Getting the right RGP lens

Ngaire and **Andy Franklin** consider some of the finer points to be borne in mind when selecting the initial rigid gas-permeable lens

The intended relationship between the cornea and the back optic zone of the lens will depend on the fitting philosophy adopted. The lens is held in place on the cornea both by the eyelids and by surface tension, which act at the lens edge where it is not covered by the lid. If the edge clearance is excessive, no meniscus forms and no surface tension acts. Reduced edge clearance and edge thickness boosts surface tension.

Broadly speaking, there are two extreme positions that can be adopted.

- *Lid attachment ('big and flat')*: Here we have a lens of about 9.50mm diameter, a BOZD of about 8.40 and a back optic zone radius (BOZR) of 0.2-0.3, flatter than K. It needs to be this flat with a BOZD this size in order to be flatter than alignment with the cornea. Essentially, the centration and movement of the lens is controlled by the lids, which pass the lens between upper and lower during the blink cycle. Lenses fitted like this do have a habit of riding a little high, especially in the long term, and exposure stain of the lower cornea is common
- *Interpalpebral ('small and steep')*: The lens is fitted with a small TD (typically 8.5-ish) and BOZD to minimise lid interference. Generally, the BOZR is fitted to give some apical clearance, and this was often done by adding 25-30 per cent of the corneal toricity to the flattest K, a procedure which has unfortunately persisted into 'alignment' fitting, where it is inappropriate. Interpalpebral fits are often rather uncomfortable, due to the interaction of lens edge and lid margins.

Most lenses these days are fitted for an 'alignment' fit that is some way between the two extremes. It should be emphasised that there isn't just one way of fitting lenses, and the short history of rigid lenses contains examples of very flat and very steep (0.3mm in the Bayshore method) lenses by modern standards, which seemed to work well, at least on some patients.

If the standard alignment fit doesn't work another philosophy might, so never be afraid to try something different.

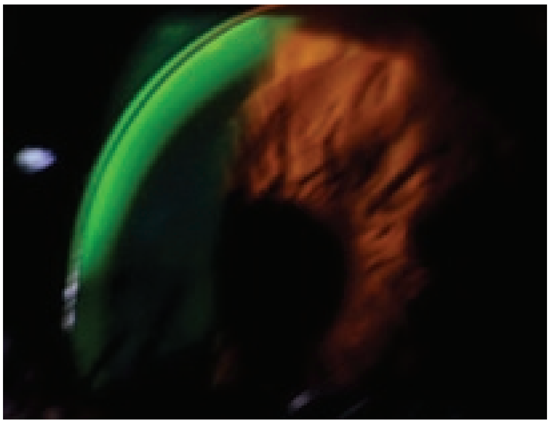

Figure 1 Edge clearance is observable with fluorescein

'Alignment' fitting

The idea here is to fit the back optic zone in close alignment with the front surface of the cornea, with a uniform, thin tear film between the two. This is a goal rather than something that is actually perfectly realised, but perfect alignment probably wouldn't work very well. The advantages of an alignment fit are as follows.

- The weight of the lens, and the force translated through the lens during the blink cycle is spread over the maximum area. If either is too localised, corneal warpage can occur
- Lens flexure is minimised, which will ensure good visual performance and minimise mechanical stress on the cornea. This is quite an important consideration when using modern high-Dk FSAs
- Provided that the periphery of the lens is also well designed, the thin tear film under the central part of the lens will be easily replenished with oxygen and never become stagnant. Furthermore, a thin tear film will not produce a major 'barrier effect', slowing the movement of oxygen through the lens to the cornea. A thicker tear film could produce the situation where the rate of flow of oxygen allowed through the tear film is less than the rate that the lens itself is capable of. Barrier effects reduce the oxygen transmission of all RGPs, especially those with high Dks.

