A turning point in toric soft lens design

New assessment techniques have improved our understanding of toric soft lens orientation and led to more successful designs, as **Anna Sulley** reports

Improvements in lens design over the past decade have made toric soft lenses a popular prescribing option for astigmatic patients. Prescribing of toric designs has increased around the world in recent years; one in four of new soft daily wear fits is a toric lens, compared to one in five in 2003.[1] In the UK, a third of new fits were torics.[2] New manufacturing techniques have brought improvements in reproducibility and made toric soft lenses simpler and quicker to fit. Daily disposable and silicone hydrogel (SiH) options are now available for enhanced physiological and comfort performance.

A major advance has been the introduction of toric soft lenses utilising the Accelerated Stabilisation Design (ASD). This was developed after much research to understand what happens during blinking and the interaction between the lids and the lens. This successful design is now available in three materials and different modalities: 1-Day Acuvue for Astigmatism; Acuvue Advance for Astigmatism; and, most recently, Acuvue Oasys for Astigmatism which is now being made available across Europe.

ASD lenses have shown a number of advantages over traditional designs in reducing variable vision and blur.[3-6] In prism-ballasted and dual-thin zone designs, the lens can interact with the lid(s) during the blink, even when correctly aligned, which can in turn result in unwanted lens rotation. With ASD, when the lens is in the correct position there is minimal destabilising interaction with the lids. Only when the lens is misaligned, for instance, when first placed on the eye, does lid interaction have maximum effect. The upper and lower lid forces therefore continually orient and stabilise the lens to return it to its correctly orientated position.

For the practitioner, achieving a stable and reliable fit while minimising chair time are key factors in successful toric soft lens fitting.[3] Unstable lens orientation and variable visual acuity were among the reasons practitioners have traditionally cited for not fitting more soft torics.[7] For the wearer, fast lens orientation is equally important so that they can achieve optimal vision correction as quickly as possible after lens insertion every morning. Recent studies have therefore focused on the rotational stability of toric soft lenses and have led to a better understanding of factors influencing lens fit.

Figure 1 Visual search task using paragraphs highlighted in a newspaper (after Zikos[4])

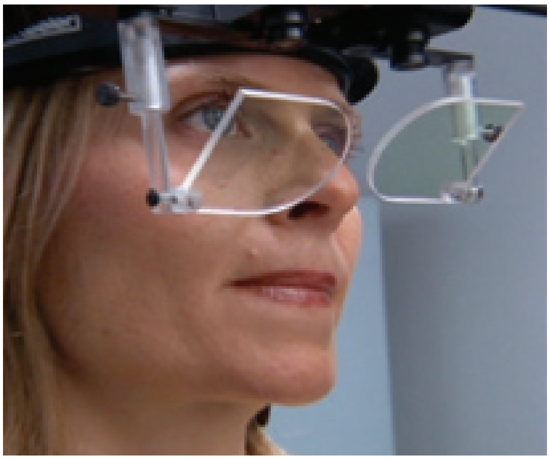


Figure 2 Recording lens position using the Eyetrack Monitoring System (after Zikos[4])

Real-world tasks

Although a toric lens fitting may appear to be successful in the consulting room, some patients still return complaining of variable vision. Visual acuity and slit-lamp assessment of lens movement, centration and rotation may not necessarily correlate with the patient's experience of vision quality during normal daily activities.

Astigmats have high expectations, particularly with regard to vision and comfort. In a survey of 335 toric soft lens wearers a few years ago,[8] prior to the introduction of ASD lenses, only 70 per cent described their habitual toric lenses as 'excellent' or 'very good', citing vision quality and stability and comfort-related factors as the most important attribute. Of those reporting symptoms, 86 per cent said they experienced blurred vision and 57 per cent reported fluctuating vision. This compares with 82 per cent rating the overall opinion of a spherical silicone hydrogel lens as 'excellent' or 'very good'.[9]

A recent peer-reviewed paper by Zikos *et al* describes novel techniques for monitoring toric lens rotational stability over a range of natural viewing conditions chosen to mimic real-world situations.[4] The aim of the study was to determine whether using a more natural test procedure, allowing large versional eye movements and frequent blinking, could be used to objectively compare the rotational stability of toric soft designs.

