



Soft Toric Contact Lens Fitting

KEY POINTS

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Improvements in toric lens speed of orientation, lens stability, corneal oxygen supply and reproducibility mean that practitioners should be confident in fitting soft toric lenses when poor vision is due to astigmatism

Assessing rotational stability in all positions of gaze and between blinks is the key to success

Practitioners should have at least two lens designs to choose from which include a prism ballasted design and non-prism ballast design

Practitioners should allow for more than one lens per eye, both in terms of time and financial consideration, but only attempt a maximum of two lenses per eye

Soft toric contact lens fitting was previously regarded as a 'speciality' only to be undertaken by experienced practitioners.

In recent years, however, the number of designs available has increased and the fitting approach simplified. The proportion of new soft toric fits is now over 30 per cent in the UK, which correlates well with the incidence percentage of the population with astigmatism between 0.75 and 2.50D.¹ However, the proportion of soft toric lenses fitted still remains low in many markets across the world.²

Soft torics are now available from stock and with an ever-increasing number offering the benefits of frequent replacement, daily disposability or silicone hydrogel materials, toric lenses can be fitted empirically or from comprehensive in-practice fitting banks. The latter now makes trialing astigmatic patients with single-use toric disposable diagnostic lenses as convenient as spherical lens fitting.

One of the reasons for this increase in the simplicity of fitting toric lenses has been advances in manufacturing technology. The advent of new low-cost moulding technology and wet moulding techniques – allowing the lens to remain hydrated throughout manufacture – has led to improvements in contact lens reproducibility and optical quality. This should give practitioners greater confidence that the lens being dispensed is the same as the lens ordered.

Nevertheless, a recent wearer survey showed the high levels of lens performance expected by toric lens wearers was not being achieved, especially when comparing comfort and vision ratings.³ The need to improve performance further, along with a better understanding of the forces that influence toric lenses, has resulted in the introduction of more advanced designs in the last few years. Stock and custom made toric soft lenses are now available in silicone hydrogel materials and the resultant increase in oxygen availability has allowed greater thickness variations in lens design to further improve orientation and stability characteristics of the lens on the eye.

Around 16 per cent of prescriptions have more than 1.00DC of astigmatism (Table 1) which increases to approximately over 30 per cent of the ametropic population with 0.75D or more of refractive astigmatism.⁴ To correct this refractive error, the practitioner has a number of alternatives:

Incidence of astigmatism, from Bennett⁴

TABLE 1

POWER OF CORRECTING CYLINDER (D)	PERCENTAGE OF TOTAL SAMPLE	PERCENTAGE OF ASTIGMATIC LENSES
0	32.0	
0.25-0.50	34.6	50.9
0.75-1.00	17.7	26.0
1.25-2.00	9.8	14.4
2.25-3.00	3.8	5.6
3.25-4.00	1.5	2.2
Over 4.00	0.6	0.9

Rigid gas-permeable lenses

RGP lenses will correct corneal astigmatism. The advantage of a spherical RGP lens to correct astigmatism is the relative ease of the fit, while the disadvantages are the reduced comfort associated with rigid lenses, the difficulty in obtaining a well-centred lens in some cases and the frequent problem of three and nine o'clock staining. However, a spherical RGP lens will not correct lenticular astigmatism. In cases of high corneal toricity the fit might become unstable and a toric periphery or full toric back surface will be required. Having a full toric back surface on the lens provides the best option in achieving an alignment fit.

Thick soft lenses

An often-quoted strategy for correcting low degrees of astigmatism with soft lenses is to increase the thickness of the lens or use a higher modulus material. The theory is that a thicker or stiffer lens will drape less on the cornea and so mask more astigmatism.

When controlled studies have been carried out, usually no significant effect has been reported for the majority of patients.^{5,6} Likewise, a higher modulus spherical silicone hydrogel material has been shown to have no significant impact on the amount of astigmatism masked when compared to a hydrogel soft contact lens.⁷ Overall it must be concluded that the degree of astigmatism correction by spherical soft lenses is clinically insignificant.

