Revised 12/17/90

QUANTITATIVE EFFECT OF OPTIC ZONE DIAMETER CHANGES ON RIGID GAS PERMEABLE LENS MOVEMENT AND CENTRATION

Christopher D. Theodoroff, B.A.,B.Sc.
College of Optometry
Ferris State University
Big Rapids, MI 49307

1990

Gerald E. Lowther, O.D., Ph.D.
School of Optometry
University of Alabama at Birmingham
Birmingham, AL 35294

Abstract

The effect of varying optic zone diameter on rigid contact lens positioning and visible post blink movement was determined on twenty patients using a 9.50 mm overall diameter lens with 7.40 mm, 7.90 mm and 8.40 mm optic zones. The smaller optic zone lens positioned more temporally and superiorly than the larger zone lenses. There was not a strong correlation between lens positioning and patient factors such as corneal shape, corneal apex position, lid position and corneal diameter. The strongest correlation was between lens position and the patient factors of actual corneal diameter and horizontal apex position. The smaller optic zone lens moved slightly less than the larger optic zone lenses.

Key Words: Rigid gas permeable lenses, fit, optic zone diameter, lens movement and positioning

Introduction

It is observed clinically that altering the parameters of a rigid gas permeable (RGP) contact lens affects the fit, positioning, and comfort. Parameters such as base curve radius (BCR), overall diameter (OAD), and optic zone diameter (OZD) are commonly specified in order to obtain proper fit of the lens for optimum comfort, vision, and maintenance of normal corneal physiology.

The clinician can alter the OZD to decrease flare from the secondary curve, to effectively steepen or flatten a lens fit, or to increase or decrease the peripheral curve width[1,2]. If the optic zone effects positioning and movement, it may also be a factor in peripheral corneal staining. More movement over the peripheral cornea may decrease the incidence of staining. Caroline and Norman pointed out the importance of optic zone diameter[3] but the consequence of the optic zone is often overlooked. To date the effect of changing the OZD on RGP lens movement and centration has not been measured. In this study the relationship between OZD and RGP lens movement and centration is quantified.

Methods

Using a Humphrey Autokeratometer (model 410), K-readings, location of the corneal apex, and shape factor measurements were obtained on one eye of each of twenty non-RGP wearing subjects. Measurements of horizontal visible iris diameter (HVID), vertical visible iris diameter (VVID), actual corneal diameter, upper and lower lid position as well as contact lens movement and positioning were made utilizing a CCD video camera. The apparatus consisted of a head rest with an attached Pulnix black and white video camera (model TM-34KC with an Olympus F.ZUIKO Auto-S, 1:1.8, f=50mm lens) (figure 1) connected to a Panasonic Omnivision II VHS videocassette recorder (model NV-8350). A Hitachi black and white video monitor (model VM-172U) was used. Lens aperture and focus were held constant throughout the study. A millimeter rule was positioned before the camera in the position of the patient and videotaped. A calibrated measuring rule was created from the magnified image on the screen and used to take measurements directly from the recorded images on the video monitor screen (figure 2). The actual corneal diameter, as opposed to the visible iris diameter, was measured using a modification of technique described by Martin and Holden [4]. Two line images (fluorsecent bulbs) were reflected from the limbal area and the point of deflection of the images where the curvature changes from the cornea to sclera was taken as the diameter.

To eliminate reflex tearing due to introduction of the lens, one drop of 0.5% proparacaine hydrochloride was instilled prior to lens placement. Three 9.5 mm overall diameter RGP lenses with optic zones of 7.40, 7.90, and 8.40 mm were then fit on each of the eyes. To maintain approximately equivalent central corneal clearance, the 8.40mm OZD lens was fit on-K, and the 7.40 and 7.90 mm OZD lenses were fit 0.05 mm steeper than K. The lenses were of Polycon II material, 0.11 mm center thickness, -3.00 D. power with two peripheral curves. The radii of the peripheral curves were such that the axial edge lift of all the lenses were the same (0.12 mm). Fluorescein was introduced, via moistened Fluor-I-Strips, for improved lens edge definition and visualization. Burton lamps were used to illuminate the lens.

