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The Hirschberg Test: A Double-Masked Clinical Evaluation

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ABSTRACT

Though the Hirschberg test has been used for over a 100 years, several different formulas are still being recommended and used clinically to determine the amount of a given ocular deviation. The purpose of this study was to obtain a double-masked clinical evaluation of the Hirschberg test. Several strabismic patients were evaluated by one investigator using the alternate cover test and by another investigator using a photographic Hirschberg procedure in a double-masked procedure. It was determined that the Hirschberg test can be used for strabismic patients of all ages and that the most appropriate formula to use is 1 mm = 22 Δ.

Key Words: Hirschberg test, strabismus measurement, corneal light reflex, strabismometry

The Hirschberg test is a commonly used clinical procedure for estimating the relative position of the lines of sight in a strabismic patient when the cover test, or other more definitive procedures, cannot be utilized effectively. The relative positions of the lines of sight, or the amount of the ocular deviation, are determined by assessing the displacement of the corneal light reflex from the angle κ position in the deviating eye, and then using a formula to obtain the amount of the ocular deviation in prism diopters (Fig. 1). The angle that is really used is angle λ. Clinically, however, the difference in the two angles is insignificant.[1]

The original description of the Hirschberg test was given in a paper by Hirschberg in 1885.[2] He discussed the use of the test by dividing patients with ocular deviations into five groups depending on the location of the corneal light reflex in the deviating eye—in the pupil but not centered, at the pupil margin, halfway to the limbus, at the limbus, and beyond the limbus. Two of these groups can be used to determine a numerical relation between the ocular deviation and the corneal light reflex displacement, a Hirschberg formula. Hirschberg stated that if the reflex is at the pupillary margin (3.0 mm pupil), the ocular deviation would be from 12° to 15°. Using these figures, and assuming an angle κ of zero, the amount of ocular deviation per millimeter of displacement of the corneal light reflex would be from 1 mm = 13.96 Δ to 1 mm = 17.45 Δ. Hirschberg also stated that if the corneal light reflex is at the limbus, the ocular deviation would be 45° to 50°. Using a 12-mm iris, and these figures, the Hirschberg formula would be from 1 mm = 13.08 Δ to 1 mm = 14.54 Δ.

du Bois-Reymond, an assistant in the Hirschberg clinic, also published a paper discussing the "reflex test" in 1886.[3] He did not discuss or propose a specific formula either, but he did indicate that if a patient had a 3.5-mm pupillary diameter and if the corneal light reflex appeared to be on the pupillary margin, the ocular deviation would be 20°. Using this information, and assuming an angle κ of zero, the amount of

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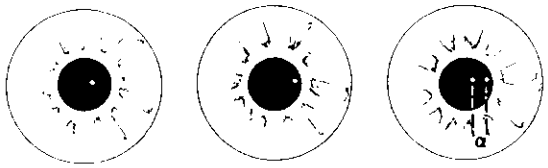

FIG. 1. Procedure for determining the relative positions of the lines of sight using the Hirschberg test. Determine the location of the corneal light reflex when the eye is fixating (angle κ position), and when the eye is deviated. Multiply this displacement of the corneal light reflex by a Hirschberg formula.

ocular deviation per millimeter of displacement of the corneal light reflex would be 19.9 Δ.

From Hirschberg's and du Bois-Reymond's data, three approximate formulas relating the amount of the displacement of the corneal light reflex from the angle κ position to the amount of the ocular deviation can be determined.

1 mm = 13.9 Δ
1 mm = 17.5 Δ
1 mm = 19.9 Δ

Although the Hirschberg test is a commonly used clinical procedure, no single formula has been accepted generally and utilized clinically. Several formulas have been proposed over the years to determine the amount of the ocular deviation from the amount of the displacement of the corneal light reflex. These formulas are:

Krimsky[4]	1 mm = 12.2 Δ
Brown[5]	1 mm = 13.1 Δ
Scobee[6]	1 mm = 14.0 Δ
Flom[7]	1 mm = 14.5 Δ (average)
Brodie[8]	1 mm = 21 Δ
Wick and London[9]	1 mm = 21.5 Δ
Jones and Eskridge[10]	1 mm = 22 Δ
Griffin and Boyer[11]	1 mm = 22.6 Δ (average)

As indicated, the Hirschberg test is a clinical method for estimating the amount of the ocular deviation, so that minor differences in the formulas would not be that significant. If we combine those formulas that are similar, we essentially have two formulas:

1 mm = 13.5 Δ
1 mm = 21.8 Δ

This difference is significant. To be a reliable and clinically useful procedure, the appropriate formula needs to be determined. The purpose of this paper is to study the Hirschberg test in a clinical situation so that the most appropriate clinical formula can be determined.

