

Chapter 4

Pre-operative assessment – eye examination

OVERVIEW

This chapter gives a detailed guide to carrying out the pre-operative assessment that is required to determine a patient's suitability for treatment. The treating surgeon will make the final decision regarding suitability and advise the patient regarding any risks specific to their case. Alternatives to LASIK and optometrist discharge is also discussed for when the patient is unsuitable for further consultation with the surgeon.

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INTRODUCTION

This chapter will look at the ocular examination and the further measurements required to determine a patient's suitability for treatment. It will also look at the optometrist's responsibility if the patient is discharged without treatment. A summary of alternative refractive procedures is also included at the end of this chapter which may be of use if the patient wishes to know more about an alternative to LASIK.

HISTORY AND SYMPTOMS

Absolute and relative contra-indications to surgery have been discussed in Chapter 2. Where the patient is taking a contra-indicated medication, it may be possible to treat them in the future once the medication has been ceased or changed to an alternative for several months. If the patient has a medical condition that is a relative contra-indication, the surgeon will need more information before making a final decision to treat the patient.

Diabetes

If the diabetes is well controlled and there are no signs of diabetic retinopathy, the surgeon may be prepared to operate on the patient. Further evidence of the status of the patient may be requested (*e.g.* the results of a haemoglobin A1C test) and a report from the patient's diabetic physician.

Depression

In some cases, the surgeon may require a letter from the patient's GP stating that their condition is stable and that the patient is psychologically fit to undergo elective surgery. In many cases, these patients also have high expectations which, if not met, could disrupt their control of their depression. Therefore, it is imperative that these patients are counselled carefully about the potential risks and complications of surgery.

Dry eye

If a patient suffers from dry eye, their symptoms will be worse after treatment. Recovery could take several months. Where the dry eye is not severe and the patient is keen for treatment, punctum plugs can be inserted immediately after treatment to minimise discomfort.

Blepharitis

This will need to be treated prior to surgery. In most cases, lid hygiene measures are adequate as long as the patient is compliant. Where blepharitis is severe,

topical or oral antibiotics may be required and referral to either the surgeon or the GP is required to obtain a prescription.

VISION ASSESSMENT

A full eye examination is carried out during the pre-operative assessment.

Refraction

The refraction result is compared to the patient's spectacles or most recent prescription. A difference of more than 0.50 D is significant and the patient will need to be rechecked again in 6–12 months' time. Suitability for treatment cannot be confirmed until the prescription is stable.

All hypermetropes will need a cycloplegic refraction. Where there is a large difference between the cycloplegic and the non-cycloplegic refraction, it may not be advisable to treat the maximum degree of hypermetropia as the patient may find it hard to adjust after treatment. In some cases, partial correction may be appropriate; in others, the patient may need to adapt to the cycloplegic result with spectacles or contact lenses before being considered for treatment.

In some cases, where a myope is suspected of over accommodating, a cycloplegic agent may also need to be instilled. The lowest myopic prescription found is then treated.

Best corrected visual acuity (BCVA)

If the patient has significant amblyopia or where the BCVA is less than 6/12, they will not be suitable for surgery. In cases where the amblyopia is mild, the patient needs to be counselled carefully about the potential risks and complications of surgery (see Chapter 5). Where the patient's BCVA is borderline, the surgeon may suggest treating one eye at a time with the amblyopic eye being treated first.

Binocular vision assessment

The binocular vision status of the patient should be assessed to identify patients who are unsuitable for treatment, or who are at increased risk of developing symptoms after treatment. The following is a list of potential problems:

- Patients that require prism to correct diplopia or decompensated heterophoria may still require spectacles after treatment.
- Moderate-to-high myopes have a significant degree of induced base in prism for near vision tasks with spectacles. If this is removed they may experience some eye strain after treatment until their eyes adapt. If the patient is exophoric or has convergence insufficiency, adaptation may not be possible and orthoptic exercises or prism correction may be required.

