VISUAL FUNCTIONS IN DIFFERENT TYPES OF ASTIGMATISM

Submitted: 08 January, 2020
Accepted: 22 December, 2020

Wazir Aqeel Hasan[1]
Rashida Riaz[2]
Abid Hussain[3]
Muhammad Hanif[4]
For Authors' affiliation & contribution see end of Article

Corresponding Author:
Wazir Aqeel Hasan
B.Sc. (Hons) Optometry
College of Ophthalmology & Allied Vision Sciences, Lahore. (COAVS)
waziraqeel12@gmail.com

ABSTRACT

PURPOSE: *The purpose of this study was to explore the impact of different types of astigmatism (Regular and Irregular) on individual visual functions (Visual acuity, color vision, contrast sensitivity, and visual field).*

METHODS: *This cross-sectional study was conducted on 66 astigmatic patients visiting the Department Of Ophthalmology Mayo Hospital Lahore. Sixty six astigmatic individuals participated having regular or irregular astigmatism. Best corrected visual acuity (BCVA) was measured by the Log MAR visual acuity chart held at a distance of 4 meters. Visual acuity was checked monocularly in each eye. Ishihara test was used to measure color vision. Contrast sensitivity was measured by using the Pelli Robson chart at a distance of 1 meter. A gross estimation of the visual field was done by the confrontation method. Keratometry was performed to detect irregular astigmatism.*

RESULTS: *Best Corrected LogMAR visual acuity was affected both in regular and irregular astigmatism. Visual acuity and contrast sensitivity was highly affected ($p<0.05$). No statistically significant difference was found in color vision and visual field in both types of astigmatism ($p>0.05$).*

CONCLUSION: *The study on the topic of visual functions in different types of astigmatism concludes that astigmatism greatly affects visual functions like visual acuity and contrast sensitivity. And Irregular astigmatism affects visual functions more than regular astigmatism. No significant defect was found in color vision and visual field both in regular and irregular astigmatism.*

KEYWORDS: *Visual functions (visual acuity, color vision, contrast sensitivity, Visual field) Regular Astigmatism, Irregular astigmatism.*

INTRODUCTION

Astigmatism is a type of refractive error which occurs due to the inability of the eye to focus light evenly on the retina resulting in blurred vision at all distances. It occurs mostly due to irregular surface curvature of cornea or lens or both. A large number of people have been affected by astigmatism worldwide. The percentage of the adult population affected by astigmatism in Europe and Asia is between 30 and 60 percent. Uncorrected refractive astigmatism of even 0.5-1.0 D can deteriorate vision and affect a patient's quality of life as well. In the case of binocular uncorrected astigmatism contrast sensitivity also reduces depending on the power of astigmatism. Astigmatism increases with increasing age, gender, and ethnicity which leads to abnormal retinal electrophysiology, meridionalamblyopia, asthenopia, eye strain, migraine, myopia, and fatigue particularly after doing tasks such as reading and working on the computer for a long time.

Astigmatism is classified into various types based on clinical factors and other characteristics. Apart from that, based on the contribution of ocular components and orientation astigmatism can also be grouped into regular and irregular astigmatism. In regular astigmatism, the principal meridians of the eye are 90 degrees apart whereas in irregular

astigmatism the principal meridians are not perpendicular toeach other. Irregular astigmatism is usually associated with ocular trauma, keratoconus, keratoglobus, prior ocular surgery or it may occur as a naturally occurring condition. A significant increase in corneal irregular astigmatism has been noted even in the case of successful orthokeratology.[1] Astigmatism is one of the most significant obstacles to achieving satisfactory visual function.

Visual acuity is considered as a measure of the total quality of vision, though it measures the function of the fovea which characterizes less than 1% of the total area of the retina. It is important to measure the visual acuity of both eyes individually and with the best correction for diagnostic purposes. However functional vision is binocular vision. In a population-based survey it is useful to measure the visual acuity of both eyes separately in order to detect eye disease.

A number of studies have been done so far to investigate the influence of astigmatism on visual function. These studies indicate that even a small amount of uncorrected astigmatism can reduce visual performance. A research conducted by Guo and Atchison reported that a subject notices a reduction in clarity of a 0.1 logMar when a cylindrical power of 0.28- 0.12 D was induced.[2] Other visual functions such as contrast sensitivity and stereoacuity also have been shown to be reduced with binocular orthogonal oblique astigmatism.[3] Another study conducted on the effect of optical defocus on color perception, reports that high uncorrected refractive error is worse than 6/24 results in decreased color vision findings. Therefore such refractive errors should be corrected before testing color vision.[4] However, to the best of my knowledge, the influence of different types of astigmatism on individual visual functions has not been investigated.

