J&J Institute

Soft Toric Contact Lens Fitting

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Whilst soft toric contact lens fitting was previously regarded as a 'speciality', in recent years the number of designs available has increased and the fitting approach simplified. This is reflected by a continuous increase in toric lens prescribing over a 15-year period observed in an international survey of toric lens prescribing.[1] In a 2019 UK contact lens prescribing survey detailing over 1000 fits, a considerable proportion of new fits and refits were soft toric lenses (31% and 28% respectively).[2] Overall, a continued trend of decline in the proportion of soft spherical-only fits was observed due to the increasing popularity of both toric and multifocal designs. Similarly, the popularity of RGP torics is dwindling as practitioners increasingly favour soft lens designs.[2]

The increasing popularity of soft toric lenses has been fuelled by the release of innovative lens designs, which are available in different lens materials with an increasingly wider parameter range, even for daily disposable lenses. The availability of comprehensive fitting banks now makes trialling astigmatic patients with 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 an advance 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 lenses being dispensed are predictable to fit.

Power of correcting cylinder, in Dioptres	Percentage of total sample
0	32.0
0.25-0.50	34.6
0.75-1.00	17.7
1.25-2.00	9.8
2.25-3.00	3.8
3.25-4.00	1.5
Over 4.00	0.6

Table 1. Incidence of astigmatism, from Bennett[3]

The incidence of astigmatism in the general population is shown in Table 1.[3] The percentage of prospective lens wearers with ≥ 0.75DC in at least one eye, who could be fitted with toric contact lenses, has been estimated at 45.4%[4] and more recently at 47.4%.[5] Whilst the prevalence of with-the-rule and against-the-rule astigmatism was similar (≥ 0.75DC; 15.3% and 14.5% respectively), astigmatism in myopes was almost twice the prevalence of that observed in hyperopes (≥ 0.75DC; 31.7% and 15.7% respectively). It was estimated that 90% of the patients considered in the study could be fitted with a toric lens power range of +6.00D to -9.00D, three cyl powers, and 18 axes. A separate study suggested that up to 96.4% of 101,973 patient prescriptions analysed could be fitted with the soft toric contact lens power ranges of frequent replacement lenses that are currently available.[6]

Despite the increasing proportion of soft toric lens prescribing, the level still falls below the prevalence of astigmatism identified in prospective lens wearers.

Studies have indicated that patients are often unaware they have astigmatism, were unaware there were lenses for astigmatism or were not offered toric lenses by their practitioner.[7] Therefore, practitioners should be proactive in these discussions. Practitioners often underestimate the effect on visual performance, of even low levels of astigmatism. A wealth of studies have indicated that visual acuity is significantly improved with toric contact lenses when compared to spherical lenses.[8-12] Similar improvements have been observed for low contrast visual acuity,[11,12] contrast sensitivity[13] and subjective vision.[8,11,14] Research data suggests that correcting even low to moderate astigmatism (-0.75 to -1.75DC) may be important for safety when driving.[15] More recently, a study found that correction of astigmatism (-0.75 to -1.50DC) with toric lenses resulted in significantly improved night driving performance when compared to correction with spherical contact lenses.[13]

Practitioner concerns about increased chair time should be dispelled; the time taken to successfully fit toric and spherical lenses in a crossover study was not significantly different (mean fitting time 10.2 and 9.0 minutes, respectively).[14] In a clinical evaluation of 200 astigmatic patients, who had not previously worn toric lenses, 88% were successfully fitted at the first attempt with the average fitting appointment taking 22 minutes.[8] Patients were fitted with either daily disposable or two-weekly disposable lenses and observed an overall success rate of 75% following a wearing period of one month. High levels of satisfaction with comfort and vision were also reported (85% and 93% respectively).[8] Similarly high levels of general satisfaction (96%) have been reported in a recent post-market evaluation study of over 1200 patients fitted with daily disposable toric lenses.[16]

The increased cost of toric lenses compared to spherical lenses may be off-putting to patients. When used on a full-time basis, it was reported the annual cost of monthly disposable toric lenses was 11% greater compared to a spherical correction in the UK.[17] Therefore, it is important to effectively demonstrate the benefits of toric correction not only to neophytes but to existing spherical lens wearers with suitable levels of astigmatism. Whilst this can be easily demonstrated using a trial frame during the consultation, the real-world improvement (such as differing contrast levels and the effect on driving performance in both photopic and scotopic conditions) is most effectively demonstrated by dispensing toric lenses for a trial period. Whilst uptake is likely to be dictated by the visual demands and wearing frequency of the individual, this at least allows patients to make an informed choice of whether toric lens correction is appropriate for them.

