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Module 3 Part 4
Contact Lens Fitting Today

Contact lens fitting today
Fitting for the irregular cornea

Successfully fitting the irregular cornea with contact lenses can be one of the greatest challenges to the contact lens practitioner. This article reviews fitting contact lenses to the irregular cornea found in primary cornea ectasias, post corneal graft and, finally, post refractive surgery.

Primary corneal ectasia CL fitting

The primary corneal ectasias include keratoconus, keratoglobus and pellucid marginal degeneration. Keratoconus is the most commonly encountered of these and so this article will concentrate on keratoconus management. These conditions are characterised by corneal thinning and ectasia, which results in varying degrees of irregular astigmatism and a scissors reflex on retinoscopy[1].

Spectacles are only used to manage primary corneal ectasias in the early stages and surgery, usually penetrating keratoplasty (*see later*), is performed when all other options have failed or visual acuity is significantly reduced. Contact lenses are used to manage keratoconus in the majority of cases.

Before making a decision on which type of contact lens fitting method is most appropriate, classifying the degree and type of keratoconus is helpful (**Table 1**)[1].

Cone classification

Being able to classify the position and size of the cone will also influence the contact lens fitting method selected. The best way to do this is to undertake computerised corneal topography, from which there are basically three cones types that can be identified[2]:

1. **Nipple Cones.** These have variable conicity and are usually located below the visual axis although these can be central.
2. **Oval Cones.** These have a larger inferior conical area and also below the visual axis. If there is significant inferior thinning, pellucid marginal degeneration should always be considered (**Figure 1**).
3. **Globus Cones.** At least 75% of the cornea is affected and Munson's sign is usually present (forward displacement of the lower lid by the cone on down gaze). These are relatively rare.

RGP materials

In choosing appropriate materials, it is important to remember that keratoconic patients (as well as in other primary corneal ectasias) demand high levels of comfort because they wear their lenses for long periods of time. With steep high minus lenses, which are often required, materials with high dimensional stability are recommended in order to minimise lens distortion. Mid to high DK/t lens materials are preferable, especially for large or flatter fitting lenses, but lower DK/t lenses are still used for stability and superior wetting properties.

Rigid lens fitting methods

Rigid gas permeable (RGP) lens fitting is by far the most common and successful method of correction of the keratoconic eye[3]. There are many lens designs to choose from and some are more successful than others at fitting different stages of the disease and cone types. Different fitting methods can be summarised as follows.

Apical clearance: With this fitting method, the lens is supported fully on the paracentral cornea, vaulting the cone. Problems with this kind of fitting include corneal oedema, diminished tear exchange, bubbles creeping into the central optic zone, which result in poor VA. Small diameter lenses are usually needed for

Table 1
Classifying keratoconus

Stage of keratoconus	Features
Early	Keratometry (Ks) normal range Good spectacle VA
Moderate	Steepening central Ks <7.3mm Presence of striae; fleischers ring
Advanced	Ks <6.1mm Presence of stromal thinning; apical scarring
Severe	Ks <5mm Globic cones Possible hydrops episode apparent

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acceptable results but this restricts the back optic zone diameter (BOZD) often resulting in flare and glare problems.

Flat fitting: Almost the entire weight of the lens bears on the cone with a wide edge stand off. Apical touch gives better visual acuity and vision may be improved immediately after lens removal due to moulding of the cornea by the contact lens. Flat fitting lenses are, however, probably associated with the development or acceleration of apical changes and scarring. Although alignment is only achievable in early keratoconus, this method is still useful in certain cases where there are displaced corneal apices, despite its drawbacks.

Three-point-touch: This is still a commonly accepted fitting method with multicurve lens designs (*see later*) where the aim is to distribute the weight of the lens between the cone and the peripheral cornea. The fit should show an apical contact area of 2-3mm and a mid peripheral contact annulus. The area of mid peripheral touch may be more crescent shaped where there is vertical asymmetry of the cone.

Rigid lens designs used in keratoconus

Multicurve: Standard multicurve designs may suffice in early keratoconus, but there are also many more specialised multicurve designs for more advanced disease, e.g. the Woodward design. The main advantage of using a multicurve is that all the lens parameters are known, and modifications can be easily ordered by the clinician.

Spherical lenses to fit the periphery: These multicurve lenses are based on the principle that the corneal periphery remains relatively unchanged in early to moderate disease. These lenses have essentially normal peripheral curves, but with a much steeper BOZR. The cone radius is selected from central Ks and there are a number of different peripheries for each cone radius to choose from, e.g. Shepherd (Acuity) NLK (Northern Lenses), Profile lenses (Jack Allen) and, of course, the Rose K system.

The Rose K is widely fitted nowadays and is particularly useful in cases where the cone is fairly central (**Figure 2**). For very inferiorly displaced cones, the Rose K is not so successful. This lens design features complex, computer-generated peripheral curves based on statistical data that Dr Paul Rose of New Zealand collected on his keratoconus patients. The lenses incorporate standard, flat and steep peripheral systems to achieve the ideal edge lift of 0.8mm. It is available in base curves of 4.75-8.mm and diameters of 7.9-10.2mm. The Rose K design decreases the optic zone diameter as the base curve steepens. Toric curves are available on the front and rear surfaces, as well as peripherally. Rose K lenses are traditionally made in the Boston ES material, but some labs make them in the Boston XO material, which offers increased oxygen permeability.