- If a pre-presbyopic myope habitually removes spectacles for near vision tasks, it could indicate that there are poor accommodative reserves. After treatment to correct the myopia, the patient will have to accommodate for reading. If the patient is unable to sustain this effort, then near vision spectacles may be required.
- If a myopic patient is esophoric for near and usually removes their spectacles for reading, the extra accommodation needed for near vision tasks after treatment will also increase convergence which may exacerbate a convergence excess esophoria, resulting in decompensation.
- Where the patient has a heterophoria that is poorly controlled, if the eyes are not perfectly binocularly balanced after surgery, it could result in a breaking down of the heterophoria into a heterotropia.

If there are any doubts about the patient's potential binocular vision after treatment, then contact lenses can be used to simulate the treatment correction. All problems associated with prism or accommodation will then be revealed except in the latter case, where treatment under or over correction is unintentional and, therefore, not predictable.

Ocular dominance testing

This is recorded as baseline data. This information will enable the surgeon to decide which eye should be undercorrected in the case of myopic presbyopes who want monovision. In other cases, where the corneal thickness is borderline for the patient's prescription, the patient may be happy to be slightly undercorrected in their non-dominant eye as it is unlikely to have a significant effect on the vision. This could mean the difference to being suitable or not suitable for LASIK.



Figure 4.1 Ocular dominance testing

The simplest way to check ocular dominance is the ‘paper telescope’ test. A piece of paper is rolled up into a long tube and handed to the patient. The patient is then asked to hold it in both hands and to look through it as if it were a telescope. The patient will hold it up to their dominant eye (see Figure 4.1).

Another method is to ask the patient to fixate a distant target and then point directly at it. If the patient automatically closes one eye to fixate, then the dominant eye is usually the open eye. If both eyes are kept open, only the dominant eye will be in line with the target (Figure 4.2a). Covering each eye in turn will establish which eye is dominant. The example in Figure 4.2b shows a right dominant

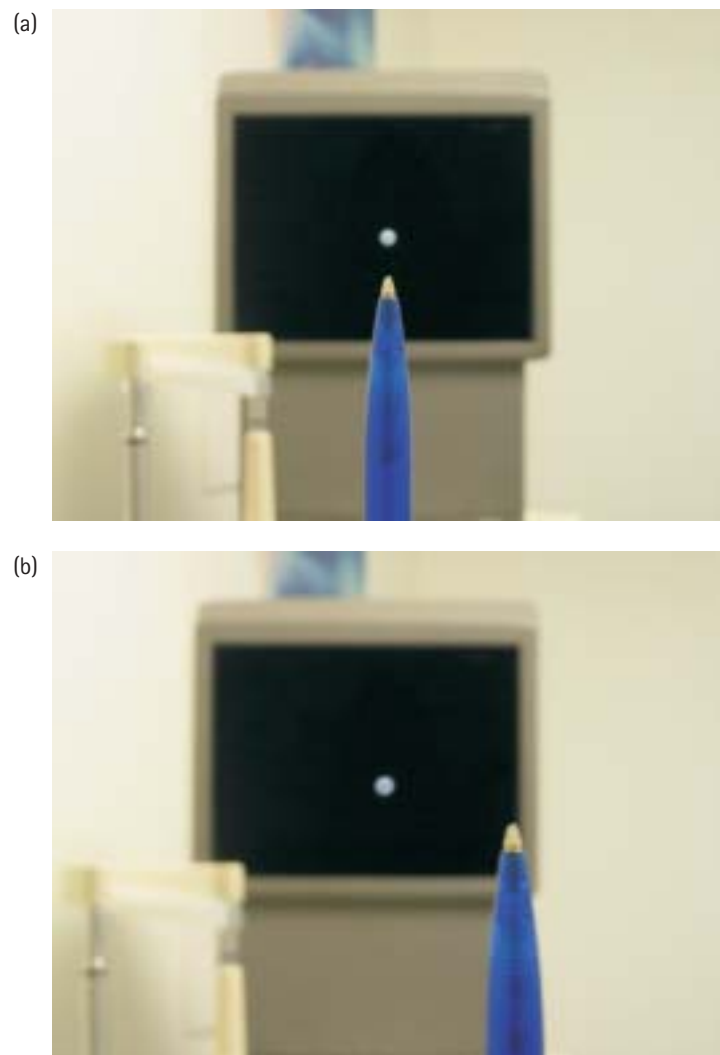


Figure 4.2 An alternative method of ocular dominance testing. (a) Target viewed through the dominant eye; (b) target viewed through the non-dominant eye

eye with the target being displaced when to the left when the right eye is closed. If there is displacement from the target in both eyes equally, there may be equal ocular dominance. Ocular dominance testing is not always consistent and it can also change between distance and near vision.

