Your Guide to Refractive Surgery

Mr. Matthew Edwards, BSc FRCOphth
Mr Mathew Raynor, MBChB FRCSEd
Consultant Ophthalmologists
Refractive Surgeons &
Corneal Specialists

Sheffield Vision Centre
Contents

Introduction 3
Sheffield Vision Centre 5
Our Surgeons 6
  Matthew Edwards 7
  Mathew Raynor 8
Our Lasers 9
Understanding Refractive Error 10
  Short Sight 10
  Long Sight 11
  Astigmatism 12
  Presbyopia 13
Refractive Surgery 15
  Free Assessment 18
  Laser Vision Correction 19
  LASIK 20
  LASEK 21
  ReLEx 22
  LASIK, LASEK or ReLEx? 23
  Wavefront Guided Treatment 24
  Results 25
  Side Effects and Complications 26
Lens Based Refractive Surgery 28
  Clear Lens Replacement 28
  Multifocal Intra-Ocular Lenses 29
  Phakic Intra-Ocular Lenses 30
Treatment for Keratoconus 30
Fees 31
What to do next 32
Introduction

The aim of this guide is to tell you about modern refractive surgery so that you can make an informed decision as to whether it is right for you.

There are many potential benefits for people who have refractive surgery. For those with an active lifestyle, reducing dependency on spectacles has quite obvious benefits. In certain occupations, spectacle or contact lens wear is very difficult and frustrating; other careers may require a particular level of unaided vision before an applicant will even be considered.

Contact lens wearers often struggle to wear their lenses comfortably throughout the day, particularly as they get a little older and their eyes become drier. Many contact lens wearers are concerned about the risks of long term regular contact lens wear; others are simply fed up with the cost and hassle so are looking for a more permanent solution.

For patients with high prescriptions, the cost of replacing and updating spectacles is a significant issue, making refractive surgery a cost effective solution in the medium and long term. Spectacles can also be uncomfortable, digging into the nose and gripping around the ears.

For many patients the unavoidable aging of the eye creates a need for several pairs of spectacles or varifocal lenses: this is often the trigger for seeking a refractive surgery consultation.

Some spectacle wearers seek treatment purely for aesthetic effect.

Whatever your reasons for considering refractive surgery, the potential benefits and risks should be considered carefully and we hope that this guide will help you to make an informed decision on whether refractive surgery is right for you.

The volume of refractive surgery has grown exponentially over the last twenty years. The main reason for this was the introduction of the Excimer and then Femtosecond Lasers and with them Laser Vision Correction. Every year millions of people worldwide have successful treatment using these techniques: In the right hands, it can reliably eliminate or significantly reduce your need for glasses.

Laser eye surgery is not the only option. Other refractive surgery techniques are also growing in popularity as they have been shown to be more effective than laser treatment for some refractive errors or for older patients. It is extremely important that you have the treatment that is best for your eyes and for your vision, and that the treatment is able to meet your personal expectations.
When considering refractive surgery we would advise any potential patient to meet their surgeon well in advance of the treatment so they have ample opportunity to ask questions and consider the advice given by their surgeon.

A patient should have total confidence in the surgeon who will be treating them before making any decisions. Patients should be familiar and comfortable with the clinical surroundings and also with the staff that support the service. We hope that this guide will demonstrate that Sheffield Vision Centre offers a safe, high quality, personalised, reliable and relaxed service.

It is also important that you read this booklet if you decide to proceed with refractive surgery as it forms part of the consent procedure for both Laser Vision Correction and Refractive Lens Surgery.

This guide cannot cover all aspects of refractive surgery and after reading it you may still have unanswered questions. If so, please make a note of your queries and contact us by post, telephone or email.

Mr Matthew Edwards  
Mr Mathew Raynor

Consultant Ophthalmic Surgeons
Sheffield Vision Centre

The Sheffield Vision Centre is situated close to the NHS Eye Department on A-floor of the Outpatients building at the Royal Hallamshire Hospital. It is owned by Sheffield Teaching Hospitals NHS Foundation Trust but provides refractive surgery on a fee-paying basis for those people wishing to reduce their dependency on glasses or contact lenses. All profits from this service are reinvested directly to support the NHS eye department within the Hospital.

Occasionally excimer or femtosecond laser treatment is indicated for treatment of eye diseases. The creation of the Sheffield Vision Centre has given NHS patients in South Yorkshire access to technology that would otherwise have been unavailable. It is our private patients who have given us a route through which to purchase this equipment and for this we thank them.

Our surgeons, Matthew Edwards and Mathew Raynor, are both full time NHS consultant ophthalmologists specialising in the anterior eye, the cornea, and refractive surgery. Both live in Sheffield with their families and along with our staff of Hospital Optometrists, Specialist Nurses, and Optical Care Advisors, offer a friendly and relaxed experience in a purpose built hospital environment.

The Vision Centre offers a comprehensive refractive surgery service: Extensive pre-treatment assessment and full counselling form an important part of this process. Skilled and experienced surgeons use the most up-to-date equipment. After treatment, all follow-up for at least the next year is included. Enhancement, when appropriate, is also included in the initial fee if required within five years of the initial treatment. We adhere strictly to industry guidelines, particularly those published by the Royal College of Ophthalmologists (http://www.rcophth.ac.uk).

Sheffield Vision Centre has some of the most advanced diagnostic and treatment equipment currently available, including Orbscan, Pentacam, Visante and Atlas topographical assessments. Wavefront Analysis is undertaken using Carl Zeiss WASCA technology. LASIK treatment is with the combination of a Zeiss Meditec Mel 80 excimer laser and a Carl Zeiss Visumax femtosecond laser.

