Contrast Sensitivity Improvement with Yellow Filter in Low Vision Patients

Amina Ahmad¹, Ume Sughra², Muhammad Kashif Habib³, Muhammad Imran⁴

ABSTRACT

OBJECTIVES: To measure the effects of yellow filter on contrast sensitivity in patients with low vision.

STUDY DESIGN: A descriptive cross sectional study.

PLACE AND DURATION: The study was carried out in the LVD of Al Shifa Trust Eye Hospital from 1st July to 31st December 2015.

METHODOLOGY: One hundred and ten patients from low vision department with decreased contrast were selected and Visual acuity of all the patients was measured using Early Treatment Diabetic Retinopathy Study (ETDRS) chart at a distance of 4 meters. The contrast sensitivity was measured with Pelli Robbson chart with full optical correction on place. Then, a yellow filter was applied on the existing optical correction if any, and the contrast sensitivity was again measured.

RESULTS: Median score for the contrast sensitivity without yellow filter (Med=7.00) was statistically lower than the median score (Med=8.00) for the contrast sensitivity with yellow filters. So the Wilcoxon Signed Rank test revealed a statistically significant improvement in contrast sensitivity with Z=-6.885, p<0.001, with a large effect size (r=0.66). In retinitis pigmentosa, contrast of 69% of patients was improved after measuring it with the yellow filter. All participants with pathological myopia showed significant results. There was no improvement in contrast sensitivity in participants with Albinism and Stargardt’s disease. In Glaucoma, Diabetic retinopathy and in Macular scaring there was significant improvement.

CONCLUSION: A significant improvement in contrast sensitivity was seen with yellow filters in low vision patients. The contrast sensitivity of patients with Retinitis Pigmentosa, Pathological Myopia, Glaucoma, Macular Scaring and Diabetic Retinopathy was improved significantly with yellow filter.

KEY WORDS: Contrast Sensitivity, Low Vision, Yellow Filter, Visual Acuity, Early Treatment, Diabetic Retinopathy, Optical Correction.

INTRODUCTION

A patient with low vision is one who has visual impairment even after best available treatment (medical, surgical, optical) and who has visual acuity of <6/18 to no perception of light or visual field of 10° from center of fixation or 20° in largest diameter in better eye but who have potential to do activities of daily life.² Globally, 32.4 million people were blind in 2010, and 191 million people had moderate to severe visual impairment (MSVI). The MSVI prevalence in older adults was highest in South Asia (23.6%), Oceania (18.9%), and Eastern and Western Sub-Saharan Africa and North Africa and the Middle East (95%).²

The contrast sensitivity of low vision patients is typically reduced and is a more significant indicator of visual function. Many activities are difficult for patients with reduced contrast sensitivity. Reading low contrast print, or colored text on a colored background; walking in foggy or cloudy conditions or in dim light, and pouring milk into a white cup are just a few examples.³

Filters with selected wavelengths are used against sunlight for protecting the retina and other ocular tissue, making a useful contribution towards low vision rehabilitation for patients with retinitis pigmentosa.⁴⁻⁵ The quality of vision is improved by decreasing the recovery time of changes in light adaptation. They reduce light dispersion within the ocular media and chromatic aberration, with the resultant increase in the contrast of the retinal image.⁶

Based on the belief that assistive devices are vision enhancing they are been advertised and prescribed especially orange

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and yellow tinted glasses. There is little objective data but there are many subjective reports of people benefiting from colored transmission filters. Mostly aviation pilots, skiers, shooters, have a subjective preference for yellow filters, and patients with low vision, especially with albinism and retinitis pigmentosa.

Yellow lenses are currently attracting attention. Blue light rays are cut by the yellow color, and it gives out a high luminous transmittance with a wavelength of 550 nm, to which human eye is very responsive and sensitive. Several authors have studied the effect of yellow lenses on contrast sensitivity.

