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ORIGINAL ARTICLE

Comparison of the Efficacy of TNO and Titmus Fly in Myopic Anisometropes

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ABSTRACT

Objectives: The aim of this study is to evaluate the stereo acuity in anisometropic myopes and to compare efficacy of TNO and Titmus fly test.

Methodology: The cross sectional study design was carried out from September 2021 to May 2022 at eye departments of different teaching hospitals of Punjab. A total study sample of 150 subjects age range between 11-33 years of both gender (male and female) having myopic anisometropia (with moderate and severe degree of anisometopia) were included in this study. All other types of refractive error except myopic anisometropes, all ocular pathologies and systemic pathologies were excluded from the study. After taking informed consent from the individual's subject to undergo routine ophthalmological examinations, including slit lamp examination of the inner and posterior chamber of the eye and best corrected visual acuity of both eyes (BCVA). Steroacuity test TNO and Titmus were performed to evaluate the stereopsis of myopic anisometropes. Data analysis was done by SPSS version 20. Independent sample t test was used for statistically analysis.

Results: Results showed that stereopsis gets reduced by myopic anisometropia. As the level of anisometropia increase from 1D and above, the stereopsis deteriorates in case of myopic anisometropia

Conclusion: TNO is considered more reliable as compared to Titmus fly test as the level of difficulty is more in TNO and is independent of monocular clues.

Keywords: Depth perception, Myopic anisometropes, TNO test, Titmus stereoacuity test.

INTRODUCTION

Optical system constructs a three dimensional image out of two retinal images. The two retinal images don't match to each other because of the difference in the vintage points of two eyes[1]. The word stereopsis is derived from Greek language that means solid power of sight. For animals having one eye spare when other eye is damaged is very necessary for the survival as they have to save themselves from predators. Moreover in some animals, they have eyes on opposite sides of their heads and hence they have a 360 degree view of the visual field that is combined by both eyes helping them in identifying their predators in the surrounding. The horizontal separation in two eyes allows eyes to see same object from two different points. Each eye aims its fovea that is the region of highest visual acuity[2]. The visual cortex is the first place where the information from both eyes is combined and where stereopsis can be observed. LGN layers in patients with normal correspondence3, even at the thalamic level where optical nerve fibres from the two eyes are first in proximity3, are monocular in those cases.[3,]

Stereopsis is described as the depth, or third-dimensional, relative ordering of visual objects. When horizontally different retinal elements are triggered at the same time, stereopsis occurs. The integration of such different pictures yields a singular, three-dimensional visual perception. Stereopsis is required for delicate and precise tasks, as well as visuomanual coordination. Indeed, if the patient does not have stereopsis, he or she may have significant difficulties in everyday life. Stereopsis is not the same as depth perception. In order to achieve fine stereopsis, both eyes must produce high-quality foveal pictures has been reported by Nabie et al.[4,5]

Giaschi[7] was of opinion that stereopsis develops in a child at the age of 3 to 6 months and hence it is not present at the time of birth. Any intrusion occurring in the way of its development cause defect in stereopsis. These intrusions are called binocular vision impairments. For instance if a child has an uncorrected cataract in early life period he/she would not be able to develop simultaneous binocular vision. Another possibility is of unilateral refractive error also called anisometropia in which child cannot produce a fused image by the both eyes instead they have two different images over the retina. As a result brain can ignore one image in order to avoid diplopia and this can lead to amblyopia also called lazy eye that further gets complicated and leads to misdirected eye called strabismus[8].

Kalloniatis and Luu[9] discovered that through the use of monocular cues and the stimulated stereopsis one eye can also give depth perception to brain through texture, gradient, defocus, color, haze and relative size.

Anisometropia is a condition in which the two eyes have unequal refractive errors, usually due to a disparity in intraocular axial lengths[10]. According to Babu et al.[11], in anisometropia, visual acuity in the eye with the highest refraction error is reduced, and the picture in that eye is defocused.

An intraocular refractive error differential of more than 1.00 D was characterised as myopic anisometropia, with each eye being emmetropic or myopic. Both eyes must have astigmatism of less than 1.00 D[12]. Stereopsis among anisometropes is more affected than isometropes and stereopsis decreases as the amount of anisometropia increases[13].

Gawecki et al.,[14] studies the Anisomteropia and Stereopsis on 20 adults with status healthy, clinically no significant error of refraction. This study access the amount of defect of stereopsis in various types and frequency of experimentally induced anisometropia. The subjects underwent the titmus stereotest later to the induced anisomteropia with trial lenses. Stereoacuity in arc sec was calculated to the mean values in each value of anisomteropia.

Stereo-acuity tests in different varieties are available and construct a three-dimensional object in various forms. Titmus stereo test based on the principle of vectograph (three-dimensional polaroidvectograph) that two target are printed in a way that each target is polarized at 90° in relevance to the other one. Titmus stereo test constitutes two plates in a shape of a booklet and while performing test, polarized glasses are used to review the test plates. Consists of

- The fly test (threshold 3000 sec of arc)
- The animal test (threshold 10,200, and 400 sec of arc)
- The circle test (threshold 800 to 40 sec of arc)[15].