Sheffield Vision Centre is also a private Opticians catering mainly for hospital employees, but is also open to the general public for private eye examinations, spectacles, and contact lenses. Profits from this service are also directly reinvested to support NHS services.

We like to think that we can cater for all your eye care needs: We are not here to sell you eye surgery. Our focus is always on you as an individual, and we aim to offer the best solution for your visual requirements and lifestyle.
Our Surgeons

Both our surgeons are full time consultant ophthalmologists at the Royal Hallamshire Hospital. They are both anterior eye, corneal and refractive surgery specialists. They are both very experienced and hold the Certificate in Laser Refractive Surgery awarded by the Royal College of Ophthalmologists.

Importantly and unlike at many more commercial laser eye surgery providers, at Sheffield Vision Centre you will meet your prospective surgeon at your assessment, before you decide whether or not to proceed with treatment. You will have the opportunity to ask questions directly to your surgeon and be given time to consider their answers before any treatment is planned.

You will need to be confident in the skill and experience of your chosen surgeon and you should feel comfortable putting your faith in their abilities. Both our surgeons and the unit as a whole are bound by the codes of conduct that one would expect from a large NHS teaching hospital.

Our surgeons are available on request at any point during the recovery and follow up period and you will be given emergency contact numbers should you need advice or reassurance from them out of hours.
Mr Matthew Edwards BSc FRCOphth

Matthew Edwards graduated from Leeds University Medical School in 1991. He trained in Ophthalmology in Sheffield, Leeds & Auckland and was awarded the position of consultant corneal specialist at the Royal Hallamshire hospital in 2001. Prior to his appointment he undertook fellowship work with Professor Charles McGhee, a leading authority on excimer laser treatment and research. He has gone on to gain considerable experience in all forms of refractive surgery.

Matthew is a full time Consultant Eye Surgeon at the Royal Hallamshire Hospital in Sheffield, specializing in ocular surface and corneal disease and refractive surgery. He runs a tertiary referral service along with Mathew Raynor for the Yorkshire & Humber Region, which includes the management of complex refractive error and post-excimer laser complications.

He is a Fellow of The Royal College of Ophthalmologists and an active member of the British Society of Refractive Surgery, European and American Societies of Cataract & Refractive Surgery.

Matthew is an Honorary Senior Lecturer at the University of Sheffield and to date has published fifteen articles in peer-reviewed journals.

His overriding aim at the Sheffield Vision Centre is to provide a safe and effective option for patients requiring a quality driven service.
Mr Matthew Raynor MBChB FRCS

Mathew Raynor graduated from Manchester University Medical School in 1994. He trained in Ophthalmology at Southampton and then in Manchester. He completed a fellowship in Corneal and Refractive surgery before moving to the Royal Hallamshire Hospital as the unit's second corneal surgeon. He works as a full-time Consultant Ophthalmologist specializing in the treatment of the anterior segment of the eye. A large part of his NHS surgical workload is corneal transplantation and along with Mr Matthew Edwards, he runs the Regional Corneal Transplant Service. He is experienced in a variety of refractive procedures including LASIK, LASEK and Clear Lens Replacement.

His published research relates to the safety of the various types of contact lenses that are in common use on the high street and this work has been presented locally, nationally and internationally. He is involved in both undergraduate and post-graduate teaching of Ophthalmology at Sheffield Teaching Hospitals and is a reviewer for two scientific journals. He is also a member of the European Society of Cataract and Refractive Surgeons.

The NHS Eye Department at the Royal Hallamshire Hospital occasionally accepts tertiary referrals from other laser companies where patients are concerned or dissatisfied with their care; our consultants, Mr Matthew Edwards and Mr Mathew Raynor will take over the management of these complex cases.

We feel that their experience in the day to day management of corneal related disorders makes them the ideal choice for safe and effective refractive surgery.
Our Lasers

The Sheffield Vision Centre uses a combined Zeiss Visumax femtosecond and Zeiss Mel80 excimer laser platform. Both are state-of-the-art lasers: we use them together so that all our LASIK treatments are “all laser” procedures. Some authorities describe this as ‘femto-LASIK’.

We are one of only a couple of centres in the UK to offer all-femtosecond treatment for short-sight: ground-breaking ReLEx SMILE.
Understanding Refractive Error

Refractive error is the reason people need glasses or contact lenses to see clearly. It occurs when the image of something you look at is not properly focused onto the retina, the ‘photographic film’ of the eye.

Light enters the eye through the cornea, which provides about two thirds of the eye’s focusing power. The cornea can be thought of as the “outer” lens of the eye. Light then passes through the pupil and then the ‘crystalline lens’ which we can think of as the “inner” lens. The crystalline lens provides the remaining one third of the focusing power of the eye. It is this inner lens that can also change its focussing power to allow the younger eye to alter focus from distant to near: accommodation. The ability of the eye to ‘accommodate’ reduces quite quickly from around the age of 45.

Whether you have short-sight or long-sight, with or without astigmatism, depends on three things: the curvature of your cornea, the focusing power of your internal lens, and the length of your eyeball. Any imbalance between these three will result in refractive error.

Short-Sight (Myopia)

If you are short-sighted you will be able to see close objects clearly, but those further away will be blurred. Myopia is relatively common, effecting approximately one in five British adults. It usually develops in teenage years and stabilises by the time you are twenty.

Myopia occurs when light entering the eye is focused in front of the retina. This happens when the cornea is too steep, or the eye too long. If you are not sure whether you are short-sighted, take your glasses off and hold them a few inches above this page: the print will look smaller through your glasses if you are myopic.

