Nigerian Medical Journal
NIGERIA MEDICAL ASSOCIATION
Print ISSN 0300-1652, E-ISSN 2229-774X

Original Artide

A Study of Visual Functions Amongst Primary Open-Angle Glaucoma Patients in Abuja, Nigeria

***Adaora Okudo[1,2,3], Olufemi Emmanuel Babalola[4,5], Adeola Onakoya[6], Adunola Ogunro[1], Aisha Sheriff Kalambe[2].**

[1]Eye Foundation Hospital, Abuja, Nigeria, [2]Department of Ophthalmology, Asokoro District Hospital, Abuja, Nigeria, [3]Department of Ophthalmology, Nile University Teaching Hospital, Abuja, Nigeria.[4]Department of Surgery, Bingham University, New Karu/Jos, Nigeria, [5]Rachel Eye Center, Abuja, Nigeria, [6]Department of Ophthalmology, College of Medicine, University of Lagos, Nigeria.

Abstract

Background: To objectively measure visual function amongst Primary Open Angle Glaucoma (POAG) patients and compare these with age and sex-matched controls by describing the characteristics of visual function in relation to the severity of POAG.

Methodology: A case-control study was carried out among 106 POAG patients and an equal number of age-sex matched controls attending Asokoro District Hospital, Abuja, and Eye Foundation Hospital Abuja from Nov 2012 to April 2013. The objective measures of visual function assessed include visual acuity (VA), contrast sensitivity (CS), colour vision (CV), and visual fields (MD) in the better eye (BE)].

Results: All measures of visual function were found to be reduced comparing cases to controls and this was statistically significant. VABE (0.39±0.73; 0.0017±0.02p<0.001); MDBE (-8.02±6.80; 0.17±0.3P<0.001); CSBE (1.46±0.59; 1.90±0.16p<0.001): Colour vision defects (54.7%; 6.6% p<0.001). In comparing mild; moderate; severe glaucoma: VABE (0.0053±0.03; 0.057±0.08; 0.766±0.90 p<0.001); MDBE (-3.46±1.93;-8.17±3.55;-16.43±6.01p <0.001); CSBE (1.88±0.26; 1.69± 0.37; 1.11±0.59 p<0.001): Color vision defects (20.6%; 31.6%; 86.9%) respectively (BE: Better Eye). While looking at the two independent groups above, mild and moderate were not statistically significant except for the visual field, but comparing mild with severe and moderate with severe, they had a statistically significant relationship across all the visual functions tested. In comparing controls with mild, color vision and visual field had a statistically significant difference. Comparing the groups with mild and moderate glaucoma, only visual fields as a visual function were statistically significant. Whereas comparing both groups with the severe group independently, they had statistically significant in all the visual functions tested.

Conclusion: In conclusion, visual function was reduced in glaucoma patients as compared to controls. Visual acuity, contrast sensitivity and colour vision differed significantly in comparing mild with severe and moderate with severe. Color vision differed significantly in comparing mild to controls.

Keywords: Visual Function; Visual Acuity; Contrast Sensitivity; Visual Field; Color Vision; Glaucoma.

Corresponding Author: *Adaora Okudo, Department of Ophthalmology, Asokoro District Hospital, Abuja, Nigeria. adaoraokudo@gmail.com

How to cite this article: Okudo A, Babalola OE, Onakoya A, Ogunro A, Kalambe AS. A Study of Visual Functions Amongst Primary Open-Angle Glaucoma Patients in Abuja, Nigeria. Niger Med J 2023;64(1):25-32

Quick Response Code:

Introduction

Glaucoma a group of optic neuropathies that is the main cause of irreversible blindness worldwide typically remains asymptomatic until very severe.[1] There are two major types of glaucoma: primary and secondary glaucoma. Both of these have two major subtypes (open-angle and angle-closure) according to the underlying anatomy and pathophysiology.[2] The global prevalence of glaucoma for the population aged 40-80 years is 3.54% (95% CI, 2.09-5.82), with the prevalence of primary open-angle glaucoma (POAG) being highest in Africa (4.20%; 95% CI, 2.08-7.35).[3] In 2013, the number of people (aged 40-80 years) with glaucoma worldwide was estimated to be 64.3 million, a projected increase to 76.0 million in 2020 and 111.8 million in 2040.[3]

A 2015 study by Kyari et al, from the Nigerian National Blindness survey, indicated that 1.1-1.4 million Nigerian adults have glaucoma with the vast majority unaware of their disease status; one in every 20 Nigerian adults above 40 years have glaucoma and one in five of those individuals are blind.[4] Glaucoma is characterized by the degeneration of retinal ganglion cells (RGC) and retinal nerve fibre layers (RNFL) that result in changes in the optical nerve head and the progressive degeneration of the optic nerve, leading to a compromise of visual function and eventually, visual impairment.

