BETRON SOFT CONTACT LENS BASE CURVE ANALYZER

Senior Research Project

ANDREA M. PALARDY

Advisor
GERALD E. LOWTHER, O.D., PH.D.
College of Optometry
Ferris State College
Big Rapids, MI 49307

Abstract

The measurement of the base curve radius of soft contact lenses is vital for proper fitting and lens replacement. However, measuring the base curve radius of hydrogel lenses often poses a challenge in clinical practice. In this study, a ne device is utilized to measure the base curves of seven different soft lenses. The device utilized is the Betron Soft Contact Lens Base Curve Analyzer. The contact lens to be measured is placed inside this unit and the unit is then placed on a radiuscope stage. The radiuscope is used to measure the sagittal depth of the lens. This is readily converted to the appropriate base curve utilizing a conversion table.

The lenses tested include: Bausch and Lomb--O3, B3, U3, and U4; American Hydron--O6 and O4; and Permaflex by Cooper Vision. Each lens was tested on six separate, non-consecutive trials. The six trials were averaged and a standard deviation calculated for each. The results obtained indicate that this device can be used with relative ease to obtain repeatable measurements. The measurements of most of the lenses were consistently flatter than the labeled base curve radius. The only lens to consistently measure steeper than the labeled base curve was the Hydron O4.

Introduction

The measurement of the base curve radius of hydrogel lenses has been very difficult and/or expensive. Due to the soft and hydrophilic nature of this material, the normal techniques used with rigid lenses are not acceptable with hydrogels. Numerous techniques have been attempted but none have been clinically acceptable (1-5).

A new, inexpensive technique using a specially designed wet cell on a standard radiuscope has been developed*. The technique is relatively simple to use in clinical practice.

Methods

The device uses the radiuscope to measure the sagittal depth of the lens over a given zone diameter. It consists of a wet cell with a pedestal at the bottom of the cell (figure 1). The lens is placed concave side down over the pedestal. The wet cell is filled with saline. There is a small hole drilled in the bottom of the cell that is connected to small screw on the side of the cell (figure 2). Once the lens is placed in the cell, the screw on the side is turned slightly until a small bubble is formed at the opening on the pedestal. One may have to tap the cell lightly to get the bubble to release and float up to the back surface of the lens. Now the cell can be placed under the radiuscope such that the opening of the hole in the pedestal is directly below the objective of the radiuscope. The radiuscope is next focused on the surface of the pedestal as one

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*The device was developed by Dr. Ronald Downing, Mansfield, Ohio would on the surface of a rigid contact lens when the radiuscope is being used to measure the base curve. At this point, the hole in the pedestal is positioned in the center of the field of view. When the radiuscope image on the surface of the pedestal is in sharp focus, the radiuscope is zeroed. Next the radiuscope is focused up until the radiuscope image from the interface of the small bubble and the lens surface is in sharp focus. This interface is easy to see. The scale reading on the radiuscope at this point is the sagittal depth of the lens over the diameter of the pedestal. The sagittal depth can then be converted to radius using a conversion table or by formula.

Two different cells are supplied, one with a pedestal chord of 11.0 mm to be used with lenses of diameters of less than 14.0 mm and a second one of 12.0 mm for lenses with diameters of 14.0 mm and over.

One of the objectives of this study was to measure lenses of different thicknesses and water contents to determine the repeatibility of the measurements. The lenses measured were Bausch and Lomb O3, U3, U4 and B3; American Hydron O4 and O6; and Cooper Permaflex Lenses. The lenses were new. Each lens was measured six times, non-consecutively.

