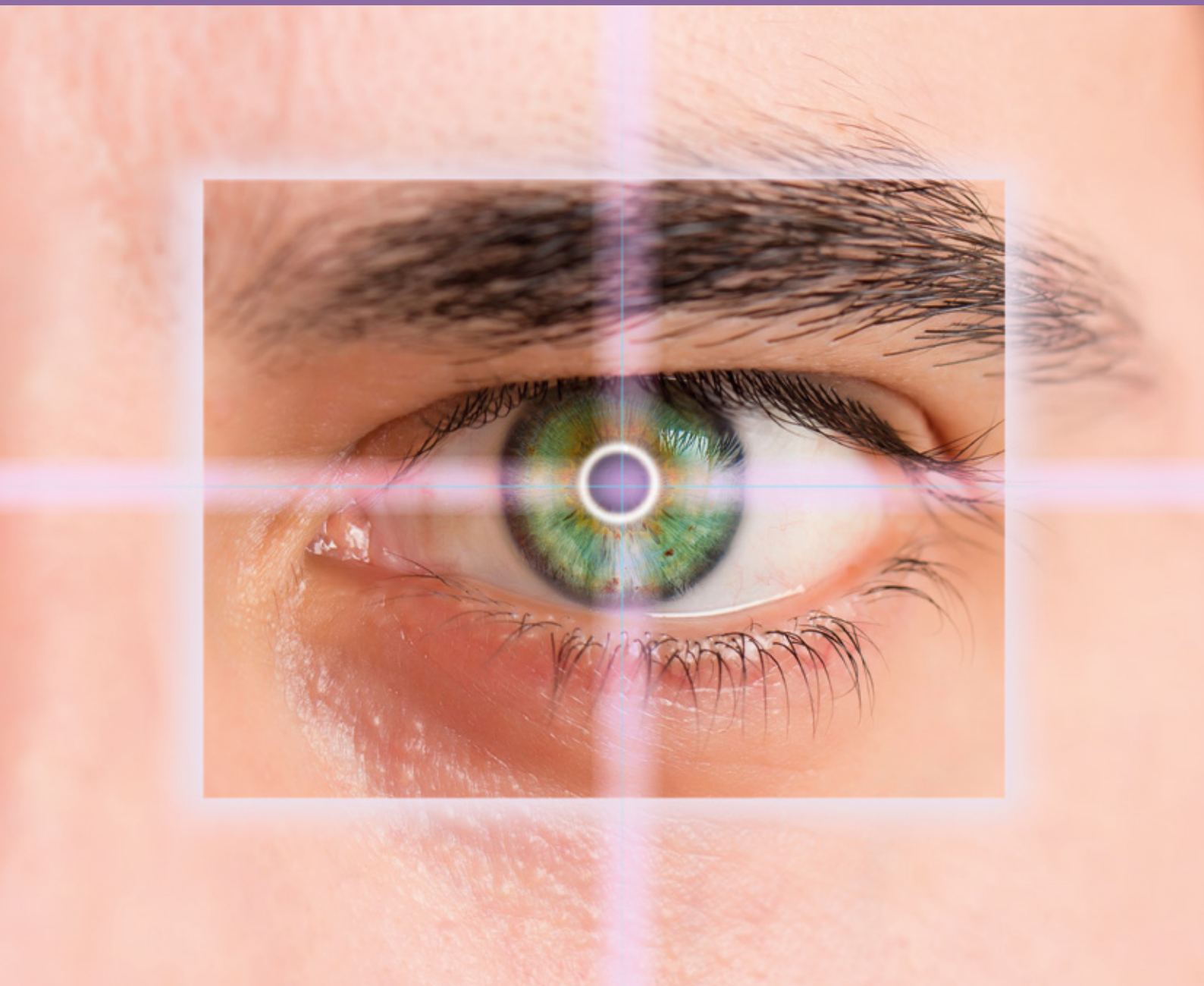
The ROYAL COLLEGE of OPHTHALMOLOGISTS

Patient Information

Laser Vision Correction



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Contents

What is Laser Vision Correction?

Modern surgical lasers are able to alter the curvature and focusing power of the front surface of the eye (the cornea) very accurately to correct short sight (myopia), long sight (hyperopia), and astigmatism.

