

Flexure of the Boston 7 RGP lens;
a low silicone content lens.

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ABSTRACT

It has been well documented in several research studies that PMMA and rigid gas permeable (RGP) contact lenses flex on toric corneas. Many variables can affect this flexure such as base curve, center thickness, and optic zone diameter of the contact lens. Also, the material of the lens can affect flexure. Lenses with high silicone content tend to exhibit a high amount of flexure. The new Boston 7 lens has a low silicone content and this should exhibit a low amount of flexure. This study was designed to measure the amount of flexure present on toric corneas that were fit on-K, Flatter-Than-K (FTK), and Steeper-Than-K (STK) with the Boston 7 RGP lens.

DISCUSSION

It has been well documented in the literature that thin PMMA contact lenses flex. Many factors can affect this flexure such as base curve, center thickness, overall diameter, optic zone diameter, lens material, amount of corneal toricity, and lid-lens interaction. In 1961, Bailey¹ noted that these lenses flexed along the flat meridian of the cornea. In 1970, Harris² also found that PMMA lenses with a center thickness of ≤ 0.12 mm showed significant flexure. This flexure was along the flattest corneal meridian and induced plus cylinder into the visual system thus altering residual astigmatism. This affect can be beneficial or detrimental regarding the patient's visual acuity.

In 1980, Harris et al³ found that 9.5 mm diameter Polycon lenses flex more than 9.5 mm PMMA lenses on toric corneas. They also found that for both materials, flexure and residual astigmatism increased as center thickness decreased.

In 1981, Harris et al⁴ showed that a Cabcurve Cellulose acetate buterate contact lens flexed more than either PMMA or Polycon lenses and that again the flexure increased with decreased center thickness.

In 1983, Herman⁵ conducted a study that looked at both base curve and material factors regarding flexure, as well as center thickness. He found that the primary factor influencing lense flexure was the base curve fitting relationship. The study found center thickness changes only marginally affected flexure. Herman also found no significant flexure differences between the Polycon lenses and PMMA lenses.

Also in 1983, Pole⁶ studied base curve changes with the Polycon RGP lens. He found that lenses fit STK flexed significantly more than lenses fit on K or FTK.

Pole et al⁷ conducted another study in 1984 regarding the effect optic zone diameter changes had on flexure. A 9.5mm overall diameter Paraperm O₂ lens was used with optic zone diameters of 7.2mm, 7.8mm, and 8.4mm. He found that optic zone diameter changes had a significant effect on flexure. The lenses with the larger optic zone diameters flexed significantly more with more residual astigmatism than the small optic zone diameter lens.

Also in 1984, Pole and Kochanny⁸ conducted a study to see if flexure varied between 3 different RGP lenses made of different material (Polycon II, Silicon, and Boston II). They did not find a significant difference in flexure between the three lenses.

In lectures by Pole,⁹ it was mentioned that, in general, lenses that have high DK values tend to flex more than lenses with low DK values. Stevenson^{10 11} showed in two separate studies in 1987 and 1989 that RGP contact lenses of higher DK tend to flex more than lower DK lenses in vitro.

Obviously, many variables regarding the contact lens itself effect flexure and thus residual astigmatism. Patient factors, such as the amount of corneal toricity, lens-lid interaction, and surface tension, also have an effect on flexure. Generally as the amount of corneal toricity increases, the amount of lens flexure also increases. The upper lid tends to add an against-the-rule (ATR) component to the flexure. A flatter lens tends to ride higher and thus will have more forces exerted upon it by the upper lid. The surface tension that is created between the tear film and the lens also causes an RGP lens to flex. This flexure due to surface tension is with-the-rule (WTR).

Although ocular factors have an effect on lens flexure, they are much more difficult for the practitioner to manipulate than are lens parameters such as base curve and center thickness. Many lens factors contribute to lens flexure, and although base curve changes may be the most influential, other factors such as lens material should not be ignored.

Our study was designed to evaluate the effect on flexure of changing the base curve to cornea fitting relationship using the Boston 7 RGP lens.

METHOD

Our study used 10 subjects (twenty eyes) as a test group. The average corneal toricity of the group was 1.875 Diopters (D) with a range of 1.00 D to 4.00D. The group included 17 eyes with WTR astigmatism, 2 eyes with ATR astigmatism, and 1 eye with oblique astigmatism. Keratometry readings were taken to determine the amount of corneal toricity present for base curve selection of the contact lens. Table 1 summarizes the keratometric and refractive information of the study group. All subjects had previously had a complete eye exam at our clinic.

The rigid gas permeable lenses used in this study were 9.0mm overall diameter Boston 7 lenses with a 7.80mm optic zone diameter and -3.00 power. Center thickness was 0.15mm. The

only varying parameter was the base curve which was changed to fit the individual eye.

The Boston 7 lens is a copolymer called satafocon A, which is composed of aliphatic fluoroitaconate siloxanyl methacrylate. The lens has an oxygen permeability of $73 \times 10^{-11} (\text{cm}^2/\text{sec})(\text{ml O}_2 \times \text{mmHg})$ and a Rockwell hardness of ≥ 115 . The silicone content of this copolymer is 5% to 7%, the lowest silicone content of any silicone acrylate or fluoro silicone acrylate RGP material.

Prior to insertion, the lenses were hydrated with Boston Original Soaking Solution and cleaned with Boston Original Cleaning Solution. Each eye was fit with contact lenses having base curves on-K, 0.1 mm FTK, and 0.1 mm STK. A 0.1 mm base curve change is equivalent to a curvature change of 0.61D. The lens was allowed to settle on the cornea to minimize tears between the lens and the cornea and ensure a stable fit. Then the amount of flexure was measured via Keratometry readings and this was followed by EyeSys topography readings.

RESULTS

Significant flexure was measured with all 3 base curve to cornea fitting relationships. The average flexure for the on-K fitting relationship as measured by the Keratometer was 0.50 D with a range of 0.00 D to 1.00 D. The average flexure for the FTK fitting relationship was 0.49 D with a range of 0.25 D to 1.50 D. The average flexure for the STK fitting relationship was 0.74 D with a range of 0.125 D to 1.50 D. See Table 2.

The mean percentage flexure to corneal toricity was 26.1% for the FTK fitting relationship, 26.7% for the on-K fittings, and 39.5% for the STK fittings.

On 14 out of 17 eyes, the STK fit flexed more than the on-K fit, with 3 cases of equal flexure. The on-K fits flexed more than the FTK fits on 8 out of 15 eyes with 5 eyes showing equal flexure.

DISCUSSION

The results of the study indicate that the amount of lens flexure is directly influenced by the base curve to cornea fitting relationship. The Boston 7 lenses fit STK flexed more than those fit on-K or FTK. This relationship has been demonstrated in several previous studies as well.

A study conducted by Ebels et al¹² found very similar amounts of flexure with the Boston II RGP lens. Our study, using the Boston 7 RGP lens, did not find significant differences in flexure versus the Boston II lens. With its lower silicone content, the Boston 7 lens should, in theory, flex less than the Boston II lens. We did not find this to be the case.

Since lens flexure can adversely affect visual acuity by inducing residual astigmatism, the fitting relationship of choice should be on-K if possible. Obviously, this cannot always be achieved as other factors such as centration and movement must also be considered.

It is important for the clinician to know how to change lens parameters to help reduce the amount of flexure, or in certain instances, to increase it. This will benefit the patient by achieving the best possible visual acuity.

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