Rotational stability of silicone hydrogel toric contact lenses

Dr Gerard Cairns compares two methods of toric lens stabilisation

The utilisation of soft toric contact lenses has increased significantly over the past few years. In 2006 the proportion of all soft lens fits that were toric was approximately 15 per cent, whereas, in 2009, this value has now risen to 34 per cent.[1,2] This could be due to a variety of new products becoming available and these products meeting the expectations that practitioner's have with regard to soft toric lens performance. There are a wide range of parameters available in the frequent replacement lens modality (and many more through custom manufacture) that include lenses providing adequate stability to correct as low as 0.75D of astigmatism. However, recalling data from large epidemiological studies, the incidence of astigmatism of 0.75D or greater in an adult population is in the range of 37 per cent to 45 per cent, indicating that there is still potential for continued growth of toric contact lens practice and a resultant improvement in patient's visual quality.[3,4]

Silicone hydrogel toric soft contact lenses

In 2002, Bausch & Lomb was the first company to introduce a silicone hydrogel soft toric contact lens, PureVision Toric, made from balafilcon A. This material has demonstrated excellent safety and physiological performance.[5] It is approved for daily and flexi wear and up to 30 days of continuous wear. Now, there is a choice of toric contact lenses that are available with high oxygen permeable materials, such as Air Optix for Astigmatism, Biofinity Toric, Acuvue Advance for Astigmatism and Acuvue Oasys for Astigmatism, all of which are approved for daily wear but no more than seven days of continuous wear.

To understand soft toric lens designs and performance, it is useful to take a closer look at the stability characteristics of two of the most utilised lens designs; Lo-Torque (Bausch & Lomb Inc, Rochester, New York, USA) and Accelerated Stabilization Design (AS) (Vistakon, Jacksonville, Florida, USA).

TABLE 1

Toric lens designs

Design	Ballast design features	How it works
Lo-Torque	Prism ballast stabilising geometry Refined optic zone, balanced vertical thickness profile and bi-curve posterior design 360° comfort chamfer and moulded, rounded edges	On each blink, the upper eyelid glides across this gradually changing thickness profile of the lens. The resultant forces acting on this ballasting geometry maintain the lens in its nominal rotational position, providing fast, stable orientation.[10]
Accelerated Stabilization Design	Four zones of stability concentrated outside of lids for minimal lid-lens interaction	This design uses zones of accelerated slope of thickness, which become positioned within the interpalpebral fissure. Thus allowing minimal interaction with the lower lid when the lens is on-axis.[11]

Lens stability

Toric contact lenses must maintain a stable orientation to provide consistent refractive error correction. The toric optics lose effective cylinder power if their orientation is not aligned with the ocular astigmatism, and at 30° of misorientation the lenses do not actually reduce any ocular astigmatism.[6] Lens orientation is a function of the forces that act upon the lens, which include the static and dynamic aspects of lid pressure, during and between blinks, the hydrostatic force of tear film (by pulling the lens toward the cornea), internal stress of a lens that conforms to the eye, and gravity.[7] Various researchers have attempted to define which ocular parameters are the greatest predictors of toric lens orientation. Associations with intercanthal angle, central lid angle, degree of myopia, palpebral aperture size, lens movement and peripheral corneal toricity have been documented.[8,9] To provide stability and promote rotational recovery following unintentional misorientation, toric soft contact lenses have utilised different designs, including: prism ballast, truncation, slab-off, double slab-off, posterior toric surface and combinations of these. Of the two designs considered in this article, Table 1 summarises the features of each and describes the current thinking on how each design works.

TABLE 2

Methods to assess rotational recovery

- Rotational velocity: the speed with which a lens returned to its resting position following a 60° temporal rotation in each eye[11]
- Reorientation speed after lenses manually rotated 45°[7]
- Lenses were rotated (either nasally or temporally) by 30° and reorientation was measured after 20 blinks[12]
- Number of blinks required to return lens to primary gaze orientation following a 45° manual misorientation[13]
- Reorientation measured 60 seconds after a 45° manual misorientation[14]

Rotational recovery

While in soft toric lens fitting significant attention is given to the ability of the lenses to find a stable orientation, if the lens should ever be misorientated throughout the day, its ability to recover is just as important. Researchers have tried to ascertain how quickly and completely ballasted lenses reorient themselves. A number of different

techniques have been utilised in studies to quantify this ability (Table 2). Factors that differentiate one method from another are based on how quickly the lens reorients itself or how completely it reorients within a given a time frame.

Clinical studies of lens stability

To investigate the ability of two very different toric lens designs to stabilise, two clinical trials were conducted.[14] These two studies utilised identical study designs except for the choice of control lens. The first study (Study 1) compared PureVision Toric lenses (PVT) to Acuvue Advance for Astigmatism lenses (AA). The second study (Study 2) compared PureVision Toric lenses (PVT) to Acuvue Oasys for Astigmatism lenses (AO). Institutional review board approval was obtained for the studies and all patients signed an informed consent form prior to participation.

