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A comparative study of noncycloplegic automated refraction, cycloplegic automated refraction and cycloplegic refraction among youngsters

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Abstract

Purpose: Comparative studies of noncycloplegic automated refraction, cycloplegic automated refraction and cycloplegic refraction among youngsters are scanty. This study aimed to compare noncycloplegic AR, cycloplegic AR and cycloplegic refraction among patients between the age group of 5-25 years. It is a descriptive cross sectional study.

Methods: Patients between 5 and 25 years with a visual acuity better than +0.3 logmar unit were included in this study. Noncycloplegic AR, cycloplegic AR and cycloplegic refraction were done for each patient. These results were compared.

Results: The study group included 63 patients between the age group 5-25 years. 55.6% (n=35) were females. The mean age of the group was 12.62 years with SD of ± 4.28 years. The mean difference between cycloplegic and noncycloplegic AR was 1.09 D (SD ± 1.1), the mean value of difference between cycloplegic refraction and noncycloplegic AR was 1.11 D (SD ±1.26) and the mean difference between cycloplegic refraction and cycloplegic AR was 0.50 D (SD ±0.52).

Conclusion: AR can be considered as a screening tool for refractive errors in youngsters but cycloplegic refraction is the gold standard for accurate measurement of the refractive status. Difference between pre and post cycloplegic AR is helpful in measuring accommodation of an individual.

Keywords: Automated refractometer, Accomodation, Cycloplegic AR, Cycloplegic refraction, Noncycloplegic AR.

Introduction

Automated refraction (AR), an office procedure is replacing time consuming retinoscopy nowadays. Autorefractometer is a computer controlled machine to provide an objective measurement of a person's refractive status. It is quick, simple, user friendly, and independent of examiner.(1) The disadvantages are the expense of the instrument and the instrument induced myopia. AR basically comprises of an infrared source and a fixation target. It is based on two main principles – optometer principle and schiener principle. Because of the close distance between the subject and the target some accommodation is inevitable. This alters the actual refractive status. A variety of targets have been used for fixation to relax accommodation. Accommodation can be relaxed by incorporating fogging technique and using flickering green light during the test.(2)

This study aimed at quantifying the fluctuations in the precycloplegic and postcycloplegic AR and retinoscopy in subjects with good accommodative ability. Further an attempt was made to analyse this variations among different refractive errors in this group.

Materials and Methods

Sixty three patients in the age group of 5-25 years were included in the study. The study period was six months. The study was approved by the institutional ethics committee. Informed consent of the patient obtained. Uncooperative patients, patients with history of ocular trauma and patients outside the specified age group were excluded from the study. Age, gender, socioeconomic status, area of residence and occupation were recorded. The distant visual acuity was assessed uniocularly by using snellen's visual acuity chart at a distance of 6 meters. Automated refraction was done using Shin Nippon Accurate K 9001refractometer before and after putting homatropine bromide 2% eye drops three times at an interval of ten minutes. Complete cycloplegia was confirmed by making the patient to read near vision chart. A decrease in visual acuity corresponding to doubling of visual angle for both distance and near were ensured.

Three readings were taken for each eye and the average of these values were calculated. Cycloplegic retinoscopy was done after dilated AR by another observer and compared. Spherical equivalent was derived after correcting for distance and drug. Statistical analysis was performed with PASW version 18. Chi square test was used for univariate analysis. One way Anova was used to measure variance.

Results

The study group included 126 eyes of 63 patients. 55.56% (n=35) were females. The age group ranged between 5 and 25 years with mean age of 12.62 years with SD of ±4.28 years. The distribution of cases based on demography and refractive status is given in Table1. The mean age of the subjects among each refractive error group was similar (Fig. 1).

Table 1: Distribution of cases based on demography and refractive status

		Number of cases (eyes)	Percentage
Age	5-10	34	27.0
	11-15	58	46.0
	16-20	28	22.2
	21-25	6	4.8
	Mean age-12.62	SD±4.28	P value-0.000
Gender	male	56	44.4
	female	70	55.6
Refractive error	emmetropia	47	38.1
	myopia	42	33.3
	hypermetropia	37	28.6
NAR Vs CAR	more	88	69.8
	less	28	22.2
	no difference	10	7.9

SD: Standered deviation
NAR: noncycloplegic automated refraction
CAR: cycloplegic automated refraction

