e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(8); 995-999

Original Research Article

Comparative Evaluation of the Stereoacuity in Subjects Having Emmetropia, Isometropia, and Anisometropia

Vikrant Sharma[1], Nandita Chaturvedi[2], Dinesh Kumar Sahu[3*], Shrishti Mishra[4]

[1]MBBS, MS, Additional Professor, Department of Ophthalmology, Post Graduate Institute of Child Health, Noida, Uttar Pradesh

[2]MBBS, MS, Associate Professor, Department of Ophthalmology, Government Institute of Medical Sciences, Greater Noida, Uttar Pradesh

[3*]MS, Ph.D., Research Officer, Central Research Facility, Post Graduate Institute of Child Health, Noida, Uttar Pradesh

[4]MBBS, MS, Senior Resident, Department of Ophthalmology, Post Graduate Institute of Child Health, Noida, Uttar Pradesh

Received: 30-06-2023 / Revised: 30-07-2023 / Accepted: 19-08-2023

Corresponding author: Dr. Dinesh Kumar Sahu

Conflict of interest: Nil

Abstract:

Background: Stereoacuity is the discrimination of differences in depth based on binocular disparity, and is a measure of stereopsis, Impairment in stereopsis can negatively affect the day-to-day activity in child subjects.

Aim: The present clinical study was aimed to comparatively evaluate the stereoacuity in subjects having emmetropia, isometropia, and anisometropia.

Methods: The study assessed 702 subjects of age 5-15 years divided into three groups emmetropes with 250 subjects, isometropes with 250 subjects, and anisometropes with 202 subjects respectively. Ambylopic eyes were 78 and 129 respectively among isometropes and anisometropes, Titmus stereo test was used to measure the stereoacuity comprising of a combination of contour targets.

Results: The study had 357 males and 345 females. In anisometropes, a significant decrease in stereoacuity was seen compared to emmetropes and isometropes. In ambylopes, the stereoacuity was worse. In the majority of subjects with anisometropia of <3.0, a fair stereoacuity was seen. With an increase in anisometropia degree to >3.0 D, a gradual deterioration in stereoacuity was seen. In severe anisometropia of >6.0 D, a marked decrease in stereoacuity was seen. Reduced stereoacuity was seen in anisometropia of ≥2.12 D. In anisometropes, stereoacuity was poorest in myopia followed by myopia with astigmatism, hypermetropia with astigmatism, and hypermetropia.

Conclusion: The study concludes that stereoacuity is the poorest in anisometropes compared to emmetropes and isometropes. A greater reduction in stereoacuity is seen in ambylopes compared to non-amblyopes. With an increase in the degree of anisometropia, stereoacuity is decreased. In anisometropes, worse stereoacuity is seen in myopes compared to hypermetropes.

Keywords: Anisometropia, ambylopes, emmetropia, isometropia, stereoacuity.

Introduction

Stereopsis results from the sudden stimulation of horizontally disparate retinal elements whose fusion results in a single vision impression perceived in depth. Gross stereopsis is vital for the orientation in a space during the walk, whereas, fine stereopsis is vital to carry out fine motor tasks. A stereoscopic image is also needed for surface inspection, analysis, and related tasks. [1]

Stereopsis is also known as the third degree of vision which can be considered as a characteristic and graphic impression of a 3-dimensional structure that is seen when stimulated 3D or real scenes are seen via binoculars. Stereopsis is related to the three-dimensionality or the compelling perception of solidity.[2] Stereopsis presents a clear space sense between a phenomenal sense of realism and space between the objects. The visual characteristics are traditionally considered a result of various views of an object that can be afforded with the motion parallax (self-motion) and disparity (binocular vision). [3]

Most of the previous literature data perceived anisometropia as a difference in the interocular refractive power of 1D. Anisometropia is well-known to disturb the binocularity along with causing a decrease in the stereopsis. It has been noted that

suppression of the fovea in the defocused eye is the main reason leading to the reduction in the stereopsis. The literature data scarce concerning the assessment of stereopsis.[4] Hence, the present clinical study was aimed to comparatively evaluate the stereoacuity in subjects having emmetropia, isometropia, and anisometropia.

