Basic contact lens course

Part 9 – Assessing the fit of RGP lenses

Andy Franklin and **Ngaire Franklin** describe how to tell if the rigid lens selected is the best fit for the patient.
Module C14590, one general point for optometrists and dispensing opticians, one specialist point for CLOs

When assessing the fit of a rigid contact lens, textbooks tell us that we must consider two things:

- The dynamic fit, or how the lens moves and centres on the eye
- The static fit, or how the back surface of the lens relates to the cornea.

Dynamic fit

On an established wearer, the way that the lens moves and centres is important, but on a patient new to rigid lenses, the dynamic fit can be frankly misleading. A tense patient is likely to have tighter lids than usual. The tear film will be abnormal both in volume and viscosity as reflex tearing in response to foreign body overlays the normal background tear secretion. For this reason, some authorities advocate the use of a local anaesthetic during the fitting assessment, though their use may make the corneal epithelium a little less resilient, and the degree of comfort of the lens cannot be assessed. When lenses are ordered empirically, it is customary to arrange the time to teach the patient how to handle the lenses to follow on from the checking of the fit. Obviously, in these circumstances, an anaesthetised eye would be dangerous. The tearing may be exacerbated by white light examination on the slit lamp. If the light is unnecessarily bright even more tearing can take place. It is therefore not surprising that many lenses inserted on patients unused to RGPs move about somewhat enthusiastically. Inexperienced practitioners may conclude from this that the lens is flat fitting.

When observing an RGP lens in these circumstances, it is important not to get too carried away with fact that the lens is centring like a half-brick. Provided it stays within the limbus, and occasionally even if it doesn't at this stage, it will probably get better once the tear film has normalised. If the lens is moving vertically with the blink cycle, it is probably not flat. Flat lenses tend to go sideways, or arc around in a semicircle. Lenses that decentre horizontally are not always flat. Lid geometry can sometimes do this, so it is useful to part the lids with the fingers and see what happens. If the lens does the decent thing and centres up, there is probably little to be gained by changing the central fit. Measures must be taken to reduce the influence of the lids, and that usually involves reducing diameters or thicknesses.

On an adapted patient, the centration and movement of the lens is more representative provided we are not attempting photocoagulation with the slit lamp. It is a good idea to use a diffuser when looking at contact lens fits, both RGP and soft. It spreads the light source, enabling us to see the whole lens evenly illuminated without glaring the patient. What we are considering for the most part is how the lens interacts with the lids, because by adjusting the total diameter of the lens, by changing the thickness of the edge or the weight of the lens we can increase or decrease 'lid hitch' as required.

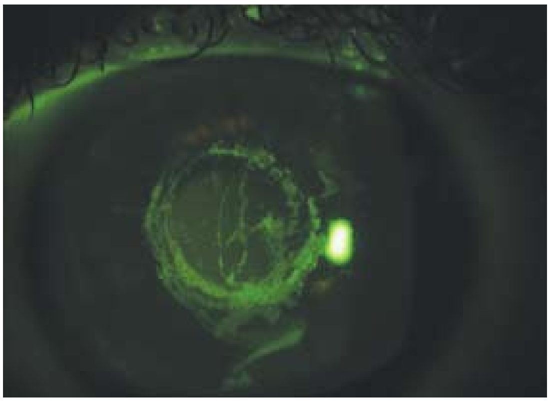

Figure 1 Central staining seen using a Wratten filter

Fluorescein assessment of contact lens fits

The relationship between the back surface of the lens and the cornea is investigated by instilling fluorescein into the tear film. This enables us to see a map showing the thickness of the tear layer under the lens. Sodium fluorescein is orange-red in colour and, when in dilute concentration in an aqueous solution, is excited by short-wavelength light (peak absorption 485-500nm) to emit a green light (maximum intensity 525-530nm). This useful property has been exploited since Obrig described it in 1938. Before that fluorescein had been in use to investigate corneal lesions for about half a century, using white light! The cobalt blue filter on the slit lamp causes fluorescence to occur while eliminating wavelengths that have little effect. This reduces veiling glare. To improve contrast, a yellow barrier filter (eg Wratten No 12) may be placed before the observation system, either built in or attached to the observation system of the instrument or as a cardboard-mounted accessory widely available from contact lens manufacturers. This filters out the reflected blue light from the eye and the background fluorescence of the cornea. Fluorescein has long been used to assess the fitting characteristics of rigid contact lenses, both scleral and corneal. Traditionally this was done using a Burton Lamp which employed a pair of 'Blacklight Blue' miniature fluorescent tubes. Unfortunately, many RGP materials absorb light in the UV-A band (315-400nm) with the result that the fluorescein under such a lens will not fluoresce sufficiently to allow accurate estimation of the fit. This is particularly likely with high minus lenses made of the widely used fluorosilicone acrylate materials, where the thickness of the lens in the more peripheral parts of the optic zone can ▶

prevent fluorescence, giving the false appearance of a steep fit. The cobalt blue filter of the slit lamp emits more longer wavelength light, so the fitting characteristics of the lens may be better visualised (Figure 1).

