A study of the effect of vertical prism in contact lenses as related to changes in vertical testing

Richard R. Gregory  
Pacific University

Richard D. Hehn  
Pacific University

Duane G. Milton  
Pacific University

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A study of the effect of vertical prism in contact lenses as related to changes in vertical testing

Abstract
There is a lack of information as to the effect of vertical prism in contact lenses upon the vertical system. The purpose of this study is to relate the prism power worn to the Von Graefe and Maddox Rod vertical phorias at far.

Degree Type
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A STUDY OF THE EFFECT OF VERTICAL PRISM IN CONTACT LENSES AS RELATED TO CHANGES IN VERTICAL TESTING

CLINIC YEAR PROJECT

BY

Richard R. Gregory
Richard D. Hehn
Duane G. Milton

In Partial Fulfillment of the Requirements of the Degree of Doctor of Optometry

Pacific University
January, 1965
ACKNOWLEDGEMENTS

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STATEMENT OF PROBLEM

There is a lack of information as to the effect of vertical prism in contact lenses upon the vertical system. The purpose of this study is to relate the prism power worn to the Von Graefe and Maddox Rod vertical phorias at far.

REVIEW OF LITERATURE

Neal Bailey, in an article, "Special Contact Lenses and Their Application", has suggested the use of vertical prism in contact lenses for the compensation of vertical imbalance. He states that the maximum amount of prism that can be produced in a wearable contact lens is approximately three prism diopters. Since it can be used only in the base down position, it is necessary to place the prism lens before the hyperphoric eye.¹

Soper, Girard and Sampson state:

"The use of these lenses to secure a prismatic effect optically has met with little success. First, a thin ophthalmic prism with a given power in air has only about one fourth of the original deviating power when placed in contact with a medium having an index of refraction equal to that of tears.

Consequently, a corneal contact lens that has six diopeters of deviation power as measured with a lensometer in air would theoretically have approximately one and one half diopeters of potential deviating power when in contact with the eye.

¹. Grosvenor, T.P. Contact Lens Theory and Practice. 343.
Second, when the lens is in contact with the eye, a new optical condition is established for the lens-eye combination. When the prism is combined with the eye in order for a constant prismatic deviating effect to result, not only is it necessary for these separate optical units to have their optic axis decentered by a constant amount, but also the prism must maintain a constant angular orientation about its axis. Since these conditions are not feasible with corneal contact lenses, there will be a highly variable optical prismatic effect ranging from a fraction of the indicated power in air to two or three times this value, depending upon the orientation of this prism on the eye."

Vodnoy refers to a patient that revealed six diopters of left hyperphoria at far and five diopters of left hyperphoria at near. He reported the patient was "successfully fitted" with contact lenses having only two and three quarters prism diopters in the left lens.

PROCEDURE

Twenty four contact lenses were employed in this study. Their base curves ranged from 42.00 diopters to 45.50 diopters in one half diopter steps. Each base curve was made with one, two and three diopters of prism. Tolerance for verification was plus or minus .37 for sphere and prism powers.

Thirty subjects were selected from the Pacific University Optometric Clinic files having corneal readings with the range of the trial set described above.

With the subject seated, the interpupillary distance was measured and eye dominancy was determined. The phoropter was adjusted to the patient's interpupillary distance, and then aligned horizontally. This was done by

2. Girard, L. J. (Editor) Corneal Contact Lenses. 290291.
aligning the Purkinje's image of the anterior surface of the crystalline lens with the cylinder axis indicators of the phoropter positioned at 180°.

With the Maddox Rod, two distant vertical phoria measurements were used to instruct the subject. Three additional vertical phoria measurements were then taken with the measuring prism before the right eye and recorded. This procedure was repeated measuring the left eye.

Next, two series of five Von Graefe vertical phoria measurements were taken. The first five were taken with the measuring prism before the right eye with the left eye fixating a single 20/20 line of letters at eighteen feet. The second series of five were taken with the left eye measuring and the right eye fixating. The last three phoria measurements in each series were recorded.

In the next part of the procedure, the dissociating prism was removed and a series of alternating supra and infra-duction were taken beginning with the right supra duction. Five of each were taken, however, only the last three were recorded.

The interpupillary distance was adjusted for near. Using the same procedure as at far, but with the near target (illustration number 1) set at sixteen inches, vertical phorias and vertical ductions were taken using the Von Graefe technique.

The subject's habitual contact lens was removed from the dominant eye and keratometer readings were taken. A one prism diopter contact lens
with a base curve near the flattest meridian was then placed on the dominant eye. This was done while seated in the examining chair. The subject was not allowed to move from his seated position. However, no other attempt was made to inhibit adaptation to the vertical prism.

