Evaluation of visual acuity and contrast sensitivity in patients of moderate to advance glaucoma with visual disability attending the low vision clinic

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Abstract

Purpose: Aims of this study is to characterise the visual disability of patients of glaucoma in terms of LogMAR visual acuity, contrast sensitivity, optic disc changes and intraocular pressure.

Materials & Methods: A total of 30 eyes with the glaucomatous damage having low vision (WHO Criteria) with predefined inclusion and exclusion criteria were included as cases and 40 eyes with normal or near normal visual status correctable by refraction were included as control in the study. The visual acuity and contrast sensitivity were noted and analysed.

Results: The best corrected visual acuity (BCVA) of all eyes in control group is less than 0.5 LogMAR units. Among cases, 25(83.3%) eyes have BCVA in the range of 0.5 to 1.0 LogMAR units and 5(16.7%) eyes have BCVA in the range of 1.0 to 1.3 LogMAR units, satisfying the inclusion criteria significantly (p value < 0.001). In case group, direct correlation of association is observed between uncorrected visual acuity and best corrected visual acuity (r = 0.8), near visual acuity (r = 0.73), best corrected near visual acuity (r = 0.48) and cup to disc ratio (r = 0.65) and inverse correlation of association with contrast sensitivity (r = -0.39) and intra ocular pressure (r = -0.51) which are statistically significant (p value <0.05).

Conclusions: In patients of glaucoma with visual impairment, there is a negative correlation between contrast sensitivity and visual acuity in logMAR units.

Keywords: Glaucoma, logMAR visual acuity, Contrast sensitivity, Visual impairment.

Introduction

Glaucoma is a progressive optic neuropathy with characteristic changes in the optic nerve head and corresponding visual field loss. Currently, glaucoma accounts for 12% of all global blindness with 4.5 million people affected worldwide.(1) In order to detect early glaucomatous changes, clinicians need to identify these changes and distinguish them from variations of normal. Rate of disease progression is one of the most important factors determining the risk of visual disability or blindness in glaucoma.(2) Defining glaucoma precisely is quite difficult as it encompasses a diverse group of disorders. All forms of the diseases have in common a potentially progressive and characteristic optic neuropathy which is associated with visual field loss as damage progresses, and in which intraocular pressure is usually a key modifying factor.(1)

In purview of the functional complaints made by glaucoma patients, the manifestation of their loss of contrast sensitivity affected by the disease process correlated to a greater extent than their high contrast visual acuity. Therefore, it is possible to detect glaucoma with various contrast sensitivity tests prior to visual acuity changes and even visual field damages.(2,3,4) In order to quantitate this loss in contrast sensitivity related to their glaucoma damage, a preliminary study was done with contrast sensitivity measurements using the Pelli-Robson chart(5) and relating these findings to visual acuity performance on LogMAR visual acuity chart.

Materials & Methods

The study was approved by the institutional review board and informed consent was obtained from each individuals. The study followed the tenets of the declaration of Helsinki. A total of 30 eyes with the diagnosis of moderate and advanced glaucomatous damage having low vision by WHO Criteria with predefined inclusion criteria of patient giving consent and having moderate and advance glaucoma with visual acuity less than 6/18 to hand movement were included as cases. Whereas, unwilling patients and patients with any other associated ocular disease e.g. Uveitis, corneal disorders etc. or systemic disease e.g. Thyroid disorders etc. were excluded from the case group in this study. Among control group 40 eyes with normal or near normal visual status correctable by refraction were included in the study.

Patients underwent detailed ophthalmological examinations including tonometry, visual acuity (LogMAR), contrast sensitivity (Pelli-Robson chart), slit lamp examination and slit lamp biomicroscopy with 78D lens, indirect ophthalmoscopy and Humphery field analyser for quantifying and diagnosing as moderate and advanced glaucoma.

The visual acuity of the patients was measured using the Bailey–Lovie logMAR visual acuity chart for distance and Bailey–Lovie word reading charts for near. The contrast sensitivity was measured using the standardized illuminated Pelli-Robson chart.

The statistical analysis software SPSS version 17 (IBM SPSS Statistics for windows, SPSS Inc., USA) was used to compare the logMAR visual acuity scores with the Pelli-Robson contrast sensitivity scores for all the patients. The non-parametric Kruskal-Wallis Test was used to find the significant difference among the mean values because of lack of normalcy of the data among groups. Mann-Whitney U Test was used for paired comparison of various parameters between control and cases individually and also between the two groups of cases. Pearson correlation coefficient test was used to study the correlation of association of various parameters within the group. P-value <0.05 was considered statistically significant.

Results

The youngest individual was 17 years and the oldest was 68 years old. In case group, 6(20%) eyes belong to less than 35 years of age group, 4(13.3%) eyes belong to 36 to 45 years of age group, 10 (33.3%) eyes belong to age groups 46 to 55 and 56 to 65 each and no eyes belong to age group 66 to 75 in case group. Among cases, 16(53.3%) eyes belong to female individuals and 14(46.7%) eyes belong to male individuals; whereas in control group, 28(70%) eyes were of male individuals and 12(30%) eyes were of female individuals.