Using the apparatus described above, the fit of each lens was videotaped through 12 to 15 full blinks. With the calibrated measuring rule and using the center of the pupil as a reference point, the vertical and horizontal position of each lens following a full blink was recorded from the projected image on the video screen. Likewise, the extent of vertical lens movement following each full blink was also recorded for each lens. The values were averaged to generate a mean horizontal lens position, a mean vertical lens position, and a mean extent of the visible post blink vertical lens movement for each lens.

Results

The mean subject age was 26.05 years $\pm$6.94 , with average corneal toricity of 0.883 D $\pm$0.465, flat k-readings of 43.85 D $\pm$0.87, and steep k-readings of 44.75 D $\pm$0.88. The shape factor was 0.1755 $\pm$0.077 with the corneal apex location of 0.275 mm temporal $\pm$0.75 and 0.734 mm inferior $\pm$0.704.

The HVID measured 11.79 mm $\pm$0.41, and the VVID was 11.17 mm $\pm$0.85. The actual horizontal corneal diameter measured from the point of change in curvature from cornea to sclera was 12.64 mm ±0.52. Average upper lid position was 1.2 mm ±0.78 of corneal coverage, and the average lower lid position was at the lower limbus ±0.48.

Figure 3 shows the mean vertical lens positions for each optic zone diameter lens. Table 1 gives a summary of the values. As can be seen the 7.40 mm optic zone lens positioned higher between blinks than did the other two zone sizes. Using the paired t-test the 7.40 mm lens vertical position was statistically different at the 98% confidence level while between the 7.40 and 8.40 mm OZD lenses the difference was only at the 90% confidence level. There was no significant difference between the 7.90 and 8.40 mm zone lenses.

Figure 4 gives the horizontal lens position for each zone diameter. The smaller the zone diameter the more temporally the lens positioned. With the paired t-test the 7.40 mm optic zone lens was significantly different at the 99% confidence level than the other two zone sizes, however, there was not a significant difference between the 7.90 and 8.40 mm zone diameter lenses.

Figure 5 shows the lens movement by optic zone diameter. The smaller optic zones moved slightly less. Statistically the 7.40 mm zone lens moved less at the 99% confidence level than did the 7.90 and 8.40 mm zone lenses. The 7.90 mm zone lens versus the 8.40 mm zone lens showed only a 91% confidence level difference.

Correlation coefficients were determined between shape factor and lens movement, horizontal apex position and lens position, vertical apex position and lens position, upper lid position and vertical lens position, vertical visible iris diameter and vertical lens position, horizontal visible iris diameter and horizontal lens position, and actual horizontal corneal diameter and horizontal lens position. All the correlation coefficients were less than 0.30 with the exception of the comparison between the actual corneal diameter and the horizontal lens position where the correlation coefficients were 0.40 to 0.46. For the horizontal apex position and horizontal lens position the values for the three lenses were from 0.30 to 0.42.

Discussion

The measurement of visible and actual corneal diameters in this study are similar to that found by Martin and Holden[4]. Likewise the corneal shape and apex position findings are similar to those previously reported. Lid positions with respect to the cornea have to our knowledge not been previously reported. Population statistics on these factors are needed for future lens design and will be reported for a larger patient population at a later date.

The smallest optic zone (7.40 mm) lens showed a marked horizontal and vertical displacement over the two larger optic zone diameter lenses but slightly less movement. The position and movement of the lens is not accurately predicted by any single one of the ocular measurements made in this study. The controlling factor(s) may be a combination of corneal shape and lid attributes.

The effect of optic zone diameter on peripheral corneal staining and other lens wearing factors needs to be determined. This study indicates that an optic zone diameter less than 7.90 mm (in this case 7.40 mm) performs differently than optic zones of 7.90 mm and larger. The results of this study showing a change in performance with different optical zones indicates the need for additional study of basic RGP lens performance. Further clinical studies are planned to determine long term effects of different optic zone diameters on wearing comfort and peripheral corneal staining.

Acknowledgments The lenses were supplied by Sola Ophthalmics and the Autokeratometer by Allergan Humphrey.

Captions

Figure 1. The Pulnix CCD TV camera used to videotape the lens position and movement.

Figure 2. Measuring lens position and movement from the TV monitor.

Figure 3. The vertical lens position with the three optic zone diameters is shown. Positive values means the lens rides above center.

