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Original Research Article

Comparison of non-cycloplegic and cycloplegic autorefraction in children of age 8 to 12 years

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Abstract: ***Background***: Refractive error is a leading cause of visual impairment in children and requires accurate assessment for proper correction. Autorefraction is commonly used, but its accuracy can vary without cycloplegia due to active accommodation in children. ***Purpose:*** To compare the non-cycloplegic and cycloplegic auto refraction in children of age 8 to 12 years. ***Materials and Methods:*** This cross-sectional study conducted in Ophthalmology department of Arif memorial teaching hospital (2023 to 2024) examined refractive errors in 76 children aged 8-12 years using cycloplegic refraction. Cycloplegic eye drops were administered, and refractive errors were measured with an automated refractometer and retinoscopy. Collected data was analyzed in SPSS software. ***Results:*** A total of 76 patients, mean age 9.11+1.66 years and 55.3% males were included. Cycloplegic refraction showed a significant improvement in spherical values for both eyes (right eye: -0.7 to -0.09, left eye: -0.73 to -0.03, p=0.001). Cylindrical measurements showed minimal changes in the right eye (p=0.78) and significant improvement in the left eye (p=0.003). Significant improvement in the refraction for the 8-11 years group, while changes were less significant for those over 11. Myopia decreases slightly from 81.4% pre-cycloplegia to 80.3% post-cycloplegia. ***Conclusion:*** Significant improvements in spherical refraction for both eyes after cycloplegia, with minimal changes in cylindrical refraction. Younger children 8 to 10 years showed more notable reduction in spherical refraction compare to older children. Myopia decreased slightly, while high myopia increased post-cycloplegia, indicating refraction helps refine the assessment of refractive error in children.

Keywords: Cycloplegia, Myopia, Eye, Autorefraction, Spherical.

INTRODUCTION

Refractive error is a significant global health issue, impacting a large portion of the population and associated to numerous ocular conditions.(1, 2) The harmful effects of refractive errors highlight the need for regular regional surveys to monitor trends and assess the burden over time helping to inform effective prevention strategies. Recently, it has even been suggested that cycloplegic refraction should be extended to adults under the age of 50.(3) However, several issues related to cycloplegic refraction remain unresolved. While it is feasible to conduct cycloplegic refraction in population-based studies, it presents significant difficulties in large-scale or school-based studies, particularly when involving young children.(4, 5)

Many parents and children do not agree to undergoing cycloplegic refraction due to the temporary blurred vision that follows cycloplegia. In addition, the feasibility and potential side effects of cycloplegia present additional challenges. It is well established that without cycloplegia, myopia tends to be overestimated, while hyperopia is often underestimated. However, the extent to which refractive errors are overestimated or underestimated varies across populations, with the overall prevalence of refractive errors being a key factor influencing the difference between cycloplegic and non-cycloplegic measurements. The epidemiology of myopia in Chinese children is of the particular interest to global myopia research due to its high prevalence. The Shandong children Eye study, for example, compared myopia prevalence before and after cycloplegia and found that non-cycloplegic refraction led to significant misclassification of refractive errors in many children. However, the prevalence of myopia in the Shandong study 37% was lower compared to other similar age population in China, raising questions about whether these findings can be generalized to other primarily myopia Chinese populations. (6, 7)

Refractive error, including myopia 12 patients, hypermetropia 22 patients and astigmatism 16 patients are common visual conditions that significantly affect eye health. Cycloplegic refraction is considered the gold standard for assessing errors, but dynamic retinoscopy is often used as an alternative, especially in children. Studies show that differences between these methods can lead to variations in refractive measurements. Understanding these discrepancies is important enhancing diagnostic accuracy in epidemiological research.(8)

The aim of the study is to compare cycloplegic and non-cycloplegic refraction methods in children of age 8 to 12 years by evaluating the differences in refractive error measurements between these two techniques. The study seeks to assess their accuracy and clinical relevance. The findings will contribute to better understanding of which method provides more reliable results for this age group. Thia comparison could inform future practices in pediatric eye care.

