International Clinical and Medical Case Reports Journal
Salient Visionary Publications
Research Article (ISSN: 2832-5788)

Refraction with and Without Cycloplegia in 10 to 16 Years Old Children - A Comparative Study

Hafsa KM[1], Hafees Abdullah Perumbally[2]* and Cyril Mathew George[1]

[1]Department of Ophthalmology, MES Academy of Medical Sciences, India

[2]Department of ENT, MES Academy of Medical Sciences, India

Citation: *Hafsa KM, Perumbally HA, George CM. Refraction with and Without Cycloplegia in 10 to 16 Years Old Children - A Comparative Study. Int Clinc Med Case Rep Jour. 2025;4(5):1-12.*

Received Date: 04 May, 2025; **Accepted Date:** 09 May, 2025; **Published Date:** 12 May, 2025

***Corresponding author:** Hafsa KM, Department of Ophthalmology, MES Academy of Medical Sciences, Perinthalmanna, Kerala, India

1. ABSTRACT

1.1. Introduction: Accommodation interferes with accurate measurement of refractive errors especially in children. This study compares automated refraction with and without cycloplegia and manual objective refraction to the final acceptance in children.

1.2. Purpose of the study:

- To determine the concordance of refractive error, determined by automated refraction with and without cycloplegia and manual refraction method.
- To compare the values obtained by automated refraction with and without cycloplegia.

1.3. Materials and Methods: Prospective cross sectional observational study in children aged between 10 to 16 years. After evaluation of the visual acuity with Snellen's chart, non-cycloplegic automated refraction was taken. After adequate cycloplegia, automated refraction as well as retinoscopic refraction was done followed by post cycloplegic final acceptance. The spherical and cylindrical error as well as the spherical equivalent of non-cycloplegic and cycloplegic automated refraction and manual refraction were compared to the final acceptance. Analysis was done using SPSS software.

1.4. Results: The study had 37 myopes and 23 hyperopes and revealed that in hyperopes, spherical error by non-cycloplegic automated refraction did not correlate with manual retinoscopic refraction or final acceptance whereas in myopes, non-cycloplegic automated refraction was reliable. But cycloplegic automated refraction correlated well to both retinoscopic refraction and final acceptance in both myopes and hyperopes. Study also revealed a significant difference between non-cycloplegic and cycloplegic refraction in hyperopes.

1.5. Discussion: Cycloplegic automated refraction is as reliable as retinoscopy in both myopes and hyperopes whereas non-cycloplegic automated refraction alone should not be used to prescribe glasses in children. Retinoscopy gives the best measurements amongst all the three.

1.6. Keywords: Refractive error; Cycloplegia; Automated refraction; Retinoscopy

2. INTRODUCTION

Refractive error is the most common visual impairment seen worldwide and second major cause of blindness in India. It is the most common reason for patients to consult ophthalmologists [1]. Simple correction of refractive error in children can have long- term developmental, educational, and social benefits. The current United States recommendation is 1 - 2 yearly visual screening in children with age-appropriatevisual acuity [2]. In recent years, Computerized Automated Refractometry has become a necessity because of the busy clinical schedule of ophthalmologists and also because of the increasing faith of patients in sophisticated mechanical devices. They have the advantage of being easier to operate, faster than other objective refraction techniques and are better tolerated by patients [3].

However, accommodation interferes with accurate diagnosis of refractive errors. Cycloplegia which overcomes accommodation gives a more accurate value of the refractive status [4].

Cycloplegics act by paralyzing the ciliary muscles and dilating the pupil. Because of the strong accommodative reserve of young people (less than 16 years of age), objective refraction with cycloplegics should be done to accurately measure refractive error. However, the refraction under cycloplegia is not final for spectacle prescription because the refractive power of the lens has been altered. Hence, cycloplegic refraction should always be verified subjectively using corrective lenses, in a post cycloplegic test. Cycloplegic retinoscopy followed by final acceptance remains the gold standard for measuring refractive status in youngsters [5].