Three types of procedure are commonly used in the UK: *LASIK*, surface laser treatments (*PRK, LASEK, TransPRK*) and *SMILE*. Risks and benefits are similar, and all these procedures normally produce very good results in the right patients. Differences between these laser vision correction procedures are explained below.

If you are suitable for laser vision correction, your surgeon will discuss which type of procedure is the best option for you.

What are the benefits?

For most patients, vision after laser correction is similar to vision in contact lenses before surgery, without the potential discomfort and limitations on activity.

Glasses may still be required for some activities after treatment, particularly for reading in older patients.

Over 95% of patients are satisfied with the outcome of surgery, and many describe it as life changing

Although laser vision correction is often bracketed with cosmetic surgery procedures, the benefits are mainly functional. It is designed to make you less dependent on glasses and contact lenses, helping you to lead an active lifestyle more easily.

Short sight and astigmatism normally stabilize in the late teens or early 20s, but natural prescription changes can occur at any stage in life. So laser vision correction sometimes needs to be repeated.

Who is suitable for laser vision correction?

You must be over 18 years of age and have a stable glasses prescription. This is normally defined as no change greater than 0.5 units (0.5D) in the last two years.

You are most likely to be suitable for laser vision correction if your glasses prescription, which can be provided to you by your optician/optometrist, is in the range:

- Up to -10.00D of myopia or short sight
- Up to +4.00D of hyperopia or long sight
- Up to ±6.00D of astigmatism

Laser vision correction can be effective for higher prescriptions in some patients. Conversely, some patients with lower prescriptions may be better suited to lens implantation techniques.

Your surgeon will advise on your best treatment options after reviewing your test measurements and your eye health

Myopia (short-sight) and astigmatism normally cause poor distance vision from the teenage years on. But hyperopia (long-sight) typically affects people more as they get into their thirties and above. Younger patients with hyperopia often have no problems seeing well. This is because flexibility of the eye's natural lens allows them to compensate. As the natural lens stiffens with age, hyperopic patients first find themselves more dependent on reading glasses than people with normal sight, and then find that they need glasses for the distance too.

Age related loss of reading vision can often be helped with laser vision correction. From the mid-40s on, surgeons often aim for good distance vision in one eye, and good vision at arms' length in the other. With both eyes open, *binocular* visual input combines to extend the range of focus. Near vision is at least partly restored with relatively little compromise optically. Variations on this approach, marketed under a variety of brand names, are often used to improve the near range in older patients undergoing laser vision correction.

You may not be suitable for laser vision correction if you have other problems with your eyes including cataracts, or problems with eye surface health

Many contact lens wearers are incorrectly diagnosed as having dry eyes and are told that they are therefore unsuitable for laser vision correction. Eye surface discomfort is sometimes experienced by contact lens wearers and is often treatable. Laser vision correction can be a good solution for patients who are having difficulties with contact lens wear.

What are the alternatives?

Vision correction surgery alternatives
Lens implantation techniques that have evolved from modern cataract surgery may be more suitable for some patients.

There are two main categories of vision correction based on lens implantation: refractive lens exchange (RLE) and phakic intraocular lenses (PIOLs).

RLE is identical to modern cataract surgery, but is performed with the main aim of increasing freedom from glasses. RLE is often preferred to laser vision correction for patients in the retirement age group in which the early stages of cataract are common. In RLE, the natural lens is replaced with a lens implant. A variety of different implants are used including multifocal lenses designed to reduce reliance on glasses for near, intermediate and distance vision.

In younger patients, artificial lenses called phakic intraocular lenses (PIOLs) are often a good alternative where the spectacle prescription is outside the normal range for laser vision correction

PIOLs are implanted in front of the natural lens without replacing it.

Alternative laser procedures
The main difference between laser vision correction procedures is speed of recovery. Patients undergoing *LASIK* are often able to return to work the day after surgery. Visual recovery after SMILE may be slower, and patients undergoing surface laser treatments (*PRK, LASEK, TransPRK*) may need a week or longer before they are at the driving standard. Although visual recovery can be slower after surface laser treatments or *SMILE*, patients can return to contact sports sooner, whereas *LASIK* patients need to wait for a minimum of one month. Also, the recovery of eye surface comfort may be slightly faster after SMILE. But differences between techniques are small and mild eye surface discomfort in early period after all forms of laser vision correction is normal. Visual results at three months are equally good for all types of laser vision correction.

