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The reliability of Mohindra's near retinoscopy in human infants (0-2 years)

Samuel Sompong Chia
Pacific University

Robert Hoch B. Michael Samek

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Abstract

Near retinoscopy as described by Mohindra is a non invasive, non cycloplegic technique for assessment of refractive error (R.E.) easily utilized with the pediatric population. The desirability of such a non invasive technique for the infant population is easily understood. The literature, however, is sparse for reliability and variability studies on an Infant population. An assessment of the variability on test retest by observer and between different observers on a pedriatric population, 0-2 years of age, was initiated. Each of 17 full term, healthy, non strabismic infants (28 eyes) were tested using the near retinoscopy technique by each of five trained clinical observers. Each observer performed the technique five times on each eye. The observer was blind to the neutralizing lens powers. All testing occurred over a 2 month period. As a control condition observers each neutralized 1 0 unknown power lenses 1 o times each on a fixed schematic eye. All experimental data was converted to equivalent spheres.

For the control condition, significant differences existed between observers for all lenses and the true power of each lens at the .05 level. The maximum mean difference from true lens power for any observer was .330 with a minimum difference of .220. Significance occurred due to very small variability by observers and was clinically insignificant. For the experimental condition no significant difference for range variability within observer was found. Mean R.E. ranges (D) (by subject) for observers varied from a minimum of .430 to a maximum of .960. Between observer ranges (by subject) showed significant differences at a .05 level for two of the 10 comparisons. ·Ranges of R.E. by subject for the 5 observers varied from a low of .870 to a high of 6.750. Mean R.E. data, by subject, between observers showed significant differences for one of the 5 examiners (4 of the 10 comparisons) at a .05 level.

The usefulness of near retinoscopy as a clinical technique in an infant population is questioned based on the inter observer differences in range and mean findings, and the magnitude of variability within and between observers. The variability may in large part be due to the interaction variables between clinicians and infants for any given examination.

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The Reliability of Mohindra's Near Retinoscopy in Human Infants (0-2 years)

Samuel Sompong Chia, Robert Hoch

B. Michael Samek

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advisor

Dr. Paul Kohl

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Abstract

Near retinoscopy as described by Mohindra is a non invasive, non cycloplegic technique for assessment of refractive error (R.E.) easily utilized with the pediatric population. The desirability of such a non invasive technique for the infant population is easily understood. The literature, however, is sparse for reliability and variability studies on an infant population. An assessment of the variability on test retest by observer and between different observers on a pedriatric population, 0-2 years of age, was initiated. Each of 17 full term, healthy, non strabismic infants (28 eyes) were tested using the near retinoscopy technique by each of five trained clinical observers. Each observer performed the technique five times on each eye. The observer was blind to the neutralizing lens powers. All testing occurred over a 2 month period. As a control condition observers each neutralized 10 unknown power lenses 10 times each on a fixed schematic eye. All experimental data was converted to equivalent spheres.

For the control condition, significant differences existed between observers for all lenses and the true power of each lens at the .05 level. The maximum mean difference from true lens power for any observer was .33D with a minimum difference of .22D. Significance occurred due to very small variability by observers and was clinically insignificant. For the experimental condition no significant difference for range variability within observer was found. Mean R.E. ranges (D) (by subject) for observers varied from a minimum of .43D to a maximum of .96D. Between observer ranges (by subject) showed significant differences at a .05 level for two of the 10 comparisons. Ranges of R.E. by subject for the 5 observers varied from a low of .87D to a high of 6.75D. Mean R.E. data, by subject, between observers showed significant differences for one of the 5 examiners (4 of the 10 comparisons) at a .05 level.

The usefulness of near retinoscopy as a clinical technique in an infant population is questioned based on the inter observer differences in range and mean findings, and the magnitude of variability within and between observers. The variability may in large part be due to the interaction variables between clinicians and infants for any given examination.