Studies suggested that yellow filters give extra brightness, by causing a reduction in opponent components of the achromatic and chromatic channels to brightness perception, resulting in improved response times to low-contrast; midrange spatial frequency square-wave gratings. Several studies suggested that yellow filters lower the increment and resolution thresholds for long-wavelength targets on short-wavelength backgrounds but this effect reduces with the age of the observer and the size of the target (because of yellowing of the ocular media). The subjective impression of brightness with yellow lenses is mediated mainly by the contribution of the rod signals to the chromatic pathway.

This study helped to measure the effects of yellow filter on contrast sensitivity in different diseases of low vision. It will help to ensure the use of filter, by letting all practitioners of low vision know about the results of this study and to create awareness about the yellow filters. The study will enhance the functional potential of visually impaired patients. This study was conducted to measure the effects of yellow filter on contrast sensitivity in patients with low vision.

**METHODOLOGY**

This was a descriptive cross sectional study was carried out from 1st July 2015 to 31st December 2015. The study was carried out in the low vision department of Al-Shifa Trust Eye Hospital. It is a tertiary eye care hospital. The patients from all over the Pakistan come here. Those individuals who have low vision or functionally disable due to their decreased vision are referred to the department of low vision. All patients presented in low vision department of Al-Shifa trust eye hospital from 1st July to 31st December 2015 were included. Patients both male and females of age group 10 to 50 years with impaired contrast sensitivity and with any retinal pathology were included in this study. Mentally handicapped, non-co-operative patients and patients with vision less than 6/240 were not included to remove the effect of any possible confounders. There were 110 low vision patients and this sample was calculated at a confidence level of 95%, 8% absolute precision and 22.5% anticipated population prevalence by using WHO statistical calculator. Non probability convenient sampling technique was used. The patients with low contrast presented in the low vision department of Al-Shifa Trust Eye Hospital were taken as sample.

**Data collection methods:** Data was collected using proforma structured by the principal researcher. All data collected was self-administered. The proforma was validated for contents and face validity by circulating them to expertise in the field including supervisors. A selected sample of 110 patients was chosen depending upon time available and keeping in view the informed consent of patients, the patients were evaluated under the supervision of senior optometrists. First of all the demographic information was taken from the participants, after that the visual acuity of all the patients was measured using ETDRS chart at a distance of 4 meters. For the patients with severe vision loss the visual acuity was measured at 2 meter and 1 meter distance by changing the distance of ETDRS chart from the patient. Grading of low vision was done and recorded in the proforma. All patients were already diagnosed by the senior ophthalmologists and were referred to the low vision department. Then the diagnosis of the patient was categorized accordingly. After that contrast sensitivity of all the patients was measured by pelli robson chart with full optical correction in place and at the room illumination. Then, a yellow filter was applied on the existing optical correction if any, and the contrast sensitivity was again measured. And finally the individual preference for the yellow filter was noted by asking the patient that whether it looks brighter and improved by wearing yellow filter or he/she feels it better without filter.

**Data analysis:** Data analysis was done using SPSS version 17. The confidence level was set at 5% (α = 0.05). The p value < 0.05 was considered statistically significant. All preliminary analysis was done to check the normality of data and for violation of any assumption for using parametric test of statistical significance. In this analysis normality assumption was violated because K-S Test value was < 0.05 which showed data to be not normally distributed. So to check for the difference in the mean scores of contrast sensitivity between two groups, non parametric alternative of the paired t-test (parametric test) that is Wilcoxon signed rank test was applied on the data.

**Ethical consideration:** Written informed consent from the participants was taken dully approved by Ethical Review Board of the hospital. Data and identity of all the patients was kept confidential. The filter used in the study did not cause any harmful effects on the individual’s health. And there is no risk of using yellow filter for the test.

**RESULTS**

Table - I: shows the demographic profile of respondents. Females were more in sample (55%) and 36.3% of the participants were in the age group of 41-50 years.

Table- II: shows the visual profile of patients in both eyes. Most eyes had a Visual Acuity of 6/24-6/48.