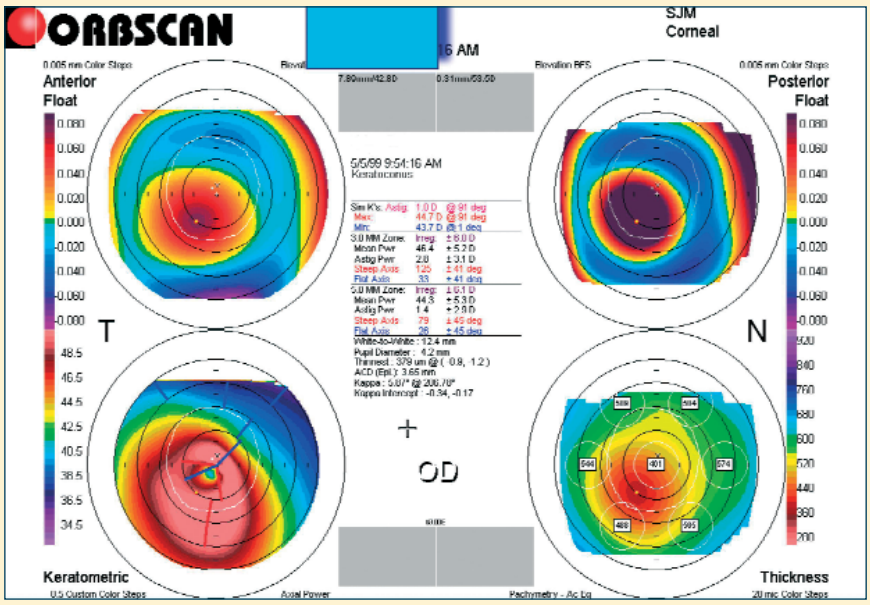


Figure 1
Orbscan topography demonstrating a keratoconic oval cone

Aspheric/elliptic: Part or fully aspheric lenses designed for normal eyes can be useful in early keratoconus. Examples of aspheric lenses designed specifically for keratoconus include the No 7 Quasar K and the Jack Allen KD, available in any requested material. Older lens designs, which are still available, include the Persecon Elliptical K (CIBA Vision) lens which is bi-elliptical in design, where the peripheral zone is flattened using a second ellipsoidal curve with the same eccentricity but flatter vertex radius. The relatively large optic zones of aspheric lenses make them useful with large pupils and for oval type cones. Aspheric lenses are now available in a wide variety of materials.

Large diameter lenses

Large bicurve and multicurve designs of up to 14.5mm are available in a number of designs. These include the following.

Soper cone. This is a bi-curve contact lens with a fitting philosophy based on sagittal depth. The vaulting effect of the lens increases as the base curve decreases for a given diameter. This avoids apical lens bearing, which may lead to corneal scarring.

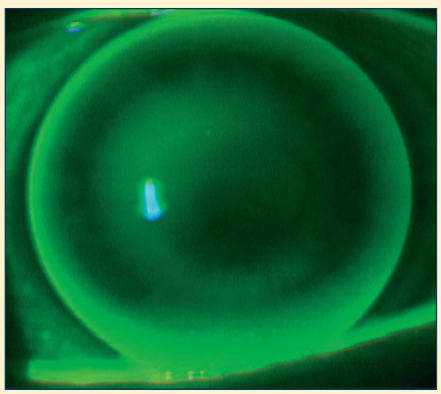
McGuire. This lens system is a modification of the Soper design and possesses four peripheral curves, which are blended together to give an almost aspheric relationship. It consists of three diagnostic lens sets, formulated for the nipple, oval or globus types of keratoconus. The fitting philosophy aims to achieve a three-point touch, which is dependent upon the size of the optic zone in relation to cone size.

Dyna Intra Limbal (DIL) (No 7). This is specifically designed for inferiorly apexed keratoconus and pellucid marginal degeneration, as well as post corneal graft (*see later*) where stability is hard to achieve with smaller diameter lenses. The standard DIL diameter is 11.2mm but can be manufactured in a range of diameters from 10.8mm to 12.5mm. Ideally, the TD should be 0.2mm smaller than the corneal diameter, which should allow approximately 0.5mm-1mm lens movement. These lenses do have a tendency to 'settle back', which may result in excessive bearing on the cone apex resulting in epithelial/stromal scarring. High DK materials are recommended with these lenses.

S-Lim lenses (Jack Allen). This semi scleral lens is manufactured to vault the graft by altering the sag depth accordingly. It is designed to rest mainly on the limbus with relatively little movement. To aid tear exchange, two standard fenestrations are included as standard but up to four are possible.

Kerasoft lenses (Ultravision). This is a soft lens (58% Terpolymer) specifically manufactured for keratoconus, which is drape resistant. In order to correct varying levels of astigmatism, it is a back surface cylindrical design which can correct (in theory at least) up to 11DC. This lens is available in three series – A, B and C – with

Figure 2
Ideal fit Rose K fit *(by courtesy of Nova)*



total diameters (TD) of 14mm, 14.5mm and 15mm. Series B is the most commonly fitted and is a flatter fit compared with the Series A lens. To steepen a Series A lens, the TD can be increased from 14.5mm to 15mm. To flatten a series A fit, a series B lens should be tried. With a series B lens, to steepen the fit either choose a 15mm TD or try a series A lens. To flatten a series B fit, move to a series C lens.