Objective measures of visual function that include visual acuity, color vision, and contrast sensitivity can be used to monitor the progression of the disease and can contribute to understanding the effect glaucoma has on patients' activities of daily living.

Mbadugha et al discovered amongst POAG patients attending LUTH that visual acuity significantly deteriorated with the severity of the disease.[5]

Contrast sensitivity helps the clinician understand a patient's report of poor vision and the disabling impact on his daily life. Its impairment affects visual performance, such as difficulties in mobility, driving, reading, face recognition, and various forms of everyday tasks. Poor contrast sensitivity[6,7] and defective color vision have been reported among POAG patients that correlate with disease severity in different case-control studies of different population groups.

Mbadugha et al measured the impact of POAG in Lagos, southern Nigeria on various visual functions (visual acuity, contrast sensitivity, color vision, visual field, and stereopsis) and found that these measures were reduced in POAG participants as compared to controls. There is a paucity of data on the effect of glaucoma on visual function in this geographical area. To the best of our knowledge, there are limited studies on assessing the visual function of glaucoma patients in northern Nigeria. For this reason, this study aims to measure visual function (visual acuity, contrast sensitivity, color vision, and visual fields) amongst POAG patients and to compare these with age and sex-matched controls in patients attending ophthalmic centres in Abuja, the Federal Capital Territory of Nigeria to describe the impact of glaucoma on visual function. The study also aims to assess visual function based on the severity of glaucoma with a view to better managing patients with POAG.

Materials and Methodology

The study was a multicenter case-control study, carried out from November 2012 to April 2013. Using the purposive sampling technique, 212 consenting POAG and non-POAG patients attending Asokoro District Hospital, Asokoro, and Eye Foundation Hospital, Abuja that met the inclusion criteria were recruited over the 6 months evenly distributed between the hospitals. The study adhered to the tenets of the Declaration of Helsinki. Ethical approval was obtained from the FCT Health Research Ethics Committee, Research Ethics Committee Asokoro District Hospital, and the Research Ethics Committee Eye Foundation Hospital.

Primary open-angle glaucoma patients in the study were defined as patients with gonioscopically open angles, glaucomatous optic nerve head changes (vertical cup-to-disc ratio of greater than or equal to 0.5 with

violation of the ISNT rule or disc asymmetry of greater than 0.2, or localized neuroretinal rim loss less than 0.1 or barring of circum linear disc vessels) and corresponding reproducible visual field defects in the absence of other identifiable causes.[8,9]Elevation of intraocular pressure (IOP) was not considered in this definition as glaucomatous optic neuropathy and progression could occur in spite of it, there are also variant s of open-angle glaucoma with normal IOP.

For cases, the inclusion criteria were all POAG patients at least 40 years of age on medical therapy or one who has had trabeculectomy done at least 3 months before the study allowing time for healing, with a reliable automated visual field test in at least one eye done within the past 6 months. Patients under the age of 40 years, those with other types of glaucoma, those with visual impairing disorders aside from glaucoma, and those with central nervous system, cognitive, hearing, or mobility impairment were excluded from the study. Those recruited as controls were consenting adults above the age of 40 years with no evidence of glaucoma, without any underlying visual impairing disorder aside from presbyopia, and no underlying central nervous system, cognitive, hearing, or mobility impairment.

A pretested questionnaire was administered to each participant, and each had an ophthalmological examination carried out.