Your degree of short-sightedness is represented in your glasses prescription as a number in the ‘sphere’ box (sph) and is expressed in dioptres (D), with a minus (-) sign before or above it. For example, a moderate myopic prescription could show a ‘−4.25’ in the SPH box.
Long-Sight (Hyperopia or Hypermetropia)

Long-sight is more difficult to describe than short-sight because its effect on vision will vary depending on the age of the individual as well as their degree of long sightedness. In general, if you are long-sighted you will be able to see far objects more clearly and easily than near objects. Long-sightedness occurs when light entering the relaxed eye is focused behind the retina: this happens when the cornea is too flat or the eye is too short for its focussing power.

Sometimes long-sighted children, teenagers, and young adults manage without glasses, despite the fact that they have been born longsighted: This is because they can comfortably overcome their refractive error by ‘focusing’ their eyes using the flexible inner lens (accommodation). Ultimately however, this youthful ability to alter the internal focussing power of the eye will reduce as time passes and will eventually result in an inevitable requirement for glasses.

On other occasions, even at a young age, the refractive error is simply too much to overcome without symptoms of eyestrain and blurred vision. These individuals will need to wear glasses or contact lenses straight away (at diagnosis). Very young children with significant degrees of long sightedness are more prone to the development of a squint (strabismus), and this is why they are prescribed spectacles at sometimes a very early age.

There is one last complicating factor: there is a slow but gradual shift towards long-sightedness as the eye ages, usually between the age of 50 and 70. This means that even individuals who have enjoyed quite excellent distance vision all of their life may need long sighted glasses in later life. Unfortunately, at this age the inner lens has no focussing ability to cope with this long-sightedness so these individuals will require distance vision glasses as well as reading glasses to focus even small degrees of long sightedness.

If you are not sure whether you are long-sighted, take your glasses off and hold them a few inches above this page: the print will look bigger through your glasses if you are hyperopic.

If you are hyperopic your degree of long-sightedness is again represented as a number in the ‘sphere’ box (SPH) of your prescription and again is expressed in dioptres (D), but this time with a plus (+) sign above or in front of it. For example, ‘+2.75’ in the SPH box represents a moderate degree of hyperopia.
Long-sightedness should not be confused with ‘presbyopia’ (see later). Patients with just presbyopia will generally be over 45 years of age and will have excellent distance vision and will simply require spectacles for reading and close work. Presbyopia is a natural aging process where the inner lens of the eye loses its flexibility and elasticity and is no longer able to alter its shape to focus on near objects.

**Astigmatism**

Astigmatism is commonly described as being due to a ‘rugby ball’ shaped eye, rather than a spherical, or football shaped eye. More accurately, astigmatism is created when the focussing surface of usually the cornea (the outer focussing lens), has two different degrees of curvature which, are normally perpendicular to each other.

For example, you may have a steeper curvature vertically and a flat curvature horizontally as in this picture of a rugby ball. Imagine the cornea as being the shape of a circular patch taken from the centre of this rugby ball. This creates an eye with two different powers along two different meridians and therefore an eye with two different focal points.

If you take the cornea from our example above, such an eye will find it impossible to focus horizontal lines at the same time as vertical lines, and so objects will not be seen clearly no matter what distance they are held from the eye.

If you have astigmatism, your prescription will be more complicated. You will notice that you have a ‘sphere’ (SPH) and also a 'cylinder' (CYL) written on your prescription. These two numbers represent the two different powers required to make you see clearly. The ‘CYL’ figure tells you the degree of astigmatism. Your astigmatism will also have an “Axis” which represents the angle of your astigmatism, that is, the angle of the steep curve if your cyl has a plus power or the angle of the flatter curve if your cyl has a negative power.

A small degree of astigmatism is very common and may be found in association with either long or short sightedness.
Presbyopia

As we get older, the crystalline lenses (the inner focussing lens) within our eyes start to lose the ability to change focus (to ‘accommodate’) from distance to near objects. This is a normal ageing process, but one that has important effects on vision which must be understood before you can make an informed decision about refractive surgery.

During middle age, it becomes harder to read for long periods of time: our eyes feel tired, and we may suffer eye strain and headaches if we do too much close work. This is because the focussing muscles within the eye are working harder to try and change the shape of our inner focussing lens. It is losing its flexibility and elasticity so is now unable to change its shape as readily as it used to. Usually the crystalline lens has lost all of its focussing ability by the time we reach our mid-fifties.

Presbyopia is a very accurate marker of age, and pretty much everyone will require some extra help for close work by their mid to late forties; this may take the form of reading, bifocal or varifocal glasses. Often patients are frustrated by this, particularly if they end up needing several pairs of glasses to enable them to deal the visual demands of modern life.

So the loss of our eyes ability to alter its focus from a distant to a near object is known as presbyopia. It will affect everyone, and may come as quite a shock if you have previously enjoyed excellent unaided eyesight.

If you have a spectacle correction for presbyopia, you will have a figure written in the ‘ADD’ box of your Opticians prescription. The ‘Add’ represents an additional magnifying power required to focus comfortably on near objects. The add number usually starts at about +0.75 in mid-forties and increases to a maximum of about +3.00 with age.

Although current laser and lens refractive surgery techniques cannot yet completely cure presbyopia, we can and do customise treatments in such a way to significantly reduce the effects of presbyopia and reduce your need for glasses beyond middle age.