This study compares the concordance of automated and manual refractometry and compares it to the subjective acceptance.

3. MATERIALS AND METHODS

This hospital based cross sectional study was conducted from 1st January 2021 to 31st December 2021 among all children aged between 10 to 16 years, evaluated for refractive errors in the Department of Ophthalmology, MES academy of medical sciences.

The sample size was calculated as 58 cases, based on the study by Anita Ganger et al. (6), by the following formula:

$$n=4(p-q)/d^2$$

p: Prevalence from previous studies

q: (100 - p)

d: Allowable error

3.1. Inclusion criteria

- Children of the age group 10 - 16 years who came to the OPD with vision less than or equal to 6/12 vision; improving with pinhole to 6/9 or better.
- Children with asthenopic symptoms.
- Children who have not worn glasses previously.

3.2. Exclusion criteria

- Children with decreased visual acuity due to causes other than refractive disorder.

After obtaining written informed consent from the guardians of children fulfilling the inclusion criteria, data was collected in the following steps.

Distant visual acuity was assessed using Snellen's chart at a distance of 6 meters. Refraction was done by autorefractometer (Accuref K -900 Shin-Nippon) for both spherical and cylindrical correction, and spherical equivalent was calculated.

Cycloplegia achieved with homatropine eye drops and manual streak retinoscopy followed by cycloplegic autorefraction was done for both spherical and cylindrical errors. All cylindrical measures were presented in negative notations. Spherical equivalent was calculated using the formula:

$$\text{Spherical equivalent} = \text{Spherical power} + \tfrac{1}{2}\ \text{Cylinder power}$$

Post cycloplegic subjective refraction was done after 3 days.

Data was entered in MS - Excel sheet and analysed using IBM - SPSS software. Association of categorical variables was assessed using Mann - Whitney U test and a p - value of <0.05 was considered to be statistically significant. The study was approved by the institutional ethics committee on 2nd December 2022.

4. RESULTS

A total of 60 right eyes of 60 patients were evaluated in the study. The mean age was 12.95 years ± 1.80 years. There were 33 girls and 27 boys in the study population (Table 1).

Based on the spherical equivalent values obtained by the final acceptance, this study population had 37 myopic eyes and 23 hypermetropic eyes. With 62 %, the study had far more myopes than hyperopes. The study had spherical refractive errors ranging from -3.25 to +2.25 Diopters (D) and astigmatic error up to -2.50 D.

Firstly, the results of spherical errors obtained by Manual Streak Retinoscopic Refraction (MR) and Final Acceptance (FA) by subjective refraction were compared. 37 myopic patients had mean and standard deviation -0.87 ± 1.18 by MR and -0.94 ± 1.01 by FA and a mean difference of 0.0675 with p value 0.680 whereas in the 23 hypermetropia, the mean and standard deviation was 0.88 ± 0.49 by MR and 0.78 ± 0.44 by FA with a mean difference of 0.097 from subjective refraction and p value of 0.403 (Figure 1 and 2) (Table 2).

When cylindrical errors obtained by retinoscopy and subjective method were compared, myopic patients had a mean and standard deviation of -0.68 ± 1.26 with MR and -0.52 ± 0.95 with FA and a mean difference of 0.16 with p value 0.768; whereas, in hypermetropia the mean and standard deviation were 0.01 ± 0.28 by MR and 0.06 ± 0.30 by FA with a mean difference of 0.054 and p value 0.404. Comparing spherical equivalent by retinoscopy and subjective method, myopic children had mean and standard deviation of -1.22 ± 1.04 by MR and -1.20 ± 0.88 by FA with a mean difference of 0.01 with p value 0.82; whereas, in hypermetropia it was 0.88 ± 0.46 by MR and 0.81 ± 0.35 by FA and mean difference of 0.07 with p value 0.73.