Continuing in glasses or contact lenses
Laser vision correction is elective. This means you can choose to proceed with it at any time, or not at all. The alternative is staying in glasses or contact lenses.

Glasses are risk free but may limit the range of activities you can do confidently and comfortably – particularly sport and exercise.

Contact lenses provide good all-round vision. They do not mist over during sport and will help you to be more active; but they can be inconvenient when travelling, make water sports more difficult, and should not be worn whilst showering, swimming or during sleep. Contact lens wear is sometimes associated with eye surface discomfort, and may be complicated by sight threatening infection.

Risks and benefits of laser vision correction should be balanced against those for contact lens wear since this is the main alternative for active people considering vision correction surgery

How is Laser Vision Correction performed?

All laser vision correction procedures are performed using eye-drop anaesthetic, and a spring clip to allow you to blink safely during surgery. You will be lying down throughout. It is usual to operate on both eyes, and the surgery typically takes about half an hour. You can return home on the same day as surgery.

LASIK

LASIK (laser in situ keratomileusis) is typically performed using 2 lasers: one (femtosecond laser) to prepare a thin protective layer (the LASIK flap), which is lifted up before a second (excimer laser) removes a lens shaped piece of tissue to reshape the cornea beneath. The protective layer is then smoothed back and sticks in place and without stitches.

SMILE

SMILE (Small Incision Lenticule Extraction) uses a femtosecond laser of the same type used to create a LASIK flap to define a lens shaped piece of tissue that is removed by the surgeon through a small incision to correct focus. This is like LASIK without the LASIK flap, but the thickness of tissue removal is slightly greater and the tissue may be removed from slightly deeper in the cornea. End results are similar to those for LASIK and surface laser treatments.

Surface laser treatments

Surface laser treatments (*PRK, LASEK, and TransPRK*) use the same excimer lasers to perform an identical removal of a lens shaped piece of tissue immediately beneath the clear skin layer of the cornea. The clear skin layer regrows over a period of about a week, then smooths off optically to complete the visual recovery over the next three months. While the skin layer is regrowing, the eye surface is normally very sore. This is one of the main differences between surface laser treatments and *LASIK* or *SMILE*, which both aim to keep the corneal skin layer intact. All surface laser treatments produce similar results, and the only difference between them is the way in which the corneal skin layer is removed. In PRK and LASEK the skin layer is removed by the surgeon – in LASEK dilute alcohol is applied to loosen the skin layer first. Some modern excimer laser systems are able to remove the skin layer as part of the reshaping treatment. This is called TransPRK. The area of skin layer removal in TransPRK is reduced to the minimum required for reshaping the cornea beneath, shortening recovery time by 1 to 2 days in comparison with PRK and LASEK.

What are the risks?

In all forms of eye surgery, problems can occur during the operation or afterwards in the healing period. Problems can result in permanent, serious *loss of vision* (vision worse than the driving standard in the affected eye that cannot be corrected with glasses or contact lenses).

More commonly, problems can be corrected with changes in medication or additional surgery. Typically, these additional operations feel like the original surgery and have a similar recovery period.

Loss of vision
Permanent serious loss of vision is rare after laser vision correction. In the worst likely scenario, a form of corneal transplantation may be required to replace a damaged block of tissue in the cornea. Problems that can lead to the need for transplantation include scarring after infection or an abnormal healing response, and an unstable corneal shape – also called corneal ectasia. These problems occur infrequently, and can often be corrected without transplant surgery. Less than 1 in 5000 patients require a corneal transplant to restore vision after laser surgery, and good vision can normally be restored when transplantation is necessary although glasses or contact lenses may be required.

Additional surgery
Much more commonly, a second operation is needed to correct a problem occurring at the time of surgery or afterwards. This would normally be a procedure that feels similar to the original laser vision correction, with a similar recovery period. Some of these procedures need to be repeated. If you have a problem, your surgeon will explain what it is and why further surgery is required. Up to 1 in 10 patients require some form of additional surgery in order to get the best result.