After an initial settling period, four visual tasks and stimuli were chosen – settling time, reading, visual search and large versional tasks – after each of which the lens position (degrees of rotation) was recorded in primary gaze. The tasks conducted required increasing amounts of ocular versions, and hence had the potential to destabilise lenses.

First, the patient was allowed to look around the consulting room for 15 minutes while the lens settled on the eye. The patient then read a broadsheet newspaper for two minutes, held at 40cm with text extending 40° horizontally and 15° vertically. Next the patient was asked to spot a given number within the newspaper, read that paragraph, and then return to primary ▶

gaze. The task was repeated with paragraphs positioned randomly 12° to 30° from centre (Figure 1). Finally, the patient was instructed to blink to the sound of a metronome set at 40 beats per minute and switch their gaze at 20 second intervals to targets positioned ±40° horizontally and ±32° vertically on a board 60cm away.

During each task, lens position was continuously recorded using the Eyetrack Monitoring System (Figure 2), a head-mounted infra-red, video-based device previously used to track head and eye movements during reading with spectacle lenses. The contact lenses were marked with small black dots to assess lens position. The system captured images of lens rotation from insertion until all testing was completed and the images were then analysed at selected time frames.

The technique was applied to two toric soft lenses using different methods of stabilisation: Johnson & Johnson Vision Care's Acuvue Advance for Astigmatism (galyfilcon A), which incorporates the ASD design, and Bausch & Lomb's SofLens 66 Toric (alphafilcon A), a prism-ballasted lens. Some 20 subjects wore each of the lens types in succession with a rest period between. All measurements were taken on the left eye under binocular viewing conditions with lenses on both eyes.

The mean rotational range (the maximum change of position observed during a task) was significantly larger with the prism-ballast lens than with the ASD lens for the settling task and large versional task (Figure 3). For both these tasks, mean rotational range was two to 2.5 times larger with the prism-ballast lens, which showed off-axis rotation of up to nearly 25° on large eye movements. Within-subject variability in rotational position was always greater for the prism-ballasted design.

Previous studies using more conventional assessment techniques support these findings. The Acuvue Advance for Astigmatism design has been shown to orientate more quickly and accurately than prism-ballasted or dual-thin zone designs, to be rotationally stable and to perform well for vision and comfort.[3]

The present authors conclude that ASD results in a more stable design after insertion, as well as during peripheral visual tasks, which can translate into better performance in real-world situations by offering more consistent clear vision. During rigorous eye movement tasks, such as extremes of gaze, when driving (for example, changing lanes), during sport (for example, teeing off in golf), a mis-rotated lens could greatly

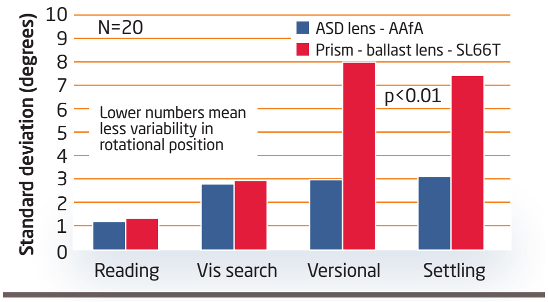
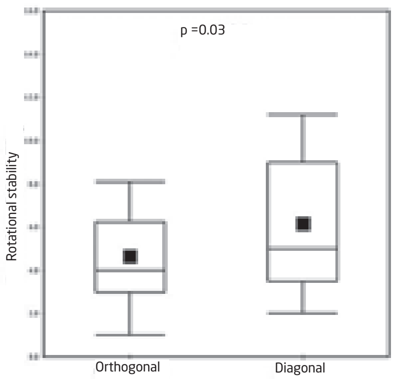


