

Research Article

Correlation Between Contrast Variability and Refractive Error

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Abstract

Background: Contrast sensitivity, is defined as the ability to detect the lowest luminance difference between an object and the background. It is one of the main requisites for good quality vision as the eye works by perceiving an object by comparing the difference between the target and the background contrast difference.

Aims and Objectives: To assess patterns of contrast sensitivity functions in patients in different types of refractive errors using Pelli Robson chart and also to measure the severity of refractive error within each group and compared the contrast sensitivity function with severity in different types of refractive errors.

Material and Method: This cross-sectional study was conducted on 500 patients (Age range from 10 to 80 years) who presented with chief complaint of refractive errors mainly myopia and hypermetropia. Patients who had previous history of ocular surgery and other ocular comorbidity were excluded from study. Selected patients were enrolled for the study after taking a written informed consent. The patterns of contrast sensitivity function in different types of refractive errors were recorded on a prescribed proforma with respect to: Visual acuity, type of refractive error, severity of refractive error, duration of refractive error, age of the patient, fundus examination and Contrast sensitivity. Statistical analysis was undertaken with $P < 0.05$ significant.

Results: A mild decrease in contrast sensitivity was recorded in majority of patients i.e 250 patients (50%). Maximum decrease in contrast sensitivity was seen in 31-60 years age group. A statistically significant direct correlation ($P < 0.05$) was observed between duration and variation in contrast sensitivity. Both the refractive error showed definite decrease in contrast sensitivity and compound astigmatism showed severe decrease in contrast sensitivity.

Conclusion: Despite having BCVA of 6/6, patients showed reduced contrast sensitivity, even without any retinal pathology, making it an essential part of a routine ophthalmic examination.

Keywords: Contrast Sensitivity; Refractive Errors; Myopia; Hypermetropia; Pelli-Robson Chart

Introduction

Contrast sensitivity is the ability to perceive slight changes in luminance between regions which are not separated by definite borders and is just as important as the ability to perceive sharp outlines of relatively small objects [1].

Since refractive errors diminish contrast sensitivity, therefore sometimes a person with visual acuity of 6/6, may not be satisfied with the quality of their vision and still complain of decreased vision because of low contrast sensitivity [1,2].

Contrast Sensitivity can be measured by different methods, most commonly used is Pelli Robson chart that measures contrast

sensitivity thresholds ranging from 100% to 0.56% and is a simple, easy-to-use, low-cost test with strong test-retest repeatability. In advent of same, we undertook the present study to assess the effect of different types of refractive errors (Myopia and hypermetropia) on patterns of contrast sensitivity functions using Pelli Robson chart. Further, we also assessed correlation of the severity of refractive error within each group and the contrast sensitivity function.

Materials and Methods

This cross-sectional study was conducted on 500 patients (Age range from 10 to 80 years) who presented with chief complaint of refractive errors mainly myopia and hypermetropia to OPD of Department of Ophthalmology after approval by institutional ethical committee and Research Committee. Patients who qualified the inclusion criteria were enrolled for the study after taking a written informed consent.

Inclusion criteria:

- OPD patients presenting with refractive errors in all age groups
- Patients with BCVA of 6/6 with glasses
- Patients without any retinal pathology

Exclusion Criteria:

- Patients who did not gave consent for the study
- Patients with history of any ocular surgery/ or ocular pathology
- Uncompliant patients

Methodology

After taking written informed consent, the patient was evaluated and the patterns of contrast sensitivity function in different types of refractive errors were recorded on a prescribed proforma with respect to: Visual acuity, type of refractive error, severity of refractive error, duration of refractive error, age of the patient, fundus examination and Contrast sensitivity.

Visual acuity was assessed by the Snellen chart. The refractive error was recorded on the basis of refraction and Post Mydriatic Test (PMT) Contrast sensitivity was recorded by the Pelli-Robson chart (Fig. 1). The data included degree, duration of myopia and hypermetropia, and the degree of astigmatism and were collected in the form of excel sheet.

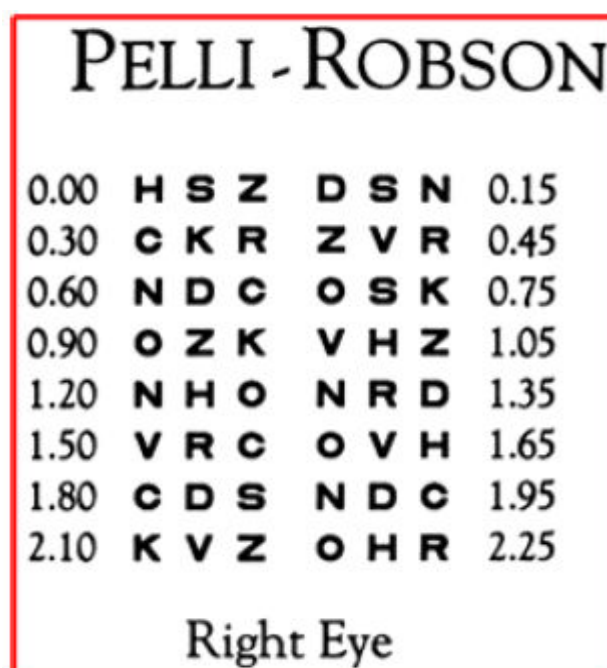


Figure 1: Pelli Robson chart.