Results

The Betron Base Curve Analyzer proved to be relatively easy to use and the measurements were quite repeatable. The mean base curve radius and the mean sagittal depth represent the average of six non-consecutive trials on each of six lenses tested. The standard deviations for the sagittal depths of the Bausch and Lomb lenses were quite low (tables 1-4). These values ranged from 0.014 (table 4, lens #3), to 0.161 (table 2, lens #5). The standard deviations for the sagittal depths of the American Hydron lenses can be observed in tables 5-6. These value ranged from 0.015 (table 5, lens #4), to 0.094 (table 6, lens #3). Table 7 shows the standard deviations for the Permaflex lenses which ranged from 0.008 (lens #4) to 0.034 (lens #3). The corresponding standard deviations for the base curve radii can be compared in tables 1-7. These values indicate that the base curve radius measurements utilizing this device were repeatable.

The center thickness appears to have an effect on the repeatability of the base curve radius measurement. As the center thickness of the lens decreases, the repeatibility of the measurement diminishes. The Permaflex lens was the thickest lens in the stuey and had the best repeatibility. The thinner lenses demonstrated less repeatability. The lens power did not effect this measurement. Also, the spincast lenses did not differ significantly from the lathe cut or cast molded lenses with respect to repeatability of base curve measurement. Again, repeatability was assessed by comparing the standard deviation values in table 8.

The Bausch and Lomb spincast lenses all measured flatter than the labeled base curve (table 8). The American Hydron 06, which is lather cut, and the Cooper Permaflex, which is molded, also measured flatter than the given base curve. The American Hydron 04, which is molded, was the only lens to consistently measure steeper than the labeled value.

Discussion

The Betron Base Curve Analyzer proved to be relatively quick and easy to use. Anyone competent at operating a radiuscope should have little difficulty utilizing this device. The entire measuring procedure took less than one minute to accomplish, slightly longer than it would take to measure the base curve of a hard lens with a radiuscope.

Repeatability was quite good with this device. The standard deviations in the summary table verify this. The Permaflex had the best repeatability, while the American Hydron 04 demonstrated the least repeatability.

Six of the seven lenses tested consistently measured flatter than the labeled base curve value. There are several possibilities that may account for this finding. It is probable that the lenses were actually flatter than the labeled value. Previous studies have reported that the lathe cutting process often produces a flatter than indicated base curve(4,6). Other studies have found that the majority of the spincast lenses measured flatter than specified by the company (7). This may be attributed to the aspheric design of the spincast lens. Due to the flattening in the periphery of an aspheric curve, the sagittal depth will be less than a spherical lens with a base curve radius of the same radius as the apical radius of the aspheric. Another possibility is that the lenses were flexing slightly during the measurement procedure, although the repeatability would not be expected to be as good if this were the case.

The American Hydron 04 molded lens was the only lens to consistently measure steeper than the labeled base curve radius. If the bubble trapped under the lens was too large, or if more than one bubble was trapped it may have caused the lens to float off the pedestal slightly, increasing the steepness of the reading. This is a possible explanation for this finding. It interesting to note that this lens also had the least repeatability of the seven lenses tested.

The back optical diameter of the lens can also introduce error. If the zone is smaller than the pedestal chord diameter, than the sagittal depth measured will be artifically low giving a flater reading then the actual base curve radius of the lens. This should not affect the repeatability of the readings, however, will not give the correct, actual radius.

CONCLUSION

The base curve radius is an important fitting parameter, and one of the most difficult to verify. Although a wide variety of soft lens base curve measurement devices have been proposed, none have enjoyed widespread acceptance. This was usually due to the expensive nature of the instrumentation, the poor repeatability of the measurements, or difficulty in utilizing the device.

The Betron Base Curve Analyzer can be used to measure soft contact lens base curves with clinical acceptable accuracy and reliability. The device is relatively easy to use. The results obtained in this study indicate that this device can indeed play an important role in the verification of the base curve radius of hydrogel contact lenses.

