



# Rigid Contact Lens Fitting

## KEY POINTS

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An ideally fitting rigid contact lens should show the following attributes:

- Acceptable comfort which improves after adaptation
- Adequate centration (no limbal overlap, BOZD centred over pupil)
- TD approx 1.4mm smaller than the HVID
- 1-1.5mm smooth movement with each blink
- Lens alignment over most of the corneal surface, or alignment along the flatter meridian in the case of spherical fits on toric corneas
- Narrow band of edge clearance

Tear lens power should be calculated to confirm an alignment fit

The use of a slit lamp to view the fluorescein fit provides a better overall assessment than a Burton lamp

Adapt a routine assessment, moving from the least to the most invasive technique

Rigid gas-permeable (RGP) contact lens fitting is often regarded as more complex than soft lens fitting, but in reality, the number of decisions practitioners must make is essentially the same when judging the fit of either lens. In addition, modern RGP lens designs can fit a wide range of the normal ametropic population, so practitioners need only specify the back optic zone radius (BOZR), total diameter (TD) and back vertex power (BVP) from a particular lens design for the manufacturer to produce the lens. While using custom-made multi-curve lens designs increases the practitioner flexibility in dealing with a range of corneal contours, many spherical and aspheric 'system' lens designs can cover most eventualities.

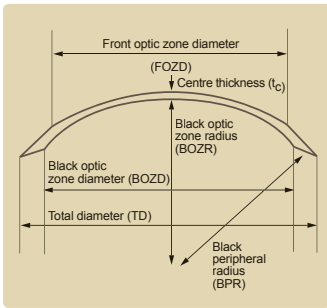


FIGURE 1 RGP dimensions

This article concentrates on basic procedures and techniques required to fit RGP lenses in routine practice, with more specific detail on both multi curve and aspheric designs available in the literature.<sup>1,2</sup> The article also introduces the reader to toric RGP lens fitting.

## The ideal RGP lens fit

As in soft contact lens fitting, the assessment of RGP lens fit involves the evaluation of both static and dynamic criteria. Figure 1 summarises basic contact lens parameters. The ideal RGP fit should show the following characteristics.

### Centration

The lens should remain centred over the pupil in primary gaze and maintain reasonable centration with each blink. The goal of RGP lens centration is to ensure that the visual axis remains within the back optic zone diameter (BOZD) for as long as possible to optimise visual acuity and avoid flare. The lens should also remain on the cornea during all positions of gaze to minimise conjunctival staining from the periphery of the lens onto the limbal conjunctiva.

### Corneal coverage

Unlike soft lenses, RGP lenses should be smaller than the corneal diameter. They should have a total diameter of at least 1.4mm less than the horizontal visible iris diameter (HVID) to facilitate tear exchange under the lens and help optimise the alignment of the lens fit.

### Dynamic fit

As well as allowing metabolic and tear debris to be removed from underneath the lens, the RGP lens must move to enable oxygen exchange due to the tear pump. Unlike soft lens fitting, there is a significant exchange of oxygen underneath an RGP lens during the blinking cycle.

Lens movement is one of the key characteristics of an ideal RGP fit. The lens should move around 1 to 1.5mm with each blink. The movement should be smooth and unobstructed in the a vertical plane, indicating a near alignment fit. Lens movement occurs either as a response to the eyelid force or by upper lid attachment. An immobile lens causes tears to stagnate beneath its surface, leading to corneal staining and distortion, while a lens with excessive movement causes patient discomfort, inconsistent vision and may also be associated with conjunctival staining.

### Alignment

This is often the aspect of RGP lens fitting that receives

### Examples to show how the site of astigmatism affects contact lens choice

OCULAR REFRACTION			K-READINGS				SITE OF ASTIGMATISM	CL OPTIONS
Sphere	Cylinder	Axis	Flattest	Along	Steepests	Along		
-3.00	-2.00	180	8.00	180	7.60	90	Corneal	Spherical RGP, soft toric
-3.00	-2.00	180	8.00	180	8.00	90	Lenticular	FS toric RGP, soft toric
-3.00	0	0	8.00	180	7.60	90	Corneal	Spherical soft, FS toric RGP
-3.00	0	0	8.00	180	8.00	90	None	Spherical soft, spherical RGP
-3.00	-2.00	180	8.00	180	7.80	90	None	FD toric RGP, soft toric
-3.00	-3.00	180	8.00	180	7.40	90	Corneal	Bi-toric RGP, soft toric

TABLE 1

most attention. However, while important, it should not be viewed in isolation of other aspects of lens fit. The ideal RGP fit should show alignment of the back surface of the lens with the cornea over most of the surface. A narrow band of edge clearance at the periphery is required to enable adequate tear exchange and facilitate lens removal (Figure 2). The alignment of the back surface with the cornea allows the force of the lens to be distributed across the maximum bearing surface of the cornea. However, slight apical clearance and an area of light corneal touch in the mid-periphery will enhance lens centration. Excessive touch can lead to tear stagnation, staining and/or distortion, while points of excessive clearance lead to an unstable lens fit in terms of centration, comfort and vision.

