International Journal of Research in Medical Sciences
Kedia P et al. Int J Res Med Sci. 2022 Apr;10(4):919-925
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20220986

Original Research Article

A study on non-cycloplegic and cycloplegic streak retinoscopy and autorefractometry in children

Puja Kedia*, Mamoni Baruah

Department of Ophthalmology, Assam Medical College and Hospital, Dibrugarh, Assam, India

Received: 26 February 2022
Revised: 15 March 2022
Accepted: 19 March 2022

***Correspondence:**
Dr. Puja Kedia,
E-mail: Pujakedia86@gmail.com

ABSTRACT

Background: Refractive errors in children should be identified and corrected as early as possible to prevent irreversible vision loss. Therefore, accurate methods of objective refraction should be employed by paediatric eye care providers when examining young children. The purpose of this study was to assess the accuracy of non-cycloplegic and cycloplegic retinoscopy and autorefractometry as objective methods of refraction, and to determine their suitability with subjective acceptance.

Methods: The one-year study included 453 children of 3-15 years. Noncycloplegic autorefraction and streak retinoscopy were done. These were followed by cycloplegic autorefraction and streak retinoscopy. Cycloplegia was attained by using atropine sulphate 1% eye drops and cyclopentolate hydrochloride 1% eyedrops for children of 3-7 years and 8-15 years respectively. Postmydriatic subjective refraction was then done. Results were compared using Analysis of Variance (ANOVA). Calculated $p<0.05$ was considered as statistically significant.

Results: Noncycloplegic methods showed underestimation of hypermetropia and overestimation of myopia. The spherical and cylindrical measurements of cycloplegic autorefraction were equivalent to cycloplegic retinoscopy. Axis of cycloplegic autorefraction was better than cycloplegic retinoscopy.

Conclusions: The most accurate method of objective refraction is cycloplegic retinoscopy. However, the spherical and cylindrical measurements of cycloplegic autorefraction can be substituted for conventional cycloplegic retinoscopy in young children.

Keywords: Refractive error, Cycloplegia, Autorefraction, Retinoscopy, Subjective refraction

INTRODUCTION

Sight is a precious gift of God to mankind and impairment of vision is one of the worst human disabilities. Uncorrected refractive errors are one such visual impairment which poses a public health problem among different population groups.[1] Refractive errors in children should be identified and corrected as early as possible to prevent irreversible vision loss secondary to amblyopia and strabismus.[2] Different techniques of measurement of refractive error are available for children.

Most children require cycloplegic refraction because of their high amplitude of accommodation. Cycloplegic drugs are used for paralysis of accommodation.[3] Methods of objective refraction are retinoscopy and autorefraction.[4] In a developing country like India, the number of professionals available to perform cycloplegic retinoscopy accurately does not meet the demand. Nowadays, autorefractometer is used because of the heavy patient load in ophthalmology clinics. It is a relatively easy and quick technique and is appreciated well by the patients.[5]

The purpose of this study was to assess the accuracy of non-cycloplegic and cycloplegic retinoscopy and autorefractometry as objective methods of refraction, and to determine their suitability with subjective acceptance.

METHODS

The study was conducted in Assam Medical College and Hospital, Dibrugarh, Assam, India on 453 patients in the age group of 3-15 years attending the Ophthalmology OPD and satisfying the inclusion and exclusion criteria of the study. The study was of a duration of 1 year from July 2018 to June 2019. Ethical clearance was taken from institutional ethics committee.

Type of study

Hospital based prospective study.

Inclusion criteria

Children in the age group of 3-15 years with: blurring or diminution of distant vision, ocular symptoms (asthenopia) or other referred symptoms due to eye-strain (headache), reduced uncorrected visual acuity, improving on pinhole test, reduced distance visual acuity in patients already on refractive correction in absence of any other cause of reduced visual acuity, already on refractive correction coming for routine checkup.

Exclusion criteria

Children with: acute infections of the eye, media opacities, squint and nystagmus, amblyopia, anterior or posterior segment pathology leading to visual complaints, allergy to cycloplegic eye drops.

