ASSESSMENT OF RIGID GAS PERMEABLE BASE CURVE MEASUREMENTS WITH THE HUMPHREY TOPOGRAPHER

by

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ABSTRACT

Background: This research study determines if the base curve of a rigid gas permeable lens can accurately be measured using the Humphrey Topographer. With the advancing technology of automated optical instruments it is evident that the manual instruments will be harder to obtain and access. Few instruments are currently available to accurately measure the base curve of a rigid gas permeable lens, thus the need for alternative methods. *Methods:* Ten spherical and ten bi-toric RGP lenses were randomly chosen with unidentified parameters. The base curve of each lens was measured using the radiuscope and the Humphrey Atlas Topographer, model 991, two trails of each lens were documented. *Results:* Based on the hypothesis that the two base curve measurements of the RGP lenses are equal, of the lenses tested 90% of the spherical lenses fell within a 95% confidence interval of the hypotheses. For the bi-toric lenses 60% were within the 95% confidence interval. *Conclusions:* After careful statistical analysis it is apparent that the Humphrey Topographer can accurately assess the base curve of a spherical RGP lenses as compared to the radiuscope. More extensive research is still needed to determine if the bi-toric RGP lenses will be as successful.

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Introduction

Assessment of the base curve radius is critical to the successful fitting of rigid gas permeable (RGP) lenses. The radiuscope, also known as an optical spherometer, is considered the "gold standard" for verifying the base curve of RGP lenses. The radiuscope is a specialized microscope that utilizes the Drysdale principle on the concave lens surface.[1] In addition, the radiuscope can serve as an inspection device and may detect warping, scratching, or crazing of a lens.[2]

An alternative manual method of base curve verification includes use of the keratometer. An autorefractor/keratometer has also been shown to produce accurate and reliable results of base curve assessment.[3] Keratometers are calibrated to measure the anterior convex corneal surface. In order to assess base curves of concave surfaces with these instruments, conversion factors must be used. Specialized lens holders also need to be mounted to position the lens perpendicular to the instrument.

Corneal topographers, like the keratometer, measure the convex corneal surface. These more sophisticated devices are gaining popularity in optometric practice as they play an increasingly important role in pre/post refractive surgery and orthokeratology assessment. Topography is useful in both qualitative RGP lens design selection and quantitative lens parameter selection. They are also useful in monitoring corneal warpage or molding throughout the RGP fitting process.[4] Like the autorefractor/keratometer, corneal topographers may prove an acceptable alternative method for base curve assessment.

Methods

Base curves of twenty RGP lenses were measured; these included ten spherical and ten bi-toric lenses. These lenses were randomly selected and the base curves parameters were masked in order for the verifier to remain unbiased. Each lens was measured with the Humphrey Atlas Topographer, model 991, and then the radiuscope. A convex holding device was mounted to the topographer, while the lens was adhered to the device with an artificial gel. Base curve measurements of these same lenses were also taken using the radiuscope. Two separate trials were performed on each lens. After collection of all of the data the base curve measurements from each trail was compared to the different methods used.

Statistics

Analysis of base curve results consisted of comparing the mean base curves of the two trials obtained from each instrument on an individual lens basis. The null hypothesis (H_o) that the mean base curve obtained by the radiuscope equaled the mean base curve obtained by the topographer was established.

The null hypothesis was tested for each lens using a student t-test (α=0.05, 2-tailed, 2 degrees of freedom). Mean base curve and standard deviation was determined for each set of trials for each instrument used. Standard error of the distance between the two means was calculated from radiuscope standard deviation and topography standard deviation for each lens. The calculated t-statistic was determined by dividing the difference of the sample means by the standard error of difference. This t-calculated value was then compared to t-critical value of 4.303 as determined from a t-distribution table (using α=0.025 for 2-tailed distribution and 2 degrees of freedom). The null hypothesis was accepted for each lens tested if t-calculated < t-critical at the 95%

confidence level. The null hypothesis was rejected if t-calculated > t-critical at the 95% confidence level.

Additional analysis of the data was made by comparing the absolute difference between the mean base curves of each instrument for each lens with ANSI Standard Z80.2-1989 (+/- 0.050mm for gas permeable lenses). See tables 1-3 for results of the individual lens calculations.

