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Toric Lens Performance: Insight into Rotational Recovery

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Introduction

The last twenty years have seen remarkable technological advances for creating soft toric contact lenses for astigmats, and these advances have increased the options and variety of lenses available. It is an important achievement that these lenses can now deliver a wide range of correction for astigmatism, which is fairly common and can have varying levels of severity. In the general population, several studies, including a study of over 2500 children in the United States, have shown that the prevalence of astigmatism of ≥1 diopter is ~30%. (Kleinstein 2003) For the contact lens-wearing population, 45% of patients have been estimated to have an astigmatism of ≥0.75 diopters. (Holden 1975) Despite the advances made, many astigmats still do not utilise toric lenses. (Morgan, 2009) With the large number of potential users, it is important that patients receive not only proper vision correction from their lenses, but also a high degree of satisfaction.

Performance of Soft Toric Contact Lenses

Lens Stability

The toric lens aligns its axis of cylinder correction to the axis of astigmatic error to neutralise any existing astigmatic refractive error. To help maintain this alignment several stabilisation designs are utilised which have some of the following characteristics: prism ballast, thin zones (e.g., double slab-off), posterior toric, chamfering, truncation, and combinations (i.e., incorporate different characteristics into a single lens design). (Russell 2003)

Several clinical techniques have been developed to assess lens stability. One technique is a simple evaluation of Primary Gaze Orientation (PGO), which assesses the orientation of a well-settled lens on an eye looking straight ahead. Another method is to evaluate the rate or degree of rotational recovery. This last method is important because a lens' ability to return to its original position following misorientation, for whatever reason, can impact vision correction.

Rotational Recovery Evaluation

Two clinical studies were conducted to evaluate the rotational recovery abilities of two toric lens designs: Lo-Torque® (Bausch & Lomb, Rochester, NY) and Accelerated Stabilisation design (AS) (Vistakon, Jacksonville, FL). (Cairns 2009, 2010) Institutional review board approval was obtained for the studies and all patients signed an informed consent form prior to participation.

In Study 1, the Lo-Torque design of PureVision® Toric (PVT) (Bausch & Lomb) was compared with the AS design of Acuvue Advance for Astigmatism (AAA). In Study 2, the Lo-Torque design of PVT (Bausch & Lomb) was compared with the AS design of Acuvue Oasys for Astigmatism (AOA).

In both studies, 32 subjects (64 eyes) were randomly assigned a stabilisation design (Lo-Torque or AS), parameter-matched, lens pairing on each eye. A total of 8 lens power/axis combinations were available as the sphere component of the lens power was -1.00 D or -5.00 D; the cylinder component for each spherical power was -0.75 D or -2.25 D; and the cylinder axis was 90° or 180°. Study 1 absolute PGO values were: PVT = 11.64 (± 9.39), AAA = 7.19 (± 8.90). Study 2 absolute PGO values were: PVT = 10.55 (± 9.96), AOA = 8.98 (± 9.27). Range in both studies was 0.00 to 45.00. PGO for the first lens was assessed 3 minutes after insertion to allow it to settle. One minute after the lens was manually displaced 45° temporally from PGO, rotational recovery was assessed based on the angular difference between PGO and the orientation that the lens recovered to after 1 minute (see Figure 1). Once this was measured, the lens was removed, the next lens was inserted, and the procedure repeated.

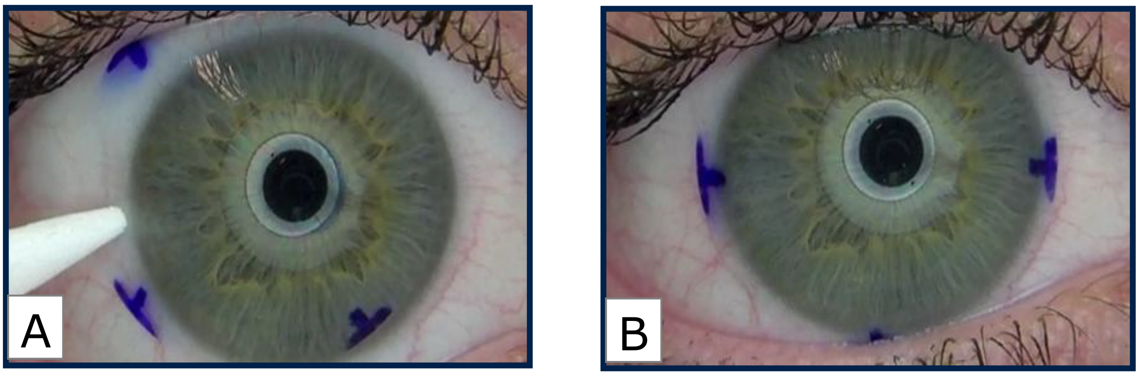


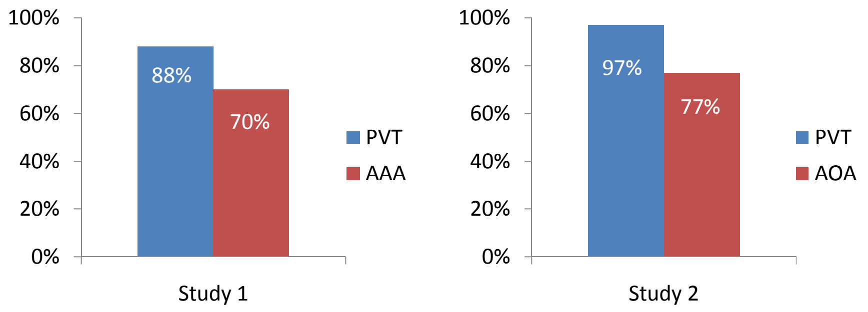
Figure 1. A) To assess rotational recovery, the lens was manually rotated 45° temporally using a surgical sponge. B) The lens demonstrates good rotational recovery by returning to PGO within 1 minute. Note: Images are for demonstration only. Study lenses were not artificially marked.