The Sheffield Vision Centre is one of the few clinics to offer Blended Vision®, where Laser Vision Correction is used to correct both eyes for near and distance, one (the dominant eye) biased towards distance, the other towards near.
This technique is distinct from and in many ways superior to ‘monovision’, the traditional way of overcoming presbyopia. We find that over 95% of people adapt well to Blended Vision®. We are also able to offer multifocal lens implants as part of 'Clear Lens Replacement': these are designed to focus at both distance and near and can significantly reduce or eliminate completely your need for close work spectacles.

You will find more information on these implants in the ‘Clear Lens Replacement’ section and again you can discuss all these options further by contacting us.

We are happy to discuss your needs on the phone or by email or we offer a free assessment when you can discuss your options face to face with one of our refractive surgeons.

An example of a typical Opticians prescription is shown below

<table>
<thead>
<tr>
<th>Eye</th>
<th>Sphere</th>
<th>Cyl</th>
<th>Axis</th>
<th>Add</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>-4.00</td>
<td></td>
<td></td>
<td>+2.00</td>
</tr>
<tr>
<td>Left</td>
<td>-3.50</td>
<td>+2.00</td>
<td>90</td>
<td>+2.00</td>
</tr>
</tbody>
</table>

- The right eye is moderately short-sighted (-4.00) with no astigmatism.
- The left eye is slightly less short-sighted with moderate astigmatism (+2.00 in the cyl box) with the steeper curvature vertically (90 degrees).
- The addition is +2.00 which means this patient is most likely about 50 years of age and requires additional power to see objects held close.

This example patient should do very well with laser eye surgery, but should consider the option of ‘Blended Vision®’ to reduce the need for reading glasses.
In the last section we described how the focusing power of the eye is derived from two structures: the cornea and the lens. In this section we will describe the different techniques used to treat these two parts of the eye: broadly corneal laser treatment and intra-ocular lens surgery.

The next table addresses which treatment might be best for you dependant on your refraction.

<table>
<thead>
<tr>
<th>Refractive Error</th>
<th>LASIK</th>
<th>ReLEx FLEX and SMILE</th>
<th>LASEK</th>
<th>Phakic Lens Implant</th>
<th>Clear Lens Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over -10 dioptres</td>
<td>No</td>
<td>Possibly</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>-10.00 to -8.0</td>
<td>Probably</td>
<td>Yes</td>
<td>Possibly</td>
<td>Possibly</td>
<td>Yes</td>
</tr>
<tr>
<td>-8.00 to -6.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Probably</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>-6.00 to -4.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>-4.00 to -2.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>-2.00 to 0.00</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>0.00 to +2.00</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>+2.00 to +4.00</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>+4.00 to +6.00</td>
<td>Possibly</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>More than +6 dioptres</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

¹ Dependant on age - see below
This table does not take into account astigmatism
The table below will give you an idea of which treatment might be best for you dependant on your age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Laser Vision Correction</th>
<th>Phakic Lens Implantation</th>
<th>Clear Lens Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-45</td>
<td>Yes</td>
<td>High myopia only</td>
<td>High hyperopia only</td>
</tr>
<tr>
<td>45-60</td>
<td>Yes</td>
<td>Probably not</td>
<td>Possibly</td>
</tr>
<tr>
<td>60+</td>
<td>Probably not</td>
<td>No</td>
<td>Probably</td>
</tr>
</tbody>
</table>

Both of these tables can only give you an idea about which treatment may be best for you and your particular refractive error. The only way to find out which treatment would be best is to have an assessment and discuss with your surgeon.

One main reason why these tables can only be a guide is that they do not take astigmatism into account (see earlier for the description of astigmatism). Most people’s astigmatism is fairly low and is treated very successfully by laser vision correction. In general, Phakic Lenses and Clear Lens Replacement can treat all levels of astigmatism.

Refractive surgery is only generally considered in people over 21 years of age. It is by this age that peoples refractive prescription has become stable: a prerequisite for surgery. An important part of your assessment will be to confirm that this is the case.

Phakic intra ocular lenses are generally only for younger patients who are unable to be treated by laser eye surgery; usually because their prescription is too high. The main benefit of a Phakic Intra Ocular Lens over Clear Lens Replacement is that younger people retain their natural lens which has the ability to ‘accommodate’ - to focus on close objects. As already discussed, in middle age, the lens within your eye begins to lose this flexibility and certainly by the age of 55 it has virtually no ability to alter its shape to focus close to. So for the over 40’s one has to wonder if a Phakic Intra Ocular lens is appropriate. Clear lens replacement, with its long term stability may become a better option.

Laser eye surgery can be undertaken at all ages. However, as the eye ages the crystalline lens within it can alter its shape and become discoloured. So, the results of Laser Eye Surgery may not be stable for as long as it would be in the younger eye. Clear lens replacement is certainly worth considering as it will be stable long term, you will not be able to develop a cataract (and will therefore not need cataract surgery in old age), and the natural discoloured and aged lens is replaced with a new beautifully clear lens implant.
High levels of refractive error are more difficult to treat predictably by laser eye surgery. Many factors need to be taken into account including your exact prescription, your age, the thickness of your cornea, your pupil size and your visual expectations. Phakic Lens Implant or Clear Lens Replacement, remains an option for patients who are unable to proceed with Laser Eye Surgery.

If you are at all unsure about your options, please come and talk to us. We offer free assessments to help you decide which path is right for you; if any. The correct path may be no intervention. The assessments are informal and relaxed, and you will not be subjected to any sales techniques or pressure to proceed.
The assessment is thorough. It will generally take about two hours and we will need to dilate your pupils so that we can examine your eyes internally. The dilating drops will blur your vision a little and they can last for some hours: so please do not plan to drive yourself home. The assessment is informal and relaxed; there is no pressure to proceed with any form of surgery. It is simply your opportunity to find out if you are suitable, to discuss the options that are available, and to ask any questions you may have, directly to a refractive surgeon. The assessment also gives you chance to meet your potential surgeon at the decision making stage rather than on the day of your surgery as can happen in some of the more commercial providers.

