Essential contact lens practice
Part 5 — Soft contact lens fitting

Jane Veys, John Meyler and Ian Davies continue their series with a discussion of the key aspects of soft lens fitting principles. C7052, two contact lens points suitable for optometrists, DOs and CLOs

Soft contact lenses continue to dominate most contact lens markets, accounting for about 90 per cent of all fits worldwide.1 Options available to the practitioner continue to evolve in lens materials, designs and replacement frequencies. Although hydrogel lenses continue to dominate, prescribing of silicone hydrogel lenses is increasing, accounting for almost one-quarter of soft lens fits globally.1

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**KEY POINTS**

- Tear film assessment should be undertaken with minimal invasion of the structure – non-invasive techniques should be used whenever possible.
- Assessment must be made both prior to and during contact lens wear. Tear film quality should be assessed both with the lens in situ and without the lens.
- Use of the Tearscope in clinical practice allows a more detailed examination of the tears to be undertaken.
- Symptoms, not just signs, are an important aspect of overall tear film assessment.

Many myths surrounding soft contact lens fitting and design have been summarised in the literature.3 This article provides a practical overview of the key aspects of soft contact lens fitting principles. It does not deal with specific products. All the rules that apply to hydrogel lens fitting also apply to silicone hydrogel materials.

The ideal soft contact lens fit

Judging the fit involves evaluating both static and dynamic criteria. The ideal soft contact lens fit should show the following characteristics:

**Corneal coverage**

The lens should cover the cornea in primary gaze (Figure 1) and in all positions of gaze. This is to avoid desiccation of an exposed cornea, leading to epithelial staining (Figure 2).

**Dynamic fit**

The lens must allow tear exchange to enable metabolic debris from the cornea to be excreted. It is now well established that soft contact lens movement plays only a minor role in corneal oxygenation. The tear pump effect for soft lenses is minimal compared to a rigid lens. This is significant in managing the soft contact lens patient. The practitioner should not increase lens movement to alleviate hypoxic signs in the hydrogel lens wearer. This will be covered later in the series.

**Alignment**

The lens should align with the cornea and the conjunctiva, and not indent conjunctival vessels that would indicate stagnation of tears in this region and reduced oxygen supply to the limbus. Similarly, the lens should also show no edge standoff (fluting) that would lead to discomfort.

**Lens centration**

The lens should remain approximately central to the cornea in all positions of gaze. Failure to achieve this may result in episodes of corneal desiccation and mechanical stress on the peripheral cornea.

![Figure 1 Lens fit in primary position of gaze](image1.png)

![Figure 2 Insufficient corneal coverage and associated desiccation staining](image2.png)
Patient response
When the above criteria are attained, the patient should achieve a high level of comfort and crisp stable vision. Table 1 summarises both the physical fit and performance requirements.

Instrumentation — keratometry

Trial lens selection
Keratometry readings are a poor indication of a soft lens fit, and several studies, such as Gundal,4 have shown no correlation between either central or peripheral K-readings and the best-fitting soft contact lens. Despite this, fitting guides continue to be produced in which K-readings are quoted as being measurements on which the initial base curve is selected. The reason why K-readings do not predict a soft lens fit has been explained by Young.5 The relationship between the sagittal depth (sag) of the lens and the sagittal height of the anterior segment of the eye over the lens diameter determines the fit of the lens.

Theoretically, if the lens sag is greater than the ocular sag, the lens will fit steeply, and vice versa. By using a mathematical model to calculate ocular sag and then inputting normal ranges of values for each variable with the model, Young showed that the normal population variability in shape factor had a greater effect on sag than either cornea radius or diameter.

Baseline data
Although keratometry does not play a role in the selection of the initial trial lens, baseline keratometry readings should be taken for comparative purposes with time.

Judging lens fit
The quality of the keratometer mires pre- and post-blink can be used to help to judge fitting characteristics. The mires should remain clear at all stages. With a steep fitting lens, the mires will...
look blurred prior to a blink with clear post-blink. With a loose fitting lens, the converse will occur. While this is often cited as a method for judging the lens fit, the authors believe this method has limited application to modern thin lens designs.