INTRODUCTION

Progress in the last twenty-five years in the area of electrophysiological, psychophysiological, and clinical studies on the mammalian visual system has completely revolutionized the basic theory regarding vision development. Experimental data from these studies support the conclusion that the need for an enriched early visual experience is a prerequisite for a normal perceptual-motor development in infants and young children. (1-9) The need for an early visual examination during infancy and early childhood is strongly emphasized as a preventative mean to ensure that no hindrance to a normal visual development is present. Early detection of visual anomalies can lead to early corrective intervention and facilitate normal development. Today, developmental optometrists are examining an increasingly greater number of pre-school children. The need for up-to-date information on the clinical procedures used in the pediatric vision exam and lens application techniques are greater than ever before. With a pediatric patient, standard optometric examination procedures used with the adult must be modified to accommodate for the children's response characteristics and temperment. A standard pediatric vision exam time is usually restricted because of the child's short attention span and lack of cooperation. Therefore, each exam procedure must be easy to perform, reliable and valid at the same time.

The assessment of infants and young children's refractive status, is an essential part of a comprehensive pediatric vision examination. The traditional means of determining young children's refractive error are static, dynamic and/or cycloplegic retinoscopy. (10)

Static retinoscopy is performed under a relaxed accommodative state, either under a controlled steady fixation of a large and slightly fogged bichrome target at distance, or under a drug induced cycloplegic condition.

During the static retinoscopy procedure, there are a number of uncontrollable variables which can greatly influence the final outcome of the refractive error measured. Since the fixation target during standard static distance retinoscopy lies beyond the young child or infant's "near manipulative space", this can easily cause unsteady fixation and unstable accommodative response of the fixing eye (11,12), thus, resulting in an erroneous refractive measurement. Another element which can alter the outcome of refractive measurement is the degrees which the measurement was taken off of the visual axis.

The use of a cycloplegic agent, on the other hand, induces a total, or near total relaxation of accommodation to ensure a dependable assessment of refractive error. However, parents are usually reluctant to expose their children to any drug agent in the apparent absence of medical abnormality. A small percentage of children are known to be at high risk of hyperactivity to cycloplegic agents (13), resulting in adverse ocular and systemic side effects. One major side effect of a cycloplegic agent is mydriasis, an enlargement of the pupil which causes an increase in spherical aberration. Ludlum (14) reported that off axis retinoscopy and the presence of spherical aberrations due to mydriasis could result in erroneous refractive measurement.

The use of dynamic retinoscopy as an objective means of assessing a distance refraction was also found to have some confounding variables. For example, the use of dynamic retinoscopy to determine the spherical component of refraction at near (15,16,17,) was flawed by the inconsistancy of the child's accommodative response, especially among young hyperopic children. Tait's (17) estimate of distant refraction with dynamic retinoscopy was based on an adjustment of the accommodative lag value on the dynamic neutrality value. The reliability and validity are questionable because of individual variations from the values of the standardized accommodative lag table.

Freeman and Hodd (18) reported that the cylindrical power and axis obtained by the dynamic retinoscopy method correlated well with those obtained by subjective refraction; however, they could not conclusively determine any significant correlations for the spherical component.

In 1975, Mohindra reported on a new, drug free retinoscopy procedure called "NEAR RETINOSCOPY." (10) It is designed for an objective assessment or estimate of distance refraction in infants and young children. Near retinscopy was introduced as a possible alternative to static, dynamic or cycloplegic procedures.

Mohindra's "near retinscopy" is performed on axis at a working distance of 50 cms. The non-fixing eye is occluded to inhibit possible interference of elements of convergence-accommodation. It is performed in a totally darkened environment with the retinoscope light serving as the fixation target. Lens bars are used to measure the refractive status of each principal meridian. The neutrality lens values in the two principal meridians are recorded and the gross sphere-cylinder (minus cylinder form) formula is derived from the meridional findings. An adjustmment factor of -1.25D is algebraically added to the spherical component of the gross sphere value (11). This adjustment factor was empirically derived by Mohindra (19) in an investigative study in which she compared the gross near retinoscopy values with those of subjective refraction of twenty-seven adult ametropes. The spherical component from the gross near retinoscopy consistantly showed on the average 1.25D more plus than the spherical component determined by subjective refraction. The adjusted near retinoscopy spherical values have a correlation coefficient of .98 when compared with the spherical component of the subjective refraction with adults, as reported by Mohindra.

Since the introduction of near retinoscopy, many other studies on this new procedure have been published.