Soft toric contact lens design

Whilst the tear lens formed by a spherical RGP will correct corneal toricity without the need for a toric lens, this is not possible with soft lenses, which simply drape over the cornea.

Thick soft lenses or high modulus materials cannot effectively mask corneal astigmatism.[18-20]

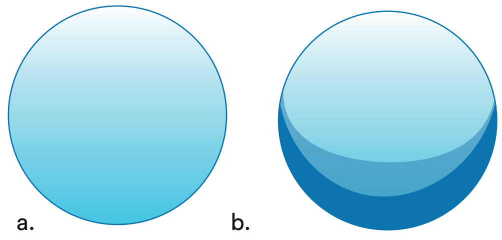

Figure 1. Thickness profiles of a prism ballast (a) and peri-ballast (b) toric soft contact lens, where darker colour indicates greater thickness.

Furthermore, the use of aspheric spherical contact lenses to reduce spherical aberrations do not effectively improve visual acuity when compared to toric lenses.[21] For success, a toric lens needs to position the correcting cyl at the desired axis and the lens needs to maintain rotational stability during and after a blink, as well as during a change in direction of gaze. Manufacturers use a number of methods to achieve this; prism ballast, peri-ballast and thin zone designs (known as double slab-off, dynamic stabilisation and Eyelid Stabilised Design).[22] The following sections will review each of these designs in turn.

Prism-ballast

This lens design relies on vertical prism to orientate and stabilise the lens. In principle, the lens is produced with an increasingly thicker profile towards its base (Figure 1a). The thinner portion of the lens locates under the upper eyelid, which then squeezes the thicker portion of the lens towards the lower lid, which has been described as the "watermelon seed" principle. With more modern lens designs, a thinner inferior lens periphery, or comfort chamfer, is used to reduce the thickness differential and improve oxygen performance.[23]

Peri-ballast

Although similar to the prism-ballast design, this design utilises eccentric lenticulation and a thinned superior lens edge to produce a prism-like rotational stabilisation effect.[24] This modification means that prism is restricted more to the lens periphery allowing for potentially prism-free optic (Figure 1b).

Thin zone designs

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 primarily involve interaction from the upper lid. The design utilises thin zones; the lids squeeze against the thickness differential across the lens aligning the thicker central portion within the palpebral aperture and the thinner zones under the eyelids (Figure 2a). Refinement of this stabilisation approach includes designs that isolate the optical correction within an optic zone resulting in independent stabilisation areas.[25] This allows orientation consistency across all powers and a thin overall thickness profile[25] (Figure 2b). More recently, Eyelid Stabilised Designs have sought to maximise effectiveness by locating thicker 'stabilisation zones' within the palpebral apertures while minimising any thickness variation of the lens under the eyelids (Figure 2c).[25]

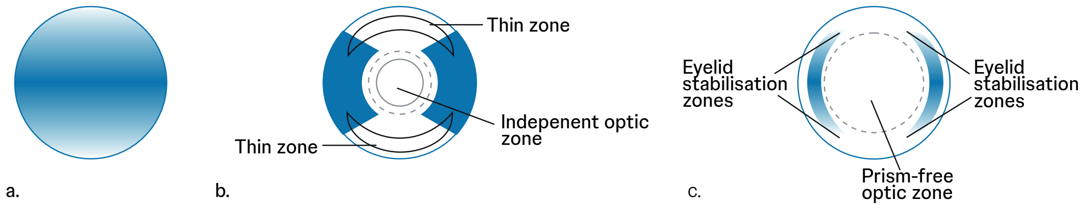

Figure 2. Thickness profiles of thin zone toric contact lens designs where darker colour indicates greater thickness in original designs (a), refined designs with independent optic zone (b) and in Eyelid Stabilised Designs (c)

Toric lens performance

When we consider contact lens performance, we must always consider comfort, vision and health. Currently, there are no published trials that have compared the different toric designs on ocular comfort. However, the impact of lens thickness on oxygen performance should be considered when selecting a lens material, particularly for higher prescriptions as this could have consequences for ocular surface physiology.