The objective measures of visual function were then carried out. Visual Acuity was assessed using Illuminated Snellen's chart for literate participants or the Illiterate E chart for illiterate participants. Snellen's visual acuity was converted to the logarithm of Minimum Angles of Resolution (log MAR) notation. Assessment of contrast sensitivity was done using the online version of the Pelli Robson Chart. The scoring system provides 0.15 credits per triplet if at least two of three letters are read correctly. Scores on the Pelli-Robson chart can range from 0 to 2.25 (corresponding to log contrast sensitivity) kindly note that an increasing value indicates increasing contrast sensitivity. Assessment of color vision was done using an online version of the City University Color Vision Test.[10] The Central visual field was measured in each eye using the Humphrey Field Analyzer II (Swedish interactive thresholding algorithm standard 24-2) (Carl Zeiss Meditec model 750i). A reliable visual field was defined as fixation losses of less than 20%, and false negative and positive of less than 33%. Tests were conducted for the participants without a reliable visual field in the last 6 months.

The Severity of glaucoma in the study was classified based on structural and functional evidence of glaucomatous optic nerve damage. The structural evidence of damage was based on dilated stereoscopic optic nerve head examination at the slit lamp using + 78 DS lens, mild or early glaucomatous damage was a vertical cup to disc ratio of ≥ 0.5 with violation of the ISNT rule, moderate glaucomatous damage was 0.6 to 0.7, severe was an eye with a cup to disc ratio greater than or equal to 0.8 in the worse eye.[11]

The functional evidence of damage was classified based on Hodapp, Parish, and Anderson's classification of the visual field deficit. Mild or early visual field defects were defined as Mean Deviation (MD) of ≤ 6 dB of the worse eye, moderate visual field defects were defined as MD of greater than 6 dB to 12 dB of the worse eye, and severe were defined as MD of greater than 12 dB of the worse eye or participants that could not satisfactorily complete or carry out a visual field testing.[12]

Data entry, editing, and analysis were done using SPSS (Software Programme for Social Sciences version 20.) Differences in categorical variables such as color vision, between cases and controls, and the severity of the disease groups were compared using the chi-square test. Continuous variables i.e., visual function parameters were presented as means and standard deviation, and an independent student T-test was used to compare (cases and controls) and (controls and mild) while analysis of variance was used to compare the disease severity groups.

Results

A total of 212 participants were enrolled in the study, consisting of an equal distribution between cases and age-sex-matched controls. Their ages ranged from 40 to 88 with a mean age of 55.2 among the cases and 55.24 among the controls. The majority of the participants were males with a ratio of 1.8:1, and those less than 60 years of age accounted for 70.8%. Thirty-four (32.1%) had mild, 19 (17.9%) had moderate and 53(50%) had severe disease.

Table1: Comparing Objective Measures of Vision Between POAG Patients and Age- Sex Matched Controls

Objective Measures of Visual Function	Cases	Control	P-value
Log mar Visual acuity BE	0.39±0.73	0.0017±0.02	<0.001**
Log mar Visual acuity WE	0.88±1.13	0.0017±0.02	<0.001**
Mean deviation BE	-8.02 ±6.80	0.17± 0.3	<0.001**
Mean deviation WE	-11.22± 8.41	0.11± 0.21	<0.001**
Contrast sensitivity BE	1.46± 0.59	1.90 ±0.16	<0.001**
Contrast sensitivity WE	1.12± 0.82	1.89± 0.17	<0.001**
Color defect RE	58 (54.7)	7 (6.6)	<0.001**
Color defect LE	58 (54.7)	7 (6.6)	<0.001**

The continuous variables are presented as means ± standard deviations. P value is based on the chi-square test for categorical variables and the independent sample T-test for continuous variables. **P value <0.05 showing a statistically significant relationship. Open-angle glaucoma BE: better eye, WE: worse eye, RE: right eye, LE: left eye

All the measures of visual function were found to be reduced in both eyes when compared with the control group and this was statistically significant.

Table 2: Comparing Objective Measures of Vision amongst Participants with Mild, Moderate and Severe Glaucoma