The chart is wall mounted at one meter from the person to be examined and the letter size is 4.9×4.9 cm and consists of eight rows of letters. Contrast sensitivity grouping is done on basis of log-MAR values as shown in Table 1.

Log MAR Values	Grade
From 1.5 To Less than 2	Mild
From 1 To Less than 1.5	Moderate
Less than 1	Severe

Table 1: Grouping of contrast sensitivity.

Contrast sensitivity is determined by the last triplet letter of which the patient should be able to read at least two. The degree of myopia is shown in Table 2 and the degree of hypermetropia is shown in Table 3.

Myopia in Dioptres	Degree of Myopia
<3D	Low Myopia
>3D to <6D	Moderate
$\geq 6D$	High

Table 2: Grading of myopia.

Hypermetropia in Dioptres	Degree of Hypermetropia
<+2.25D	Low Hypermetropia
>2.25D to +5.00D	Moderate
$\geq +5.00D$	High

Table 3: Grading of hypermetropia.

Statistical Analysis

The data was collected and entered in Microsoft Excel 2010 (Microsoft corp.) and analyzed using the SPSS version 20.0 operating on Windows 10. All the descriptive data were presented as mean, standard deviation, frequency and percentages represented as the pie charts and bar diagrams. Qualitative and Quantitative data pertaining to the research was collected and an appropriate test was applied. Chi square test was used for associated categorical parameters. If p-value is less than 0.5 then it would be considered statistically significant.

Results

A decline in Contrast sensitivity is most commonly caused by refractive errors in patients. In the present study we addressed factors such as age, degree and duration refractive error and the degree of astigmatism as for their role in causing decline in contrast sensitivity of myopic and hypermetropic patients.

Patients were studied in three age groups i.e., under 30, 31-60 and more than 61 years. 160 patients (32%) were under 30 years while 231 (46.2%) were 31-60 years and remaining 109 (21.8%) were over 61 years.

Age Group	Contrast Sensitivity			Total	Chi Square
	Mild	Moderate	Severe		
<=30 Years	71	35	54	160	$X^2 = 48.912$
	28.40%	21.70%	60.70%	32.00%	
31-60 Years	127	76	28	231	
	50.80%	47.20%	31.50%	46.20%	
≥ 61 Years	52	50	7	109	p-value = 0.000

	20.80%	31.10%	7.90%	21.80%	Significant
Total	250	161	89	500	
	100.00%	100.00%	100.00%	100.00%	
	100.00%	100.00%	100.00%	100.00%	
	100.00%	100.00%	100.00%	100.00%	

Table 4: Variation in contrast sensitivity in different age group.

A statistically significant correlation ($P < 0.05$) was observed between age group and variation in contrast sensitivity. A decline in CS was seen in all age groups. Mild decrease in contrast sensitivity was recorded in majority of patients i.e., 250 patients (50%) i.e., 71 (28.4%), 127 (50.8%), 52 (20.8%) for ≤ 30 years, 31-60 years and ≥ 61 years respectively. Max mild decrease was seen in (31-60) years group and max severe decrease was seen in ≤ 30 years age group.

Duration	Mild	Moderate	Severe	Total	Chi Square
Upto 6 Months	105	87	18	210	$X^2 = 85.487$
	42.00%	54.00%	20.20%	42.00%	
7-12 Months	45	61	49	155	
	18.00%	37.90%	55.10%	31.00%	
≥ 13 Months	100	13	22	135	P-value = 0.000
	40.00%	8.10%	24.70%	27.00%	Significant
	250	161	89	500	
	100.00%	100.00%	100.00%	100.00%	

Table 5: Variation in contrast sensitivity according to duration.

According to duration of refractive error, patients were studied in 3 groups i.e., upto 6 months, 7-12 months and more than 1 year. A statistically significant correlation ($P < 0.05$) was observed between duration of refractive error and variation in contrast sensitivity. Mild decrease was recorded in 105 patients (42%) in upto 6 months duration group followed by 45 patients (18%) in 7-12 months and 100 patients (40%) in > 1 year group. Mild decrease in C.S is seen upto 6 months and severe decrease in CS seen in 7-12 months duration.