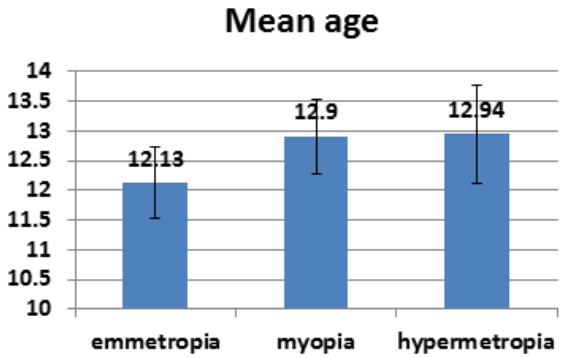

Fig 1: Distribution of cases based on age

The mean cycloplegic retinoscopy value was 0.66D (SD ±1.09), the mean noncycloplegic AR was 1.42D (SD ±1.59) and the mean cycloplegic AR was 0.84D (SD ± 1.17). The comparison between cycloplegic refraction, noncycloplegic and cycloplegic AR is given in Table 2. The difference between the cycloplegic refraction and the pre as well as post cycloplegic AR showed similar relation with the age of the patient (Fig. 2).

Table 2: Comparison between actual objective retinoscopy, noncycloplegic and cycloplegic AR

Factors	Mean	SD	95% Confidence interval	
			Lower	Upper
Age	12.62	4.28	11.86	13.37
Noncycloplegic Automated Refraction	1.42	1.59	1.14	1.7
Cycloplegic Automated Refraction	0.84	1.17	0.63	1.05
Actual retinoscopy	0.66	1.09	0.47	0.86

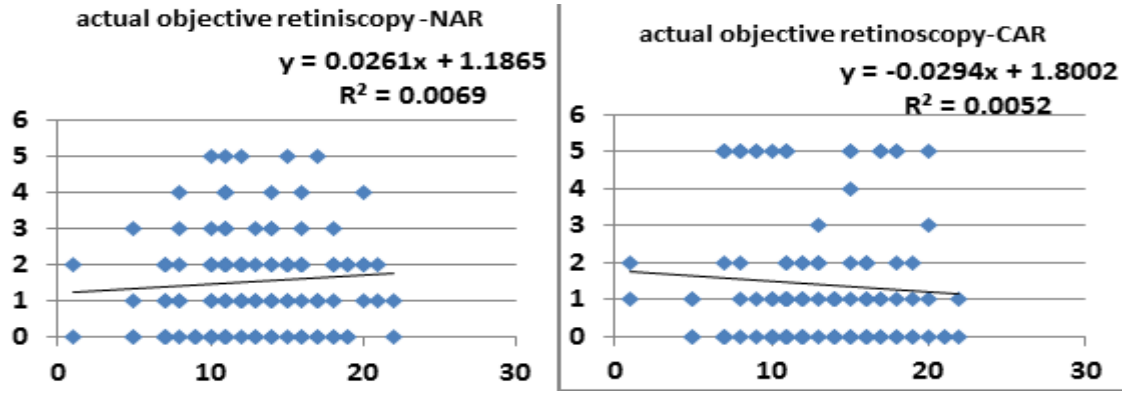

Fig: 2 Difference between the actual objective refraction and the pre as well as post cycloplegic AR with the age

The mean value of the difference between cycloplegic and noncycloplegic AR was 1.097 (SD ±1.1), the mean value of difference between cycloplegics retinoscopy and noncycloplegic AR was1.11 (SD ±1.26) and the mean difference between cycloplegic retinoscopy and cycloplegic AR was. 0.50 (SD ±0.52).

According to the retinoscopy values (corrected for drug and distance), 37.3% (n=47 eyes) were emmetropes, 33.3% (n=42 eyes) were myopes and 29.3% (n=37 eyes) were hypermetropes. By noncycloplegic AR, 87.3% (n=110 eyes) were myopes, and by cycloplegic AR 46% (n=58 eyes) were myopes (Fig. 3).

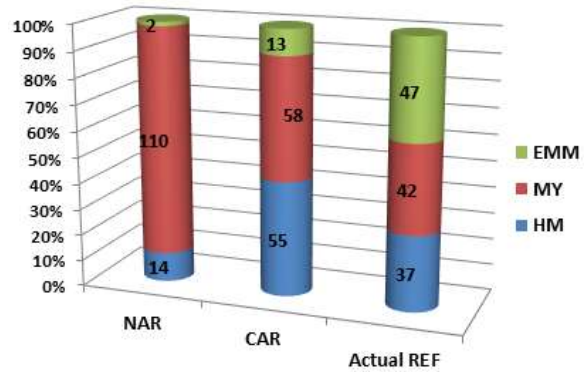

Fig. 3: Distribution of cases based on refractive status

When cycloplegic objective refraction and cycloplegic AR were compared, 38.89% (n=49) of eyes showed a difference of less than 0.5D in all the three refractive states. A difference of > 2 D was observed among a minority. 15.87% (n=20) showed no difference in retinoscopy in all the three refractive states. This observation was statistically significant p=0.000 (Fig. 4a).