The quantity of vertical prism within the central optic zone has been investigated for a variety of stabilisation designs by Sulley et al.[26] Despite advances in prism ballast and peri-ballast designs to reduce unwanted prism, significantly higher levels of vertical prism were observed in the prism ballast and peri-ballast designs (range, 0.52Δ to 1.15Δ) compared to the non-prism ballast designs (0.01Δ). The authors concluded that practitioners should consider this factor, particularly when fitting monocular astigmats with binocular vision anomalies, as unwanted vertical prism may be present if fitted with a prism ballast or peri-ballast design.*

Stability of lens rotation must also be considered and has been investigated across several studies. Rotational stability when performing large saccadic versional tasks was deemed to be superior with an Eyelid Stabilised Design compared to a prism ballast lens, although reading and a visual search task resulted in similar levels of stability.[27] In a comparative study of three prism ballast lenses and an Eyelid Stabilised Design lens, both designs showed fast re-orientation speeds after manual rotation by 45 degrees (22-25 degrees per minute).[28]

* Vertical heterophoria possibly caused by prism dissociation due to the presence of induced optical prism is a relevant factor for practitioners to consider when fitting toric contact lenses for monocular astigmats or those requiring a mix of toric soft contact lens designs.[38,39] Clinical studies have not been done to fully characterize the clinical effects of differences in base down prism among different contact lenses.

However, significant differences between lens designs were observed when patients were moved to a recumbent position, with prism ballasted lenses rotating further than the Eyelid Stabilised Design lens (Figure 3). Similar findings of increased rotational stability during ocular movements and reduced gravitational effects for Eyelid Stabilised Design lenses compared to other lens designs have also been reported.[29] Conversely, in a recent study, an optimised prism ballast lens showed the lowest level of lens rotation from the vertical position and an improved re-orientation speed after manual rotation by 45 degree when compared to four other lenses of differing designs.[30λ] 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.[31] Whilst it is impossible to predict which lens will offer superior stability for an individual patient, it may be preferable to fit Eyelid Stabilised Designs for more dynamic situations (watching or playing sport) or occupations such as dancers or mechanics.

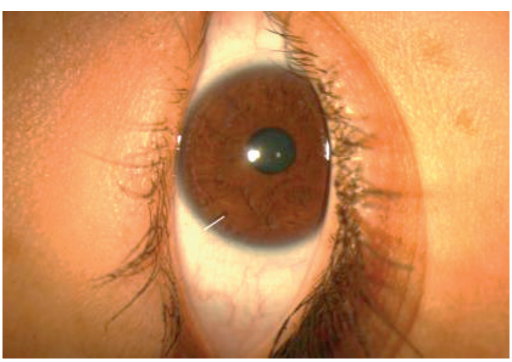

Figure 3. The effect of gravity on a prism ballasted soft toric contact lens (Image courtesy of Graeme Young)

[λ] Study contact lenses included: PureVision Toric, Air Optix for Astigmatism, Acuvue Advance for Astigmatism, Biofinity Toric and Proclear Toric.

Lens orientation marks

Soft toric lenses feature an orientation marking to allow the practitioner to assess the amount of lens rotation and lens stability. It should be noted that the orientation mark does not indicate the cyl axis. A variety of orientation marks are used by manufacturers, typically either at the six o'clock or the three and nine o'clock positions (Figure 4). Lens rotation can either be measured by rotating a fine slit beam to align with the lens orientation marking and reading the axis from the external protractor scale using a graticule (Figure 5) or estimated using the orientation marks as a guide (Figure 6). 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. Certain orientation markings can be difficult to observe and viewing the markings in indirect or retro-illumination, rather than direct illumination can help.

