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The Effect of off- the Visual Axis Retinoscopy on Objective Peripheral Refraction

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ABSTRACT

To find the effect of off-the-visual-axis retinoscopy on the objective refractive measurements at a distance fixation in a routine clinical setting. Twenty-five volunteers underwent retinoscopy evaluation of their right eye on-the-visual-axis, and 5, 10, 15, 20 degrees off-the-visual axis in nasal horizontal meridian. Out of these nine subjects underwent cycloplegic retinoscopy to see if there is any effect of accommodation. All the refractions at different eccentricities are carried out randomly by single examiner. The average spherical equivalent retinoscopy values at 0, 5, 10, 15, 20 degrees off-axis retinoscopy was –0.46, -0.55, -0.64, -0.56 and –0.68DC respectively. There was also a significant increase in induced cylindrical error of –0.29, -0.32, -0.4, -0.51, -0.72DC for each degree of eccentricity. Emmetropes and Hyperopes showed a significantly induced myopic shift for each of the above positions of eye alignment. There was an induced against-the-rule astigmatism with increase in the eccentricity. Objective refractive measurements altered significantly with off-the-visual-axis retinoscopy. The induced error is clinically important even with small degrees of eccentricity. off the visual axis refraction, Peripheral refarction,cycloplegic retionscopy,eccentric refraction and refractive error.

Key words: Retinoscopy, Emmetropes, Hyperopes.

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INTRODUCTION

The term "objective refraction" is used when the refractive error of an eye is determined without any input from the subject and moreover it provides starting point for subjective refraction [1]. Many techniques emerged in detecting objectively refractive error, but still retinoscopy remains the gold standard [2]. Retinoscopy is used to objectively determine the refractive status of the eye relative to the point of fixation [1].The retinoscopy findings may be heavily relied on for prescriptions when patients are unable or unwilling to give reliable subjective responses. In such cases the accurate retinoscopy is critical and off the axis cannot be overcome in cases like, examination under anesthesia, poor fixation at distance, practitioner's inability to perform retinoscopy with the corresponding eye and in strabismus. The off axis retinoscopy is inevitable for static retinoscopy otherwise the examiner completely occludes the fixation and makes erroneous results in refraction and such obliquity should be less than 3 degrees for accurate results [2].

Jackson et al reported that small changes in eccentricities resulted significant errors in refraction on small cohort and reported that mean spherical equivalent refraction showed myopic shift from -0.02Ds on the axis to -0.98Ds at 20^0 off the visual axis at distance of 40cm [3]. Tay et al reported myopes and emmetropes showed significant myopic shift on power vector analysis for M, J0 and J45 compared to hyperopes [4]. The peripheral astigmatism increases as the eccentricity increases however Seidemann and Millodot reported that myopes tend to have lesser amounts of peripheral astigmatism compared to hyperopes and emmetropes [5, 6]. Millodot reported that hyperopes are more myopic by -1.50Ds compared to myopes at 20^0 temporal to fovea using Topcon Refractometer [6].

In literature contradicting results being reported on peripheral refractions among ammetropes can be attributed to refraction methods, age groups and refractive error range [1, 4, 5, 6]. The reported recent literature on peripheral refractions are at large eccentricities up to 60 degrees for studying the effect of peripheral defocus in myopia progression [6] and at closer working distance [3] does not simulate off axis retinoscopy in clinical setup where the eccentricities are much lower and the studies conducted on off axis retinoscopy often had small sample making the results not reliable and hence unable to study the effect of type of ametropia on off axis retinoscopy. In the present randomized clinical study we investigated effect of off axis retinoscopy measurements on emmetropic, hyperopic and myopic subjects in a routine clinical setup.

MATERIAL AND METHODS

Methods

The study protocol adhered to Tents Declaration of Helsinki and the study approved by institutional review board at LV Prasad Eye Institute. Prior consent obtained from all the subjects who participated in this study. All subjects had undergone a comprehensive ophthalmic examination including visual acuity assessment by Snellen chart, objective and