Secondly, when spherical errors given by Non-Cycloplegic Autorefraction (NCAR) and final acceptance was compared; myopic patients had mean and standard deviation of -0.85 ± 1.33 in NCAR, mean deviation of 0.094 and p value of 0.696. Whereas, in hypermetropia; mean and standard deviation with NCAR was 0.31 ± 0.37 with mean deviation of 0.467 and p value <0.0001 (Figure 3 and 4) (Table 2).

When cylindrical errors obtained by non-cycloplegic automated refraction and subjective method was compared, myopic patients had a mean and standard deviation of -0.69 ± 0.82 with NCAR and a mean difference of 0.17 with p value 0.678; whereas, in hypermetropia mean and standard deviation was 0.07 ± 0.34 by NCAR and a mean difference of 0.01 and p value 0.635 (Figure 5 and 6) (Table3). When spherical equivalent was compared between non cycloplegic automated refraction and final acceptance, myopic patients had a mean and standard deviation of -1.29 ± 1.25 with NCAR and a mean difference of 0.83 with p value 0.78; whereas, in hypermetropia mean and standard deviation was 0.35 ± 0.42 by NCAR and a mean difference of 0.46 and p value <0.0001 (Figure 5 and 6) (Table 3).

Thirdly, refractive errors obtained by automated refraction with and without cycloplegia was compared with each other. When spherical errors were compared, in myopes, the mean and standard deviation obtained with Cycloplegic Autorefraction (CAR) was -0.63 ± 1.44 and the mean difference between NCAR and CAR was 0.216 with p value of 0.43. Whereas, in hypermetropia mean and standard deviation for CAR was -0.89 ± 0.37 with a mean difference of 0.567 from NCAR and the p value was <0.0001.

When cylindrical errors were compared, myopes had mean and standard deviation of - 0.81 ± 0.83 with CAR and mean difference from NCAR was 0.114, p value was 0.66. Whereas, in hypermetropia mean and standard deviation was 0.01 ± 0.39 with CAR with a mean difference of 0.065, the p value was 0.63.

When spherical equivalents were compared, in myopes, the mean and standard deviation was -1.04 ± 1.31 with CAR and on comparison with NCAR, the p value was 0.401 with a mean difference of 0.252. Whereas in hypermetropia, the mean and standard deviation of NCAR was 0.89 ± 0.32, and on comparing with NCAR, p value obtained was <0.0001 with a mean difference of 0.543 (Figure 7).

Lastly, mean deviation of cycloplegic and non-cycloplegic autorefraction and manual retinoscopic refraction from final acceptance was compared. In myopes, p value was >0.05 for spherical, cylindrical as well as spherical equivalent. Whereas in hypermetropia NCAR showed significant deviation from FA in both spherical and spherical equivalent errors (Figure 7).

Table 1: Age distribution.

Age	Frequency	Percentage

10	8	13.3
11	5	8.3
12	12	20
13	10	16.7
14	12	20
15	8	13.3
16	5	8.3
Total	60	100

Table 2: Mean of refractive errors in myopics and hypermetropics.

Mean of refractive errors in Myopia			**Mean of refractive errors in Hypermetropia**		
		Mean			Mean
Sphere	NCAR	0.8514	Sphere	NCAR	0.3152
	CAR	0.6351		CAR	0.8913
	MR	0.8784		MR	0.8804
	FA	0.9459		FA	0.7826
Cylinder	NCAR	0.697	Cylinder	NCAR	0.761
	CAR	0.8108		CAR	0.0109
	MR	0.6892		MR	0.0109
	FA	0.527		FA	0.0652
Spherical equivalent	NCAR	1.29257	Spherical equivalent	NCAR	0.35326
	CAR	1.04054		CAR	0.89674
	MR	1.22297		MR	0.88587
	FA	1.20946		FA	0.81522
NCAR – Non Cycloplegic Auto Refraction					
CAR – Cycloplegic Auto Refraction					
MR – Manual Streak Retinoscopic Refraction					
FA – Final Acceptance by Subjective Refraction					

Table 3: Mean deviation from final acceptance (NCAR – Non-Cycloplegic Auto Refraction, CAR-Cycloplegic Auto Refraction, MR-Manual Retinoscopic Refraction, SE-Spherical Errors).