The assessment involves five steps

1. An introduction by one of our surgeons. This is just a brief discussion about your needs and expectations. Our surgeon will consider your age and your prescription to help us decide which tests are most appropriate during your assessment.

2. A thorough Refraction with one of our hospital based optometrists. The Optometrists role is to determine an accurate refraction and to consider the stability of that prescription. They will also look at how your eyes coordinate and advise the surgeon accordingly.

3. Measurements. There are whole raft of measurements that need to be taken. The measurements will vary, but may include:
   - Pupil size, especially in low light conditions
   - Pachymetry (measurement of corneal thickness)
   - Topography / Tomography (measurement of corneal shape)
   - Wavefront Analysis in both bright (photopic) and dark (scotopic) lighting conditions.
   - Optical Biometry (measurement of the length of your eye and the positioning of the internal structures).

4. Examination – Our surgeon will examine your eyes in detail. They will use a microscope to examine both externally and internally (following the use of dilating drops). They will also take special care to consider the lubrication of your eyes; they will look for signs of dryness or inflammation, injury or disease.

5. Discussion – It is only after all these tests have been completed that our surgeon will be able to discuss accurately the treatment options that are available to you. We feel it is important that all prospective refractive surgery patients are able to meet their surgeon at the decision making stage and ask any questions that they may have direct to that surgeon. It is a big decision that you are making and that decision should be based on the very best advice available.
Laser Vision Correction

The most common form of refractive surgery at present is Laser Vision Correction. This is when a femtosecond and/or an excimer laser is used to precisely reshape the cornea and thereby improve focus, reducing dependency on spectacles or contact lenses. Excimer lasers were first used to treat humans in 1990, femtosecond lasers in 2001, but the technology and treatments have improved massively since then. Although there is no follow-up data available on Laser Vision Correction beyond 23 years, there is no evidence to suggest even the possibility of any long-term problems.

Early treatment was known as 'photo-refractive keratectomy' (PRK), which is when an excimer laser is used to reshape the corneal surface directly – ‘surface ablation’. Today we have moved forwards in terms of technique and laser capability, the three different techniques used at the Sheffield Vision Centre are LASEK, LASIK and ReLEx SMILE

The Excimer Laser uses exact and accurately controlled pulses of light energy to remove microscopically small amounts of corneal tissue to change its shape and thereby modify focusing. The Femtosecond laser uses extremely precise pulses of light energy to separate corneal tissue. It is used in LASIK to create a flap under which the cornea can be reshaped using the excimer laser. In ReLEx the femtosecond laser is used to create a precise 'lenticule' within the cornea that is then removed through a small incision.

Deciding which of these treatments is most appropriate for you is one part of the assessment process for laser eye surgery.
LASIK (Laser Assisted *In-situ* Keratomileusis)

The LASIK procedure involves the surgeon creating a thin flap of corneal tissue with the femtosecond laser, gently lifting this to one side, and then using the excimer laser to accurately reshape the corneal tissue beneath. The flap is then repositioned. The procedure is quick, taking typically 20-25 minutes for both eyes, and people are often surprised at how comfortable the procedure is. Anaesthetic eye drops are used to numb the surface of your eye so the procedure is painless.

The recovery process generally involves little more than mild discomfort, watering and some sensitivity to bright light. The speed of visual recovery does vary, but all patients have functional vision the moment that they sit up and most have good vision by the evening.

Despite the relative comfort of the procedure and the speed of visual recovery, this is eye surgery so we recommend that you have someone with you to ensure that you can get home safely after your surgery. You should plan for a relaxed day following treatment: lots of people have a sleep in the afternoon.

Since laser refractive eye surgery is so safe, it is routine to do both eyes at the same session.

So from start to finish, you will perhaps be with us for an hour. Treatment in the laser room normally takes about 20 to 30 minutes if you are having both eyes treated. Following a quick check and instruction about post-operative care and follow-up, you will be free to go. All patients who have had LASIK are seen the next day by their surgeon, and then on several occasions by one of our hospital employed opticians to monitor your progress and to ensure you are satisfied with the outcome. Both Mr Edwards and Mr Raynor are NHS Consultants within the eye department at the Royal Hallamshire Hospital, and therefore follow up appointments with your surgeon can be arranged at any point in your recovery if you have any further need of their expertise or opinion.
LASEK (Laser Sub-Epithelial Keratomileusis)

LASEK is a slightly simpler technique which does away with the need to create a substantial flap. With LASEK, the surgeon simply loosens the very thin superficial surface layer of the cornea known as the epithelium. This thin layer is delicately lifted and folded back; the laser treatment is then applied in exactly the same way as LASIK, just to the more superficial layers of the cornea. We call this procedure 'surface treatment' as the laser is applied very close to the surface of the eye whereas with LASIK the laser is applied deeper in the cornea. The epithelium is then repositioned and a temporary contact lens placed over it to protect this surface layer as it regenerates.

Visual recovery is not as quick after LASEK, often taking two to four days. During the early post-operative period the eye may be uncomfortable, but we provide drops and analgesics to minimise symptoms. Patients are seen at about five days post-operatively, when the contact lens is removed, and then several times again over the next few months as the visual acuity stabilises. We would not judge the final results from a LASEK procedure until three months postoperatively.
ReLEx (Refractive Lenticule Extraction)

FLEEx (Femtosecond Laser Extraction) and SMILE (Small Incision Lenticule Extraction)

ReLEx FLEEx and SMILE are ground-breaking new techniques that take laser vision correction for short-sight beyond LASIK. Both solely use the femtosecond laser to precisely separate and then remove a ‘lenticule’ (a very thin disc) of tissue to re-shape the cornea and change its lens power.

