Original Article

Comparison of Subjective Refraction under Cycloplegia Versus Post Mydriatic Refraction in Pediatric Population

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ABSTRACT

Reduced vision throughout early childhood is typically due to errors of refraction**. Objective:** To compare refractive status in children (age 5 to 15 years) checked with subjective refraction under cycloplegia versus post mydiatric test (PMT). **Methods:** Comparative cross-sectional study was conducted in pediatric ophthalmic clinic of College of ophthalmology and Allied vision sciences /Mayo hospital Lahore including 120 non-pathological eyes of 60 subjects. Individuals with nystagmus and deviation of eyes were excluded. Power of SE (P1) was taken as proposed number of glasses to be dispensed. After three days PMT was done and prescription of glasses with BCVA (P2) was noted and prescribed. At PMT (P2-P1) was noted and evaluated. All data entered and analyzed by using SPSS-23. P-value equal or less than 0.05 was taken as significant. **Results**: Among 120 eyes (n=120), the distribution of myopia was 57.5% and hyperopia was 42%. The mean age of 60 individuals (female: 35% and male: 65%) was 9.47 ± 2.50 years. Among 120 eyes (n=120), the distribution of myopia was 57.5% (n = 69 eyes) and hyperopia was 42% (n = 51 eyes). Interclass correlation: Two-way mixed effects model where people effects are random and measures effects are fixed. a. The estimator is the same, whether the interaction effect is present or not. b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance. c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise. **Conclusion:** There was statistically significant difference of SE of SRC and PMT_SE in both myopic and hyperopic children in both cases. PMT was significantly less as compared to SRC, in hyperopic patients, this difference increases with the amount of hyperopia. PMT can be predicted from SRC with 98% accuracy in both myopic and hyperopic cases. With following given formula.

$$PMT = 0.77 \cdot CR.sph - 0.03 \quad r=0.98. \text{ (Hyperopia)}$$
$$PMT = 0.96 \cdot CR.sph - 0.03 \quad r=0.99. \text{ (Myopia)}$$

This study strongly negates the need for PMT as PMT can be strongly predicted from SRC.

INTRODUCTION

Reduced vision throughout early childhood is typically due to errors of refraction [1]. There are three main types of refractive errors: hypermetropia (farsightedness), myopia (near sightedness), and astigmatism [2]. According to WHO globally 314 million people are visually impaired, out of them 153 million are affected from untreated refractive errors [3]. In children risk of developing refractive errors are at a high rate due to their increased academic pressure and near visual tasks [4]. Frequency of error of refraction in children, is proved by means of uncorrected vision equivalent to or poorer than 20/40 and it differs from low to high. To eliminate the preventable blindness in children WHO urged a global initiative, VISION 2020-The right to sight [5, 6]. For inhibition of amblyopia in kids, it is very significant that a correct measurement of refractive error is done [7]. Goal of vision screening in infancy is to

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distinguish numerous complaints causing visual imperfections [8]. Though calculation of refractive error in pediatric populace is right challenging even for a practiced optometrist [9]. Selection for amblyopia and amblyogenic hazards in youngsters, monitored by proper management, is effective in decreasing the incidence and severity of optical damage in grown person [10]. Cycloplegic refraction is a method that permits evaluation of an accurate refractive error by preventing accommodation [11]. Cycloplegia is compulsory; for satisfactory modification of refractive error, mainly in young kids and patients with accommodative esotropia or high hypermetropia demanding more accommodative power [12]. Lack of cycloplegia is related to slight overestimation of myopia and obvious mistakes in evaluation of incidence of emmetropia and hyperopia [13]. There is no consistent method of regulating non-cycloplegic refraction to approximate cycloplegic refractions as the amount of refractive error varies from individual to individual as well as the type of cycloplegic refractive error. Non-cycloplegic refraction is therefore tricky [14]. Cautious choice of cycloplegic drug is significant as it is harder to attain complete cycloplegia in kids with darker irides, so usually cyclopentolate 1% is suggested to bring about adequate cycloplegia [15]. Other drugs like, Tropicamide is also introduced, and however it does not fully obstruct accommodation in children [16]. Test performed after three days of cycloplegic refraction when the effect of cycloplegia and mydriasis is completely disappeared, is termed as PMT (post mydriatic test) which is subjectively refined spectacle prescription obtained under non-cycloplegic condition from the values obtained from cycloplegic refraction. As for PMT an additional appointment is required, patients assume it very difficult for them [17, 18].

