Do all children need a cycloplegic refraction? A comparison of Mohindra’s versus cycloplegic refraction

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Purpose: In 1–12 years old children, we assessed correlation, regression, and agreement between spherical equivalents (SE) obtained on Mohindra’s near retinoscopy (MNR) and the post cycloplegic refraction (PCRef), performed 72 h after a cycloplegic refraction (CRef) using cyclopentolate 1% drops.

Methods: In this prospective comparative study, Mohindra’s near retinoscopy (MNR) was performed on 202 eyes of 101 children, from 50 cm with a streak retinoscope, in a dimly lit room, subtracting 1.25 from the trial lens used for neutralization, to obtain the final refraction. Subsequently we undertook CRef, half-hour after instilling 1% cyclopentolate, with a PCRef 72 h later. All refractive data were converted to SE for evaluation. We compared the SEs using correlation, linear regression, and agreement (Bland–Altman graphic analysis) and paired t-test. Significance was set at \( P \leq 0.05 \).

Results: The mean SE on MNR was \( 1.71 \pm 2.49 \) D compared to \( 1.43 \pm 2.42 \) D on PCRef. A significant correlation with \( r = 0.97 \) (\( r^2 = 0.94, P < 0.001 \)) existed. Agreement analysis suggested that MNR overestimates hypermetropia and underestimates myopia each by 0.3 D than the standard procedure of CRef-PCRef. The regression analysis suggested that SE on PCRef is 95% of that on MNR, less 0.20.

Conclusion: Our study suggests that MNR offers single point refraction very similar to CRef-PCRef, and may be considered as a viable option more often.

Key words: Cycloplegic refraction, Mohindra’s near retinoscopy, post cycloplegic refraction

Refraction errors are one of the most common cause of avoidable and treatable blindness worldwide, and in younger children if uncorrected, can lead to amblyopia. In younger children, if detected and appropriately corrected, amblyopia can be either prevented or remedied with appropriate therapy. Thus, refraction forms an important part of the examination of the eyes in children. Usually this involves one of three approaches: (A) performing static retinoscopy, when a co-operative person views the visual acuity chart at optical infinity viz. 20 feet. (B) by retinoscopy while suspending the accommodation of the eye by the use of topical cycloplegic drugs, or (C) by doing near retinoscopy as described by Mohindra.[7,8] All these methods basically involve holding the accommodation steady; an important criteria for obtaining the correct refractive state. The younger population have stronger accommodation, which gradually decreases with age.[9,10] This accommodation is eliminated by using topical cycloplegic drugs, of varying potency, appropriate for the age. The commonly used drugs are 1% topical tropicamide for adults, and 1% atropine or 1% cyclopentolate for younger children and 0.5% of the latter in infants.[11-14] Despite being effective, they have their downsides: in the case of atropine, this often induces a prolonged cycloplegia associated with photophobia; occasionally acute psychosis occurs, more commonly with cyclopentolate while hyperpyrexia and flushing along with local allergic reactions may happen too, along with the need of a repeat visit for a postcycloplegic test.[15-19]

In 1977, Indra Mohindra popularized a near retinoscopy technique performed from 50 cm in an otherwise dark room, which dispensed with the use of any cycloplegics. The retinoscope filament is the only interesting thing that the child focuses on, thus stabilizing the accommodation to an extent that reliable measurements of retinoscopy are obtained.[20] Allowing for “dark myopia,” a subtraction of 1.25 D is made from the power of lens used for neutralization from a half meter.[7,21] Despite being quick, Mohindra’s near retinoscopy (MNR) has the advantage of reducing the number of visits for the children/parents while avoiding systemic and neurological side effects of atropine and cyclopentolate and being feasible for a mass screening approach.[15,19,22]

There are a just a handful of studies, which have compared the MNR with cycloplegic refraction, with most performing correlation analyses while only one looked at agreement.[7,8,21-24] Although they have reported high and significant correlations of 85%–97%, this is hardly surprising since both methods are measuring the same refractive state, and thus are bound to correlate. We sought to answer the far more appropriate question: How well do the measurements of ocular refraction values agree between the two techniques, apart from looking at correlation as a prelude to regression, to explore the possibility of predicting the postcycloplegic refraction (PCRef) with MNR. We aimed

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to study agreement, correlation, and linear regression between Mohindra's near retinoscopic refraction and cycloplegic-post cycloplegic technique of refraction under cyclopentolate.