Refractive Errors	Mild	Moderate	Severe	Total	Chi Square
Compound Myopic Astigmatism	48	42	82	172	$X^2 = 255.838$
	19.20%	26.10%	92.10%	34.40%	
Simple Myopic Astigmatism	56	68	0	124	
	22.40%	42.20%	0.00%	24.80%	
Simple Myopia	26	1	5	32	P-value = 0.000
	10.40%	0.60%	5.60%	6.40%	
Compound Hypermetropic Astigmatism	17	34	0	51	
	6.80%	21.10%	0.00%	10.20%	
Simple Hypermetropic Astigmatism	77	10	2	89	Significant
	30.80%	6.20%	2.20%	17.80%	
Simple Hypermetropia	26	6	0	32	
	10.40%	3.70%	0.00%	6.40%	
Total	250	161	89	500	
	100.00%	100.00%	100.00%	100.00%	

Table 6: Variation in contrast sensitivity in refractive error.

A statistically significant correlation ($P < 0.05$) was observed between refractive errors and variation in contrast sensitivity. Out of 500 patient's majority of patients i.e., 172 (34.4%) had Compound Myopic Astigmatism with 48 having mild, 42 having moderate and 82 having severe variation in CS. 124 (24.8%) had Simple Myopic Astigmatism, 89 (17.8%) had Simple Hypermetropic Astigmatism, 51 (10.2%) had Compound Hypermetropic Astigmatism and only 32 (6.4%) each had Simple Myopia and Simple Hypermetropia. A mild decrease in CS was observed in all refractive errors with maximum 77 patients with Simple Hypermetropic Astigmatism followed by 56 patients with Simple Myopic Astigmatism and least 17 (6.8%) for Compound Hypermetropic Astigmatism. Severe decline in CS seen in Compound Myopic Astigmatism (Fig. 2).