		Mean deviation from final acceptance	
		Myopia	**Hypermetropia**
Sphere	NCAR	0.0945	0.4674
	CAR	0.3108	0.1087
	MR	0.0675	0.0978
Cylinder	NCAR	0.3554	0.0109
	CAR	0.2838	0.0543
	MR	0.1622	0.0543
SE	NCAR	0.08311	0.46196
	CAR	0.16892	0.08152
	MR	0.01351	0.07065

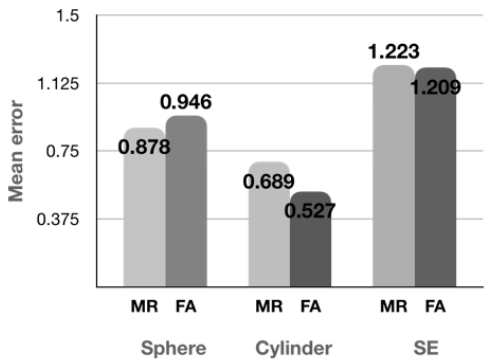

Figure 1: Comparison of mean of MR (Manual Streak Retinoscopic Refraction) and FA (Final Acceptance) in myopic patients.

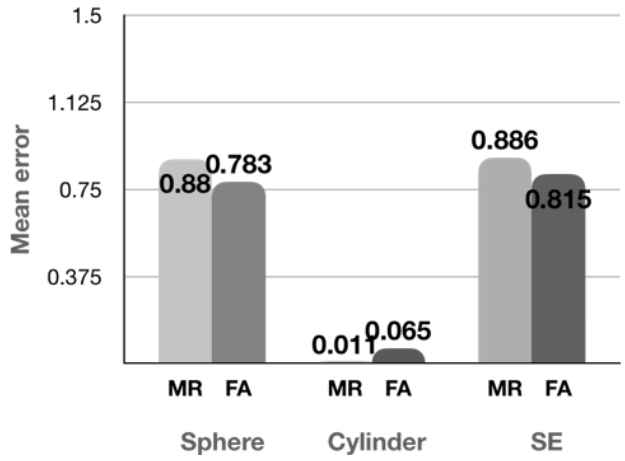

Figure 2: Comparison of MR (Manual Streak Retinoscopic Refraction) and FA (Final Acceptance) in hypermetropic patients.

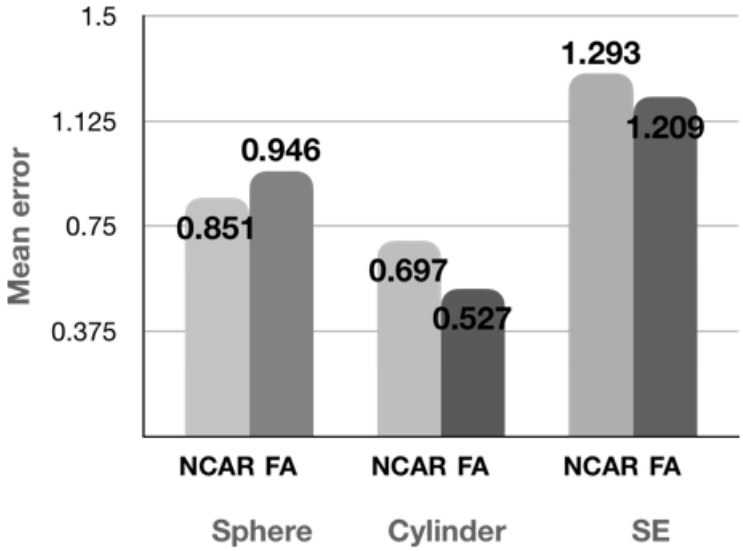

Figure 3: Comparison of mean of NCAR (Non-Cycloplegic Auto Refraction) and FA (Final Acceptance) in myopic patients. SE - Spherical Errors.