The data from these studies have suggested that Mohindra's near retinoscopy is a reliable and valid procedure. A study was conducted by Owens et. al. (20), using both adult and infant subjects to determine the effectiveness of a retinoscope beam as an accommodative stimulus. Their results indicated that the retinoscope light source viewed under near retinoscopy conditions (monocular fixation) is not an effective accommodative stimulus. This confirmed earlier clinical observations by Mohindra and others that during near retinoscopy, accommodation remains virtually steady near its resting focus. Molinari & Mohindra (21) compared the results of near retinoscopy with the results of cycloplegic retinoscopy (using a 1% solution of tropicamide and 10% phenylephrine hydrochloride) on thirty-one young school children age 5 to 7 years. Their experimental data indicated that there is a good match between the two techniques. Furthermore, there was a high correlation between the refractive measurements obtained by the two experimenters. Borghi & Rouse (22) reported on a study in which they also compared the refractive error obtained by near retinoscopy with results of cycloplegic retinoscopy on twenty-one children ranging in age from 3.6 to 10 years. In this study, however, the cycloplegic agent used was 1% cyclogyl (cyclopentolate). Borghi & Rouse found that the average cycloplegic retinoscopy readings consistantly showed 0.50D to 0.75D more plus than near retinoscopy measurements. When they considered the "cut-factor" to adjust for the normal accommodative tonus which were eliminated under cycloplegic condition, the two procedures appear to have essentially the same result. This further validates Mohindra's near retinoscopy procedure.

Near retinoscopy has been well documented to be both a reliable and valid procedure for the determination of refractive error. Although it has been alluded to in the literatures that near retinoscopy is a useful

procedure for the determination of infant's and young children's refractive status, we, however, found no published study on the validity and reliability of the technique when used with an infant population (below age two), and only one paper, Maino et. al. (23), on a toddler population (18-36 months of age).

There is little data available to make one believe that the excellent correlation between near retinoscopy and tonus corrected cycloplegic retinoscopy in children below the age of two should be different from that above the age of two, but, the difficulty in maintaining attention and fixation in the pediatric patient below the age of two raises the question of how variable the near retinoscopy technique is both from clinician to clinician and on test retest situations.

This study has tried to answer two questions:

(1) What is the expected interclinician/intraclinician variability when the near retinoscopy procedure is used with an infant population (below the age of two)?

(2) What is the expected test, retest (intrasubject) variability when the near retinoscopy procedure is used with an infant population? And, If the near retinoscopy procedure is standardized among clinicians, what is the level of variation one can expect within a single subject?

METHODS

Subjects were ten infants ranging from 2 months to 23 months of age. All age calculations were based on gestational age and not chronological age, (due dates vs birth date). Nine of the infants were male and five were female. Ten of the fourteen infants completed the testing sequence with all five examiners. Approximately equal numbers of children were tested within the age ranges of 0 to 12 months and 12 to 24 months. The infants were all caucasian and children of optometry students at Pacific Unviersity College of Optometry.

Testing was conducted between 8 a.m. and 11:30 a.m.. The first visit was a general pediatric vision exam. This consisted of the infant's birth and due dates, history of the pregnancy and any complications, the infant's general health, family history of disease or ocular problems, preferential looking acuity, pupillary responses, monocular light reflex, Hirschberg test, entrance skills (eye movements and cover test), and ocular health assessment (ophthalmoscopy and external evaluation). Any infant failing to meet the expected norms in any of these areas, or having any ocular health problem was omitted from this study.

Five examiners took part in this study. A third year optometry student (M.S.) who had worked in the infant clinic for three years and had previously worked with infants. Three fourth year optometry students (R.H., F.G., and S.C.) who had no previous experience with testing of infants, and one faculty member (P.K.) who directs the infant/pediatric clinic.

As a control, retinoscopy on a Copeland schematic eye was performed through ten lenses of unknown powers. The schematic eye was neutralized for the fifty centimeter working distance. Each lens was neutralized, using retinoscopy, ten times in a random manner using four sets of (+) and (-) lens bars ranging in powers from +4.0 diopters in .50 diopter increments. The lens values were determined to the closest .25 diopter. Lenses in the lens bars were marked with letters rather than numbers to

minimize the memorization factor of the lenses. The lenses were neutralized in a random manner. All other lenses were neutralized before the same lens was again neutralized. The lenses were neutralized for power in each meridian with the letter designation for the lens and the axis recorded on a prepared form. Also recorded was the lens bar set used for each lens neutralization. Each examiner performed 100 lens neutralizations on the schematic eye. All examiners used the same model Welch-Allen retinoscope during the neutralizations from the fifty centimeter distance in a darkened room.