Risks of contact lens wear
Continuing in contact lenses is often the main alternative for people considering sight correction surgery. If you follow the right safety advice, contact lens wear is low risk; but approximately 1 in 3000 wearers each year will develop a serious corneal infection.

To minimise this risk, you should not swim or shower in contact lenses, and should not wash them in tap water. Sleeping in contact lenses, including those designed for overnight wear, increases the risk of infection significantly. Soft, daily disposable lenses are safer than non-disposable lenses.

What are the side effects?

Side effects are problems which most patients experience to some degree after surgery. They normally improve with time, but do not always resolve completely.

Vision
Most patients experience some light scatter side effects in the early period after laser vision correction, particularly those who have treatment for higher spectacle prescriptions. These can take a variety of forms including glare, halos, starbursts and ghost images. Increased flare from oncoming car headlights is a common symptom, and night driving may be difficult at first. With modern laser systems, visual side effects are usually mild and improve within a few months. Lasting problems are unusual, but may still occur.

Eye comfort
Other common side effects are intermittent blurring (variable vision) and eye surface discomfort (dry eye symptoms). Both are caused by reduced stability of the tear film between blinks. Tear film stability improves over a few months after treatment as the corneal surface heals. During the healing period, most patients are able to stay comfortable using tear supplements when required.

Eye comfort usually returns to normal within a few months of treatment and, for contact lens wearers in particular, may be better after laser vision correction than before.

For patients with a normal eye surface prior to surgery, lasting problems are unusual.

Eye Appearance
Red blotches are often visible on the white of the eye after any form of eye surgery, and are particularly common after LASIK. These are called subconjunctival haemorrhages, and are caused by a small leak of blood under the clear membrane (the conjunctiva) covering the white part of eye wall. Although they can be quite unsightly, red blotches are temporary, and do not affect eye health; but they can take up to 6 weeks to go away completely.

Will laser vision correction affect my future eye health care?

If you develop a new eye health problem in later life, laser vision correction should not prevent you having successful treatment.

Common eye health problems like diabetic retinopathy and age related macular degeneration are monitored and treated as normal after laser vision correction.

Laser vision correction can affect eye pressure measurements used to check for glaucoma, causing them to under-read, especially in patients who have had treatment for high myopia. Corrections to eye pressure measurement can be applied to help ensure that glaucoma is picked up at an early stage and treated effectively; but it is worth reminding your optometrist or doctor that you have had laser vision correction when they are checking for, or treating glaucoma. A record of your last prescription for glasses before laser vision correction may help them to make adjustments to your eye pressure readings more accurately.

Laser vision correction can reduce the accuracy of focus correction and vision after future cataract surgery. Any detrimental effect is small, and is reducing as more patients who have had previous laser vision correction are entering the cataract age group and modifications to lens implant selection calculations are becoming better understood. If you are having cataract surgery, remember to tell your surgeon that you have had laser vision correction. This helps to your surgeon to make the right modifications to lens implant selection.

How can I reduce the risk of problems?

You can eat and drink normally before surgery, and should take any regular medication as usual. You have to be awake for laser vision correction so that you can look up to a target light. This helps you keep your eye in the right position during treatment.

Stay as relaxed as you can during the surgery, and try to keep your head still after the surgeon has positioned it comfortably for you. Most people are anxious prior to surgery. Your surgeon will be used to this, and will talk you through the procedure, encouraging you at every stage. Keep your breathing calm and tell your surgeon if you need a break. An anti-anxiety, muscle-relaxing drug such as diazepam can be helpful, particularly if you have a tendency to squeeze your eyes shut when they are being touched. Discuss this with your surgeon before the day of surgery if you are worried.

Modern laser systems either hold the eye still with gentle suction or have accurate tracking systems that follow eye movements during surgery, and a spring clip is used to hold the eyelids apart. So you should not worry too much about moving or blinking during the procedure. But try to listen to instructions and keep your eyes on the fixation light when asked to do so.