**Corneal topography**

Corneal topography can be used to locate the apex of the cornea. This is valuable because the lens will centre on the corneal apex rather than on the geometric centre of the cornea. If the apex is displaced, the lens will decen- trate. Locating the apex will help in determining the best management option to overcome it.

**PD rule**

The normal PD rule may be used for measuring gross external parameters. Horizontal visible iris diameter (HVID) is of value to the soft lens fitting and will act as a determinant of total diameter. The HVID must be at least 1mm less than the TD of the lens to be fitted. Measuring the anterior segment by using such a ruler is a crude method, so a graticule on the slit lamp should be used.

**Biomicroscopy**

The biomicroscope is an essential tool. In soft lens fitting, its primary purpose is to allow the practitioner to judge, and then record, the fit of the lens on the eye. In soft lens fitting, in addition to recording lesions and anterior segment measurements, slit lamp graticule also allows the practitioner to assess accurately the precise post-blink movement of a contact lens.

While many texts and fitting guides refer to an optimally fitting soft contact lens as being 1mm, the actual post-blink movement usually measures 0.2mm to 0.4mm. In Figure 3, a cursor is superimposed on the eye to demonstrate how big 1mm looks through a slit lamp. A lens that moves as much as the marker does in Figure 3a, would be judged by most practitioners as showing excessive movement, even though the recorded measurement is 1mm. In fact, the amount shown in Figure 3b is closer to that typically seen in a soft contact lens, and, in this case, is 0.3mm.

The slit lamp is also used for assessing lid tightness, judging centration and corneal coverage, assessing edge fit and viewing the overall lens fit by using the push-up test.

**Techniques**

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

**Initial trial lens — choice and insertion**

The first trial lens should be chosen using the basis of the following criteria:

- Back vertex power should be as close as possible to the patients’ prescription to allow them to judge the benefits of contact lens wear correctly and to facilitate adaptation. If the exact power is not available, it is preferable that the lens is chosen to under-correct rather than to over-correct to avoid accommodative spasms that could influence over-refraction. If monovision is to be tried, the lens should be chosen to be as close to the correct powers as possible.
- Total diameter must be larger than the HVID by approximately 2.5mm to allow for full corneal coverage.
- Back optic zone radius - if a choice of base curve is available, follow the manufacturer’s guidelines for which lens to try first. This should be done without regard to K-readings.

Adaptation period — fitting characteristics

Once the lenses have been inserted, the fit must be assessed after a suitable settling period. Soft lenses lose water as soon as they are placed on the eye, and this will change their parameters and, possibly, the fitting characteristics. Intuitively, it is important, therefore, that the fit is assessed once the lens is in equilibrium with the tear film.

Classical soft lens theory states that the lens should settle for 20 to 40 minutes before the fit is assessed. More recent work by Brennan et al. looked at changes in fitting characteristics in low and high water content lenses over an eight-hour wearing period. They found that lens movement decreased significantly over the first 25 to 30 minutes of wear. The most effective time to predict the final fitting characteristics was five minutes after the lens was inserted. It is proposed, therefore, that the fit should be assessed, initially, after five minutes and, if unacceptable at this time, another trial lens should be inserted.

Adaptation period — physiological and psychological characteristics

Five minutes is clearly insufficient to judge how they feel in lenses for varying activities throughout the day. A longer ‘walkabout’ trial allows the patient to appreciate what wearing contact lenses entails, and experience a more real world beyond the consulting room chair. Ultimately, ongoing aftercare permits the practitioner to judge patient suitability and evaluate patient needs.

Patient subjective response

The lens should feel virtually indiscernible on the eye, particularly on insertion. Any initial discomfort due to differences between the osmolarity and pH of the lens storage solution and the patient’s tears should be quick to
resolve. Lens sensation should be consistent, with no significant differences in lateral eye movement or blinking. As a general rule, comfort should be reported as 9/10 or better.

- Vision – with the appropriate over-refraction in place, vision should be stable and clear, although patients with higher refractive errors may notice peripheral distortion and have initial difficulty in judging distances due to magnification changes. These should, however, soon resolve.