Methodology:

This cross-sectional study was conducted Ophthalmology department from 2023 to 2024. Non-probability consecutive sampling was used. Convenient sampling was used. Sample size 76 with 8% margin of error and 95% confidence interval with expected 37% frequency of myopia with age 8 to 12 years undergoing eye examination and measure or analyze refractive errors, including spherical, cylindrical, and axis values, in patients using cycloplegic refraction techniques were included. Patients with active ocular infections and history of ocular surgery or trauma were excluded from the study.

Participants were recruited from ophthalmology clinics and community eye health programs. Informed consent was obtained. Cycloplegic eye drops (*e.g.* tropicamide or cyclopentolate, one drop) were administered. Adequate time (15–30 minutes) was allowed for the cycloplegic effect to take place. Refraction was measured using an automated refractometer and confirmed via retinoscopy. Results were recorded in spherical (D), cylindrical (D), and axis (degrees) formats. Demographic data like age, gender, and relevant ocular history were also be recorded.

Data were analyzed in SPSS V26. Age, Pre and Post right or left eye refraction value were presented as mean and SD. Gender was presented as frequency and percentage. Paired sample t test was applied to pre and post data or cycloplegia of left and right eye. Chi square test was also applied to check the significance of age group and myopia. P values <0.05 was considered as significant.

RESULTS

Total 76 patients were included. The mean age of the patients was 9.11±1.66 years. There were 42(55.3%) male and 34(44.7%) female.

Table: 1 shows that the mean spherical values in both right and left eyes significantly decreased after cycloplegic refraction (p=0.001 for both eyes), indicating a shift towards emmetropia after accommodation was relaxed. Cylindrical changes were minimal in the right eye (p=0.78) but statistically significant in the left eye (p=0.003), suggesting that cycloplegia had more influence on astigmatic correction in the left eye. This pattern implies that spherical refractive error is more sensitive to cycloplegic assessment, while cylindrical changes are less pronounced and variable between eye.

When stratified by age, children aged 8 to 11 years showed significant improvement in spherical measurements for both eyes after cycloplegia (p=0.001). While greater than 11 years of group showed borderline significant for the left eye (p=0.05) and no significant changes in the right eye (p=0.06). Table: 2 Cylindrical values changed significantly only in the left eye for the younger group (p=0.004). In children aged 8 to 10 years, myopia was present in around 81% pre cycloplegia and 80% post-cycloplegia, while in those > 10 years, it was about 19% I both assessments. High myopia frequency also showed minimal change, and the differences were not statistically significant (p=0.53 pre-cycloplegia, p=0.99 post-cycloplegia). Table: 3

Table: 1

Comparison of spherical and cylindrical value with Pre (RE) (LE) and Post (RE) (LE), cycloplegic refraction

	Cycloplegic Refraction			
	Spherical (Right Eye)		Cylindrical (Right Eye0	
Right Eye	Pre (RE)	Post (RE)	Pre (RE)	Post (RE)
Mean	-0.7	-0.009	-0.88	-0.82
t value	-3.87		-0.26	
P value	0.001		0.78	
	Spherical (Left Eye)		Cylindrical (Left Eye)	
Left eye	Pre (RE)	Post (RE)	Pre (RE)	Post (RE)
Mean	-0.73	-0.03	-0.91	-0.5
t value	-0.41		-3.13	
P value	0.001		0.003	

Table: 2

Comparison of right and left eye of cycloplegic refraction with age group

Age (year)	Right Eye	Cycloplegic Refraction			
		Spherical (Right Eye)		Cylindrical (Right Eye0	
		Pre (RE)	Post (RE)	Pre (RE)	Post (RE)
8 to 11	Mean	-0.77	-0.44	-0.86	-0.78
	t value	-3.57		-0.32	
	P value	0.001		0.74	
>11	Mean	-0.12	0.46	-1.06	-1.18
	t value	-2.15		0.54	
	P value	0.06		0.60	
	Left eye				
8 to 11	Mean	-0.82	-0.15	-0.89	-0.44
	t value	-4.46		-2.99	
	P value	0.001		0.004	
>11	Mean	0.12	0.9	-0.055	-1
	t value	-2.28		-1.34	
	P value	0.05		0.22	