A complete history along with general, medical and ophthalmological examination was performed. Visual acuity was tested in children in the age group of 3-5 years and above 5 years to 15 years by Landolt's C test and snellen's visual acuity chart respectively. Non-cycloplegic automated refraction was carried out in all the children using an autorefractometer. Three readings were taken and the average of the three readings was considered as the final reading. After this, non-cycloplegic retinoscopy was carried out and the readings were recorded. In children aged 3-7 years cycloplegia was achieved using atropine sulphate 1% eye drops.[6] It was given three times a day for three successive days, then once on the morning of appointment.[7] The child was called for cycloplegic objective tests on the fourth day. In children aged 8-15 years cycloplegia was achieved using cyclopentolate hydrochloride 1% eye drops.[8] Three drops were instilled at 10 minutes interval. Cycloplegic objective tests were performed on complete cycloplegia, approximately 30 minutes after the last use of cyclopentolate 1% eye drops.[9] Cycloplegic autorefractometry was performed by the same method as non-cycloplegic autorefraction. Cycloplegic retinoscopy was then performed at 1 meter distance using a self-illuminated streak retinoscope. The values were recorded after deducting 1D for the working distance (i.e. 1 meter). Also, 0.75 D and 1.00 D were deducted for tonus allowance if cycloplegic drugs used were cyclopentolate and atropine respectively. To exclude any posterior segment pathologies, fundus examination was performed.

The patients in which atropine was used, were reviewed again after 2 weeks and with cyclopentolate were reviewed after 3 days for the assessment of subjective dioptric refractive acceptance (post mydriadric test). They were then prescribed with appropriate refractive correction.

The following measurements in diopters [D] were documented for analysis: spherical power, cylindrical power, axis, spherical equivalent [spherical power + (cylindrical power × ½)].

Statistical analysis

The statistical analysis of data was performed using the computer program, Statistical Package for Social Sciences (SPSS for Windows, version 21.0. Chicago, SPSS Inc.) and Microsoft Excel 2010. Results on continuous measurements were presented as mean ± standard deviation and were compared using Analysis of Variance (ANOVA). Where the p value was found significant ($p<0.05$) among 3 groups, post hoc analysis was done to find out the significance between 2 individual groups. For all analyses, the statistical significance was fixed at 5% level ($p<0.05$).

RESULTS

In this study, 906 eyes of the 453 children were divided into two groups- positive and negative sphere group based on the spherical power of subjective refraction. The values of spherical equivalent, spherical power, cylindrical power and axis were compared in the above two groups before and after cycloplegia.

Out of the 453 patients, maximum and minimum number of patients were in the age group of 13-15 years and 3-5 years respectively. The mean age group of the patients was 11.84±2.83 years.

Males constituted 41.28% while 58.72% of them were females.

It was observed that 42.38%, 28.26%, 20.75% and 8.61% patients presented with respective symptoms of diminished vision, headache, for routine check-up and other symptoms like eye strain, dizziness, insomnia, frequent low-grade infection of the eye, etc.

It was observed that 50.55% eyes had negative spherical power (myopia), 21.85% had positive spherical power (hypermetropia), and 27.59% had cylindrical power (astigmatism).

Table 1: Mean and standard deviation of refraction power in all the eyes using the different methods.

Methods	Spherical		Cylindrical		Axis		Spherical equivalent	
	Mean	± S.D.	Mean	± S.D.	Mean	± S.D.	Mean	± S.D.
Non-cycloplegic autorefraction (NCAR)	-1.57	2.90	-0.39	1.10	83.97	41.49	-1.54	2.85
Non-cycloplegic retinoscopy (NCR)	-1.16	3.25	-0.85	1.78	83.28	49.81	-1.22	3.26
Cycloplegic autorefraction (CAR)	-0.20	3.17	-0.24	0.91	91.28	52.49	-0.24	3.10
Cycloplegic retinoscopy (CR)	-0.17	3.10	-0.48	1.27	88.61	48.78	-0.23	3.07
Subjective refraction (SR)	-0.18	2.83	-0.23	1.10	93.14	37.58	-0.20	2.79
P value	<0.001		<0.001		0.0083		<0.001	

Table 2: Comparison of spherical equivalent in all the eyes.