**Methods**

After clearance from the institutional review board and obtaining informed consent from the parents, we recruited 101 cooperative children between 1 and 12 years of age, form the eye OPD. We excluded children with previous ocular surgeries, past or present ocular inflammation, poor media clarity, and neurological disease. After basic ophthalmic workup, each subject underwent objective refraction, which included Mohindra’s near retinoscopy (MNR), followed by cycloplegic refraction with 1% topical cyclopentolate (CRef) on the same visit, with a PCRef at least 72 h later. The spherical and cylindrical values of neutralizing lenses were masked while performing refraction.

1. **Mohindra’s near retinoscopy technique**

MNR included dry retinoscopy performed in a dimly lit room so that there should not be any accommodative target visible to the children. Self-illuminated Heine Beta 200 Streak Retinoscope was used to perform retinoscopy for each eye at 50 cm, by an experienced refractometer (>30 years experience). To ensure the correct distance, a nonstretchable cord of 50 cm was tied to the handle of streak retinoscope [Fig. 1]. After obtaining the dioptric value of the neutralizing lenses, 1.25 D was subtracted to obtain the refraction. The average illumination of the room while performing MNR was 6–10 lux measured by digital Lux meter (Brand: ANMOL, Model: LX-1010B).[22,25]

2. **Procedure for cycloplegic and postcycloplegic refraction**

Each subject underwent wet retinoscopy using topical cyclopentolate. Two drops of 1% cyclopentolate was instilled in the conjunctival cul-de-sac of each eye, 10 min apart. Punctal pressure was applied for two min each time the drops were instilled. Following 30 min of the last drop, retinoscopy was performed from 50 cm, the usual distance at which our senior refractionist performs retinoscopy. Adequate cycloplegia was confirmed by observing nonvarying retinoscopic reflexes, when the child attempted to look at different objects. Diopteric equivalents for distance (2.0 Diopeters for 50 cm) and for cycloplegia (0.5 Diopters for cyclopentolate) were subtracted from the values of spherical neutralizing lenses to obtain ocular refraction.[14]

Children were asked to return after 72 h for CRef, when PCRef was performed with subjects encouraged to fixate at the vision charts at six meters.

For statistical analysis, we considered the average values of right and left eye for each measured entity.

**Statistical analysis**

We used JASP Version 0.9.0.1.[26] and MedCalc Trial Version for statistical analysis.[27] Paired t-test was used to compare means of refractive data. We described our data using mean (SD), 95% confidence intervals (CI) are quoted wherever possible. P value of ≤0.05 was considered as statistically significant.

**Results**

We included 101 children (202 eyes). The baseline demographic data, and refractive data are depicted in Table 1. The mean ± SD in logarithm of the minimum angle of resolution (logMAR) for average uncorrected visual acuity (UCVA) was 0.26 ± 0.20 and best corrected visual acuity (BCVA) was 0.1 ± 0.01. Three subjects were from preverbal age group (1.5 years), and therefore we were unable to obtain their visual acuity (VA) data. The mean ± SD spherical equivalent with MNR was 1.71 ± 2.49 D and with PCRef was 1.43 ± 2.42 D; implying that on average, it was more with MNR by a mere 0.28 D, although it was statistically significant (Paired t-test: P value <0.001; 95% CI of 0.16 to 0.40 D).