It should be remembered that K readings are taken at points not far away from the corneal apex, whereas we are trying to align an area of cornea over twice as wide. For the majority of patients the spherical curve that will best align with the cornea will be somewhat flatter than K, and the wider the BOZD, the flatter we need to go. In practice, fitting on flattest K seems to work well with conventional designs of 9.00mm diameter or thereabouts. Once we get up to 9.50mm, we need to go flatter, because the average corneal radius is likely to be flatter. On a larger diameter, the primary sag of a spherical curve increases, resulting in a steeper-fitting lens.

Therefore, if you increase the BOZD by 0.5mm, you need to flatten the BOZR by 0.05mm to achieve a 'clinically equivalent fit'. Most lenses fitted on flattest K are probably a fraction steeper than alignment really, but this seems to work well and may aid centration without seriously compromising in other respects. With an alignment fit, the practice of steepening the BZOR by a proportion of the corneal toricity is inappropriate as any steepening of the fit along the flattest meridian will only serve to push the whole lens further from the cornea, inducing central clearance. It will, therefore, have no effect on edge stand-off in the steeper meridian which is the usual intention. It does sometimes help the lens to centre though, if a back surface toric is not an attractive option.

If you are fitting an aspheric design, it's probably best to read the manufacturers' recommendations as the nominal BOZR initially selected will be related to the degree of aphericity ('eccentricity' or 'shape factor') of the lens design. The principles are similar though.

The periphery

The periphery of the lens may be generated either by working a set (typically three or four) of progressively flatter spherical curves on to the back surface, or as a consequence of using an aspheric curve.

In either case, it is worth considering what we have a periphery for. Part of the reason has to do with tear circulation under the lens. If we don't have edge clearance, tear fluid will not be able to get under the lens. This will have two effects.

Firstly, the lubricative effect of the tear film would be lost. The lens is then likely to adhere to the epithelium and eventually mechanical damage to this vital layer will occur.

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Secondly, the oxygen normally carried by the circulating tears will be lost to the cornea under the lens. This is not too important provided the lens is able to transmit sufficient oxygen through its own substance, but for a lens of low transmission tear exchange may be an important source of oxygen delivery. For a PMMA lens, it is the only source. Central corneal hypoxia will compromise epithelial integrity further. Clearly then, we must have enough peripheral clearance to allow adequate tear exchange.

The other reason for peripheral clearance became apparent when silicone acrylate lenses first appeared. Practitioners reasoned that improved oxygen transmission reduced the need for tear exchange, and lenses with very little edge clearance were both more comfortable and tended to centre well, due to the improved tear meniscus around the lens. The downside to all this became apparent when it was time to remove the lenses, as a certain amount of edge clearance is needed to allow the eyelids to dislodge the lens.

The problem was made slightly worse by the fact that many of the patients being fitted with these lenses were used to PMMA lenses, which needed quite a lot of edge clearance in order to get oxygen to the cornea. Removal techniques made sloppy by loosely fitting lenses (a sharp tap to the back of the head would probably have removed some of the designs then in common use) were severely challenged by the minimal peripheries of the RGPs. A tactical withdrawal to slightly more generous peripheries was undertaken.

Modern 'system' lenses have peripheries that are worked out by computer to give a smooth progression and where spherical curves are used the transitions between them are polished to 'blend' the curves into one continuous surface. They are calculated to work on the majority of patients, but if a patient has an unusual corneal shape factor, too much or too little edge clearance will result. This can be detected once the lens is observed on the eye with fluorescein, and laboratories can increase or decrease the edge lift of the lens produced while keeping the optic zone the same.

For a lens ordered empirically, a system lens is usually the best bet, unless you are aware of unusual corneal characteristics.

The terms edge clearance and edge lift are not interchangeable. Edge clearance refers to the gap between the front surface of the cornea and the back surface of the peripheral curves, and it is edge clearance that is observable with fluorescein. Edge lift is a geometrical characteristic of the lens itself, and is definable in either axial or radial forms. The difference between them is shown in Figure 2.

