

EFFECT OF CYCLOPLEGIA ON CORNEAL BIOMETRICS AND REFRACTIVE STATE

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Abstract

Introduction

Cycloplegic agents have diagnostic and therapeutic applications. A thorough assessment of the anterior segment is crucial for corneal refractive surgery, diagnosis, and follow-up. The objective of this study was to compare pre- and post-cycloplegic measurements in both eyes to assess the effect of cycloplegic agent instillation on anterior segment parameters such as spherical power (SPH), cycloplegic refraction, and keratometric readings (K1, K2), as well as gender differences in these changes.

Methodology

This cross-sectional analytical study was conducted in the Department of Ophthalmology, Paf Hospital Islamabad, from 1st January 2024 to 30th June 2024. Patients with clear ocular media and normal anterior segment morphology were eligible for this study. All subjects got a baseline anterior segment examination. Data was stored and analyzed using IBM SPSS version 23.0.

Results

The results showed large increases in spherical power after cycloplegic refraction, as well as a significant drop in the steeper keratometric value (K2) following cycloplegia in both eyes.

Conclusion

Cycloplegia causes large increases in spherical power and decreases in steep keratometric readings among juvenile patients. The findings emphasize the importance of cycloplegic evaluation in juvenile refractive assessment

INTRODUCTION

The choroid is a highly vascularized layer that is essential for optimal eye function. The outer retina receives oxygen and nutrients through finely controlled blood flow, works as a heat diffuser to protect photoreceptors, and secretes growth factors [1]. The form of the choroid is mostly dictated by the course and branching pattern of the ciliary arteries, as it is a vascular

tissue. SD-OCT technology now allows for accurate visualization and quantification of the human choroid [2, 3].

Recent clinical trials link choroidal thickness alterations to many eye disorders. Previous research suggests that short-term variations in choroidal thickness are caused by an autonomic nerve supply that activates sympathetic adrenergic

and parasympathetic muscarinic receptors [4]. However, the specific mechanism remains unknown [5]. In addition to autonomic innervation, the choroid receives sensory fibers from the trigeminal ganglion via the ophthalmic nerve. These fibers have a vasodilatory impact on choroidal blood flow through a local effector function known as the "axon reflex [1, 4]."

Nowadays, cycloplegic agents such as tropicamide, homatropine and cyclopentolate have diagnostic and therapeutic applications. These clinical applications include fundus examination, anterior segment assessment, cycloplegic refraction, treatment of uveitis, amblyopia treatment via pharmacological penalization [6]. A thorough assessment of the anterior segment is crucial for corneal refractive surgery, diagnosis, and follow-up. Accurate cycloplegic refraction, corneal curvature assessment, and CCT measurement are crucial for pre- and post-operative evaluation of corneal refractive surgery [7]. Multiple studies have investigated the effects of cycloplegia on the anterior segment characteristics and biometry components of the eyes, however there are some disputes concerning the modifications [1, 4, 5, 10,

The objective of this study was to compare pre- and post-cycloplegic measurements in both eyes to assess the effect of cycloplegic agent instillation on anterior segment parameters such as spherical power (SPH), cylinder, and keratometric readings (K1, K2), as well as gender differences in these changes.

Methodology

This cross-sectional analytical investigation was designed to assess the effect of a cycloplegic drug on anterior segment parameters. The research was conducted in the Department of Ophthalmology, Paf Hospital Islamabad from 1st January 2024 to 30th June 2024. The institutional review board granted ethical approval prior to data collection, and all participants (or their guardians in the case of children) provided informed consent.

Patients with clear ocular media and normal anterior segment morphology were eligible for

this study if they agreed to undergo cycloplegic refraction and anterior segment examination. Participants under the age of 18 were recruited to ensure homogeneity in accommodation response and ocular development. Patients were excluded if they had undergone ocular surgery or trauma, had corneal pathology or irregular astigmatism, or had any systemic or ocular disorder that affected accommodation or corneal curvature. Individuals with known hypersensitivity to cycloplegic agents were also barred from participating.

All subjects got a baseline anterior segment examination, which included spherical power (SPH), cylinder, and keratometric readings (K1, K2) for both eyes. Cycloplegia was created by instilling 1% cyclopentolate eye drops into both eyes three times after every 10 minutes. Measurements were repeated 30-45 minutes after the previous instillation to ensure complete cycloplegia, as shown by the absence of light reflex and full pupil dilation. The autorefractometer was used to capture anterior segment characteristics, and the results for the right and left eyes were reported independently.

Statistical Analysis

Data were stored and analyzed using IBM SPSS version 23.0; Counts with percentages were reported for gender and right and left number of eyes. Mean with standard deviation were given on age (years) and anterior segment parameters. Paired sample t-test was used to compare the mean of these parameters before and after instillation of cycloplegic agent for right and left eye of samples. Comparison was also made with respect to gender to see the effect of gender on outcomes. P-values less than 0.05 were considered statistically significant. Bar diagram and pie charts were also used to give graphical presentation of study outcomes.