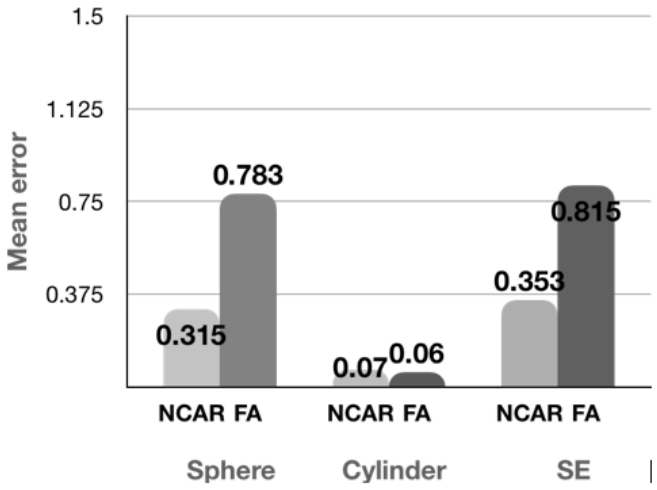

Figure 4: Comparison of mean of NCAR (Non-Cycloplegic Auto Refraction) and FA (Final Acceptance) in hypermetropic patients. SE - Spherical Errors.

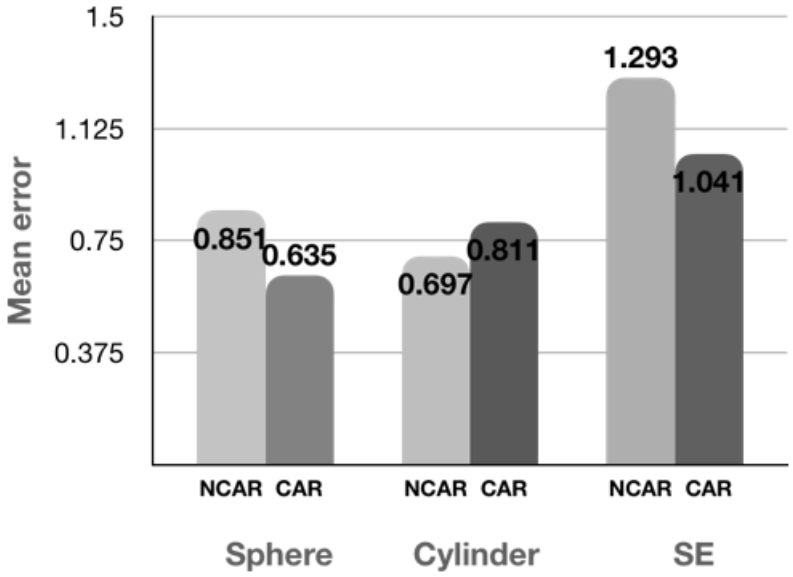

Figure 5: Comparison of mean of NCAR (Non-Cycloplegic Auto Refraction) and CAR (Cycloplegic Auto Refraction) in myopic patients. SE - Spherical Errors.

