The Watermelon Seed Principle

Upper lid pressure applied to the prism ballast wedge follows the 'watermelon seed' principle of rapid movement away from the wedge apex.

By Anthony J. Hanks, B. Optom., F.A.A.O.

For a practitioner prescribing any particular contact lens type, it is important that he or she understands the functioning principles involved. Such an understanding is helpful in arriving at the final prescription where it may become necessary to take advantage of these factors which are contributing to the clinical performance observed or desired.

This argument is certainly true for soft toric lenses and the design components responsible for achieving stable lens orientation. The most popular orientating component in current toric lenses is prism ballast. Those lenses currently approved by the Food and Drug Administration are listed in the accompanying table. Also shown are the methods of orientation for each product. As will be explained in this paper, each in fact includes some form of prism ballast.

Weighting for gravity effect

When considering prism ballast designs, most ophthalmic practitioners will attribute the lens orientation achieved to a weight or gravity effect; that is, the base of the lens being relatively thicker than the apex causing a thickness and weight differential to be created as a result. This is not only accepted by many practitioners, but is also promoted in literature from several soft toric contact lens manufacturers.

Careful viewing of the literature from some of these manufacturers will, however, throw this weight theory already into doubt.

Reprinted with permission by Ciba Vision Care from *Contact Lens Forum*, September 1983.

Anthony Hanks graduated from the University of New South Wales, Australia, in 1972, receiving a "Bachelor of Optometry" degree (O.D. equivalent) with Honors together with the Nissel prize for "Best Contact Lens Student". He was in private practice in Port Macquarie, Australia, specializing in contact lenses from 1972 until 1979.

In 1980, Dr. Hanks joined the research and development staff of Bausch & Lomb Soflens as Manager of Optometric Research Clinic and in 1981, he moved to Ciba Vision Care as Director of Optometric Research.

He is a member of the A.O.A. Contact Lens Section, serves on the editorial panel for the Australian Journal of Optometry, and is a Fellow of the American Academy of Optometry.

Advertising material for some toric designs include a comfort chamfer or slabbing off of the lower prism thickness at the base. If weight is the orientating effect in prism ballast designs, then surely this chamfer will have a detracting effect on lens orientation and its consistency.

Similarly, the toric lenses which use truncation as part of their orientation system do so in conjunction with prism ballast. Again, this inclusion of a truncation at the prism base, like the comfort chamfer, detracts from the weight differential top to bottom in the finished lens. As shown in the table, this combination of truncation and prism ballast is found in both American Hydron and Wesley-Jessen soft toric designs.

If it is accepted that the comfort chamfer and the truncation have detracted from the weight effect created by prism ballast, it certainly must be admitted also that the soft toric designs mentioned earlier still continue to maintain clinically acceptable degrees of stable lens orientation.

The 'watermelon seed' analogy

The dominant mechanism at work is an underlying engineering principle related to pressure effects upon wedges. Henry Knoll referred to this as a "watermelon seed" principle, as it is analogous to a moist seed squeezed between the thumb and forefinger. The result of this action is typically for the seed to be expelled by the pressure, with such movement in a direction away from the seed, or wedge apex (Figures 1 and 2).

The same principles are true for the upper lid pressure applied to the prism ballast wedge profile in a soft toric lens. This is shown diagramatically in Figure 3 and is simply the result of lens thickness profile interaction with the upper lid pressure.

To demonstrate the strength of the watermelon seed principle, as opposed to the gravity theory, a simple experiment with a female patient was conducted. A soft toric lens having prism ballast as its only orientation component was used. After an acceptable fitting had been achieved, the stabilized lens orientation was measured. Observation of this is shown in Figure 4. The patient was then asked to stand on her head and the orientation observation and measurement was repeated. If the lens had oriented initially due to weight, it could now be expected to swing through 180 degrees and maintain prism base toward the floor. In fact, this was not the case. As shown in Figure 5, the lens continues to orient with prism base away from the upper lid. The thickness profile interaction with the upper lid ("watermelon seed" principle) is the domi-

Figures 1 & 2: The result of a moist watermelon seed squeezed between thumb & forefinger.

Figure 3: Upper lid pressure applied to the prism ballast wedge profile in a soft toric lens.

Figure 4: Stabilized prism ballast lens orienting with base down, away from the upper lid.