Table 1: Baseline Characteristics of studied samples

Variable	N	%	
Gender	Male	78	91.8
	Female	7	8.2
Age (years)	Mean (±SD)	13.2	±4.5

Results

Table-1 reports the descriptive on gender and age of patients, in the present study male were (91.8%), mean age of samples was 13.2 (SD=±4.5) years.

Table-2 reports the mean comparison on anterior segment parameters among samples before and after instillation of Cycloplegic agent

Results showed for a right eye a significant increase in SPH (MD=-1.2) and Cylinder (MD=-0.7), and significant decrease in K2 (MD=0.7) after instillation of Cycloplegic agent (p<0.05), similarly for the left eye a significant increase in SPH (MD=-1.1) and Cylinder (MD=-0.7) was observed and a significant decrease in K2 (MD=0.6) was found after instillation of Cycloplegic agent in patients (p<0.05).

Table 2: Mean Comparison of Anterior Segment Parameters before and after Instillation of Cycloplegic Agent

Parameters	Before Instillation		After Instillation		Mean Difference	p-value
	Mean	SD	Mean	SD		
Right Eye						
SPH	1.7	1.6	2.8	1.6	-1.2	<0.01*
Cylinder	-2.2	1.0	-1.5	0.8	-0.7	<0.01*
Cylindrical Axis	81.5	57.4	81.5	57.5	0.0	0.99
K1	42.1	0.8	42.1	0.8	0.0	0.32
Axis K1	81.2	53.4	81.5	53.2	-0.3	0.22
K2	44.3	0.9	43.7	0.9	0.7	<0.01*
Axis K2	98.1	49.6	97.3	49.5	0.8	0.45
Left Eye						
SPH	1.7	1.6	2.8	1.6	-1.1	<0.01*
Cylinder	-2.2	1.0	-1.6	0.8	-0.7	<0.01*
Cylindrical Axis	81.3	56.5	82.9	57.5	-1.6	0.73
K1	42.1	0.8	42.1	0.8	0.0	0.96
Axis K1	80.9	52.3	82.8	53.1	-1.9	0.63
K2	44.3	1.0	43.7	0.9	0.6	<0.01*
Axis K2	98.3	50.2	96.9	50.0	1.4	0.75

*p<0.05 was considered statistically significant using Paired Sample t-test

Table-3 reports the mean comparison on anterior segment parameters among male samples before and after instillation of Cycloplegic agent. Results showed for a male patient with right eye a significant increase in SPH (MD=-1.14) and Cylinder (MD=-0.69), and significant decrease in K2 (MD=0.67) was observed after instillation of

Cycloplegic agent (p<0.05), similarly for the left eye among male patients a significant increase in SPH (MD=-1.1) and Cylinder (MD=-0.7) was observed and a significant decrease in K2 (MD=0.6) was found after instillation of Cycloplegic agent in patients (p<0.05).

Table 3: Mean Comparison of Anterior Segment Parameters before and after instillation of Cycloplegic Agent among Male Samples

Parameters	Before Instillation		After Instillation		Mean Difference	p-value
	Mean	SD	Mean	SD		
Right Eye Male						
SPH	1.5	1.4	2.7	1.4	-1.14	<0.01*
Cylinder	-2.3	1.0	-1.6	0.8	-0.69	<0.01*
Cylindrical Axis	85.1	57.6	85.1	57.6	0.00	0.99
K1	42.1	0.8	42.1	0.8	-0.01	0.32
Axis K1	84.9	53.7	85.2	53.5	-0.32	0.22
K2	44.3	0.9	43.7	0.9	0.67	<0.01*
Axis K2	95.3	50.2	94.4	50.0	0.90	0.45
Left Eye Male						
SPH	1.8	1.6	2.9	1.6	-1.1	<0.01*
Cylinder	-2.2	1.0	-1.6	0.8	-0.7	<0.01*
Cylindrical Axis	75.9	53.9	77.3	54.7	-1.4	0.78
K1	42.1	0.9	42.2	0.9	0.0	0.96
Axis K1	75.5	49.2	77.2	49.7	-1.7	0.68
K2	44.4	1.0	43.7	0.9	0.6	<0.01*
Axis K2	99.7	51.4	97.9	51.4	1.8	0.70

*p<0.05 was considered statistically significant using Paired Sample t-test

Table-4 reports the mean comparison on anterior segment parameters among female samples before and after instillation of Cycloplegic agent, results showed for a female patient with right eye a significant increase in SPH (MD=-1.4) and Cylinder (MD=-0.60), and significant decrease in K2 (MD=0.60) was observed after instillation of

Cycloplegic agent (p<0.05), similarly for the left eye among female patients a significant increase in SPH (MD=-0.9) and Cylinder (MD=-0.5) was observed and an insignificant decrease in K2 (MD=0.5) was found after instillation of Cycloplegic agent in female patients (p<0.41).