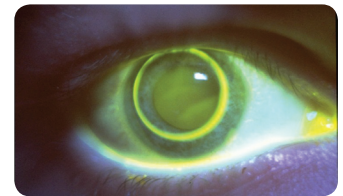


FIGURE 2 Fluorescein pattern of an ideal lens fit

## Patient response

When all the above are achieved, the patient should experience stable vision with the appropriate correction. The lens comfort should also be stable, depending on the degree of patient adaptation, but initial comfort will of course be less than that achieved with a soft lens.

## Instrumentation

### Keratometry

- **Lens selection:** Central keratometry readings (K-readings) are the principal values used to select the initial trial, or empirically ordered, lens in RGP fitting. As well as assisting in choosing the appropriate BOZR, the K-reading in conjunction with the pupil size, may also be used to judge the appropriate BOZD. K-readings should be taken as the mean of three readings measured. The assessment of peripheral K-readings is of limited

value in routine contact lens practice, although in the absence of corneal topography it can be helpful in fitting the unusually contoured cornea, such as following refractive surgery or in cases of corneal pathology.

- **Baseline data:** As in all contact lens practice, baseline K-readings must be recorded prior to fitting. An assessment of mire quality is especially valuable in RGP fitting as a rigid lens has the greatest capacity to cause distortion and alter this.
- **Tear quality:** With the lens *in situ*, the keratometer can be used to record pre-lens tear break-up time.
- **Corneal astigmatism:** The keratometer reading should be used together with the refraction result to determine the site and degree of any astigmatism. Spherical RGP lenses will only correct corneal astigmatism through neutralisation by the tear lens. Of course, this cannot always be achieved with higher degrees of corneal astigmatism because of unstable fitting characteristics. In these cases, back surface toric RGP lenses are required to achieve a satisfactory fit. If astigmatism is lenticular, a spherical RGP lens will have no effect on its correction. As a rule of thumb, 0.10mm difference between K-readings equates to 0.50DC of corneal astigmatism.

Table 1 shows some worked examples of this and some suggested suitable contact lens options, depending on the site of astigmatism.

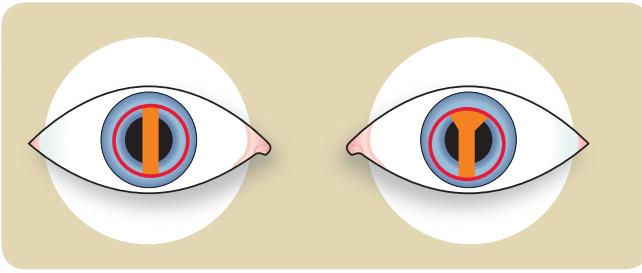
- **Lens flexure:** With the lens *in situ* on the eye, over K-readings will show any flexure of the lens on the eye. Flexure may occur either as the lens tries to assume the shape of a toric cornea under the influence of lid pressure, or as a lens becomes distorted with age or mishandling. Flexure is greatest with steep fitting lenses. If a satisfactory end-point of refraction cannot be obtained, then over K-readings can be used to confirm or eliminate flexure as a possible cause.

## Corneal topography

### Shape factor

The shape factor (p value) of the cornea is the extent to which its shape varies from a sphere, which is the assumption made when K-readings are taken. Topography allows practitioners to measure the shape factor of the cornea. This can be used to help choose the lens design and the extent to which the peripheral curves of the lens need flattening to maintain corneal alignment.

Some videokeratoscopes have software that can recommend a lens design. While results may not be any more accurate in routine fitting, it may certainly assist in more complex cases and reducing the number of trial lenses before achieving final fit.<sup>3</sup> Knowledge of the shape factor can be important in the analysis of some fluorescein patterns and is an important variable in orthokeratology fitting.



**FIGURE 3** Retinoscopy reflex with centred RGP lens (above left) and decentered lens (above right)

### Apex position and contour

Videokeratometry provides a contour map of the cornea, and this can be of value in looking for reasons to explain unusual fluorescein patterns or poorly centred lenses. Videokeratometry allows visualisation of the apex of the cornea, which may not be in line with the visual axis, and hence show the reason for a displaced lens. It will also show changes in contour due to pathology, surgery or even normal variations. As well as being a useful clinical aid, this technique assists the practitioner in explaining the mechanism of the lens fit to the patient.