In the author's experience, these lenses take a long time to settle in order to accurately assess the fit and they are not particularly successful at correcting moderate to high levels of astigmatism, therefore tending to only work in early cases of keratoconus.

Hybrid SoftPerm lenses

The SoftPerm lens (CIBA Vision) consists of a RGP centre of 8mm made of a silicone acrylate tertiary butylstyrene copolymer, surrounded by a soft 25% water content HEMA hydrophilic skirt with a TD of 14.3mm. A major drawback with this lens type is its very limited oxygen transmissibility (Dk/t) – and unacceptable lens tightening is a commonly encountered problem leading to inadequate lens movement. In the author's experience at least, the inevitable consequence of this is that corneal neovascularisation occurs, thus threatening the success of any future graft that may be required. For these reasons, very careful patient selection is necessary and careful follow-up is essential to ensure these lenses remain well fitting and complications avoided.

The next generation of hybrid lenses are now at an advanced research and development stage with clinical trials well underway. The new versions will offer higher oxygen permeability (Dk 100 to 105 ISO barrers units), with a 40-45% water content HEMA skirt[4].

Combination or piggyback lenses

Soft lenses are sometimes indicated where there is hypersensitivity to RGPs, or where lid sensation is a problem. However, good visual acuity may not be achievable with soft hydrogels alone. The increasing use of piggyback lenses (i.e. an RGP lens fitted on top of a soft lens) concept has resulted from the growing popularity of silicone hydrogels[5]. The increased rigidity (giving a lesser tendency to wrap to irregular corneas) and enhanced oxygen transmission of these lenses, compared with conventional soft lenses, makes silicone hydrogels a good choice for piggyback combinations in early keratoconus, as well as other cases involving irregular astigmatism. However, in more advanced cases with increased conicity, particularly involving inferiorly displaced cones, silicone hydrogels tend to pucker and not fit well, making piggyback combinations in these cases unsuccessful.

Where possible, the principle is to fit a best fit silicone hydrogel or conventional soft lens with a low plus back vertex power, e.g. +2.00D. Keratometry is then measured with the soft kens *in situ* on which to choose the BOZR of the RGP, which should be slightly flatter than K. The BOZD should be around 7.8mm to 8mm. Lens TD is determined by practitioner preference and lid aperture. The RGP lens should centre well over the soft lens. Two-step hydrogen peroxide solutions are recommended for disinfection of the lenses[6].

Scleral lenses

With the continued development and improved availability of sealed sclerals (i.e. unventilated) these are another option for irregular corneas due to the primary corneal ectasias, as well as post keratoplasty (*see later*). An irregular corneal surface is completely neutralised by scleral lenses and, therefore, makes the fitting of very irregular eyes much easier. Scleral lenses still play a very important role in the management of keratoconus where corneal lens fitting is rendered impossible in advanced disease, and when surgical intervention is not advisable due to severe atopic eye disease or in the presence of a vascularised cornea.

Current high DK/t lens materials allow sufficient oxygen transmission through the required thickness of scleral lenses. The excellent range of RGP lens materials from which they are now made makes the risk of corneal oedema a minor problem. Gas permeable sclerals are fitted in a preformed design and lathe cut, then usually fitted 'sealed' with saline in contact with the eye. These lenses are supported almost entirely by the sclera and generally centre very well. Toric haptic portions are also possible to manufacture if the patients have toric sclerae. They are simple to maintain and easy to handle by the patient who will find them almost impossible to lose. In some cases, sealed sclerals are unsatisfactory and so a corneal impression moulding is needed to produce a shell that fits the irregular cornea.

Common aftercare fitting problems in keratoconus

Peripheral staining. This is usually in the form of three and nine o'clock staining in areas of drying surrounding the lens. Trying larger diameter lenses, reducing edge lift, using blinking exercises or using ocular lubricants, are recommended.

Vortex staining. This is seen with flat fitting lenses, which insult the epithelium. The swirling pattern of fluorescein staining is due to migration of epithelial cells. Steepening the lens to reduce pressure on the cone and increasing Dk/t of the lens material are helpful.

Dimpling. This is due to bubbles creeping into the optic zone, which are effectively smooth foreign bodies trapped under the lens. These are often seen when

Table 2

Summary of keratoconus management options (AOP Hospital Information Series)[7]

Options	Early	Moderate	Advanced nipple	Advanced oval	Severe globus
Spectacles only	*				
Soft lenses	*				
SoftPerm	*	*			
Standard RGP	*	*			
Aspheric RGP	*	*			
Multicurve RGP		*	*		
Peripheral		*	*		
Apical fit			*		
Large TDs				*	
Piggybacks		*	*		
RGP sclerals		*	*	*	*
Surgery			*	*	*

Table 3

Post graft corneal topography classification

Corneal graft type	Comment	Percentage of cases	Topographic appearance
'Nipple like' or 'proud'	Graft steeper than host periphery	30%	Central red bow-tie; prolate topography centrally
'Flat' or 'sunken'	Graft appears sunken	30%	Central blue bow-tie; plateau or oblate topography centrally
Mixed	Flat side and steep side with regular and irregular astigmatism	18%	Combined prolate and oblate topography
Tilted	Causes CL decentration	-	Various
Other	-	-	-

using normal GP lens designs on an early keratoconic, or where there is excessive apical clearance. Try reducing the BOZD and adding in an additional peripheral curve by using a different multicurve design.