Aspheric hydrogel lenses

There is some evidence that the use of aspheric front surfaces, which reduce the spherical aberration in the lens/eye system, may improve visual performance in low degrees of astigmatism compared to spherical soft lenses even though the astigmatism remains uncorrected. However, aberrations of the eye vary considerably between subjects, which may explain in part why lenses of this type meet the needs of some wearers but not others. In addition, more recent research has shown that the performance of an aspheric lens surface when fitted to low astigmats decreased with larger pupils and did not match the visual acuity, resulting in full astigmatic correction with a soft toric contact lens.⁸

Soft toric lens

The final option for the practitioner is to fit a soft toric lens. This has the comfort advantage of soft material and generally improved visual performance over the other soft lens options discussed. The rest of this article will discuss soft toric contact lens fitting in practice.

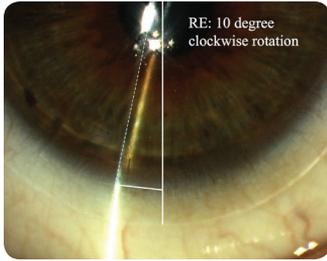


FIGURE 1 Rotation of beam to align lens marking and measure lens position (Courtesy of Trusit Dave)

Instrumentation

The basic instrumentation required for soft toric lens fitting is the same as that needed to fit regular soft lenses. A slit lamp having a graticule with a protractor is of particular value in soft toric lens fitting to assist in locating the axis. If this is not available, rotation of the slit beam and a scale indicating the degree of rotation can be helpful (Figure 1).

Lens trial

The ideal system would be to have a comprehensive bank of single-use trial lenses in practice to allow astigmatic patients to experience lens wear as conveniently as their spherical counterparts. The alternative is empirical fitting, whether fitting a disposable lens or conventional stock toric lens. If a disposable lens fit, this means the practitioner orders a diagnostic lens for the specific patient. Regardless of the approach, a lens must be assessed on the eye to allow the practitioner to assess both the physical fit of the lens and its rotational behaviour, which will determine the optical result. Maintaining the rotational stability of the lens is the key to successful soft toric fitting, not just in the primary position of gaze, but maintaining stability also with more lateral eye movements as well as during different head positions.

Surface toricity

A rigid toric lens maintains its position on the cornea through the alignment of the back surface of the lens with the toric cornea, assuming that the cornea has sufficient toricity to justify the toric fitting. If a soft lens is produced with a toric back surface, its reduced modulus of elasticity means the lens will still drape and so rotate on the eye. Most current moulded toric soft lenses incorporate a toric back surface and are equally suitable to fit on spherical corneas when correcting lenticular astigmatism. More recent designs have a spherical fitting curve which surrounds the back surface toric optic portion. However, to keep the astigmatic correction of the lens in alignment to that of the eye, the lens must be held in position. There are two basic ways to achieve this:

- Prism-ballasted design
- Non prism-ballasted design (eg double slab-off, dual thin zone, accelerated stabilisation design).

Prism-ballast design

This was the first and, although considerably adapted over the years, is still the most common means of stabilising a lens in the eye. In principle, the lens is produced with an increasingly thicker profile towards its base (Figure 2a). The thinner portion of the lens locates under the upper eyelid,

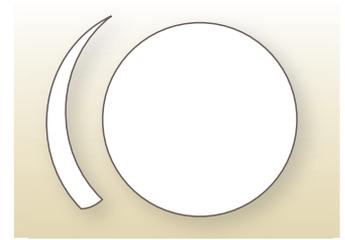
which then squeezes the thicker portion of the lens towards the lower lid (the so-called watermelon seed principle). It was considered for many years that gravity did not play a part in the axis location. However more recent research – which observed what happens when prism-ballasted lens wearers lay on their side – shows gravity does have some effect as shown in Figure 3.⁹ In this position, the prism base swings towards the vertical. Lid position, blink and gravity are all important influences on lens orientation with this type of lens design. When prism-ballasted lenses rotate 45 degrees from their normal position, they rapidly re-orientate through the first 20 to 30 degrees under the influence of gravity. When gravitational force is no longer significant, most rotation occurs during the blink because of the rapid motion of the upper lid as it sweeps against the contours of the lens.