Figure 3 Standard deviation of lens rotation for four visual tasks and two toric soft designs (after Zikos[4])

Figure 4 Subject under examination (after Chamberlain[5]) (Image courtesy of Eurolens Research)

Figure 5 Orthogonal vs diagonal measures of rotational stability with slit lamp (courtesy of Paul Chamberlain[5])



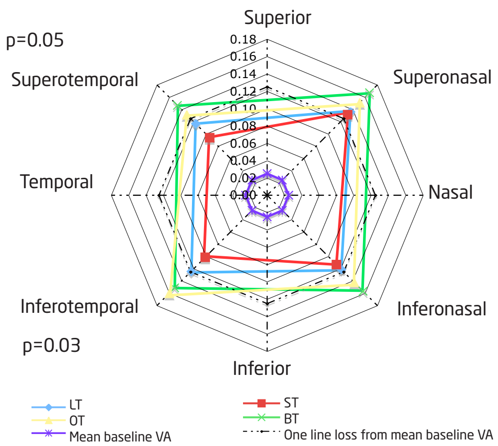


Figure 6 Refixation acuity by gaze direction (after Chamberlain[5]) (Figure courtesy of Eurolens Research)

compromise vision. They suggest that the technique described in this study could be used for testing new toric lens designs or, in special cases, to assess patients while performing specific eye movement tasks required for their occupation.

Application in practice

So how can these findings be applied to everyday clinical practice?

Toric soft lens rotation is usually evaluated with the patient's gaze in the primary position and head constrained by the slit-lamp chin and brow rest. While this may identify poorly fitting lenses under static viewing conditions, it does not reflect normal daily activities over a range of visual tasks.

Some authors have already suggested assessing stability of orientation during forced blinking and version movements.[10] Incorporating more realistic tasks and stimuli, similar to those used in this study, may help to ensure greater patient satisfaction under real-world conditions.

Another potential new tool for assessing soft toric rotational stability and consequent visual performance uses visual tasks to simulate and quantify visual disturbance.[5] Chamberlain *et al* measured visual acuity using a near logMAR target at baseline and after each of four diagonal directions of gaze (Figure 4). The test proved sensitive in quantifying changes in acuity and providing a measure of toric lens performance. Initial results with four soft toric lenses (balafilcon A toric (BT), lotrafilcon B toric (LT), omafilcon A toric (OT) and senofilcon A toric (ST)) showed that moving eyes diagonally led to a greater visual disturbance than version movements along the primary orthogonal (Figure 5), highlighting that it is better to measure rotational stability post-diagonal eye movements rather than the more traditionally used orthogonal versions. Differences were shown between lens types for specific gaze directions, with the ASD design (Acuvue Oasys for Astigmatism) having the most consistent visual performance in all gaze directions (Figure 6).

Gravity and other forces

This research is just some of the recent work that has led to a reappraisal of toric soft lens design and fitting.[11] The effects of gravity, head movements and posture on lens orientation have been another area of investigation.[12]

For many years it was thought that pressure from the lids pushing the lens against the eye influenced toric lens orientation, and that prism-ballasted ▶

lenses orientated because of interaction with the lids rather than due to gravity (the 'watermelon seed' principle). Although it was accepted that lid forces during the blink have some effect on lens rotation, the influence of the blink was downplayed as the lids moved in conflicting directions. It is both the lids and gravity that can influence toric lens orientation.

High-speed video recording (Figure 7) of lens orientation pre and post-blink has now led to a greater understanding of the effects of blinking on toric soft lens rotation, such as the finding that lid-induced rotation takes place during rather than between blinks.[13] Upper lid forces generated during the blink are more influential than the forces of the static lid pressing against the lens and the eye.