Nebulae. These are caused by wearing a flat fitting lens, causing a small raised area of scarring in the superficial stroma. This causes discomfort and reduced wearing time. A nebulus may be mechanically debrided with, for example, a scalpel blade or even removed with excimer laser phototherapeutic keratectomy (PTK) if available.

Stromal scarring. This is inevitable in later stages of the disease and may affect visual acuity. If VA is decreased significantly as a result, then this may be an indication for graft surgery.

Thinning. This is managed similarly to stromal scarring. Although not likely to cause corneal perforation, if significant thinning is present then surgery is again indicated.

GPC. This is a difficult problem but unfortunately common because of associated atopic disease seen with keratoconus in particular. Non-preserved solutions, mast cell stabilisers, e.g. Opticrom and Alomide, are helpful as well as steroids if this is severe enough to warrant their use.

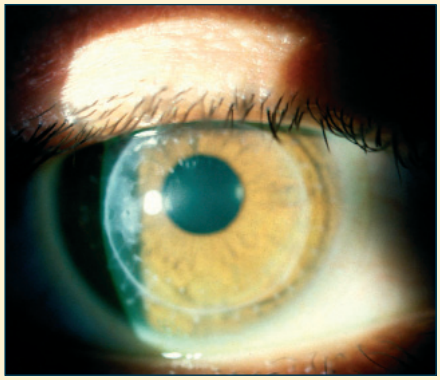
Neovascularisation. This should be avoided at all costs as this will seriously jeopardise the success of future corneal graft surgery. Softperms and PMMA sclerals are the worst offenders.

Table 2 summarises keratoconus management options.

Post penetrating keratoplasty contact lens fitting

Fitting contact lenses post penetrating keratoplasty (PK) can be one of the greatest challenges to the contact lens practitioner. PK involves the replacement of abnormal host tissue by healthy donor corneal tissue, and a corneal graft may be partial thickness (lamellar or deep lamellar) or full thickness. Despite advances in surgical techniques for PK[8], post-operative ametropia and high irregular astigmatism still remain common. Up to 10% of patients undergoing PK benefit from a contact lens to achieve optimal visual acuity[9].

Figure 3
Corneal graft *(by courtesy of Stephen Morgan)*



Factors affecting CL fitting post PK

These include the following.

Post PK endothelial morphology. Endothelial cell damage does occur at the time of PK surgery, with more cells being lost from the peripheral graft and recipient cornea nearer the junction compared with the centre of the graft. For this reason, appropriate contact lens materials with sufficient high DK/t values should always be used[10].

Post transplant corneal topography. Important features of the post PK cornea, which influence contact lens design and fitting, include graft size, graft centration, suturing technique and overall corneal topography[11]. Wherever possible, computer assisted topographical assessment of the central, and peripheral cornea should always be undertaken in order to assess what contact lens options will be the most appropriate[12]. Another important consideration is the fact that corneal sensitivity is reduced but lid sensation remains normal post PK. The normal cornea is a prolate shape, which is in contrast to that of the PK cornea[13]. Post PK corneal astigmatism may be as high as 15D but is usually around 6D. The corneal topography of the post PK cornea is classified in **Table 3**[14].

Suturing technique and the **sizing of the corneal graft** are other important surgical factors affecting contact lens fitting outcomes.

Two different suture techniques are used or a combination of both. Interrupted sutures, particularly when relatively long on the recipient side, tend to cause a flattening, or 'drum head' effect, due to the radial forces induced. This is in contrast to the 'purse string' effect producing a steep corneal profile, seen with continuous or double continuous sutures as a result of the tangential forces induced[15].

The diameter of the graft zone is usually between 7.5mm and 8.5mm for the best prognosis[16] (**Figure 3**). The donor tissue trephine is usually sized 0.25mm larger than the host but, in certain cases, e.g. in active infection, pellucid marginal degeneration or most commonly keratoconus, the graft may need to be decentred and possibly oversized to encompass this pathology. This may induce various amounts of graft decentration and also astigmatism. In such cases, aligning the graft over the centre of the pupil (which approximates to the line of sight) is not possible[17].

Optical CL fitting post PK

No particular type of lens or fitting regimen is ideal post PK, although RGP lenses are the most common type used. The most

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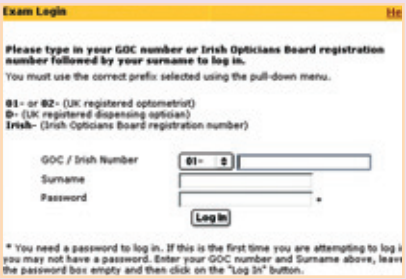

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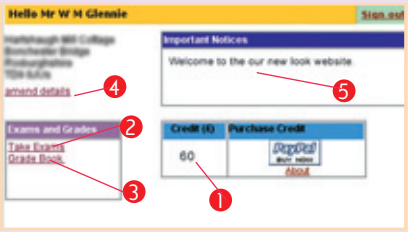

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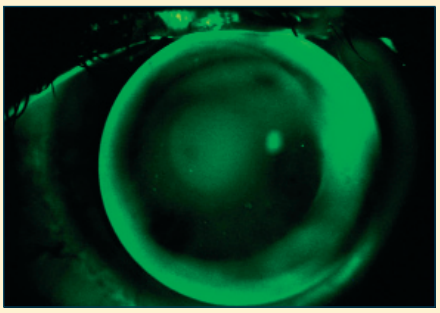


Figure 4
RGP fitting over a proud graft

common diagnosis eventually leading to PK is keratoconus, which accounts for around 60% of cases[18]. Of these, up to 25% of patients may require contact lens correction post surgery[19]. Where irregular astigmatism is involved, RGPs provide the best contact lens solution for visual performance and patient tolerance (**Figure 4**).