### Location of astigmatism

Corneal astigmatism can be calculated from any given two meridians from the centre to the periphery and can be displayed as a meridian contour map. The principal meridians and degree of astigmatism can be shown at various positions from the centre of the cornea. Importantly, this method of measurement demonstrates that corneal astigmatism is not necessarily uniform over the entire surface of the cornea, but varies according to the location on the cornea.

## Retinoscopy

As well as playing a role in refraction, the retinoscope also allows the practitioner to judge pupil coverage by the BOZD of the lens. The retinoscopic reflex should be regular across the pupil. If the BOZD is not fully covering the pupil, then the reflex will become distorted at the transition between the central and peripheral radii (Figure 3).

### Refraction

Over-refraction will provide the practitioner with the necessary information to determine the correct BVP for an individual patient. Beyond this, it has two further important uses in RGP lens fitting.

- **Tear lens thickness:** Optically, a RGP lens can be thought of as correcting ametropia in two ways — the replacing of the natural curvature of the cornea with a different curvature to correct the refractive error and the neutralisation of the front surface of the cornea by the posterior lens surface. The power of this

latter lens, the tear lens, can be calculated by over-refraction. This provides an invaluable means of assessing the lens/cornea alignment relationship.

- **Lens flexure:** Over-refraction can also be used to judge lens flexure when an optimal visual result cannot be obtained with spherical lenses or over-refraction. If the practitioner is confident that the lens is correcting the corneal astigmatism and that there is no lenticular astigmatism present, then the flexure in the residual astigmatism produced is due to the lens flexing on the cornea.

### PD ruler

The PD ruler (or preferably the graticule on the slit lamp) should be used to measure the horizontal visible iris diameter (HVID), which may be used to choose the initial total diameter of the lens to trial. It should also be used to measure mean and maximum pupil diameters that will have an influence on the BOZD being selected. Finally, it would be used to measure vertical palpebral aperture size (VPA), both to assist in TD choice and as a baseline measurement as research has indicated that the VPA can decrease with RGP lens wear.

### Biomicroscopy

#### Dynamic lens fit

Dynamic lens fit can be both assessed and measured using a slit lamp with a graticule in the same way as soft lenses.

#### Lens/corneal alignment

- **White light:** an optic section can be used to judge the relationship of the lens to the cornea using white light and no fluorescein.

- **Cobalt-blue light:** the alignment of the back surface of the lens to the front surface of the eye is most effectively visualised using fluorescein. The fluorescein stains the tear film that makes up the tear lens. When the fluorescein is illuminated with the appropriate wavelength of blue light it fluoresces a green colour. The intensity of the green colour is a function of the thickness of the fluorescein film. The thicker the film, the more yellow the appearance.<sup>4</sup>

Fluorescein in the tears fills the space between the back surface of the lens and the anterior corneal surface. When excited with the cobalt-blue filter, the distance between the two surfaces is represented by the intensity of the fluorescent light, with the brighter the colour seen, the greater the gap and vice versa. By looking at the change in intensity of the fluorescein across the lens, the distance between the posterior lens surface and the anterior corneal surface can be visualised, the so-called fluorescein pattern (Figure 2).

As in the use of fluorescein for other purposes, the use of a yellow barrier filter over the slit-lamp eyepiece will assist in increasing the contrast between the yellow fluorescein and the background. In carrying out this technique, it is important to ensure that excessive fluorescein is not placed in the eye, as this will make the interpretation of the fit more difficult due to excessive fluorescein on the front surface of the lens.

## Burton lamp

### Fluorescein fit

The Burton lamp is a UV light source mounted with a magnifying glass in a rectangular frame. It allows the practitioner to view fluorescein patterns using the UV light to excite the fluorescein. The disadvantages are that the magnification is not as good as that achieved with the slit lamp and is ineffective when used with lenses that have a UV inhibitor in the polymer. For this type of lens, the cobalt-blue light on the slit lamp is the preferred option.

### Pupil size

Maximum pupil size can be measured in a darkened room with the eye illuminated using the UV light on the Burton lamp. The pupil can then be easily visualised against the fluorescence of the crystalline lens.