OCULAR EXAMINATION

If any of the following examinations reveal any potential contra-indications to surgery, the patient will need to be referred to the treating surgeon for an assessment before suitability for treatment can be confirmed. Ideally, this should be scheduled at least 24 hours prior to treatment day as indicated in The Royal College of Ophthalmologists' guidelines.

Anterior eye examination

The lids and lashes must be clear of any signs of blepharitis. The conjunctiva and sclera should also be quiet. The cornea should be checked for any corneal dystrophies or signs of previous herpetic activity. The anterior chamber should be examined and assessed prior to dilation. The lens is also checked for any signs of cataract, which if found, may alter the type of refractive surgery recommended to the patient.

Tear film assessment

The tear prism height will give an indication of tear volume; Figure 4.3 shows an adequate tear prism. Fluorescein has been used in this case to allow ease of observation but is not always necessary. Non-invasive tear break-up time will indicate



Figure 4.3 An indication of tear volume can be found by measuring the tear prism height

tear quality; this can be done by observing the tear film on a slit lamp or by observing keratometer mires (see Figure 4.4). In some cases, surgeons may prefer to use a Schirmer type test.

Dilated fundoscopy

The retina should be healthy and in particular, be checked for any signs of optic disc damage, retinopathy or peripheral retinal thinning dystrophies.

Tonometry

This measurement is required for baseline data purposes as it is likely to change after corneal surgery. The measurement can be taken with non-contact or contact tonometry or even both.

Endothelial cell analysis

This is an optional examination which can help to screen for corneal anomalies. If the endothelium has already been significantly compromised by contact lens overwear, it may alter the effectivity of the endothelial pump to resolve corneal oedema.

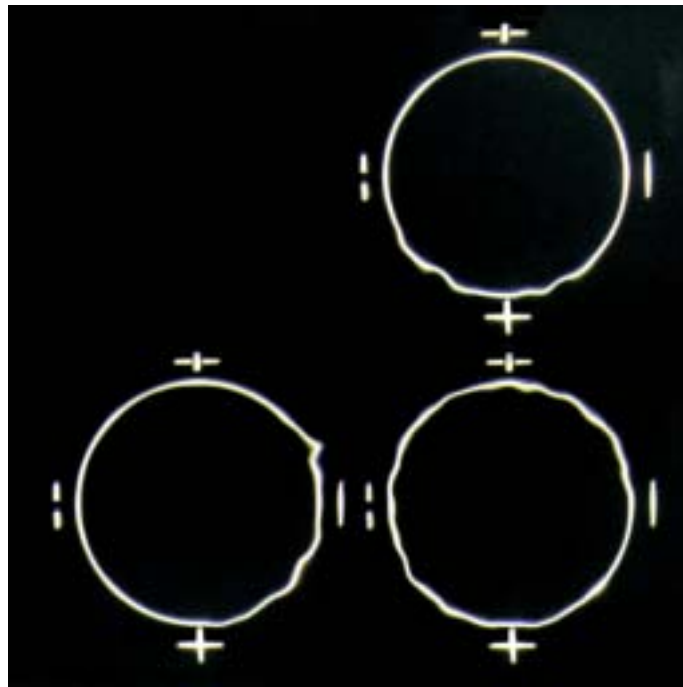


Figure 4.4 The time taken between blinks for the mires to distort as shown here is the tear break-up time which is an indicator of tear quality

PACHYMETRY

This measurement is an essential piece of pre-operative data which is used to calculate the residual stromal bed and ultimately determines whether or not the treatment can be carried out. Ultrasound pachymetry has been considered the gold standard but recent studies have shown that instruments such as the Orbscan II which use a scanning slit also have good correlation on pre-operative corneas.¹⁻⁴

The cornea is usually the thinnest at the centre and in keratoconus, at the apex of the cone. Therefore, when taking pachymetry measurements, it is best to check the topography for any potential corneal thinning dystrophies before relying on the central measurement. In the normal eye, the thinnest area is usually in the central area of the cornea. Thickness increases towards the periphery with the temporal cornea being thinner than the nasal.