The difference between the cycloplegic refraction (SE corrected for drug and distance) and noncycloplegic AR was less than 0.50D among emmetropes and myopes. Out of 36 hypermetropes, 41.67% (n=15) showed a difference of 1-2D. 3.97% (n=5) showed no difference. The above observation was statistically significant p=0.000 (Fig. 4b).

While comparing noncycloplegic AR and cycloplegic AR, 35.42% (n=17) of emmetropes and 33.33% (n=12) of hypermetrops showed a peak at 1-2 D. 35.71% (n=15) myopes showed a peak at 0.5-1 D. No difference was seen in 3.97% (n=5) eyes. This observation was also statistically significant p=0.000 (Fig. 4c).

Accommodative ability of patients had no statistically significant relation with the visual acuity of the patients in our study.

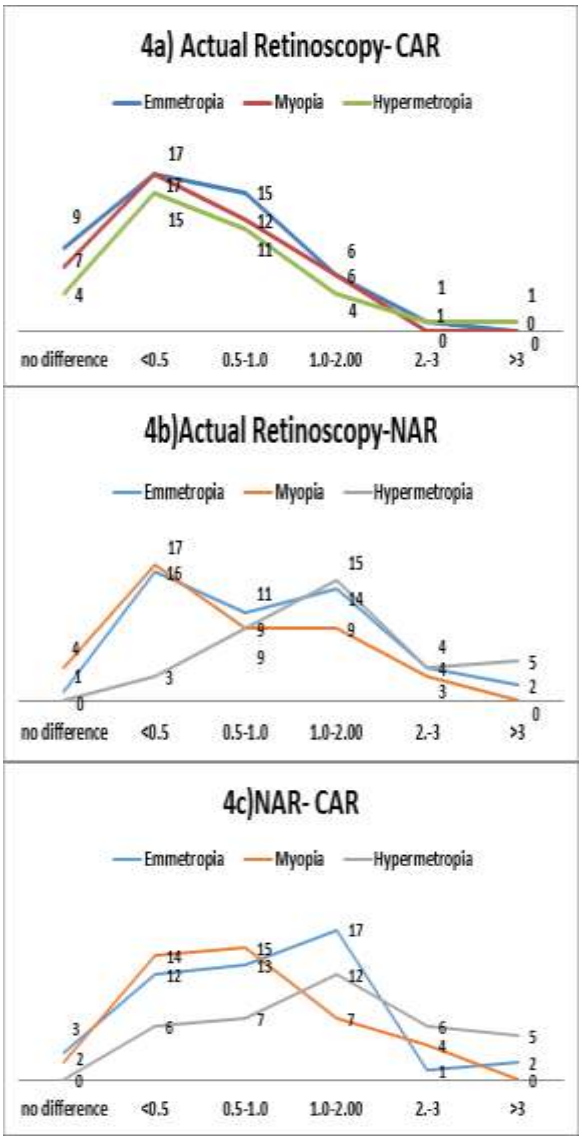

Fig. 4: Difference bewteen the actual refractive error and AR values among emmetropes, hypermetropes and myopes.

NAR-noncycloplegic automated refraction
CAR- cycloplegic automated refraction

Discussion

For the subjective adjustment of refraction and prescription of spectacles objective determination of refractive status is important.[3] Photorefraction, refractometry, automated refractometry are the three methods of objective determination of refraction.[3] Cycloplegic retinoscopy is the gold standard for assessing the refractive status in children and is considered more accurate than automated refraction.[1,4,5,6,7,8] In retinoscopy the image of optical aberrations of the eye is evaluated so that it gives an idea about the optical quality of the patient's

eye.[3] Though the method is with great flexibility it needs skill and patience.[3] The retinoscopy has to be done at the centre of pupil to avoid the optical aberrations induced by the dilated pupil.[3] The differences between cycloplegic and noncycloplegic retinoscopy are due to the accommodative response of the individual.[5] Noncycloplegic retinoscopy in the dark can be considered as an alternative to cycloplegic retnoscopy.[8] While an autorefractometer can predict the accommodative system activation in children and young adults, dynamic retinoscopy is required to measure it accurately.[6] Latent refractive errors cannot be accurately diagnosed in youngsters due to accommodation.[6] Diurnal variation of tonic accommodative amplitude is 1.00 D with a stable day to day values.[6] In children increased accommodative response is due to increased ciliary muscle thickness.[6] The noncycloplegic refraction showed a more myopic spherical equivalent than their cycloplegic counterparts.[9]