subjective refraction, cover tests to determine the tropias and Slit- lamp examination with Haag-striet Slit-lamp for any ocular problems. The subjects included in the study with the following criteria: age above 15 years with spherical refractive error +/- 3.00Ds and cylindrical error +/- 1.00Dc and the subjects with significant ocualr pathology and strabismus are excluded. The non cyloplegic refarctions carried out on visula axis (0 degrees) and at 5,10,15,20 off the visual axis in adduction gaze on the right eye to overcome the examiner obstructing the target. The targets selected from snellen chart and presented isolated optotpes are of 6/60 letter size and the letters are attached to the wall at different eccentricities at a distance of 6 meters from the subject. Neutrality is a point midway between just noticeable with and against motions in order to determine more accurately the refractive end point. And this is obtained in spherical or spherocylindrical form. Of these 9 (2 Emmetropes, 4 Myopes and 3 Hyperopes) subjects underwent cycloplegic refractions at different eccentricities with cyclopentolate 1% and phynylephrine 10%. Both the drops were instilled twice at a interval of 15 minutes and the refraction carried out after 15 minutes of second drop and before refraction the near vison test was carried out to see enough cycloplegia being achieved. All the refractions were carried out in one single room and by one single examiner at a constant working distance of 50cm. The refractions carried out on all the subjects before noon and randomly at different eccentricites. The subjects were recruited from the Bausch and Lomb school of Optometry. When the far point of the patient's eye corresponds to the nodal point of the observer's eye, a neutral point occurs. The retinoscopic endpoint will then be the dioptric power midway between just noticeable "with" and "against" motions [1]. All the refractions were carried out in negative cylinder using Heine Beta 200 retinoscope.

Data Analysis

The data is entered in Microsoft Excel sheet and was analyzed using SPSS. Repeated measures analysis of variance (ANOVA) is used to compare the effect of off-the-visual-axis retinoscopy. Statistical significance set at $p<0.05$.

RESULTS

The results were calculated from 25 eyes, of which 16 (64%) eyes belong to females and 9 (36%) eyes belong to males. Among 25 eyes, 6 were emmetropes, 10 were myopes and 9 were hyperopes. The mean age of the subjects is 22+/- 2 years. The mean spherical equivalent refractive error is -0.46,-0.55,-0.64,-0.56,-0.68 at 0, 5, 10, 15 and 20 degrees of eccentricity from the visual axis respectively and there is no statistical significant difference in refractive error with *p* value of 0.298.

The mean cylindrical error on-the-visual-axis and at each position of off-the-visual-axis alignment was –0.29D, -0.32D, -0.40D, -0.51D, -0.72D at 0 degrees, 5 degrees, 10 degrees, 15 degrees, 20 degrees of eccentricity respectively which is statistically significant (p value 0.001). The group wise comparisons made for cylindrical peripheral refractions and the mean cylindrical change in emmetropes and hyperopes statistically significant for different

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eccentricities from the visual axis with *P* value of 0.001 and 0.003 respectively and myopes did not show any statistically significant difference in induced cylinder (*p* 0.867).

Total mean 9 subject's cycloplegic refractions are not statistically significant except at 5^0 and 20^0 and the difference is not really any of clinical significance.

Table: 1 Shows the mean cylindrical power change in different eccentricities from the visual axis and the statistically significance in *Italics*

	0	5	10	15	20	*Significance*
Emmetropes	0	-0.04	-0.13	-0.54	-0.79	*0.001*
Hyperopes	-0.11	-0.22	-0.36	-0.39	-0.67	*0.003*
Myopes	-0.63	-0.59,	-0.60	-0.60 Ds	-0.73	*0.867*

Table: 2 Mean spherical equivalent difference between non cycloplegic and cycloplegic refraction. Statically significant values are shown *Italics.*

Without Cycloplegic – With Cycloplegic	Paired Difference				Sig.(2 tailed)
	Mean	Std. Deviation	95% Confidence Interval		
			Lower	Upper	
0 Degrees	-0.18111	0.31359	-0.42215	-0.05993	0.121
5 Degrees	-0.25000	0.25000	-0.44217	-0.05783	*0.017*
10 Degrees	-0.04000	0.18755	-0.18416	-0.10416	0.540
15 Degrees	-0.24333	0.38471	-0.53905	-0.05238	0.094
20 Degrees	-0.19778	0.25297	-0.39223	-0.00333	*0.047*

DISCUSSION

In the optometric examination the accurate retinoscopy is indispensible. The accurate objective retinoscopy findings play a vital role in pediatric examination as the subjective responses are unpredictable, often not available. The repeatability of retinoscopy findings is more accurate on visual axis and as the eccentricity increases unwanted cylinder is being induced in prescriptions [4]. Thus accurate objective refraction is paramount in the cases where subjective responses are not reliable for defing objective refraction measurements. However the retinoscopy performed is inevitably off the visual axis by small degree.

