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Abstract

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DOES ACCIDENTAL PHOROPTER TILT HAVE A SIGNIFICANT EFFECT ON DETERMINATION OF CORRECTING CYLINDER?

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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE DOCTORATE OF OPTOMETRY.

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Approved by Niles Roth

Advisor

INTRODUCTION

The aim of this study is to determine if there is a significant effect on cylindrical power and axis determination with two and one-half and five degree phoropter tilt about an axis perpendicular to the frontal plane.

In our review of the literature we have not found any mention of phoropter tilt and its effect on correcting cylinder determination. We have written to Robert E. Bannon of American Optical Company (1972) in hopes of securing additional background information on previous works in this area. He has informed us that he knows of no such work. He mentions phoropter tilt around the X axis, and its effect on aphakic prescriptions.

HYPOTHESIS

It would be expected that a phoropter tilt of two and one-half degrees will produce a significant change of cylindrical power and/or axis, whereas a more noticeable tilt of five degrees will produce a greater error.

METHODS & MATERIALS

Our equipment consisted of a plastic protractor to which was attached a piece of wood with dimensions of 12x1x3/8 inches. The point of attachment at the mid point of the 0-180 base line of the protractor was accomplished by a small bolt, washer and nut assembly. This enabled the slat of wood, which was centered about the nut-bolt assembly, to rotate through the 180 degree arc of the protractor. A bisecting vertical line was inscribed on the slat. This was to facilitate the reading of the protractor scale. A small bubble level from a phoropter was fastened to the top of the slat by contact cement. The level was centered about the vertically inscribed line (Fig. 1).

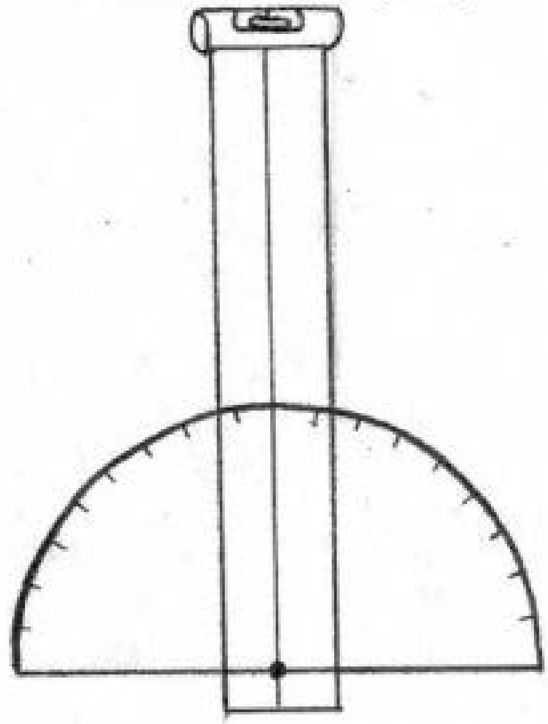

Fig. 1

In this experiment, the instrument used was a Bausch and Lomb Green's Refractor. The subject was seated in the examining chair and the head rest was adjusted to maintain the head in a constant vertical position throughout the test. The phoropter was aligned so the ocular portals were centered about the subject's eyes. Our measuring device was then placed upon the two perpendicular posts that hold the rotary prisms, cross cylinders, and maddox rod. The device was applied in such a manner that the 0-180 degree baseline of the protractor rested upon these posts. The slat of wood was now rotated through the 180 degree arc of the protractor until the bubble in the level was centered. In all our subjects this "level" position corresponded to the 90 degree mark on the protractor. This indicated that there did not appear to be any anatomical displacement between the two eyes of each of our subjects. At this point an astigmatic clock dial, red green (Bichrome) test, and Jackson Cross Cylinder for refinement of axis and power were applied. These findings were recorded as our "level" readings. The phoropter was then tilted 2.5 degrees to the clinician's right. This was accomplished by rotating the slat 2.5 degrees counterclockwise of the 90 degree position of the protractor, then the phoroptor was tilted to the right until the bubble in our measuring device was centered. At this point the subject was instructed not to tilt his head to compensate for the phoropter tilt. The J.C.C. procedure was performed starting with the "level" finding in place. This new finding was recorded as our 2.5 degree right finding. The same procedure was done for a 5 degree right, 2.5 degree left, and 5 degree left phoropter tilt.

The eight subjects in this experiment were Pacific University Optometry students, ranging in age from 24 to 34 years. The subjects were senior optometry students, well trained and experienced for this type of testing. They had previous knowledge of the aim of this experiment. They were selected according to the following criteria: The subjects were to have no existing pathology. In addition, the subjects were chosen on the basis of their degree of astigmatic correction. Two subjects had cylinder of the magnitude of one-half diopter. Three subjects had between one and two diopters of cylinder, and three had over two diopters of correction.