## Techniques

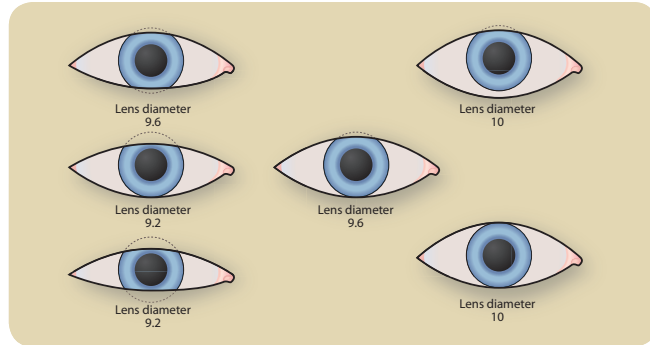
As with all contact lens fittings, an initial examination is required to judge patient suitability and evaluate patient needs.

### Initial trial lens – choice and insertion

The initial lens to trial should be chosen using the following criteria:

#### Back vertex power

Where possible, this should be as close as possible to the patient's final prescription, both to provide the patient with as natural vision as possible and to minimise the potential changes in fit from variation in power. As the centre of gravity and edge design of a plus-powered lens is in a different position to a minus lens, the fit may be different. It is important, therefore, that hypermetropes be assessed with positively powered lenses and vice-versa for myopes. If there is a choice of prescription, the practitioner should err towards under-correction rather than over-correction of myopes to minimise the chances of accommodative spasm.



**FIGURE 4** Selection of total diameter as a function of palpebral aperture, according to Guillon

### Back optic zone radius

The back surface design of RGP lenses may be spherical, aspherical or a combination of both. Spherical lenses may be bi-curve, tri-curve or multi-curve and with each different BOZR the peripheral curve design can result in a constant axial edge lift or constant axial edge clearance design. Generally, aspheric designs vary from those with a fixed elliptical curve (eg  $e = 0.5$ ) to those where the eccentricity of the curve varies from the centre of the lens to the edge (eg polynomial or variable eccentricity).

- **Spherical lenses:** the initial trial lens should be chosen, based on the K-readings, using either the manufacturer’s recommendations for a particular lens design or the values shown in Table 2. The practitioner should note that the values provided for the initial trial lens fitting are guidelines only.

- **Aspherical lenses:** elliptical aspheric lenses generally need a flatter fitting than spherical lenses to provide alignment across the corneal surface. However, polynomial and variable eccentricity aspheric designs can be fitted in very much the same way as spherical designs. The initial trial lens should be fitted in accordance with the manufacturer’s recommendation, which is generally on, or slightly flatter, than the flattest K.

**Choice of BOZR based on K-readings for spherical RGP lenses (7.50 BOZD)**

ASTIGMATISM (BY KERATOMETER)	APPROXIMATE BOZR
Spherical to 0.75 D	Fit on flattest keratometer reading
0.50 to 1.00 D	Fit on flattest keratometry reading to 0.05 steeper than the flattest keratometer reading
1.00 to 2.50 D	Fit near flattest keratometer reading (0.05 to 0.10 steeper at most) to minimise flexure and achieve good acuity with a spherical lens <sup>5</sup>
Over 2.50 D	A toroidal back optic zone is recommended

TABLE 2



## Total diameter

The total diameter (TD) chosen is based upon the HVID and lid position. As a generalisation, the TD should be at least 1.40mm smaller than the HVID. The smaller the palpebral aperture, the smaller the TD should be. Guillon recommends that the choice is made in accordance with Figure 4. Once again, the initial trial lens recommendation is a guide from which the optimal lens fit may be judged.

## Centre thickness

For physiological reasons, the lenses should be made as thin as possible to maximise oxygen transmissibility. For most rigid lens materials today, the realistic minimal centre thickness is approximately 0.14mm.

## Back optic zone diameter

The BOZD should be at least 1.00mm larger than average pupil size in normal room illumination to avoid flare. The BOZD also has most influence on the corneal alignment of any of the posterior diameters. As the cornea flattens, a larger BOZD should be considered to maintain alignment over the cornea. With 'system' lenses, the practitioner often has little control over this parameter, although it should be considered in relation to pupil size.

## Material

It could be argued that the lens material used for the lens fitting assessment should ideally be the same as the intended material for the final lens prescribed. This is to minimise the possibility of the prescription lens behaving differently from the initial lens assessed in terms of flexure, centration or wetting. For physiological reasons, materials of  $Dk >50$  should be routinely considered for daily wear of RGP lenses. RGP materials used today include silicone acrylates and fluorosilicone acrylate, the latter having the advantage of better wettability and fewer deposits. However, it requires more careful manufacture and can be brittle if too thin.

## Insertion and adaption

### Insertion

New lenses should be hydrated in a soaking solution for at least 24 hours before an accurate assessment of the fit can be made. Immediately prior to insertion, patients should be instructed on the foreign-body sensation they are likely to experience. They should also be asked to look downwards once the lens is inserted. This minimises the action of the lid on the lens edge and reduces the foreign-body sensation.