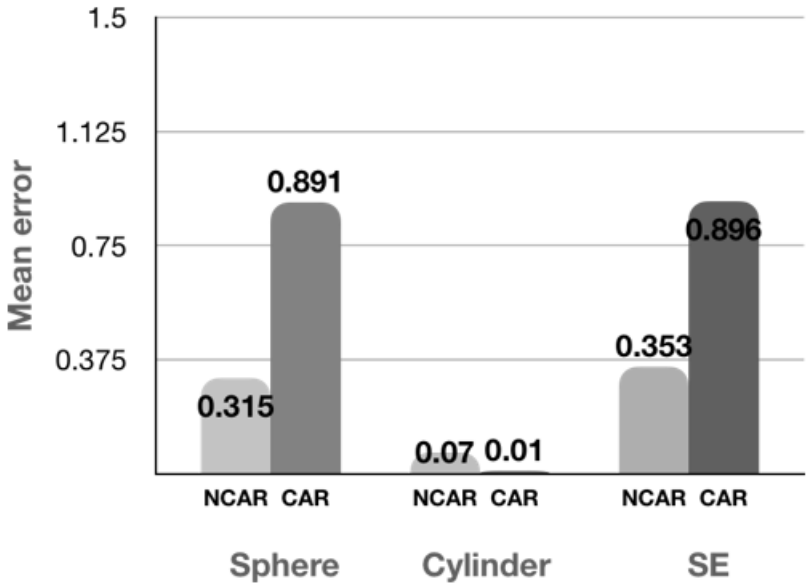

Figure 6: Comparison of mean of NCAR (Non-Cycloplegic Auto Refraction) and CAR (Cycloplegic Auto Refraction) in hypermetropic patients. SE - Spherical Errors.

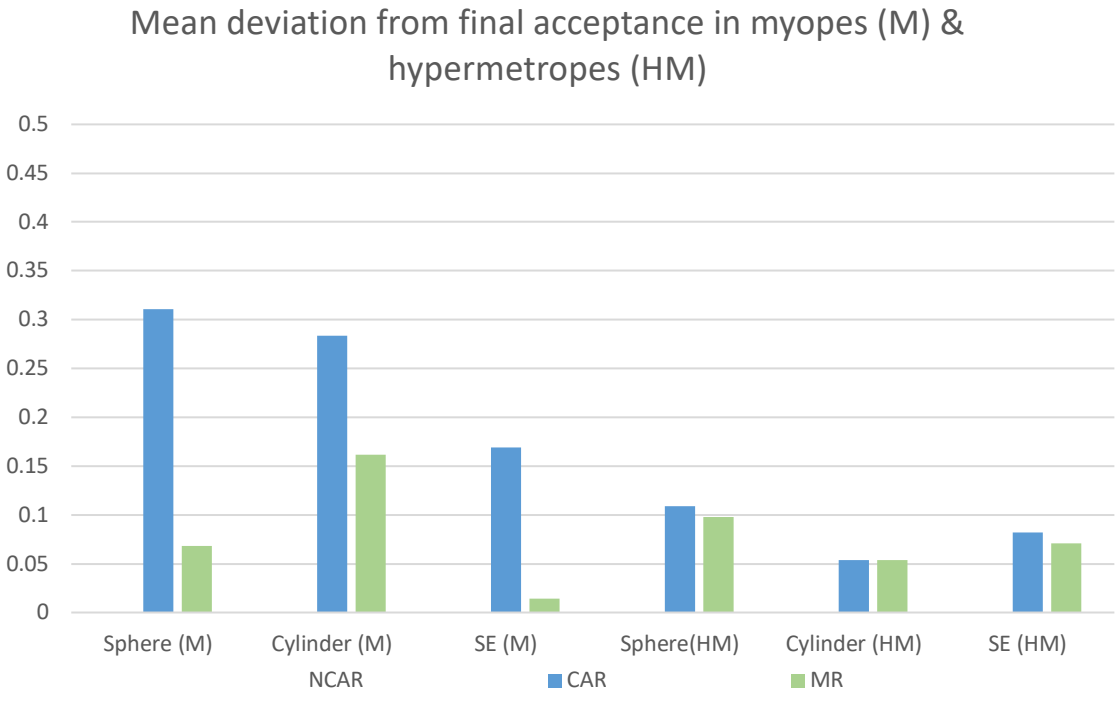

Figure 7: Mean deviation from FA in myopes (left) and hypermetropes (right). (M-Myopes, HM-Hypermetropia, NCAR- Non-Cycloplegic Auto Refraction, CAR-Cycloplegic Auto Refraction, MR-Manual Retinoscopic Refraction)