Table 1 BAUSCH & LOMB O3

LENS #	1	2	3	4	5	6
POWER	-2.00	-2.25	-2.50	-2.75	-3.25	-3.50
MEAN SAG.	1.827	1.833	1.837	1.855	1.892	1.878
S.D. SAG.	0.056	0.060	0.064	0.042	0.036	0.043
MEAN RADIUS	9.192	9.168	9.152	9.081	8.940	8.993
S.D. RADIUS	0.218	0.232	0.245	0.159	0.131	0.159

Table 2 BAUSCH & LOMB U4

LENS #	1	2	3	4	5	6
POWER	-2.25	-2.50	-3.25	-3.25	-3.50	-3.75
MEAN SAG.	2.387	2.350	2.395	2.386	2.397	2.378
S.D. SAG.	0.064	0.052	0.023	0.028	0.161	0.027
MEAN RADIUS	8.734	8.835	8.713	8.737	8.708	8.758
S.D. RADIUS	0.165	0.140	0.059	0.073	0.392	0.071

Table 3 BAUSCH & LOMB U3

LENS #	1	2	3	4	5	6
POWER	-1.50	-1.75	-2.00	-3.00	-3.25	-3.75
MEAN SAG.	1.797	torn	1.843	1.855	1.863	1.827
S.D. SAG.	0.020	----	0.069	0.049	0.037	0.042
MEAN RADIUS	9.315	----	9.128	9.081	9.050	9.192
S.D. RADIUS	0.082	----	0.261	0.185	0.139	0.165

Table 4 BAUSCH & LOMB B3

LENS #	1	2	3	4	5	6
POWER	-1.75	-2.25	-2.50	-2.75	-3.00	-3.25
MEAN SAG.	1.755	1.765	1.735	1.722	1.748	1.774
S.D. SAG.	0.044	0.045	0.014	0.027	0.023	0.027
MEAN RADIUS	9.496	9.452	9.585	9.644	9.527	9.413
S.D. RADIUS	0.189	0.191	0.063	0.220	0.101	0.114

Table 5 HYDRON 06

LENS #	1	2	3	4	5	6
POWER	-2.25	-2.25	-2.50	-2.50	-3.00	-3.25
MEAN SAG.	2.185	2.132	2.157	2.138	2.207	2.178
S.D. SAG.	0.031	0.026	0.031	0.015	0.034	0.030
MEAN RADIUS	9.330	9.509	9.423	9.488	9.259	9.353
S.D. RADIUS	0.099	0.089	0.102	0.051	0.106	0.097

Table 6 HYDRON 04

LENS #	1	2	3	4	5	6
POWER	-2.25	-2.50	-2.50	-2.50	-2.75	-3.00
MEAN SAG.	2.135	1.985	2.013	2.008	2.017	1.890
S.D. SAG.	0.056	0.049	0.094	0.018	0.139	0.057
MEAN RADIUS	8.152	8.612	8.520	8.536	8.507	8.948
S.D. RADIUS	0.153	0.159	0.288	0.301	0.414	0.206

Table 7 PERMAFLEX

LENS#	1	2	3	4	5	6
POWER	-2.25	-2.50	-2.75	-2.75	-2.75	-3.00
MEAN SAG.	2.193	2.187	2.218	2.187	2.187	2.183
S.D. SAG.	0.022	0.019	0.034	0.008	0.015	0.018
MEAN RADIUS	9.304	9.324	9.224	9.324	9.324	9.337
S.D. RADIUS	0.070	0.061	0.105	0.026	0.049	0.058

Table 8 SUMMARY OF RESULTS

	labeled BCR	measured BCR	s.d.	c.t.	% water
B & L 03	8.9	9.088	0.102	0.035	38.6
B & L U4	8.5	8.748	0.046	0.070	38.6
B & L U3	8.6	9.153	0.105	0.070	38.6
B & L B3	9.0	9.520	0.085	0.120	38.6
HYDRON 06	8.7	9.394	0.097	0.060	38.0
HYDRON 04	8.6	8.546	0.254	0.040	38.0
PERMAFLEX	8.7	9.306	0.042	0.145	70.0