Table 4: Mean Comparison of Anterior Segment Parameters before and after instillation of Cycloplegic Agent among Female Samples

Parameters	Before Instillation		After Instillation		Mean Difference	p-value
	Mean	SD	Mean	SD		
Right Eye Female						
SPH	3.3	2.2	4.8	2.3	-1.4	<0.01*
Cylinder	-1.6	0.9	-1.0	0.6	-0.6	0.003*
Cylindrical Axis	42.1	40.6	42.1	40.6		N.A
K1	42.4	1.0	42.4	1.0		N.A
Axis K1	40.0	27.7	40.0	27.7		N.A
K2	44.0	0.9	43.4	0.8	0.6	0.003*
Axis K2	130.0	27.7	130.0	27.7		
Left Eye Female						
SPH	0.8	0.3	1.7	0.3	-0.9	0.02*
Cylinder	-2.0	0.6	-1.5	0.3	-0.5	0.24
Cylindrical Axis	165.0	7.9	170.0	7.9		N.A
K1	41.8	0.3	41.8	0.3	0	0.99
Axis K1	165.0	7.9	170.0	7.9		
K2	43.8	0.6	43.3	0.5	0.5	0.41
Axis K2	75.0	7.9	80.0	7.9		N.A
*p<0.05 was considered statistically significant using Paired Sample t-test						
N.A: test was not applicable because the standard error of the difference was zero						

Discussion

The current study investigated the effects of cycloplegic agent instillation on anterior segment parameters in pediatric patients, with a particular emphasis on changes in spherical power (SPH), cylinder, and keratometric readings (K1 and K2). The results showed large increases in SPH and cylinder, as well as a significant drop in the steeper keratometric value (K2) following cycloplegia in both eyes. When gender was evaluated, identical tendencies were detected in male subjects, however in females, the drop in K2 for the left eye was not statistically significant. These findings add to the advancing body of knowledge that cycloplegia not only changes refractive error measures (by relaxing accommodation), but it may also affect anterior segment biometry in children and adolescents. Previous research has found comparable effects:

for example, in one large paediatric sample, the fraction of myopia dropped and hyperopia rose following cycloplegia, showing an accommodation-induced bias in refractive categorization [8, 9]. The present changes in SPH and cylindrical refraction support this hypothesis: removing accommodation may indicate a higher hyperopic shift (or less myopic shift) than non-cycloplegic data.

According to the studies, cycloplegia frequently causes an increase in anterior chamber depth (ACD) as well as alterations in lens location or thickness. For example, multiple investigations discovered a deeper ACD and lower lens thickness following cycloplegia [10, 11]. While the current study did not expressly mention ACD or lens thickness, the observed flattening of corneal curvature (lower K2) may be due to biomechanical or accommodating impacts on the

cornea or ciliary body. In one research of keratoconus patients, K1 and K2 levels reduced considerably after cycloplegia, which was attributed to ciliary muscle relaxation and subsequent corneal flattening in a biomechanically weak cornea [12, 13].

Both males and females showed increases in SPH and cycloplegic refraction, although in females, the change in K2 in the left eye was not statistically significant in the present study. This might be due to the limited sample size (just 7 females) or to differences in biomechanical or accommodative responses between genders during adolescence. Because few researches have investigated cycloplegic effects by gender, this finding may merit additional examination.

From a clinical standpoint, these findings emphasize the significance of cycloplegia in evaluating refractive error and anterior segment biometric characteristics in young people and adolescents. The significant fluctuations in spherical refraction highlight the danger of miscalculation of refractive status if accommodation is not controlled, in accordance with previous research indicating that non-cycloplegic measurements may overstate myopia or underestimate hyperopia in young populations [9, 14]. Furthermore, the observed changes in keratometry (and, by extension, corneal curvature) suggest that biometric devices and clinical decisions (e.g., contact lens fittings, refractive surgery evaluations) should take into account the accommodative/cycloplegic state of the eye when interpreting corneal power data, particularly in younger patients.

However, numerous limitations must be recognized. First, the female sample size was extremely small ($n = 7$), reducing the power of gender-based comparisons and increasing the likelihood of type II error. Second, the study did not assess additional anterior segment metrics such as ACD, lens thickness, or axial length, which have been demonstrated in past research to alter following cycloplegia. Future studies should include larger, more gender-balanced cohorts, as well as other anterior segment parameters, (ACD, lens thickness, axial length, and corneal biomechanics) before and after

cycloplegia. Longitudinal investigations might determine if the extent of cycloplegic-induced alterations vary according to age, refractive error category, or corneal biomechanics.

Conclusion

In conclusion, the findings of this study show that cycloplegia causes large increases in spherical power and decreases in steep keratometric readings among juvenile patients. These findings emphasize the importance of cycloplegic evaluation in juvenile refractive assessment and indicate that ciliary muscle activity may alter corneal curvature and anterior segment arrangement. In younger populations, reliable ocular measurements and refractive surgery decision-making needs taking the cycloplegic component into account.

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