Commencement of CL fitting

Optical correction, as opposed to therapeutic contact lens fitting, may start as early as three months but usually six to 12 months post PK. Contact lens wear after PK has a potential risk of complications, including epithelial defects, corneal ulcers, neovascularisation and graft rejection or failure. Close monitoring is essential and frequent lens changes may be required, particularly in the early years when steroids are being gradually reduced and when sutures may still be in place. The importance of regular follow-up and educating PK patients to seek urgent attention should they develop any pain, redness or decreased vision cannot be over emphasised[20].

Post PK rigid CL fitting

Irregular astigmatism PK is a common indication for optical contact lens fitting, but other indications include spherical anisometropia and astigmatic anisometropia. Post PK, the host graft junction is often quite irregular and so fitting contact lenses that fit within the graft area may cause mechanical irritation at the host graft junction and induce neovascularisation into the donor tissue[21]. Therefore, current practice recommends that large diameter lenses (greater than 10mm TD), which vault the graft where ever possible, are used. The lens should rest on the host peripheral cornea as much as possible, but without excessive bearing in any one location and with acceptable alignment. This is particularly true with proud, tilted or displaced grafts[22]. The BOZD should be larger than the donor button to give optimum vision, thus avoiding glare problems[23]. Fluorescein corneal staining is a common drawback with large TD lenses caused by inadequate lens movement. Fenestrations and/or ocular lubricants may be useful in managing this problem.

Rose K2 Post Graft Lens

The Rose K Post Graft Lens has a diameter of 10.4mm and a BOZR ranging from 6-9mm. High DK/t lens materials are recommended, such as Boston XO (DK/t 100). The best way to fit this lens is usually by using trial lenses and assessing the fluorescein fit both centrally and peripherally. The early graft post PKP will nearly always be flatter than the donor/host interface, which often has raised areas of scar tissue significantly steeper than the central cornea. This can cause the lens to decentre towards the steepest cornea. To overcome this, steeper or larger lenses are helpful. In the periphery, an optimum fit will give a fluorescein band 0.5mm to 0.7mm wide with no excessive stand-off anywhere.

It is also important to optimise location. If a lens decentres in any direction, then increasing the diameter usually improves centration; a diameter increase of 0.5mm will have a significant affect. A reduction in lens diameter should be considered if the lens is riding too high and encroaching onto the upper sclera. Post PKP, the graft will often have toricity and this should initially be ignored by using spherical trial lenses. If a toric lens is indicated, it must be determined whether the toricity is required over the entire lens or just the graft itself; commonly, a toric lens with the last 1mm spherical gives an optimum fit.

Dyna Intra Limbal (DIL) lens

In addition to keratoconus applications, the DIL lens is designed specifically for high astigmatic corneas post refractive surgery (*see later*) and tilted grafts. As with keratoconic fits vaulting the cone, this lens is also specially designed to vault the host graft interface area. Impingement on this area may result in complications and could cause graft failure. The DIL is fitted within the limbus, as opposed to other designs that extend onto the sclera. When using corneal topography to assist fitting, the initial trial lens should be selected to closely match the corneal curvature at the 4-5mm temporal position. Otherwise, start with the middle BOZR lens in the trial set. The lens should be flattened or steepened accordingly until good peripheral alignment is achieved with not too much central pooling. The optimum fluorescein pattern should show a minimum vault over the donor cornea and good alignment with the host cornea. In case of steepened grafts, light touch centrally is acceptable. Optimum axial edge lift should show 0.2mm of clearance. The DIL system starts with a standard edge lift but this can be increased or decreased in a step system. Computer modelling at the time of manufacture ensures reproducibility.

This versatile lens is available in a range of parameters including toric, bitoric and reverse geometry secondary curves with variable optic zone sizes.

S-Lim

See earlier.

Bi-sym lens

The post graft aspheric Bi-sym lens, manufactured by Corneal Lens Corporation of New Zealand, is particularly useful in keratoconic PKP cases. This lens uses asymmetric geometry (off-centred) to allow the back surface of the lens to locate over the decentred corneal apex, whilst maintaining orientation of the optic region at the visual axis. This is achieved by steepening the lower mid periphery of the lens independently of the upper mid periphery, creating a 'tuck-in' effect in the lower half of the lens. This improves the fit where excessive lower edge lift is a problem with other more conventional keratoconic designs.

The Bi-sym lens is produced on a DAC 'OTT' lathe. This features an oscillating cutting tool (moves in and out) in precise synchronisation with rotation of the spindle, so surfaces may be turned on the lathe that are not rotationally symmetrical about the geometric centre. This lathe is capable of cutting two contours perpendicular to each other and activates an edge to centre continuous pass over the lens surface.

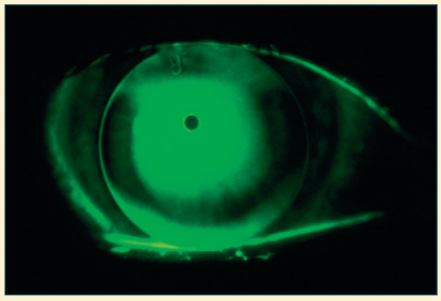
Where four asymmetric back surface quadrants and four blend zones are produced, this is called the 'Quad-Sim' lens. This is indicated where complex corneal topographies are involved[24].