Like LASIK, the corneal surface layer remains largely untouched so ReLEx procedures share the same benefit of minimal post-operative discomfort and rapid visual recovery. But because no excimer treatment is necessary, the laser procedure itself is quicker: there is no ablation.

ReLEx SMILE in particular has significant added benefits: the corneal surface incision is dramatically smaller - there is no ‘flap’ so the approximately 20mm cut of LASIK is reduced by more than three-quarters. Because of this corneal structure is much less compromised so higher prescriptions and thinner corneas may be more suitable for laser vision correction.

The smaller surface involvement also means that corneal sensitivity is much less reduced by treatment: this is the reason that ‘dry-eye’ symptoms are less common after FLEEx procedures.

For ReLEx FLEEx and SMILE the treatment day itself is very similar to the other laser treatments. You will be in the clinic for about an hour, in the treatment room for about 20 minutes. Your vision will be significantly better the moment that you get up off the couch: after a quick post-op check and instruction on post-op care, you will be able to go home for a rest. All ReLEx patients are reviewed the next day and then like the other procedures, at 1 week and then at approximately 1,3,6 and 12 months.
LASIK, LASEK or ReLEx?

The decision about which technique of laser vision correction is right for you is made after assessment and discussion with your surgeon. It depends on factors such as your prescription and many aspects of your ocular examination but also your personal choice.

LASIK gives fast visual recovery with little discomfort: for these reasons it is the commonest choice for many people. It involves creation of a very thin and precise LASIK flap; it may not be appropriate if you participate in contact-sports or if your cornea is thinner than normal. On the other hand for some refractive errors LASIK is the only choice.

ReLEx FLEx and SMILE are exciting new techniques that share many of the advantages as LASIK but have less of an impact on corneal strength so the contact-sport and corneal thickness issues are less relevant. ReLEx can at the moment only be used for treatment of short-sight.

LASEK does not require flap or lenticule creation so in many ways is the simplest treatment. However, visual recovery is slower and your eye will be uncomfortable during the early post-operative period. LASEK may be the treatment of choice for thin corneas. LASEK is best suited to correction of low to moderate degrees of short-sight.

A final decision about which treatment to have can only be made after full ophthalmic examination and discussion with your consultant.

The Combined MEL80 and Visumax lasers from Carl Zeiss
Wavefront Guided Treatment

Wavefront analysis (also known as aberrometry) is a technique for measuring the complete refractive status of the eye; it measures the quality of the eyes' ability to focus light to a clear and crisp image. In the same way that you can buy camera lenses of different quality and cost, each person’s eyes will vary in their ability to precisely focus light onto the retina particularly in low light levels when the pupil dilates. The information derived from Wavefront analysis can be used to customise laser treatment for both Laser Vision Correction.

‘Lower order’ optical ‘aberrations’ are those that can be corrected by glasses or contact lenses (Sphere and Cylinder). Higher order aberrations cannot be corrected in the same way requiring, more complex surface curvatures. Wavefront analysis has been designed to measure both lower and higher order aberrations. When significant higher order aberrations are found, a customised treatment pattern may be applied to correct both the spectacle prescription and the higher order aberrations that may otherwise degrade the image quality. 'Tailor-made' ablation like this may offer benefits to some patients, for example those at risk of experiencing night-time symptoms following treatment.

At the Sheffield Vision Centre all Laser Vision Correction patients undergo Wavefront analysis, and Wavefront guided treatment will be performed if it is to your benefit at no extra cost. We consider it an essential step in the assessment pathway.

Carl Zeiss Aberrometry (Wavefront Analysis)
Results (Laser Vision Correction)

The final results of Laser Vision Correction are as a rule, excellent. Of course there are many important pre-operative considerations: these will be identified and discussed at your pre-operative consultation.

First of all let's deal with the safety issue. Since the Sheffield Vision opened in 2005, no patient has suffered significant or permanent loss of vision in either eye\(^1\). This doesn't mean that it couldn't happen in the future, but that it is extremely unlikely.

Audit of outcome, or 'success rate', of Laser Vision Correction can be presented in many ways, some of which can be a little confusing or sometimes misleading. For example, stating '100% of patients can drive without glasses after treatment' sounds good initially, but on closer inspection means little. For example, the minimum legal standard for driving in this country is to be able to read a number plate at 20.5 metres - with both eyes open. This is far below what most people would consider a good outcome from Laser Vision Correction.

At the Sheffield Vision Centre we use the scientific standard audit outcomes\(^2,3\). Audit is an on-going process so we ensure that all of our outcome data is continually recorded and analysed. The best way to learn of our unit's or your individual surgeon's figures is to ask them to give you the most up-to-date data. This will give you an opportunity to understand what the figures really mean.

No operative procedure can ever be 100% predictable – the response of natural tissue will always vary between individuals. It is well accepted that enhancements are necessary in a small proportion of Laser Vision Correction subjects, but, the large majority of these patients are happy after one re-treatment.

One measure of outcome sometimes quoted is ‘enhancement rate’ – the percentage of people who need a second treatment to achieve the desired refractive outcome. In our most recent audit (which included up to five years of follow-up) our enhancement rate was 4.8% this means that just over 95% (or 19 out of 20) of all our customers were happy with the results of their first treatment.