Method	Number (n)	Mean	± SD	P value
SE-NCAR	906	-1.54	2.85	0.113
SE-NCR	906	-1.22	3.26	
SE-NCAR	906	-1.54	2.85	<0.001
SE-CAR	906	-0.24	3.10	
SE-NCAR	906	-1.54	2.85	<0.001
SE-CR	906	-0.23	3.07	
SE-NCAR	906	-1.54	2.85	<0.001
SE-SR	906	-0.20	2.79	
SE-NCR	906	-1.22	3.26	<0.001
SE-CAR	906	-0.24	3.10	
SE-NCR	906	-1.22	3.26	<0.001
SE-CR	906	-0.23	3.07	
SE-NCR	906	-1.22	3.26	<0.001
SE-SR	906	-0.20	2.79	
SE-CAR	906	-1.54	3.10	0.959
SE-CR	906	-0.23	3.07	
SE-CAR	906	-0.24	3.10	0.848
SE-SR	906	-0.20	2.79	
SE-CR	906	-0.23	3.07	0.889
SE-SR	906	-0.20	2.79	

Table 3: Comparison of sphere power in all eyes.

Serial No.	Method	Number (n)	Mean	± SD	P value
1	SPH-NCAR	852	-1.57	2.90	0.051
	SPH-NCR	852	-1.16	3.25	
2	SPH-NCAR	852	-1.57	2.90	<0.001
	SPH-CAR	846	-0.20	3.17	
3	SPH-NCAR	852	-1.57	2.90	<0.001
	SPH-CR	852	-0.17	3.10	
4	SPH-NCAR	852	-1.57	2.90	<0.001
	SPH-SR	852	-0.18	2.83	
5	SPH-NCR	852	-1.16	3.25	<0.001
	SPH-CAR	846	-0.20	3.17	
6	SPH-NCR	852	-1.16	3.25	<0.001

Continued.

Serial No.	Method	Number (n)	Mean	± SD	P value
	SPH-CR	852	-0.17	3.10	
7	SPH-NCR	852	-1.16	3.25	<0.001
	SPH-SR	852	-0.18	2.83	
8	SPH-CAR	846	-1.57	3.17	0.884
	SPH-CR	852	-0.17	3.10	
9	SPH-CAR	846	-0.20	3.17	0.916
	SPH-SR	852	-0.18	2.83	
10	SPH-CR	852	-0.17	3.10	0.962
	SPH-SR	852	-0.18	2.83	

Table 4: Comparison of cylindrical power in all the eyes.

Serial No.	Method	Number (n)	Mean	± SD	P value
1	CYL-NCAR	378	-0.39	1.10	0.004
	CYL-NCR	282	-0.85	1.78	
2	CYL-NCAR	376	-0.39	1.10	0.180
	CYL-CAR	360	-0.24	0.91	
3	CYL-NCAR	376	-0.39	1.10	0.466
	CYL-CR	276	-0.48	1.27	
4	CYL-NCAR	376	-0.39	1.10	0.221
	CYL-SR	252	-0.23	1.10	
5	CYL-NCR	280	-0.85	1.78	<0.001
	CYL-CAR	360	-0.24	0.91	
6	CYL-NCR	280	-0.85	1.78	0.049
	CYL-CR	274	-0.48	1.27	
7	CYL-NCR	280	-0.85	1.78	<0.001
	CYL-SR	250	-0.23	1.10	
8	CYL-CAR	360	-0.39	0.91	0.052
	CYL-CR	274	-0.48	1.27	
9	CYL-CAR	360	-0.24	0.91	0.905
	CYL-SR	250	-0.23	1.10	
10	CYL-CR	274	-0.48	1.27	0.088
	CYL-SR	250	-0.23	1.10	

Table 6: Comparison of axis in all eyes.