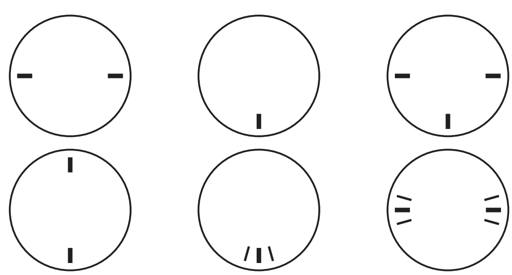

Figure 4. Examples of the different orientation markings used on soft toric contact lenses

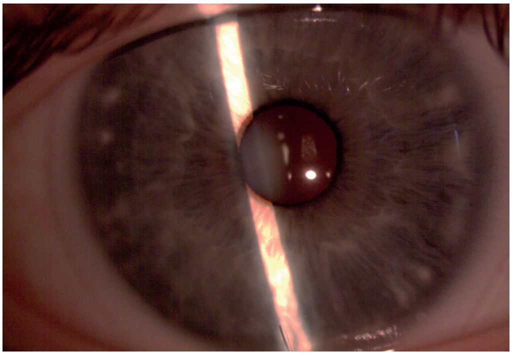

Figure 5. Measurement of soft toric contact lens rotation by rotating a fine slit beam to align with the lens orientation marking and reading the axis from the external protractor scale.

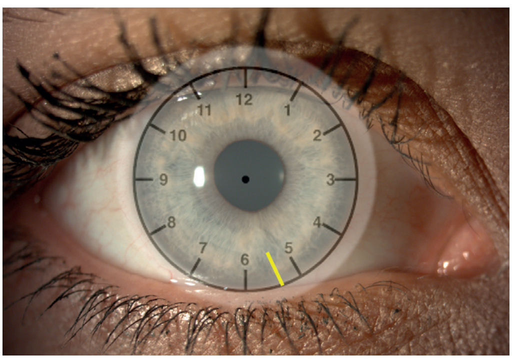

Figure 6. Estimation of rotation using a clock face as a guide, where rotation to the '5 o'clock' position would indicate 30 degrees of rotation. In this example, the yellow line indicating the toric marking is sitting approximately two thirds of the way between the 5 and the 6 o'clock, indicating rotation of around 20 degrees.

Adjusting for rotation

The amount of lens rotation indicates how far the cyl axis has rotated compared to the intended position. As long as the lens rotation is stable, the lens can be re-ordered to compensate for this rotation.

The axis of the next lens to trial is decided by the following mnemonic:

LARS where
Left rotation = **A**dd and
Right rotation = **S**ubtract (Figure 7)

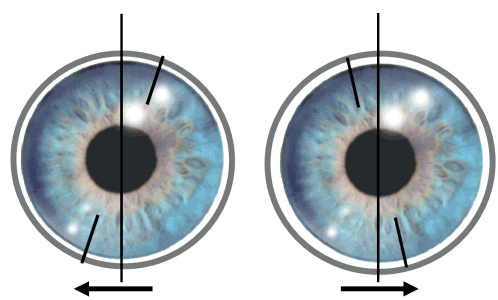

Figure 7. LARS rule where Left rotation (left image) = Add and Right rotation (right image) = Subtract

CAAS where
Clockwise rotation = **A**dd and
Anticlockwise rotation = **S**ubtract
(Figure 8)

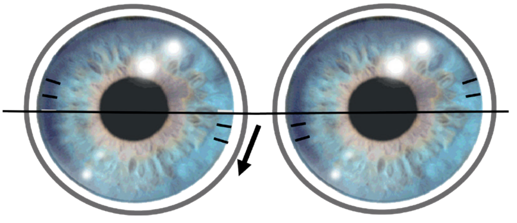

Figure 8. CAAS rule where Clockwise rotation (left image) = Add and Anticlockwise rotation (right image) = Subtract

Although both mnemonics are useful, LARS may be preferred for lenses with orientation markings at 6 o'clock and CAAS for lenses with orientation markings at the three and nine o'clock positions.