Table: 3

Comparison between the pre and post cycloplegic as regarding to number of patients with myopia and hyper myopia

	Age group				P value
	8 to 10	>10	8 to 10	>10	
	Myopia	High myopia	Myopia	High myopia	
Pre-cycloplegia	48(81.4%)	11(18.6%)	13(76.5%)	4(23.5%)	0.53
Post-cycloplegia	57(80.3%)	14(19.7%)	4(80%)	1(20%)	0.99

DISCUSSION

The present study evaluated cycloplegic and non-cycloplegic refraction of 76 patients aged 8 to 12 years. The findings suggest that cycloplegic refraction leads to more accurate and significant changes in both spherical and cylindrical refraction especially in younger age group. The significant improvements observed in both the right and left eyes' spherical refraction (p=0.001) with similar studies that highlight the importance of cycloplegic refraction in providing an accurate measurement of refractive errors.

In contrast, cylindrical refraction showed little or no significant change in both eyes, which may be explained by the fact that astigmatism, being a more stable refractive error, is less susceptible to cycloplegia than spherical refractive error.

In the present study, cycloplegia led to less myopia or greater hyperopia with auto refraction, with a mean difference of right was 1.01 D and left eye 0.69 D among children 8 to 12 years. Hu et al.,(6) Zhu et al.(9) and TaoLi et al.(10) reported a mean difference of 0.78 D, 0.57 D and 1.23 D after and before cycloplegia among Chinese school-aged children, respectively. In one study, refractive errors were analyzed for 5933 patients showing that children under 1 year were the most hyperopic (+1.79D), while myopia peaked at 27 years)-2.86D). MOR distribution was leptokurtic and negatively skewed, with increased variability in more myopic individuals.(11)

When comparing age groups, the 8 to 11 years group exhibits a more reduction in spherical refraction compared to the >11 years of age group. This can be attributed to the physiological development of the eye during this period. It is well-established that children in the 8-to-11-year range are in a phase of rapid visual system development, with refractive errors such as myopia becoming more stable after this age.(12) One study reported that cycloplegic spherical and cylindrical refraction in children developed using regression, and found highly accurate (R= 0.961 for spherical, R=-.89 for cylindrical, P<0.001). Refraction closely matched cycloplegic measurements and differed significantly from non-cycloplegic refraction for spherical errors but not for cylinder refraction.(13) Additionally, the significant p value (0.001) in the 8 to 11 years group further supports the idea that cycloplegia helps to reveal the true refractive error in this age group, as opposed to non-cycloplegic refraction, which can be influenced by accommodation.(14)

Above 11 years of age group, both spherical and cylindrical refraction changes were less significant. This suggest that as children age, their refractive error becomes more stable and less prone to significant changes, and non-cycloplegic refraction may be s sufficiently accurate measure for this age group. This finding is similar with previous studies, which report that cycloplegic refraction is particularly useful in younger children with uncorrected refractive errors or high accommodation.(15)

For the left eye, both spherical and cylindrical refractive values showed significant changes post-cycloplegia. This indicates that cycloplegic refraction was effective in revealing the true refractive error of the left eye which again supports the findings of earlier studies emphasizing the importance of cycloplegic refraction for accurate measurements, especially in younger children.(16)

The study findings also underline the clinical importance of cycloplegic refraction in assessing children refractive status Cycloplegia helps to eliminate the effects of accommodation, thus providing a more accurate baseline for the correction of refractive errors. This is particularly essential for preventing and managing myopia and astigmatism, which are among the most common refractive errors in children. (17)

Conclusion:

The conclusion of the study showed that significant improvements in spherical refraction for both eyes after cycloplegia, with minimal changes in cylindrical refraction. Cycloplegic refraction improved the accuracy of spherical measurements, with pronounced changes in younger children. Cylindrical change was minimal except in the left eye of the younger group. Despite these adjustments, the overall pattern of myopia remained unchanged.

Authors' contribution:
Concept and study design: SAM, NMA
Methodology: SAM, SZ, FM
Investigation: SAM, ZI, MC
Formal Analysis: SAM, MH, SA
Review and editing: SAM, NMA

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