Table 1. Results of Spherical Lens Calculations

	Radiuscope		**Topographer**			
Trial lens #	Mean base curve (mm)	Std. Dev.	Mean base curve (mm)	Std. Dev.	t-calculated	Absolute difference between means
1	7.37	0.01414	7.36	0	1.003	0.01
2	7.685	0.02121	7.685	0.00707	0	0
3	7.895	0.02121	7.89	0	0.334	0.005
4	7.75	0.01414	7.775	0.00707	2.240	0.025
5	7.295	0.00707	7.27	0.01414	2.240	0.025
6	7.555	0.02121	7.545	0.00707	0.633	0.01
7	7.995	0.00707	7.955	0.02121	1.887	0.04
8	7.47	0.01414	7.47	0.01414	0	0
9	8.10	0	8.125	0.02121	1.668	0.025
10	8.27	0.01414	8.12	0	15.045	0.15

Table 2. Results of Bi-Toric Steep Meridian Calculations

	Radiuscope		**Topographer**			
Trial lens #	Mean base curve (mm)	Std. Dev.	Mean base curve (mm)	Std. Dev.	t-calculated	Absolute difference between means
1	6.6	0.31113	6.76	0.01414	6.621	0.16
2	7.19	0.07071	7.08	0.01414	2.157	0.11
3	7.53	0.01414	7.43	0.01414	7.071	0.10
4	6.845	0.00707	6.68	0	33.007	0.165
5	7.655	0.09192	7.615	0.04950	0.542	0.04
6	7.55	0.01414	7.49	0.01414	4.243	0.06
7	7.83	0.07071	7.84	0.01414	0.196	0.01

8	7.385	0.13435	7.26	0.02828	1.288	0.125
9	6.97	0.01414	6.88	0.01414	6.364	0.09
10	7.15	0.04243	7.11	0	1.334	0.04

Table 3. Results of Bi-Toric Flat Meridian Calculations

	Radiuscope		**Topographer**			
Trial lens #	Mean base curve (mm)	Std. Dev.	Mean base curve (mm)	Std. Dev.	t-calculated	Absolute difference between means
1	6.96	0.25456	7.12	0	0.889	0.16
2	7.51	0.07071	7.46	0.02828	0.929	0.05
3	7.79	0.01414	7.8	0	1.000	0.01
4	7.47	0.02828	7.44	0	1.501	0.03
5	8.13	0.09900	8.11	0	0.286	0.02
6	7.85	0.04243	7.83	0	0.667	0.02
7	8.26	0.07071	8.285	0.03536	0.447	0.025
8	7.89	0.18385	8.195	0.02121	2.331	0.305
9	7.11	0.01414	7.12	0	1.000	0.01
10	7.37	0.07071	7.49	0.01414	2.353	0.12

Results

Evaluation of spherical RGP base curve measurements with the radiuscope versus the topographer were made by comparing t-calculated with t-critical. For 90% (9/10) of the lenses tested, H_0 could be accepted with 95% confidence that there was no significant difference between the means. Thus, the radiuscope and topographer yielded statistically similar results. Ninety percent (9/10) of the time, the difference between the means for the two instruments were within the 0.05mm ANSI tolerance range.

Evaluation of bi-toric RGP base curves for the two instruments were made by comparing each of the two meridians independently for each lens. Sixty percent (6/10) of the time, H_0 could be accepted with 95% confidence that there was no significant difference between the mean base curves assessed in the steep meridian. Only 30%

(3/10) of the time, mean base curve differences were within ANSI tolerance. For the flat meridian, 100% (10/10) of the time, H_0 could be accepted with 95% confidence. Seventy percent (7/10) of the time, mean base curve differences were within ANSI tolerance.

In summary for bi-toric lenses, 80% (16/20) of the time, there was no significant difference between the mean base curves of the meridians. Only 50% (10/20) of the absolute mean differences were within ANSI tolerance.

Discussion

The results of this study suggest that the corneal topographer may provide an acceptable alternative to verification of RGP lenses. For spherical lenses, the corneal topographer produced base curves comparable with those obtained using the radiuscope. Bi-toric lens assessment yielded statistically equivalent base curves at a lower frequency than the spherical assessment. For unexplained reasons, the base curve measurements obtained by each instrument for the flat meridians were found to be statistically equivalent more often than for the steep meridians.

Variability of the measurements obtained may be the result of several sources of error. This includes human operator error, possible existing warpage of the lenses used, and possible reflections from the surface of the solution used to adhere the lens to the mounting device. Additionally, the topographer is capable of measuring a larger area than the radiuscope, which measures the exact central point of the lens.

Automated instruments such as the autorefractor/keratometer are now replacing manual instruments because they decrease the variability caused by human error.[3] As radiuscopes are becoming far less accessible to contact lens practitioners, other methods of base curve verification need to be found. Corneal topography will likely become the standard of care for managing contact lens patients.[4] Corneal topographers may prove to demonstrate an acceptable alternative to the radiuscope as a method of base curve assessment.

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