The increase in the thickness of the lens means less oxygen is transmitted through the material and this can also lead to a decrease in comfort, especially against the lower lid. To overcome this, manufacturers remove as much of the prism as possible from the lens through 360 degree comfort chamfers and eccentric lenticulation, which are designed to reduce the thickness of the lens¹⁰ (Figure 2b). In addition, prism-ballast designs have seen further refinements, resulting in prism-free optics (peri-ballast) and prism that is restricted to the lens periphery.^{11,12} Other designs aim to control the thickness profile vertically to limit unwanted rotational forces and minimise differences in stabilisation between lenses of different power and cylinder axis.¹³ (Figure 2c).

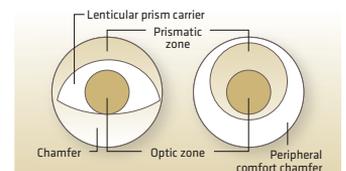
Non-prism-ballast design

These designs also rely on the interaction between lids and the lens to achieve stabilisation. Both eyelids play an active role unlike with prism-ballast designs that involve interaction primarily from the upper lid. These designs show little or no rotation resulting from gravity. In early designs, stabilisation is achieved by designing a thin zone that is superior and inferior to the optic zone, resulting in no additional thickness. The lids will squeeze against the thickness differential across the lens, maintaining its stability. The advantage of this type of design is that the overall thickness profile can be kept to a minimum, optimising physiological response and patient comfort. Refinement to this stabilisation approach includes designs that isolates the optical correction within an optic zone resulting in independent stabilisation areas.¹⁴ This allows orientation consistency across all powers and a thin overall thickness profile to improve oxygen transmissibility (Figure 4b). More recently, designs have maximised effectiveness by locating thicker 'active zones' within the palpebral apertures while minimising any thickness variation of the lens under the

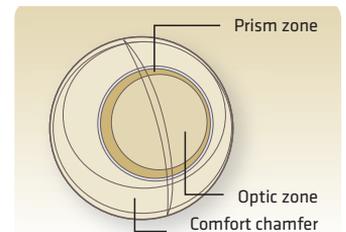
FIGURE 2 Prism-ballast designs (for illustration purposes only)



a) Cross-section through a prism-ballasted soft toric lens, showing the variation in thickness



b) A prism-stabilised soft toric lens, showing the prism-free central optic zone and the peripheral carrier with prism and comfort chamfer, from *Grant*

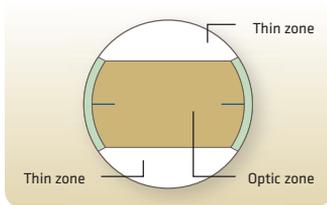


c) A prism-stabilised soft toric lens, showing the prism free central optic zone and the peripheral carrier with prism and comfort chamber to allow control of lens thickness with different lens powers (adapted from *Cox et al*)

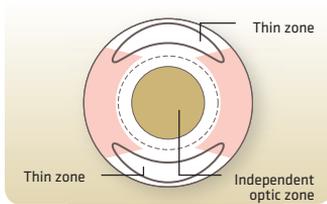


FIGURE 3 The effect of gravity on a prism ballasted toric soft lens (Courtesy of Graeme Young)

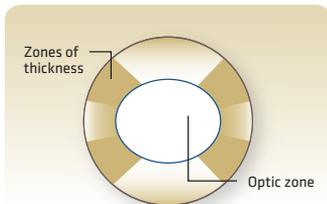
FIGURE 4 Non-prism ballast designs (for illustration purposes only)



a) Double slab-off stabilised lens design



b) Dual thin zone with independent optic zone



c) Accelerated stabilisation design with zones of thickness located outside the open eyelid

eyelids¹⁵ (Figure 4c). This results in a lens that rotates quickly to its desired position but reduces the likelihood of the lens to rotate away from its intended position between blinks or due to the sideways movement of the lower lid during blinks.