However, enhancement rate figures can also be misleading. The figure just quoted covers all patients from approximately -10 dioptres of short-sightedness to +6.00 dioptres of long-sightedness and includes up to 5 dioptres of astigmatism. Many issues, including pre-treatment refractive error as well as others affect outcome and therefore enhancement rate.

---

1. Significant visual loss defined as two or more lines of Snellen acuity.
3. Laser Refractive Surgery. Royal College of Ophthalmologists 2009
Side Effects & Complications
(Laser Eye Surgery)

Although Laser Vision Correction gives excellent results, side effects and complications can happen. If managed correctly, the large majority of these do not affect the final visual outcome. As stated elsewhere, since the Sheffield Vision Centre opened at the Royal Hallamshire Hospital in April 2005, no patient has suffered any significant visual loss in either eye.

'Dry eye' symptoms - This is a fairly common but fortunately usually a mild side-effect. Both LASIK and LASEK can cause some 'dry-eye' symptoms like grittiness. Such symptoms are nearly always transient, often resolving by six months and artificial teardrops can be used to alleviate them. One of the big advantages of ReLEx is that it is much less likely to cause dry-eye symptoms.

Over or Under Correction - As discussed in the previous section, no surgical procedure can ever be 100% predicable. This means that a small minority of patients will require a second 'fine tuning' procedure to achieve the required visual outcome. Fortunately ‘enhancements’ are safe and usually very effective. All such procedures are included in the initial cost for a five year period.

Regression – Regression is where there is a gradual, mild, loss of effect after an initially good outcome. Fortunately it is fairly rare. It may be looked upon as a limited ‘healing’ response in the cornea where it reshapes towards its preoperative curvature. When it does occur, the degree of resultant myopia or hyperopia will be small compared to the pre-treatment level. As with over or under-correction, regression usually responds well to an enhancement procedure. Again, such further treatment is included in the initial cost.

Glare and Haloes – A small number of people experience glare and haloes following treatment, usually around lights at night-time. Like other side effects, this usually resolves with time. Night-time symptoms used to be more common, but modern treatment methods mean that it is now rarely encountered. Some people are more prone than others, and if you are one of these we will discuss this at your assessment. Wavefront guided ablation may be used to reduce the possibility of such symptoms.

Mild fluctuation in vision - As already highlighted, Laser Vision Correction is a process, not a single event. The natural healing response caused by treatment may mean transient fluctuation in vision, particularly in the first couple of weeks. These symptoms settle faster with LASIK.

Micro-corneal erosions - Rarely the corneal epithelium may not properly re-attach to the tissue beneath following treatment. This may lead to transient loosening lasting for minutes or seconds, usually first thing in the morning. Such symptoms almost always resolve with regular use of lubricant drops.
Corneal Haze - Haze on the surface of the cornea after LASEK is another effect of the healing response. Minor degrees are fairly common but do not affect vision in any way and resolve with time. Significant haze is rare and again, it usually resolves with time and appropriate treatment.

Infection - Infection after Laser Vision Correction is very rare. We take the utmost precautions to maintain hygiene at the time of treatment. Again, if an infection is managed quickly and appropriately, it does not usually compromise the final visual result.

Flap complications - Flap complications are obviously specific to LASIK. Modern femtosecond laser flaps are extremely precise, but the creation of a flap does add very small potential risks. There are a number of reported flap complications, but again they are very rare and if they do occur, they do not usually compromise the end result.

Ectasia - This is an exceedingly rare complication generally specific to LASIK. Creation of the flap does to a small degree, permanently weaken the cornea and may cause progressive ‘stretching’ of the residual tissue with loss of visual clarity. A thorough assessment will aim to identify those patients at greatest risk of corneal ectasia and who therefore might be unsuitable for laser treatment.
Lens Based Refractive Surgery

As already discussed, Laser Vision Correction is not suitable or the best option for everyone. For some people other refractive procedures may be more appropriate. Examples include people with certain eye conditions, people with high or extreme degrees of refractive error, and also older people in whom there is a chance that they may start to develop age-related lens changes such as cataract.

Clear Lens Replacement

In Clear Lens Replacement a precision-made intra-ocular lens is used to replace the natural crystalline lens of the eye. A variety of such lenses are available: they can be used to correct virtually any degree of long or short-sightedness and can also be designed to cope with any degree of astigmatism. They can be used to effectively overcome the need for reading glasses.

Intra-ocular lenses have a long track-record; they have been used effectively for over fifty years so are recognised to be stable long-term.

Insertion of these lenses is an intra-ocular procedure (within the eye), distinct from Laser Vision Correction which is extra-ocular (outside the eye). Modern small-incision lens-surgery is very precise and controlled, but the nature of the treatment does mean the risks, although still very low, are slightly greater than for Laser Vision Correction.

The LENTIS MPlus Intra Ocular Lens from Topcon UK
Clear Lens Remplacement - Multifocal Intra-ocular lenses

Multifocal lenses, used at the time of Clear Lens Replacement, are becoming a very popular treatment to reduce or eliminate the need for reading as well as distance glasses. They start to become a real alternative to Laser Vision Correction with increasing age.

Such lenses have been available for a number of years but have now become so refined that the large majority of people are very happy with the results of their insertion. 'Multifocal' lenses are in reality ‘bifocal’ (or now 'trifocal'), in that they have two (or three) distinct focal lengths: reading (intermediate) and distance. However, they are not like bifocal glasses, where reading vision is only obtained when looking through the lower part of the lens and vice versa. With multifocal intra-ocular lenses, near and distance vision is achieved in all positions of gaze.