METHODS

We decided to do another laboratory study of the Hirschberg test to evaluate our photographic procedure, and then do a double-masked clinical evaluation of the Hirschberg test. A procedure was developed to photograph the corneal light reflex at a fixation distance of 100 cm (Fig. 2). To accomplish the laboratory evaluation of the Hirschberg test, a patient with normal binocular vision and good visual acuity was placed in the head rest in front of the camera with one eye occluded, and directed to look at a cross-hair target in the center of the camera lens. A photograph was then taken of the corneal light reflex. The patient was then asked to fixate targets located 15, 25, 35, 45, 55, and 65 cm to the sides of the camera in eso and exo directions (Fig. 3). Photographs were taken at each fixation point. A photograph with the eye fixating the target at 35 cm in the eso direction is shown in Fig. 4.

To accomplish the double-masked clinical evaluation of the Hirschberg test, 15 strabismic patients having varying amounts of esotropia and exotropia were evaluated. All the patients had central fixation in the deviating eye. Each patient was placed in the head rest in front of the camera. The normally fixating eye was occluded, the patient was asked to fixate the cross-hair target in the center of the camera lens with the normally deviating eye, and a photograph was taken of the position of the corneal light reflex in the normally deviating eye (angle κ). The normally fixating eye was then uncovered, the patient was asked to fixate the cross-hair target in the center of the camera lens with the normally fixating eye, and a photograph of the position of the corneal light reflex in the normally deviating eye was taken. Photographs of one patient are presented in Fig. 5.

The subjective alternate cover test was then performed with the patient fixating the cross-hair target in the center of the camera lens. The alterate cover test measurements were done by one investigator (BW) and the evaluation of the Hirschberg test from the photographs was done by another investigator (JBE) with no exchange of information until the conclusion of the study.

RESULTS

The photographs of the normal patient taken with central and peripheral fixations were de-

FIG. 2. Photograph of the laboratory apparatus.

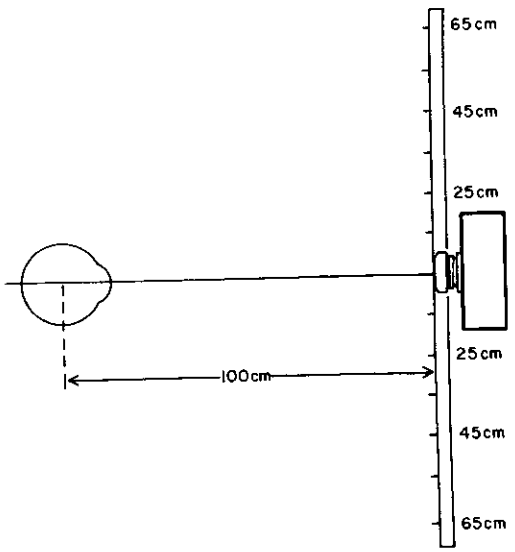

FIG. 3. Schematic drawing of the laboratory apparatus.

veloped. The displacement of the corneal light reflex from the angle κ position (position with central fixation) for each position of peripheral fixation was measured using the ruler that was photographed with each fixation position (see Fig. 4). These data are presented in Table 1. The average ocular deviation per millimeter of displacement of the corneal light reflex for these data is 22.74 Δ.

The values of the displacement of the corneal light reflex and the associated ocular deviation of the eye from the information in Table 1 are plotted in Fig. 6. The formula determined from the best fit straight line of the data ($r^2 = 0.999$) is 1 mm = 22.94 Δ.

The photographs of the positions of the corneal light reflex for the 15 squinters were developed, and the displacements of the corneal light reflex from the angle κ position were measured using the ruler in the photographs. These data and the corresponding alternate cover test measurements are presented in Table 2. The average ocular deviation per millimeter of displacement of the corneal light reflex for these data is 21.9 Δ. These data are also plotted in Fig. 7. The formula determined from the best fit straight line of these data ($r^2 = 0.979$) is 1 mm = 21.7 Δ.

DISCUSSION

The results of our laboratory evaluation of the Hirschberg test are very similar to those determined by Jones and Eskridge[10] and Brodie.[8] At least from a laboratory point of view, the appropriate formula for the Hirschberg test is 1 mm = 22 Δ.

The results of our clinical evaluation of the Hirschberg test are nearly the same as those determined by Wick and London.[9] Our patients were all adults, whereas Wick and London's patients were children from birth to age 5 years. This indicates that the same Hirschberg formula can be used for patients of all ages.

Our clinical results are also similar to the average results obtained by Griffin and Boyer.[11] Although they found a slightly higher formula for exotropes than for esotropes, they concluded that the 1 mm = 22 Δ formula is the most appropriate Hirschberg formula.