Taking the measurement

1. Check that the probe head has been disinfected.
2. Instil a topical anaesthetic.
3. Place the tip of the probe so that it is normal to the cornea and make contact.
4. Most pachymeters beep when a reading has been taken.
5. Repeat the measurement to obtain an average of 3 readings.

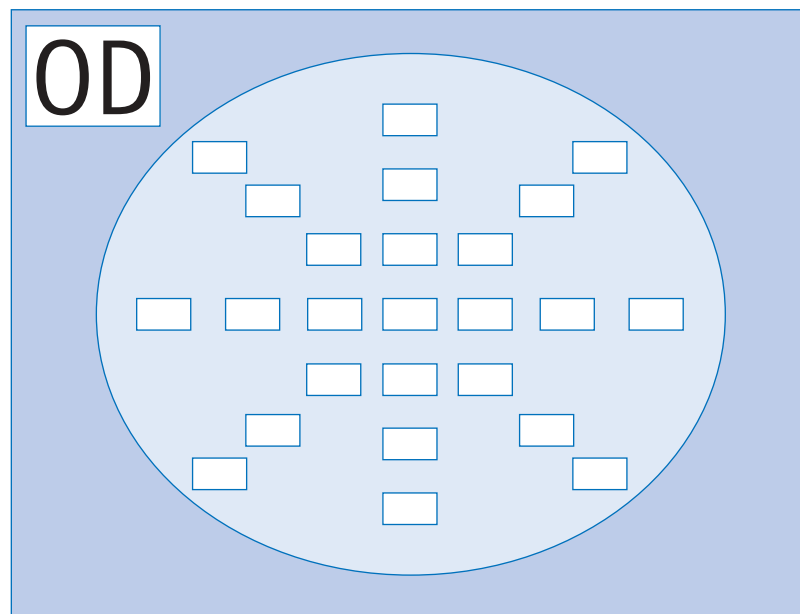


Figure 4.5 A pachymetry map of the cornea can be built up by systematically measuring different points of the cornea

6. Where topography indicates a localised area of steepening or flattening, carry out measurements in those areas.
7. It is then best to record these measurements as a pachymetry map (see Figure 4.5).

Suitability calculation

This can be done by the optometrist to rule out any obviously unsuitable patients before they have a final assessment with the surgeon. The ablation depth for each patient can be calculated using specific tables provided by the laser manufacturer which are based upon the Munnerlyn formula.⁵

$$\text{Depth of ablation} = (\text{Diameter of ablation})^2 \times (\text{Dioptres of correction})$$

Table 4.1 shows typical ablation depth per dioptre, and it can be seen that a greater treatment zone diameter requires a greater depth of ablation to achieve an equivalent amount of correction. Proprietary software results in different lasers ablating different amounts of tissue per dioptre of correction. The treatment zone is determined by the scotopic pupil measurement, and the dioptic power of the treatment is taken from the highest powered meridian of the patient's prescription. The ablation depth is read off the appropriate column and then subtracted from the lowest pachymetry measurement. The result indicates the total remaining corneal thickness. It is generally recognised by ophthalmologists that a minimum residual stromal bed thickness (RST) of 250 μm must remain under the flap after surgery. The flap thickness is usually set by the treating surgeon and depends upon the microkeratome being used. It can be between 110 and 180 μm .

$$\begin{aligned} \text{The residual stromal bed must be } &\geq 250 \mu\text{m} \\ \text{RST} &= \text{Corneal thickness} - (\text{Ablation depth} + \text{Flap thickness}) \end{aligned}$$

Table 4.1 Ablation depth required per dioptre of correction for set treatment zones