Testing of the infant's refractive error, using near retinoscopy, was performed with the infant comfortably seated on the lap of the parent across from the examiner. Two examiners were present in the room during the testing. Monocular testing was performed on all infants with a coverlet eye patch used for occlusion on the non-tested eye. The same four sets of (+) and (-) lens bars were used and handed to the examiner in a random manner in the darkened room, depending if he/she asked for a more (+) or more (-) lens power while neutralizing. Each eye was neutralized five times by each examiner and the letter designation in each meridian and the axis was recorded. Also recorded was the lens bar set used (I, II, III, or IV) after each neutralization. A confidence level of one, two, or three was then recorded; one being the most confident and three being the least confident. Each testing sequence lasted no more than 30 minutes, with several sittings required for each infant to complete the necessary data for all five examiners. Each data point used in the analysis represents the neutralizaiton of one eye.

Testing on all the infants took place over a two month period of time. Due to scheduling difficulties, some subjects were not seen within the one month period for all data collection as desired. For the purpose of statistical analysis, the control data was analyzed by meridian and the experimental data by equivalent sphere. An analysis of variants was used for statistical analysis with a Fisher PLSD (Protected Least Square Difference) used for a test of significance.

RESULTS

A comparison of observers mean retinoscopy values by meridian for all 10 lenses against the true lens power, using an ANOVA, indicates a significant difference at the ($P<.05$) level for all observers. A significant difference at the ($P<.05$) for the comparison of the means of differences from true lens power across the five observers was also found. The maximum dioptric mean difference from true lens power (for all 20 meridians) for any observer was .33D with a minimum of .22D. (Table 1) For the experimental condition, using an ANOVA, a comparison of mean range data within each observer, for all eyes, showed no significant difference at ($P<.05$). For any individual observer the maximum variability found on any eye was 3.5D with a minimum variability (after 5 trials) of 0.0 D. The mean range comparisons between each observer for all eyes, using an ANOVA, indicated a significant difference at the ($P<.05$) level for two of the 10 possible comparison (one observer differing from two others). When the mean of the range data of all eyes (for each observer) is compared across all five observers a range of .43D to .96D existed (See Table 2). The absolute dioptric range of spherical equivalent refractive error for each eye by all five observers varied from a low of .87D to a high of 6.75D (See Table 3). The difference in mean refractive error data by subject across all five observers, using an ANOVA-repeated measures design, showed significance (at $P<.05$ level) for four of the ten possible comparisons (one observer differing from the four others).

DISCUSSION

A significant difference existed between all observer mean values and the true control lens values. This can be explained by the low variability found within and between each observer. This is illustrated by the small mean difference of each observer when compared to the true lens power and the small mean range found for each meridian, both within and between observers. Of the 50 neutralizations performed on each of the 10 lenses the maximum range value for any trial was 1.5D and this was found in only 3 of the 500 neutralizations. The average standard deviation around the mean for all observers was below .25D; indicating very good internal consistency when neutralizing a static optical system. Also supporting this is the fact that the maximum dioptric range observed between observers and the true lens value was only .77D while for most of the other trials this value remained below .25D; well within the range of clinical acceptability. For the experimental condition the variance, based on range data, for each observer, for all eyes was not significant, indicating, again, that observers were relatively internally consistent for ranges around there own mean. The largest mean range for any one observer for any eye was 3.50D, which occured twice for observer #5. This is considered an aberration and possible recording or reading error. The next largest mean range value was I.5D and was also only observed twice. Of the 85 sets of trials, a mean range for each eye > 1.0D was seen only with 15/85 of the trials. (See Table 2)

When we compared the mean of the ranges for each observer to all other observers we found significant differences, for only 2 of the 10 comparisons (observer #5 different from observers #3 and #4). But when we compare the values in dioptors for the means of the range values, we find a minimum value of .43D compared to a maximum value of .96D. (See Table 2) These values are much higher then the .25D values found for the control condition. Also considering that our experimental data is in spherical equivalent form, as compared to true meriodional power in the

control conditions, these results become even more troublesome clinically. A mean range for a clinical refractive procedure approaching .75D becomes unacceptable. When we look across each of the 17 eyes by observer we find a minimum range of .87D with a maximum range of 6.75D (See Table 3). Observer #5 did vary considerably from the other observers on a few of the subjects, especially on subject #11. When that data is removed the maximum range is reduced to 2.50D for any eye. Still, the ranges for 13 of the 17 eyes is > l.5D with 5 of the 17 ranges greater than 2.0D. Only <u>one</u> of the ranges by eye was below 1.0D. Clinically to have refractive error findings between observers with expected ranges close to 2.0D is again unacceptable.