TNO test is based on random dot stereogram test that exclude monocular clues and is graded to facilitate retinal disparities from 15 to 480 sec of arc and advantage of bringing quantitative analysis without any change in testing distance. TNO test available in booklet form and have seven plates of different shapes either squares crosses or dots. First three are for gross stereopsis establishment and further four are to quantitate the level of stereopsis. Red green spectacles are used while performing the test, binocularly[15].

Dadeya et al.,[16] states that anisometropia is one of the causative factor for amblyopia and strabismus therefore any degree of anisometropia should be considered and corrected to ensure optimal visual development and maturation. One diopter of anisometropia have imapcts on stereopsis and showing decline in it whether myopic, hypermetropic or anisometropic amblyopia and mechanism by which it shows decline is not clear and the probable mechanism behind binocularity is suppression and mentions that anisometropia in adults is similar to the anisometropia in children and it interferes with binocular response.

Binocular disparity provides information about the three-dimensional arrangement of the world to the visual system. Recent physiological research in the primary visual cortex has provided insight into the mechanisms by which single neurons can detect disparity. Additionally, it demonstrates that additional processing is required to make the types of signals required for depth perception obvious (such as the ability to match features correctly between the two monocular images). Extra-striate cortex generates some of these signals, such as those expressing relative disparity. Other data suggests that the relationship between perception and neuronal activity is stronger in the extra-striate cortex than in the main visual cortex[1].

METHODOLOGY

This study was carried out at Department of Ophthalmology of different teaching hospitals of Punjab. This study was conducted from September 2021 to May 2022 in a study period of 8 months. Comparative cross sectional design was conducted. Data was collected by convenient Sampling technique. The sample size was of 30 patients in this study. To conduct this study inclusion and exclusion criteria was generated. Myopic anisometropes (Moderate and severe degree) of age group 11-33 years of both genders were included. All ocular pathologies and systemic pathologies were excluded except anisometropic myopes.

Data collection Instruments including Visual acuity testing chart (projection based LED), Autorefractometer (NIDEK), Trial box and trail frame (Essilor instruments), Titmus steroacuity test (Birmingham optical) and TNO test (ninth edition LAMERIS OOTECH). Research tools was Self-structured proforma.

Consent was taken from each subject. The study was conducted on 150 myopic anisometropes with no other visual problems. All subjects were had to undergo routine ophthalmological examination that include slit lamp examination of interior and posterior chamber of eye and best corrected visual acuity of both eyes (BCVA).The refractive error was calculated. BCVA was calculated with Snellen VA chart. Stereopsis was measured with Titmus fly and TNO test. Tests performed in such a way that one on half of population and the other on 2nd half of total sample population and Stereopsis of anisometropic myopes was tested and both tests were compared. And the results were compiled. For statistically analysis independent t test was used. Data analysis procedure was done with SPSS software and the results were >5% probability.

Both verbal and written consent were obtained after briefing sufficient information, respective objectives and design of the study, presumed adequate opportunity to consider all the options, all the will ensured understood this information, to volunteered subject matter and continued to provide information, exchanged information and asked questions were relevant to the study.

RESULTS

A total number of 150 subjects having refractive error myopic anisometropia were included in this study for assessment of stereopsis by using Titmus and TNO test. On evaluation and analysis of data the number of patients with varying age groups and percentage. Out of 150 subjects only 1 patient within age group 10-15years (0.67%) and 44 patients among 16-21years (29.33%) and 63 patients within 22-27years (42.00%) and 42 from 28-33years (28.00%) (Table 1).

Table 1: Age Distribution of myopic anisometropes

Age (Year)	Frequency of the subjects (myopic anisometropes)	Percentage
10-15	1	0.67%
16-21	44	29.33%
22-27	63	42.00%
28-33	42	28.00%
Total	150	100%

There were 150 total subjects (N=150) in which 72 were males (47.68%) and 78 were females (51.66%). In the study there was greater number of female anisometropic myopes than males.

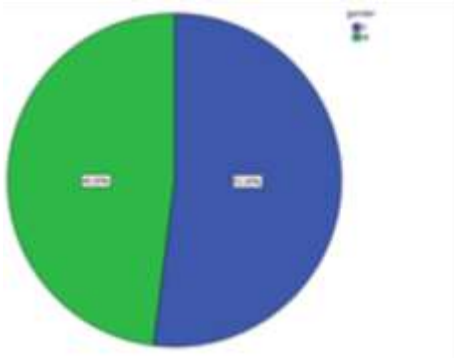

Figure 1: Pie chart of Gender Distribution

Then the visual acuity among the total of 150 subjects were find out and distinguished into two categories having visual acuity less than 6/60 or greater than 6/60 among total of subjects there were 78 subjects having visual acuity greater than 6/60 and 72 subjects having visual acuity 6/60 and less than that (Table 2).

Table 2: Visual acuity distribution

Visual acuity	Frequency of subjects
<6/60	72
>6/60	78

After the evaluation of visual acuity the degree of anisometropia present were accessed among the subjects in whom there were 75 subjects having anisometropia 1D and 75 subjects having anisometropia greater then 1D having an equal percentage of 50%.