It is important to keep the eyes well lubricated in the first few hours after treatment, particularly after LASIK. Stay awake, but rest with your eyes closed when you can, and use lubricant drops frequently.

You can wash and shower normally from day one after LASIK or SMILE, and once any bandage contact lenses used after surface laser treatment have been removed – typically on day 4 to day 7 after surgery.

Most surgeons recommend no swimming for a week and, after LASIK, no contact sports for a month. Non-contact sports such as gym and jogging can be resumed from day one after surgery.

Set yourself a reminder and use the antibiotic and anti-inflammatory drops as prescribed to help the eyes to heal well. It is good to leave at least two minutes between different types of eye drop so that they each absorb well before the next drop is applied. If you miss the first time or you are not sure, applying a second eye drop is no problem.

Some variability of vision and comfort is normal in the early weeks after surgery, and patience is required. But you should not be afraid to contact your surgeon if you have any concerns, or if you have an injury to the eye. You should contact your surgeon without delay if you have increasing pain, light sensitivity, redness, blur or an injury to the eye followed by pain, blur or watering.

You may not be aware of a problem that requires treatment in the healing phase. So make sure you attend your review appointments even if your eyes feel good.

How much does laser vision correction cost?

Surgery to correct the need for glasses or contact lenses is not available as an NHS procedure and is not covered by private health insurance schemes.

Your clinic should be clear from the outset about the total cost of the procedure. This normally includes follow up clinic visits and treatment for any problems resulting from surgery. Additional laser treatments to fine-tune the visual result are also normally included in this cost for up to two years after surgery. Although most prescription changes from three months after surgery are very small, it can take up to two years for the results of laser vision correction to stabilise fully. Most problems requiring further treatment would occur within this period.

Most clinics do not accept an open-ended liability and will charge for additional treatment relating to natural prescription changes occurring later than two years after laser vision correction. Treatment or tests for any unrelated eye health problems are also normally charged separately.

Refractive Surgery Glossary of Terms

Accommodation the reflex by which the eye brings a near object into focus by changing the shape of the natural lens. The *natural lens* gets less flexible with age, and powers of accommodation diminish. This affects reading vision and the ability to compensate for *hyperopia*.

Artisan/Verysise PIOL this is a type of *PIOL* that is clipped on to the *iris* during implantation. PIOLs are a commonly used alternative to *laser vision correction* for younger patients.

Astigmatism irregular defocus, or an eye that is 'more rugby ball shaped than football shaped.' The first number in your prescription for glasses describes the amount of long or short sight. The second number describes the amount of astigmatism. Most of us have at least some astigmatism, and a small amount can even help extend the range of activities you can do without reading glasses when you get older.

Biometry this test involves measurement of the eye and a set of calculations (biometry formulae) that help determine the right focusing power for an *IOL* before *cataract surgery* or *RLE*.

Binocular vision this is vision measured with the two eyes open.

Cataract when the *natural lens* gets misty enough to make vision hazy, it is called a cataract.

Cataract surgery this is surgery to replace the natural lens with an *IOL*. Cataract surgery is identical to *RLE* but is performed in patients who cannot see clearly despite using glasses or contact lenses with the main aim of restoring clear vision.

Conjunctiva the membrane covering the white of the eye. The conjunctiva produces mucus to help spread the watery *tear film* over the eye surface.

Cornea the clear part of the eye wall at the front of the eye. Two thirds of the focusing power of the eye is in the cornea.

Corneal epithelium the corneal skin layer

Corneal topography this is a scan that maps the surface curvature of the cornea.

D or Dioptre a unit for measuring the refractive power of a lens.

Excimer laser this type of laser removes tissue by non-thermal vapourisation (photoablation). Excimer lasers are extremely accurate and do not damage the surrounding tissues. They are used in *LASIK* and *surface laser treatments (PRK, LASEK and TransPRK*).

Femtosecond laser this type of laser is designed to cut any 3D shape in clear eye tissues such as the *natural lens* or the *cornea* with a high degree of accuracy. They work by creating a 3D pattern of tiny gas bubbles, which is traced through the target tissue at high speed. Femtosecond lasers are used in *LASIK*, *SMILE*, and increasingly in *RLE* and *Cataract surgery*.