Reverse geometry lenses (RGLs)

When the central graft is relatively flat and the peripheral cornea is more than 4.00D steeper, a conventional multicurve RGP (i.e. one that flattens progressively from centre to periphery) may well be unsuccessful. In such cases, the peripheral fit is usually satisfactory but there is unacceptably excessive central clearance and bubbles may result. Flat post-operative corneal grafts are the main indication for RGLs. These have become available because of the development of advanced computer numeric controlled (CNC) lathes. Although template fitting sets are available from various manufacturers, these usually only provide a starting point on which to design the final lens for individual patients.

RGLs were originally developed for use in orthokeratology[25] and later post refractive surgery, e.g. radial keratotomy (RK), photorefractive keratectomy (PRK)

Figure 5
Standard C3 RGP fit over a -5.00D PRK treatment – note central pooling



and laser *in situ* keratomileusis (LASIK) (*see later*). Some of the best known types include the Plateau lens, OK series (Contex) and the Plateau lens (Menicon)[26,27]. Typically, the secondary reverse curve is 1.00D-5.00D steeper than the BOZR. Optic zones range between 6-8mm and lens diameters range from 9.5mm-11.5mm to aid stability of the lens fit. When fitting RGLs, the aim is to achieve a fit with slight central clearance, mid peripheral alignment and good centration[28]. Lin *et al* reported 100% success with the RK 4 lens in a series of 15 selected post PK patients and provided visual acuity of Snellen 6/9 or better in 93% (14/15)[29].

In a recent study conducted at the Department of Ophthalmology, University of Nottingham, 11 cases (six male and five female; mean age 38 years) out of a total of 148 PK procedures in the study period had flat corneas 5-22 months post surgery[30]. All these were appropriately fitted with RGLs.

Soft lenses

Soft lenses with a TD of more than 15mm and a BOZR greater than 9mm are often required post keratoplasty. This is because, in the early stages post PK, many grafts are flatter than the host cornea (*see earlier*). Complete corneal coverage is also essential. The stock parameters in which disposable hydrogels are available are, however, still limited and therefore not suitable in all cases post PK[31]. For example, the TD of most disposable lenses only goes up to 14.5mm with a BOZR range of 8.3-9.1mm. Recently, the SofLens 66 (Bausch & Lomb) has been recommended as a good choice of disposable lens post keratoplasty owing to its incorporation of a reverse geometry design. This makes the lens particularly useful when fitting a proud graft[32].

Conventional toric soft lenses may well be satisfactory in PKP cases with relatively regular corneal astigmatism. These are often worth trying in the first instance to determine whether more complex lens options are required.

Combination or piggyback lenses

As with keratoconus, where there is increased sensitivity to RGP lenses, combination or piggyback lenses may also prove successful (*see earlier*).

Hybrid combinations

The SoftPerm lens (*see earlier*) is useful in some cases of decentred grafts, highly irregular corneal topographical profiles, tilted grafts or highly sensitive eyes. The same drawbacks and precautions apply with these lenses in post graft fitting as with keratoconus management, however.

Scleral lenses

These lenses are also useful post graft (*see earlier*).

CL fitting following refractive surgery

Despite recent advances in refractive surgical procedures, a small proportion of patients still achieve sub-optimal results for a variety of reasons[33]. In such cases, contact lenses may provide the only option for visual rehabilitation and restoration of binocular vision post refractive surgery. Fitting contact lenses after refractive surgery carries a reduced success rate for practical and psychosocial reasons. Often patients are very disappointed at having to wear contact lenses, particularly when it was problems with lenses that made them choose to undergo refractive surgery in the first place.

The most common laser refractive procedures are laser-in-situ keratomeliusis (LASIK), laser *in situ* keratomeliusis (LASEK) and photorefractive keratectomy (PRK). Following these procedures, the mid-peripheral cornea remains unchanged from its pre-operative state[34]. As the amount of attempted correction increases, the difference in curvature between flattened (in myopic corrections) or steepened (in hypermetropic corrections) central cornea and normal peripheral cornea increases. In low powered corrections the difference in corneal corneal curvature centrally compared with peripherally is not that significant. In high-powered corrections, special back surface designed contact lenses are indicated, i.e. RGLs (*see earlier*).

In many instances, conventional soft lenses can be fitted in the normal way, giving good levels of acuity[35]. This is particularly true for low powered corrections, or where contact lenses are preferred by the patient to spectacles, which give good levels of acuity as well. Any of the available daily disposable or frequent replacement soft lens modalities are viable options for most post refractive surgery cornea. However, traditional soft contact lens designs often provide less than optimal visual acuity. Improved optical correction can be accomplished with soft lens designs that incorporate anterior aspheric optics, since the aspheric optics aid in the correction of spherical aberration. As the difference in topography increases between the central and peripheral cornea, lens fit will become less stable.

The first soft lens choice would have a BOZR of approximately 0.3mm flatter than the flattest keratometry reading. Once settled, the lens should be assessed for adequate centration and lens movement (0.5-1.5mm) on blinking. There should be a stable over-refraction and visual acuity. Adequate soft lens fit can be determined from assessment of lens movement and an absence of central bubbles.

