

Comparison of Distance stereoacuity in corrected Myopic and Hypermetropic children.

Sounak Choudhuri

SAERA. School of Advanced Education Research and Accreditation

ABSTRACT

Purpose

To measure and compare the distance stereoacuity of corrected myopic and hypermetropic children between 6-12 years.

Method

Distance Stereoacuity testing was performed by using Distance Randot^R Stereotest (manufactured by Stereo Optical Company, Inc.) in twenty-five children with corrected myopia (n=25) and twenty-five children with corrected hypermetropia (n=25) and compare the median value of these two groups.

Result

Distance Stereoacuity was equal in both the groups. (Myopia: Median = 100 arc sec; Hypermetropia: Median = 100 arc sec)

Conclusion

The distance stereoacuity in corrected eyes is not affected by the type of the refractive error i.e. Myopia or Hypermetropia.

Keywords: *Stereoacuity; Stereopsis; Myopia; Hypermetropia*

INTRODUCTION

The measurement of distance stereoacuity may be useful in assessing strabismic patients who have different deviation for near and distance, especially with intermittent exotropia. It has shown early promise for monitoring deterioration in intermittent exotropia. (Adams,2008).

Randot Distance Stereoacuity^R is a polaroid vectogram-based distance stereoacuity which can be easily administered quantitative test for measuring distance stereoacuity at 3 meters in children. The distance Randot Stereotest is a useful tool for measuring distance stereoacuity in patients with or without strabismus.

Fu et al. (2006) evaluated the normative data of Randot Distance Stereoacuity on 23 normal children, 21 normal adults and 131 patients with a variety of strabismic conditions. Further study on normative data, reliability and validity was carried out by Wang et al (2010).

Extensive literature exists on normative stereoacuity values for younger children, but there is less information on distance stereoacuity in different refractive errors. According to Leske et al. (2006) the Distance Randot Stereotest is very sensitive to disturbances of binocularity.

The aim of the current study was to measure and compare the distance stereoacuity in corrected myopic and hypermetropic children from 6 to 12 years old in otherwise normal eyes.

METHODS

Data was collected from a pediatric optometry clinic. The patient was examined along three months of cycloplegic refraction and prescription of glasses. Anterior segment and posterior segment of all the recruited children were assessed by a pediatric ophthalmologist.

Full correction was given to all myopic children (Goss,2006). Full correction was given for hypermetropia with accommodative esotropia and 1.50D hypermetropia was deducted from all non-accommodative hypermetropic eyes (Moore,2008).

PARTICIPANTS

The data was obtained from 50 children.

Twenty-five myopic children were examined out of which nine children had mild myopia of -0.25D to -3.00D (Spherical Equivalent-S.E), ten children had moderate myopia of -3.25D to -6.00D (S.E); and 6 children had severe myopia of more than -6.00D (S.E).

Twenty-five hypermetropic children were examined out of which eighteen children had a corrected refractive error of +0.25D to +3.00D (S.E) and seven children had refractive error above +3.00D (S.E).

The inclusion criteria were, minimum Visual acuity of 0.7 (Decimal acuity) monocularly with ETDRS chart. All subjects had near stereopsis of minimum 100 arc of second with Titmus Fly Stereo acuity^R. The age was between 6 years to 12 years old. Nobody had astigmatism higher than 1D. All subjects had fusion with distance and near Worth Four Dot Test. The minimum Distance

stereoacuity of 400 arc seconds. All subjects had normal anterior segment with no congenital ocular malformities. The spectacle compliance was good for all enrolled children of this study.

None of the recruited children had constant tropia with spectacle correction. There were no history of ocular surgery. Pathological myopia excluded from this study.

DISTANCE RANDOT STEREOTEST PROTOCOL

Distance Randot Stereotest is a Polaroid vectrographic random dot test designed to test stereoacuity at distance fixation of 3 meters or 10 feet. The range of stereoacuity measured in this test is from 400 arc seconds of arc to 60 seconds of arc.