Floaters floating shadows cast on the retina by opacities in the *vitreous*. Most of us are aware of *floaters* in some lighting conditions.

Glaucoma this is a condition in which the optic nerve is gradually damaged causing the visual field to contract. Left untreated, patients with glaucoma may develop 'tunnel vision.' Glaucoma is often associated with a higher than normal *intraocular pressure*, and treatment is centred on drugs or surgery to lower the intraocular pressure.

Hyperopia long sight. People with hyperopia typically have good vision as young adults. As they get older, they find themselves reliant on glasses for reading, and then for the distance vision too. Younger people are able to compensate for hyperopia by *accommodation*. The amount of hyperopia is shown by a positive number in your spectacle prescription.

ICL (intraocular collamer lens) this is the most commonly used type of *PIOL*. It is implanted behind the *iris* and vaults over the *natural lens* – a bit like a contact lens implanted in the eye. ICL implantation is a commonly used alternative to *laser vision correction* in younger patients.

IOL (intraocular lens) IOLs are small synthetic lens implants that are used to replace the natural lens in cataract surgery and RLE.

Intraocular pressure (IOP) this is the pressure of fluid within the eye. It is often measured with a puff of air in routine eye checks or (more accurately) with a yellow drop and a blue light.

Iris this is the coloured part of the eye behind the cornea that expands and contracts in response to light to dilate or constrict the pupil.

LASEK (laser assisted sub-epithelial keratectomy) this is a form of *surface laser treatment* in which the corneal skin layer is soaked with dilute alcohol to loosen it before removal.

Laser vision correction correction of sight using *excimer* and/or *femtosecond* lasers to alter the curvature and focusing power of the cornea.

LASIK (laser in situ keratomileusis) this is the commonest form of laser vision correction in which a thin protective flap is created using a femtosecond laser. The protective flap is moved aside by the surgeon before optical reshaping of the cornea using an excimer laser. The flap is then replaced, and adheres without stitches, keeping the corneal skin layer intact and giving a fast visual recovery.

Meibomian glands the specialized oil glands in the eyelids that pump out a stabilizing layer of oil each time we blink that floats on top of the watery layer of the *tear film*. Inflammation of the eyelid margins upsetting this layer (blepharitis or meibomitis) is one of the commonest reasons for eye discomfort.

Micromonovision this is the name often given to the strategy of aiming for a clearer distance focus in one eye and a clearer focus at arms' length in the other. Input from the two eyes combines to extend the range of focus for patients in the reading glasses age group undergoing vision correction surgery.

Monofocal IOL an IOL with one clear point of focus. These are the lenses most commonly used in standard cataract surgery. They have fewer optical side effects than multifocal lenses, but glasses are normally required for at least some activities after implantation.

Multifocal IOL an IOL with more than one point of clear focus. Multifocal IOLs are often used in RLE in order to help increase freedom from glasses in the near range as well as providing good distance vision.

Myopia short sight. People with myopia are able to see up close but not in the distance. They typically first need glasses as school age children. The amount of myopia is shown as a negative number in your spectacle prescription.

Natural Lens the natural lens sits just behind the pupil and is suspended by a trampoline like array of microligaments from the ciliary muscle, which contracts during *accommodation*. The natural lens accounts for one third of the focusing power of the eye and is the flexible element of focus. The natural lens gets less flexible with age. It also becomes less clear as we get older. If the natural lens gets misty enough to make vision hazy, it is called a *cataract*.

Phacoemulsification this is the standard technique for liquefying the natural lens in *cataract surgery* and *RLE*. Ultrasound energy delivered from the tip of a fine, hollow probe liquefies the lens. Fluid is washed continuously into the eye around the probe, and the liquefied lens material is sucked away. Where previously the natural lens had to be shelled out like a pea, phacoemulsification allows it to be removed through a tiny, key-hole entry into the eye. This development revolutionised modern cataract surgery. *Femtosecond lasers* are now commonly used to break the lens up into small fragments before phacoemulsification.

