IMPACT OF REFRACTIVE ERRORS ON STEREOPSIS IN SCHOOL GOING CHILDREN OF RURAL HARYANA

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ABSTRACT

Purpose: *Normal development of stereopsis is based on good binocular vision and might get disrupted by a number of factors like refractive errors, amblyopia and/or strabismus. The study was undertaken with the aim to analyze impact of refractive errors with and without amblyopia and/or strabismus on stereopsis in school going children of rural Haryana.*

Methods: *Subjects in the age group of 5-15 years without any organic disorders were included over a period of two months. Cycloplegic refraction was undertaken and stereo acuity was demonstrated on Titmus fly stereogram under standard conditions. Subjects were divided into three groups: Plain refractive errors (isometropic or anisometropic) (group-I), subjects with amblyopia (group-II) and with strabismus (group-III). Further subgroups were made as per the type of refractive error.*

Results: *Subjects in group-I retained better stereo acuity as compared to group-II ($P<0.01$) and group-III ($p<0.01$). Isometropes in group-I retained better stereo acuity as compared to anisometropes ($p=0.04$); the difference was significant with cylindrical and mixed refractive errors but not with spherical refractive errors. Subjects in group-II revealed worse stereopsis as compared to group-I in all the three types of refractive errors ($p<0.01$). All subjects in group-III had absent stereo acuity.*

Conclusion: *Unequal refractive errors i.e. anisometropia with or without amblyopia could lead to subnormal stereopsis; this might be because of aniseikonia leading to disruption of binocular functions. Cylindrical and mixed refractive errors cause more difficulty in fusion of images as compared to spherical errors. It is important to identify subjects with anisometropia early so that amblyopia could be prevented and a better stereo acuity and fusion could be attained.*

Key words: *Refractive errors, Stereopsis, Amblyopia, Strabismus, Titmus fly stereogram, Anisometropia*

INTRODUCTION

Binocular single vision is the state of simultaneous vision, achieved by the coordinated use of both eyes; separate and slightly dissimilar images arising in each eye are appreciated as a single image by the process of fusion. Binocular vision has multiple advantages, the first and foremost being single vision; besides it also results in stereopsis which is the most precise kind of depth perception.[1-3]

Stereo acuity is measured in seconds of arc. Two types of stereo acuity can be applied in analysis: contour and random dot tests.[4] The Titmus stereo test is one of the commonly used contour tests and is a useful tool to quantify the performance of stereopsis. Normal stereo acuity is considered to be less than 40 seconds of arc, stereo acuity between 60 to 3000 second of arc is considered as partial stereoscopic acuity.[5]

Normal development of stereopsis is based on good binocular vision; blurred vision early in life may provoke a particular pattern of functional loss thus leading to a subnormal binocular vision. It has been thus accepted that reduced stereo acuity can occur with multiple factors like high refractive error, amblyopia, strabismus, nystagmus and aphakia. There are studies in literature which discuss effect of individual factors on stereo acuity; [6-12] however detailed analysis of effect of refractive error with or without amblyopia and/or strabismus on stereo acuity has not been undertaken. We applied the Titmus stereo acuity test on school going children in the age group of 5-15 years to study the impact of refractive errors, amblyopia and strabismus on stereo acuity.

MATERIALS AND METHODS

The study was held over 2 month's duration from 1st July 2014 to 31st August 2014 after obtaining approval from the Institutional Ethical Committee. Subjects in the age group of 5-15 years with refractive errors with or without amblyopia and/or strabismus presenting to the Paediatric Ophthalmology and Strabismus clinic of our institute were included. Subjects with congenital cataract, pseudophakia, aphakia, glaucoma, retinal pathologies, ocular trauma history, mental retardation, neurological disorders and those who could not cooperate for the test were excluded. Also excluded were subjects with any form of complicated and paralytic strabismus and those with any form of congenital strabismus assuming them to have congenital subnormal stereo acuity.