Objective Measures of vision	Mild	Moderate	Severe	P-Value
Visual acuity BE	0.0053±0.031 ^{R}	0.057±0.081^{R}	0.766±0.897®	<0.001**
Visual acuity WE	0.0106±0.043 ^{R}	0.075±0.017 ^{R}	1.734±1.043®	<0.001**
Mean deviation BE	-3.46 ±1.93®	-8.17 ±3.55®	-16.43 ± 6.01®	<0.001**
Mean deviation WE	-4.44 ±2.04®	-10.50± 2.44®	-20.76 ± 5.83®	<0.001**
Contrast sensitivity BE	1.88 ±0.26 ^{R}	1.69 ±0.37 ^{R}	1.11 ±0.59®	<0.001**
Contrast sensitivity WE	1.82 ± 0.27 ^{R}	1.66 ±0.38 ^{R}	0.47 ±0.64®	<0.001**
Color defect RE	7 (20.6)	6(31.6)	46 (86.8)	<0.001**
Color defect LE	6 (17.6)	6 (31.6)	47 (86.8)	<0.001**

The p-value for the continuous variable is the overall P value across the relationship among the three groups using ANOVA. ®® or ® ^{R} indicates that the relationship between the two groups was statistically significant with a P value < 0.05 but $^{R\ R}$ indicates the relationship between the groups was not statistically significant p-value ≥ 0.05.

All measures of visual function were found to be deteriorating with the advancing of the disease.

Table 3: Comparing Objective Measures of Vision Between Mild POAG Participants and Controls

Objective Measures of Visual Function	Control	Mild cases	P-value
Visual acuity BE	0.0017±0.02	0.0053±0.031	0.397
Visual acuity WE	0.0017±0.02	0.0106±0.043	0.085
Mean deviation BE	0.17± 0.3	-3.46 ±1.93	<0.001**
Mean deviation WE	0.11± 0.21	-4.44 ±2.04	<0.001**
Contrast sensitivity BE	1.90 ±0.16	1.88 ±0.26	0.585
Contrast sensitivity WE	1.89± 0.17	1.82 ± 0.27	0.055
Color defect RE	7 (6.6)	7 (20.6)	0.042**
Color defect LE	7 (6.6)	6 (17.6)	0.084

All objective measures of visual function were reduced amongst those with mild glaucoma when compared to controls but only mean deviation in both eyes and color vision in one eye was statistically significant.

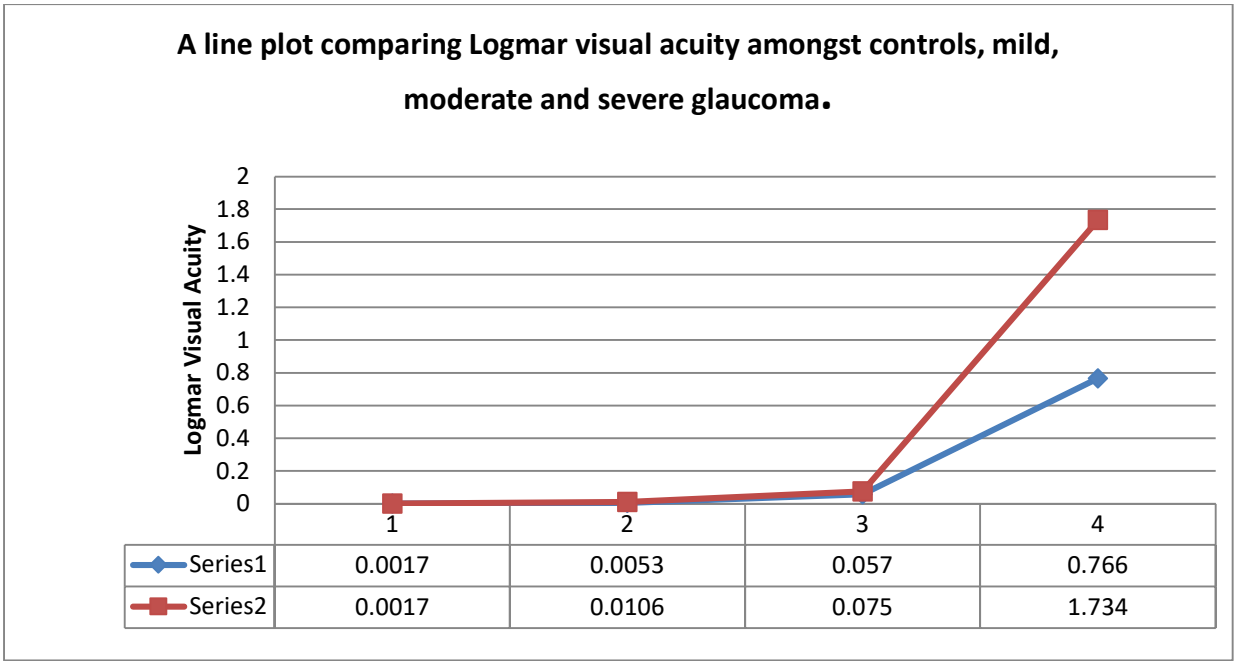

Figure 1: A-Line Plot Comparing Log mar Visual Acuity amongst Controls, Mild, Moderate and Severe Glaucoma