The contrast sensitivity of 110 patients was measured before the application of filter and then it was measured after wearing the yellow filter. The effect was seen on both eyes separately and contrast sensitivity was measured with the Pelli robson contrast chart. As the population was not normally distributed so the non parametric test was used. The Wilcoxon signed test is applied which is a non parametric test and is used as an alternative of the repeated measure t-test. The analysis done by applying Wilcoxon Signed Test is given in the table - III. In Table - III result for wilcoxon signed rank test is shown for both contrast sensitivity with and without yellow filters. Median score for the contrast sensitivity without yellow filter
TABLE - I: FREQUENCY OF AGE AND SEX DISTRIBUTION PARTICIPANTS (N=110)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>55 (45%)</td>
</tr>
<tr>
<td>Female</td>
<td>65 (55%)</td>
</tr>
<tr>
<td>Age Groups</td>
<td></td>
</tr>
<tr>
<td>10-20 years</td>
<td>32 (29.1%)</td>
</tr>
<tr>
<td>21-30 years</td>
<td>27 (24.5%)</td>
</tr>
<tr>
<td>31-40 years</td>
<td>11 (10%)</td>
</tr>
<tr>
<td>41-50 years</td>
<td>40 (36.4%)</td>
</tr>
</tbody>
</table>

TABLE - II: FREQUENCY OF VISUAL PROFILE OF THE PARTICIPANTS (N=110)

<table>
<thead>
<tr>
<th>Visual acuity</th>
<th>Frequency Right Eye</th>
<th>Frequency Left Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/6 - 6/19</td>
<td>21 (19.1%)</td>
<td>27 (24.5%)</td>
</tr>
<tr>
<td>6/24 - 6/48</td>
<td>52 (47.3%)</td>
<td>50 (45.5%)</td>
</tr>
<tr>
<td>6/60 - 6/96</td>
<td>22 (20%)</td>
<td>21 (19.2%)</td>
</tr>
<tr>
<td>6/120 - 6/152</td>
<td>11 (10%)</td>
<td>6 (5.4%)</td>
</tr>
<tr>
<td>6/192 - 6/240</td>
<td>4 (3.6%)</td>
<td>6 (5.4%)</td>
</tr>
<tr>
<td>Total</td>
<td>110 (100%)</td>
<td>110 (100%)</td>
</tr>
</tbody>
</table>

TABLE - III: DESCRIPTIVE STATISTICS WILCOXON SIGNED RANKS TEST (N=110)

<table>
<thead>
<tr>
<th>Contrast sensitivity</th>
<th>Median score</th>
<th>test</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast sensitivity without yellow filter</td>
<td>7.00</td>
<td>Z</td>
<td>-6.885</td>
</tr>
<tr>
<td>P-value</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrast sensitivity with yellow filter</td>
<td>8.00</td>
<td>Z</td>
<td></td>
</tr>
</tbody>
</table>

(\text{Med}=7.00) was statistically lower than the median score (\text{Med}=8.00) for the contrast sensitivity with yellow filters. So the test revealed a statistically significant improvement in contrast sensitivity, \(Z=-6.885, p<0.0005\), with a large effect size (\(r=0.66\)). Since Wilcoxon signed rank test was applied due to the skewed data (non normal distribution) so, scores are given instead of ranks.

DISCUSSION

The low vision patients suffer from different problems due to decreased vision, loss of color vision and also a decrement in contrast sensitivity. With low vision patients contrast sensitivity loss is a common problem regardless of the congenital condition or underlying pathology. In pathologies such as glaucoma a very early problem is contrast loss that has a functional impact more than what one would expect solely on visual field loss or acuity. In this study the effect of yellow filter on contrast sensitivity in low vision patients was seen. A total of 110 individuals with different diseases of low vision participated in this study, out of which 62 (56.4%) individuals showed significant improvement (\(p < 0.0005\)). Similar results were seen in a study done by Y.Z. Rosenblum et al, in this study 15 adult patients with partial cataract and 80 children with congenital pathology (i.e. macular hypoplasia, Albinism, Aphakia after congenital cataract) were tested using four types of filters including yellow filter. There was 27–34% increase in contrast sensitivity function (CSF) for all frequencies and a marked reduction in glare sensitivity.\(^4\)