Experiments in which prism-ballasted soft lens wearers laid on their side (Figure 8) show that gravity does indeed have an effect; the prism base swings towards the vertical although not through a full 90° (Figure 9). Non-ballasted designs such as ASD show little or no rotation under these conditions. These designs may therefore be the preferred choice for certain occupations or hobbies, such as for dancers, mechanics or military personnel,[13] or simply with more everyday activities, for example lying on the sofa while watching television.

The latest study used both of these techniques to compare the effect of abnormal gaze direction and posture on toric soft lens orientation.[6] Four lens types were assessed: Acuvue Oasys for Astigmatism, PureVision Toric (Bausch & Lomb), Air Optix Toric (CIBA Vision) and Proclear Toric (CooperVision).

In the first part of the study, lens orientation was photographed while subjects were in a recumbent position. In the second part, subjects were positioned at a slit-lamp and video recordings taken as they changed their gaze from the primary position to each of the eight cardinal directions of gaze.

Mean rotation when subjects lay on their side was lowest with the ASD lens Acuvue Oasys for Astigmatism, being 11° compared with 30° for Proclear Toric for example, and the consequent reduction in VA was the lowest of the four lens types. The ASD lens also showed significantly less rotation on inferio-nasal version than each of the other prism-ballasted lens designs. These authors conclude that toric soft stability in extreme versions, particularly diagonal eye movements, and postural positions can affect lens orientation and VA.

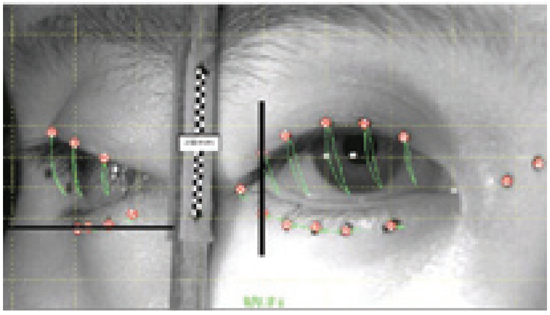


Figure 7 High-speed video recording of blink (Image courtesy of Queensland University of Technology, Australia)

Figure 8 Photographing lens orientation with subject in recumbent position (Image courtesy of Visioncare Research)

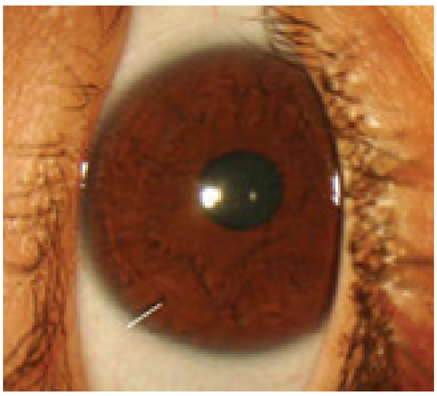


Figure 9 Effect of gravity on a prism-ballasted toric soft lens (Image courtesy of Visioncare Research)

KEY POINTS

- Orientation stability and position are essential for good visual performance and patient satisfaction with toric soft contact lenses
- ASD lenses offer significant advantages over prism-ballasted designs for visual performance
- Practitioners need to understand the patients' visual needs and lifestyle in their usual environment
- Recent studies have led to a reappraisal of toric soft lens design and fitting
- New assessment techniques help determine the best vision performance results both within and beyond the consulting room

Conclusion

The recent peer-reviewed results show the importance of toric soft lens design on visual performance. In clinical practice, ASD lenses are especially useful in dynamic situations where clear, stable vision is critical, such as when watching or playing sport. However, it is worth remembering that most astigmatic patients lead active lives that challenge lens performance in many different ways, even in sedentary situations and occupations. Everyday activities such as looking in a rear-view mirror when driving or watching TV when lying down are other demanding visual situations where rotational stability is important and ASD lenses would offer significant advantages.

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