5. DISCUSSION

In the study by Anita Ganger A [6] done in 100 eyes of children of age 7 - 14 years, cycloplegic AR, cycloplegic manual retinoscopy and subjective refraction was compared and found to have no significant deviation between them. This study had a lower sample size due to covid pandemic and was conducted in slightly older children but also included non-cycloplegic autorefraction. No significant deviation was found with cycloplegic autorefraction and the final acceptance. But non cycloplegic autorefraction showed significant deviation from manual refraction using retinoscopy and final acceptance in hypermetropia. Bullimore MA [7] compared 3 autorefractors to measure its accuracy to that of subjective refraction in a cross-sectional study on 117 children; but all 3 autorefractors gave accurate and repeatable values under cycloplegia. Similar findings with good concordance of cycloplegic retinoscopy in children was seen in a study by Wilson LB, et al. [8]. Study by Bullimore MA [7] also revealed the tendency of autorefractors to minus overcorrection under non cycloplegic conditions, but was found to be insignificant. In this study non cycloplegic autorefraction gave more minus errors in myopes and less plus values in hyperopes, showing a myopic shift in non-cycloplegic refraction. But this difference was found to be significant only in hypermetropia. Study by Ilechie AA [9] conducted in African children of 6 to 15 years gave highly inaccurate values using non cycloplegic autorefraction especially in hyperopes. This suggests that in hypermetropic children, excess use of accommodation at the time of checking autorefraction can alter the refractive error values.

5.1. Difference observed between cycloplegic and non-cycloplegic refractions

A study conducted by Babitha V [10] on comparing cycloplegic retinoscopy and non-cycloplegic AR showed about <0.5D difference in myopes and emmetropes, and 1-2D difference in hyperopes. This difference was large for hyperopic eyes (mean difference of -2.98 +/- 1.65 D for hyperopia of at least +2.00 D) and small for myopic eyes (mean difference of -0.41 +/- 0.46 D for myopia of -2.00 D or more). Whereas in this study a mean difference of 0.2D in myopes and 0.5 diopters in hyperopes was observed.

Rosenfield M [11] used Nikon Retinomax handheld auto refractometer to determine its accuracy as compared to subjective as well as cycloplegic retinoscopy. Greater than -2.0 D overcorrection was observed in 24% of the cases when cycloplegia was not done. More than three quarter of the study population had <1D of myopic spherical equivalent difference in a study by Guo X [12]. Uras R [13] did a study in 192 right eyes of 192 healthy young adults. On comparing the mean spherical equivalent values obtained by non-cycloplegic AR with subjective refraction, the AR values were not correlating well with the subjective refraction.

5.2. Cycloplegia and astigmatic error

Study by Asharlous A, et al. [14] using cyclopentolate cycloplegic eye drops in a mixed age group found cycloplegia cause statistically significant shift in with the rule and against the rule in astigmatism as compared to oblique astigmatism. Bagheri A [15] used an autorefractor and Scheimpflug imaging system in his study and

found a change in astigmatic axis along with increased central corneal thickness and change in curvature of posterior corneal surface. These changes were more evident in higher orders of astigmatism.

This study had an astigmatic error of upto -2.5D only, and did not find any significant change in the power of the cylindrical component. Axis was not compared in this study. These results were in line with the findings of a study done by Doherty SE [16] and Li T. [17]. A study by Goyal S [18] done in children of age 4 to 17 years also found no significant difference in the power and axis of astigmatism after cycloplegic refraction as compared to non-cycloplegic refraction.

6. CONCLUSION

Although an auto refractometer is a very useful machine in a busy ophthalmic clinic, it cannot replace the accuracy of a streak retinoscope in the hands of an expert. Cycloplegic retinoscopy remains the gold standard for refraction. Cycloplegic autorefraction also shows good agreement with retinoscopic refraction and hence can be used for prescribing glasses in both myopic and hypermetropic patients. Auto- refraction without cycloplegia tends to underestimate hypermetropia and overestimate myopia and should be avoided in patients who have good accommodative power. So, it is recommended to do cycloplegic refraction either automated or manual before prescribing glasses to children.