Soft toric lenses post refractive surgery

Where there is astigmatism (>0.75DC) then toric soft contact lenses may appropriate. These are fitted in much the same way as normal. Empirical fitting is, however, not recommended because of the atypical rotation on oblate corneas post refractive surgery[27] compared with normal, prolate corneas.

However, in higher degrees of astigmatism post refractive surgery, this may make toric soft lens fitting very difficult due to stabilisation problems, and difficulties aligning the lens adequately to the different curvatures across the cornea. It is important to remember that soft lenses cannot fully correct for irregular astigmatism that may occur post refractive surgery[28]. In the presence of significant astigmatism, rigid lenses may be preferable.

Rigid lenses may prove to be the only viable option in a number of cases where visual correction is required post-refractive surgery. However, fitting can be more complex since a rigid lens cannot follow the shape of both the flattened central cornea and the relatively steeper periphery. In higher corrections, as the amount of ablation increases, so the difference

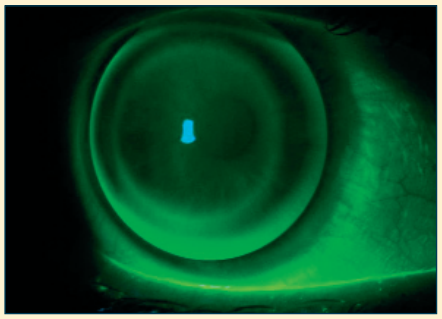


Figure 6
Reverse geometry lens *in situ*
(by courtesy of No 7)

between the flat central ablated zone and the relatively steeper peripheral cornea increases. This results in unstable optics, unacceptable central pooling and trapped bubbles when the lens is fitted in alignment with the peripheral cornea. In contrast, attempts to fit in alignment with the central cornea will give rise to grossly unstable flat fitting lenses. In such cases, RGLs are indicated, which create a plateau configuration more closely resembling the post refractive surgery cornea[32].

RGP lenses are fitted in much the same way as normal. The initial lens selection can be based on keratometry readings following surgery. However, these may be misleading as no information is provided about the mid peripheral and far peripheral corneal areas. Computerised corneal topography can be very helpful in understanding why a particular trial lens behaves in a certain way, but it is of little real practical help in actually fitting a lens.

Aspheric designs, e.g. B and L Quantum or No 7 Quasar, are preferred because these designs distribute lens mass more evenly across the cornea. The BOZR should, in general, be 0.1mm steeper than the mean keratometry reading 9.2-10mm TD. The fit should be assessed with fluorescein, checking for good lens centration, adequate pupil coverage and optimum lens movement (0.5-1.5mm). There should be good tear exchange, and slight apical fluorescein pooling is inevitable. For larger eyes (as in high myopes), consider larger TDs to aid centration and wider BOZDs for large pupils. The positive tear meniscus created in a myopic correction will be neutralised by additional minus power in the over-refraction. Very high Dk/t materials are not recommended, because these are relatively less rigid and tend to give more unwanted lens flexure.

Iatrogenic corneal ectasia, although relatively rare, is a serious complication post refractive surgery[36]. This results in a bulging forward of the weakened cornea, giving rise to a condition mimicking keratoconus[37]. Management is very similar to that of keratoconus (*see earlier*) with contact lenses being indicate in mild to moderate cases, but corneal grafting for severe cases.

Following LASIK, and LASEK, RGP lenses can be fitted approximately eight to 12 weeks after surgery, provided that the refraction and topography have stabilised, and corneal sensitivity has returned to its pre-operative state. However, following PRK the topography and refraction can take up to 12 months to stabilise. In the case of LASIK, at three months the integrity of the flap interface is usually sufficient to withstand the minor trauma associated with lens insertion, as well as the on-eye movement that occurs with blinking[38]. However, in some rare cases, stabilisation can take up to six months and there is little point commencing a fit if the topography is not stable, unless the patient is prepared for frequent lens changes.

Decentered ablations

Almost all patients with decentered ablations are left with varying degrees of uncorrected myopia[38]. This is due to the eccentric ablation zone, in which only a portion of the treatment zone lies over the visual axis. Viewing through the edge of the ablation frequently results in a loss of best corrected visual acuity, monocular diplopia and ghosting of distance images, especially under scotopic conditions.

The severity of symptoms often correlates with the size of the pupil. A decentered ablation with a large 6-7mm pupil will produce more serious complaints than a similarly displaced ablation over a small 3-4mm pupil.

Soft contact lenses rarely provide adequate optical correction in this small subset of patients. Optimal visual performance usually requires the use of an RGP lens design[39].

Lens parameters are best assessed based on pre and post surgical topographical maps but in the absence of these, assumptions can be made based on either pre and post surgical keratometry, or at least the pre and post surgical prescriptions and the post-surgical K readings, when the pre-surgical corneal shape can be predicted.

Significant astigmatism can add to lens instability and toric RGLs are not readily manufactured. In the absence of such lenses, the only problem solving approach to post surgical astigmatism is to keep total lens diameter as small as practical, and certainly less than 9.5mm.

Conclusions

- Patients with irregular corneas are challenging to fit
- If fitted at the appropriate time, these patients appreciate the benefits contact lenses provide for them
- Expect frequent re-fitting
- The initial fitting is the easy part as a range of associated complications can be difficult and challenging to mange
- A wide range of lens designs and materials are now available to choose from
- Post traumatic irregular astigmatism may be managed using a combination of the lens designs and techniques discussed in this article

References

For a full set of references, visit www.optometry.co.uk/references.