Once the lens has been inserted, lifting the upper eyelid will enable the practitioner to judge whether or not any discom-

fort is due to normal adaptation (in which case it will disappear when the lid is lifted) or a foreign body trapped between the lids (in which case it will remain).

### Adaptation

Once reflex tearing has subsided, the fit of the lens can be grossly assessed, normally after approximately five minutes. At this stage, the assessment is only to ensure that the lens is stable enough for a reasonable trial period. Assessments should be made with white light and the naked eye to check overall lens centration and then a gross fluorescein fit assessment. If a reasonable fit is obtained, patients should be sent for a longer trial period to enable them to judge their subjective response and allow some degree of adaptation. This period should be a minimum of 30 minutes.

### Subjective response

At the end of the tolerance period, the patient should be tolerably aware of the lenses and any reflex lacrimation should have stopped. If the lens is near the correct power, the patient should report stable vision in all positions of gaze.

### Assessment of fit

Fit assessment should be made, starting with the least invasive technique and moving on to the most invasive to minimise the stimulation of reflex tearing, which could alter the fit.

### Over-refraction and visual acuity

A spherical over-refraction should be conducted initially with binocular balancing to relax the accommodation that may have been induced from the foreign-body sensation of the lens in situ. The visual acuity should be crisp and stable with a precise end-point of refraction. If unstable or unacceptable acuity is found, a cylindrical refraction should be carried out. The refraction should be both subjective, and objective using the retinoscope. The finding should be recorded so that tear lens power can be calculated and adjustments made to the central fit if necessary.

### White light

Under white light and with the naked eye, the practitioner should judge the centration of the lens in primary gaze and on lateral eye movement. In addition to centration, the movement with blink should be judged, the lens should move with each blink under the influence of the upper eyelid and return to cover the pupil immediately afterwards.

### Fluorescein assessment

With the patient at the slit lamp or using the Burton lamp, a fluorescein assessment of the fit should be carried out. A minimal amount of fluorescein should be inserted into the conjunctival

sac and the patient should be asked to blink. The practitioner should then systematically assess the brightness of the fluorescein in three regions: central, mid-peripheral and peripheral. A simple grading scale has been advocated by Guillon to assess the lens fit (Table 3).

Put simply, if fluorescein is seen under the lens during assessment then it can range from a little (alignment or slight apical clearance) to a moderate amount (+1) or an excessive amount (+2). If it is difficult to judge because of an apparent even film of fluorescein, this is an alignment fit. It is generally easier to detect a steep fit than a flat fit. This may be worth bearing in mind when selecting the first trial lens.

## Interpretation of findings

### Subjective response

Comfort with RGP lenses is initially less than with soft lenses, although, following a 30-minute adaptation period, the patient should report no more than lens sensation. If 'pain' is reported, together with excessive reflex tearing, then the lens needs modification.

Vision and visual acuity should be stable and crisp, with the correct spherical over-correction in place. If a stable result cannot be obtained with spherical lenses, a cylindrical over-correction should be attempted. A stable result indicates that residual astigmatism exists within the optical correction and that a toric lens may be required.

Before going ahead with a toric fit, the practitioner should analyse the results of the over-correction to identify the site of the residual astigmatism and make sure it is not lens flexure that is causing the poor vision. If no site for the astigmatism can be found, or it is variable, the most likely cause is lens flexure.

**Grading of fluorescein fit, according to Guillon**

	+2	+1	0	-1	-2
<b>GENERAL FIT</b>	Excessively steep	Slightly steep	Alignment	Slightly flat	Excessively flat
<b>PERIPHERAL FIT</b>					
Width	Extremely wide (0.4mm)	Slightly wide (0.3 to 0.4mm)	Optimal (0.2 to 0.3mm)	Slightly narrow (0.1 to 0.2mm)	Extremely narrow (<0.1mm)
Height	Excessive	More than optimal	Optimal	Less than optimal	Insufficient
<b>MID-PERIPHERAL FIT</b>					
	Hard, well-defined contact	Poorly defined contact	No contact		

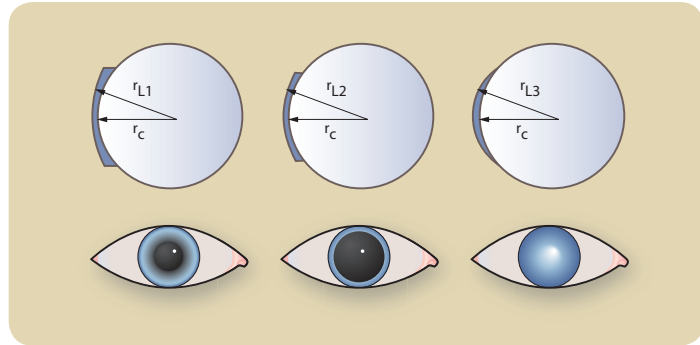


FIGURE 5 Tear lens thickness

In cases of lens flexure, changes to the lens/eye fitting relationship are the preferred management option. Table 4 summarises the causes of poor comfort and vision and the management options.