Lenses across eight power and axis configurations were evaluated for their fit and their ability to recover from manual misorientation. In each of the randomised studies, 32 subjects (64 eyes) were randomly assigned a parameter-matched Test and Control lens pairing on each eye. Lens powers were spherical: -1.00D or -5.00D; cylinder: -0.75D or -2.25D; axis was 90° or 180°.

After allowing the lenses to settle for three minutes, movement, centration and primary gaze orientation (PGO) were assessed. Rotational recovery (RR) was assessed by manually rotating the lens 45° temporally from PGO and allowing one minute for the lens to recover (Figure 1). The absolute difference between the position of the lens following the recovery period and the PGO was taken as the measure of interest. The lens was then removed, the appropriate parameter-match lens inserted and the procedure repeated.

The results of these studies demonstrated that for routine fitting parameters, there was very little to distinguish between the Lo-Torque and AS designs. There was no difference between PVT and AA or AO with respect to mean horizontal decentration (ANOVA, $p>0.05$) and there was no difference between PVT and AA with respect to mean movement (PVT = 0.17mm; AA = 0.15mm; ANOVA, $p>0.05$). There was a small but statistically significant difference between PVT and AO for movement, (PVT = 0.15mm; AA = 0.20mm; ANOVA, $p<0.05$).

For rotational aspects of the lens fit, the mean (+/-SD) absolute PGO and RR values for the study of PVT and AA lenses are presented in Table 3 and the mean (+/-SD) absolute PGO and RR values for the study of PVT and AO lenses are presented in Table 4. All PGO means were significantly different from a 0° PGO position (T-test; $p<0.05$).

When the RR ability of the lenses is compared, real and significant differences due to lens design emerge. There was a significant difference in favour of the PVT lens for RR in both studies (T-test; $p<0.05$ in all cases). Furthermore, in both studies there was significantly greater consistency (reduced variance) of recovery with PVT (Levene's Homogeneity of Variance Test; $p<0.05$ in all cases).

The PVT lens demonstrating superior mean value and consistency of performance for RR becomes very important when we consider how well the lenses return to within 10° of PGO. In Study 1, 88 per cent of the PVT lenses achieved this mark compared with 70 per cent of the AA lenses and in Study 2, 97 per cent and 77 per cent of the PVT and AO lenses, respectively, returned to within 10° of PGO (Figure 2).

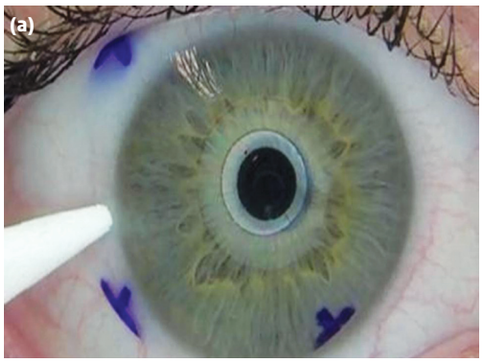

Figure 1 A misoriented lens (a) For assessment of rotation recovery, the lens was manually rotated temporally by 45° using a surgical sponge. (b) A lens demonstrates good rotational recovery when it returns to the primary gaze position within one minute. Note these images are for demonstration only. Study lenses were not marked

TABLE 3

Rotational stability results from the study comparing PVT and AA lenses. Values reported are absolute

Study 1	n	Mean (°)	Std dev (°)	Range (°)
PGO AA	64	7.2	8.9	0 - 45
PGO PVT	64	11.6	9.4	0 - 45
RR AA	64	10.7	13.5	0 - 70
RR PVT	64	5.8	7.3	0 - 30

TABLE 4

Rotational stability results from the study comparing PVT and AO lenses. Values reported are absolute

Study 2	n	Mean (°)	Std dev (°)	Range (°)
PGO AO	64	9.0	9.3	0 - 45
PGO PVT	64	10.6	10.0	0 - 45
RR AO	64	7.7	7.8	0 - 35
RR PVT	64	4.3	4.3	0 - 20

Conclusion

With the introduction of silicone hydrogel soft toric contact lenses, patients with astigmatism are able to wear soft contact lenses that correct their vision while their eye care providers are reassured that sufficient oxygen is reaching the surface of their eyes. While lens centration and movement are important indicators of a good fit, rotational stability can provide information related to potential vision outcomes. Rotation of the lens can temporarily reduce visual performance in wearers of soft toric lenses and often lead to the wearer's impression of reduced vision with this type of lens.[15] A recent consumer survey revealed that 84 per cent of toric wearers experience rotational issues, although patients may not raise this during a routine visit.[16] In the two clinical studies that evaluated the Lo-Torque design against lenses utilising the AS design, it has been shown that standard fitting parameters such as centration, movement, and PGO were similar between designs. However, these measures may not be enough to understand how these lenses perform in all circumstances.