We split the children into two groups of 1-6 years and 7-12 years with 36 children in the younger group and 65 children in the older group. For children from younger group, the SE was more by 0.26 ± 0.75 D on MNR compared to PCRef (P value = 0.05; 95% CI-0.03 to 0.5). Likewise, for children from older group, the SE was more by 0.29 ± 0.49 D on MNR compared to PCRef (P value <0.001; 95% CI 0.1843 to 0.42). On comparing the mean SE of the two groups the younger group measured more than the older group by a non-significant difference of 0.01 ± 0.8 D (Paired t-test: P value = 0.93; 95% CI of 0.26 to 0.28).

Expectedly a high and significant positive correlation was demonstrated between the SE on MNR and PCRef (r = 0.97; 95% CI of 0.96–1.0 and P value <0.001).

Linear regression analysis (LRA) was done to predict spherical equivalent (SE) of PCRef on the basis of the values of the SE obtained by MNR technique. The analysis showed that 94% of the values of PCRef can be predicted on the basis of MNR (r² change = 0.96). The regression formula thus obtained was: [Fig. 2a]:

\[
\text{SE of PCRef} = -0.188 + (0.945 \times \text{SE by MNR})
\]

Considering that most glass prescription are usually of a small power; we re-evaluated the 91 subjects with refractive error within ±4.0 D. The regression formula obtained for those 91 children was [Fig. 2b]:

\[
\text{SE of PCRef} = -0.05 + (0.82 \times \text{SE by MNR})
\]

Bland–Altman plot [Fig. 3] used for agreement analysis, showed MNR measures on average a mere 0.3 D more hypermetropia, which in terms of myopia means 0.3 D less myopia, than that measured by PCRef.

**Discussion**

We included 101 children of 1–12 years of age. We found a high and significant correlation between SE on MNR and PCRef: (r = 0.97, P < 0.001). Although, the mean difference between SE on MNR and PCRef was statistically significant, it was clinically unimportant: 0.28 ± 0.12 D; P < 0.001. Linear regression analysis (LRA) suggested that 94% of the variation of the SE on PCRef could be explained on the basis of the SE on MNR [Fig. 2a]. Agreement analysis suggested that MNR overestimates hypermetropia and underestimates myopia each by on average 0.3 D (Bland–Altman plot- Fig. 3) than the standard procedure of CRef-PCRef.

| Number (N) | Total | Males | Females |
|-----------|-------|-------|---------|
| 101       | 51 (50.5%) | 50 (49.5%) |
| Mean age (SD) in years | 7.63 ± 3.1 | 7.3 ± 3.52 | 7.97 ± 2.59 |
| Emmetropia | 03 (2.97%) | 01(0.99%) | 02 (1.98%) |
| Hypermetropia | 86 (85.14%) | 44 (43.56%) | 42 (41.58%) |
| Myopia | 12 (11.88%) | 06 (5.94%) | 06 (5.94%) |
| Amblyopia | 14 (13.86%) | 5 (4.95%) | 9 (8.91%) |
Indra Mohindra in 1977 came out with her novel technique of near dry retinoscopy, which was later popularized as Mohindra’s near retinoscopy. After exhaustive online and offline search, we found only the short abstracts of her first two studies (1977).[7,8]

In 1979, Mohindra and her colleague Molinari, compared the technique of Mohindra’s near retinoscopy, with that of cycloplegic refraction using a combination of 1% tropicamide and 10% phenylephrine eye drops: the two techniques were each performed by two optometrists with varying experience. They enrolled 31 primary grade children of 6–12 years of age with mean age = 6.26 years. The SE error by the two techniques performed by the experienced optometrist-I (extensive experience with near retinoscopy technique) and non-experienced optometrist-II (no experience with near retinoscopy technique) demonstrated high correlation ($r = 0.97$; $P$ value = 0.001); in addition, the SE by the two different techniques by the same optometrist also demonstrated high correlation. This supported Mohindra’s hypothesis that her technique can stabilize the accommodation as adequately as 1% tropicamide and 10% phenylephrine does.[21] High correlation should not surprise anyone, since the two optometrists or the two techniques were essentially measuring the same parameter: higher values by one person or technique are likely to be measured higher by the other person or technique: we believe agreement should be the outcome of interest.