MCQs

Module 3 Part 4 of Contact Lens Fitting Today

Fitting for the irregular cornea

Please note there is only ONE correct answer

1. **Which one of the following statements is true?**
a. In keratoconus, nipple cones affect 75% of the cornea
b. The position and size of the cone do not influence the contact lens fitting method
c. Munson's sign is often seen in early keratoconus
d. Keratometry readings are less than 6.1mm in advanced keratoconus

2. **Which one of the following statements is false?**
a. Apical clearance is a fitting method in which the lens is supported fully on the paracentral cornea
b. The three-point touch fitting method aims to distribute the weight of the lens between the cone and the peripheral cornea
c. With a multicurve lens design, all the lens parameters are not known and modifications cannot easily be made
d. The Rose K is particularly useful in cases where the cone is fairly central

3. **Which of the following statements is true?**
a. The Soper cone lens is a multicurve contact lens based on back optic zone diameter changes
b. The McGuire lens is a modification of the Rose K lens system
c. The S-Lim lens vaults the graft by altering sag depth accordingly
d. The Dyna Intra Limbal (DIL) lens is contraindicated in pellucid marginal degeneration

4. **Which one of the following statements is true?**
a. When fitting a DIL lens, the total diameter (TD) should be approximately 0.2mm smaller than the cornea
b. When fitting a DIL lens, the TD is should be approximately 0.2mm larger than the cornea
c. The DIL lens is available in diameters of 9.8-13.5mm
d. Settling back is not seen with DIL lenses

5. **With regards to Kerasoft lenses, which of the following statements is true?**
a. To flatten series A Kerasoft lens, a series B should first be tried
b. To flatten a series A fit, the lens total diameter should be increased to 15mm from 14.5mm
c. The Kerasoft is a front surface toric lens design
d. Lens pucker is a common fitting problem with the Kerasoft lens

6. **Which one of the following statements is true?**
a. Neovascularisation is not a common complication seen with SoftPerm hybrid lenses
b. New generation SoftPerm lenses have a skirt with a water content of 40-50%
c. Silicone hydrogel lenses work well in a piggyback combination with SoftPerm lenses
d. Scleral lenses do not usually correct all irregular corneal astigmatism

7. **With regards to penetrating keratoplasty (PK), which one of the following statements is true?**
a. Endothelial cell damage does occur at the time of PK surgery with more cells being lost from the central graft
b. The normal cornea is usually an oblate shape
c. The average amount of corneal astigmatism post PK is 6.00DC
d. Flat or sunken grafts occur in approximately 18% of cases

8. **Which one of the following statements is true?**
a. Large diameter lenses post PK should be avoided as these may damage the limbus
b. Post PK, the host graft junction is usually regular and so fitting contact lenses that fit within the graft area is achievable
c. If a lens decentres in any direction, then decreasing the diameter usually improves centration over the graft following PK
d. The Bi-sym lens uses asymmetric geometry to allow the back surface of the lens to locate over the decentred corneal apex, whilst maintaining orientation of the optic region at the visual axis

9. **Which one of the following statements regarding reverse geometry lenses (RGLs) is true?**
a. Steep post-operative corneal grafts are the main indication for RGLs
b. Flat post-operative corneal grafts are the main indication for RGLs
c. The Plateau lens, Rose K2 and DIL lenses are all RGLs
d. RGLs are indicated where there is at least 6.00D difference in curvature between central and peripheral cornea

10. **Which one of the following statements is false?**
a. The SofLens 66 has been recommended post PK, where there is a proud graft owing to its incorporation of a reverse geometry design
b. Post PK optical contact lens fitting should be commenced at three months
c. Post PK complications include epithelial defects, corneal ulcers, neovascularisation and graft rejection or failure
d. Post PK, corneal sensitivity may be reduced for up to five years

11. **Which one of the following statements is true?**
a. Post refractive surgery, where there is astigmatism of >1.75DC, toric soft contact lenses usually always work
b. In higher refractive surgery corrections, as the amount of ablation increases, so the difference between the flat central ablated zone and the relatively steeper peripheral cornea decreases
c. Following LASIK and LASEK, RGP lenses can usually be fitted approximately eight to 12 weeks after surgery
d. Almost all patients with decentered ablations are left with varying degrees of uncorrected hypermetropia

12. **Which one of the following statements is correct?**
a. A decentered ablation with a small pupil will produce more serious complaints than a similarly displaced ablation over a large pupil
b. For larger eyes, consider larger TDs to aid centration and wider BOZDs for large pupils post refractive surgery
c. Iatrogenic corneal ectasia is seen where the remaining corneal thickness is less than 450 microns post laser refractive surgery
d. Hybrid SoftPerm lenses are a viable alternative to using reverse geometry lenses in higher corrections

An answer return form is included in this issue. Paper entries ONLY need to be returned by November 16 to: CET initiatives (c-1403), *OT*, Victoria House, 178-180 Fleet Road, Fleet, Hampshire, GU51 4DA.

Please note that model answers for this *Pay-As-You-Learn* series will not be available until January 13, 2006. This is so that readers submitting answers online can join at any time from now until January 11, 2006 and take part in any or all of the six articles as they are published. Paper entries will be marked on the normal monthly basis.