A Study of Stereopsis in Children and Adolescents with Myopic Refractive Error

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ABSTRACT

Introduction: Stereo acuity is important part of binocular single vision, playing precise role in our skilful activities. Study was done to find out the correlation between stereopsis and myopia in age group of 5 to 18 years and to investigate whether there is improvement in stereopsis after correcting the refractive error.

Material and methods: It was a prospective observational study conducted at tertiary care centre. 75 myopic patients with myopia were included. Participants with squint, amblyopia, nystagmus, congenital cataract, glaucoma, retinopathy of prematurity, mental retardation, neurological disorders, etc were excluded. All participants underwent vision assessment, cycloplegic refraction and baseline stereopsis was assessed with TNO test. Refractive error was corrected with glasses and reassessment of vision and stereopsis was done after one month.

Results: Out of 75 participants 24 were simple myopes with mean of -2.32D ± 1.42D SD (Range -0.25D to -6.5D), 51 were astigmatic with mean of -1.14D ± 1.40D SD(Range -0.25D to -5.5D), 65 were having anisometropia with mean of -1.09D ± 1.60D SD(Range -0.25D to -7.5D). Simple myopia of >-3 D, astigmatism of > -1 D, anisometropia of > -1 D were associated with decreased stereoacuity on TNO test (P = 0.000624, 0.031724, 0.0188 respectively) and there was significant improvement in stereopsis after correction of refractive error (P = <0.00001).

Conclusions: Simple myopia of >3D, Astigmatism and anisometropia of >1 D are associated with reduced stereopsis, however with the use corrective lenses there is improvement in stereopsis.

Keywords : Stereopsis, Myopia, Astigmatism, Anisometropia

INTRODUCTION

Visual acuity is the ability of eye to discriminate between two points.[1] Binocular single vision is a state when a normal individual fixes his visual attention on an object of regard and the image is formed on the fovea of both eyes separately; but the individual perceives it as a single image.[2]

Stereo acuity is the smallest amount of horizontal retinal image disparity [measured in arc seconds] giving rise to perception of relative depth or stereopsis. Factors affecting development of stereopsis are ocular conditions such as ametropia, aniseikonia, amblyopia, strabismus, nystagmus, aphakia, monovision and monofixation syndrome The refractive status refers to the locus within the eye conjugate with optical infinity during minimal accommodation. Uncorrected refractive error is associated with decreased vision-related quality of life (QOL) and increasing difficulty in performing vision-related tasks. All types of refractive errors adversely affect stereopsis by inducing visual blur resulting in decreased binocular function with poor sensory fusion and hence affecting stereopsis[3]

Myopia, where incident parallel rays of light are brought to a focus in front of the retina is the commonest cause of gradually developing painless diminished vision in paediatric age group.

Though, the prevalence of myopia varies by country, age and ethnic group, it is a major cause of visual impairment in both the developed and the developing world.[4-6] In East Asia the prevalence of myopia has been reported to be very high particularly in South Korea,[7,8] Singapore,[9] Taiwan,[10,11] Hong Kong,[12,13] and China,[14-17] though much lower rates have been reported from South Asia.[18-22] While there are no large scale studies in India for assessing the magnitude of myopia in the school going population, available studies show higher prevalence rates in urban areas compared to rural areas.[20–22]

Considering the above epidemiology of Myopia in Asia and importance of Stereopsis in day to day life but fewer reports that address the correlation between the severity of myopic ametropia and stereoacuity, we conducted a cross-sectional study to investigate the association between myopia, myopic astigmatism and anisometropia with stereoacuity.

MATERIAL AND METHODS

This was prospective, observational study carried out in Ophthalmic outpatient department of tertiary care health centre during year 2014-2015. The study was approved by the Institutional Ethics Committee. 75 patients of both sexes, age ranging from 5 to 18 years with myopic refractive error were included. Patients with squint, amblyopia, nystagmus, congenital cataract, glaucoma, retinopathy of prematurity, mental retardation, neurological disorders, or those with history of ocular surgery or trauma were excluded Written informed consent was obtained after explaining the aim and nature of the study to the parents and assents were obtained from participants. Baseline visual acuity for distance was checked on Snellens chart at 6 meter and for near on Jaegger chart at 30 cm in well illuminated room. Colour vision was recorded using Ischihara chart. Slit lamp examination was done to rule out anterior segment abnormalities. Alternate cover uncover test was done to rule out strabismus. Cycloplegic refraction was done after dilatation with cyclopentolate (1%) eye drops using Streak retinoscopy followed by fundus examination. After 1 week post mydriatic test was carried out to determine best corrected visual

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acuity. The final prescription was balanced with the duochrome test. Stereopsis was checked and recorded using TNO test at distance of 30cm using red green glasses. This was baseline stereopsis without correction.

Participants corrected with only concave spherical correction were grouped as simple myopia and those who accepted both spherical and cylindrical lenses as astigmatic. Spherical equivalent was calculated for them by adding value of the sphere and half of cylinder and then further sub grouped. The difference between Spherical equivalents (SE) of two eyes were grouped as anisometropia. Participants were advised to wear the corrective glasses. At one month follow up BCVA and Stereopsis was rechecked. Any improvement in visual acuity or Stereopsis was recorded.

