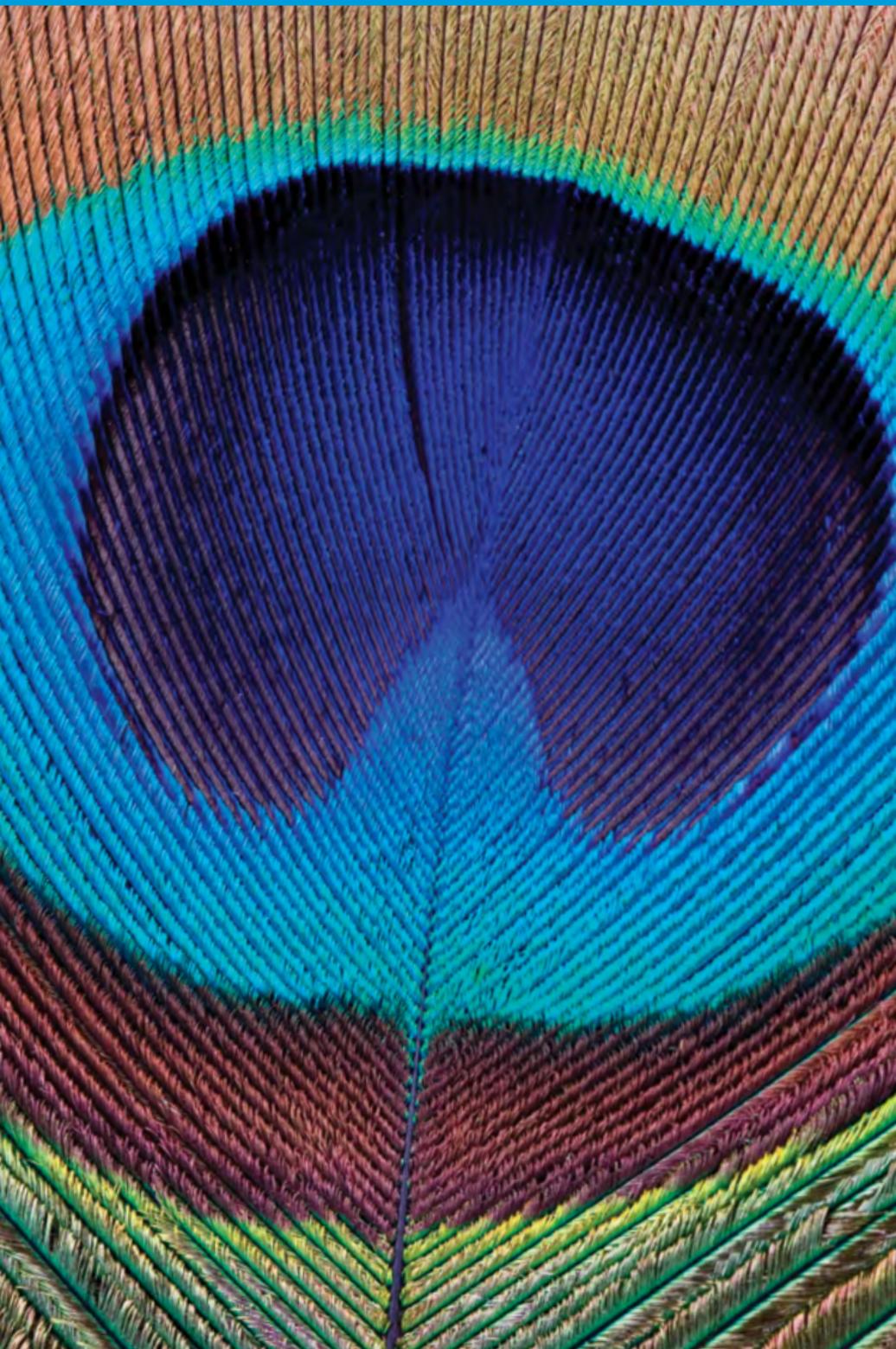


Refractive Surgery



Moorfields
Eye Hospital Centre

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How images are formed in the eye

Rays of light enter the eye (Figure 1) through its front surface, which is called the cornea (A), go through the hole in the iris, which is called the pupil (B), and travel through the crystalline lens (C). The cornea and lens are responsible for focusing the rays onto the retina (D), the light sensitive layer at the back of the eye. The retina converts light rays into impulses and these are sent to the brain via the optic nerve. At the brain level the impulses are recognized as images. Around 2/3 of the eye's focusing power comes from the cornea and 1/3 from the lens.