Figure 4. The horizontal lens position with the three optic zone diameters is shown. Negative values means the lens rides temporally.

Figure 5. The mean amount of movement with the three optic zone diameter lenses is shown.

References

1. Young, G., Fluorescein in Rigid Lens Fit Evaluation. ICLC 15(3):95-100, 1988.

2. Lowther, GE, Review of Rigid Contact Lens Design and Effects of Design on Lens Fit. ICLC 15(12):378-389, 1988.

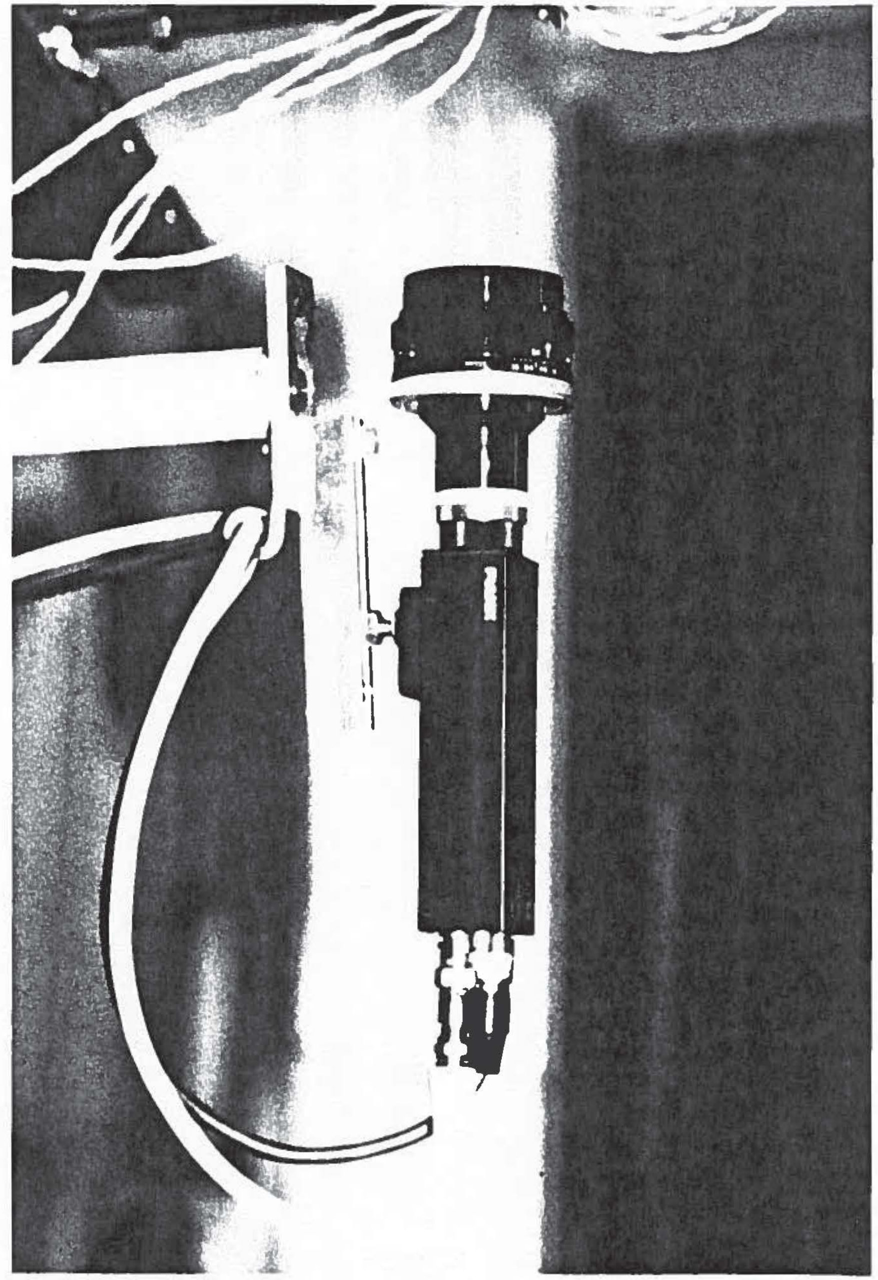
3. Caroline, PJ, Norman, CW. A Blueprint for Rigid Lens Design. Contact Lens Spectrum 3(11):39-50, 1988.