Parameters	No of participants	Mean(D) ± standard deviation	Range(D)
Simple myopia	24	-2.32 ± 1.42	-0.25 to -6.5
Astigmatism	51	-1.14 ± 1.40	-0.25 to -5.5
Anisometropia	65	-1.09 ± 1.60	-0.25 to -7.5

Table-1: The profile of mean refractive error of participants

STATISTICAL ANALYSIS

SPSS ver. 17.0 software program (SPSS, Chicago, IL) software was used for statistical analysis and Chi square test was used as test of significance and P value of <0.05 was considered significant.

RESULTS

Out of 75 participants 24 were simple myopes, 51 were astigmatic, 65 were having anisometropia (table-1). Table 2 shows that simple myopia od >3D, astigmatism of >1D and anisometropia of >1D were associated with abnormal stereopsis. Table 3 and 4 show that there is significant improvement in stereopsis after correction of refractive error.

DISCUSSION

Stereopsis refer to the perception of depth and 3-dimensional structure obtained on the basis of visual information and horizontal disparities received_from two eyes. Stereopsis has a positive impact on exercising practical tasks such as needle-threading, ball-catching (especially in fast ball games[23]), pouring liquids, etc. Professional activity may involve operating stereoscopic instruments such as a binocular microscope. Also

Simple myopia	Stereopsis without correction			Total	P Value
	Normal	Equivocal	Abnormal		
-1.75 to -3	2	1	2	5	0.000624
>-3	0	1	5	6	
Total				24	
Astigmatism					
-0.25 to -0.5	11	1	2	14	0.031724
-0.75 to -1	6	3	8	17	
>-1	5	3	12	20	
Total				51	
Anisometropia (D)	Stereopsis without correction			Total	
	Normal	Equivocal	Abnormal		P Value
-0.25 to -0.5	12	3	5	20	0.018835
-0.75 to -1	9	1	2	12	
>-1	9	4	20	33	
Total				65	

(Stereopsis has been divided into normal i.e. less than 120 arc seconds, equivocal i.e. 120 to 240 arc seconds and abnormal i.e. more than 240 arc seconds)

Table-2: Stereopsis in patients with Simple myopia, astigmatism and anisometropia without correction

Simple myopia	Stereopsis with correction			Total	P Value
	Normal	Equivocal	Abnormal		
-0.25 to -1.5	13	0	0	13	0.134931
-1.75 to -3	4	1	0	5	
>-3	5	0	1	6	
Total				24	
Astigmatism					
-0.25 to -0.5	14	0	0	14	0.531139
-0.75 to -1	16	1	0	17	
>-1	17	2	1	20	
Total				51	
Anisometropia					
-0.25 to -0.5	20	0	0	20	0.452165
-0.75 to -1	11	1	0	12	
>-1	28	4	1	33	
Total				65	

Table-3: Stereopsis in patients with simple myopia, astigmatism and anisometropia after correction of refractive error

Stereopsis with TNO Test	No of participants Before correction	No of participants After correction	P Value by Chi-square test
Normal(≤120 Arch Seconds)	37	69	0.00001
Equivocal (240 Arch seconds)	9	4	
Abnormal (>240 Arch seconds)	29	2	
Table-4: Improvement in stereo acuity after correction of myopia			

surgeons[24] normally demonstrate high stereo acuity.

In our study, we observed the influence of myopic refractive error on performance of stereo acuity and the improvement of stereopsis after the use of corrective glasses. We found that simple myopia of >-3 D was associated with diminished stereopsis. P value for stereoacuity without correction was 0.000624 that is statistically significant, suggesting that there was deterioration of stereoacuity as spherical error increased. However, J-W. Yang et al found that stereopsis was not significantly affected in patients with simple myopia.[25]

In our study; astigmatism >1 D, spherical anisometropia >1 D, were associated with reduced stereo acuity (P=0.031724, 0.0188 respectively). This could be probably due to astigmatism, anisometropia causing optical blur that results in decreased binocular function and hence reduced stereopsis. Regarding astigmatism >1 D associated reduced stereopsis similar results were reported by J-W Yang et al[25] Also, similar to our observation, J.-W. Yang et al in his study found anisometropia >1 D was associated with reduced stereopsis, using Titmus stereotest.[25] John Vincent Lovesick et al found that -1.5 D of anisometropia has the same effect on stereoacuity as an aniseikonia close to 8%. Since the calculated aniseikonia for 1.5 D is 4%, the additional decrease in stereoacuity is attributed to retinal blur. There are studies demonstrating that 1D of experimentally induced spherical anisometropia reduces stereo acuity to an average 57-59 s of arc[22] and that spherical anisometropia of >2 D resulted in decreased binocular function.[27] In our study, use of corrective glasses for 1 month resulted in improvement of stereo acuity (P=<0.00001) Our findings are consistent with Mai GH et al, who reported that with correction of refractive error there is improvement in binocular vision and stereopsis.[28]

CONCLUSION

Based on our observation, Simple myopia of >3D, Astigmatism and anisometropia of >1 D are associated with reduced stereopsis. There was significant improvement in baseline stereopsis after correction of refractive error thus we suggest there is a definite role in screening of preschool children so that the refractive error gets detected and treated early. Also, TNO test was effective and easy test for screening and quantifying stereopsis in school age children. The observation of improvement in stereopsis with use of corrective glasses encourage the practice of prescribing corrective glasses for children.

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