Materials and Methods

The present cross-sectional retrospective clinical study was aimed to comparatively evaluate the stereoacuity in subjects having emmetropia, isometropia, and anisometropia. The study was done at Department of Ophthalmology, Post Graduate Institute of Child Health, Noida, and Uttar Pradesh after getting clearance from Institutional Ethical Committee bearing no. 2023-08-IM-46. Consent waiver was taken from CPSCO and DHR approved Institutional Ethical Committee (IEC) as nature of study was retrospective data analysis. The study assessed 702 subjects of age 5-15 years divided into three groups, emmetropes with 250 subjects, isometropes with 250 subjects, and anisometropes with 202 subjects respectively attending eye OPD of PGICH Noida during span of five years. Ambylopic eyes were 78 and 129 respectively among isometropes and anisometropes, Titmus stereo test was used to measure the stereoacuity comprising of a combination of contour targets.

The inclusion criteria for the study were subjects in the age range of 5-15 years, having emmetropia, isometropia, or anisometropia of >1D. The exclusion criteria were subjects who were uncooperative, had a history of ocular trauma, underwent previous ocular surgery, had non-centric fixation, ocular deviation, lenticular opacity, had hazy media.

Procedure: Anisometropia for the present study was taken as an interocular difference of more than 1.00 D in the spherical equivalent and 0.75 D cylindrical equivalent. Amblyopia was taken as a difference in visual acuity of 2 or more lines on the ETDRS (Early Treatment Diabetic Retinopathy Study) chart between eyes/visual acuity of 6/12 or worse bilaterally.

After the final inclusion of the study subjects, detailed history was taken from all the participants followed by a comprehensive ocular examination. In all the subjects, the post-mydriatic test and cycloplegic refraction test were done manually by a single refraction expert in the field. ETDRS chart was used to assess the refractive status and the distant visual acuity with the subjects seated at 4 meters distance and it was recorded in logMAR units. A Jaeger chart was used to record the near vision followed by the cycloplegic refraction. The refractive correction was then prescribed. In all the study subjects, the spherical component with ½ cylinder component comprising spherical equivalent was calculated.

Meticulous fundus and slit-lamp examination were done for all the subjects using the slit-lamp bio microscopy and indirect and direct ophthalmoscopy using a 90-D lens to rule out any existing ocular pathology.

Titmus stereo test [5] was done by a single orthoptist expert not aware of refractive status in any study subject to assess the stereoacuity which comprised of combined contour targets. For assessing the stereoacuity, the subjects wore their best refractive correction before the test. The subjects were asked to wear the polarized glasses and asked to see the stereo chart from a distance of 40 cm. The stereopsis level was assessed based on the last one whether animal or circle assessed correctly seconds of arc based on the highest (finest) stereoacuity as 40 seconds of arc and lowest stereoacuity and lowest stereoacuity as 3552 seconds of arc.

The subjects included in the study were divided into three group's emmetropes (Group I) with 250 subjects, isometropes (Group II) with 250 subjects, and anisometropes (Group III) with 202 subjects respectively. Depending on the refractive error type, isometropes and anisometropes were further classified into 4 subgroups namely hypermetropia with astigmatism, hypermetropia, myopia with astigmatism, and myopia. The difference in spherical equivalent or the degree of anisometropia between two eyes in the anisometropic group was further classified as mild, moderate, and severe with >1-3 D, >3-6 D, and >6 D respectively.

Statistical Analysis: The data gathered was analysed statistically using SPSS software version 21.0 an independent t-test and a one-way ANOVA (analysis of variance) test. The data were expressed as numbers and percentages and mean and standard deviation. The p-value of >0.05 was considered statistically significant.

Results

The study assessed 702 subjects of age 5-15 years divided into three groups emmetropes with 250 subjects, isometropes with 250 subjects, and anisometropes with 202 subjects respectively. Ambylopic eyes were 78 and 129 respectively among isometropes and anisometropes, Titmus stereo test was used to measure the stereoacuity comprising of a combination of contour targets.

In the anisometropia group, hypermetropia with astigmatism, hypermetropia, myopia with astigmatism, and myopia was seen in 17.32% (n=35), 19.80% (n=40), 33.66% (n=68), and 28.71% (n=58) study subjects respectively. The anisometropia degree of mild, moderate, and severe was seen in 43.56% (n=88), 36.13% (n=73), and 19.80% (n=40) study subjects respectively. In the

isometropia group (II), hypermetropia with astigmatism, hypermetropia, myopia with astigmatism, and myopia was seen in 13.2% (n=33), 15.6% (n=39), 38.8% (n=97), and 34.4% (n=86) study subjects respectively.