Over-refraction and visual acuity
A normal over-refraction should take place with binocular balancing. The refraction should have a clear endpoint and visual acuity should be stable and crisp. Variations of this could indicate a poor lens fit, and the use of the retinoscope to confirm is recommended.

Biomicroscope examination
Following over-refraction, the lens fit should be assessed at the slit-lamp. Diffuse direct illumination and medium to high magnification should be used to visualise the lens on the eye.

The following assessments should be made:

- Corneal coverage – with the eye in primary position, the lens should show full corneal coverage before, after and during the blink (Figure 1) and around 1mm of conjunctival overlap.
- Centration – the lens should be centred to the cornea in the primary position of gaze and should retain full corneal coverage of excursion gaze (lag) (Figure 4), and upgaze (sag) (Figure 5). Although tests and fitting guides recommend assessing both variables to judge the fit of a lens, studies indicate they have little predictive value in deciding if a lens is fitting successfully or not.
- Primary gaze post-blink movement – this should be judged, or, ideally, recorded, with a graticule. This can be achieved by looking at the bottom of the lens during the blink or, if the lower lid obscures the inferior lens edge, at 4 or 8 o’clock. In some cases, it may be necessary to displace digitally the lower lid prior to making the assessment.
- The ideal lens movement, as measured, should be 0.2mm to 0.4mm. In modern, thin, high water and low elastic modulus lens designs, the movement seen is often less than in older, thicker, lower water content designs. At times, it can be difficult to judge the fit on movement alone, and a better assessment of lens dynamics can be made using the push-up test.

- Push-up test – assessing the tightness of the lens is a measure of the fitting relationship of the lens with the eye. It is the most effective way to judge the dynamic fit of the lens. The practitioner moves the lens vertically, through pressure on the lower eyelid, using the finger. The lens is allowed to re-centre while being observed by the practitioner (Figure 6).

The practitioner assesses the relative ease with which the lens is displaced and the speed of its recovery to its original position. A percentage grade has been proposed, with 100 per cent representing a lens that is impossible to move and 0 per cent a lens that falls away from the cornea without lid support. An optimum fitting lens would be recorded as 50 per cent.

The significance of the push-up test has been described by Martin et al. Martin showed the movement of fluid beneath a soft lens is determined by the squeeze pressure, or the force between the front surface of the eye and the back surface of the lens. As squeeze pressure increases, the amount of fluid exchange decreases.
Soft contact lens movement shows a poor correlation to squeeze pressure, which acts as a limiting factor, above which a lens shows no movement.

This correlation is illustrated in Figure 7, which is adapted from Martin et al, that shows that lenses may have a low enough squeeze pressure for fluid exchange to take place and yet show no movement. In comparison, tightness, as measured by the push-up test, showed a linear relationship with squeeze pressure (Figure 8), and so should be considered the arbitrator in judging lens fit.

Interpretation of findings
Consistent with good clinical practice throughout optometry, a particular observation should not be viewed in isolation. Interpreting results is facilitated by the practitioner following a structured routine (Table 2).

Table 3 summarises the key assessments made during the soft contact lens fitting procedure, and shows the characteristics of an ideal fit. The table also illustrates sub-optimal responses that may be seen and suggests remedial actions. In this section, we will review the factors affecting fit and the remedial actions that may be taken.

Indications of a tight or loose fit are summarised in Table 4, and illustrated in Figures 10 and 11.

Ocular factors affecting lens fit

- Corneal apex – a displaced corneal apex will lead to a centred lens. Increasing the total diameter will expand the corneal coverage if it becomes exposed, while changes in the base curve will have little effect on centration.
- Lid pressure – tight lids often result in a high-riding lens and, possibly, excessive lens movement. Using a thin lens design and/or increasing lens diameter are management options. Loose lids generally have less effect on lens fits, although insufficient lens movement is a possible consequence.
- Tear morphology – both pH and osmotic pressure can change lens parameters and affect the fit of the lens. A reduction in pH leads to a steepening of the ionic contact lens parameters, and one study has shown that both ionic and non-ionic lenses tighten in fit as the tonicity of the tear film is reduced. This is clinically significant because if a satisfactory fit cannot be obtained with one contact lens material, then it might be worth changing the ionicity or water content to another material.