Table 3: Mean and Standard Deviation of stereopsis with Titmus and TNO test

Group Statistics				
	Group	N	Mean	Std. Deviation
Stereopsis with Titmus and TNO test	TNO	75	173.1081	108.55118
	TITMUS FLY TEST	75	265.6579	147.13563

The above table 3 showed the frequency distribution of two groups that have participated in the research. Total subjects (N=150) were divided in two groups. Mean and standard deviation of the stereopsis with TNO test is 173.10±108.55 and mean and standard deviation with Titmus fly test is 265.65±147.13.

There were two tests which were used in study TITMUS FLY TEST and TNO test. The efficacy of both test was compared by

applying these tests on myopic anisometropes and evaluating there stereopsis. And to compare the effectiveness of Titmus fly test and TNO stereoacuity test among myopic anisometropes. The below table showed independent samples test. The equality of means was 4.374 test. The mean difference is 92.54979 and 92.54979 respectively for TNO and Titmus fly test. Both these tests are performed over anisometropic myopes to measure stereopsis. To check the comparison of TNO and titmus fly test independent T test sample was used. The p-value that is $p<0.05$ showed that there is significant association present at 5% level of significance.

Table 4: Independent Samples Test

		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Stereopsis with Titmus and TNO test	Equal variances assumed	9.695	.002	-4.374	148	.000	-92.54979	21.15704	-134.35870	-50.74088
	Equal variances not assumed			-4.392	137.987	.000	-92.54979	21.07341	-134.21834	-50.88123

DISCUSSION

Good vision and stereopsis is important for better life and in case of any error or change it may effects daily life tasks and livelihood. Activities like driving whether any sort of vehicle or operating any device it requires fine vision and stereopsis and requires both eyes working simultaneously. In case of any change in both eyes it causes conditions like anisometropia and might lead to amblyopia and deteriorates vision and leads to poor lifestyle [15].

Myopia is the most frequent refractive error and dominating in recent years irrespective of other refractive errors like hypermetropia and amblyopia. Myopia is basically nearsightedness, subject able to see at near but blur image at distance. Anisometropia is intraocular differences of refractive error in eyes of same individuals which causes reduction of visual functions such as contrast sensitivity and stereopsis along with defocusing of vision to cause it blur. Despite of clear vision, good levels of contrast sensitivity and stereopsis are essential measure for a better lifestyle[16].

Similarly, a research study finds the impact of anisometropia on binocular interactions and their results showed that all of the subjects had reduced levels of stereopsis on TNO tests and concluded that even small amounts of intraocular difference or anisometropia less than 1 D can also have significant impacts on reduce stereopsis[17].

Present study reveals that anisometropia is causing deterioration of stereopsis and myopic anisometropia is common among the population and the comparison of two stereo-tests efficacy and by using both tests Titmus and TNO the most accurate results were obtained by TNO which is a global testing method as compared to the Titmus fly test. Amount of refractive error also influence the stereopsis among the subjects and worsening of vision also deteriorates the stereopsis and patients response towards the Titmus and TNO is compared which confirms that TNO is suggested as the more reliable method for testing stereopsis in myopic anisometropes and clinically more significant. Likewise, it has been found in the study that anisometropia has adverse effects on stereopsis [18]. The results of this study completely agree to the results of our study and also making good reasoning that we choose spherical refractive error to study upon[19].This study provides better understanding of association between stereopsis and anisometropia and how age affects the stereopsis and the degree of anisometropia among the population. The findings of this study support previous findings that anisometropia impairs binocular interaction, and that the level of interference is proportional to the degree of anisometropia, i.e., the greater the anisometropia, the poorer the binocular function. Stereopsis deteriorates when anisometropia grows, and the degree of anisometropia with age also affects stereopsis, as stereopsis impacts more from adolescence to adulthood, and binocularity swings, resulting in a lack of stereopsis. This study backs up previous research findings and deems TNO to be the most reliable tool for clinically assessing stereopsis in myopic anisometropes. It doesn't matter what gender you are, how old you are, or how much anisometropia you have.

CONCLUSION

As the level of anisometropia increase from 1D and above, the stereopsis deteriorates in case of myopic anisometropia and above 3D spherical causing complete loss of stereopsis and study conclusively showed that anisometropia interferes with binocular interaction and the level of interference is directly related to the degree of anisometropia. And the testing method for stereopsis evaluation in myopic anisometropia, TNO is considered more reliable as compared to Titmus fly test as the level of difficulty is more in TNO and is independent of monocular clues.

Recommendation: The purpose of the study was to evaluate the stereoacuity in myopic anisometropes and to assess the efficacy of Titmus and TNO stereoacuity test in myopic anisometropes. Traditionally the most widely used stereo acuity test is titmus fly test. Although it is designed for children. The newly formed TNO test is independent of monocular clues and hence gives precise results for stereopsis. This study will help eye care practitioner to measure stereopsis among myopic anisometropes by most reliable and appropriate method of testing clinically.

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