The amount of fluorescence emitted by the fluorescein will depend on tear thickness but it is also proportional to concentration, pH and the amount of light used to irradiate it.

Concentration of the fluorescein affects the minimum thickness of tears that will fluoresce. At higher concentrations even very thin layers, such as that found under an aligned lens will fluoresce, albeit weakly. As the tears dilute the concentration, the same thickness of tears will produce no detectable green fluorescence. It is still the same tear film, however. The absence of fluorescence does not necessarily indicate touch. It just means that the tear layer under the lens is too thin to fluoresce, at the current concentration. If in doubt, put some more in, and see what happens. However, if the concentration of fluorescein is too high, it may fluoresce rather feebly. This 'black hole' effect is due to collisions between molecules resulting in non-fluorescent energy release. The technical term is 'quenching'. If this happens, the best thing to do is to wait a few seconds, resisting the temptation to put even more fluorescein in to the eye.

The degree of fluorescence is influenced by other factors:

- The pH in the eye and even the pH of the saline used to moisten the Fluoret can affect the fluorescein pattern. The absorption spectrum and the degree of fluorescence depend on pH, peaking when the pH is 8. Buffered saline should be used with fluorescein, or at least always use the same type of saline to ensure consistency
- Illumination has a major effect on fluorescein patterns. Up to a point, (and unless you can smell burning, you probably haven't reached it) the more light you put in, the more fluorescence you get back. To get a decent fluorescein pattern on most slit lamps, you must turn the rheostat right up. This means that there is enough fluorescence being produced to make a Wratten filter worthwhile. If you use a Wratten with low illumination it won't work, as it, like all filters, subtracts light rather than adds it. The use of the diffusing filter is also recommended, as it allows the whole lens to be illuminated at one time.

Fluorescein is best applied in the form of Fluorets. These impregnated strips circumvent the fact that liquid fluorescein is a splendid culture medium for *Pseudomonas*. On new or nervous patients the moistened strip is best applied to the lower sclera, with the patient looking up. That way, if the patient panics and Bell's phenomenon occurs, the cornea is protected. The strip should be touched flat to the sclera. Wiping (the 'slash' technique) or prodding ('the bayonet') both carry the risk of a paper cut to the eye, which is not a pleasant prospect. When wetting the Fluoret, it is sensible to shake off the excess, unless the patient has specifically requested a tie-dyed shirt in tasteful orange.

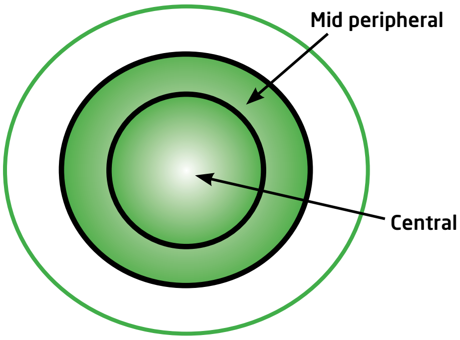

Figure 2 Central and mid-peripheral zones

Assessment of the fit

The static fit of the lens consists of two elements, which should be considered separately.

- The central zone
- The periphery.

It is important to consider the position of the lens on the cornea when assessing the fluorescein pattern. The central curves of the lens are usually designed to align with the central area of the cornea, and this can only be assessed if the lens is centred correctly. On new patients, centration may be poor, and the practitioner may have to control the position of the lens with the patient's lids. Failure to do this will result in misinterpretation of the fluorescein pattern. The classic error occurs when a flat lens is allowed to drop so that the central zone of the lens is sitting on a more peripheral part of the cornea. In most patients, the peripheral cornea is rather flatter, and the result can be that pooling of fluorescein will occur under the lens. The lens can then be interpreted as steep. This can be expensive.

Central fit and alignment

The area under the optic portion of the lens that should be considered first, as it influences centration and movement, flexure and oxygen supply. Usually we are aiming for an 'alignment' fit. In other words, we want the tear layer to be uniformly thin over as much of the optic zone as possible. We need therefore to consider what this looks like. A thin tear film with a high concentration of fluorescein will have a slight greenish glow. As the fluorescein dilutes that greenish glow will cease. Provided that the periphery allows efficient tear exchange and aligned lens should go from high concentration to low rather quickly. Therefore an aligned optic zone will either have a slight greenish glow or none, depending on how much fluorescein you put in, and how long ago you put it in. So how do you tell it is aligned?

The optic zone must be sub-divided into two imaginary zones, central and mid-peripheral (Figure 2)

To assess the central fit, simply compare the amount of green visible in the two.