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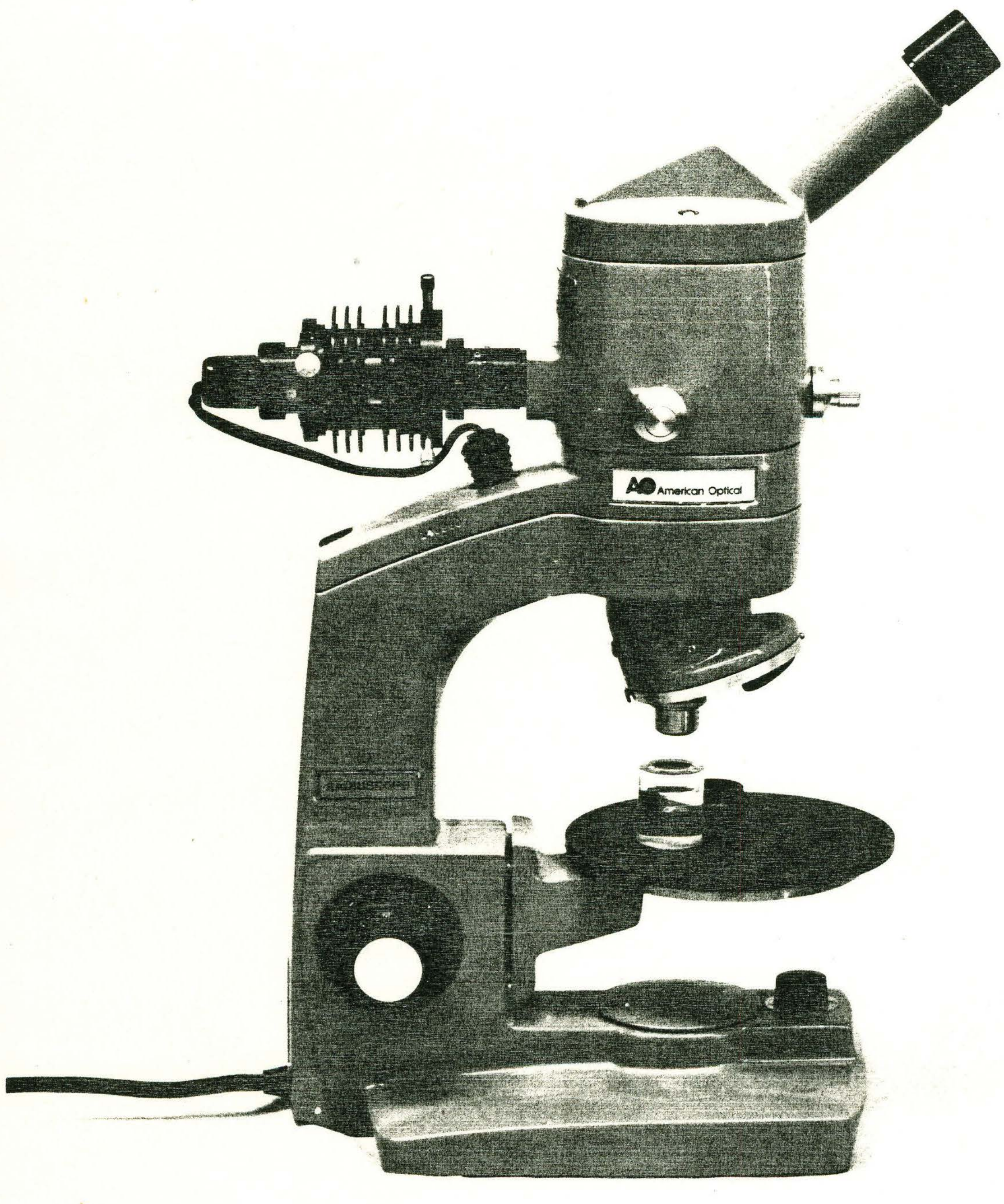
Captions

Figure 1. The Betron Base Curve Analyzer is shown positioned under the radiuscope.

Figure 2. A close-up of the wet cell showing the lens positioned on the pedestal with a small bubble under the center of the lens. The screw at the right is turned to create the bubble under the lens.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