Refractive errors

Myopia (nearsightedness):

In an eye with Myopia the corneal focusing power is too strong for the eye's overall length. Images fall in front of the retina rather than being focused onto it and the vision is blurred (M).

Hypermetropia / Hyperopia (farsightedness):

In an eye with hypermetropia, the corneal focusing power is too weak for the eye's overall length. Images fall behind the retina rather than being focused onto it and the vision can be blurred (H).

Astigmatism:

Astigmatism occurs when the cornea is more curved in one direction (a meridian) compared to another. In these cases the cornea is shaped more like a rugby ball rather than a football. If astigmatism is significant, images reaching the retina are stretched and distorted and the vision is blurred.

High order aberrations (HoA):

Sometimes the visual problems are more complex than the ones described above. This typically occurs when the corneal surface is irregular. The most frequent high order aberrations are Spherical Aberration and Coma, but there are many more of them. HoA can be the result of previously complicated surgery, trauma or different eye conditions. In eyes with HoA the quality of the vision is typically poor even if glasses or soft contact lenses are worn and the only valuable option may be either wearing a **hard or a gas permeable contact lens**, or undergoing **laser refractive surgery**.

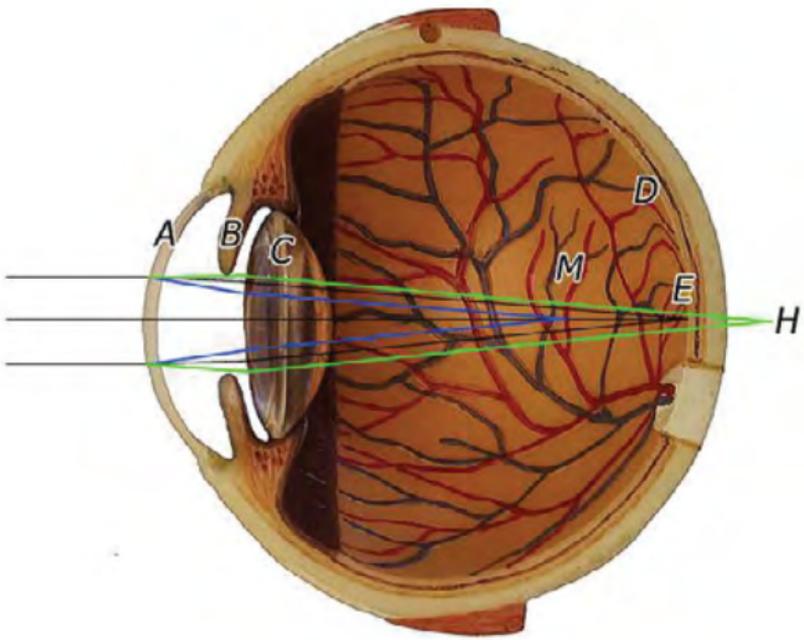


Figure 1: Eye model showing the cornea (A), the iris and the pupil (B), the crystalline lens (C), the retina (D). The most common refractive errors such as myopia (M) and hypermetropia (H) are shown compared to the normal (emmetropic) eye (E) where the images form exactly on the retina.

Refractive surgery

Most refractive errors can be corrected (or at least improved) by means of Refractive Surgery. This is a generic term, which comprises both **Laser Refractive Surgery** and correction by means of **lens implants** inside the eye. The latter is called **Phakic intraocular lens (IOL) surgery**.

Am I a good candidate for Refractive Surgery?

Not everyone is suitable for Refractive Surgery and your Corneal Specialist will advise you whether you are or not. We have strict inclusion criteria to minimize complications and to ensure a long lasting result. Minimum age normally is 21, you should not be pregnant or nursing, and should be free of any corneal

disease. The glasses or contact lens prescription should be stable for at least one year. You must be willing to accept the potential risks, complications and side effects possibly associated with each procedure (see page 21).

Laser refractive surgery

General principles of laser refractive surgery:

Laser refractive surgery involves using an **Excimer laser** (specialist ophthalmic laser) to reshape the cornea and permanently modify its refractive power (making it either weaker or stronger). In Moorfields Dubai we use the **Amaris 750S** excimer laser (Figure 2), which delivers up to 750 extremely fine laser beams in a second, making it the fastest laser currently on the market. The laser beams are targeted in a very precise way via a 6-D tracker which scans and follows the eye movements 1060 times each second.