In this study there were 29 individuals with Retinitis Pigmentosa, out of which 20 (69%) individuals showed significant improvement. Another study done by Gonzalo Carracedo et al showed a significant improvement on the quality of contrast vision of patients with Retinitis Pigmentosa when wearing the filters on contact lenses or glasses in comparison to control.\(^6\) There were different types of tinted filters used to check the contrast sensitivity, but in this study only yellow filter was used. The tinted filters minimize photoreceptor damage by diminishing short wavelength exposure.

All individuals with pathological myopia in this study showed significant improvement. A total of 12 (100%) patients with pathological myopia were included in this study and all of them showed improvement in contrast with yellow filter. Earlier studies did not test contrast sensitivity by applying yellow filters on patients with pathological myopia.

This study showed that in maculopathy there was a total of 8 individuals participated in the study, out of which 4 (50%) showed improvement in contrast while remaining 4 (50%) individuals did not show improvement. There was no other study done to check the effect of yellow filter in individuals with maculopathy.

In this study, out of 11 patients with macular scarring, 6 (54.5%) individuals showed improvement while contrast of 5 (45.5%) individuals remained same. The patient co-operation and their response toward the yellow filter also have an influence on results. In this study there were 8 individuals with age related macular degeneration out of which only 3 (37.5%) individuals showed improvement, while a study done by Frennesson I, Nilsson U et al showed the contrast sensitivity that is peripheral to an absolute central scotoma in macular degeneration (age related) and the influence of an orange filter or a yellow filter was measured, the results showed significant improvement in contrast sensitivity at certain spatial frequencies only.\(^17\) This study showed that the patients with albinism did not show any improvement. There were total 14 patients with albinism, out of which only 1 patient showed slight improvement. Provinces WF et al concluded that neither filter enhanced nor degrade the contrast sensitivity among the subjects, a more extensive investigation may reveal that subtle but real contrast enhancement occurs with yellow filter use.\(^18\)

In this study, the individuals with Stargart’s disease did not show any improvement. Out of 7 individuals no one showed any improvement. There was significant improvement in contrast sensitivity of individuals with glaucoma and diabetic retinopathy. A total of 12 glaucomatous individuals were checked, out of which 8 (66.7%) individuals showed significant improvement. There were 8 patients with diabetic retinopathy, one of them did not show any improvement while 7 (88.9%) others revealed significant improvement.

The strength of this study was that all diseases of low vision
were considered and the effect of yellow filter on contrast sensitivity was measured. The results were different in different pathologies. The study is done by the chief researcher herself. The limitations in this study were that the number of subjects was low, the duration of study was short and the sample size was not randomly selected.

**CONCLUSION**

It is concluded that in low vision patients with yellow filters there was a significant improvement in contrast sensitivity especially patients with Retinitis Pigmentosa, Pathological Myopia, Glaucoma, Macular Scaring and Diabetic Retinopathy showed significant improvement with yellow filter.

**RECOMMENDATIONS**

Filter trial should be made necessary for all patients of low vision department. It is necessary for the Low vision practitioners to advise yellow filter to a patient with decreased contrast. Not only for the low vision patients but it should also be recommended to the general eye departments, that any patient who complains of decreased contrast should given a trial of filter.

**CONTRIBUTIONS OF AUTHORS**

Ahmad A: Conceived Study, Literature Research, Data Collection, Data Analysis, Sughra U: Research Designed, Research Proposal, Data Analysis, Writing Manuscript Habib MK: Research Designed, Literature Research, Data Analysis. Imran M: Data Analysis, Writing Manuscript

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**Conflict of Interest:** None.

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