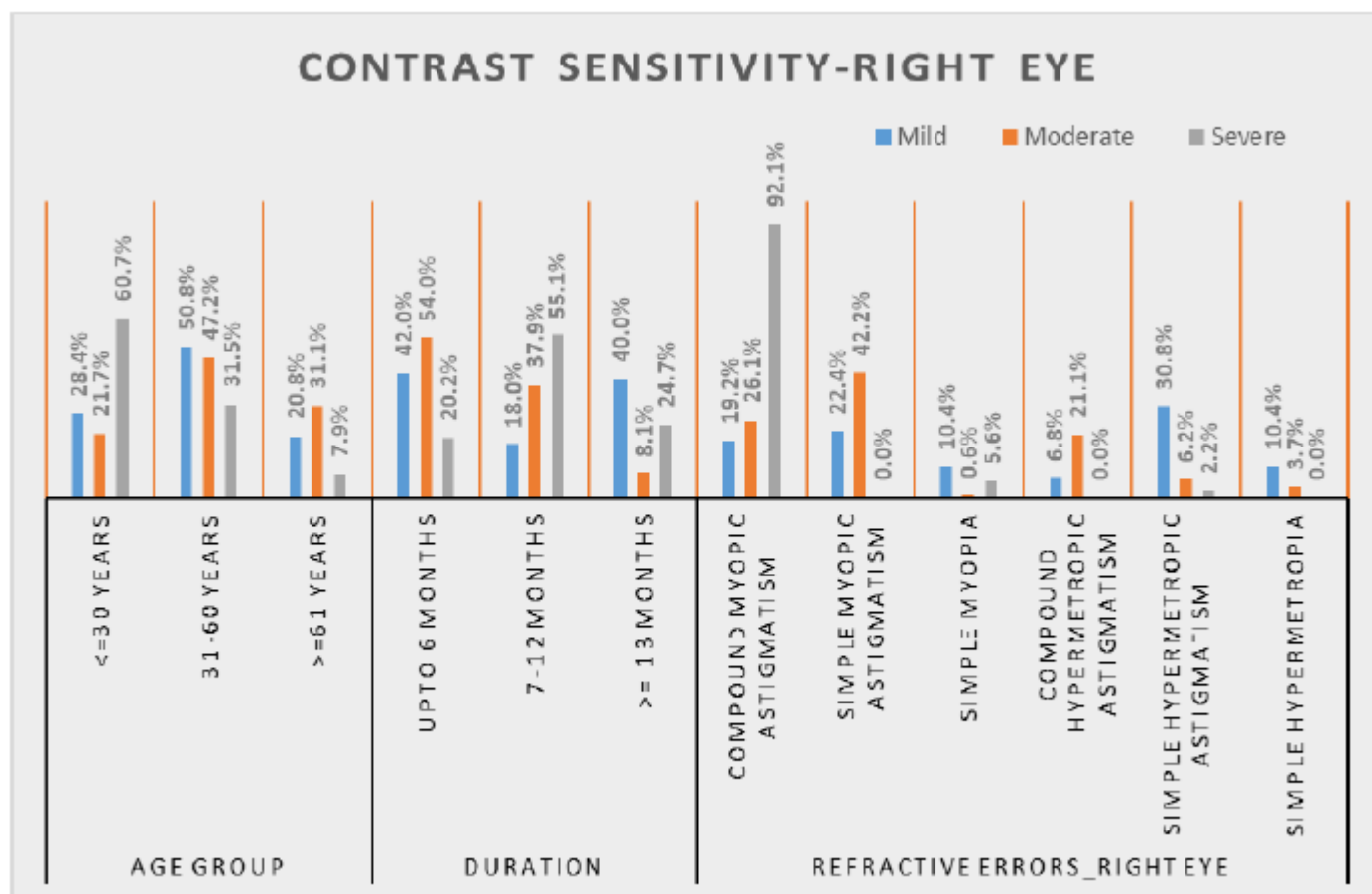


Figure 2: Variation in contrast sensitivity.

Discussion

Contrast sensitivity is one of the most important requirements for healthy vision and can be influenced by many variables unlike visual acuity. Especially with newly developed multifocal intraocular lenses and other refractive procedures, the success of the procedure depends on the contrast sensitivity test results, even if the visual acuity is accurate [5-8]. Therefore, contrast sensitivity testing gained popularity in recent era. Refractive errors are a known cause of decline in contrast sensitivity in patients. To improve the quality of life of a patient with refractive error, sharpness vision plays an important role [9-13].

In the present study, factors such as age, degree and duration of myopia and hypermetropia, and the degree of astigmatism as for their role in causing decline in contrast sensitivity of myopic and hypermetropic patients was evaluated, compared and studied. Patients in age groups of 10-80 were included in our study which were similar to study done by Zhouyue Li, Yin Hu, et al., and Shreya T, et al., which had patients in the age group 20-70 years [2,10,15]. A statistically significant inversely proportionate correlation ($P < 0.05$) was observed between CS and age. In our study a decline in contrast sensitivity was seen in all the age groups. Severe decline in CS was recorded maximum in ≤ 30 years age group. With increasing age severity of C.S function decreased but no definite pattern was observed in our study which was similar to studies done Packer M, et al., Li J. et

al. However, studies done Hinds A, et al., Shah P, et al., Bart VA, et al., indicated declines in both photopic and scotopic contrast sensitivity with aging that contrast sensitivity functions were directly proportional to increasing age and are more severely affected in the old age group of >69 years [11,13,16,21]. The possible reason being there is a much larger decrease in the number of rods compared to that of cones [17,18]. These changes explain the decreases in light sensitivity, contrast sensitivity, and visual acuity as well as prolonged dark adaptation that affect individuals over the age of 50 [16]. This contrast with other studies can be attributed to smaller sample size (92 patients) in these studies as compared to ours (500 patients) [22]. Majority of patients i.e., 78.2% belonged to age group <60 years in contrast to older patients in data collected by other studies.

We have observed that duration of myopia was a significant factor which was in concurrence with the results of the study conducted by Bistra Stoimenova, et al., which suggested that contrast sensitivity is negatively related to the degree and duration of myopia [23]. He studied 60 myopes and showed that 89% subjects with myopia of more than 10 years had severe decline in contrast functions [22].

On comparing contrast sensitivity between astigmatism in myopic patients i.e., Compound myopic astigmatism, simple myopic astigmatism and Simple myopia, mild decrease observed maximally in Simple myopic astigmatism. Severe decline in contrast sensitivity was seen in compound myopic astigmatism, showing a direct relationship between astigmatism and contrast sensitivity. This was similar to the study conducted by Yumi Hasegawa, et al., on 12 emmetropic volunteers, which also suggested that astigmatism deteriorates contrast sensitivity depending on the amount of astigmatic power [24]. The only difference between the studies was that we did not have any comparison group of emmetropic patients.

In present study among hypermetropic patients, simple hypermetropia has the majority of patients with mild decrease in CS which are in concurrence with study done by Karatepe, et al., and severe decline seen in simple hypermetropic astigmatism [25]. On comparing different refractive error, maximum severe decline in CS was seen in compound myopic astigmatism.

Conclusion

It is crucial to create databases of contrast sensitivity values standardized according age, refraction. In our study no definite relationship seen between age and CS. Direct relationship seen between duration of refractive error and contrast sensitivity. Among the astigmatic patients compound myopic astigmatism showed severe decline in contrast sensitivity. Despite having fully corrected refractive error with a visual acuity of 6/6, myopic and hypermetropic patients showed reduced contrast sensitivity, even without any retinal pathology, making it an essential part of a routine ophthalmic examination.

Limitations

Demographic factors like sex, occupation needs to be addressed. CS in patients with refractive errors was not compared with emmetropic patients.

Conflict of Interest

The authors have no conflict of interest to declare.

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