Wheeler[12] also did a study comparing the re-

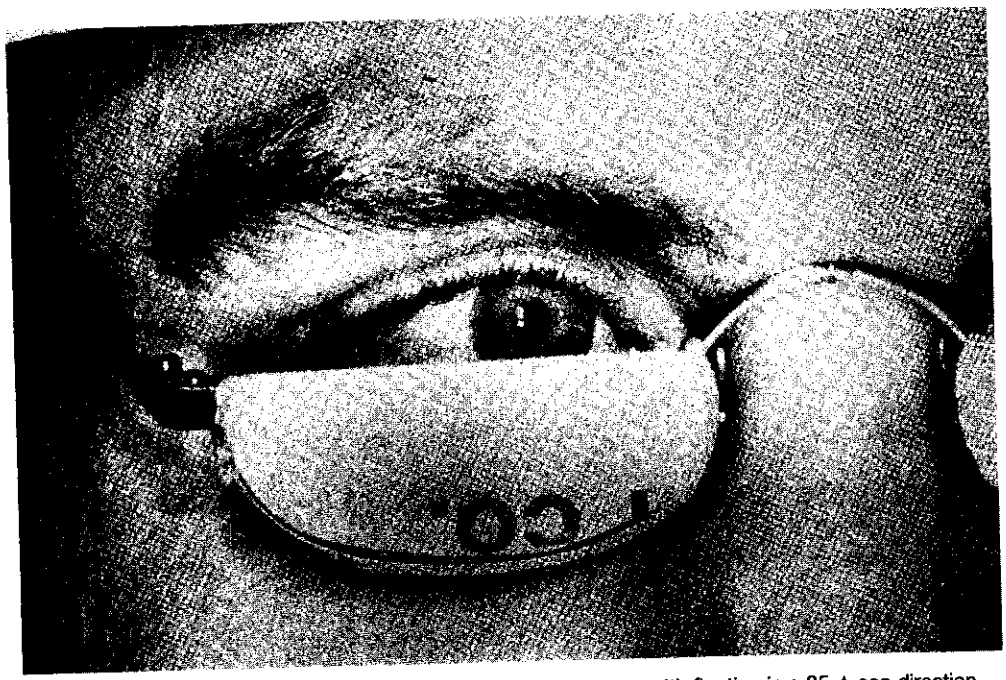

FIG. 4. Photograph of the corneal light reflex in a normal eye with fixation in a 35 Δ eso direction.

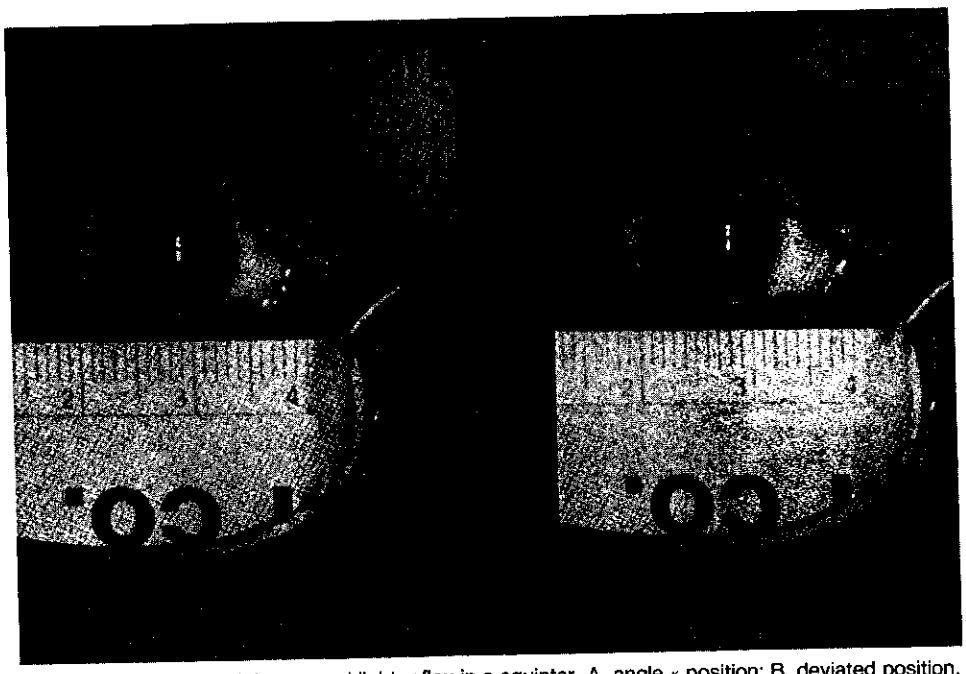

FIG. 5. Photograph of the corneal light reflex in a squinter. A, angle κ position; B, deviated position.

sults of the Hirschberg test with the results from the cover test for a number of strabismic patients. The average ocular deviation measured by the cover test was 47.1 Δ. The Hirschberg formula that he used was 1 mm = 14 Δ. The average ocular deviation measured by using this formula was 33.9 Δ. Wheeler attributed the difference between the two findings to the measurement conditions. The Hirschberg measurements were made under binocular viewing con-

TABLE 1. Displacement of the corneal light reflex from the angle κ position for various positions of ocular deviation of the eye of a normal patient.