- If there is more green in the central zone than the mid-peripheral one, the lens is steep. As the fit becomes progressively steeper, the diameter of the central green zone contracts, and the contrast between the two zones increases. This is because the tear exchange under the lens is compromised. This also has the effect of prolonging the fluorescein pattern, so a steep lens tends to look the same for minutes on end, rather than the seconds that an aligned pattern may persist.
- If the central area shows no fluorescence, but the mid-peripheral zone does, the fit is flat. With increasing flatness, the size of the blue area of 'touch' in the centre will contract. It should be remembered that 'touch' is a misnomer. A thin tear film is present, but not enough to fluoresce detectably.
- An aligned fit should show either a hint of green under the whole optic zone or blue touch. If in doubt, put some more fluorescein in and have another look, when the green glow and its demise should occur in quick succession. However, if the periphery is tight you may not be able to get enough fluorescein under the lens to create a glow even initially. If there is no central glow at any stage, look at the peripheral zone to see if that could be the problem before changing central curves.

The fit should be recorded as aligned, steep or flat with some indication of degree. However, given that half of the population have asymmetric corneal curves something a little more detailed might be useful. Van der Worp (2005) described a system whereby the ▶

Figure 3 Good peripheral clearance

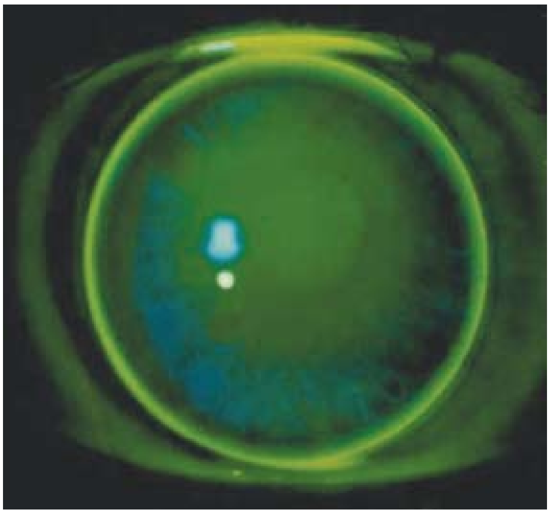

Figure 4 Narrow peripheral clearance

fluorescein thickness at a number of points on the lens could be graded. A grade of zero indicates a satisfactory tear thickness, -1 slightly too thin and –2 much too thin. A grade of +1 indicates a tear layer which is slightly too thick, and +2 much too thick. Both central and peripheral fluorescein patterns can be recorded in this way. The system allows greater detail, but it is recorded relative to an anticipated pattern, so it would be worth recording the type of fit against which we are judging the lens (eg alignment or inter-palpebral) for future reference.

Peripheral fit

The degree of edge clearance that a 'system' lens will show will depend the design of the lens and the shape factor of the patient's cornea. It is inadvisable to alter the BOZR and BOZD to adjust edge clearance. The parameter to address is edge lift, which with modern computer assisted lathes, can be easily varied for any given central zone. In general, good peripheral clearance looks like a band of green 0.5-0.75mm wide under the periphery of the lens

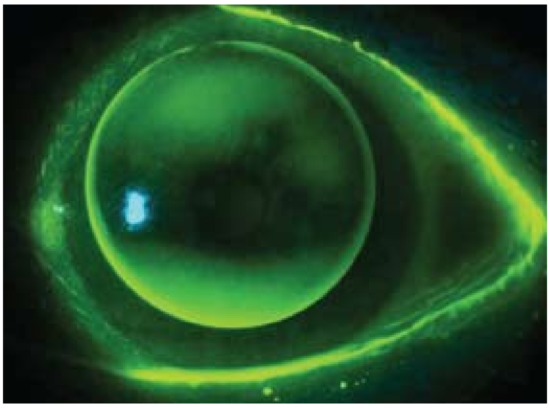

Figure 5 Spherical lens on astigmatic cornea

(Figure 3).

If the green band is too narrow, check that is actually under the lens, as a sealed periphery may show a thin green band around the edge (Figure 4).

Ideally, the green band should gradually blend into the blue area of 'touch'. An abrupt change from green to blue indicates a sharp transition. This can compromise tear exchange and cause corneal trauma and the periphery may need 'blending' with intermediate curves.

As discussed in the section on lens design, edge clearance is ultimately required to allow tear exchange under the lens, and lens removal. The precise physical dimensions required depend on the oxygen transmission and surface characteristics of the material.

It is worth observing the peripheral fit as the lens moves with blinking and excursions of the eye. Dark areas of touch may appear. These may indicate 'grounding' of the lens edge, which may result in physical trauma to the cornea. A tight periphery may also restrict movement of the lens. This can cause the lens to decentre, usually downwards. If the lens has a tendency to decentre, look for peripheral touch on the opposite side to the direction that the lens has decentred.