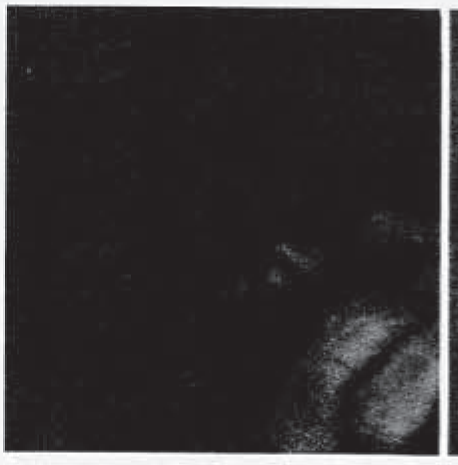

Figure 1

Figure 2

Figure 3

Figure 4

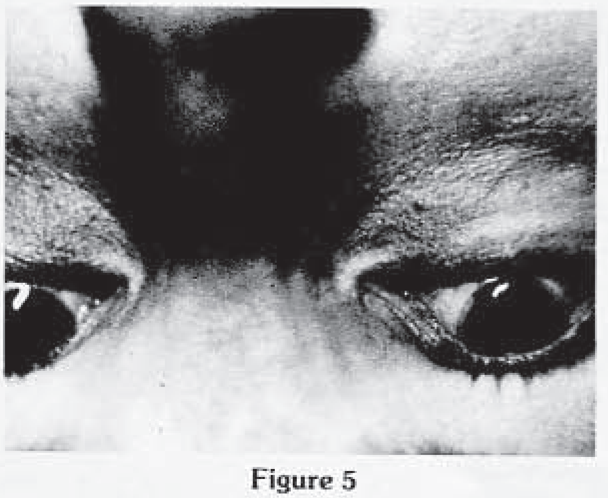

Figure 5

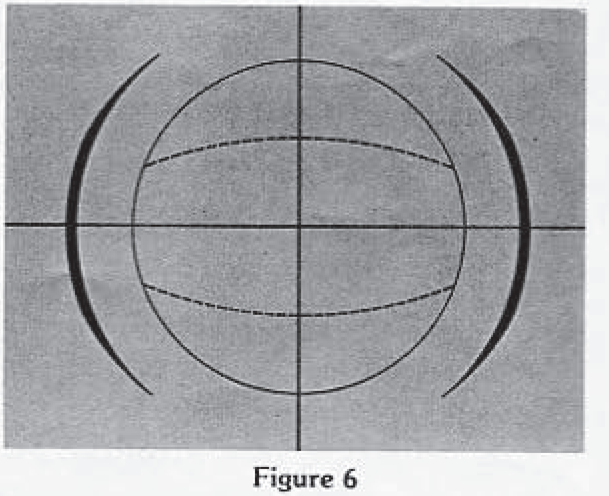

Figure 6

Figure 5: Patient inverted. Prism ballast lens continues to orient with base away from the upper lid.

Figure 6: Double slab-off or "thin zones" design concept.

nant component. Weight or gravity is a less significant effect.

This experiment was repeated several times with the same result. The only time limit on continued lens orientation despite the patient's inverted position has been the patient's ability, or willingness, to maintain the head-stand position. During trials in excess of 15 minutes, well-fitted toric soft lenses continued to maintain a stable prism base orientation away from the upper lid.

Apart from those lenses in the table which use prism ballast directly, there are two other products which list other orientation components. These are the "bal-flange" or peri-ballast of Salvatori and the "thin-zones" or double slab-off of Ciba Vision Care. The role of the "watermelon seed" principle in orienting both these designs can also be considered.

The peri-ballast design confines the prismatic thickness profile changes to the lens carrier. Prism is not included in the optic zone, thus allowing center thicknesses similar to those available in popular spherical lenses. For example, Hydron Australia offers a "Zero 6" toric soft lens by utilizing the peri-ballast design. For lenses of this design, the weight differential achieved is even less since it is only contained in the lens periphery. Nevertheless, the thickness profile changes are achieved for upper lid interaction.

The double slab-off design has been popular in Europe for several years and also takes advantage of the "watermelon seed" principle. The concept of this design is shown in Figure 6. The slabbing off or "thin zones" applied to the superior and inferior portions can in fact be likened to comparable features in conventional prism ballast. The upper slab-off is analogous to the prism itself while the lower slab-off is similar to the comfort chamfer. No prism exists in the optic zone and no weight differential is achieved in the vertical meridian as both slab-offs are of equal size. Once again, the dominant lens orientation effect is achieved when pressures from the upper lid closure interact with the slabbed-off thickness profile change, as per the "watermelon seed" principle.

Clinical implications

Once the contact lens practitioner using toric soft lenses accepts the contribution made by this principle as opposed to gravity, several clinical implications can be of benefit. As a simple example, the advice to soft toric patients not to lie on their side to watch television is inappropriate. The only exception will be during extreme lateral gaze where tighter lids will again interact with lens thickness profiles.

Besides the orientation component of the lens design (i.e., prism ballast, slab-off, etc.), the thickness change in different lens sectors induced by the cylinder has a potential effect on the final lens position. The size of this effect varies between different lens types based on such things as whether or not the lens is toric throughout or simply in the optic zone. If spherical lenses are used to predict

Toric Soft Contact Lenses

Manufacturer	Orientation Method
Bausch & Lomb	Prism Ballast
Ciba	Double slab-off "thin zones"
Barnes-Hind/Hydrocurve	Prism Ballast
Hydromarc	Prism Ballast
American Hydron	Prism Ballast & Truncation
Salvatori	Peri-ballast "bal flange"
Wesley-Jesssen	Prism Ballast & Truncation

lens orientation before ordering, a different result may well be seen when the thickness profile changes due to the added cylinder are included. For example, a lens with minus cylinder axis 70 (with increased power and increased thickness along the 160 meridian) may be expected to rotate more in a counterclockwise direction compared to the spherical diagnostic lens. This occurs as the upper lid interacts with the relatively increasing lens thickness on the left-hand side before the right. This effect due to added cylinder compared to spherical diagnostic lenses is greatest for larger cylinders and for those lenses where the cylinder extends beyond the optic zone. Thus, it would seem wise to use a full prescription lens as close as possible to the final Rx to predict lens orientation. This suggestion can be extended to supporting the practice of soft toric fitting from inventory.

In conclusion, contact lens practitioners who fit specialty lenses like soft torics need to be aware of the design components contributing to final clinical performance. For each of the soft toric contact lenses currently available, there is a significant influence from an engineering principle related to pressure effects on wedges. This "watermelon seed" principle is the significant orienting influence for each of the soft toric designs and dominates over the widely popular weight or gravity explanation.

Knowledge of this contribution has clinical implications in the fitting of soft toric contact lenses, particularly in the consideration of thickness profile changes. These will be relevant when using some *spherical diagnostic* lenses and *prescription* lenses which have full front surface *cylinders*. The "watermelon seed" principle will also affect the final clinical result when predictions for lens orientation are made based on toric soft lenses having cylinder powers or cylinder axes widely different from the refractive effects required in the final lens.