METHODS

Comparative cross-sectional study was conducted on 120 non-pathological eyes of 60 subjects. Individuals with nystagmus and deviation of eyes were excluded. Refractive status was measured by cycloplegic retinoscopy. At the time of cycloplegic refraction the SE of retinoscopy was calculated. The eye was labeled as myopic if the SE was less than zero and hyperopic if it was more than zero. Patient came for cycloplegic refraction cycloplegia was done with cyclopentolate 1% eye drop, instilled thrice with the gap of 15 minutes. After 1 hour of last drop cycloplegic refraction was done, and SE was calculated. Power of SE (prescription 1, P1) was taken as proposed number of glasses to be dispensed. Three days after, PMT was done and prescription of glasses with BCVA (prescription 2, P2) was noted and prescribed. The difference between proposed prescription and actual required prescription at PMT (P2-P1) was noted and evaluated. The participants were distributed into myopic and hyperopic categories and data was analyzed for the both groups. All data entered and analyzed by using SPSS-23. Normality of quantitative facts was inspected with Shapiro Wilk test and paired sample t-test was done. Interclass correlation was find out in myopic and hyperopic patients. Bland-Altman plot was drawn. P-value equal or less than 0.05 was taken as significant.

RESULTS

The mean age of 60 individuals (female: 35% and male: 65%) was 9.47 ± 2.50 years. Among 120 eyes (n=120), the distribution of myopia was 57.5% (n = 69 eyes) and hyperopia was 42% (n = 51 eyes). Interclass correlation: Two-way mixed effects model where people effects are random and measures effects are fixed. a. The estimator is the same, whether the interaction effect is present or not. b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance. c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.
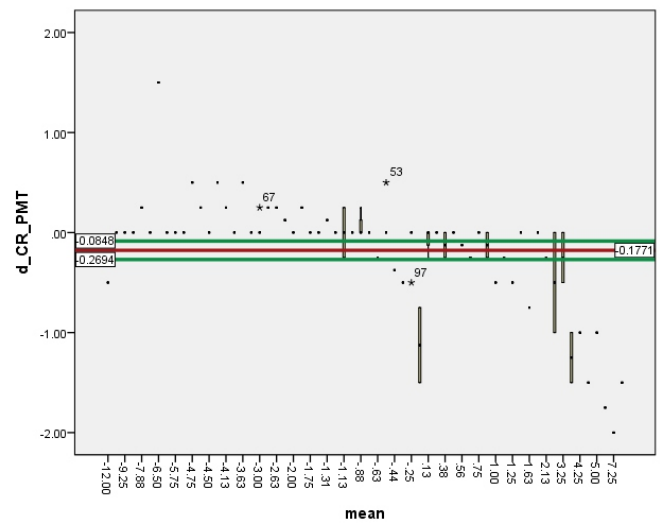

Figure 1: Bland Altman plot comparing difference between spherical equivalent of subjective refraction under cycloplegia and PMT

Figure 2: There was a significant difference in hyperopic eyes as P_value was ≤0.00%.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between C.R SpE and PMT_SpE equals 0.	Related-Samples Wilcoxon Signed Rank Test	.023	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 3: There was a significant difference in myopic eyes as P_value was ≤0.023%.

Ref_Type		Intraclass Correlationb	95% Confidence Interval		F Test with True Value 0			
			Lower Bound	Upper Bound	Value	df1	df2	Sig
Hyper	Single Measures	.960ª	.931	.977	49.002	50	50	.000
	Average Measures	.980ᶜ	.964	.988	49.002	50	50	.000
Myopic	Single Measures	.995ª	.992	.997	413.738	68	68	.000
	Average Measures	.998ᶜ	.996	.999	413.738	68	68	.000

Table 1: Intraclass Correlation Coefficient

Interclass correlation coefficient table was constructed by analyzing PMT_SE and C.R SE in reliability indices and selecting interclass correlation with two way mixed model and consistency type in statistics. Interclass correlation coefficient table showed single measurement 96% and average measurements 98% in hypermetropia. Whereas in myopia showed stronger correlation with 99% both single and average measurements. In hyperopic children we can predict PMT from CR.sph with the help of formula

$$PMT = 0.77*CR.sph - 0.03 \text{ with R value of } 0.98.$$

In myopic children we can predict PMT from CR.sph with the help of formula

$$PMT = 0.96*CR.sph - 0.03 \text{ with R value of } 0.99.$$

The table showed that there was a significant difference in proposed value and dispensed value of myopic children and hypermetropic children. According to above given formula prescribed prescription in PMT can be predicted from proposed value in subjective refraction under cycloplegia with R coefficient value in 98% hyperopic and in 99% myopic patients.