A detailed ophthalmic examination was undertaken including:

1. Unaided visual acuity in each eye individually by Snellen's / Allen's chart

2. Cycloplegic refraction under 1% Atropine eye ointment or 2% Cyclopentolate eye drops done by hand held retinoscope
3. Visual acuity with glasses in each eye (BCSVA) individually by Snellen's / Allen's chart done on the next visit
4. Documentation of presence or absence of amblyopia (difference of ≥2 lines in the BCSVA)
5. Alternate cover uncover test for distance and near for documentation of presence or absence of strabismus
6. Binocular stereo acuity by Titmus Fly stereogram with glasses at a distance of 40 cms. The test incorporates the fly, wirth circles and animals (figure-1) and quantifies the stereo acuity from absent stereopsis to normal stereo acuity of 40 seconds of arc.[13] For the purpose of analysis; subjects with no stereopsis were assigned the worst measurable value (3000 seconds of arc).

For the purpose of statistical analysis, subjects were divided into various groups and subgroups (table-I). SPSS (version-16) was used for statistical analysis and one way analysis of variance (ANOVA) was undertaken for finding out significance of variables; p-value of <0.05 was considered significant.

RESULTS

A total of 398 children (234 boys and 164 girls) were included. Mean age was 11.40±2.64 years; range 5-15 years. There were total of 229 children in group-I, 97 in group-II and 72 in group-III (table-II). The performance of stereo acuity obtained by the Titmus test in different groups and subgroups was compared (Table III and IV).

Table 1: Different groups and subgroups

Group I: Children with refractive errors but no amblyopia and strabismus:
Group - I(A): Isometropia i.e. interocular difference between the lens power of glasses in the spherical equivalent of <1.0 diopter (D).
Spherical (IAa): <1.0 D of astigmatism
Cylindrical (IAb): >1.0 D of astigmatism but <1.0D of sphere
Mixed (IAc): >1.0 D of astigmatism and <1.0D of sphere
Group - I(B): Anisometropia i.e. interocular difference between the lens power of glasses in the spherical equivalent of ≥1.0 diopter (D).
Spherical (IBa): ≤1.5D interocular difference in astigmatism
Cylindrical (IBb): ≥1.5D interocular difference in astigmatism but <1.0D interocular difference in sphere
Mixed (IBc): ≥1.5D interocular difference in astigmatism and >1.0D interocular difference in sphere
Group II: Children with amblyopia (refractive) but no strabismus:
Spherical (IIa): ≤1.5D interocular difference in astigmatism
Cylindrical (IIb): ≥1.5D interocular difference in astigmatism but <1.0D interocular difference in sphere
Mixed (IIc): ≥1.5D interocular difference in astigmatism and >1.0D interocular difference in sphere
Group III: Children with strabismus with or without amblyopia.

Table 2: Mean age and stereopsis in the three groups

	No. in each group	Age (Years)		Stereopsis (Seconds of Arc)	
		Mean±SD	Range	Mean±SD	Range
Group I	229	11.19±2.64	5 to 15	120.60±76.36	40 to 400
Group II	97	12.30±2.50	5 to 15	1510.00±1198.25	100 to 3000
Group III	72	13.00±1.53	5 to 15	3000	3000

Table 3: Analysis of variance: P-value between groups

	p-Values
Group- I vs Group- II	<0.01
Group- IA vs Group- III	<0.01
Group- II vs Group- III	0.01
Group- IA vs Group- IB	0.04
Group- II vs Group- IA	<0.01
Group- II vs Group- IB	<0.01
Group- IAa vs Group- IBa	0.28
Group- IAb vs Group- IBb	<0.01
Group- IAc vs Group- IBc	<0.01