For example, a trial lens of -3.00/-1.75x180 is fitted initially and rotates anticlockwise, or right, by 10 degrees when placed on the eye. The correction the patient experiences will therefore be -3.00/-1.75x10 degrees and the vision will be blurred. To compensate for this, using the LARS or CAAS mnemonic the new trial lens to be ordered will be -3.00/-1.75x170. When the new lens is placed on the eye, the interaction between the lids and lens will be the same, rotating the lens 10 degrees anticlockwise again. This rotation will bring the axis round to desired 180 degrees to allow for optimal visual correction (Figure 9).

Toric lens fitting

The exact fitting procedure for soft toric lenses and for the supply of diagnostic or trial lenses may vary among the different brands and practitioners are encouraged to follow individual manufacturer's guidelines. A standardised fitting process is described below.

Initial trial lens selection and application

The choice of back optic zone radius (BOZR), lens material and replacement modality for a soft toric lens should be made in the same way as one would select a spherical soft design. The effect of the back vertex difference (BVD) should be carefully considered and calculated empirically for each meridian or determined using manufacturer's effectivity tables or online calculators. Mistakes can be made by guessing the optimal power, particularly in plus power lenses where practitioners often mistakenly reduce the cyl power (Table 2).

Spectacle prescription (BVD 12mm)	Contact lens power
-5.00DS / -2.75DC x 180	-4.75DS / -2.25DC x 180
+5.00DS / -2.75DC x 180	+5.25DS / -3.00DC x 180

Table 2 Calculated contact lens power for myopic and hyperopic spectacle prescriptions. Note the relative increase in contact lens cyl power for the hyperopic prescription and the decrease for the myopic prescription

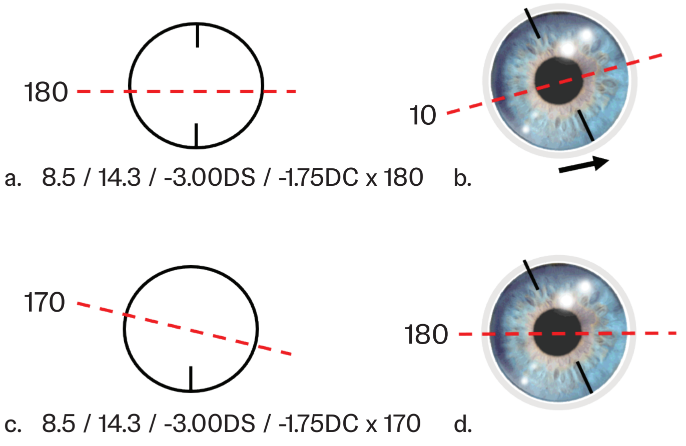

Figure 9. Using LARS and CAAS to manage toric rotation. Here a toric contact lens with a cyl axis at 180° (denoted by the red dashed line) is ordered (a). Once applied to the eye, the contact lens rotates 10° anticlockwise, or right, meaning the cyl axis lies at 10° (b). A new trial lens is ordered using the LARS or CAAS calculation with a cyl axis of 170° (c). Once applied to the eye, the contact lens again rotates by 10° anticlockwise, meaning the cyl axis is now along the desired 180°.

Typically, toric contact lens cyl powers are only available in 0.50DC steps. Where the desired lens falls between two powers it is generally advisable to select the lower cyl power initially. Unwanted lens rotation will have a detrimental impact on visual quality and this can be exacerbated if the cyl is over-corrected. The cyl power can be checked during the over-refraction and amended if the higher power is beneficial however. Axis availability for most disposable lenses is in 10-degree steps around the clock, or even five degrees for extended power ranges. Where the desired lens falls between two axes it can be beneficial to use a trial frame with the patient's spectacle prescription to determine which axis they prefer.