Lens variables affecting lens fit

- Total diameter – increasing the total diameter will expand the sag of the lens and tighten the fit, whereas reducing it will have the opposite effect. Total diameter might also be increased to improve corneal coverage in a lens.

TABLE 2

Schematic flow chart of soft CL fitting procedures

<table>
<thead>
<tr>
<th>Insert trial lens</th>
<th>Symptom – Comfort – Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit-lamp examination – Corneal coverage – Edge alignment – Primary gaze movement – Centration – Push-up test</td>
<td></td>
</tr>
<tr>
<td>Vision assessment – Visual acuity – Over refraction</td>
<td></td>
</tr>
<tr>
<td>Sub-optimal result</td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 7 Relation between in vivo lens movement and the squeeze pressure measured on the model eye (according to Martin et al).

FIGURE 8 Relationship between the clinical assessment of lens fit and the measured squeeze pressure on the model eye (according to Martin et al).

FIGURE 9a The common falsely predicted effect of varying BOZR on lens movement (According to Young).

FIGURE 9b The real effect of varying BOZR on soft lens post-blink movement (According to Young).
### TABLE 3
Key assessments made during the soft contact lens fitting procedure

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Ideal result</th>
<th>Variations from norm</th>
<th>Possible cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort</td>
<td>Comfortable lens &gt;9/10 None or minimal lens awareness</td>
<td>Continual discomfort</td>
<td>Foreign body (FB) Thick lens</td>
<td>Remove and replace lens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discomfort worse on blinking</td>
<td>Loose lens Edge standoff</td>
<td>Refit with thinner lens</td>
</tr>
<tr>
<td>Vision</td>
<td>Crisp, clear, stable vision</td>
<td>Blurred vision, after blinking</td>
<td>Incorrect power Loose lens Loose lens</td>
<td>Over-refract Modify to tighten fit</td>
</tr>
<tr>
<td></td>
<td>Precise over-refraction</td>
<td>Variable over-refraction</td>
<td></td>
<td>Modify to tighten fit</td>
</tr>
<tr>
<td>Centration</td>
<td>Full corneal coverage (1mm to 2mm overlap)</td>
<td>Greater than 2mm conjunctival overlap Corneal exposure</td>
<td>Lens too large Too small lens Poor centration</td>
<td>Reduce total diameter Increase total diameter</td>
</tr>
<tr>
<td></td>
<td>Centred in all positions of gaze</td>
<td>Corneal exposure at extremities of gaze</td>
<td>Loose lens Tight lids</td>
<td>Modify to tighten fit</td>
</tr>
<tr>
<td>Edge alignment</td>
<td>Regular alignment to conjunctiva</td>
<td>Edge stand-off or buckling</td>
<td>Loose lens Peripheral lens design Tight lens Peripheral lens design</td>
<td>Modify to tighten fit Try different design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conjunctival indentation</td>
<td></td>
<td>Loosen lens Try different design</td>
</tr>
<tr>
<td>Primary gaze movement</td>
<td>0.25mm to 0.50mm movement</td>
<td>Less than 0.25mm More than 0.50mm</td>
<td>Tight lens Hypotonic tears Loose lens Excessive lacrimation See comfort</td>
<td>Loose lens Try different material Modify to tighten fit Check for FB Allow longer setting See comfort</td>
</tr>
<tr>
<td>Push up test</td>
<td>Smooth recovery from push-up</td>
<td>Resistance to movement Excessive movement and erratic recovery</td>
<td>Tight lens Hypotonic tears Loose lens Excessive lacrimation See comfort</td>
<td>Loose lens Try different material Modify to tighten fit Check for FB Allow longer setting See comfort</td>
</tr>
</tbody>
</table>

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![Figure 10 Edge fluting due to loose lens fit](image)

![Figure 11 Limbal vessel ‘nipping’ due to tight lens fit](image)