The aim of this study was to investigate for the first time the effect of different types of astigmatism (Regular astigmatism and irregular astigmatism) on individual visual functions.

MATERIALS AND METHODS

The study was approved by the Ethical Review Board (ERB) of College of Ophthalmology and Allied Vision Sciences (COAVS)/ Mayo Hospital, King Edward Medical University Lahore, and consent signature was taken from each participant of the study. Visual functions were checked thoroughly both in regular and irregular astigmatic patients. Visual acuity was measured by LogMAR chart separately for both eyes with corrective glasses on. Color vision was assessed by using the Ishihara color vision test. Contrast sensitivity was checked by using the Pelli Robson chart. The gross estimate of the visual field was done by the confrontation method. Data were analyzed by making tables and graphs in SPSS 205 software and calculated frequencies and percentages of different variables through it. Chi-square test was applied to demonstrate the effect of astigmatism on visual functions.

RESULTS

The total number of 66 astigmatic patients were included in this study. The Visual functions including visual acuity, color vision, contrast sensitivity, and visual field were calculated both in regular and irregular astigmatic patients. Out of 52(78.8%), regular astigmatic patients and 14(21.2%) were Irregular astigmatic patients. Independent sample t-test was conducted to compare visual functions in regular astigmatism and irregular astigmatism. It suggests that irregular astigmatism affects visual acuity and contrast sensitivity more than regular astigmatism however both regular and irregular astigmatism does not have an effect on color vision and visual field.

Table - 1:

Group Statistics					
	ASTIGM	N	Mean	Std. Deviation	Std.Error Mean
BCVA_R	REGULAR	52	1.7692	1.11347	.15441
	IRREGULAR	14	4.5000	2.06621	.55222
BCVA_L	REGULAR	52	2.0577	1.21128	.16797
	IRREGULAR	14	4.3571	2.13423	.57040
CS	REGULAR	52	6.8654	1.69230	.23468
	IRREGULAR	14	4.5000	1.82925	.48889
CV	REGULAR	52	1.0385	.27735	.03846
	IRREGULAR	14	1.2143	.42582	.11380
VF	REGULAR	52	1.0577	.23544	.03265
	IRREGULAR	14	1.0000	.00000	.00000

The above table shows the group statistics. Which includes Mean, N value, std. Deviation and std. Error Mean.

Table: 2

Independent Samples Test										
		Levine's Test for Equality of Variances		T-test for Equality of Means						
				t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.							
BCVA	Equal Variances assumed	27.586	.000	-6.659	64	.000	-2.73077	.41011	-3.55005	-1.91148
	Equal Variances not assumed			-4.762	15.089	.000	-2.73077	.57340	-3.95232	-1.50922
CS	Equal Variances assumed	.553	.460	4.565	64	.000	-2.36538	.51819	1.33019	3.40058
	Equal Variances not assumed			4.362	19.419	.000	2.36538	.54230	1.23200	3.49877
CV	Equal Variances assumed	10.962	.002	-1.864	64	.067	-.17582	.09432	-.36425	.01260
	Equal Variances not assumed			1.464	16.086	.163	-.17582	.12013	.43037	0.7872
VF	Equal Variances assumed	3.772	.057	.912	64	.365	.05769	.06328	-.06873	.18411
	Equal Variances not assumed			1.767	51.000	.083	.05769	.03265	-.00785	.12324

1. There was a significant difference in scores for visual acuity in regular astigmatism (M=1.7, SD=1.1) and irregular astigmatism (M=4.5, SD= 2.0) conditions: t(64) = -6.6, p=0.0.

2. A significant difference was also present in scores for contrast sensitivity in regular astigmatism (M=6.8, SD=1.7) and irregular astigmatism (M=4.5,SD= 1.8) conditions t (64) = 4.5, p= 0.0

3. For color vision scores in regular astigmatism (M=1.04, SD= 0.37) and in irregular astigmatism (M= 1.2, SD=0.4) conditions t (64) = -1.8, p= 0.06.F

4. No significant difference was found in scores for visual field in regular astigmatism (M=1.0, SD= 0.2) and in irregular astigmatism (M=1.0, SD=0.0) conditions t(64)=0.9, P=0.8

These results suggest that irregular astigmatism affects visual acuity and contrast sensitivity more than regular astigmatism however both regular and irregular astigmatism does not have an effect on color vision and visual field.