### Over-refraction

Determining the over-refraction allows the tear lens to be calculated. It is the difference in power between the refraction at the corneal plane and the power of the contact lens needed to correct the ametropia. The power of the tear lens is an invaluable means of assessing the alignment of the lens to the cornea. If the lens is fitting steeply, a positive tear lens will result and the power of the contact lens will require less plus or more minus than the ocular refraction. If the lens is fitting flatter than the cornea, the tear lens will be negative and the converse will

Possible causes of patient symptoms with RGP lenses

SYMPTOM	POSSIBLE CAUSES	REMEDY
Poor comfort	Excess movement Excess edge clearance Edge too thick Foreign body Damaged lens edge Astigmatic cornea	Tighten fit Reduce edge clearance Thinner edge Remove and replace lens Replace lens Modify fit Consider an aspheric design Consider a toric design Thinner lens design
	Patient sensitivity	Increase total diameter Soft lens Remove and clean lens
	Poor wetting	Change material
Poor vision	Refractive change Corneal shape change Residual astigmatism Flexure	Refract and change power Assess fit and modify Toric lens Flatten fit Change material
	Deposits Heavy surface scratches Poor wetting	Clean lens Polish or replace lens Remove and clean lens Replace lens if old Change material

TABLE 4

### Examples to show how the tear lens power can be used to assess the lens/cornea alignment

OCULAR REFRACTION	CL POWER IN AIR	OVER-REFRACTION	TEAR LENS	FITTING RELATIONSHIP
-3.00	-3.00	0	0	Alignment
-3.00	-2.50	0	-0.50	Flat
-3.00	-3.50	0	+0.50	Steep
-3.00	-3.00	-0.50	+0.50	Steep
-3.00	-3.00	+0.50	-0.50	Flat

TABLE 5

### Management of lens decentration

LENS POSITION	POSSIBLE CAUSE	REMEDY
Continually high, not dropping after blink	Flat peripheral zone Widen peripheral zone Too large TD Lens too thick With-the-rule cyl	Steepen periphery Narrow periphery Reduce TD Reduce Tc and/or Te BS toric design Toric periphery design
Continually low/rapid drop after blink	Lens too small Lens too thick No lid attachment	Increase TD Reduce Tc Add peripheral negative carrier
Continually to one side	Displaced corneal apex  Lens too small Lens too flat Against-the-rule cyl	Increase TD Soft lens Increase TD Steepen design Back surface toric design Toric periphery design
Stationary	Lens too steep	Flatten fit
Excessive decentration beyond limbus	Excess lacrimation Lens too flat Excess corneal cyl	See symptoms Steepen design Back surface toric design

TABLE 6

apply (Figure 5). Table 5 shows some worked examples of different tear lenses. A general guide towards calculating tear lens powers is that 0.50DS difference in over-refraction relates to 0.10mm difference between lens radius and corneal radius.

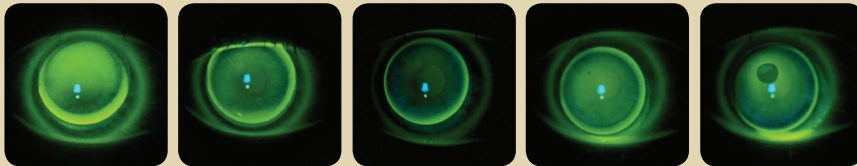
### Lens centration

The lens should remain centred over the visual axis between blinks and on lateral gaze. Some higher minus-powered lenses may 'hook' on to the upper eyelid, which holds the lens in position. In these cases, the lens moves with the lid. The same effect can be obtained by ordering a lens with a front surface negative peripheral carrier, which may be of value in fitting hypermetropes whose lenses continually drop. As long as the BOZD covers the pupil and the edge does not cause excessive

TABLE 7

## Management of lens movement

STRATEGY	VARIABLE			
	BOZR	BOZD	TD	TC
Increase movement	Increase	Decrease	Decrease	Increase
Decrease movement	Decrease	Increase	Increase	Decrease



CENTRAL FIT	-1	0	0	+1	+2
PERIPHERAL width height	+2 (inferior) +2 (inferior)	+1 +1	0 0	+1 -1	-1 -1
MID-PERIPHERAL FIT		+1	+1	0	-1
ACTION	Steeper BOZR	Try steeper BOZR	Dispense	Try flatter BOZR	Flatten BOZR

FIGURE 6 Interpretation of fluorescein patterns (courtesy of David Ruston)

pressure on the limbal region, some degree of decentration is acceptable on rigid contact lens fitting. If either of these result in fluctuation of vision, glare/haloes, conjunctival or limbal staining, the lens fit needs modifying. Table 6 shows options available to improve the centration of a decentred lens.