Series 1: Better eye
Series 2: Worse eye
1. Control 2. Mild 3. Moderate 4: severe

The line plot shows worsening Log mar visual acuity with the severity of the disease most marked in those with severe glaucoma.

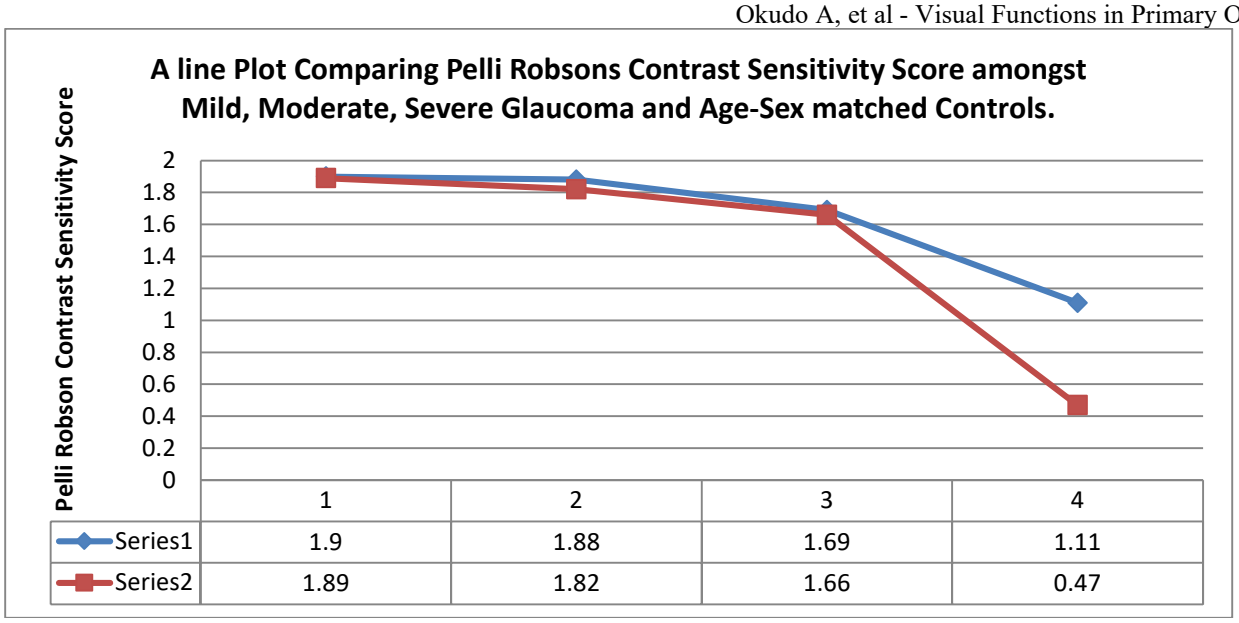

Figure 2: A-Line Plot Comparing Pelli Robson Contrast Sensitivity Score Amongst Mild, Moderate, Severe Glaucoma and Age-Sex Matched Controls

Series 1: Better eye
Series 2: Worse eye

1. Control 2. Mild 3. Moderate 4: severe

There was worsening in the Pelli Robson contrast sensitivity with the severity of the disease and was most marked in those with severe glaucoma.

