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ORIGINAL ARTICLE

Functional Visual Outcomes of Wearing Colored Filters in Patients with Dry Age-Related Macular Degeneration

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ABSTRACT

Background: Age-related macular degeneration (AMD) leads to a permanent decrease in vision, thus affecting the quality of life. Any intervention or modality that enhances the quality of vision and, in turn, quality of life is vital.

Objective: To evaluate the functional benefits of wearing colored filters in patients with dry age-related macular degeneration.

Methods: The study was conducted from March to October 2023 after approval by the Ethical Review Board. Thirty-one patients above 50 years of age diagnosed with dry AMD at Mayo Hospital, Lahore, Pakistan, were selected using a non-probability convenient sampling technique. After informed consent, different color filters were placed in the patient's glasses according to their compliance. Each eye was tested separately for contrast sensitivity (CS) and best-corrected visual acuity (BCVA) before and two weeks after the filter placement. Contrast sensitivity was assessed using the Lea contrast Flip chart, and BCVA was assessed using the LogMar chart. A paired sample t-test was applied for data analysis. P value of less than 0.05 was considered as statistically significant.

Results: Best corrected visual acuity in right and left eye improved significantly from 1.00±0.41 to 0.72±0.25 (p=0.000) and from 0.96±0.43 to 0.72±0.30 (p=0.000), respectively after applying filters. However, changes in contrast sensitivity were not significant in right eye (p=0.59) and left eye (p=0.39).

Conclusion: Using colored filters significantly improves the best corrected visual acuity, with no contrast sensitivity improvement. This shows that filters selectively impact functional vision in patients with dry age-related macular degeneration.

Key Words: Macular degeneration, Contrast sensitivity, Visual acuity, Color filters

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INTRODUCTION

Age-related macular degeneration (AMD) is a disease that causes irreversible damage to the macula with increasing age and leads to a defect in the central field of vision (central scotoma). AMD is more prevalent in patients over 60 years of age. Patient with AMD suffers from difficulties like reading, driving, face recognition, mobility, tracking, and so on. In industrialized countries, AMD is a significant factor in the irreversible accomplishment of tasks like reading, face recognition, etc.[1-4]

Decrease in the central visual acuity, reduced contrast sensitivity, defects of color vision, and

metamorphopsia are the leading sequelae of age-related macular degeneration. Patients suffering from early AMD usually are asymptomatic.[5,6]

Tinted lenses are specialized lenses that effectively filter light at a particular wavelength. Tinted lenses decrease light transmission without affecting the maintenance of contrast sensitivity and visual acuity. Tinted lenses are used to reduce intense glare, to protect the eyes from damaging ultraviolet rays (UV), in ocular diseases like cataract, albinism, and retinitis pigmentosa (RP), to reduce the light dispersion, in color vision defects to enhance the ability to differentiate colors, and in strabismic patients for cosmetic purpose.[7] Patients with ocular conditions that cause increased light sensitivity (photophobia) such as intense dry eye syndrome, migraine, traumatic brain injury, and cone dystrophies have a positive impact after use of tinted lenses.[8]

In a study, 30 patients with peripheral and central visual field defects caused by retinal disorder were chosen to assess the functional benefits of selective blue-violet light filters and Photochromic lenses. Glare test (GT), Mars contrast sensitivity (CS), black-on-white best corrected visual acuity (BW-BCVA), and white-on-black best corrected visual acuity (WB-BCVA) were measured in all participants. Selective blue-violet blocking lenses and photochromic lenses proved to be effective in all selected participants.[9]

There are several reasons to explore the functional benefits of colored filters i.e. they can improve a patient's quality of life by reducing visual discomfort. By improving residual vision (BCVA, contrast sensitivity) patient can perform daily living activities, like reading, writing, face recognition, mobility, tracking, and driving independently and comfortably. In addition, the lack of local literature on this subject also prompted the researchers to carry out this study.

METHODS

This study received **Ethical approval** from the Ethical Review Board of the College of Ophthalmology and Allied Vision Sciences (Ref #COAVS/1461/23, issued on 03.11.2023).

This was a quasi-experimental study. The duration of the study was from March 2023 to October 2023. Assuming the mean difference in visual acuity before and after the intervention to be 3.30, we estimated the sample size to be 21 for each group (right eye and left eye groups) at a 5% level of significance and 80% power.[10] Although the sample size calculated was 21, we recruited thirty-one patients by non-probability convenient sampling technique. Patients above 50 years of age and with dry AMD were included while those with wet (exudative) AMD, Retinal detachment, and Retinal dystrophies were excluded. Diagnosis of dry AMD was made by the consultant after retinal examination through dilated pupil by slit lamp bio microscopy. The left eye of all thirty-one patients was diagnosed as having dry AMD while the right eye of 29 patients was found to have dry AMD.