	Required correction 6 mm treatment zone	Ablation depth (μm) 7 mm treatment zone
-1.00	12	16.3
-2.00	24	32.7
-3.00	36	49
-4.00	48	65.3
-5.00	60	81.7
-6.00	72	98
-7.00	84	114.3
-8.00	96	130.7

Example calculation

Scotopic pupil = 5.8 mm

Refractive error = $-3.00 / -3.00 \times 180$ (highest powered meridian)
= -6.00)Pachymetry = 540 μm *Assuming a treatment zone diameter of 6 mm*Flap thickness = 160 μm Ablation depth (from table) = 72 μm RST = $540 - 160 - 72 = 308 \mu\text{m}$

This treatment can be safely carried out. It should be made clear to the patient that the final clinical suitability is decided upon by the treating surgeon who will also select the final surgical parameters. Any indication of suitability by the optometrist is for final assessment by the treating surgeon only and not for the treatment itself.

FINAL ASSESSMENT

If the patient is found to be suitable for treatment, they can then be booked in for surgery. The surgeon will need to meet the patient and check the notes to confirm suitability. The surgeon may also wish to check that all the patient's questions about treatment have been answered. This has usually been done on the day of treatment itself but recently, The Royal College of Ophthalmologists has produced guidelines indicating that this should be carried out at least 24 hours before treatment so that the patient has an adequate cooling-off period.

OPTOMETRIST DISCHARGE

If the patient is not suitable for treatment, other refractive surgery options may still be an option. A summary of these other options can be found at the end of this chapter. If the patient is not proceeding with treatment, the optometrist still has a duty of care to the patient to ensure that an examination to detect 'signs of injury, disease or abnormality in the eye' has been carried out according to *The Optician's Act (1989)*.⁷ The purpose of the assessment is not a routine eye examination as in practice, but specific to determining suitability for treatment in the clinic. Therefore, it is not necessary to issue a prescription for spectacles. The patient should be informed that a routine eye examination should still be carried out by their own optometrist after the usual recall period. However, if any abnormality is found, it must be referred to the patient's GP.

OTHER REFRACTIVE SURGERY OPTIONS

Surface ablation

This refers to photorefractive keratectomy (PRK) and laser epithelial keratomileusis (LASEK). These two procedures are very similar and involve removing the epithelium before applying the laser. In PRK, the epithelium is removed using rotating abrasive brushes. In LASEK, ethanol is applied for up to 30 s to loosen the epithelium before it is peeled back. It can then be replaced after treatment, whereas in PRK, the epithelium needs to regenerate completely. At the end of the LASEK procedure, a bandage contact lens is applied to the eye which helps to keep the epithelium in place. Epi-LASIK (epipolis laser in situ keratomileusis) is an alternative method of lifting the epithelial flap mechanically using a blunt oscillating blade rather than an alcohol solution. It is still a relatively new technique and few studies have been performed to date.⁸

Surface ablation surgery is not subject to the same risks as LASIK where a flap is cut using a microkeratome, but the risk of haze and regression is greater in larger corrections. It is also possible for the epithelial flap to become detached during treatment, so the surgeon may attempt LASEK, but actually carry out PRK. This method of treatment is suitable for mild-to-moderate myopes whose corneas are thin, for which LASIK may not be possible. It may also be more suitable than LASIK for those patients who are at high risk of ocular trauma in their occupation or hobbies. Early postoperative discomfort is greater with surface treatments, but final visual outcome is similar to that of LASIK.

Some studies have indicated that the benefits of the LASEK 'epi-flap' were faster healing, reduced risk of haze and less postoperative pain than with PRK.⁹ Other studies have not supported this,¹⁰ with one study stating 'no additional clinical benefit is seen from the LASEK procedure relative to the PRK procedure'.¹¹ It is generally accepted that more studies are needed to understand the potential benefits of LASEK.¹² The LASEK technique is discussed in more detail in Chapter 10.

Radial keratotomy

Radial incisions which may involve up to 90% of the corneal thickness are arranged in a concentric pattern around a central optic zone. The refractive effect is controlled by the number and depth of incisions, as well as the size of the central clear zone. The effect will depend upon the age of the patient. It can be used to correct mild degrees of myopia, and is now used more as secondary technique to correct residual myopia after other surgical procedures.