Non-prism ballasted designs can be more beneficial on those patients with a high lower lid, particularly if the lid is tight, which can encourage nasal rotation. As gravity has minimal rotational influence on non-prism ballast designs, they may be more optimal for certain more dynamic situations (watching or playing sport) or occupations such as dancers, mechanics, military personnel etc.⁹

As no one soft toric design is suitable for all eyes, the practitioner should have a minimum of two different designs available, prism and non-prism ballasted with the optimal choice of material being silicone hydrogel.

As well as selecting soft toric lens fitting sets with different designs, the practitioner should also ensure the lenses being fitted are reproducible and, for non-disposable type lenses, that exchanges are available from the manufacturer, if required. Soft toric lens reproducibility has improved over the years, although lathe-cut lenses, in particular, might still show some variability.

All soft toric lenses require some form of marking on the lens if the practitioner needs to identify the position of the cylinder power axes. A variety of symbols are used by manufacturers to mark either the six o'clock or prism base of the lens or the three and nine o'clock positions (Figures 5 and 6).

Techniques

Initial fitting

Lid position, the upward or downward slope of the lids and palpebral aperture size have been shown to be the main patient factors associated with lens orientation and stability.¹⁶ Even with increasing knowledge of soft toric lens fitting, it doesn't yet allow practitioners to fit them without some trial and error, however it does allow them to better understand where problems may occur and how best to solve them. The exact fitting procedures for soft toric lenses may vary among the different brands. The basic principles, however, remain the same as long as a toric lens is used for on-eye assessment. Some manufacturers advocate empirical fitting – ordering the final lens without first observing a lens on the eye and then making any necessary adjustments once the lens has been evaluated on the eye. Disposable toric lens fitting allows an individual trial lens to be ordered empirically or the appropriate powered lens to be selected from an in-practice fitting bank.

Physical fit

The physical fit for a soft toric lens should be the same as for a spherical soft lens. The lens should cover the cornea in all the gaze positions, allow adequate tear flow to enable metabolic debris to be removed and remain in alignment with the cornea and conjunctiva. If a lens fit is borderline between being adequate or having slight excessive movement, the more mobile fit would generally be chosen to allow the various forces to have the desired effect on the lens rotation.

Initial trial lens-choice and insertion

The choice of back optic zone radius (BOZR), total diameter (TD) and centre thickness (tc) for a soft toric lens should be made in the same way as one would select a spherical soft design. The power of the lens should be chosen with the spherical and, more importantly, the cylindrical power and axis as close as possible to the predicted final lens parameters. While earlier soft toric designs tended to predictably rotate nasally by 5 to 10 degrees from the intended position, this is not the case with more modern designs. A number of patient factors and lens fit characteristics influencing soft toric lens orientation have been identified, but the findings fall short of allowing practitioners to accurately predict toric lens orientation. Hence no initial compensation of the cylindrical axis should be made when choosing the initial trial lens.

As both the cylinder power and axis is varied on a lens, there is a risk that different stability and degrees of rotations may result, especially with designs where the stabilising thickness profile is dependent on lens power. Contrary to popular belief, axes of astigmatism are nearly equally distributed around the clock face for lower amounts of astigmatism (Table 2). Oblique cylinders are generally accepted as being more difficult to succeed with, in terms of vision, although more recent advanced designs attempt to minimise these rotational differences.