To treat **myopia**, the surgeon uses the laser to remove a circle of central corneal tissue, thereby flattening the cornea and weakening the focusing power of the eye. The tissue is removed in a sophisticated way programmed into the computer by the surgeon. When **myopia is very high or when the cornea is too thin**, laser may not be safe anymore, as this would require too much tissue to be removed and the cornea could potentially become weak (there would be a risk of developing **keratoconus**). In these cases Phakic IOL surgery may be a possible alternative, provided that your eyes are suitable.

To treat **hypermetropia**, the surgeon uses the laser to remove a toroid (a doughnut shape) of peripheral corneal tissue, thereby steepening the central cornea to increase the focusing power of the eye.

To treat **astigmatism**, the laser removes tissue in an elliptical pattern, selectively reshaping only some areas of the cornea in order to form a smooth and symmetrical surface (imagine transforming a rugby ball into a round basketball).

To treat **High Order Aberrations**, a sophisticated **Corneal or Ocular Wavefront Treatment** is needed. This is a customized treatment based on your specific Corneal or Ocular Wavefront aberrations. Phakic IOLs cannot be used to correct HoA.

Types of Laser refractive surgery:

Laser refractive surgery can be divided into two broad categories: **LASIK and SURFACE ABLATIONS**. In **LASIK** a flap is lifted and the

main laser reshaping is carried out under the flap whereas in **SURFACE ABLATIONS** the reshaping is done directly on the corneal surface.

LASIK



Figure 3: *LASIK flap.*

In LASIK **the vision recovers quickly**, and typically you should be able to resume your work and drive within 1-2 days.

In LASIK there is a **mild discomfort** lasting only for a few hours after surgery.

Typically patients need to come back for follow up **1 day** after surgery and then after **3 months**.

Surface ablations

In SURFACE ABLATIONS, the epithelium (the outermost layer of the cornea which regenerates spontaneously every few days) is removed using different techniques (**PRK, LASEK, Epi-LASIK, Trans-PRK**). This is like creating a scratch on the eye surface, but in a controlled manner. Then the laser excimer (exactly the same laser used for LASIK) reshapes the stroma, the underlying layer. A zero-power bandage contact lens is applied to protect the eye while the epithelium heals, which occurs in 4-6 days. Surface ablations are more uncomfortable initially than LASIK, but are ideal in **patients with thin corneas** and in those ones whose occupation or hobbies make it more dangerous to have a flap, as this could be dislodged accidentally (**this applies to army personnel, professional fighters, extreme sportsmen**).

The only aspect in which surface ablations differ from each other is the way in which the epithelium is removed. In **PRK** (PhotoRefractive Keratectomy) the epithelium is removed mechanically by the surgeon using a blunt instrument. In **LASEK** (LAsEr Sub-Epithelial Keratectomy) it is removed mechanically by the surgeon using a diluted alcohol solution and a blunt instrument (the alcohol makes it easier and less traumatic to remove the epithelium compared to PRK). In **Epi-LASIK** the epithelium is removed using a machine with a blunt blade while in **TRANS-PRK** instead the epithelium is entirely removed by the laser and the eye is hardly touched by the surgeon. This is the latest procedure but it is not suitable for all refractive errors.

Your surgeon will advise you whether you are suitable or not.

In SURFACE ABLATIONS the **vision recovers slowly**, not allowing you to resume your work for at least **5-7 days**. Typically the vision won't be good enough to drive for around **1 week** after surgery. The vision will not be very sharp for around 1 month after surgery, but most often it will be reasonably good already after a couple of weeks. In some patients the vision may take longer to improve.

In SURFACE ABLATIONS the eyes are **uncomfortable or painful** and **very sensitive to light** for around 3-5 days.

Typically patients need to come back for follow up visits after **4-6 days** from surgery and then after **1 and 3 months**.

What is best in general, LASIK or SURFACE ABLATION?

In terms of recovery of vision, LASIK and SURFACE ABLATIONS are **equally effective after the first month** (during the first month LASIK recovery is faster). The vision can be very good already after a couple of days with LASIK but it will take at least 1 week before you can drive again following a Surface Ablation. In both cases however, **full visual recovery requires a period of 3 months or longer**, as little changes in the quality of vision can still occur.