PRETEST

The subject was asked to identify black-and-white pictures of the 4 geometric shapes (circle,triangle,square and star) to confirm that they were able to name or match the shapes used in the test. The test proceeded only if the subject was able to name or match the shapes.

TEST PROTOCOL

The test subject places the Stereo Optical Polarized Viewers over their eyes. At each level the subject must correctly identify both of the test shapes (A and B). Testing begins with the picture labeled '400A' followed by '400B'. If the subject correctly matched or named both shapes at the 400 arc seconds level, testing proceeded to 200 arc sec and so on. The smallest disparity at which the child

identified both shapes correctly was recorded as stereoacuity. Available stereoacuity was 400;200;100 and 60 seconds of arc.

RESULTS

Twenty-fivemyopic children and twenty-five hypermetropic children of 6-12 years old were recruited in this study. The mean age was 9.02 years. (Myopic group= 8.96 years old and Hypermetropic group=9 years old)

MYOPIA

The mean refractive error in the right eye was -3.89 D with standard deviation of 2.59 D and the mean refractive error in left eye was -3.88 D with 2.63D of standard deviation in myopic group. The mean stereopsis was 125.6 seconds of arc with standard deviation of 73.60 seconds of arc. The median stereopsis was 100 seconds of arc.

Table.1 Details of myopic groups.

	Right Eye	Left Eye	Stereopsis*	Age
Mean	-1.19	-1.31	102.22	8.56
Median	-1	-1.875	100.00	8.00
S. D	0.51	0.75	40.55	2.29
Moderate Myopia				
	Right Eye	Left Eye	Stereopsis*	Age
Mean	-4.07	-2.57	126.00	9
Median	-4.25	-3.75	100	9.5
S. D	0.62	0.59	52.54	2.1
High Myopia				
	Right Eye	Left eye	Stereopsis*	Age
Mean	-7.63	-5.17	160.00	9.5
Median	-7.88	-7.25	100	9.5

S.D 1.16 2.29 126.49 1.87

(* Measured in seconds of arc)

The data of myopic children further divided into three groups based on the amount of refractive errors according to the guidelines of American Optometric Association of 2006 into low, moderate and severe myopia.

Low myopia group was up to -3.00D of refractive error. In low myopia group the total number of children was 9 (n=9) whose mean age was 8.56 yearsold with standard deviation of 2.29 years old. The mean refractive error of right eye was -1.19D and left eye was -1.31D with standard deviation of 0.51D and 0.75D in this group. The difference in mean and median stereopsis in this group was clinically insignificant. The

mean stereopsis was 102.22 seconds of arcand median stereopsis was 100 seconds of arc.

The second group was moderate myopia of more than-3.00D to-6.00D.10 children(n=10) with mean age of 9 years(SD= $\pm$ 2.1 years old) were recruited in these group. The mean myopia in the right eye was -4.07D and left eye was-2.57D with standard deviation of 0.62 and 0.59. The mean stereopsis was 126 seconds of arc and median stereopsis was 100 seconds of arc. The difference of mean and median stereopsis was significant clinically (26.0). The distribution of the valuewas very wide with outliers of 200 so the median value was chosen.

In high myopia group (above -6.00D)there were 6 children with mean refractive error of -7.63D in the right eye and -5.17 D in the left eye. The standard deviation of refractive errors 1.16 and 2.29 in right and left eye. The mean stereopsis was 160.0and median stereopsis was 100. The difference of 60.0betweenmean and median stereopsis was very significant. In this group of six, one observation was very high 400 seconds of arc, marked as outliers and which was the reason of high mean. Therefore, the median value was considered more reliable.

The median stereoacuity was equal in all three groups, whereas the mean stereoacuity was gradually reduced from low to high. Although the outliers in moderate and high myopia group was significant.