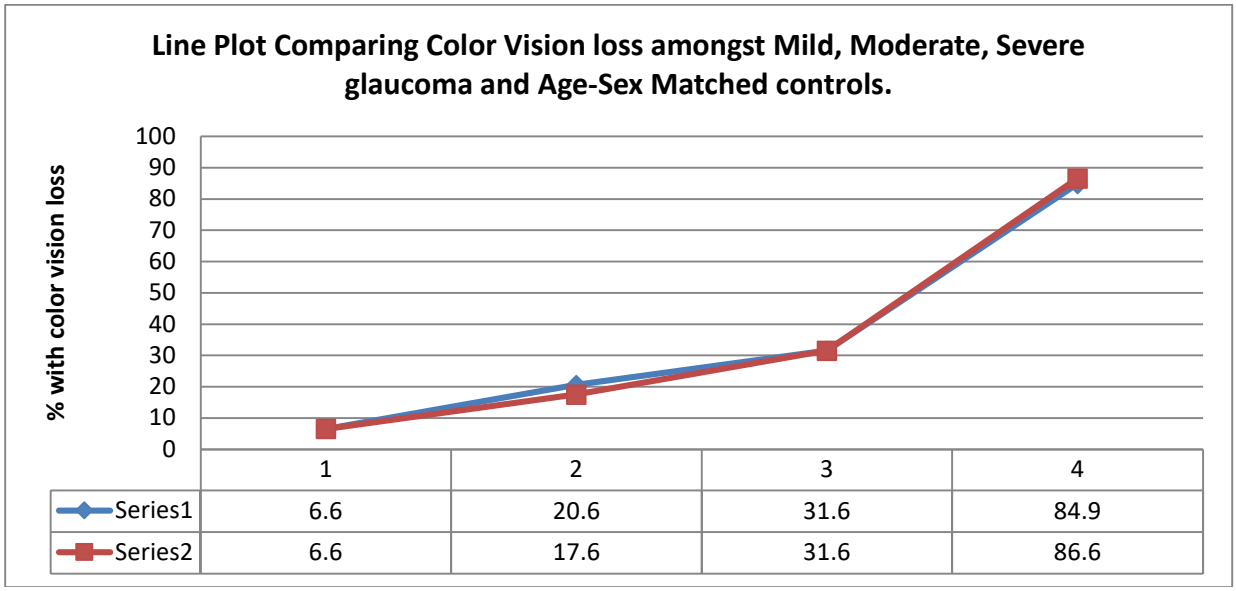

Figure 3: A-Line Plot Comparing Color Vision defects amongst Mild, Moderate, Severe Glaucoma and Age-Sex Matched Controls

Series 1: right eye
Series 2: left eye

1. Control 2. Mild 3. Moderate 4: severe

There was an increasing trend with color defect and even appreciable early in the disease.

Discussion

The objective measures of visual function assessed in this study that included visual acuity, visual field, contrast sensitivity, and color vision were found to have been reduced in the cases as compared to the controls, this was statistically significant, and this was found to worsen with the severity of the disease.

The mean Pelli Robson's contrast sensitivity BE: (1.90: 1.88: 1.69: 1.11) and WE: (1.89: 1.82: 1.66: 0.47) for controls, mild, moderate, and severe respectively, was found to be decreased as the disease progressed and even early in the disease comparing mild to controls. The difference was significant when comparing cases with controls, mild with severe, and moderate with severe. This difference shows the impact glaucoma would pose on their everyday life. Similar findings were seen amongst POAG patients in LUTH as the mean Pelli Robson's contrast sensitivity in BE (1.87: 1.72: 1:1.69: 1.33 $p<0.001$). Janet et al reported the mean Pelli Robson's contrast sensitivity between glaucoma patients with mild to moderate severity was found to be significant when compared to controls CSBE: (1.58 vs 1.74 $p<0.001$) and WE: (1.38 vs 1.7 $p<0.001$).[13] Freeman et al also reported the number of Pelli Robson chart letters that could be read amongst bilateral, unilateral, and no glaucoma was 24, 27, and 31 respectively.

There was a statistically significant difference in color defects as 54.75% of cases compared to 6.6% of controls had color defects using the City Online University color vision test, and this was found to deteriorate with the severity of the disease. This change was also evident early in the disease as 20.6 % of mild compared to 6.6 % of controls had these defects in their right eye. This trend was also seen amongst POAG patients in LUTH as 4.5%: 9.1%: 20.5% and 52.3% in the right eye and 4.5%: 9.1%: 22.7% and 40.9% in the left eye of controls, mild, moderate and severe glaucoma had color defects. More of the POAG patients in this study 54.75% had color vision defects compared to the 29.5% of cases in LUTH[6] probably because 50 % of the cases in this study had severe glaucoma while a third of the cases in LUTH had severe cases as theirs were predetermined even distribution amongst the severity groups and ours were every consecutive patient. They also reported that there was a strong correlation between those with color vision defects with the severity of the disease (52.3%:20.5%:9.1%) in the right eye of severe, moderate and mild respectively and (40.9%: 22.7%:9.1%) in the left eye[6].