Autorefractometer is a suitable instrument for screening for abnormal hypermetropia in noncycloplegic condition.[10] Automated refraction is more repeatable than subjective refraction.[11] The results obtained by autorefractometers are influenced by accommodative activity and pupillary size of the subject.[2] With the advent of handheld AR machines (Retinomax), AR is being considered as screening tool to evaluate refractive error among children.[10,12,13,14,15] It may be useful in young adults as well.[13] Büchner TF, et al reported that noncycloplegic autorefractometer screening has poor accuracy in detecting spherical equivalent, but has high accuracy in detecting cylinder power and axis in young so that objective retinoscopy in childhood must be performed with cycloplegia.[13,16,17] In adults measurement of distance refraction by AR is accurate, due to progressive decrease in the accommodative capabilities, but in children the performance of AR is less reliable due to their strong accommodative abilities.[6] Even though an autofogging system incorporated in the autorefractometers, distance refraction values were not accurate in children. According to Krishnacharya PS autorefractometer measurements were reliable but over-corrected by more than −2.00 D in 24% of children.[6] In young adult over-refraction through +2.00 D fogging lens provide additional relaxation of accommodation similar to cycloplegia when performing open field autorefraction.[18]

Asthenopia depends not only on the absolute refractive error but on the accommodation - convergence balance and coexistant heterophorias. Determination of accommodation anomalies, accommodative amplitude and accommodative range requires techniques like dynamic retinoscopy (DR) and instruments like RAF rule, synoptophore etc, which are not freely available with the practitioners. This precludes better understanding of the role of these factors in inducing symptoms. Thus even when the refractive error is corrected fully with spectacles, the subject is left symptomatic and unhappy. Dynamic retinoscopy requires more skill, patience and trained hands. It helps to assess accommodative abilities, amplitude of accommodation and to quantify accommodation in children.[6,19,20] Krishnacharya reported that, AR is comparable to the DR in measuring accommodative effort, before and after cycloplegia. Under cycloplegia, both AR and DR measured the refraction in positive spherical correction, suggesting concurrence of the two methods.[6]

It was observed that the postcycloplegic AR corrected for the drug was comparable to the cycloplegic refractive value obtained after cycloplegic retinoscopy. A negligible difference was observed among emmetropes, myopes and hypermetropes. Precycloplegic AR showed a more myopic spherical equivalent than its counterpart. This was in accordance with the studies of Jorge J et al and Krishnacharya, Pokupec R.[5,6,7] However the difference was minimal among ammetropes and myopes. A significant error was noted among hypermetropes. In young high hypermetropia is a common type of refractive error.[10] Asthenopic symptoms in children between the ages of 11–15 years is probably due to prolonged reading and writing activities.[6] But comparing pre and post cycloplegic retinoscopy values an estimate of the tonic accommodative amplitude can be calculated among subjects with hypermetropia. This helps in better understanding of the causes of asthenopia among such a group. The difference between pre and post cycloplegic AR was independent of the age or the visual acuity of the subject. It becomes an easy objective assessment technique for tonic accommodative amplitude, and accommodative abilities as compared to dynamic retinoscopy. Though the accuracy of AR is less for quantifying spherical errors the difference between pre and post cycloplegic AR will provide an accurate estimate of tonic accommodative amplitude of the subject.

This work was based on the spherical equivalent. The presence of cylinder was not evaluated separately. Higher refractive errors >4D were excluded. Use of other cycloplegics (atropine, cyclopentolate, tropicamide-phenylephrine) were not considered. Subjects with visual acuity less than 0.3 logmar units were avoided. The strength of the study is in the exclusion of confounding bias in terms of age, visual acuity, and higher refractive errors, which can alter the tonic accommodative amplitude. Though the sample size is not comparable with many of the population based work by Jorge J et al and Cordonnier M et al this is a representative group of young adults with asthenopia.[4,5,10,12]

Conclusion

Cycloplegic AR gives a good estimate of the measure of refractive error among young emmetropes and ammetropes. Difference between the pre and post cycloplegic AR can be utilised to quantify the tonic accommodative amplitude of an individual. In small degrees of refractive error this is independent of age or visual acuity. Thus AR can be used to find out accommodative anomalies.

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