### Lens movement

The lens should show sufficient vertical movement to allow tear exchange to take place. Typically, this is around 1mm to 1.5mm. Excessive movement leads to poor comfort, vision and the potential for conjunctival staining. Insufficient movement leads to tear stagnation, corneal staining and distortion. Options to increase or decrease lens movements are given in Table 7.

### Fluorescein patterns

Figure 6 shows a series of fluorescein patterns, with grading and recommended management options. Interpretation of fluorescein patterns should not be undertaken in isolation; confirmation of the lens/eye relationship should be made by calculating the tear lens and a steep-looking fit should show a positive tear lens and vice versa.

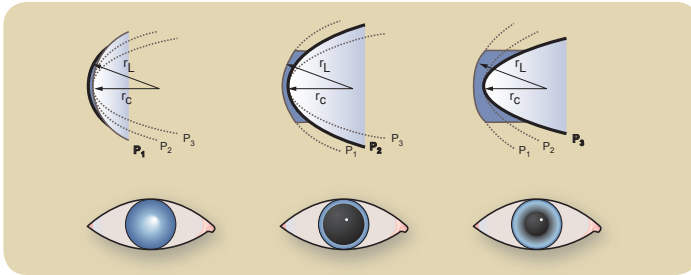


FIGURE 7 Effect of corneal shape factor on fluorescein fit

Occasionally, a steep or flat-looking fit may occur, even when the BOZR of the lens and the K-readings of the cornea appear to match one another exactly. There are two reasons for this: the trial lens has the incorrect BOZR or it is due to the corneal shape factor. If the cornea has higher than average eccentricity (ie  $e > 0.5$ ), it flattens out at a faster than normal rate towards the periphery and consequently, a spherical lens of the same central radius may show central pooling (Figure 7). The fit will have to be modified in the same way as dealing with a steep-fitting lens.

### Interdependency of fitting variables

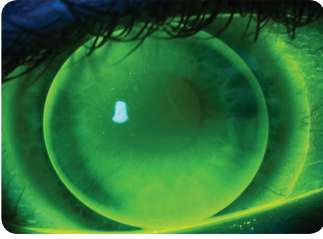
Every variable in RGP lens design has an inter-dependency on other variables. If there is a need to change one parameter on the lens, such as BOZD, then, if the same fitting relationship is to be maintained, the BOZR also has to be altered to maintain the same sagittal height. Changing either the BOZD or the BOZR will also alter the tear lens and hence the power of the lens/eye system. The extent of these changes will depend upon, to some extent, the ocular parameters and the lens material characteristics.

The basic rules of thumb in making alterations to lens parameters are outlined below.

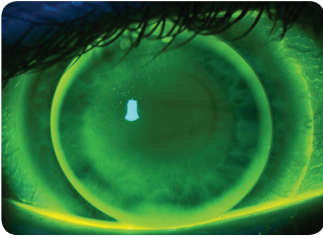
- A change in BOZR of 0.05mm is equivalent to 0.25D change in power if radius is in region 7.80mm
- A change in BOZD of 0.5mm requires the BOZR be changed by 0.05mm to maintain the same fluorescein pattern.

### Toric RGP fitting

In cases where the amount of corneal astigmatism results in an unsatisfactory fit from a spherical RGP contact lens (usually when  $>2.50\text{DC}$ ), it is often necessary to fit a back surface toric lens. This allows the back surface of the lens radii to align with the steepest and flattest corneal radii as measured by keratometry. This results in more equal distribution of the lens over the toroidal cornea, better centration and lens stability as well as subjective comfort for the wearer. The ideal lens fit should show the same fluorescein pattern as a spherical lens on a spherical



**FIGURE 8a** Spherical RGP lens on a cornea with 3.00D of astigmatism



**FIGURE 8b** Back surface toric lens on the same eye (courtesy of David Ruston)

cornea and behave in an identical manner (Figures 8 a and b). With a closely aligned fit, lens rotation is minimal so the incorporation of additional prism stabilisation is not required. Any back surface toric RGP lens will result in 'induced' astigmatism due to the toroidal back surface and difference in refractive index between the tears and lens material. This usually involves the need for a small 'neutralising' cylindrical correction on the front surface, but this need not concern the practitioner as the manufacturer will calculate the amount required to correct the induced astigmatism and any residual astigmatism that might exist. Hence the final manufactured lens is actually bi-toric, a toric back surface to fit the toroidal cornea and a toric front surface to correct any induced astigmatism.