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### TABLE 4

<table>
<thead>
<tr>
<th>Indications of a loose fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive lens movement</td>
</tr>
<tr>
<td>Poor centration in primary gaze (usually inferior lag)</td>
</tr>
<tr>
<td>Buckling of lens edge</td>
</tr>
<tr>
<td>Lens awareness</td>
</tr>
<tr>
<td>Variable vision — more immediately post-blink</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indications of a tight fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>No movement (immobile)</td>
</tr>
<tr>
<td>Limbal vessel constriction ‘nipping’</td>
</tr>
<tr>
<td>Conjunctival indentation</td>
</tr>
<tr>
<td>Conjunctival redness</td>
</tr>
<tr>
<td>Low grade inflammation</td>
</tr>
<tr>
<td>Vision improves immediately post-blink</td>
</tr>
</tbody>
</table>

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Fitted onto a cornea with a displaced apex. Changes to lens diameter impacts fit to a greater extent than changes to BOZR. Back optic zone radius — traditional soft contact lens fitting theory states that, as the BOZR increases, lenses move more and that, as it decreases, lenses move less (Figure 9). Most practitioners have experienced situations where changing BOZR has a minimal, if any, effect on the lens fit. This has been supported by several studies. Numerous researchers have shown BOZR has no predictive value on lens movement. Roseman’s group also demonstrated that decreasing BOZR could improve centration without compromising the dynamic fit of the lens. This is not to say that changing the base curve will not affect movement, only that it may not have the predicted effect.

Peripheral lens design — the peripheral design of a lens, which is the relationship between the front and back peripheral curves, has a marked effect on lens fit, as shown by Young et al. As well as fitting characteristics, the peripheral design influences lens handling characteristics and comfort. The practitioner is, generally, unable to change these parameters, and, indeed, very little has been published that demonstrates the value of making changes. In practical terms, practitioners have experienced situations where changing BOZR has a minimal, if any, effect on the lens fit. This has been supported by several studies. Numerous researchers have shown BOZR has no predictive value on lens movement. Roseman’s group also demonstrated that decreasing BOZR could improve centration without compromising the dynamic fit of the lens. This is not to say that changing the base curve will not affect movement, only that it may not have the predicted effect.
ers should be aware that changing a lens from one design to another with the same BOZR and total diameter will not guarantee the lens will fit in the same way.

Conclusions
Although practitioners have fewer parameters to choose from in deciding the optimal fit for a soft contact lens than with rigid lenses, it is still important that it is assessed accurately to ensure successful lens wear. As hydrogel lenses have become thinner, with lower elastic moduli, and as lens designs have improved, the number of parameters required to fit a normal population has declined. With the introduction of higher modulus silicone hydrogel materials, optimising fit is important for success.

In many ways, contact lens texts and manufacturers' fitting guides have not kept up with the understanding of the dynamics and the assessment of soft lens fitting. This article has tried to provide a practical guide to the key aspects of modern soft contact lens fitting.

Of course, the process for assessing soft contact lens fit does not cease after the initial assessment. The effects of factors such as wearing time, environmental conditions and ocular physiology must be monitored constantly. Ongoing aftercare is key to continued contact lens success.

Acknowledgements
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References
2 Young G. Why one million CL wearers have dropped out. Cont Lens Ant Eye, 2004; 27:2 83-85.
9 Martin D and Holden B. Forces developed by the slit-lamp?

MULTIPLE-CHOICE QUESTIONS

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Which of the following properties is not characteristic of a well fitting soft lens?</td>
<td>D Comfort is a good predictor of the fit of a lens</td>
</tr>
<tr>
<td>2 The keratometer: A Predicts the base curve to be chosen for a trial soft lens</td>
<td>B Provides base line data of central corneal contour</td>
</tr>
<tr>
<td>3 When inserting a trial lens which of the following is not true? A Initial discomfort should resolve rapidly</td>
<td>C Provides a mean of judging tear quantity</td>
</tr>
<tr>
<td>4 Which of the following assessments should not be made while viewing with the slit-lamp? A Corneal centration</td>
<td>D Squeeze pressure under lens</td>
</tr>
<tr>
<td>5 Which of the following is true of squeeze pressure? A It is directly correlated with post-blink movement</td>
<td>B It is an assessment of the oxygen flux exchange</td>
</tr>
<tr>
<td>6 Which of the following external factors will not have an influence on lens fit? A Corneal thickness</td>
<td>C Material incompatibility</td>
</tr>
</tbody>
</table>

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