Serial No.	Method	Number (n)	Mean	± SD	P value
1	AX-NCAR	378	83.97	41.49	0.894
	AX-NCR	282	83.28	49.81	
2	AX-NCAR	376	83.97	41.49	0.141
	AX-CAR	360	91.28	52.49	
3	AX-NCAR	376	83.97	41.49	0.359
	AX-CR	276	88.61	48.78	
4	AX-NCAR	376	83.97	41.49	0.050
	AX-SR	252	93.14	37.58	
5	AX-NCR	280	83.28	49.81	0.170
	AX-CAR	360	91.28	52.49	
6	AX-NCR	280	83.28	49.81	0.371
	AX-CR	274	88.61	48.78	
7	AX-NCR	280	83.28	49.81	0.076
	AX-SR	250	93.14	37.58	
8	AX-CAR	360	83.97	52.49	0.644

Continued.

Serial No.	Method	Number (n)	Mean	± SD	P value
	AX-CR	274	88.61	48.78	
9	AX-CAR	360	91.28	52.49	0.737
	AX-SR	250	93.14	37.58	
10	AX-CR	274	88.61	48.78	0.408
	AX-SR	250	93.14	37.58	

The percentage of eyes with negative and positive spherical equivalent were 61.81% and 38.19% respectively.

As shown in the table, the mean of the spherical power and the spherical equivalent of all the eyes were more negative by the non-cycloplegic methods, than by the cycloplegic methods and the subjective refraction. (Table 1)

The table shows the comparison of spherical equivalent values by different methods. The comparison between NCAR-NCR, CAR-CR, CAR-SR and CR-SR were not statistically significant (p>0.05). (Table 2)

The comparison of spherical power values between NCAR-NCR, CAR-CR, CAR-SR and CR-SR were not statistically significant (p>0.05). In this group, the spherical power of subjective acceptance correlated the most with that of cycloplegic retinoscopy followed by that of cycloplegic autorefraction. There was good correlation between the spherical power values of cycloplegic autorefraction and retinoscopy. (Table 3)

The table shows the comparison of cylindrical power values by different methods. The comparison of cylindrical power values between NCAR-NCR, NCR-CAR, NCR-CR and NCR-SR were statistically significant (p<0.05). Subjective acceptance power was most consistent with that of cycloplegic autorefraction. (Table 4)

The comparison of the axis showed that none of the comparisons was statistically significant (p<0.05). The axis of subjective acceptance correlated the most with that of cycloplegic autorefraction followed by that of cycloplegic retinoscopy. (Table 5)

In our study, 78.69 % of the eyes had normal visual acuity of 6/6 after subjective refraction. None of the eyes had visual acuity of less than 6/9.

DISCUSSION

In the present study, the mean age was found to be slightly higher than the other studies. This variation may be because the highest number of patients in our study were in 13-15 years age group. In a study conducted by Rotsos et al to compare cycloplegic refraction and retinoscopy on the RMA-3000 autorefractometer in children aged 3 to 15 years, the mean age of the patients was found to be 8.61 years (0.25).[10] The number of males and females were 187 (41.28%) and 266 (58.72%) respectively. In the study conducted by Lowery et al, it was 38.66% and 61.33% respectively.[7] In our study, larger number of children had diminished vision as their presenting symptom (48.57%). In the study conducted by Rotsos et al11, maximum number of the patients came for routine eye check-up (46.5%) and were found to have refractive error.