Astigmatic corneas

Spherical lenses on astigmatic corneas produce a characteristic 'dumb-bell' shaped fluorescein pattern. For example, let us consider a cornea that shows 'with-the rule' astigmatism, that is one where the flatter meridian of the cornea and the negative cylinder axis is roughly horizontal. If we fit a spherical optic zone to align with the flatter horizontal meridian, it follows that the lens will be rather flatter than the corneas steeper vertical meridian (Figure 5).

'Against the rule' and obliquely astigmatic corneas will produce similar patterns but at a different orientation. The trick to interpreting these patterns is to identify the principal meridians (not exactly rocket science if you have the spectacle Rx or Ks) and consider the fluorescein distribution along each of them in turn. This avoids the classic student error, where the lens is pronounced flat as opposed to 'with-the rule aligned', for example) on the evidence of only one meridian. Further consideration to the fitting of astigmatic corneas will be found in a later chapter.

Troubleshooting

In general, most lenses ordered empirically, or selected from a fitting set, will not be too far away from optimal, provided the selection is done carefully. This may be news to many students of optometry as one of the most difficult tasks a contact lens examiner faces is to get a student to admit that a selected lens is optimal. However, there are a number of ways in which lenses may misbehave which have simple remedies.

For corneas with low astigmatism

If the lens decentres horizontally on a near-spherical cornea, part the eyelids to check if the lids are causing this. If they are, a smaller, interpalpebral lens may help, though discomfort may be an issue. If the interpalpebral lens doesn't work, there are always soft lenses.

If this isn't a lid effect the sag of the lens should be increased, by increasing the BOZD (and probably the TD) or steepening the BOZR. Either has the effect of making the fit steeper.

If the fluorescein pattern indicates an aligned lens, but the lens moves too much in a vertical plane, a lens with a bigger BOZD may be more stable, but you should flatten the BOZR to maintain alignment. In general, an increase in BOZD of 0.5mm will require a flattening of the BOZR of 0.05mm to create a 'clinically equivalent fit'. Remember that initial lacrimation will exaggerate movement, so allow the lens to settle before changing anything.

A high riding lens can be modified to reduce lid influence, by one or more of the following methods:

- Reduce total diameter
- Truncate the lens. In other words chop a bit off. Most high-riding lenses have minus power, so truncation tends to remove a portion of the thickest part of the lens. This will generally rotate to the top due to the way the upper lid squeezes the lens, which has the evocative title of the 'Melon-seed effect'
- Lenticulation of the lens will thin the edge of a minus lens. It is applied to most lenses these days as a standard characteristic, but it might be worth checking
- Prism ballast can be added, either alone or with lenticulation. It is also possible to weight the lens with a platinum insert
- A material with greater specific gravity, or a lens of the same material made with greater centre thickness, will tend to drop more. It will also flex less, which is a good thing. However, it will transmit less oxygen, which is less good

A lens that drops can be more difficult to improve, but try the following:

- A larger TD will give the upper lid more lens to grab. However, it will also make the lens heavier unless the design is modified.
- Lenticulation. Most dropping lenses have plus power. Lenticulation will reduce the overall weight and move the centre of gravity back a bit. Both may help, and the centre thickness will be reduced, thus boosting the oxygen transmission.
- Use a negative or parallel surface carrier, which thickens up the edge and gives the lid more to grab.
- A lens made of a material of lower specific gravity may hold up better.
- Check the periphery, as it may be grounding on the upper areas of the cornea.

Troubleshooting astigmatic fits will be considered later in the series.

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MULTIPLE-CHOICE QUESTIONS – take part at opticianonline.net

1 Sodium fluorescein in dilute concentration in an aqueous solution has a peak absorption of light of what wavelength?
A 485-500nm
B 500-525nm
C 525-530nm
D 575-600nm

2 Which of the following influence fluorescence of instilled fluorescein?
A Tear pH
B Tear volume
C Nature of irradiating light
D All of the above

3 What pH will allow peak fluorescence of fluorescein?
A 6
B 7
C 8
D 9

4 Which of the following potential pathogens has a particular affinity for fluorescein?
A *Acanthamoeba*
B *Staphylococcus sp*
C *Pseudomonas sp*
D *Streptococcus sp*

5 The central zone of a trial lens shows no fluorescence centrally while the mid-peripheral zone does. Which of the following best describes the fit?
A On alignment
B Flat
C Steep
D Toric

6 Good peripheral clearance on a spherical cornea would be seen as a green band of what thickness?
A No peripheral band
B 0.5-0.75mm
C 1-2mm
D 0.5-0.75mm at 3 & 9 o'clock

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The deadline for responses is September 30 2010