Posterior capsule opacification (PCO) in *cataract surgery* and *RLE*, the *IOL* is implanted within the capsule of the natural lens. This thin, clear membrane then shrink-wraps the IOL and stabilises it in the natural position in the eye. As part of this healing up process, the membrane often goes misty, causing gradual loss of vision after surgery. This is posterior capsule opacification (PCO). It can be treated successfully with a one-off minor laser procedure called *YAG capsulotomy*.

Presbyopia age related loss of reading vision and the ability to focus on a near object without help from glasses.

PIOL (phakic intraocular lens) an eye that still has the natural lens in place is described as 'phakic.' PIOLs are small, synthetic lenses that are implanted in the eye without taking the natural lens out. PIOL implantation is an alternative to laser vision correction for younger patients.

Posterior vitreous detachment (PVD) as we age, the vitreous shrinks and will often peel off the back of the eye. For some of us, this event passes unnoticed. In others, a new shower of floaters will prompt them to attend for an eye examination. Doctors examining patients after a PVD look carefully for any abnormal attachment of the gel to the retina which could lead to a retinal detachment.

PRK (photorefractive keratectomy) this is a form of *surface laser treatment* in which preparatory removal of the corneal skin layer is done by the surgeon.

Refraction this is the test that is done to determine the numbers in your spectacle prescription and the amount of *myopia, hyperopia* or *astigmatism*.

Refractive surgery this is another name for vision correction surgery or surgery to reduce the need for glasses and contact lenses.

Retina the carpet of light sensitive cells lining the back of the eye, which is sometimes described as 'the film in the camera.' Images are focused on the retina by the *cornea*, the *natural lens*. Information from the retina is fed through the *optic nerve* to the visual areas of the brain.

Retinal detachment the retina sometimes detaches from the eye wall and its blood supply. Urgent surgery is then required to re-attach the retina in order to prevent visual loss. Patients with high myopia are more likely to get a retinal detachment. Retinal detachments are also more common in the early years after cataract surgery or RLE. Warning signs are a sudden change in vision with field loss (a dark shadow in part of the visual field); flashing lights (arcs of light – even with the eyes closed); and a sudden new shower of *floaters*.

RLE (refractive lens exchange) this is surgery to replace the natural lens with an *IOL*. RLE is identical to cataract surgery but is performed in patients who can see clearly if they wear glasses or contact lenses. The aim of RLE is to help people to see clearly for more activities without glasses or contact lenses.

SMILE (small incision lenticule extraction) this is a form of *laser vision correction* in which a lens shaped piece of corneal tissue is marked out using a femtosecond laser and removed surgically through a small incision.

Surface laser treatment a collective term for *PRK*, *LASEK*, *TransPRK* and other similar forms of *laser vision correction* in which optical reshaping of the cornea is performed on the corneal surface after removal of the corneal skin layer.

TransPRK (transepithelial PRK) this is a form of *surface laser treatment* in which the corneal skin layer is removed by the laser itself.

Tear film a multilayered wet film covering the front of the eye, which is essential for vision and comfort. A layer of mucus produced by specialized cells in the *conjunctiva* helps the watery layer of the tear film to spread over the eye. The watery layer is stabilized between blinks by an oily layer that forms a thin film (a bit like petrol floating on water) and acts to prevent localized evaporation. The oily layer is pumped out from specialized glands in the eyelids called *meibomian glands* each time we blink.

Visual acuity this is the main measurement of how well we can see and is tested by asking you to read down a chart which has smaller letters on each line. The lower you can read, the better your visual acuity is. Measurements are expressed as a fraction. If your visual acuity is 6/6 (normal) then you can see at 6 meters what a normally sighted person can see at 6 meters. If your vision is 6/9 you can see at 6 meters what a normally sighted person can see from 9 meters away et cetera. In the USA, the same measurement is made in feet, with 6 meters being roughly 20 feet. Many people are familiar with the American definition of normal ‘20/20’ vision. This is the same as 6/6 vision in the UK measurement.

Vitreous this is the gel filling the back of the eye. It tends to shrink as we age and accumulates wrinkles and opacities that cast floating shadows (*floaters*) on the retina.

Wavefront scan this is an optical map of your eye used to guide modern *excimer laser* treatments.

YAG capsulotomy a one-off minor laser procedure used to treat *posterior capsule opacification* (PCO).

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