In our study, we found that the values of spherical equivalent and sphere power in non-cycloplegic autorefraction and retinoscopy were consistently more negative (or less positive) than the corresponding values after cycloplegia. The results were comparable to the studies conducted by Zhao et al in china and Funarunart et al in Thailand.[12,13] The comparison of spherical equivalent by different methods showed that there was good correlation between cycloplegic retinoscopy and cycloplegic autorefraction in our study. This was similar to the results of Akil et al.[2] There was statistical significance when non-cycloplegic autorefraction was compared with, cycloplegic autorefraction and cycloplegic retinoscopy. However, there was good agreement between cycloplegic retinoscopy and cycloplegic autorefraction. This was comparable to the results of Pedamallu et al and Guha et al.[14,15]

In our study, the comparison of the cylinder power of eyes in the positive sphere group, before and after cycloplegia was found to be statistically insignificant. The results were comparable to several published studies. In a study conducted by Pokupec et al, the comparison was insignificant.[16] However, the subjective acceptance of cylinder power was more comparable with cycloplegic autorefraction values in our study. It was comparable to the study by Walline et al.[17]

In our study, there was no significant change of axis between non-cycloplegic and cycloplegic methods. This was comparable to several other studies like by Pokupec et al.[16] It was seen that, subjective acceptance of cylindrical axis correlated the most with that of cycloplegic autorefraction. This was consistent with the study by Pedamallu et al, who said that cycloplegic autorefraction cylindrical axis measurements were the best of all methods.[14]

Thus, cycloplegia seems optional in the correct diagnosis of the value of cylinder power and axis in astigmatism. Cycloplegic autorefraction may be particularly useful because of the difficulty in determining the precise axis of astigmatism with retinoscopy. In our study, maximum number of the eyes (78.69 %) had normal visual acuity of 6/6. None of the eyes had visual acuity less than 6/9 after subjective refraction.

There was good correlation between cycloplegic autorefraction when compared with cycloplegic retinoscopy in all the 906 eyes. The study conducted by Pokupec et al, found that the exact value of the refractive error is obtained only with cycloplegia – either by retinoscopy or an automatic refractometer.[16] A study by Wood et al, found that results of objective refractors after cycloplegia, is comparable or superior to retinoscopy in accuracy in children.[16] In a study by Jorge et al, the results obtained for the value of the spherical equivalent showed that the autorefractor values were more negative in the myopia and less positive in the hypermetropia than retinoscopy and subjective refraction.[19] These results tally with that of Bullimore et al and Mutti et al.[20]

Though automatic refractometer produces a fast and repeatable measurement, one must assess its agreement with the gold standard method, i.e. cycloplegic retinoscopy. Autorefractors should be used with caution in young children, in whom accommodation is more active than in older patients. In them, significant instrument myopia may be induced by the device or the real hyperopia may be underestimated.

The limitations of our study were small children <3 years were not included in our study and exclusion of cases with strabismus and ocular diseases may have caused change in overall results. Also, we have not checked the systemic status, height, weight, BMI of the patients and some studies showed nutritional status also changes the power of accommodation.

CONCLUSION

The spherical and cylindrical measurements of cycloplegic autorefraction can be substituted for conventional cycloplegic retinoscopy in young children. The cylindrical axis measurements of cycloplegic autorefraction are even better than that of cycloplegic retinoscopy. Although expensive, cycloplegia autorefraction can be a valuable method of refraction for children, as it can be easily run by an ophthalmic assistant and therefore eliminates the ophthalmologist's examination time required for retinoscopy. Non-cycloplegic autorefraction and retinoscopy were not found to be reliable in estimating the refractive error in children, as they can underestimate hyperopic refractive errors as well as overestimate myopic refractive errors. Further studies are required to understand the exact correction factor required for accurate assessment of refraction among children when resorting to non-cycloplegic methods.

