A COMPARATIVE STUDY OF STEREOACUITY IN AGAINST THE RULE AND OBLIQUE ASTIGMATISM

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Nimra Asif[1]
Muhammad Anwar Awan[2]
Bareera Aslam[3]

For Authors' affiliation & contribution see end of Article

Corresponding Author:
Nimra Asif
BSc. (Hons) Optometry
College of Ophthalmology & Allied Vision Sciences, Lahore. (COAVS)
cheekusalvakia.ke@gmail.com

ABSTRACT

OBJECTIVE: *To measure and compare the stereopsis level among the persons with against-the-rule and oblique astigmatism using Lang I and Lang II tests.*

METHODS: *Informed consent was obtained from each patient both in verbal and written form. A proforma was filled at the time of examination. Visual acuity was checked on Snellen chart which was then converted to log MAR values. The type and amount of astigmatism was measured by performing refraction subjectively using trial lenses. Individuals having cylindrical value at the axis of 70-120 degrees were considered to have against-the-rule astigmatism while individuals having cylindrical value at the axis of 20-60 degrees and 130-160 degrees were considered to have oblique astigmatism. Lang I and Lang II are performed for detailed or fine measurement of stereopsis. The sample size was 36 with a confidence level of 95% is taken and the study is conducted in the College of Ophthalmology and Allied Vision Sciences (COAVS), LAHORE. Data was entered and analyzed using a statistical package for social sciences (SPSS version-25.00). Mann-Whitney test was applied to compare the results. P-value ≤0.05 was considered significant.*

RESULTS: *A total of 36 individuals were included in this study and out of 36 individuals 18 individuals had against-the-rule astigmatism and remaining 18 had oblique astigmatism. Stereoacuity was measured in these two groups of astigmatism. Subjective refraction showed that the visual acuity of most of the individuals in right eye was equal to 6/36 and in left eye 6/24. And a greater number of individuals had plano spherical power in both eyes and cylindrical power of -0.50 DC in both eyes. The p-value of visual acuity, spherical readings, cylindrical readings showed that these all were insignificant in our results as p-value is >0.05. The results of Lang I test showed that large number of individuals (52.8%) did not respond to this test while Lang II test showed that (41.67%) individuals did not respond to this test means the stereopsis was absent in them. Shapiro Wilk test was used to check the normality of data and according to this test the p-value is ≤0.05 (p<0.01). It means that our data is not showing normality therefore we apply non-parametric tests. Then the p-values were find using Mann Whitney test (non-parametric test). And it showed that the p-value in Lang I test is (p=0.006) is ≤0.05. Similarly, the p-value for Lang II is (p=0.034) is also ≤0.05. As the p-values in Lang I and Lang II are ≤0.05 it means that the results are significant for this study.*

CONCLUSION: *Oblique astigmatic individuals had significantly poor stereopsis as compared to against-the-rule astigmatic individuals using Lang I and Lang II tests.*

KEYWORDS: *Astigmatism, Against the rule astigmatism, Oblique astigmatism, Stereopsis, Stereoacuity, Lang I, Lang II, Visual acuity.*

INTRODUCTION

The most common type of visual problem are the refractive errors that makes it difficult for a person to see clearly and these errors usually occur when the rays of light are not focused on the retina. The light rays are focused either in the front or back of the retina. A person who has trouble with his vision may present with many symptoms out of which blurry vision is the most common complaint. Other symptoms include double vision, headache, eyestrain, difficulty in reading and focusing, and misalignment between the eyes (squinting). There are five major kinds of refractive errors: myopia, hyperopia, presbyopia, anisometropia, and astigmatism.

Myopia is a condition in which a person cannot see distant objects clearly because the refractive power of the visual system is too large concerning the eyeball length. The rays of light are focused in front of the retina and it will result in the blurred image being formed at the fovea.