Fig.1 Distance stereoacuity of corrected myopic children

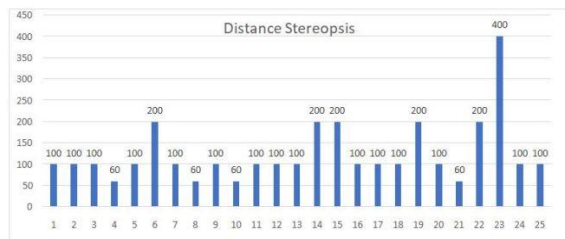


Fig.2 Distribution of distance stereopsis in myopes.

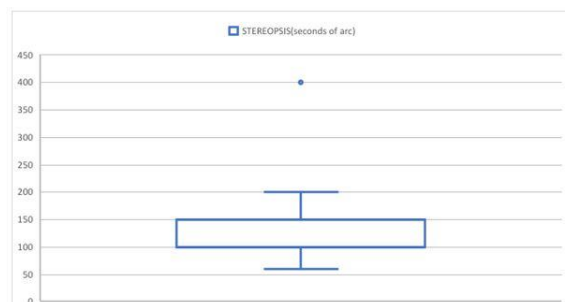


Fig.2 shows the distance stereoacuity of corrected myopic children, where the minimum was 60, 1st quartile was 60, 2nd quartile was 100, 3rd quartile was 150 and the 4th quartile was 200 with one outlier of 400. The maximum was 400. The median value is 100. The interquartile range was 50.

With relation to the frequency of distance stereoacuity in corrected myopic children, from 25 children, 4(16%) had distance stereoacuity of 60 seconds of arc. 15 children (60%) had distance stereoacuity of 100 seconds of arc and 5 children (20%) with distance stereoacuity of 200 seconds of arc. 4% had a distance stereoacuity of 400 seconds of arc, which was only 1 child out of 25 children.

As we can see most of the children was having a distance stereoacuity of 100 seconds of arc, which was also the median

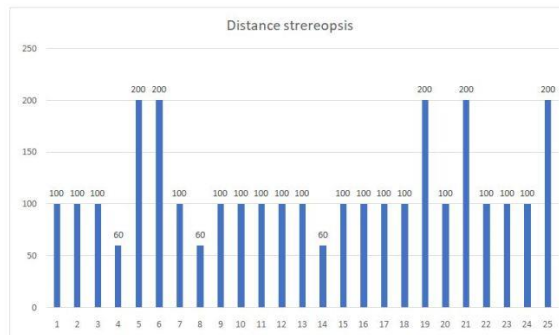
distance stereoacuity of corrected myopic children.

HYPERMETROPIA

In the hypermetropic group total 25 children(n=25) were recruited. The mean age of this group was 9.08 years old with standard deviation of 2.23years old. The group was further divided into 2 groups (Table.2) based on the refractive error. Fig.3 shows the individual distance stereopsis of each child recruited in this study.

We can see from fig.4 that most of the observations were close to 100 except few observations in which the stereoacuity were 200.

Fig.3 Distance stereopsis in corrected hypermetropic children



The mean refractive error of the right eye was +2.18D with standard deviation of 1.64D and the mean refractive error of the left eye was +2.33 with standard deviation of 1.68D. The median stereopsis of this group was 100 seconds of arc and the mean stereopsis was 115.2 seconds of arc with standard deviation of 45.19seconds of arc.

Table.2- Distribution of refractive error in hypermetropic children.

Group- (Fig.3)				
	Right Eye	Left Eye	Stereopsis*	Age
Mean	1.30	1.41	104.44	9.2
Median	1.25	1	100	9
Standard Deviation	0.60	0.64	37.92	2.12
Group-2 Above +3.00D SI No-19-25 (Fig.3)				
	Right Eye	Left Eye	Stereopsis*	Age
Mean	4.43	4.68	142.86	8.86
Median	4.5	4.5	100	7
Standard Deviation	1.26	1.16	53.45	2.67

(*Stereopsis measured in seconds of arc)

The data of hypermetropic group was further divided into two groups based on the refractive error. Group.1 and Group.2.