Although lens fitting can be achieved using back surface toric fitting sets and sph/cyl over-refraction, it is easier to order a lens empirically from the keratometry readings and the spectacle prescription. The three easy steps are:

- Measure the steepest and flattest corneal radii with the keratometry
- Convert the spectacle prescription into an ocular prescription (this represents the power required along the steepest and flattest BOZR assuming an alignment fit)
- Specify TD, BOZD and peripheral curves should be based on the same criteria used for a spherical lens design.

### Example 1

Spectacle Rx (BVD = 10mm)

-7.50/-4.50x180

Ocular Rx (BVD = 0mm)

-6.50/-3.75x180

Meridional powers -6.50 and -10.25

K-readings 8.10 along 180. 7.30 along 90

Order lens  $\underline{8.10:7.00/9.5}$

7.30

C4 axial edge lift 0.13mm -6.50 along  
flat -10.25 al steep.

There are times when keratometry readings indicate a near spherical cornea. However, the spectacle refraction indicates significant refractive astigmatism. Hence, when assessing a spherical RGP lens on this eye, over-refraction (as predicted from the keratometry readings) indicates residual astigmatism (usually lenticular). To fully correct the refractive error with an RGP lens, a front surface toric lens is required which must be rotationally stable. Prism stabilisation is therefore included in the lens design as well as truncation if further stabilisation is required. The final lens power can be calculated empirically or more easily by over-refracting an RGP spherical lens. Correc-



tion could also be achieved by a soft toric lens in this example.

### Example 2

Spectacle Rx (BVD = 12mm)

-2.00/-2.00x75

Ocular Rx (BVD = 0mm)

-2.00/-1.75x75

K-readings 8.10 along 165. 8.00 along 75.

Trial lens 8.10:7.30/9.20 -3.00D

Over-refraction: +1.00/-1.25x75

Order 8.10:7.30/9.5

9.1

C3 AEL 0.14mm -2.00/-1.25 x 75

Add 1.50 prism base down (along 270). 0.4mm truncation along 180  
Optional engraving to help with lens orientation and stability assessment – dot prism apex and base.

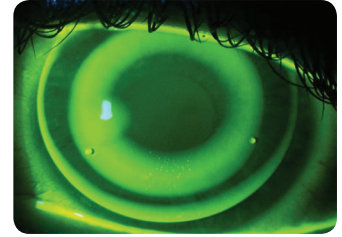
In other examples, the refractive error may be spherical but keratometry readings show significant corneal astigmatism. This would also require a front surface toric design to correct the expected residual astigmatism. In this example, full correction of the refractive error would be achieved more easily with a soft spherical lens. A more detailed overview of toric RGP lens fitting can be obtained from the literature.<sup>6,7</sup>

### Orthokeratology

Orthokeratology involves the fitting of a RGP lens in such a way to induce changes in the corneal curvature to, albeit temporarily, reduce myopia and with-the-rule astigmatism. Increased interest and use of this technique has resulted from greater availability of instrumentation that allows the measurement and monitoring of the corneal topography (videokeratoscope), reversed geometry lenses that allow greater control and speed of the change in corneal shape and higher Dk RGP contact lenses approved for overnight use so as to allow overnight wear and removal during the day.

Ideally, a well-fitted lens should induce flattening of the central cornea to reduce myopia while avoiding introducing induced astigmatism (Figure 9). Average reduction tends to be 1.50 to 2.00D with half of the corneal astigmatism eliminated. However, predicting the amount of change is difficult. Research has shown a correlation between corneal shape and induced change.

Orthokeratology is a labour intensive and specialised RGP fitting technique outside the scope of the article. However, practitioners should be aware of the basic principle. More detailed information on fitting and subsequent care is available in the literature.<sup>8</sup>



**FIGURE 9** A well-fitted reversed geometry lens (courtesy of David Ruston)

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## Conclusions

The practitioner has many parameters to choose from in deciding the optimal fit for a rigid lens. Although system-designed lenses are suitable for many, optimum comfort or visual acuity should not be compromised if an ideal fit cannot be achieved. Skilled laboratories can design lenses to exact specifications, if required. As with all contact lens practice, a systematic approach should be utilised. Changes to lens parameters should not be made unless there is a logical reason to do so. ■

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