The goal of the trial fitting is two-fold: to assess the physical and physiological fit and response to the lens and to measure orientation position along with orientation stability. Following insertion, the lens should be allowed to settle, as for a spherical soft lens, before the fit is assessed. With more recent designs, speed of orientation is faster allowing assessment within one to three minutes following insertion.

Visual assessment

After the settling period, an over-refraction should be carried out. The purpose of the over-refraction is not to determine lens power or degree of rotation, but to see how stable the end-point result is and effectively assess lens stability. If the patient reports that the vision blurs with each blink, either

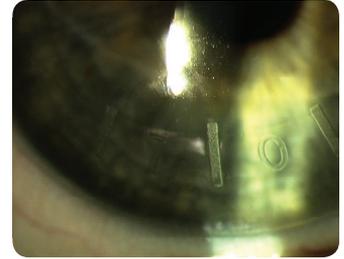
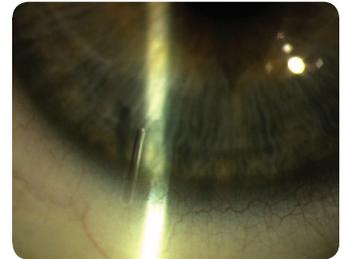


FIGURE 5a AND 5b Axis marks on different soft toric lenses (Courtesy of Trusit Dave)



the lens fit is unsuitable or the rotational stability of the lens is poor. In either case, another lens needs to be inserted, either a different parameter (in the case of a poor fit) or design (if the lens is rotationally unstable). Assuming a clear end-point of refraction can be obtained, the practitioner should go on to assess the lens fit and rotational position.

Before the physical fit is determined, the practitioner should look first for the rotational stability of the lens. This is carried out by viewing the axis location marks on the lens. These should not show rotation with each blink or in-between blinks and should be close to their intended position (vertically or horizontally). If the lens position is more than 30 degrees from the intended position it suggests that there is inadequate stabilisation and an alternative lens design should be considered.

If the location marks are stable in the primary position of gaze, the practitioner should note their position in relation to their intended position and the direction and degree of rotation seen (if any). This can either be measured using a graticule or the slit beam width rotation on the slit lamp (Figure 1) or estimated using the axis marks as a guide (Figure 6, 7). Care should be taken when assessing the location marks on a lens that has decentred as it may appear the lens has rotated when actually there is no rotation. An advantage of a toric lens with two markings opposite each other is that by passing a slit-beam through both markings, a more accurate measurement of lens rotation is achieved, whether the lens has decentred or not. Stability of orientation should be assessed further while the patient performs forced blinking and during version movements. Ask the patient to look up, down, left and right, while looking for any significant lens rotation. If the

Distribution of cylinder axis orientations, from Bennett⁴

CYLINDER POWER (D)	PERCENTAGE DISTRIBUTION OF AXIS ORIENTATION IN EACH CYLINDER POWER		
	WITH THE RULE	AGAINST THE RULE	AXIS OBLIQUE
0.50	36	34	30
1.00	34	34	32
1.50	35	31	34
2.00	38	24	38
2.50	50	18	32
3.00	54	17	29
3.50	49	17	34
4.00	50	15	35
Over 4.00	58	13	29

lens remains relatively stable during this simulation, then it should provide relatively stable vision. Visual performance should also be assessed at near.

The axis rotation gives the practitioner the information needed to order the lens. The rotation of the lens shows how far the axis of the cylinder will be mis-located when the final lens is placed on the eye. This mislocation can be compensated for by ordering a lens with the axis at a different position.

If, for example, an ocular refraction is $-3.00/-1.75 \times 180$ and a trial lens rotates clockwise by 10 degrees when placed on the eye, the correction will be $-3.00/-1.75 \times 170$ degrees and the vision will be blurred. To compensate for this, if the lenses are ordered as $-3.00/-1.75 \times 10$, the 10 degree clockwise rotation will bring the axis round to 180 degrees and the required axis, and vision will be clear. The basic rule is that if the lens rotates clockwise the degree of rotation should be added to the axis, but if it rotates anti-clockwise the rotation should be subtracted from the axis (CAAS). Alternatively, if the lens rotates to the left the rotation should be added and if it is to the right it should be subtracted (LARS).