All eyes in control group are having visual acuity less than 0.5 LogMAR units. In case group, 25(83.3%) eyes have visual acuity in the range of 0.5 to 1.0 LogMAR units (WHO category I, moderate visual impairment) and 5(16.7%) eyes have visual acuity in the range of 1.0 to 1.3 LogMAR units (WHO category II, severe visual impairment). Both the case and the control groups are satisfying the inclusion criteria significantly with p value < 0.001 (chi square test).

The values of uncorrected visual acuity, best corrected visual acuity and contrast sensitivity are shown in table1.

Table 1: Baseline characteristics of visual acuity and contrast sensitivity assessment for case and control groups

	UCVA			BCVA			CS		
	Min.	**Max.**	**Mean (SD)**	**Min.**	**Max.**	**Mean (SD)**	**Min.**	**Max.**	**Mean (SD)**
Case	0.78	1.68	1.16(0.28)	0.60	1.08	0.74(0.16)	0.33	1.65	0.92(0.48)
Control	0.02	0.54	0.34(0.14)	0.00	0.24	0.09(0.08)	1.55	2.23	1.82(0.20)
Test of significance of mean among the groups (Kruskal- Wallis Test)	p value < 0.05			p value < 0.05			p value < 0.05		

The values of minimum and maximum uncorrected visual acuity (UCVA) in LogMAR units range from 0.78 to 1.68 in case group and 0.02 to 0.54 in control group. The mean of uncorrected visual acuity among case and control groups are 1.16(SD 0.28) and 0.34(SD 0.14) showing significant difference of UCVA among the groups with p value < 0.05 (Kruskal- Wallis Test).

The value of minimum and maximum best corrected visual acuity (BCVA) in LogMAR units is 0.60 to 1.08 in case group and 0.00 to 0.24 in control group. The mean of BCVA among case and control groups are 0.74 (SD 0.16) and 0.09 (SD 0.08) showing significant difference of BCVA among the groups (p value < 0.05) with cases having poorer visual acuity in spite of best refractive correction to the eyes.

The value of minimum and maximum contrast sensitivity (CS) in Logarithmic units is 0.33 to 1.65 in case group and 1.55 to 2.23 in control group. The mean of CS among case and control groups are 0.92 (SD 0.48) and 1.82 (SD 0.20) with glaucoma group individuals having poorer CS (p value < 0.05).

The values of minimum and maximum vertical cup to disc ratio (CDR) are 0.5 to 1 in case group and 0.3 to 0.5 in the control group. The mean of CDR among case and control groups are 0.76 (SD 0.15) and 0.38 (SD 0.05) with cases having larger CDR (p value < 0.05).

The minimum and maximum intraocular pressure (IOP) ranges from 10.00 to 28.00 millimetre of mercury (mmhg) in case group and 11.85 to 18.45 mmhg in control group. The mean of IOP among case and control groups are 18.60 (SD 5.09) and 14.65 (SD 1.97) which shows that the difference is insignificant (p value 0.7).

The minimum and maximum near visual acuity are 1.10 to 1.60 logMAR units in case group and 0.70 to 1.20 logMAR units in control group and the minimum and maximum best corrected near visual acuity are 0.70 to 1.50 logMAR units in case group and 0.50 to 0.80 in control group with significant difference for both near visual acuity and best corrected near visual acuity (p value < 0.05) showing cases having poorer near and best corrected near visual acuity.

The paired comparison of the parameters i.e. UCVA, BCVA, CS, CDR, IOP, near visual acuity and best corrected near visual acuity of the cases with the same parameters of the control group is done using Mann-Whitney U Test. A significant difference with p value < 0.05 is found for all the parameters between the case and control group. (Table 2).

Table 2: Paired comparison of various parameters between cases and control group individually (Mann-Whitney U Test)

Paired comparison of parameters among case and control group	Uncorrected visual acuity	Best corrected visual acuity	Contrast sensitivity	Cup to disc ratio	Intra ocular pressure	Near visual acuity	Best corrected near visual acuity
Mann-Whitney U Test	P value <0.001	P value <0.001	P value <0.001	P value <0.001	P value <0.001	P value <0.001	P value <0.001

The study of correlation of association using Pearson correlation coefficient test was done among the parameters i.e. uncorrected visual acuity, best corrected visual acuity, contrast sensitivity, cup to disc ratio, intraocular pressure, near visual acuity and best corrected near visual acuity within the individual group separately.(Table 3).