4. Martin, DK, Holden, BA. A New Method for Measuring the Diameter of the In Vivo Human Cornea. Am J Optom 59(5):436-441, 1982.

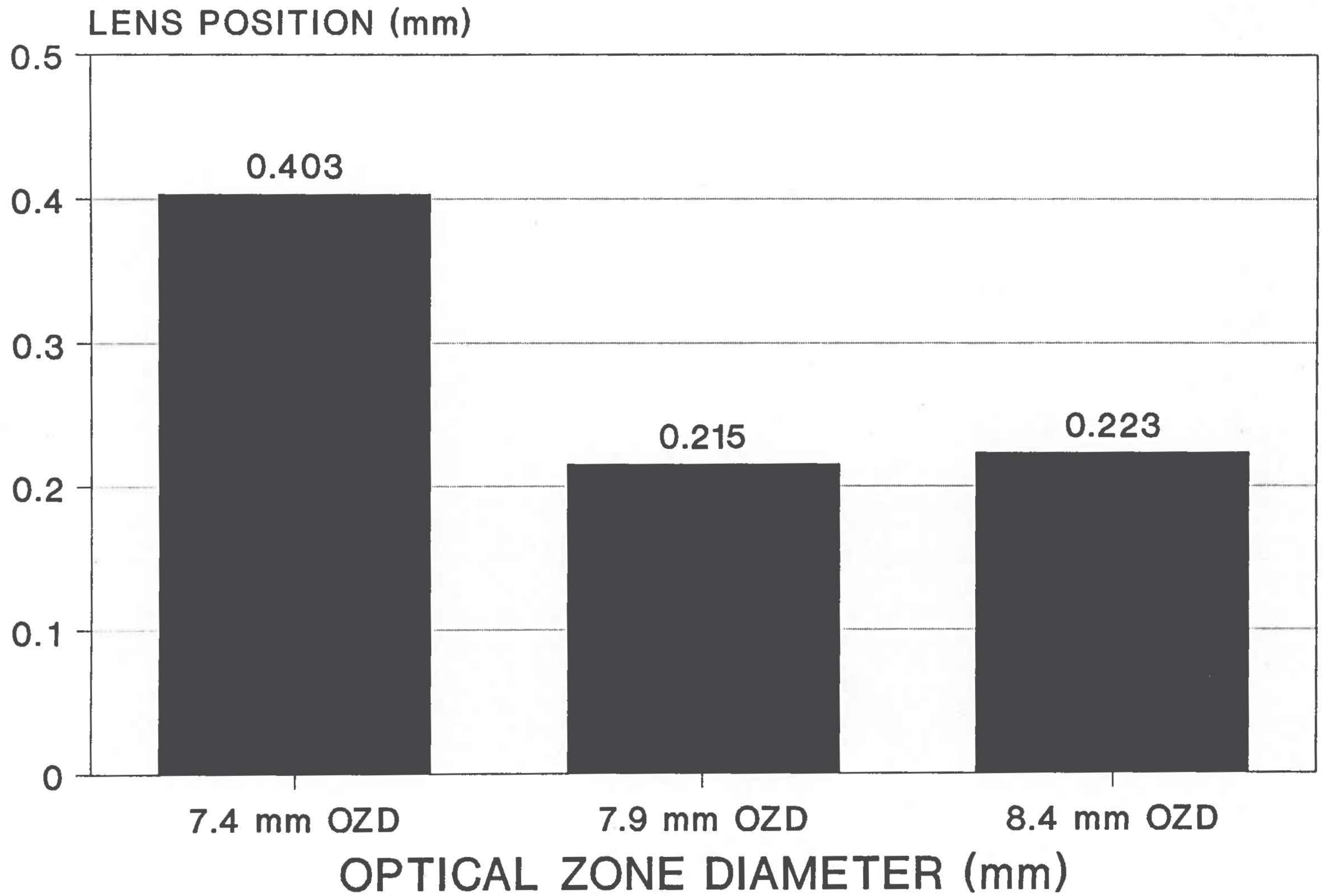
TABLE I

	OPTICAL ZONE DIAMETER		
	7.40	7.90	8.40
Vertical position	0.403 (0.59)	0.215 (0.566)	0.223 (0.51)
Horizontal position	-0.80 (0.35)	-0.455 (0.52)	-0.356 (0.36)
Vertical movement	1.195 (0.337)	1.38 (0.34)	1.493 (0.44)

Values given in millimeters with standard deviation in parenthesis.