Over-refraction

If the trial lens scribe marks lie within 10 degrees of the intended position, vision can be assessed and a spherical over-refraction carried out to determine whether an alternate spherical power should be ordered. Lenses that position off-axis will produce a residual refractive error, which is a function of the cylinder power and degree of mis-orientation. For example, a toric soft lens of power $-3.00/-1.75 \times 180$ that matches the patient's ocular prescription but orientates 20 degrees off-axis will result in an over-refraction of $+0.50/-1.25 \times 55$. The stability of the end-point gives a good indication that lens fit is adequate; however, it is impossible to determine whether the spherical component of the final prescription to be ordered requires adjustment. Consequently, a new trial lens should be inserted after compensation of the cylinder axis for lens rotation to allow a meaningful spherical over-refraction. The final order for the lens should include BOZR, TD, tc (if variable) and the power in terms of the sphere, cylinder and desired axis.

Troubleshooting

Poor vision

The most common problem encountered with soft toric lens fitting is unacceptable or variable visual acuity. The most common reason for this is mislocation of the axis. The visual acuity might be found to be reduced, either at the time of

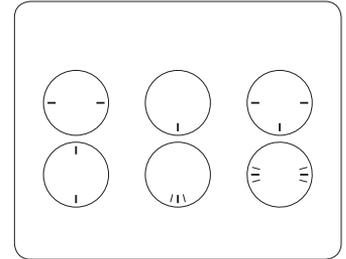


FIGURE 6 Examples of axis marks on different soft toric lenses

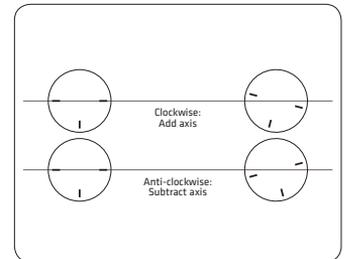
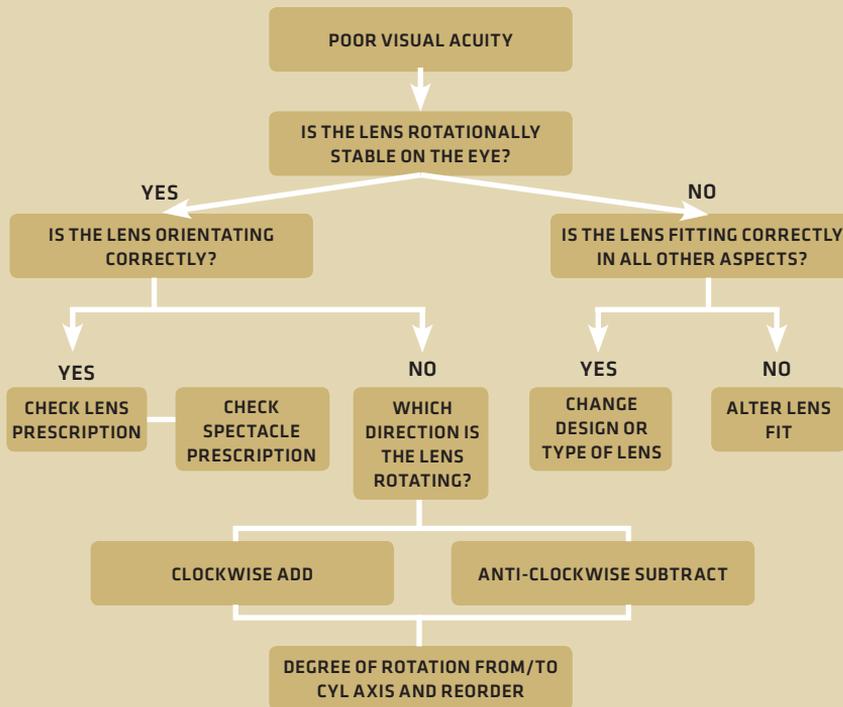