Hyperopia is a condition in which you see the distant objects clearly but objects at near may be blurry. This is because the refractive power of the eyeball is too small as compared to eyeball size. The rays of light are thus focused behind the retina and it results in the blurred retinal image.

Presbyopia is an age-related condition in which there is decreased ability to change the focus to and from near objects due to loss of elasticity of the lens and structural changes in ciliary muscles and suspensory ligaments.[1] Anisometropia is a condition which occurs when both eyes have different refractive powers.

Astigmatism comes from the Greek word (''a'' meaning absence and ''stigma'' meaning point) and is one of the groups of eye conditions called refractive errors. It is a common vision condition in which the surface of the cornea is curved in an abnormal way which results in blurry vision.The prevalence of astigmatism was reported 30% among old people in Myanmar to 77% in Indonesia. In various countries such as Japan, Indonesia, and Taiwan astigmatism is commonest among the refractive errors. The prevalence of refractive errors like astigmatism, hyperopia and myopia has been reported in several studies.[2-5] Astigmatism is classified into two major types irregular and regular. When the principal meridians are 90 degrees apart from each other then it is regular astigmatism. It is classified into three types; with-the-rule astigmatism, against-the-rule astigmatism, and oblique astigmatism. In with-the-rule astigmatism, the vertical meridian is steepest and remains close to 90 degrees. In against-the-rule astigmatism, the horizontal meridian is steeper than the vertical meridian and remains close to 180 degrees. In oblique astigmatism the horizontal and vertical meridians do not lie at 90 or 180 degrees and, instead, its prime meridians lie at 30-60 degrees and 120-150 degrees. If the two principal meridians are not 90 degrees apart from one another then it is called irregular astigmatism.

Astigmatism can be corneal, lenticular and both (total astigmatism). If there is an anomaly in the cornea such as the difference in the radius of curvature of principle meridians then it is called corneal astigmatism and if there is any problem in a lens such as a lens dislocation and refractive changes in the lens then it is called lenticular astigmatism.[6] Astigmatism is an autosomal dominant trait[7] and a child whose parents are astigmatic is at greater risk of developing astigmatism. Astigmatism varies with age,[8] gender,[9] ethnicity,[10] abnormal retinal electrophysiology,[11] myopia, asthenopia, and migraine.

Stereoacuity is derived from the Greek word ''stereo'' meaning solid and ''opsis'' meaning sight. The ability to perceive depth with the help of 3D structures of objects is called stereopsis.[12,13] It is a process of binocular vision in humans in which the two eyes perceive images which are different to some extent as they are separated horizontally. The major requirements for stereoscopic vision are decussation of afferent visual fibers partially, large overlapping of visual fields binocularly, and coordinated conjugate eye movements. Many factors can influence the stereo acuity such as level of illumination, color, contrast, anisometropia, refractive errors, and other binocular anomalies like amblyopia and squint.[14] The work performance of certain occupations is dependent upon the stereopsis and poor stereopsis will lead to poor work performance and quality of well-being.[15]

Different kind of refractive errors affect the stereopsis differently. Astigmatism results in decrease in the stereoacuity. The stereoacuity is affected with both against-the-rule astigmatism and with-the-rule astigmatism While in the case of oblique astigmatism, stereo acuity is greatly affected especially at the axis of 45 degrees while it is least affected at the 180-degree axis in both myopic and hyperopic astigmatism.[16]Hence, oblique astigmatism affects stereoacuity much more after that against-the-rule (ATR) astigmatism and least affected by with-the-rule (WTR) astigmatism.[16] Near stereoacuity decreases with the increasing dioptric power of astigmatism, and this astigmatism results in an image blur and reduce visual acuity resulting in stereoacuity deterioration. Astigmatism can also cause reduction in visual acuity of an individual. According to a recent study the visual acuity is affected by the axis of cylinder with good vision with the 90-degree axis of the cylinder than any other axis as in the case as in 180, 45, and 135 degrees of axes.[17]

The purpose of the study is to check the stereo acuity in both against-the-rule astigmatism and oblique astigmatism. The study will also show that in which type of astigmatism the stereo acuity is worse and check that

whether the stereo acuity is more affected in against-the-rule astigmatism or oblique astigmatism.