ACKNOWLEDGEMENTS

I express my heartfelt gratitude and indebtedness to my respected teacher-cum-guide, Dr. (Mrs.) Mamoni Baruah, and my HOD Dr. J.J. Kuli whose encouragement has helped me in carrying out this study in a proper and precise manner.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Ovenseri-Ogbomo G, Omuemu V. Prevalence of refractive error among school children in the Cape Coast Municipality, Ghana. Clin Optom. 2010;59.
2. Akil H, Keskin S, Çavdarli C. Comparison of the Refractive Measurements with Hand-held Autorefractometer, Table-mounted Autorefractometer and Cycloplegic Retinoscopy in Children. Korean J Ophthalmol. 2015;29(3):178.
3. Clinical Refraction. In: Clinical Optics. American Academy of Ophthalmology. 2018.
4. Lowery J, Johachim R, Olson R, Peel J, Pearce N. Autorefraction vs. 2005;16(1):3-8.
5. Deepikadevi S, Sundararajan D, Namitha K, Murali K. Comparing the effect of conventional method of retinoscopic refraction with computerized automated refraction in various refractive error patients. Int Arch Integr Med. IJAM. 2017;4(10):104-10.
6. Abrams D. Objective methods of refraction. In: Duke-Elder's Practice of Refraction. 10th ed. India: Butterworth Heinemann Elsevier. 2016;169.
7. The pediatric eye examination. In: Basic and clinical science course, volume 6,Pediatric ophthalmology and strabismus. American Academy of Ophthalmology. 2018.
8. Abrams D. Objective methods of refraction. In: Duke-Elder's Practice of Refraction. 10th ed. India: Butterworth Heinemann Elsevier. 2016;170.
9. Havener WH. Ocular pharmacology. Second. United States of America: The C.V. Mosby Company. 1970;196.
10. Bron AJ, Tripathi RC, Tripathi BJ. The cornea and sclera. In: Wolff's Anatomy of the eye and orbit. 8th ed. Spain: Chapman and Hall Medical. 1997;235-63.
11. Rotsos T, Grigoriou D, Kokkolaki A, Manios N. A comparison of manifest refractions, cycloplegic refractions and retinoscopy on the RMA-3000 autorefractometer in children aged 3 to 15 years. Clin Ophthalmol. 2009;2009:429-31.
12. Zhao J, Pan X, Sui R, Munoz SR, Sperduto RD, Ellwein LB. Refractive error study in children:

Results from Shunyi District, China. Am J Ophthalmol. 2000;129(4):427-35.
13. Funarunart P, Tengtrisorn S, Sangsupawanich P, Siangyai P. Accuracy of noncycloplegic refraction in primary school children in southern Thailand. J Med Assoc Thail. 2009;92(6):806-12.
14. Pedamallu S, Reddy K, Pedamallu R, Pedamallu C. Reliability of Cycloplegic Autorefractor Measurements to determine Spherical and Astigmatic Refractive Errors in Young Children. Internet J Ophthalmol Vis Sci. 2012;6(1):1-5.
15. Guha S, Shah S, Shah K, Hurakadli P, Majee D, Gandhi S. A comparison of cycloplegic autorefraction and retinoscopy in Indian children. Clin Exp Optom. 2017;100(1):73-8.
16. Pokupec R, Mrazovac D, Popović-Suić S, Mrazovac V, Kordić R, Petricek I. Comparison between refractometer and retinoscopy in determining refractive errors in children--false doubt. Coll Antropol 2013;37(Suppl 1):205-8.
17. Walline J, Kinney K, Zadnik K, Mutti D. Repeatability and validity of astigmatism measurements. J Refract Surg. 1999;15(1):23-31.
18. Wood MG, Mazow ML, Prager TC. Accuracy of the Nidek ARK-900 objective refractor in comparison with retinoscopy in children ages 3 to 18 years. Am J Ophthalmol. 1998;126(1):100-8.
19. Jorge J, Queirós A, Almeida JB, Parafita MA. Retinoscopy/autorefraction: Which is the best starting point for a noncycloplegic refraction? Optom Vis Sci. 2005;82(1):64-8.
20. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnik K. Parental myopia, Near Work, School Achievement, and Children ' s Refractive Error. Investig Opthalmology Vis Sci. 2002;43(12):3633-40.

Cite this article as: Kedia P, Baruah M. A study on non-cycloplegic and cycloplegic streak retinoscopy and autorefractometry in children. Int J Res Med Sci 2022;10:919-25.