The study subjects were in the age range of 5-15 years and had a mean age of 9.72±2.42 years. There were 51.85% (n=364) female and 48% (n=337) males in the present study. No significant difference concerning age or gender was seen in the three study groups. In anisometropics, more refractive error was seen in the right eye compared to the left eye with 52% and 48% of subjects respectively. The eye with the higher refractive error was taken as the worst eye and the other one as the fellow eye.

Amblyopic eyes in anisometropia were 64% (n=129). The worst eye had amblyopia in 36.2% (n=21), 48.5% (n=33), 71.3% (n=28), and 75.5% (n=28) eyes respectively with myopia, myopia with astigmatism, hypermetropic group, and hypermetropia with astigmatism group. Amblyopia in fellow eyes was seen in 4.2% (n=2), 5.2% (n=3), 11.3% (n=4), and 14.7% (n=10) subjects with myopia, myopia with astigmatism, hypermetropic group, and hypermetropia with astigmatism group respectively. In all the subgroups, the maximum number of worst eyes amblyopia was falling in the severe anisometropia group.

Owing to bilateral and equal high refractive error, isometropic amblyopia was seen in a few subjects of Group II (isometropia), In isometropes, 31% (n=88) eyes were amblyopic. In different subgroups, 7.5% (n=6), 11.5% (n=5), 17.5% (n=16), and 38.8% (n=13) right eyes were amblyopic in myopia, myopia with astigmatism, hypermetropic group, and hypermetropia with astigmatism group respectively. In left eyes, amblyopia was seen in 7.6% (n=7), 11.5% (n=4), 15.3% (n=14), and 39% (n=13) eyes in myopia, myopia with astigmatism, hypermetropic group, and hypermetropia with astigmatism group respectively.

Titmus stereo test assessed stereoacuity from best (40) to worst (3552) seconds of arc. The mean stereoacuity in the anisometropia group was 614.42±1027.82 and the range of 40-3552 seconds of arc with a statistically significant negative correlation in stereoacuity and degree of anisometropia with $p<0.001$. In the anisometropia group, worse stereoacuity was seen in amblyopic eyes compared to non-amblyopes with 1002.23±1199.86 and 148.14±447.86 respectively, and $p<0.001$. In the isometropia group, stereoacuity was 132.36±405.434 which was worse in amblyopes compared to non-amblyopes with 583.67±889.96 and 46.36±11.73 respectively, and $p<0.001$. In the emmetropic group, mean stereoacuity was 40.14±1.56 and range of 40-60 seconds of the arc.

On assessing stereoacuity in a subgroup of subjects with anisometropia, the mean value of stereoacuity was 378.85±310.157 in subjects having Hypermetropia with astigmatism, 676.06±1010.877 in subjects having hypermetropia, 783.14±1246.369 in subjects having myopia with astigmatism, and 518.23±1014.29 in subjects having myopia respectively. The difference was statistically significant with $p=0.031$ and the highest stereoacuity in myopia with the astigmatism subgroup as shown in Table 1.

On the bivariate correlation analysis, it was seen that stereoacuity decreased with the degree of anisometropia. It was also that the poorest stereoacuity is seen in the myopia subgroup followed by myopia with astigmatism subgroup, hypermetropia with astigmatism subgroup, and hypermetropia subgroup respectively. The results were statistically significant with $p<0.001$ as depicted in Table 2. In anisometropes, worse stereoacuity was seen in subjects with the unequal vision of difference of more than two lines known as amblyopes with stereoacuity of 1039.96±1245.96 compared to subjects with less than two-line differences with stereoacuity of 622.27±1226.76 which was a statistically significant difference with $p<0.01$.