A similar trend was also reported by Lakowski and Drance as 34% of those with early, 54 % moderate and 74% severe visual field defects were found to have color vision defects using FM 100 hue test and similar findings have also been found between glaucoma patients and controls as reported by Gunduz[14]

The strengths of the study are the case-control study design with broadly comparable age and sex-matched controls. The study was also a multicentre study involving a public and private hospital which gave a more diverse picture. The objective measures were also assessed solely by the researcher to reduce inter-observer error.

The Limitation of the study was that although it was a multicentre study, the study population was small and the sampling technique was convenient, therefore the findings may not be easily generalizable to the general population of the Federal Capital Territory.

Conclusion

In conclusion, visual function was reduced in glaucoma patients as compared to controls. Visual acuity, contrast sensitivity and color vision differed significantly in comparing mild with severe and moderate with severe. Color vision differed significantly in comparing mild to controls. The incorporation of contrast sensitivity and color vision into our clinical practice may help better manage our glaucoma patients.

References

1. Weinreb RN, Leung CK, Crowston JG, Medeiros FA, Friedman DS, Wiggs JL, Martin KR. Primary open-angle glaucoma. *Nat Rev Dis Primers*. 2016; **2**:16067. doi: 10.1038/nrdp.2016.67.
2. Harasymowycz P, Birt C, Gooi P, Heckler L, Hutnik C, Jinapriya D, Shuba L, Yan D, Day R. Medical Management of Glaucoma in the 21st Century from a Canadian Perspective. *J Ophthalmol.* 2016; **2016**:6509809. doi: 10.1155/2016/6509809.
3. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. O*phthalmology*. 2014; **121**:2081-90. doi: 0.1016/j.ophtha.2014.05.013.
4. Kyari F, Entekume G, Rabiu M, Spry P, Wormald R, Nolan W, Murthy GV, Gilbert CE. A Population-based survey of the prevalence and types of glaucoma in Nigeria: results from the Nigeria National Blindness and Visual Impairment Survey. *BMC Ophthalmol.* 2015;**15**: :176. doi: 10.1186/s12886-015-0160-6.
5. Mbadugha CA. The impact of POAG on quality of life of patients attending the Guinness Eye Center, LUTH, Idi araba Lagos State. Dissertation for the award of Fellowship of National Postgraduate Medical College of Nigeria in Ophthalmology Nov 2009.
6. Cynthia O, Contrast Sensitivity, *Ophthalmol Clin N Am*. 2003; **16**:171 -177.
7. Freeman EE, Munoz B, West SK, Jampel HD, Friedman SD. Glaucoma and Quality of Life. *The Salisbury Eye Evaluation American Academy of Ophthalmology* 2008; **115**: 233- 238.
8. Johnson GJ, Minasssian DC, Weale RA, West SK. Epidemiology of eye disorders 3rd Edition World Scientific Publishers 2012:
9. Kanski JJ. Clinical Ophthalmology. A systemic approach 6th Edition Butterworth Heinemann; Philadelphia 2006:14.
10. A new web-based color vision test City University London. [Online]. 2007 (Assessed 01/06/2012). Available from URL. http://www.city.ac.uk/health/research/research-areas/optometry/a-newwebbasedcolorvisiontest.
11. Amaryl MF. Genetic determination of cup/disc ratio of the optic nerve. *Arch Ophthalmol*. 1967; **78**: 35-43.
12. Hodapp E, Parrish RKII, Anderson DR: Clinical decisions in glaucoma. Mosby 1993.**52**-61.
13. Janet P, Szlyk, Daniel P, Taglia JD, Jennifer P, Deepak P, Edward. Driving Performance In Patients With Mild To Moderate Vision Changes. *Journal of Rehabilitation and Research Development* 2002; **39**: 467 – 490.
14. Kemal G, Gündüz K, Arden GB, Perry S, Weinstein GW, Hitchings RA . Color Vision Defects in Ocular hypertension and glaucoma. *Arch Ophthalmol*. 1998; **106**:929 – 935.