After Informed consent, each eye was tested for two functional parameters, namely contrast sensitivity and BCVA using the Lea contrast Flip chart and LogMar chart respectively. For measurement of BCVA, the patient was seated 1 meter from LogMar and his BCVA was measured by occluding each eye one by one. Similarly, Contrast sensitivity was measured uniocularly by holding the Lea contrast Flip chart at 1 meter.
Afterward, the Patient's compliance with the incorporation of different color filters (Red-Brown, Dark- Brown, Amber, Grey, Orange, Yellow) in their glasses was checked. Eventually, each patient was advised a specific filter in their glasses to which he/she was most compliant and comfortable in terms of reducing glare and photophobia. Both contrast sensitivity and BCVA were assessed before and two weeks after applying different color filters. During follow-up, no patient reported a complaint or side effect of using filters in their glasses and all 31 patients completed their follow-up.

In this study, two functional parameters, namely contrast sensitivity and BCVA were evaluated.

Contrast sensitivity was assessed using the Lea contrast Flip chart and BCVA was assessed using the LogMar chart. Normal Visual acuity on LogMar chart is 0.0 which corresponds to 6/6 of snellen's chart.[11] Similarly, contrast sensitivity measured on Lea chart can either be 25, 10, 5, 2.5 or 1.2.[12]

Statistical Analysis

Data was analyzed using SPSS version 26. Categorical variables are expressed as frequency and percentages. Quantitative variables were presented as mean ±SD. A paired sample t-test was used to compare with and without a filter. P value ≤ 0.05 was considered statistically significant

RESULTS

Thirty-one subjects aged 50 years and above were included in this study. The mean age of the patients was 61.93±11.26 years with a predominance of male patients (67.7%) (Table 1). The lowest recorded visual acuity was 1.30 and the highest recorded visual acuity was 0.1 LogMar in the patients examined in the study. The highest contrast sensitivity was scored at 25/25 and the lowest contrast sensitivity was 5/25.

Table 1: Mean age and gender distribution of participants

	n	mean±SD
Age (years)	31	61.93±11.26
Gender	**n**	**%**
Male	21	67.7
Female	10	32.3
Total	31	100.0

The type of color filters used are given in the Table 2. Large number of patients showed compliance with yellow and brown filters followed by orange, and amber. The frequency of patients that showed compliance with red, brown, grey, and dark brown filters was less (Table 2). There was significant improvement in BCVA in right eye and left eye (p=.000), no significant improvement in contrast sensitivity was seen (p>0.05) (Table 3).

BCVA was improved with all filters that were applied. Yellow, brown, and orange filters were noticed to be most effective in improving BCVA in some patients but contrast sensitivity was not improved significantly. The Patients were comfortable visually because filters reduced the glare sensitivity.

Table 2: Filter color prescribed to patients

Filter Color	n (%)
Brown	7(22.58)
Amber	4(3.2)
Dark-brown	1(3.2)
Grey	1(12.9)
Orange	4(12.9)
Red-brown	2(6.45
Red	1(3.2)
Yellow	11(35.5)
Total	31(100)

Table 3: Comparison of best corrected visual acuity (BCVA) and contrast sensitivity before and after application of filters

Parameter	n	Before Filter (mean±SD)	After Filter (mean±SD)	p-value
Visual Acuity				
Right eye	29	1.00±0.41	0.72±0.25	0.00*
Left Eye	31	0.96±0.43	0.72±0.30	0.00*
Contrast Sensitivity				
Right Eye	29	2.60±1.19	2.33±1.26	0.59
Left Eye	31	2.67±1.37	2.38±1.43	0.39

Paired sample t-test was applied; P value less than 0.05 was considered significant.*

DISCUSSION

There was significant improvement in BCVA in right and left eyes, whereas as no improvement in contrast sensitivity was noticed.

The study conducted on patients with albinism investigated the occurrence and intensity of photosensitivity, its association with ocular characteristics and their interaction with selection and utilization of optical filters. There was no association of photosensitivity with iris transparency, marked association with fundus hypopigmentation, and no correlation with contrast sensitivity seen. Neutral and color filters with reduced light transmission were favored.[13] Likewise, our study also showed that color filters improved contrast sensitivity. In another study,

changes in contrast sensitivity were assessed in patients having retinal disorders with yellow-amber no-infra-red (NoIR) lenses. Patients with diabetic retinopathy, hereditary maculopathy, pathological myopia, and age-related macular degeneration had no improvement in contrast sensitivity using yellow-amber NoIR lenses,[14] whereas in the present study contrast sensitivity was improved with the use of filters, however, it was statistically insignificant.