MATERIAL AND METHODS

It was a cross-sectional study. Persons having against the rule and oblique astigmatism and persons who are older than 15 years are included in this study. And uncooperative patients, persons having any external ocular disease, mentally retarded individuals, persons having any other type of refractive error except against the rule and oblique astigmatism and strabismic patients are excluded in this study. Informed consent was obtained from each patient both in verbal and written form. A proforma was filled at the time of examination. Visual acuity was checked on Snellen chart which was then converted to log MAR values during data entry. The type and amount of astigmatism was measured by performing refraction subjectively using trial lenses. Individuals having cylindrical value at the axis of 70-120 degrees were considered to have against-the-rule astigmatism while individuals having cylindrical value at the axis of 20-60 degrees and 130-160 degrees were considered to have oblique astigmatism. Lang I and Lang II were performed for detailed or fine measurement of stereopsis. The sample size was 36 with a confidence level of 95% was taken and the study was conducted at the College of Ophthalmology and Allied Vision Sciences (COAVS), LAHORE. And this study was performed after obtaining ethical consideration from COAVS. Data was entered and analyzed using a statistical package for social sciences (SPSS version-25.00). Mann-Whitney test was applied to compare the results. P-value ≤0.05 was considered significant.

RESULTS

Out of 36 individuals 18 (50%) individuals were having against-the-rule astigmatism and18 (50%) individuals had oblique astigmatism. Stereoacuity was measured in these two groups of astigmatism using Lang I and Lang II. Lang I test for stereoacuity testing, showed that 55.6% of individuals did not respond to Lang I test having greater number of oblique astigmatic individuals, while in the remaining individuals the test showed positive results out of which 38.9% individuals had the Lang I value of 550 seconds of arc means that they had good stereo acuity and 8.33% individuals had the Lang I value of 1200 seconds of arc which means that they had poor stereopsis (Table 1).

Table- 1: Lang I test

Lang I	Values in second of arc	550	1200	Nil	Total
Type of Astigmatism	Oblique astigmatism	4	0	14	18
	Against the rule astigmatism	10	2	6	18
Total		14	2	20	36

Lang I test for stereo acuity testing, showing that majority of the individuals do not respond to this test having greater number of oblique astigmatic individuals. It means that they have poor stereopsis.

Lang II test for stereo acuity testing showed that 41.7% of individuals did not respond to the Lang II test having the greater number of oblique astigmatic individuals. While 27.8% of individuals had a Lang II test value of 200 seconds of arc, means that they had good stereopsis and 5.6% individuals had a value of 400 seconds of arc means that they had poor stereopsis and 25% individuals had value of 600 seconds of arc (Table 2).

Table-2: Lang II test

Lang II	Values in second of arc	200	400	600	Nil	Total
Type of Astigmatism	Oblique astigmatism	4	0	3	11	18
	Against the rule astigmatism	6	2	6	4	18
Total		10	2	9	15	36

The mean and standard deviation of against-the-rule and oblique astigmatism were found by comparing means using Mann-Whitney-U test. The p-values of all these tests were significant (≤0.05) (Table 3).

Table- 3: Against-the-rule and oblique astigmatism of Lang I and Lang II

	Type of astigmatism	Mean	Standard deviation	Mean Rank	P - value (2 - tailed)
Lang1	Oblique astigmatism	122.22	235.286	14.28	0.006
	Against-the -rule astigmatism	438.89	378.680	22.72	
Lang2	Oblique astigmatism	144.44	225.499	14.78	
	Against-the -rule astigmatism	311.11	239.826	22.22	0.025

DISCUSSION

This study was performed to check the association of astigmatism with the stereopsis and to evaluate that how against-the-rule and oblique astigmatism affects the stereo acuity. A total of 36 candidates were enrolled in that study out of which 14(38.9%) candidates were male and 22 (61.1%) candidates were female. Out of the total population half, 50% of candidates had against-the-rule astigmatism and 50% of candidates had oblique astigmatism.