Concerning the stereoacuity in four subgroups of subjects having isometropia, the mean stereoacuity was reduced in Hypermetropia with astigmatism subgroup with 452.56±922.26 and was within the normal range in hypermetropia, myopia with astigmatism, and myopia groups with mean stereoacuity of 58.23±48.53, 94.23±152.44, and 81.83±280.68 respectively which was a statistically significant difference with $p<0.001$ as shown in Table 3. On analyzing the overall stereoacuity in amblyopes and non-amblyopes of both isometropia and anisometropia groups, worse stereoacuity was seen in amblyopes with 930.27±116.87 compared to non-amblyopes with 79.29±238.87 which was a statistically significant difference with $p<0.001$.

On comparing the stereoacuity in three groups namely emmetropes, isometropes, and anisometropes, the mean stereoacuity was found to be 40.14±1.56, 132.36±405.45, and 614.42±1027.82 respectively depicting worse stereoacuity in anisometropes compared to isometropes and emmetropes with a statistically significant difference with $p<0.001$ as shown in Table 4.

Table 1: Stereoacuity in four subgroups of subjects with anisometropia

S. No	Group	Mean ± S. D	p-value
1.	Hypermetropia with astigmatism	378.85±310.157	0.031
2.	Hypermetropia	676.06±1010.877	
3.	Myopia with astigmatism	783.14±1246.369	
4.	Myopia	518.23±1014.29	

Table 2: Analysing the degree of anisometropia with stereoacuity in different subgroups

S. No	Group	Pearson's correlation coefficient	p-value
1.	Hypermetropia with astigmatism	-6997	<0.001
2.	Hypermetropia	-0.342	0.002
3.	Myopia with astigmatism	-0.756	<0.001
4.	Myopia	-0.817	<0.001

Table 3: Stereoacuity in four subgroups of subjects with isometropia

S. No	Group	Mean ± S. D	p-value
1.	Hypermetropia with astigmatism	452.56±922.26	<0.001
2.	Hypermetropia	58.23±48.53	
3.	Myopia with astigmatism	94.23±152.44	
4.	Myopia	81.83±280.68	

Table 4: Stereoacuity profile comparison in subjects having emmetropia, isometropia, and anisometropia

S. No	Group	Mean ± S. D	p-value
1.	Emmetropia	40.14±1.56	<0.001
2.	Isometropia	132.36±405.45	
3.	Anisometropia	614.42±1027.82	

Discussion

The study results showed that for stereoacuity in a subgroup of subjects with anisometropia, the mean value of stereoacuity was 378.85±310.157 in subjects having Hypermetropia with astigmatism, 676.06±1010.877 in subjects having hypermetropia, 783.14±1246.369 in subjects having myopia with astigmatism, and 518.23±1014.29 in subjects having myopia respectively. The difference was statistically significant with p=0.031 and the highest stereoacuity in myopia with the astigmatism subgroup. This large amount of difference in spherical equivalent in myopes as compared to hypermetropes may be responsible for poorer stereoacuity in myopes than hypermetropes. These results were comparable to the results of the previous studies by Yang JW et al [6] in 2013 and Levi DM et al [7] in 2015 where authors reported comparable stereoacuity in subjects having anisometropia as in the present study.

On carrying out the bivariate correlation analysis, it was seen that stereoacuity decreased with the degree of anisometropia. It was also that the poorest stereoacuity is seen in the myopia subgroup followed by myopia with astigmatism subgroup, hypermetropia with astigmatism subgroup, and hypermetropia subgroup respectively. The results were statistically significant with p<0.001. In anisometropes, worse stereoacuity was seen in subjects with the unequal vision of difference of more than two lines known as amblyopes with stereoacuity of 1039.96±1245.96 compared to subjects with less than two-line differences with stereoacuity of 622.27±1226.76 which was a statistically significant difference with p<0.01. These results were consistent with the previous studies of Habiba UE [8] in 2017 and Weakly DR [9] in 2001 where authors reported a decrease in the degree of anisometropia with a reduction in stereoacuity.

The study results also showed that for the stereoacuity in four subgroups of subjects having isometropia, the mean stereoacuity was reduced in Hypermetropia with astigmatism subgroup with 452.56±922.26 and was within the normal range in hypermetropia, myopia with astigmatism, and myopia groups with mean stereoacuity of 58.23±48.53, 94.23±152.44, and 81.83±280.68 respectively which was a statistically significant difference with p<0.001. This can be attributed to the presence of more amblyopes in the hypermetropia with the astigmatism group. These findings were in agreement with the findings of Levi DM et al [10] in 2011 and Nabie R et al [11] in 2019 where authors reported results comparable to the present study.