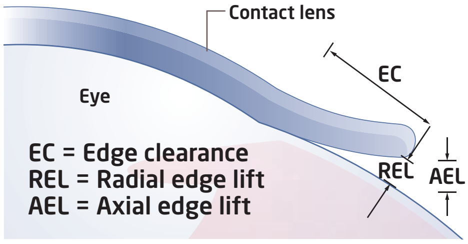

Figure 2 Axial and radial edge lift and edge clearance

Edge profile

The shape of the edge is an important determinant of lens comfort, especially in the early stages.

Laboratories tend to have their standard designs, but if you find that the lenses coming through are not as comfortable as they should be, you could ask for a different form (or change labs, of course). Generally, for the alignment fit with partial lid attachment it is interaction between the lens edge and the eyelids rather than the cornea that seems to determine comfort. Rounding of the anterior rather than the posterior edge seems to be the important factor.

Centre thickness

Modern lenses, because of their material properties and thin design, tend to flex, especially in low minus-powered lenses. In general, flexure increases with Dk, and with the degree of toricity of the cornea the lens is sitting on. Normally, 'system' lenses take care of this for you.

Once corneal astigmatism gets to about 2.00D a further 0.02mm is needed, so if you are fitting an astigmatic cornea with a spherical lens you might need to order something a bit thicker. This will, of course, compromise the oxygen transmission a little.

Back vertex power

The power of the contact lens required would normally be calculated from the spectacle prescription corrected for vertex distance, but must take the power of the tear lens between the contact lens and cornea into consideration.

If the lens is in perfect alignment with the central cornea, it follows that the tear lens will have zero dioptric power, and over-refraction is rather a good way to measure the degree of alignment. A lens which is steeper than the cornea will give rise to a tear lens of positive power, and a flat lens will create a negative tear lens. The power of the tear lens can be calculated precisely, but for lenses fitted fairly close to alignment this is unnecessary.

A simple rule of thumb exists. For every 0.05mm that the BOZR is steeper than K, the tear lens power increases by +0.25D. Therefore, you must counter this by adding -0.25D to the power of the contact lens. Obviously if the contact lens is flat by 0.05mm, an extra -0.25 is added to the power of the tear lens, and the power of the lens ordered must be increased by +0.25D.

Example

Let's consider a simple example.

A patient has a spectacle prescription of -05.00DS at a back vertex distance of 10mm.

His K readings are 7.80mm in all meridians, but we have elected to fit him with a lens with a BOZD of 7.75mm.

The first step is to adjust the spectacle lens power to account for the fact that the contact lens is sitting on the eye. This can be calculated using the formula:

$$L = \frac{F's}{1-dF's}$$

Where L = power of contact lens
d = vertex distance of spectacle lens
F's = power of spectacle lens

However, it is much easier to look it up in a table, such as that provided in the *ACLM Manual*. A spectacle lens at 10mm BVD has an effective power in the corneal plane of -4.75D, so this is the power we need for the contact lens.

The lens is 0.05mm steeper than K, so the liquid lens will have a power of +0.25D. To counter this, we need to add -0.25D to the contact lens power, which takes us back to -5,00D. This is the power we will order.

If we decided that the 7.75 base curve looked a bit steep, we might choose to order a flatter lens next time. Suppose we wanted to order a BOZR of 7.85 this time. This is 2 x 0.05mm flatter than the previous lens, so we would create a tear lens with an extra -0.50D. We would need to modify the power of the lens we ordered by +0.50, so we would order -4.50D.

On the other hand, we might not do this, even if it is theoretically indicated, as we also need to consider the inconvenient fact that most of our patients have two eyes. These two eyes usually work together, though sometimes not as well as we might hope.

● **Ngaire** and **Andy Franklin** practise in Gloucestershire. This is based on their book *Eye Essentials; Rigid Gas Permeable Contact Lenses,* edited by William Harvey and Sandip Doshi