Another study examined the effectiveness of filters (yellow, orange, pink and no filter) on contrast sensitivity in patients with maculopathy, glaucoma, cataract, and pseudophakia. Contrast sensitivity was measured with Spot checks and a contrast sensitivity chart. Yellow filter with illumination at 100lx distinctly enhanced contrast sensitivity in maculopathy, but no manifest enhancement in the remaining groups. In cataract patients, there was a close link between filter and illumination.[15] Tinted sport lenses have been associated with enhancing visual acuity and contrast sensitivity, especially, in low light situations and yellow lenses have shown a beneficial impact on reaction time in particular situations, such as driving and in dim lighting conditions. However, studies show this impact may vary in elderly and young drivers. Filter or tinted lenses showed improvement in contrast sensitivity.[16] In the present study visual acuity improved by using filters, but contrast sensitivity showed no improvement.

A study was conducted to compare the visual performance and optical characteristics of three filters. The best possible visual acuity in mesopic conditions was improved in progressive addition lenses 0.13 (PRO) and from 0.15 to 0.12 (STD, $p< 0.05$). With drive filters best possible vision under glare was improved as compared to clear filters ($p<0.05$) from 0.08-0.12 (PRO and STD) for SVL and from 0.03 to 0.01 (PRO) to -0.02 (STD) for PAL. No difference was observed in the Best possible vision in photoptic condition.[17] These results support the findings of our study in which visual acuity increased significantly with use of filters from 1.0 to 0.7 LogMar (Table 3).

A prospective longitudinal pilot study was conducted to evaluate the impact of contact lenses with blue light filters on tear quality and quantity and contrast sensitivity. Contrast sensitivity was markedly different among all participants. Groups having contact lenses with blue light filters and video display terminals had no marked differences in break up time (BUT) ($p>0.05$), but the mean value is higher than the standard contact lenses ($p>0.05$). The results demonstrate a possible link between enhanced contrast sensitivity, use of contact lenses with blue light filter, and tear stability[18], a finding shared by our study. In Taiwan national health insurance, a cohort study was conducted to investigate the occurrence rate of age-related macular degeneration after cataract surgery, and to differentiate the proportional occurrence rate of AMD in pseudophakic patients, using blue wavelength filtering intra-ocular lenses and non-blue wavelength filtering intra-ocular lenses. Non-blue wavelength filtering intra-ocular lenses were surgically inserted in 165,465 patients (88.7%) and blue wavelength filtering intra-ocular lenses were surgically inserted in 21,126 patients (11.3%). After cataract surgery, 1655 patients were diagnosed with exudative AMD, and 12,533 patients were diagnosed with non-exudative AMD with 6.1 years of average follow-up duration. With blue wavelength filtering intra-ocular lenses the occurrence rate for exudative AMD was 1.22 and for non-exudative AMD was 9.95.[19]

A study has reported no improvement in contrast sensitivity in patients with intermediate AMD whereas improvement seen in patients with early AMD. In the present study, patients were not categorized according to the stages of AMD.[20] This might be the reason for no improvement in Contrast sensitivity.

A cohort study was performed to investigate the impact of blue light filtering intra-ocular lenses (BLF IOLs) on the advancement of neovascular AMD after cataract surgery. After cataract surgery, there was no significant impact of BLF IOLs. BCVA and severity of AMD were

correspondent in both IOLs.[21] Contrary to these results our study reported significant gains in visual acuity after use of filters.

A retrospective case study to evaluate the impact of blue light filtering intraocular lenses on prevention of initiation of wet AMD. Two groups were selected with AMD and without AMD, both had cataract surgery. No relation was established between BLF IOLs and the incidence of AMD.[22]

CONCLUSION

Different colored filters showed significant improvement in best-corrected visual acuity, but only little improvement in contrast sensitivity. This suggests that filters have a selective impact on functional vision.

Limitations of Study

Being a single-centered study with a small sample size was the main limitation of the study. Further study on colored filters should be done to better comprehend their impact.

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AUTHORS' CONTRIBUTION:

SBJ: Conception and designed the study, data acquisition, approval of the final version to be published

MS: Drafted the work, literature review, approval of the final version to be published

AR: Statistical analysis, reviewed it critically for important intellectual content, approval of the final version to be published

All Authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

CONFLICT OF INTEREST:

All authors declared no conflict of interest.

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The data are available from the corresponding author upon reasonable request.