DISCUSSION

Visual damage in children is most commonly produced by refractive errors and that visual loss is reversible. Therefore for better outcomes and to reduce occurrence and brutality of visual complaints in children timely recognition and management of refractive errors is necessary. Principal objective for vision assessment is for early declaration to lessen the burden of ocular diseases in young age. Ciliary muscles are essential in the process of accommodation. The movement of ciliary body and ciliary muscles causes zonular relaxation due to which lens shape becomes more curved and its refractive power increases that procedure is labelled as accommodation. Cycloplegic agents are the drugs that are instilled to inhibit accommodation for refractive error evaluation. For precise evaluation of actual refractive error the best proposed method is cycloplegic refraction [19]. In the identification and management of important ophthalmic disorders a through cycloplegic investigation is a fundamental procedure specifically in children as they are going through a critical process of visual maturation and have high amplitude of accommodation due to which actual refractive error is masked. Ciliary muscles are temporarily paralyzed by using different cycloplegic agents and actual refractive error is determined this process is called cycloplegic refraction. Overcorrection and under correction is also experienced if influence of cycloplegia is insufficient. For an ideal cycloplegic agent time is an important factor to minimize adverse reaction and achieve good results. However, some practitioners follow dilated refraction and PMT as part of their regular refraction procedure, thus unduly increasing time for the prescription process. Considering that dilatation is performed as part of a comprehensive eye examination, we proposed subjective refraction under cycloplegia after performing cycloplegic retinoscopy as an alternative to avoid PMT visit in prescribing refractive corrections. Hashemi *et al.*, conducted a research in Iranian children in 2018. According to their results Auto refractometer can be used dependably in Iranian children above six years of age, if led in cycloplegic state [20]. In contrast Cycloplegic retinoscopy was preferred in this study for children age 5 to 15 years. Supporting this study, another research also concluded that auto refraction can be performed in children but gold standard technique is cycloplegic retinoscopy [21]. In the present study, the change in spherical equivalent among the refractive groups of myopia and hyperopia was compared. Evaluated 60 participants with a mean(±SD)age of 9.47 (±2.50) years, with female: 35% and male: 65% participated in the study. Among them, the distribution of myopia was 57.5% (n = 69 eyes) and hyperopia was 42% (n = 51 eyes). The results showed a statistically significant difference in myopic and hypermetropic children. In hypermetropic children difference between SE increases as refractive error increases. Many parents find it difficult to visit for PMT as it requires an extra appointment which is mutually burdensome for parents and examiner as well. Because pediatric refraction requires attention and is time consuming, it is much easy for examiner to perform retinoscopy and subjective refraction (under cycloplegia) on the same day to avoid PMT. A research showed if artificial pupil is used under cycloplegic state and subjective refraction was done, PMT can be avoided [18]. Consequently, according to this study subjective refraction under cycloplegia can be performed on the same day following cycloplegic retinoscopy in myopic and hypermetropic patients. Although there was a statistically significant difference in proposed and prescribed number in both type of errors. By help of given formula PMT_SE can

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be predicted in both type of refractive errors. In hyperopic children we can predict PMT from CR.sph with the help of formula:

PMT = 0.77*CR.sph - 0.03 with r value of 0.98

In myopic children we can predict PMT from CR.sph with the help of formula:

PMT= 0.96*CR.sph - 0.03 with r value of 0.99

CONCLUSION

There was statistically significant difference of SE of SRC and PMT_SE in both myopic and hyperopic children in both cases. PMT was significantly less as compared to SRC, in hyperopic patients, this difference increases with the amount of hyperopia. PMT can be predicted from SRC with 98% accuracy in both myopic and hyperopic cases. With following given formula.

PMT = 0.77*CR.sph - 0.03 r=0.98. (Hyperopia)
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This study strongly negates the need for PMT as PMT can be strongly predicted from SRC.

Conflicts of Interest

The authors declare no conflict of interest.

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REFERENCES

[1] Jarwal PN, Singh R. Evaluation of amblyopia in school going children. DJO. 2020 Jan; 30(3).

[2] Almudhaiyan T, Alhamzah A, AlShareef M, Alrasheed A, Jaffar R, Alluhidan A, Al-Hazazi M, Aldebasi T. The prevalence of refractive errors among Saudi adults in Riyadh, Saudi Arabia. Saudi Journal of Ophthalmology. 2020 Nov; 34(1):30-34. doi: 10.4103/1319-4534.301297

[3] Sirang Z, Nanji K, Jeeva IK, Khan ZW, Kazmi HS. Types of refractive errors in northern Pakistan: a hospital-based survey. Ophthalmology Journal. 2019; 4:86-91. doi: 10.5603/OJ.2019.0010

[4] Hashemi H, Yekta A, Nabovati P, Khoshhal F, Riazi A, Khabazkhoob M. The prevalence of refractive errors in 5–15 year-old population of two underserved rural areas of Iran. Journal of Current Ophthalmology. 2018 Sep; 30(3):250-4. doi: 10.1016/j.joco.2017.05.004

[5] Yasir ZH, Basakran FA, Alhumaid NA, Balous MA, Banaeem AS, Al-Shangiti AK, et al. Prevalence and determinants of refractive error and related ocular morbidities among Saudi adolescence population in Riyadh, Saudi Arabia. Oman Journal of Ophthalmology. 2022 Mar; 15(1):25-30. doi: 10.4103/ojo.ojo_114_21

[6] Agrawal D, Sahu A, Agrawal D. Prevalence of ocular morbidities among school children in Raipur district, India. Indian Journal of Ophthalmology. 2020 Feb; 68(2):340-344. doi: 10.4103/ijo.IJO_1454_19

[7] Fries T. Vision disorders in Ohio's children vision screenings vs. comprehensive eye exams. Public Health Review. 2019 Mar; 2(1).