In group 1 eighteen children(n=18) were recruited on the basis of their refractive error which was up to +3.00D (S.E). The mean age of this group was 9.2 years old with standard deviation of 2.12 years old. The mean refractive error of right eye was +1.30 D with standard deviation of 0.6D, and the mean refractive error of the left eye was +1.41D with 0.64D standard deviation. The difference in mean and median refractive error in right eye was not clinically significant(0.05D) while in the left eye it was 0.41D which was clinically significant. The reason of this difference was the wide range of data distributions in the left eye.

In group 2 total seven children (n=7) were recruited whose refractive error was more than +3.00D in both eyes (S.E). The mean age of this group was 8.86 years old with standard deviation of 2.67 years old. The mean refractive error in right eye was

+4.43D with 1.26D of standard deviation. The average refractive error in left eye was +4.68D with standard deviation of 1.16D. The median refractive error was close to the mean refractive error.

The median distance stereopsis in group 1 was 100 seconds of arc and in group 2 was 100 seconds of arc. The median stereopsis in both eyes were equal. (Fig.4)

The mean distance stereopsis of corrected hypermetropia group 1 was 104.44 seconds of arc with standard deviation of 37.2. and group 2 the mean distance stereopsis was 142.86 seconds of arc with standard deviation of 53.45.

The difference of mean and median distance stereoacuity in group 1 was 04.44 seconds of arc which was not clinically significant. Whereas in group.2 the difference of mean and median distance stereopsis was 42.86 seconds of arc. This difference was clinically significant. The reason of high mean stereoacuity in group.2 was the number of outlier (200) were significant in this group.

Therefore, the median values of distance stereoacuity were reliable in both the groups.

Fig.4 Distribution of distance stereoacuity in hyperopes

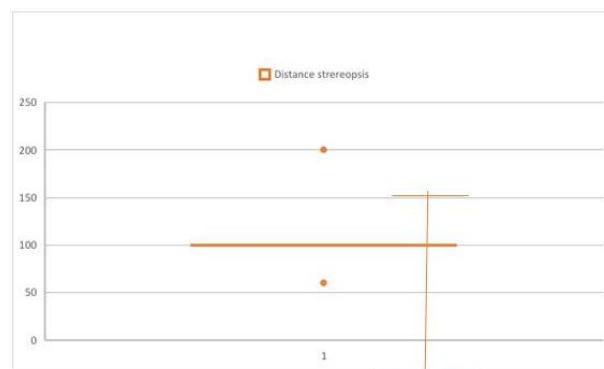


Fig.4 represents the distribution of distance stereoacuity of corrected hypermetropic eyes. Here the sample size was 25 with the minimum value of 60 and maximum value of 200. The 1st quartile was 100, median 100 and 3rd quartile was 100. Interquartile range was 0, which represents by the single line in this figure. The outlier was 200.

With relation to the frequency of distance stereoacuity in uncorrected hypermetropic eyes, from a total sample size of 25 in children, 3 (12%) presents a distance stereoacuity of 60 seconds of arc. 17 children (68%) had distance stereoacuity of 100 seconds of arc. There were 5 children (20%) with distance stereoacuity of 200 seconds of arc. No one (0%) in this group had a stereoacuity of 400 seconds of arc.

The median distance stereoacuity (n=25 each group) was equal (Median=100 arc sec) in both corrected myopic and hypermetropic group.

Fig.6 Comparison of median stereopsis in different myopic and Hypermetropic group.