DATA WORKUP AND RESULTS

Cylinder powers for each eye were standardized, where necessary, by calculating the 90° or 180° component depending on which of these was closer to the power meridian of the given cylinder. Thus, these standardized values automatically took into account shifts of cylinder axis associated with phoropter tilt. For example, for a level finding of -5.75DC ax 20, the power in the 90° meridian is -5.08D (Subj. D.G., O.D.). With 5° left phoropter tilt the cylinder correction became -5.50DC ax 15 or -5.13D in the 90° meridian. The difference between level reading and 5° left tilt reading is, therefore, -0.05D in the 90° meridian. This calculation was done for all cylinder corrections equal to or greater than 1.00D, and the differences were tabulated (Table I). Corrections of several eyes were less than 1.00DC. These were not included in the workup, but are listed on the data sheet as indicators of the retest variations, i.e., a test for possible unforseen artifacts.

A nondirectional t test of the significance of differences between all 5° tilt readings and corresponding level readings ($n = 20$), indicates that the obtained differences would probably occur about 8% of the time from random causes alone. This inference pertains to cylinder powers ranging from 1.00D to 5.75D with a mean and standard deviation of 2.00D and 1.38D, respectively. The same test applied to the $2\frac{1}{2}$° readings indicated that the obtained amounts of cylinder change, with this much tilt, would probably occur randomly about 16% of the time.

DISCUSSION

The foregoing analysis of results with this sample leads to the inference that phoropter tilt of $2\frac{1}{2}^{\circ}$, right or left, probably has negligible effect on determination of correcting cylinder. This conclusion is based on the estimated probability of occurrence of the observed differences from only random causes, 16%. However, accidental phoropter tilt of 5° appears to have a more significant effect on correcting cylinder (8% level of significance).

These conclusions may seem surprising until one realizes that tilting a phoropter around its pivot, which is a considerable distance from the eye's axis, has more of a decentering than a torsional effect on the correcting cylinder. This is so even if the phoropter is steady, and the patient tilts his head. In any case, excessive tilt should be avoided, and precautions should be taken during the examination to ensure that the initial alignment remains unchanged. This is particularly important when using a phoropter that has a friction lock, since slippage of this kind of lock can occur during examination. A further safeguard against misalignment is the use of a headrest.

Uncertainty about the suitability of a cylinder correction for a given patient can be reduced further by following Borish's suggestions for using a trial frame. The tentative correction is put into the trial frame and the patient wears it for specific activities. Any needed modifications should be made in the trial frame until the correction is found acceptable.

Since this study seems to be the avant garde in this area, further study is indicated, using larger samples.

TABLE I

Level Readings and 5° Phoropter Tilt Values

L = Level Rdg. T_R = Rt. Tilt Val. T_L = Lt. Tilt Val.

θ = Angle between Std. Merid. (90 or 180) and Cyl. Axis

P_{90} = Pwr. @ 90 P_{180} = Pwr. @ 180 d = Diff. between standardized power @ 90 or 180 and standardized Level Rdg.