In the two parameter-matched studies detailed above, the Lo-Torque lenses showed superior performance in rotation recovery as demonstrated by a significantly lower mean RR value, a ▶

significantly greater consistency of RR and a significantly higher percentage of lenses returning to within 10° of PGO. These rotational recovery results can give practitioners insights as to how the lens performs when the patient has left the practice. Accordingly, for aftercare assessments, careful attention to patient's symptoms and concerns could point to difficulties that may be due to a lens with poor RR. A simple in-chair recovery test over a period of 60 seconds could help provide important performance information and assist in choosing superior performing lenses.

Good RR is determined by the variety of forces acting on the lens. It is believed that the mis-rotated AS design of the Acuvue lenses can become caught by the upper lid as a result of the thicker ballast region distributed in the inter-palpebral region of the lens.[17] The effect of the top lid holding on to the ballast region may, in some patients, prevent the lens from promptly returning to PGO. Conversely, the thickness distribution associated with the Lo-Torque design is located toward the base. As a result, the thicker portion of the lens is less likely to be caught by the upper lid when the lens is mis-rotated.

Continuing investigations in this area should help provide additional insights as to why the AS design lenses fail to re-orientate to within 10° of PGO in 60 seconds in approximately one in four patients, and confirm the mechanics behind the Lo-Torque design demonstrating a greater propensity to return the lens to its original position.

When choosing a toric contact lens, consideration should be given to a full range of aspects that establish the essence of a 'Good Fit'. Prescribing lenses that not only perform in the test room but continue to provide clear, stable vision throughout the day will inspire confidence in eye care practitioners and patients alike.

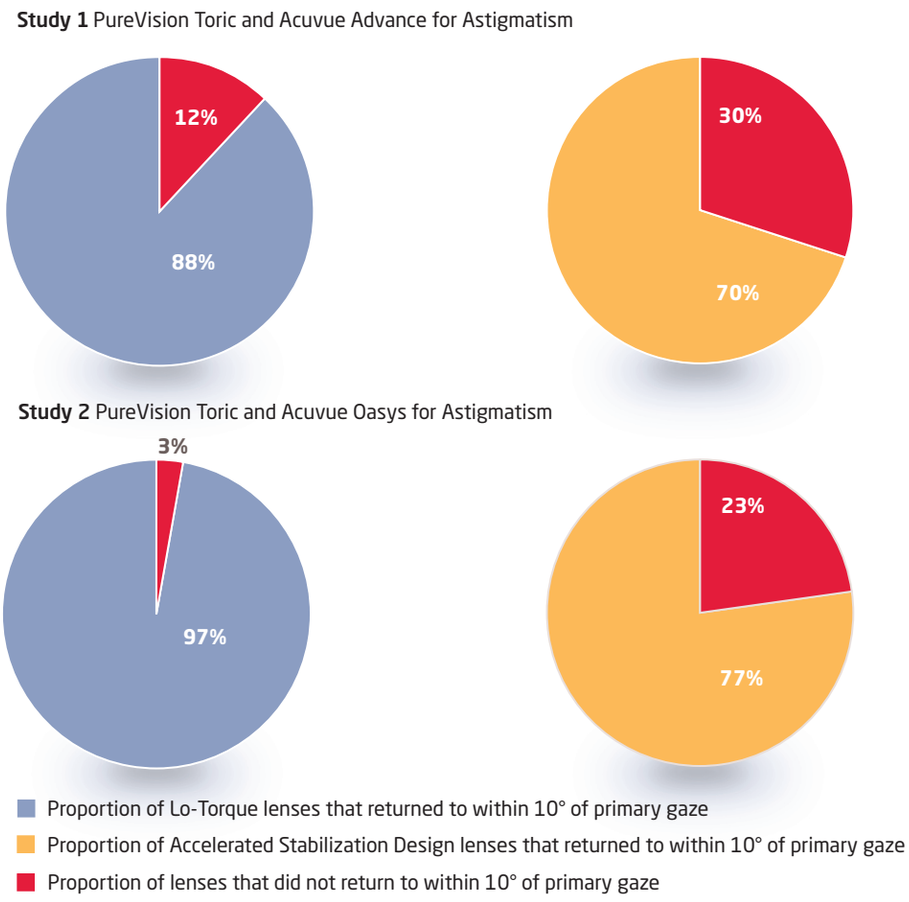

Figure 2 Percentage of lenses returning to within 10° of primary gaze orientation (Studies 1 and 2)

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