Whilst several patient factors and lens fit characteristics influencing soft toric lens orientation have been identified, 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. The patient should be forewarned of an initial increased level of lens awareness with a toric lens, particularly if fitted unilaterally or if a spherical lens patient is being refitted with a toric lens. Lens awareness is due to the thickness differential from the lens stabilisation design and typically resolves after a short period of adaptation. Following application, the lens should be allowed to settle, as for a spherical soft lens, before the fit is assessed. Whilst some practitioners prefer to apply toric lenses with the orientation mark in the correct position to optimise the speed of orientation, this isn't necessary. With more recent designs, speed of orientation is faster allowing assessment within one to three minutes following application.[8]

Lens fit assessment

As for a spherical lens, an optimal lens fit with good centration is desirable; a steep fitting lens is likely to impair re-orientation whereas a flat fitting lens is likely to result in reduced lens stability and increased rotation.

The location of the orientation marking should be assessed whilst the patient fixates in the primary position initially. If the orientation marking is stable in the primary position of gaze, the practitioner should note the position in relation to the intended position and the direction and degree of rotation seen (if any). The method used to measure lens rotation is described earlier in the lens orientation marking section. 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.

With the patient in primary gaze, the lens may show a minimal amount of nasal rotation, typically of up to five degrees either during or immediately after a habitual blink, which is due to the movement of the lower lid during a blink. Excessive rotation following a habitual blink, particularly for higher cyl powers, is likely to result in unstable vision, and an alternative lens design is indicated.

Orientation stability should be assessed further while the patient performs forced blinks and during versional movements. To simulate real world eye movements, ask the patient to look up, down, left and right, while looking for any significant lens rotation. Provided the lens remains stable it should provide relatively consistent vision. The efficacy of the lens re-orientation can be assessed by manually rotating the lens off-axis using the lower eyelid. If the stabilisation method is optimal, the lens should return to its original position quickly following a few blinks. As long as the lens is stable, any consistent rotation that impairs the visual performance can be corrected with the LARS or CAAS mnemonic, as described earlier.

Over-refraction

An over-refraction should be carried out to determine the optimal lens power and to provide further information on lens stability.

If the patient reports that the vision blurs with each blink, this confirms the lens fit is unsuitable or the rotational stability of the lens is poor. In either case, another lens needs to be applied, either a different parameter (in the case of a poor fit) or stabilisation design (if the lens is rotationally unstable).

Visual performance should also be assessed at near.

If the trial lens orientation marking lies 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. A full sphere-cyl over-refraction is unnecessary and will over-complicate the process.

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 -3.00DS /-1.75DC x 180 that matches the patient's ocular prescription but orientates 20 degrees off-axis will result in an over-refraction of +0.50DS / - 1.25DC x 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 applied after compensation of the cylinder axis for lens rotation to allow a meaningful spherical over-refraction.

Troubleshooting

Poor visual performance

The most common reason for reduced visual performance is rotation of the axis or poor lens stability. If the lens has rotated but remains stable then the degree of rotation should be corrected with the LARS or CAAS mnemonic. If the lens axis has previously been altered to compensate for rotation, it can be beneficial to check the lens is sitting in the expected "off axis" position. Checking the lens power in relation to the spectacle prescription may identify mistakes with back vertex distance compensation or even simple human error. If poor lens stability is observed or the patient reports unstable vision then the lens fit should be optimised. A steep fitting lens is likely to impair re-orientation whereas a flat fitting lens is likely to result in reduced lens stability and increased rotation. Furthermore, a change in the lens stabilisation design is likely to be beneficial where there is inconsistent lens rotation. Figure 10 suggests a flowchart procedure to tackle poor visual performance.

Poor comfort

Discomfort should be managed with the same approach as for a spherical lens. Increasing the lens replacement frequency is likely to be beneficial. Whilst the range of parameters may not be quite as wide in daily disposables as reusables, particularly for the higher cyl powers, a study has shown that under correction of the cyl by up 0.50DC, while maintaining the spherical equivalence has no significant adverse effect on visual performance.[32] Another