That was a comparative study to check the level of

stereopsis in the two types of astigmatism i.e., against the rule and oblique astigmatism. The stereopsis level was checked using two types of tests including Lang I test and Lang II test. Lang I and Lang II tests were performed for fine measurement of stereopsis. When Lang I was performed a large number of individuals 55.6% showed no response to this test from which the greater individuals had oblique astigmatism. Stereopsis was absent in those individuals. Out of the remaining individuals 38.9% had Lang I value of 550 seconds of arc means that they had good fine stereopsis and 5.6% of individuals had Lang I value of 1200 seconds of arc means that they had poor fine stereopsis.

Similarly, when Lang II test was performed 41.7% individuals did not respond to this test means that no fine stereopsis was present having greater number of oblique astigmatic individuals. 27.8% individuals had Lang II value of 200 second of arc means they had good stereoacuity while some individuals had stereopsis of 400 and 600 seconds of arc on Land II meaning their stereopsis was present but not good.

Shapiro Wilk test was used to check the normality of data and according to this test the p-value is ≤0.05 ($p<0.01$). It means that our data is not showing normality therefore we apply non-parametric tests. Then Mann Whitney test is used to analyze our data. Two hypotheses were made one was null hypothesis and other was alternative hypothesis. In this study our null hypothesis was that there is no significant difference between the stereoacuity in against the rule and oblique astigmatism and stereoacuity is affected greatly in against the rule astigmatism. And our alternative hypothesis was made according to our research data which is that the stereoacuity is different in against the rule astigmatism and oblique astigmatism and stereoacuity is affected greatly in oblique astigmatism. The results of the Mann Whitney test statistics showed that the p-value in Lang I test is 0.006 and it is <0.05. Similarly, the value for Lang II is 0.025 and it is also <0.05. As the p-value in Lang I and Lang II is ≤0.05 it means that the results were significant in these two tests and in these cases, we will reject the null hypothesis and will accept the alternative hypothesis which states that the stereoacuity is greatly affected in oblique astigmatism as compared to against the rule astigmatism.

In another study monocular myopic and hyperopic astigmatism was induced using 2.00D cylinder at different axes of 45, 90 and 180 degrees. The study results showed that a small amount of astigmatism either monocular or binocular will affect the stereoacuity and the value of reduction was dependent upon the axis of astigmatism.[18]

Results of a study showed that the great reduction of stereoacuity occurred in oblique astigmatism followed by against the rule astigmatism and then with the rule astigmatism.[16]

Our study is similar to the previous studies and like the previous researches it showed that even a smaller amount of astigmatism[18] causes a reduction in stereopsis. Previous studies also showed that stereopsis was affected greatly in oblique astigmatism than any other type of astigmatism[16] which is similar to our results.

CONCLUSION

Oblique astigmatic individuals had significantly poor stereopsis as compared to against-the-rule astigmatic individuals using Lang I and Lang II tests.

Authors' Affiliation & Contribution

[1]Nimra Asif
BSc. (Hons) Optometry
College of Ophthalmology & Allied Vision Sciences (COAVS)
cheekusalvakia.ke@gmail.com
Conception of idea, Literature search, Data collection

[2]2Muhammad Anwar Awan
Optometrist
College of Ophthalmology & Allied Vision Sciences (COAVS)
anwaroptom@ymail.com
Results, Discussion

[3]Bareera Aslam
Optometrist Student
College of Ophthalmology & Allied Vision Sciences (COAVS)
bareeraaslam1122@gmail.com
Data analysis

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