduce this risk. The risk for keratectasia after EpiLASIK and LASEK is negligible. Medium term studies show significant benefits for using the anti-scarring drug MMC in selected patients undergoing EpiLASIK or LASEK, but MMC is associated with a low, but as yet unquantified, risk of long-term corneal damage. MMC is not used in LASIK

- The benefits of refractive surgery are primarily functional. It is not a cosmetic procedure. Freedom from glasses and contact lenses will enable you to enjoy sport and physical exercise, and to pursue a healthy active lifestyle. Refractive surgery is provided free to military personnel in the USA. 1 in 3 refractive surgeons who were previous spectacle wearers has already had refractive surgery performed on themselves. The commonest procedure chosen was LASIK.

Suitability for treatment with Wavefront LASIK, LASEK or Epi-LASIK

Refractive errors typically do not stabilise until the late teens or early twenties. To be suitable for refractive surgery of any sort, you should be over 21 years of age with minimal changes in your spectacle or contact lens prescription over the previous 2 years. The first step towards refractive surgery is obtaining an up to date spectacle prescription and records of any previous prescriptions over the last 2 years from your optician.

Laser refractive surgery is safest and most accurate in treating a defined range of refractive errors:

Myopia (-1.00 to -10.00D)
Astigmatism (up to ±6.00D)
Hypermetropia (+1.00 to +6.00D, rarely higher than this)

For refractive errors outside this range, and for many patients over 60, the most appropriate refractive surgical procedures are based on implanting a new artificial lens – refractive lens exchange (RLE), an operation identical to modern cataract surgery, or intraocular collamer lens (ICL) implantation.

Laser refractive surgery may not be suitable if you have:

- Only one good eye

If you have a common condition called amblyopia (a lazy eye), or for any other reason you have one eye in which the vision cannot be improved to a normal level with either glasses or contact lenses, any risk to the vision in your good eye is harder to justify. This issue requires particularly careful consideration if you are reliant upon good vision in one eye only for work or driving.

- Ocular surface disease

If you have dry eyes, active blepharitis, or allergic eye disease requiring regular drug treatment, corneal healing after laser refractive surgery may be adversely affected.

- Corneal disease or abnormality

You will be carefully screened to ensure that you do not have a condition called keratoconus prior to laser treatment. Mild forms of this corneal shape abnormality are relatively common, and can predispose to a poor result from laser refractive surgery.

- Glaucoma

Altering the shape of the cornea can affect the accuracy of intraocular pressure measurements and therefore the treatment of glaucoma. But corrections to pressure measurement after laser refractive surgery can be applied where necessary.

- Cataracts

Cataract extraction presents an opportunity for refractive correction without laser surgery. An artificial lens is normally implanted in the eye during cataract surgery. The power of this lens can be chosen to correct any pre-existing refractive error. Patients over 50 years old commonly have early stage cataracts.

- Aspects of general health which might affect corneal healing

These include pregnancy, diabetes mellitus, autoimmune diseases, keloid scarring, and diseases requiring steroid medication by mouth. Small changes in your spectacle prescription may occur whilst you are pregnant or breast feeding. For mothers with new babies, refractive surgery is normally postponed until 1 month has elapsed from the end of breast feeding.

Planning treatment

Having scheduled your appointment for surgery (this can be done with Leigh Reeves (020 7566 2414) you will be given comprehensive instructions on preparation and aftercare appropriate to your procedure choice.

Time off work

Treatments are normally performed on a Wednesday morning (or Thursday afternoon) with initial postoperative review the following day or the following Monday morning. Office based work is usually no problem from the day after LASIK. For outdoor occupations, professional drivers and patients having Epi-LASIK or LASEK, work can normally be resumed by the Monday following treatment in most cases. There is nonetheless significant haze at this stage that settles over the following weeks.

Postoperative consultation schedule
Patients are normally reviewed a minimum of 3x after LASIK (the first post-op visit, one month later and finally at six months) and 3x after Epi-LASIK (at 5-6 days, three months and finally 6 months after treatment) with additional review appointments as required during the year after surgery. Liaison with a referring ophthalmologist is usually possible for overseas patients.

Monovision – an option normally considered for patients over 40
Electing to leave one eye relatively myopic (typically a -0.75D to -1.50D undercorrection) to assist near vision (monovision) is the strategy of maximum spectacle independence for patients in the reading glasses age group (43 years and over). Glasses will still often be required to read fine print comfortably but monovision may delay the onset of spectacle dependence for reading until the mid fifties or later. Even then, spectacle dependence is decreased for common near vision tasks such as computer work, reading a menu or a price label. Monovision does not work for everyone, and may increase spectacle dependence for some distance vision tasks (typically night driving), but the compromise for distance vision is relatively small. If you are in the reading glasses (presbyopic) age group, the pros and cons of monovision will be discussed with you by Mr Ionides at your refractive surgical consultation.

The day of surgery
The surgery itself is relatively brief (under 30 minutes is required to treat both eyes), but some waiting time prior to surgery is usual, and further time is required for aftercare instruction and postoperative checks. Most patients spend 2-3 hours in hospital.

The surgery itself is not painful. You will feel touching around the eye, cold fluid on the eye surface, and pressure on the eye at various stages during the surgery, but anaesthetic drops administered prior to surgery are highly effective in minimizing any discomfort.

What if I blink?
Adhesive drapes are used to tape the lashes out of the way and a gentle eyelid retainer is used to keep the lids open. Blinking is no problem. At the appropriate times, Mr Ionides will encourage you to look up at a flashing red/orange fixation light – as if you are staring at a star on the horizon. The eye we are not operating on will be covered. You simply look up at the fixation light with both eyes open.

What if I move?
You can help the surgery to proceed quickly and accurately by gazing directly up at the flashing fixation light throughout the procedure, but involuntary eye movement is no problem. The S4IR CustomVue system incorporates a sophisticated eye tracking mechanism that follows eye movements during treatment. Any movement outside the safe range will cause the laser to stop automatically. Mr Ionides will be looking at your eyes through an operating microscope throughout, and can override the laser's automatic cut out to stop and start the treatment as often as necessary.

Mr Ionides will talk you through the procedure and most patients comment that it is surprisingly easy. After the surgery, it is like looking through fogged up glasses. You are able to see enough to walk around without assistance, but the vision is not clear. Relatively clear vision normally returns within a few hours of LASIK treatment (you can typically see at the driving standard by the next day). Blurred vision is normal for up to 2 weeks after surface laser treatments (EpiLASIK and LASEK).