Ocular Deviation (Δ)		Displacement of Corneal Light Reflex from Angle κ Position (mm)
Eso Direction	15	0.70
	25	1.20
	35	1.60
	45	2.00
	55	2.40
	65	2.80
Exo Direction	15	0.70
	25	1.10
	35	1.50
	45	2.00
	55	2.40
	65	2.70

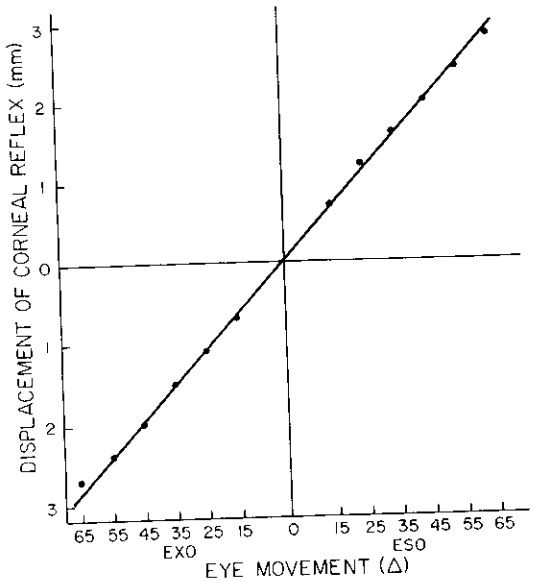

FIG. 6. Relation of the ocular deviation of the eye in prism diopters to the displacement of the corneal light in millimeters in a normal patient.

ditions, and the cover test measurements were made under monocular viewing conditions. However, if the formula for the Hirschberg test is changed to 1 mm = 19.46 Δ, the average Hirschberg measurement and the average cover test measurement for Wheeler's patients would be the same.

SUMMARY

The Hirschberg test is a commonly used clinical procedure for estimating the amount of ocular deviation in a strabismic patient. Though the test is commonly used, there is no formula that has been accepted generally and utilized clinically to determine the amount of the ocular deviation from the amount of displacement of the corneal light reflex from the angle κ position. At least eight formulas have been proposed over the years, in addition to those that can be determined from Hirschberg's and du Bois-Reymond's papers.

TABLE 2. Displacement of the corneal light reflex from the angle κ position in patients with strabismus of various amounts.

Ocular Deviation (Δ)		Displacement of Corneal Light Reflex from Angle κ Position (mm)
Exo	7	0.3
	12	0.6
	19	0.9
	25	1.0
	47	2.2
Eso	8	0.4
	11	0.5
	15	0.7
	17	0.7
	25	1.1
	25	1.1
	35	1.6
	36	1.8
	58	2.5
	60	2.9

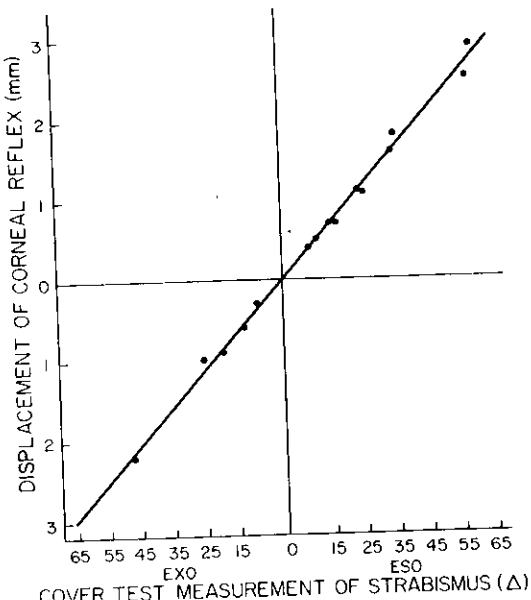

FIG. 7. Relation of the cover test measurement of strabismic patients in prism diopters to the displacement of the corneal light reflex in millimeters.

The results of this laboratory and double-masked clinical study indicate that the Hirschberg test can be used for esotropes and exotropes of all ages, and that the most appropriate formula to use with the Hirschberg test is: 1 mm = 22 Δ.

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