In summary:

LASIK

Flap, quick healing, little discomfort.

- **Femtosecond LASIK** (flap made with IntraLase laser; safe and accurate).
- **LASIK** (flap created with a blade; more dangerous; at MEHD we have stopped performing this many years ago).

SURFACE ABLATIONS

No-flap, longer healing, more discomfort, ideal in thin corneas.

- **PRK**
- **LASEK**
- **Epi-LASIK**
- **Trans PRK**

Will I ever need to do it again?

Sometimes an enhancement (extra treatment) is needed if your vision is not fully corrected after the first 3-4 months or if it deteriorates later. The second situation is called **regression** and it can happen either months or years after the original procedure. In case of LASIK, **enhancements** can be done by simply lifting the original flap, whereas in Surface Ablations the original procedure needs to be repeated again and recovery is equally slow as after the first surgery. Sometimes eyes which underwent LASIK many months before may need to have new flaps created rather than the old ones lifted and occasionally it may be better to perform a Surface Ablation on top of an old LASIK flap, rather than lifting this up.

What are the risks, complications and side effects?

As with any operation, complications with LASIK and Surface Ablations are possible, but fortunately they are quite rare. Undercorrection or overcorrection or development of astigmatism can occur but can generally be improved with glasses, contact lenses, or by additional laser surgery. Most complications can be treated without losing any vision and permanent vision loss is very rare. It can happen that your vision will not be as good after surgery as before, even with glasses or contact lenses.

Almost everyone experiences some dryness and fluctuating vision during the day. For most people these symptoms fade within one month, although some people may continue to have symptoms for a longer period of time. Other side effects may include red patches on the sclera (the white part of the eye) for a few weeks after LASIK, discomfort, blurry vision, dryness, scratchiness, glare, halos or starbursts around lights and light sensitivity. Most of these side effects disappear over time, but in rare situations they may be permanent. Infections are possible but they normally clear well with antibiotics. Rarely in LASIK there could be complications occurring to the flap requiring further surgery. In Surface Ablations, rarely a corneal haze (scarring) may develop in the center of the cornea and require further surgery. Even after refractive surgery, certain people may still need to wear glasses or contact lenses. Surgery, contact lenses and glasses each have their benefits and drawbacks.

Neither LASIK nor Surface Ablation correct presbyopia, the age related loss of the close-up focusing power due to stiffness of the crystalline lens. **With or without refractive surgery, almost everyone who has excellent distance vision will need reading glasses by the time they reach their early forties.**

PHAKIC INTRAOCULAR LENS (IOL) SURGERY

Phakic IOLs are designed for people with high degrees of myopia that cannot be safely corrected by means of laser refractive surgery. Phakic IOLs are often referred to as “implantable contact lenses” and are implanted inside the eye in front of the crystalline lens (this is left in order to maintain the ability to focus). Phakic IOLs can be placed either in front or behind the iris. The lenses placed behind the iris are called **Visian ICLs** and the ones placed in front of the iris (clipped to it) are called **Artisan or Artiflex** iris-claw lenses. Extensive tests and a lengthy consultation with your Corneal Specialist are needed to evaluate if you are suitable for this procedure or not, as there could be a risk of long-term corneal damage or glaucoma. **Please be prepared to stay in the Hospital for a few hours or to have to come back on another occasion to complete the assessment.**

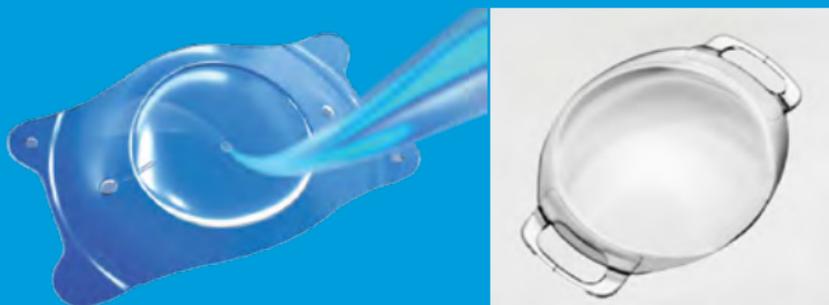


Figure 4: *Visian CentraFlow ICL (STAAR) and Artiflex iris clip IOL (OPHTEC).*

PRESBYOPIA

Experiencing difficulties while reading close up or while looking at the computer screen after the age of around 40 is called Presbyopia and this is a completely natural (and unavoidable!) phenomenon. This happens because the eye gradually loses its ability to focus for near as the crystalline lens becomes stiffer. This process starts at around the age of 40 and is normally completed by the age of 65.