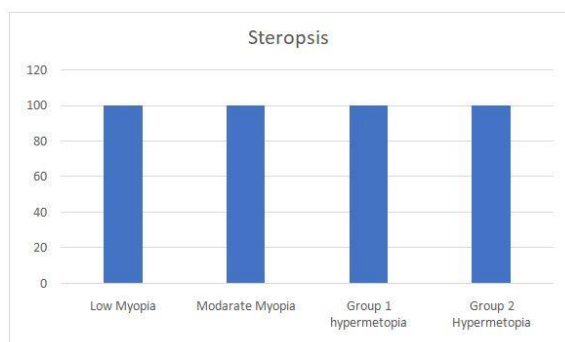
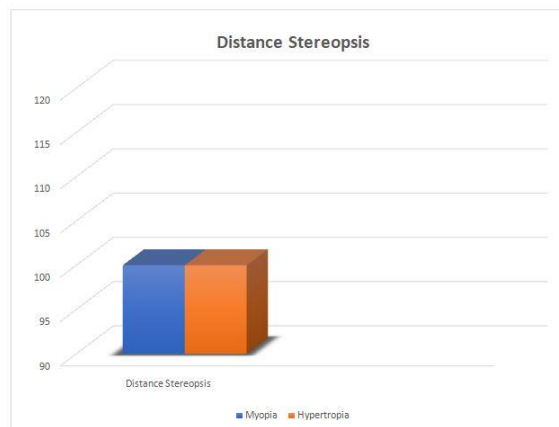


Fig.6 compares the median values of distance stereoacuity in low and moderate myopia with group 1 and group 2 hypermetropia.

The median stereopsis was equal in all four groups. The median stereopsis was 100 seconds of arc.

Fig.7 Comparison of distance stereoacuity in Myopic and Hypermetropic eyes

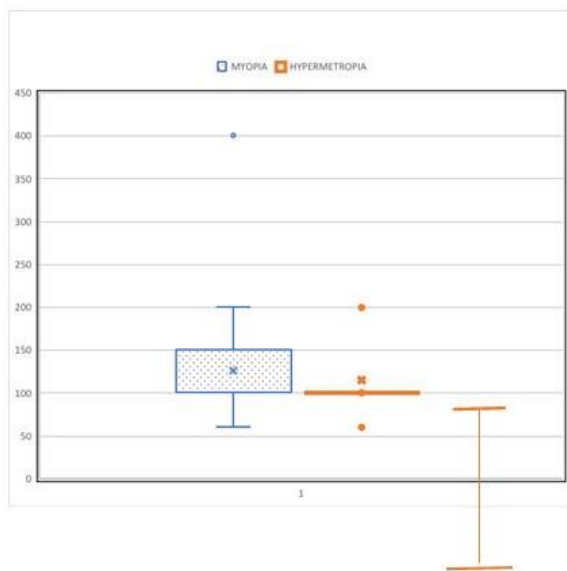


The data distribution of distance stereoacuity in corrected myopic and hypermetropic eyes were described in fig.8.

As we can see most of the observations were in the 100th scale of the 'Y' axis, which means most of children who recruited in these studies were having distance stereoacuity of 100 seconds of arc. The mean value was represented by the sign of 'x'. The mean value of distance stereoacuity in corrected myopia was 125.6 seconds of arc and in corrected hypermetropic group it was 115.2.

The difference of mean and median distance stereoacuity was clinically significant in myopic group. However, in hypermetropic group the difference between mean and median distance stereoacuity was statistically significant but clinically it was not very significant.

Fig.8 Comparison in the data distribution of distance stereopsis in corrected Myopes and Hyperopes



CONCLUSION

This report provides comparative dataset on distance stereoacuity in corrected myopes and hyperopes in otherwise normal eyes. Additionally, this study gives an idea on normative values of distance randot stereoacuity in corrected myopes and hyperopes.

According to Leske et al (2006) distance randot stereotest very sensitive to disturbances of binocularity. The purpose of this study was, to evaluate the distance stereopsis of those subjects who had normal binocularity for distance and near, with good stereopsis for near, positive distance stereopsis and good visual acuity. According to Pei et al (2016) refractive correction with good spectacles compliance improves stereoacuity. In this study the distance stereoacuity was measured in children with

good spectacles compliance which shows the same kind of result.