Rotational Recovery Results

In both studies, mean (± SD) rotational recovery for the PVT lenses was statistically significantly better (T-test; $P < 0.05$ in both studies) than the AAA and AOA lenses. In Study 1, mean (± SD) rotational recovery was 5.8° (± 7.3°) for PVT lenses and was 10.7° (± 13.5°) for AAA lenses. In Study 2, it was 4.3° (± 4.3°) for PVT lenses and 7.7° (± 7.8°) for AOA lenses. Also, both studies demonstrated that significantly less variability of rotation recovery was experienced with the PVT lenses (Levene's Test; $P < 0.05$ in both studies).

In addition, both studies showed that a greater proportion of PVT lenses, vs the AAA and AOA lenses, returned to within 10° of PGO (χ^2 Test, $P < 0.05$ in all cases) (Figure 2).

Figure 2. Proportion of PVT, AAA, and AAO lenses returning to within 10° of PGO within 1 minutes.

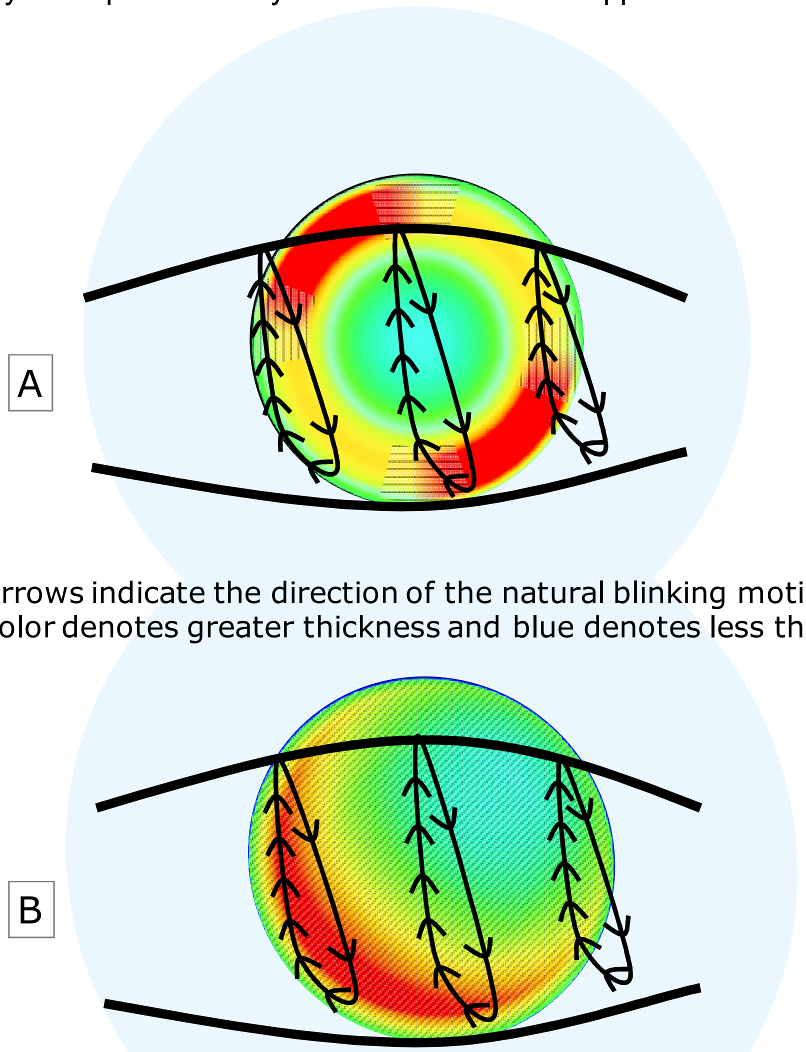


Discussion

To provide consistent vision correction, soft toric contact lenses must keep a stable orientation. Lens rotation leads to a reduction of effective cylinder power, and is almost entirely ineffective when rotated by as much as 30°. When a toric contact lens rotates from the PGO, lens design characteristics can play an important role in realigning the lens.

Figure 3 illustrates how lid forces associated with a blink interact with lens thickness profiles. In this figure, two different toric lens designs have been rotated

temporally: Figure 3A illustrates a dual thickness design. Figure 3B illustrates a prism ballast design. The arrows highlight lid motion direction and resulting lid forces that occur during a blink. As the lids close over the misaligned lens, the upper lid moves down and nasally in a rapid motion, which is followed by a temporal motion and slower return to the open position. It is believed that the return to PGO of the dual thickness lens is delayed by the thicker ballast region being caught by the upper lid. For the prism ballast lens, the return to PGO is less likely to be prevented by the interaction of the upper lid.



(Arrows indicate the direction of the natural blinking motion. Red color denotes greater thickness and blue denotes less thickness.)

Figure 3. Schematic of rotated lens design interaction with eyelids. A) Dual thickness design. B) Vertical thickness tapered design. Note: These images are for demonstration only and may not represent the actual thickness profiles of the study lenses.

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During the brief time that practitioners are afforded to assess individual toric lenses during a fitting session, it can be important to understand toric lens rotational recovery as part of the lens fit. This can provide insight into the real-world lens stability and consistency of vision that the patient will experience.

A lens' ability to return to PGO following rotation should be considered when choosing a toric contact lens. Additional study should be pursued to further elucidate the relationship between lid force and lens designs, and establish the characteristics of the Lo-Torque design that contribute to its greater propensity to return to PGO.

References

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