*not statistically significant

Table 4: Detailed value of stereopsis in different subgroups

Group	Subgroup		Number	Mean Stereopsis (seconds of arc)
Group- I			**229**	**120.60±76.36**
	Isometropia (IA)		121	*80.40±25.36*
		Spherical (IAa)	79	*60.25±12.40*
		Cylindrical (IAb)	32	*104.20±32.55*
		Mixed (IAc)	10	*112.30±44.25*
	Anisometropia (IB)		108	*245.25±24.50*
		Spherical (IBa)	52	*115.50±24.50*
		Cylindrical (IBb)	39	*284.55±42.40*
		Mixed (IBc)	17	*248.60±25.55*
Group- II			**97**	**1510.00±1198.25**
		Spherical (IIa)	51	*1080.50±940.50*
		Cylindrical (IIb)	36	*2145.50±746.35*
		Mixed (IIc)	10	*2040.40±440.35*
Group- III			**72**	**3000.00**

DISCUSSION

Subjects with plain refractive errors (group-I) without amblyopia and/or strabismus retained near normal stereopsis in our study; thus indicating that simple refractive errors if given appropriate glasses could demonstrate normal binocularity. It was interesting to observe that in this group, isometropes retained better stereo acuity as compared to anisometropes. This indicates that even in absence of amblyopia anisometropia could impede normal development of binocularity. The possible explanation to this could be the fact that unequal refractive errors in the two eyes with their corrective glasses could lead to perceived retinal image size difference i.e. aniseikonia; this could lead to disruption of binocular functions such as fusion and stereopsis. Campos and Enoch reported that a larger than 5% aniseikonia resulted in loss of stereopsis.[14] It was also an important inference that subjects with cylindrical and mixed anisometropia had a worse stereo acuity as compared to their respective isometropes; thus indicating that aniseikonia could be more significant with cylindrical refractive errors as compared to spherical.

The results of study by Lee JY were in contrast to ours in which they found that level of stereopsis with the anisometropic glasses was clinically near normal.[6] The possible variations in the results could be explained by the fact that subjects in their study had been wearing glasses over a period of time; while in our study; the subjects were prescribed glasses freshly and thus might not have spent enough time for improving the binocular interaction.

In our study subjects with anisometropic amblyopia demonstrated worse stereo acuity compared to subjects without amblyopia; this was valid for all the three subgroups i.e. spherical, cylindrical and mixed. This was in accordance with a recent study by Chen BB on subjects with previously untreated anisometropic amblyopias in which larger anisometropic magnitudes caused severe amblyopia and lower levels of fusion and stereopsis.[8] This outcome of our study has very important implications. Children with anisometropia often lack noticeable physical abnormalities in childhood and are usually able to compensate subnormal visual acuity in one eye by making use of the better eye; it is for this reason that numerous patients with anisometropic amblyopic subjects present late beyond the critical period.

As expected strabismic subjects in our study demonstrated the worst stereopsis. Subjects with strabismic amblyopia are expected to present earlier as compared to those with anisometropic amblyopia. This however was not the case in our study where subjects with strabismus presented very late (mean age 13.00±1.53 years); this could be attributed to the fact that our referral is from rural community where there is prevalence of a lot of misconceptions and beliefs regarding management of strabismus in young children.

There are certain limitations in our study. Firstly the Titmus stereo test used in the study is a contour test and has the disadvantage of monocular clues on low grade tests. Secondly, we have not divided the subjects in each category as myopic and hypermetropic, instead they have been classified broadly into spherical, cylindrical and mixed refractive errors. A further classification of these errors into myopia and hypermetropia would assist further in knowing stereo acuity in the specific type of refractive error.

In relation to the clinical treatment of children with refractive errors with or without strabismus and/or amblyopia, it's not just important to regain normal visual acuity and alignment but restoration or maintenance of highest level of stereo acuity possible, with some stereo acuity being better than none.[15] A timely initiation of treatment in children with refractive errors and early visual rehabilitation could prevent long term consequences of amblyopia and / or strabismus and might help in attaining some form of binocular vision.

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