Table 3: Correlation study of association of various parameters within the group using Pearson correlation coefficient test

Parameters Groups	Best corrected visual acuity	Contrast sensitivity	Near visual acuity	Best corrected near visual acuity	Cup to disc ratio	Intra ocular pressure
Uncorrected visual acuity (case)	r = 0.8 p value < 0.001	r = -0.39 p value 0.034	r = 0.73 p value <0.001	r = 0.48 p value 0.007	r = 0.65 p value <0.001	r = -0.51 p value 0.004
Uncorrected visual acuity (Control)	r = 0.75 p value <0.001	r = -0.44 p value <0.001	r = 0.77 p value <0.001	r = 0.74 p value <0.001	r = 0.43 p value 0.006	r = 0.12 p value 0.479

Among cases, direct correlation of association is observed between uncorrected visual acuity and best corrected visual acuity (r = 0.8, p value < 0.001), near visual acuity (r = 0.73, p value <0.001), best corrected near visual acuity (r = 0.48, p value 0.007) and cup to disc ratio (r = 0.65, p value <0.001) and inverse correlation of association with contrast sensitivity (r = -0.39, p value 0.034) and intra ocular pressure (r = -0.51, p value 0.004) which are statistically significant with p value <0.05. Similarly among control group, the statistically significant association with p value < 0.05 is observed between uncorrected visual acuity and best corrected visual acuity (r = 0.75, p value <0.001), near visual acuity (r = 0.77, p value <0.001), best corrected near visual acuity (r = 0.74, p value <0.001), cup to disc ratio (r = 0.43, p value 0.006) and intraocular pressure (r = 0.12, p value 0.479) and inverse relationship with contrast sensitivity (r = -0.44, p value <0.001).

Discussion

In our study, all eyes in control group are having visual acuity less than 0.5 LogMAR units. In case group, 25(83.3%) eyes have visual acuity in the range of 0.5 to 1.0 LogMAR units (moderate visual impairment) and 5(16.7%) eyes have visual acuity in the range of 1.0 to 1.3 LogMAR units (severe visual impairment). Both the case and the control groups are satisfying the inclusion criteria significantly with p value < 0.001 (chi square test).

We observed that the value of minimum and maximum best corrected visual acuity (BCVA) in LogMAR units is 0.60 to 1.08 in case group and 0.00 to 0.24 in control group. The mean of BCVA among case and control groups are 0.74 (SD 0.16) and 0.09 (SD 0.08) showing significant difference of BCVA among the groups (p value < 0.05) with cases having poorer visual acuity in spite of best refractive correction to the eyes similar to the findings of the study by Kathleen A. Turano et al. In their study in 1999, they found significantly higher LogMAR units in the glaucoma group compared with the normal–vision group (Wilcoxon test, Z 5 5.35, P, 0.001).[6] Similarly, Henry D. Jampel in his study in 2001 found that mean logMAR visual acuity was 0.09 ± 0.10 in the study subjects' better eye and 0.48 ± 0.65 in the worse eye. [7]

In our study, the value of minimum and maximum contrast sensitivity (CS) in Logarithmic units is 0.33 to 1.65 in case group and 1.55 to 2.23 in control group. The mean of CS among case and control groups are 0.92 (SD 0.48) and 1.82 (SD 0.20) with cases having poorer CS (p value < 0.05) similar to the findings of the study by Kathleen A. Turano et al. In their study in 1999, they found log CS was significantly lower in the glaucoma group compared with the normal–vision group (Wilcoxon test, Z 5 26.64, P, 0.001).[6] Similarly, Jacob T. Wilensky et al. in their study in 2001 found a significant correlation for the logMAR visual acuity (correlation coefficient 0.266, P value = 0.054).[8]

The significant findings of our study are compared with the relevant findings of previous study in table 4.

Table 4: Comparison of our study with previous study

Parameters	Our study		Henry D. Jampel's study
	Case group	Control group	
Uncorrected visual acuity	Mean 1.16, SD 0.28	Mean 0.34, SD 0.14	Mean logMAR visual acuity 0.09 ± 0.10 in better eye and 0.48 ± 0.65 in the worse eye
Best corrected visual acuity	Mean 0.74, SD 0.16	Mean 0.09, SD 0.08	
Contrast sensitivity	Mean 0.92, SD 0.48	Mean 1.82, SD 0.20	
Cup to disc ratio	Mean 0.76, SD 0.15	Mean o.38, SD 0.05	
Intra ocular pressure	Mean 18.60, SD 5.09	Mean 14.65, SD 1.97	Mean 16.5 ± 4.9 in the right eye and 17.4 + 7.1 mm Hg in left eye.

When we compare case group of our study with the international study of Henry D. Jampel, we find that the mean of uncorrected visual acuity and the mean of best corrected visual acuity are 1.16 and 0.74 respectively as compared to the mean of 0.48 in worse eye of his study group. This indicates that visual acuity in our study group is poorer. The probable reason could be that patients coming to us are in more advanced stage of glaucoma. The mean contrast sensitivity of case group (0.92) is compared with that of the control group (1.82) and a significant difference (p value <0.05) is found. The mean intra ocular pressure in glaucoma group in our study is 18.6 mmhg as compared to the mean intra ocular pressure of 16.5 in the right eye and 17.4 mm Hg in left eye in Henry D. Jampel's study group. Both the values are comparable.

Conclusions

There is a positive correlation between decreases in contrast sensitivity and visual impairment in patients of moderate to advanced glaucomatous damage. LogMAR visual acuity chart and its near vision equivalent greatly simplify the process of calculating the estimated magnification required by the patient, therefore its clinical importance as a screening device for testing and monitoring the status of our patients can now be realised and implemented for prescription of low vision devices with ease.

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