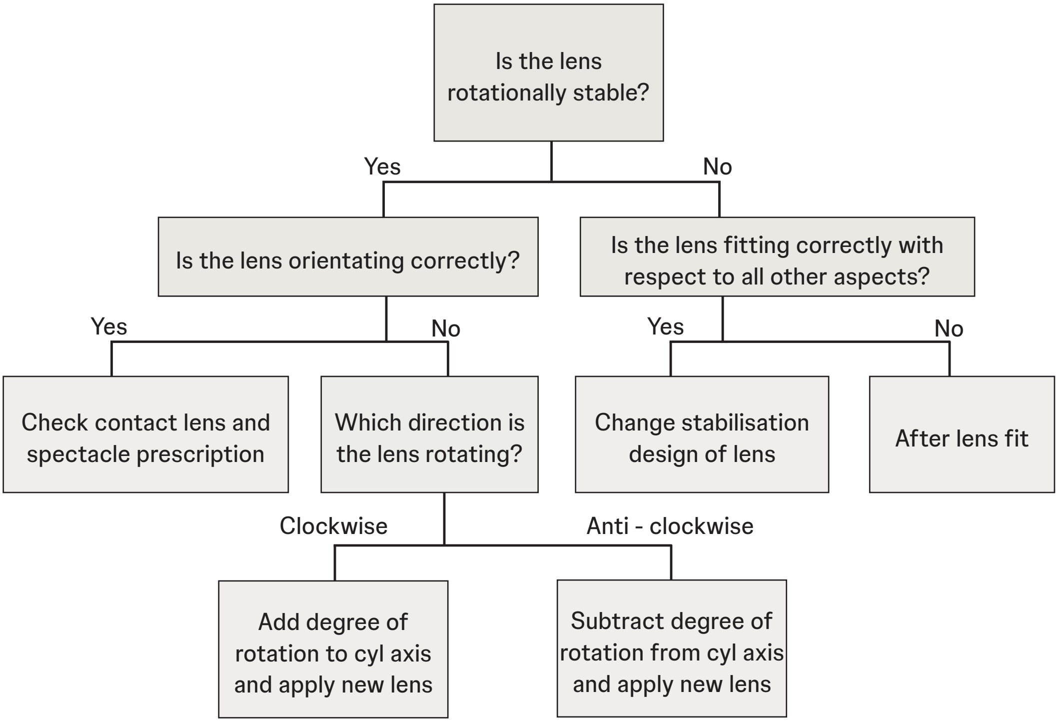

Figure 10. Flowchart to aid problem solving with poor visual acuity

factor to consider is the likely thickness differential of the current lens as refitting with a different stabilisation design may be beneficial.

Contact lens wear dropout

> Discomfort and poor vision are the primary causes of permanent discontinuation of contact lens wear, or dropout across all lens types.[33, 34]

In a prospective study of retention rates over a 12-month period, within the toric lens group the main reasons for discontinuation were poor vision (48%) and expense (19%).[34] In a study published in 2011, soft toric lens wearers reported more frequent and intense discomfort and dryness compared to spherical lens wearers.[35] More recently however, a retrospective study by Sulley and colleagues investigating neophyte wearers found no significant difference in dropout between spherical and toric lens wearers with 79% and 73% still wearing lenses after 12 months.[36] It was suggested this may reflect more recent advances in toric lens design or increased practitioner confidence in fitting such lenses.

The practitioner is key to identifying patients at risk of dropout. Disappointingly, considering the toric lens patients that discontinued lens wear in the study by Sulley, less than a third were offered an alternative lens by their practitioner.[36] Real world eye movements are difficult to reproduce on the slit lamp, therefore subjective reports of poor lens performance may not correlate with objective measures such as lens rotation and stability. Furthermore, high contrast visual acuity may not indicate the real-world visual performance of soft toric lenses. Therefore, practitioners should ask patients about fluctuations in vision during specific activities and in different environments to identify their level of satisfaction.[37] To avoid dropout patients should be proactively refitted and informed of new lens developments.

Conclusions

With a greater understanding of the forces that influence soft toric lenses on the eye, designs continue to improve with faster orientation when first applied, as well as being more predictable and more stable during dynamic vision situations. In many ways, fitting a soft toric lens today is as straight forward as fitting a spherical lens for most patients and with improving performance and patient satisfaction, should continue to be an integral part of contact lens practice. Practitioners should be proactive in explaining the effects of astigmatism and the possible benefits of toric lenses, encourage trials and identify and refit current wearers at risk of dropout.

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