DISCUSSION

Astigmatic defocus causes a substantial reduction in visual performance, uncorrected astigmatism causes asthenopia, blurring, headache, and meridonial amblyopia. A small degree of clinically measurable astigmatism occurs commonly. Around 60% of the adult population is known to have more than 0.25D of ocular astigmatism. Prevalence of astigmatism in any population differs depending upon the definition of astigmatism used. Most studies have shown that low astigmatism i.e. ≤0.50D occurs most commonly while high astigmatism ≥of 3.00 is rare. Previous studies revealed that the prevalence of astigmatism is from 11.3% to 70% in related studies. Factors responsible for the development of astigmatism include age, gender, ethnicity, genetics, and unequal pressure of extraocular muscle on the cornea. Astigmatism is measured both in magnitude and direction. Decreased image quality is seen in astigmatism which is induced due to corneal asymmetry. Astigmatism of ≥1.00D negatively affects reading performance and night-time driving ability. Although published data are limited, both preoperative astigmatism and postoperative residual astigmatism affect visual function and vision-related quality of life, resulting

in increased humanistic burden. JS Wolffsohn reported that Uncorrected astigmatism, even as low as 1.00 D, caused significantly decreased vision and if left uncorrected could significantly affect patients' independence, quality of life, and well-being. Another study conducted on the effect of refractive error on color vision reported that although color vision defect was correlated with poor visual acuity and amblyopia, there was no correlation between color vision defect with refractive error, amblyopia, and anisometropia Uncorrected astigmatism diminishes visual acuity as well as contrast sensitivity.

Another study revealed that contrast sensitivity reduces with increasing age, high myopia, and astigmatism. It suggested that the wide range variability should be considered when contrast sensitivity is tested.

CONCLUSION

Astigmatism greatly affects visual functions like visual acuity and contrast sensitivity. Irregular astigmatism affects visual functions more than regular astigmatism. No significant defect was found in color vision and visual field both in regular and irregular astigmatism.

Authors' Affiliation & Contribution

[1]Wazir Aqeel Hasan
B.Sc. (Hons) Optometry
College of Ophthalmology & Allied Vision Sciences (COAVS), Lahore.
waziraqeel12@gmail.com
Methodoloy, Data collection

[2]Rashida Riaz
FCPS (Ophthalmologist)
College of Ophthalmology & Allied Vision Sciences (COAVS), Lahore.
rashidariaz@gmail.com
Data analysis, Discussion

[3]Abid Hussain
B.Sc. (Hons) Optometry
College of Ophthalmology & Allied Vision Sciences (COAVS), Lahore.
abidmir2019@gmail.com
Data collection

[4]Muhammad Hanif
B.Sc.(Hons) Optometry
College of Ophthalmology & Allied Vision Sciences (COAVS), Lahore.
hanif.issakhail12@gmail.com
Data collection

REFERENCES

1. Hiraoka T, Furuya A, Matsumoto Y, Okamoto F, Sakata N, Hiratsuka K, et al. Quantitative evaluation of regular and irregular corneal astigmatism in patients having overnight orthokeratology. J Cataract Refract Surg. 2004;30(7):1425-9.
2. Atchison DA, Mathur A. Visual acuity with astigmatic blur. Optom Vis Sci. 2011;88(7):E798-E805. doi:10.1097/OPX.0b013e3182186bc4.
3. Jupiter DG, Katz HR. Management of irregular astigmatism with rigid gas permeable contact lenses. The CLAO journal: official publication of the Contact Lens Association of Ophthalmologists, Inc. 2000;26(1):14-7.
4. Sehlapelo R, Oduntan A. Effect of optical defocus on colour perception. African Vision and Eye Health. 2007;66(2):77-81.
5. Sorsby A, Sheridan M, Leary GA, Benjamin B. Vision, visual acuity, and ocular refraction of young men. British medical journal. 1960;1(5183):1394.
6. Anderson DF, Dhariwal M, Bouchet C, Keith MS. Global prevalence and economic and humanistic burden of astigmatism in cataract patients: a systematic literature review. Clinical ophthalmology (Auckland, NZ). 2018;12:439.
7. Wolffsohn JS, Bhogal G, Shah S. Effect of

uncorrected astigmatism on vision. Journal of Cataract & Refractive Surgery. 2011;37(3):454-60.

8. Rajavi Z, Sabbaghi H, Baghini AS, Yaseri M, Sheibani K, Norouzi G. Prevalence of color vision deficiency and its correlation with amblyopia and refractive errors among primary school children. Journal of ophthalmic & vision research. 2015;10(2):130.

9. Kobashi H, Kamiya K, Shimizu K, Kawamorita T, Uozato H. Effect of axis orientation on visual performance in astigmatic eyes. Journal of Cataract & Refractive Surgery. 2012;38(8):1352-9