[8] Basheikh A, Howldar S, Basendwah M, Baqais R, Bamakrid M, Alhibshi N. Astigmatism among children in Jeddah, Saudi Arabia: prevalence and associated factors. Middle East Journal of Family Medicine. 2021 Feb; 19(2). doi: 10.5742/MEWFM.2021.93976

[9] Yassa ET and Ünlü C. Comparison of Autorefraction and Photorefraction with and without Cycloplegia Using 1% Tropicamide in Preschool Children. Journal of Ophthalmology. 2019 May; 2019:1487013. doi: 10.1155/2019/1487013

[10] Aboumourad R and Anderson HA. Comparison of Dynamic Retinoscopy and Autorefraction for Measurement of Accommodative Amplitude. Optometry and Vision Science. 2019 Sep; 96(9):670-677. doi: 10.1097/OPX.0000000000001423

[11] Kim SH and Lee YC. Availability of cycloplegic refraction in children and adolescents. Journal of the Korean Ophthalmological Society. 2020 Mar; 61(3):274-80. doi: 10.3341/jkos.2020.61.3.274

[12] Curi I, Nakayama SA, Pereira ÉM, Hopker LM, Ejzenbaum F, Barcellos RB, et al. Brazilian guideline for pediatric cycloplegia and mydriasis. Arquivos Brasileiros de Oftalmologia. 2022 Mar; S0004-27492022005005215. doi: 10.5935/0004-2749.20230049

[13] Ashok A. Refraction and glass prescription in pediatric age group. Kerala Journal of Ophthalmology. 2019 Jan; 31(1):78. doi: 10.4103/kjo.kjo_5_19

[14] Saxena R and Sharma P. Pediatric Ophthalmology Expert Group. National consensus statement regarding pediatric eye examination, refraction, and amblyopia management. Indian Journal of Ophthalmology. 2020 Feb; 68(2):325-332. doi: 10.4103/ijo.IJO_471_19

[15] Sun YY, Wei SF, Li SM, Hu JP, Yang XH, Cao K, et al. Cycloplegic refraction by 1% cyclopentolate in young adults: is it the gold standard? The Anyang University Students Eye Study (AUSES). British Journal of Ophthalmology. 2018 Jun. doi: 10.1136/bjophthalmol-2018-312199

[16] Ayadi A, Ademola-Popoola DS, Olatunji FO. Cycloplegic Effect of 1% Atropine Compared to 1% Cyclopentolate– 1% Tropicamide Combination in Children. Nigerian Journal of Ophthalmology. 2020 Jul; 28(2):70. doi: 10.4103/njo.njo_3_20

[17]   Wakayama A, Nishina S, Miki A, Utsumi T, Sugasawa J, Hayashi T, et al. Incidence of side effects of topical atropine sulfate and cyclopentolate hydrochloride for cycloplegia in Japanese children: a multicenter study. Japenese Journal of Ophthalmology. 2018 Sep; 62(5):531-536. doi: 10.1007/s10384-018-0612-7

[18]   Theruveethi N, Ve RS, Srinivasan K. Comparison of endpoint of subjective cycloplegic refraction with artificial aperture and post-mydriatic test among adults with refractive error. Taiwan Journal of Ophthalmology. 2019 Sep; 10(3):212-216. doi: 10.4103/tjo.tjo_36_19

[19]   Yang LJ. Evaluation of cycloplegic effectiveness of atropine, cyclopentolate and tropicamide. International Eye Science. 2018; 1665-8.

[20]   Hashemi H, Khabazkhoob M, Asharlous A, Yekta A, Emamian MH, Fotouhi A. Overestimation of hyperopia with autorefraction compared with retinoscopy under cycloplegia in school-age children. British Journal of Ophthalmology. 2018 Dec; 102(12):1717-22. doi: 10.1136/bjophthalmol-2017-311594

[21]   Kauser F, Gupta Y, Amitava AK, Saxena J, Raza SA, Masood A, et al. Do all children need a cycloplegic refraction? A comparison of Mohindra's versus cycloplegic refraction. Indian Journal of Ophthalmology. 2020 Nov; 68(11):2458-2461. doi: 10.4103/ijo.IJO_229_20