FIGURE 7 Examples showing alignment and mis-alignment of axis

Flowchart procedure to approach the problem of poor visual acuity with soft toric lenses



dispensing, with the final lens or at a subsequent aftercare examination. If at aftercare examination, it is important to understand if there is a particular visual task that results in poor visual satisfaction, for example when reading a broad sheet newspaper, a task which often involves different positions of gaze, or when watching TV when lying down. In these cases, axis position and visual acuity in the primary position of gaze may appear correct, however the symptoms suggest lens stability is inadequate and an alternative lens design should be trialed.

If poor vision is found at dispensing, the practitioner should first review the patient's record to see what the power of the trial lens was. If the power of the trial lens (spherical and axis) was similar to that of the prescription lens, one or other of the lenses might differ from the marked parameters. In some cases, the reason for the poor vision is axis rotation, caused by the different effects of the eyelid on the final prescription lens and on the trial lens. This in turn can be brought on by the different thickness profiles, and therefore

stabilisation effectiveness, of some lens designs. This problem can be avoided by using trial lenses that closely match the patient's ocular prescription or using lens designs that offer independent optical and stabilisation areas.

Figure 8 suggests a flowchart procedure to tackle poor visual acuity.¹⁷ This approach is based on assessing the rotational stability of the lens in the eye. If the lens is rotationally stable but the axis is mislocated, the practitioner compensates for axis rotation and reorders the lens. If the lens is rotationally unstable, either a different fit or design of the soft toric lens is required. A sphere/cyl over-refraction can be useful in determining whether poor visual acuity is due to lens mislocation alone or resulting from differences between labeled and actual specification. If the residual refractive error shows a result where the cylinder power is numerically twice the sphere power, it is a good indication that the lens is simply sitting off-axis.¹⁸

Poor comfort

Lens comfort has been shown to be related to overall lens volume. If a patient is complaining of comfort problems with soft toric lenses, the practitioner should consider changing the design of the lens to one that has a thinner profile. This can be achieved, for example, by moving to a thinner prism-ballasted design or to a thinner non-prism ballasted design. In addition, changing to a silicone hydrogel material can improve comfort and reduce dryness symptoms for many contact lens wearers.

Oedema

The increased thickness of soft hydrogel toric lenses over spherical soft hydrogel lenses means there is less oxygen supply to the cornea, which can result in localised oedema and vascularisation. Early toric lens designs with low water content and increased thickness profiles did produce significant corneal oedema. To increase oxygen flow with hydrogel materials, practitioners should either use a design with a thinner profile or higher water content or, ideally, a combination of both. With the increasing availability of soft silicone hydrogel toric lenses, oedema can be avoided for the majority of patients.

Staining

As soft torics are specifically designed to prevent rotation to achieve the desired optical effect, this might result in reduced tear exchange and entrapment of debris. In turn, this can result in corneal staining. If corneal staining occurs, the same principles for its management apply for soft toric lenses as for soft spherical lenses. With silicone hydrogel

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torics, it is important to rule out the possibility that the lens material/lens care combination being used are the cause of the staining. In these cases a change to a more compatible lens care solution for the particular material being used will reduce the staining.

Conclusions

Of the strategies to correct astigmatism with soft contact lenses, the use of the soft toric lens provides the least compromised means. With the better understanding of the forces that influence soft toric lenses on the eye, designs continue to improve with faster orientation when first inserted, as well as being more predictable and more stable during more dynamic vision situations. The availability of silicone hydrogel torics has improved both comfort and oxygen availability to the cornea. In many ways fitting a soft toric lens today is as straight forward as fitting a spherical lens for the majority of patients and with improving performance and patient satisfaction, should continue to be an integral part of contact lens practice. ■

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