The study results on analyzing the overall stereoacuity in amblyopes and non-amblyopes of both isometropia and anisometropia groups, worse stereoacuity was seen in amblyopes with 930.27±116.87 compared to non-amblyopes with 79.29±238.87 which was a statistically significant difference with p<0.001. These results were comparable to the findings of Jeon HS [12] in 2017 and Gawecki M[13] in 2019 where authors

suggested worse stereoacuity in amblyopes compared to non-amblyopes.

It was seen that on comparison of the stereoacuity in three groups namely emmetropes, isometropes, and anisometropes, the mean stereoacuity was found to be 40.14±1.56, 132.36±405.45, and 614.42±1027.82 respectively depicting worse stereoacuity in anisometropes compared to isometropes and emmetropes with a statistically significant difference with $p<0.001$. These findings were in line with the studies of Vincent SJ et al[14] in 2003 and Huynh SC et al[15] in 2006 where authors reported the worst stereoacuity in anisometropes compared to emmetropes and isometropes as seen in the present study.

Conclusion

Considering its limitations, the present study concludes that stereoacuity is poorest in anisometropes compared to emmetropes and isometropes. A greater reduction in stereoacuity is seen in ambylopes compared to non-amblyopes. With the increase in the degree of anisometropia, stereoacuity is decreased. In anisometropes, worse stereoacuity is seen in myopes compared to hypermetropes.

References

1. Barry, S.R. Beyond the critical period: Acquiring stereopsis in adulthood. Plasticity in sensory systems. 2012; 1:175–95.
2. Andalib D, Nabie R, Poormohammad B. Factors affecting the improvement of stereopsis following successful surgical correction of childhood strabismus in adults. Strabismus. 2015; 23:80–4.
3. Hoyt CS, Taylor D. Pediatric Ophthalmology and Strabismus, Expert Consult-Online, and Print, 4: Pediatric Ophthalmology and Strabismus. Elsevier Health Sciences. 2012.
4. Von Noorden GK, Campos EC. St Louis, Mosby. Binocular Vision and Ocular Motility, Theory and Management of Strabismus. (6th ed) 2002:21–25.
5. Fawcett SL, Birch EE. Validity of the Titmus and Randot circles tasks in children with known binocular vision disorders. J AAPOS. 2003; 7:333–8.
6. Yang JW, Huang TY, Lee JS, Yeung L, Lin YF, Sun CC. Correlation between myopic ametropia and stereoacuity in school-aged children in Taiwan. Jpn J Ophthalmol. 2013; 57:316–9.
7. Levi DM, Knill DC, Bavelier D. Stereopsis and amblyopia: A mini-review. Vis Res. 2015; 114:17–30.
8. Habiba UE, Hussain Z. Comparison of stereopsis and contrast sensitivity in myopic and hyperopic anisometropia. Ophthalmol Pak. 2017; 7:17–21.
9. Weakley DR., Jr The association between non strabismic anisometropia, amblyopia, and subnormal binocularity. Ophthalmology. 2001; 108:163–71.
10. Levi DM, McKee SP, Movshon JA. Visual deficits in anisometropia. Vis Res. 2011; 51:48–57.
11. Nabie R, Andalib D, Khojasteh H, Aslanzadeh SA. Comparison of the effect of different types of experimental anisometropia on stereopsis measured with titmus, random, and TNO stereo tests. J Ophthalmic Vis Res. 2019; 14:48–51.
12. Jeon HS, Choi DG. Stereopsis and fusion in anisometropia according to the presence of amblyopia. Graefes Arch Clin Exp Ophthalmol. 2017; 255:2487–92.
13. Gawęcki M. Threshold values of myopic anisometropia causing loss of stereopsis. J Ophthalmol. 2019; 2019:2654170.
14. Vincent SJ, Collins MJ, Read SA, Carney LG. Myopic anisometropia: Ocular characteristics and aetiological considerations. Clin Exp Optom. 2014; 97:291–307.
15. Huynh SC, Wang XY, Ip J, Robaei D, Kifley A, Rose KA, et al. Prevalence and associations of anisometropia and aniso-astigmatism in a population-based sample of 6-year-old children. Br J Ophthalmol. 2006; 90:597–601.