This study shows the comparison of distance stereo acuity in corrected myopia and hypermetropia. The data confirmed that the distance stereo acuity is an independent factor which is not influenced by the nature of the refractive error.

Although the mean distance stereoacuity in corrected high myopia and hypermetropia of more than +3.00D was noted to be reduced significantly, however the small sample size (n=50) cannot confirm the findings.

The limitation of this study was small sample size. Further study required with larger sample size to confirm the findings. Especially the number of participant in high refractive error groups were not enough to analysis the changes in distance stereoacuity.

Measurement of distance stereoacuity has been used previously to assess the severity of intermittent exotropia and to determine whether deterioration has occurred. (Stathacopoulos et al.1993) This study shows that distance stereoacuity is equal in corrected myopes and hyperopes and distance stereoacuity is not influenced by the amount of refractive error.

According to Webber et al. (2005) the most common deficit associated with amblyopia under ordinary (binocular) viewing condition is impaired stereoscopic depth perception. Therefore, the importance of measuring distance stereoacuity in pediatric age group is undeniable. Brain plasticity is known to peak during critical period in early childhood and to decrease thereafter (Bavelier et al.,2010; Movshon & Van Sluyters,1981; Wiesel,1982). Early detection ensures better prognosis. Normal distance stereoacuity indicates normal

distance binocularity and a stable refractive status. Further studies require to assess the effect of glasses on distance stereoacuity.

The Distance Randot Stereotest^R is a simple and efficient approach to making reliable and valid measurements of distance stereoacuity in all type of refractive errors with correction.

REFERENCES

- Adams WE, Leske DA, Hatt SR, et al. Improvement in stereopsis in distance stereoacuity following surgery for intermittent exotropia AAPOS 2008;12:141-4
- Bavelier D, Levi DM, Li RW, Dan Y, Hensch TK. Removing brakes on adult brain plasticity: From molecular to behavioral interventions. The Journal of Neuroscience. 2010;30(45):14964-14971.
- Fu VL, Birch EE, Holmes JM. Assessment of a new Distance Randot stereoacuity test. JAAPOS. 2006; 10:419-23.
- Gross DA, Grosvenor T.P, Keller J.T, Tootie-Marsh Wendy, Norton Thomas T, Zadnik K: Care of the patient with Myopia; Optometric clinical practical guideline; American Optometric Association; <https://www.aoa.org/documents/optometrists/CPG-15.pdf>
- Jingyun W, Sarah R. Hatt et al. Final Version of Distance Stereotest: Normative Data, reliability, and validity AAPOS 2010;14:142-146.
- Leske DA, Birch EE, Holmes JM. Real depth vs Randot Stereotest. Am J Ophthalmol 2006;142:699-701
- Movshon JA, Van Sluyters RC. Visual neural development. Annual Review of Psychology. 1981;32:477-522.
- Moore B.D, Augsburger AR, Ciner EB, Cockrell D.A Fern K.D Harb E; Care of the patient with Hypermetropia; Optometric clinical practical guideline American Optometric Association <https://www.aoa.org/documents/optometrists/CPG-16.pdf>
- Pei-Wen L, Hsueh-Wen C, Ing-Chou L, Mei-Ching T et al. Visual outcomes after spectacles treatment in children with bilateral high refractive amblyopia. Clinical and Experimental Optometry, Volume 99, issue-6, Page-550-554
- Stathacopoulos RA, Rosenbaum AL, Zanoni et al. Distance stereoacuity; assessing control in intermittent exotropia. Ophthalmology 1993; 100:495-500
- Webber AL, Wood J et al. Amblyopia: Prevalence, natural history, functional effects and treatment. Clinical and Experimental Optometry, 2005;88:365-375.
- Wiesel T. Postnatal development of the visual cortex and the influence of environment. Nature. 1982; 299:583-591.