7. FUNDING

NIL

8. ACKNOWLEDGEMENT

NIL

9. CONFLICTS OF INTEREST

None declared

10. REFERENCES

1. Cost-effective screening of schoolchildren for refractive errors - PubMed [Internet]. [cited 2024 Mar 8]. Available from: https://pubmed.ncbi.nlm.nih.gov/7794456/
2. Honavar SG. Pediatric eye screening - Why, when, and how. Indian J Ophthalmol. 2018;66(7):889-92.
3. 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.
4. Krishnacharya PS. Study on accommodation by autorefraction and dynamic refraction in children. J Optom. 2014;7(4):193-202.
5. Choong YF, Chen AH, Goh PP. A comparison of autorefraction and subjective refraction with and without cycloplegia in primary school children. Am J Ophthalmol. 2006142(1):68-74.

6. Ganger A, Bala S, Kaur I, Kaur P. Comparison of Autorefractometer, Retinoscope and Subjective Method in Myopic and Hypermetropic Patients. 2017;4(3)-740-3.
7. Bullimore MA, Fusaro RE, Adams CW. The repeatability of automated and clinician refraction. Optom Vis Sci. 1998;75(8):617-22.
8. Wilson LB, Melia M, Kraker RT, VanderVeen DK, Hutchinson AK, Pineles SL, et al. Accuracy of Autorefraction in Children: A Report by the American Academy of Ophthalmology. Ophthalmology. 2020;127(9):1259-67.
9. Ilechie AA, Addo NA, Abraham CH, Owusu-Ansah A, Annan-Prah A. Accuracy of Noncycloplegic Refraction for Detecting Refractive Errors in School-aged African Children. Optom Vis Sci. 2021;98(8):920-8.
10. Babitha V, Parbhu PB, Nadhiya T, Raju KV. A comparative study of noncycloplegic automated refraction, cycloplegic automated refraction and cycloplegic refraction among youngsters. Indian J Clin Exp Ophthalmol. 2017;3(2):202-6.
11. Rosenfield M, Chiu NN. Repeatability of subjective and objective refraction. Optom Vis Sci. 1995;72(8):577-9.
12. Guo X, Shakarchi AF, Block SS, Friedman DS, Repka MX, Collins ME. Noncycloplegic Compared with Cycloplegic Refraction in a Chicago School-Aged Population. Ophthalmology. 2022;129(7):813-20.
13. Uras R, Belfort Jr R, Hofling-Lima AL, Martins EN. Automatic objective refraction and clinical refraction - a comparative analysis. Arq Bras Oftalmol. 200;64:33-8.
14. Asharlous A, Hashemi H, Jafarzadehpur E, Mirzajani A, Yekta A, Nabovati P, et al. Does astigmatism alter with cycloplegia? J Curr Ophthalmol. 2016;28(3):131-6.
15. Bagheri A, Feizi M, Shafii A, Faramarzi A, Tavakoli M, Yazdani S. Effect of Cycloplegia on Corneal Biometrics and Refractive State. J Ophthalmic Vis Res. 2018;13(2):101-9.
16. Doherty SE, Doyle LA, McCullough SJ, Saunders KJ. Comparison of retinoscopy results with and without 1% cyclopentolate in school-aged children. Ophthalmic Physiol Opt. 2019;39(4):272-81.
17. Li T, Zhou X, Zhu J, Tang X, Gu X. Effect of cycloplegia on the measurement of refractive error in Chinese children. Clin Exp Optom. 2019;102(2):160-5.
18. Goyal S, Phillips PH, Rettiganti M, Gossett JM, Lowery RS. Comparison of the Effect of Cycloplegia on Astigmatism Measurements in a Pediatric Amblyopic Population: A Prospective Study. J Pediatr Ophthalmol Strabismus. 2018;55(5):293-8.