Borghi and Rouse, in 1985, compared Mohindra’s near retinoscopy with cycloplegic retinoscopy using 1% cyclopentolate eye drop in 22 children of 3.6–10 years old. 85% correlation was found between the two techniques. Results suggested that this noncycloplegic technique measured more hypermetropia by 0.5 to 0.75 D, (Student’s t-test, $P < 0.05$ (sic)).[23]

Chen et al., in 2011, performed a comparative study between cycloplegic and noncycloplegic refraction in Chinese neonates. Cycloplegic retinoscopy, with the combination of 0.5% cyclopentolate and 0.25% phenylephrine eye drops, was done on 81 neonates randomly selected from 185 neonates who had undergone noncycloplegic refraction (nC group). On an average the cycloplegic measurement was more by a mean of +3.0 D: +3.58 D Vs +0.50 D. This study concluded that the Mohindra’s technique of non cycloplegic refraction was not sufficiently uncovering the hypermetropia, and thus should be considered inappropriate to assess refractive error in neonates.[24] The authors also elaborate that the accommodation in Mohindra’s near retinoscopy may vary on the time duration when it is performed, suggesting that in the initial period children do accommodate more, but over two min tend to relax their accommodation. This may explain some of the variation in the different studies. We do not as a routine see or refract such small children, since all the subjects in this study were less than a week old. Therefore, although this study does suggest higher differences, this is quite not...
representative of the population that most of us are screening in our hospitals in India.

In this era, where most ophthalmologists strongly recommend cycloplegic refraction to unmask hypermetropia completely, Mohindra's retinoscopy technique has not gained much popularity. Hence, studies using noncycloplegic techniques have been far and few.

Recently, Natarajan et al. (2016) did a prospective observational study, very similar to our study, including 500 eyes of 250 patients from 30 to 60 years of age. They have found 99.1% correlation between Mohindra's retinoscopy and static refraction and 98.3% correlation between monocular and binocular subjective refraction. Agreement analysis using Bland–Altman plot showed that on an average Mohindra's near retinoscopy measured 0.39 (1.96) D more hypermetropia in comparison to the static refraction. They proposed Mohindra's near retinoscopy as a quick and effective measure of objective refraction in mass screening scenario taking consideration of time, space, and money.[25]

Limitations

In our study the retinoscopy by the two methods was performed by the same refractionist, and therefore there could be a chance of incorporation of examiner bias. Although we masked the data of the MNR from the refractionist, it would have been better to have a different refractionist perform the two techniques. Arguably, on the contrary, that may have introduced interobserver differences. It might have been informative to compare the cylindrical errors, but we avoided the tedious vector analysis that would have been necessary.

Conclusion

We are of the opinion that MNR measurement agrees well with the practice of cycloplegic post cycloplegic refraction. For the mathematically inclined, we have developed a regression equation to predict the standard PCRef spherical equivalents on the basis of that measured by MNR. This is especially true for the children from toddler to early school years. Especially for those within ±4.0 D ametropia [Fig. 2b], this could simply be reduced to: SE on PCRef is 80% of the MNR, rounding off 0.82 to 0.80 D and dropping off the 0.05 subtraction, since it tends to zero, being 1/20th of a diopter.

With the inherent advantage of being quick, drugless, one-visit procedure, and measuring up well with the standard technique, the MNR may be resorted to more often in a clinical setting for routine assessment of children of ages 1–12 years old. In future studies, it would be important to compare the MNR with cycloplegic refraction in those with anisometropia, strabismus, and amblyopes and assess how well it performs, for a more universal adoption. For the moment then, it offers a viable option in routine screening of children.

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Conflicts of interest

There are no conflicts of interest.

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