Literature reported that less eccentricity would be ideal for precise accurate measurements and greater the eccentricity, more erroneous results are expected. Jackson et al reported with eccentricity increase the spherical equivalent refractions tend to be myopic on a small cohort [3]. Jackson et al reported that mean spherical equivalent change in refraction is -0.02, -0.59, -0.45, -0.64 and -0.98 at 0, 5, 10, 15, & 20 eccentricity and our study also confirms increase in myopic shift for the eccentric refractions and did not reach the statistical significance level as the group comprised of myopes, emmetropes and hyperopes in which the spherical equivalent nullified the effect of off axis retinoscopy induced cylinder. Conversely,

with group wise comparison induced cylinder at different eccentricities showed statistically significant difference only for emmetropes and hyperopes. Our study has did not show any significant difference in myope's peripheral refraction while the Tay et al reported for hyperopes and the possible reasons could be the number of subjects being studied, mean age of the sample for each refractive group and mean refractive error of the groups and the eyes being tested right eye versus left eye [4].

However in recent years with myopia research advancement the peripheral refractions are studied at large eccentricities up to 60^0 which do not replicate the real life clinical setting where the eccentricities in objective refraction are of small degree up to < 20^0. Our study aimed at finding the off the axis retinoscopy findings in clinical setup which simulates the refractions in uncooperative children and in strabismus cases and refractions under anesthesia. Our study results are based on large sample compared to Jackson et al. This confirms that with increasing eccentricity, increases the amount of induced cylinder, thereby reducing the accuracy of on axis prescriptions. The peripheral refractions tend to be more astigmatic [3, 5] and myopic due to complex nature of the retinal reflex and the retinal shape from center to periphery and difference in judging the neutral point during eccentric gaze. The refractive power of the eye is determined essentially by the cornea, axial length and the crystalline lens. It has been discussed in earlier articles the myopic shift in spherical equivalent refractions are not attributable to cornea and axial length as the corneal curvature flattens towards periphery and short axial length peripherally (oblate shape) should produce hyperopic error [3, 7]. The oblique light striking the ophthalmic lens results in more astigmatic and myopic defocus [6]. The myopic shift in eccentric refractions is not purely spherical and they are because of induced cylinder, thus one cannot presume that its solely because of oblique ray striking the lenses as reported in literature since the corneal curvature though flattens unequally at the medial and temporal regions in periphery but not in spherical nature [8]. The axial length is shorter but the horizontal and vertical meridians shape really effects the peripheral refractions. Support this finding, in the our study on group wise comparisons the myopic shift is not significantly seen in myopes compared with emmetropes and hyperopes indicating the myopic shift is not solely because of the obliquity of crystalline lens.

Though the crystalline behaves in similar fashion to ophtalmic lens but one should not over look the corneal ashericity and retinal aspherivity causing the myopic shift and research work should aim to study the effect of corneal asphericity and retinal asphericity on peripheral refraction in an experimental model to nullfy the effects of each refractive componennet on off axis refractions. To support the crystalline lens being the cause for peripheral astigmatism, it is being reported that the young adults have greater astigmatism compared to older adults since the corneal and axial length measurements are constant throughout the adult life and the lens changes are responsible for peripheral astigmatism [9]. Atchison reported that there no significant differences being seen among young and older adult peripheral refractions for low- to moderate refractive errors [10]. Our study used the subjects with mean age of 22+/- 2 years which do not affect the peripheral refractions. Contradicting results in some studies reported that the peripheral refractions with age have not suggested crystalline lens alone is not the cause for peripheral astigmatism [10].

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Seidemann et al also reported that non cycloplegic spherical equivalent peripheral refractions are less myopic for myopes compared to hyperopes and about -1.24Ds in periphery for hyperopic subjects and -0.039Ds for myopic subjects at 22 Degrees eccentricity on photorefraction among the age group of 21 -33 years [5] similar to our study. In our study astigmatic errors shift towards Against the Rule Astigmatism (ATR) for both With the Rule Astigmatism (WTR) subjects and pure spherical errors which is a similar trend reported in literature [1, 3].

Our study measured only the refraction on adductions as discussed above, but one should measure in abduction gaze also as the corneal asphericity is not the same to confirm the effect of crystalline lens on myopic shift at periphery and moreover significant asymmetry being reported among nasal and temporal astigmatism of about 1.5Ds [11]. The future studies should aim at large sample size with different age groups versus different refractive groups with varying degree of ametropia should be compared to establish the effect of off axis refractions on refractive error. The cycloplegic refractions carried out and our study shows no significant differences between non cycloplegic and cycloplegic refractions indicating the accommodation being controlled during off axis refractions.

CONCLUSION

To conculde off the axis refractions even at samll degrees of eccentricities resulted in significant errors in refractions. The optometrists should be aware of this to minimze the off the axis retionscopy especially when the subective responses are not guiding the precriptions properly specifically in pediatric examination.

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