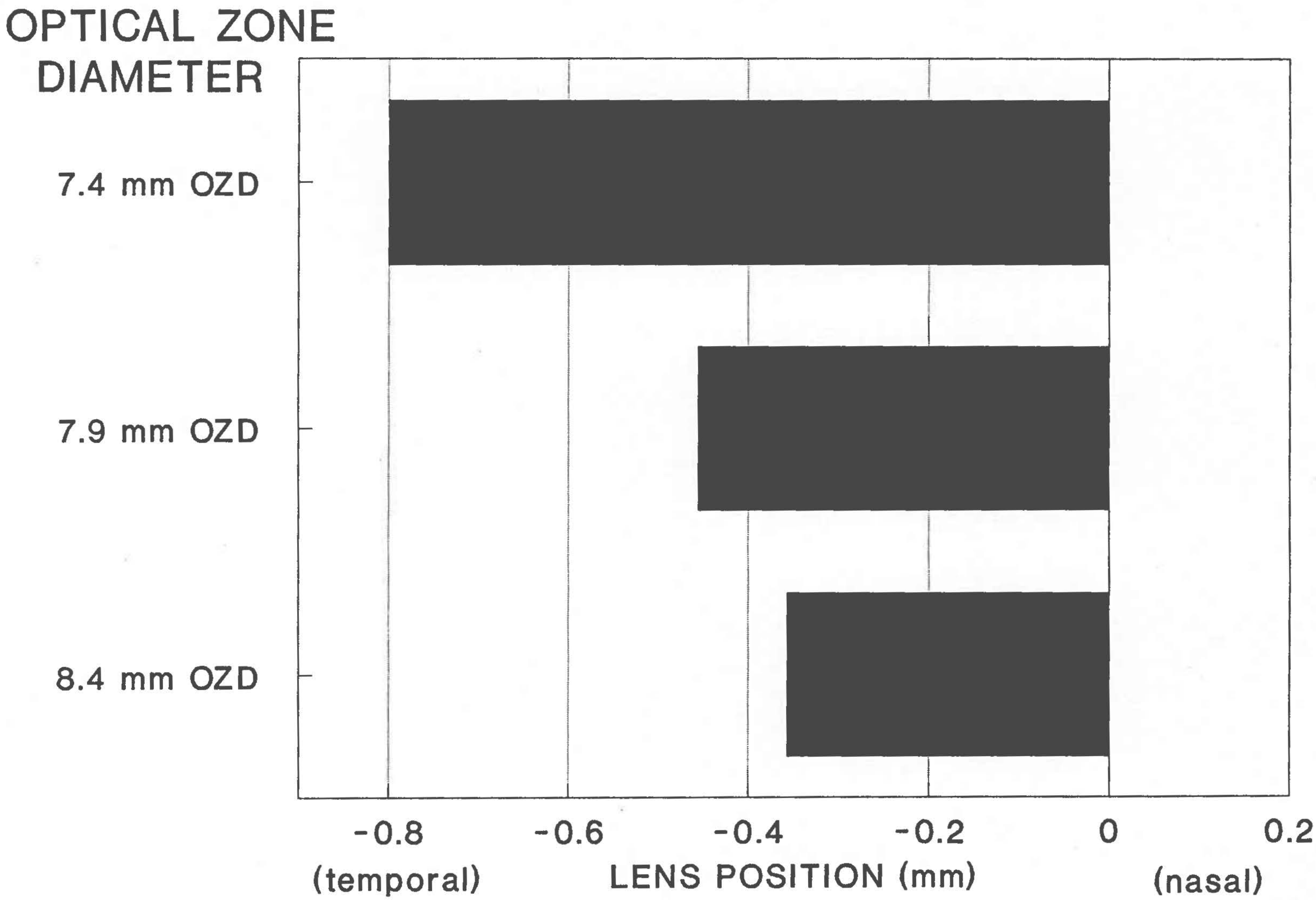


VERTICAL LENS POSITION



+ value is above center

HORIZONTAL LENS POSITION



LENS MOVEMENT