One major advantage of clear lens replacement for the older patient is the stability of the refractive result. After a short recovery period, the results will thereafter remain stable throughout life. As the eye’s natural lens has been replaced, it is impossible to develop cataract in old age.

Clear Lens Replacement is an intra-ocular procedure undertaken in an operating theatre. The large majority of people have local-anaesthetic. We nearly always undertake each eye separately, but usually only a week apart.

Post-operative recovery is fast: there is usually minimal post-operative discomfort and vision returns over the coming hours.

As it is intra-ocular, Clear Lens Replacement has increased, although still small risks compared to Laser Vision Correction. The risk of long term visual loss in one eye is approximately 1 in 1000.

To find out whether Clear Lens Replacement is the right treatment for you the best thing to do is to contact us or to arrange a free assessment.
Phakic Intra-Ocular Lenses

A ‘phakic lens’ is inserted into the eye in addition to (not replacing) the natural crystalline lens. In this way they may offer a solution for younger people who are too short-sighted (or their cornea too thin) for Laser Vision Correction.

These implants can be thought of as permanent intra-ocular (within the eye) contact lenses. Several types are currently in use, but all work in conjunction with the eye’s natural lens, thereby maintaining accommodation (the ability of the eye to change its focus from distant to near objects). High degrees of astigmatism can also be successfully treated.

Unlike Laser Vision Correction or Clear Lens Replacement, Phakic Intra-ocular Lens insertion is potentially reversible. The range of lens powers that are available or can be manufactured mean that virtually any degree of short-sightedness and/or astigmatism can be corrected.

Insertion of Phakic Intra-ocular lenses is again an intra-ocular procedure. This means that the risks are low, but slightly greater than those of Laser Vision Correction.

Treatments for Keratoconus

Keratoconus is a condition where the shape of the cornea, the main lens of the eye, becomes progressively irregular. It is generally a disease that patients become aware of in their teenage or young adult life. Glasses become increasingly in-effective and many sufferers become dependent on rigid contact lenses to allow them reasonable vision.

Keratoconus is a clear contra-indication to Laser Vision Correction, but we are able to offer two other treatments that can both prevent progression and also reduce a patient’s need for glasses.

Intra Corneal Rings (ICRs), such as Kerarings, are small implants that can be inserted into the cornea to improve shape and thereby help un-aided and spectacle corrected vision. ICRs are inserted using our Visumax femtosecond laser: the procedure is relatively quick and results are generally very good.

Corneal Collagen Cross-Linking is a relatively new, but exciting treatment that can prevent progression of keratoconus. It can be used with or without ICR insertion to maintain vision and give peace of mind. Again, treatment is relatively quick and pain free although the recovery can be uncomfortable for a day or two.

If you know that you have keratoconus, please contact us for information on whether these two treatments may be appropriate for you.
Fees

After initial assessment and additional pre-operative testing if required are free. Fees cover treatment and post-operative follow-up. They also include enhancement and/or surgery over a five-year period. Emergency access to your surgeon is available. These guarantees apply to the refractive surgery procedure provided but do not cover other unrelated, subsequent pathology that may develop.

Most patients are discharged by one year because they are happy with their treatment. However they are able to arrange review following this if they have concerns regarding their refractive surgery.

Enhancement is undertaken when it is felt necessary by the patient and worthwhile and safe by their surgeon.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Assessment</td>
<td>No Charge</td>
</tr>
<tr>
<td>All-laser LASIK and ReLEx</td>
<td>£1900 per eye</td>
</tr>
<tr>
<td>(All inclusive – Wavefront guided treatment as required)</td>
<td></td>
</tr>
<tr>
<td>LASEK</td>
<td>£1500 per eye</td>
</tr>
<tr>
<td>(All inclusive – Wavefront guided treatment as required)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Assessment</td>
<td>No Charge</td>
</tr>
<tr>
<td>Clear Lens Replacement (Monofocal)</td>
<td>£2900 per eye</td>
</tr>
<tr>
<td>Clear Lens Replacement (Monofocal Toric)</td>
<td>£3300 per eye</td>
</tr>
<tr>
<td>Clear Lens Replacement (Multifocal)</td>
<td>£3300 per eye</td>
</tr>
<tr>
<td>Clear Lens Replacement (Multifocal Toric)</td>
<td>£3500 per eye</td>
</tr>
<tr>
<td>Phakic intra-ocular lens</td>
<td>Price on application</td>
</tr>
<tr>
<td>Keratoconus Treatments</td>
<td>Price on application</td>
</tr>
</tbody>
</table>

*There will be a supplementary charge for any patient wishing to have surgery under a general anaesthetic. The price above covers laser capsulotomy within the first year if necessary.*
What to do next

Call us to discover if you could be a suitable candidate for vision correction:

Sheffield  0114  2711564

We will need to gather some basic information (including your latest prescription) before an appointment can be made. After this we can arrange for an assessment appointment, at your convenience, in order to determine your candidacy.

At the assessment, you will:
- Have a thorough eye examination.
- Have the opportunity to discuss your hopes and expectations with a Consultant Ophthalmologist.
- Have all your questions answered (Bring a list).
- Discover if you are suitable for refractive surgery.

At the assessment, you will not:
- Feel in any way pressured to proceed with vision correction.
- Be issued with a prescription for spectacles or contact lenses.

Before the assessment:
- If possible, let us have two or more of your previous spectacle prescriptions (or bring them with you).
- We will send you advice about how long to leave out your contact lenses prior to your assessment. (*Generally one week for soft lenses and four weeks for rigid lenses*)
- Plan not to drive after your assessment (you will have dilating eye drops instilled).

Thank you for taking the time to read and consider this information. We look forward to seeing you soon.