$$P_\theta = P_{cyl} \times \sin^2\theta$$

	L	θ	P_{180} or P_{90}	T_R	θ	(1) P_{180} or P_{90}	T_L	θ	(2) P_{180} or P_{90}	d_1	d_2
G.N. O.S.	$\bar{1}.50 \times 173$	83	$\bar{1}.48$	$\bar{1}.75 \times 165$	75	$\bar{1}.64$	$\bar{1}.75 \times 163$	73	$\bar{1}.60$	$\bar{0}.16$	$\bar{0}.12$
J.M. O.S.	$\bar{1}.50 \times 175$	85	$\bar{1}.49$	$\bar{1}.25 \times 180$	90	$\bar{1}.25$	$\bar{1}.75 \times 175$	85	$\bar{1}.74$	$^+0.24$	$\bar{0}.25$
G.W. O.S.	$\bar{1}.00 \times 100$	80	$\bar{0}.98$	$\bar{2}.00 \times 102$	88	$\bar{2}.00$	$\bar{0}.75 \times 110$	70	$\bar{0}.66$	$\bar{1}.02$	$^+0.32$
A.D. O.S.	$\bar{1}.75 \times 83$	83	$\bar{1}.73$	$\bar{2}.25 \times 88$	88	$\bar{2}.25$	$\bar{2}.00 \times 80$	80	$\bar{1}.94$	$\bar{0}.62$	$\bar{0}.21$
I.S. O.S.	$\bar{2}.25 \times 172$	82	$\bar{2}.20$	$\bar{2}.75 \times 174$	84	$\bar{2}.72$	$\bar{2}.75 \times 165$	75	$\bar{2}.57$	$\bar{0}.52$	$\bar{0}.37$
D.G. O.S	$\bar{1}.50 \times 10$	80	$\bar{1}.46$	$\bar{1}.75 \times 20$	70	$\bar{1}.55$	$\bar{1}.25 \times 10$	80	$\bar{1}.22$	$\bar{0}.09$	$^+0.33$
G.N. O.D	-1.00×83	83	$\bar{0}.97$	$\bar{1}.00 \times 90$	90	$\bar{1}.00$	$\bar{1}.25 \times 80$	80	$\bar{1}.18$	$\bar{0}.03$	$\bar{0}.21$
J.M. O.D.	$\bar{1}.50 \times 3$	87	$\bar{1}.49$	$\bar{1}.75 \times 5$	85	$\bar{1}.72$	$\bar{2}.00 \times 3$	87	$\bar{1}.98$	$\bar{0}.23$	$\bar{0}.49$
I.S. O.D.	$\bar{2}.00 \times 180$	90	$\bar{2}.00$	$\bar{1}.75 \times 5$	85	$\bar{1}.72$	$\bar{2}.25 \times 174$	84	$\bar{2}.21$	$^+0.28$	$\bar{0}.21$
D.G. O.D	$\bar{5}.75 \times 20$	70	$\bar{5}.08$	$\bar{5}.25$	70	$\bar{4}.64$	$\bar{5}.50 \times 15$	75	$\bar{5}.13$	$^+0.44$	$\bar{0}.05$

$n = 20$, $\sqrt{n} = 4.47$, $\Sigma d^2 = 2.91$, $\Sigma d = -2.97$, $\bar{d} = \bar{0}.15$

$s_d^2 = 0.13$, $s_d = 0.36$

$$t = \frac{\bar{d}\sqrt{n}}{s_d} = \frac{\bar{0}.15 \times 4.47}{0.36} = 1.86$$

Signif. at 8% Level

$t_{19 d.f.}$	α
1.73	0.10
1.86	0.08
2.09	0.05

.36, .13; 0.05; $x = 0.02$

$$x = \frac{0.05 \times .13}{.36} \cong 0.02$$

DATA SHEET
(Recorded OD/OS)

G.N.

5L -1.25 X 80 / -1.75 X 163

2.5L - 1.25 X 75 / - 2.00 X 160

Level -1.00 X 83 / -1.50 X 173

2.5R -75 X 85 / -1.75 X 165

5R -1.00 X 90 / -1.75 X 165

J.M.

5L -2.00 X 2 1/2 / -1.75 X 175

2.5L -2.00 X 2 1/2 / -1.25 X 172 1/2

Level -1.50 X 2 1/2 / -1.50 X 175

2.5R -1.50 X 2 1/2 / -1.50 X 172 1/2

5R -1.75 X 5 / -1.25 X 180

G.W.

5L -1.25 X 130 / -.75 X 110

2.5L -.75 X 89 / -.75 X 103

Level -.75 X 95 / -1.00 X 100

2.5R -.75 X 100 / -1.50 X 100

5R -.50 X 100 / -2.00 X 102

A.D.

5L -.50 X 115 / -2.00 X 80

2.5L -.50 X 117 1/2 / -2.25 X 80

Level -.50 X 120 / -1.75 X 82 1/2

2.5R -.50 X 117 1/2 / -2.00 X 90

5R -.50 X 117 1/2 / -2.25 X 87 1/2

<u>I.S.</u>

5L -2.25 X 174 / -2.75 X 165

2.5L -2.25 X 179 / -2.75 X 172

Level -2.00 X 180 / -2.25 X 172

2.5R -1.75 X 3 / -2.50 X 175

5R -1.75 X 5 / -2.75 X 174

<u>R.B.</u>

5L -.50 X 160 / -.25 X 35

2.5L -.75 X 165 / -.25 X 25

Level -.75 X 165 / -.25 X 20

2.5R -.50 X 167 / -.50 X 112

5R -1.25 X 155 / -.75 X 14

<u>D.G.</u>

5L -5.50 X 15 / -1.25 X 10

2.5L -5.00 X 20 / -1.50 X 10

Level -5.75 X 20 / -1.50 X 20

2.5R -5.50 X 20 / -1.75 X 20

5R -5.25 X 20 / -1.75 X 20

<u>M.S.</u>

5L Pl / -.75 X 171

2.5L -.25 X 135 / -.75 X 12

Level -.25 X 110 / -.75 X 180

2.5R -.25 X 130 / -.75 X 175

5R -.25 X 121 / -.50 X 10

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