Surgical options for Presbyopia:

Currently there is no perfect solution to treat presbyopia and all surgical options require a certain degree of compromise, all having their benefits as well as their drawbacks. One option is **Monovision**, in which the dominant eye is corrected for distance, while the non-dominant one is corrected for near. This is typically accomplished by means of laser refractive surgery, applying a different correction in the two eyes. A more modern procedure to correct presbyopia involves the implantation of a small disc with a central hole in it in the non-dominant eye. This procedure is called **Acufocus Kamra Inlay**. The corneal pocket which is needed to implant the disc is created with the femtosecond laser (the same laser used for the LASIK flap).

This procedure has the advantage of being completely reversible and if you are not happy with the result, the disc can be removed.

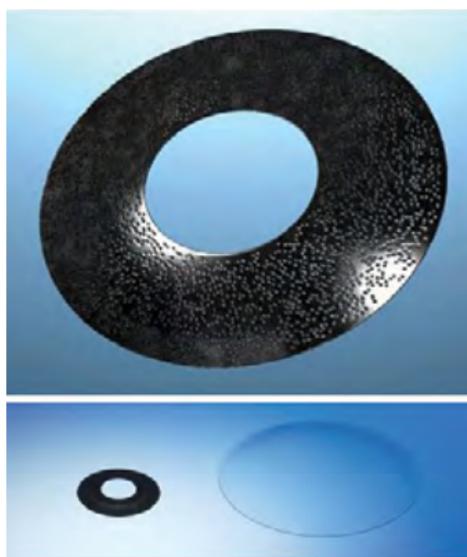


Figure 5: *Acufocus Kamra inlay*

On the other hand, if you are **well beyond your 40s** or if your crystalline lenses are already showing some signs of **cataract**, then a better option may be performing **Cataract Surgery** or **Clear Lens Extraction** and implanting a **Multifocal IOL** (intraocular lens- Figure 6) inside the eye(s). These are **premium lenses**, which give simultaneous distance and near vision in both eyes. Not all patients are suitable for multifocal IOLs as sometimes they may cause excessive night glare or halos and may need to be removed. Pilots and professional night drivers are for example not good candidates for multifocal IOLs. A comprehensive discussion with your ophthalmologist is needed to see if you could be a good candidate.



Figure 6: *Oculentis Mplus multifocal IOL*

Which method is best for me?

There is no single best method for correcting refractive errors. After detailed measurements of your eyes and a discussion of your requirements, your Corneal Specialist can guide you towards the best procedure for you.

Are you a good candidate for Refractive Surgery?

Refractive surgery may be a good option for you provided the following:

- You wish to decrease your dependence on glasses or contact lenses.
- You qualify for the procedure following the initial assessment.
- You accept the risks and potential side effects of the procedure.

You would not be a good candidate for refractive surgery if you are completely satisfied with glasses or contact lenses and are unwilling to accept any uncertainty in the outcome of refractive procedure.

Important facts:

Over 95 % of people who have had refractive surgery can pass a driver's license test requiring a visual acuity of 6/12 or better without glasses or contacts. Surgical enhancement may be needed to achieve the desired result.

You may still need glasses or contact lenses to achieve your best vision even after refractive surgery. Fitting contact lenses may be difficult or impossible because of corneal changes following refractive surgery. Reading glasses may still be necessary for middle-aged and older adults. Refractive surgery does not alter the aging process of the eye and does not prevent presbyopia.

If you have **specific occupational requirements**, check with your employer about regulations concerning refractive surgery and discuss them with your Corneal Specialist.

Important!

Getting ready for the initial consultation:

- **Stop wearing contact lenses** before the appointment:
 - a. 1 week for soft contact lenses.
 - b. 2-3 weeks for hard or gas permeable contact lenses.
 - c. The doctor will be unable to advise and you will be asked to come back if you don't do so.
- **Do not apply any make up on the eyes** as this interferes with the corneal scans and may hide important pathologies.
- **If your myopia is continuously getting worse** you are not suitable for refractive surgery. Still, it is worth coming for a consultation to check that the eyes are healthy.
- **If your near vision is continuously getting worse** refractive surgery may instead be an option.

How to reach us

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