CONCLUSION

Reliability of retinoscopy as illustrated by clinically insignificant variance and close agreement with true lens powers has been shown for the static, schematic eye condition. This agrees with other retinoscopy studies.(24,25)

The reliability and clinical usefulness of near retinoscopy is questionalbe considering its relatively large variability both between different trained observers and to a smaller extent within each observer.

While Mohindra reports good reliability and close correlation with cycloplegic and subjective refraction for adults and school age children, Maino et. al. report poor correlation when comparing near retinoscopy with cycloplegic refraction in 18-36 month old children. This apparent desparity along with our results may be due to the population chosen. When utilized with an infant population the same stability of fixation, accommodation, and attention is not available to the retinoscopist at the same level as with older children and adults. In this infant age group often the intervention of lens bars, loose lenses or lens flippers is enough to alter fixation and change attention.

Experience with infants may improve ones ability to utilize near retinoscopy in a clinical setting, as seen by our most experienced (with infants) retinoscopist having the smallest variability. But even with experience and in light of Maino's study (23) the usefulness of near retinoscopy with infants is suspect.

At this writing it may be most prudent that refractive error measurements on infants be performed under cycloplegia, until a quicker, more reliable method of refractive error determination can be found. Refinements and new improvements of photorefractive techniques, as proposed by Urness, (26) may indeed be the answer to a non-invasive method for refractive error determination in infants.

Future studies on larger populations with comparisons of different refractive error measurement techniques will be undertaken.

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TABLE 1

THE MEAN DIFFERENCES FROM THE TRUE LENS POWERS					
	#1	#2	#3	#4	#5
1	0.03	0.16	0.23	0.20	0.10
2	0.17	0.00	0.00	0.20	0.23
3	0.25	0.14	0.25	0.22	0.25
4	0.50	0.47	0.75	0.10	0.20
5	0.50	0.25	0.03	0.20	0.45
6	0.77	0.45	0.75	0.29	0.40
7	0.17	0.20	0.30	0.35	0.30
8	0.30	0.13	0.45	0.25	0.17
9	0.35	0.20	0.33	0.25	0.30
10	0.12	0.13	0.31	0.34	0.25
14	0.12	0.03	0.25	0.22	0.55
15	0.25	0.23	0.30	0.41	0.30
16	0.42	0.15	0.30	0.30	0.50
17	0.35	0.20	0.18	0.28	0.50
18	0.03	0.15	0.28	0.36	0.15
19	0.08	0.05	0.25	0.25	0.31
20	0.35	0.30	0.40	0.33	0.25
MEAN ERROR	0.28475	0.221	0.3345	0.26385	0.3076

columns represent observers 1-5
rows represent lenses tested

TABLE 2

MEAN DIOPTRIC RANGE FOR EACH SUBJECT BY EACH OBSERVER

Eye Number	Observer Number				
	1	2	3	4	5
1	0.50	0.50	0.50	0.50	1.25
2	0.25	0.50	0.75	0.62	0.50
3	0.50	1.62	0.37	0.12	1.50
4	0.75	0.75	0.50	0.50	0.00
5	0.00	0.50	0.25	0.62	1.25
6	0.50	1.25	0.62	0.50	0.50
7	1.00	0.25	0.25	0.25	0.50
8	1.50	0.50	0.12	0.62	3.50
9	1.50	1.25	0.37	0.37	0.50
10	0.75	1.12	0.62	0.50	0.50
11	0.25	0.50	0.25	0.37	0.50
12	0.75	1.00	1.00	0.50	3.50
13	0.50	0.75	1.00	0.50	0.50
14	0.50	0.75	0.25	0.25	0.50
15	0.75	0.50	0.75	0.50	0.50
16	0.50	0.75	0.12	0.12	0.50
17	0.25	0.37	0.50	0.50	0.50
Mean (D)	0.66	0.72	0.50	0.43	0.96