After the phoropter was repositioned, the prism base orientation and rotation was observed using "Lumicon" markings on the prism base and the cylinder axis indicators. If rotational movement of greater than fifteen degrees was observed the subject was rejected.

20/20 acuity at far was established by the red green test in the eye wearing the experimental lens.

The phorias and ductions at far and near were repeated. Upon completion of each sequence the location of the prism base was again noted. This entire sequence was also performed with the subject wearing a two and a three prism diopter contact lens.

$y = \frac{\Delta y}{\Delta x} = 8/6$
\[ l_y = \frac{\sum x y}{\sum x^2} = 1.055 \]
FORMULII UTILIZED

\( \langle x^2 \rangle = \langle x^2 \rangle - (\langle x \rangle)^2/n \)

\( \langle y^2 \rangle = \langle y^2 \rangle - (\langle y \rangle)^2/n \)

\( \langle xy \rangle = \langle xy \rangle - (\langle x \rangle \cdot \langle y \rangle)/n \)

Correlation Coefficient:

\[ r = \frac{\langle xy \rangle}{\sqrt{\langle x^2 \rangle \cdot \langle y^2 \rangle}} \]

Regression Line

\[ \hat{y} = b_y x \]

\[ b_y = \frac{\langle xy \rangle}{\langle x^2 \rangle} \]

Standard Error of Estimate:

\[ \sigma_{y|x} = \sqrt{(\langle y - \hat{y} \rangle)^2/n - 2} \]

Mean:

\[ \overline{x} = \frac{\sum x}{n} \]

Median:

\( \text{Md} = 1 + \frac{(n/2 - f_b/f_w)}{f_w}i \)

Variance:

\[ \sigma^2 = \frac{\sum y^2}{n} \]

Standard Deviation:

\[ \sigma = \sqrt{\frac{\sum y^2}{n}} \]

\[ s = \sqrt{\frac{\sum y^2}{n - 1}} \]
## STATISTICAL SUMMARY

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<th>prism</th>
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<th>$Y$</th>
<th>MdnY</th>
<th>$n$ responses</th>
<th>% responses per 1</th>
<th>$s$</th>
<th>$r$</th>
<th>Sy•X</th>
<th>by</th>
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DISCUSSION

A variation in the mean response to a given stimulus was observed between the two methods of testing. All responses of the two tests were less than the prism worn and only the mean responses of the Von Graefe method indicated a possible proportional progression.

The percentages of the sample falling within one standard deviation were equal (see statistical summary) for the Von Graefe and Maddox techniques while wearing the one prism diopter lens. It may be an indication of usefulness of this magnitude as a therapeutic device. Disparities between the two measurement methods and three prism dipters are as follows:

Maddox Rod2 = 63%; Von Graefe2 = 65%; Maddox Rod3 = 76%, and Von Graefe3 = 65%. Possible factors effecting this disparity are mentioned below.

The standard deviation increases as the amount of prism was increased. The deviation in responses for the several stimuli variables did not change proportionally to the prism worn.

In the scattergram the slope of the Von Graefe regression line indicates a trend toward a unit relationship between the prism worn and prism measured. However, the Maddox Rod shows a greater disparity in response.

There are wide variations in subjective responses to the prism worn, as indicated in the included graphs. Some subjects showed a reverse phoria pattern to the one expected. After the subject and lens positions were checked, the findings were retaken and recorded.
Possible sources of error:

One possible source of error may have been changes in the subject's position during the initial testing and subsequent tests. As acuity correction was made, prism may have been induced by the lenses in the phoropter. This amount of prism could also have varied with the subject's head movement.

A more elaborate contact lens library containing the corrective powers for the subjects along with the variation of prism powers and base curves would have been desired in this study.

The subjects were allowed binocular exposure proceeding and during testing. As a result, some degree of adaptation may have taken place. They were not, however, allowed to walk while wearing the lenses.

While prism base positioning was observed before and after testing, the rotational movement during testing was difficult to observe.

Since the same phoropter was used for all patients, discrepancies in the vertical positioning of the rotary prism and that of its marking would result in a constant error. The three values recorded represent two from the base down to alignment and only one from the base up directions.

The inherent looseness of the gear mechanism of the rotary prism may also induce some error.

Upon repetition of this study it is suggested the above mentioned items be considered.
Bibliography


Vodnoy, Bernard E. "The Use of Prism B.H.A. Contact Lenses With Triple Truncation in Hyperphoria," Ophthalmic Weekly, LIV #45 (Nov. 7, 1963)