A variation of this is astigmatic keratotomy, where an incision is made perpendicular to the axis of the steepest meridian. This has the effect of flattening that meridian and correcting the astigmatism. The degree of flattening depends upon the length, depth and position of the incision. It can be used to correct up to 4.00 D of astigmatism.

Clear lens extraction and intraocular lens (IOL) implant

This procedure is essentially the same as modern cataract surgery except that the lens is removed before opacification has occurred. The IOL implant that is used to replace the natural lens is calculated to correct the refractive error of the patient. Toric IOLs are also being used by some surgeons, although the outcome for correcting corneal astigmatism is less predictable. Any residual prescription can be treated with LASIK or surface ablation. If there is any astigmatic error, it could also be treated with astigmatic keratotomy.

This procedure is particularly suitable for presbyopes who may have early lens opacities and for those patients whose refractive error is too great to be corrected safely with LASIK or surface ablation. Although cataract extraction and the insertion of IOLs is a relatively common procedure, it is not without risk and this should be discussed with the treating surgeon. The main risks associated with this type of surgery are infection. The risk of retinal detachment also increases after surgery.

The loss of accommodation makes this procedure unsuitable for young patients and although multifocal implants are available, they do not consistently provide good near vision for all patients. Implants that simulate accommodation are also emerging and in time, they may remove this barrier to lens extraction in pre-presbyopic patients.

Phakic intraocular lens implant

This procedure for myopia is carried out when the patient's own crystalline lens needs to be preserved. The lens can be placed in the anterior chamber, fixed to the iris or in the posterior chamber. This procedure is less popular now due to the advances made in alternative techniques.

Implantable contact lens (ICL)

This is a reversible procedure which allows the correction of high degrees of myopia and, in some cases, hypermetropia. It is primarily used when corneal surgery is not suitable and where accommodation needs to be preserved. The ICL is inserted through a small sutureless incision into the posterior chamber but does not touch the crystalline lens. Potential complications include endothelial or lens trauma, and lens decentration. Peripheral iridectomy is also required with this procedure to prevent pupil block glaucoma. Visual complications include glare, haloes and ghosting when the pupil dilates in scotopic conditions due to the edge of the ICL falling within the pupillary area.

Intrastromal corneal ring segments (ICRS)

These are curved polymethylmethacrylate corneal implants that extend 150° of arc that are placed at a depth of 66% of the corneal thickness in the peripheral cornea. The distension in the periphery causes a flattening of the central cornea

Table 4.2 Summary of alternative refractive surgery procedures

Procedure	Treatment range	Accommodation preserved	Reversible	Risks specific to treatment	Risks that apply to all treatments
Surface ablation (PRK/LASEK)	+1.00 to -4.00 D	Yes	No	Haze Regression	Infection
Radial keratotomy	Up to -6.00 D	Yes	No	Micro-perforation Progressive hypermetropia Endothelial cell loss Limited predictability Variable vision	Inflammation Under/over correction
Phakic IOL	Manufacturer's availability	Yes	Yes	Endothelial cell loss Crystalline lens trauma	Induced astigmatism
Intraocular contact lenses				Lens opacities	
Aphakic IOL	Manufacturer's availability	No	No	Endothelial cell loss Increased risk of retinal detachment	Irregular astigmatism
Intrastromal corneal ring segments	-1.00 to -3.00 D	Yes	Yes	Stromal deposits Focusing difficulties Discomfort	Glare, haloes, ghosting

and a subsequent reduction in myopia. The reduction depends upon the thickness of the implant and can correct between 1.00 and 4.00 D of spherical myopia. Sutures are not required and the procedure is also reversible as no corneal tissue is removed. The procedure is very safe and complications, although rare, include induced astigmatism, vascular ingrowth, and peripheral stromal deposits. Visual complications include glare, focusing difficulty and discomfort. This technique can also be used to manage keratoconus.

A summary of the main features of these techniques is presented in Table 4.2.

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