

Original Article

Quantity and Quality of Vision Using Tinted Filters in Patients with Low Vision Due to Diabetic Retinopathy

Naser Sadeghpour¹, MS; Ali Agha Alishiri¹, MD; Reza Ajudani², MD; Mohammad Hossein Khosravi², MD
Mohammad Agazadeh Amiri³, OD; Omid Sadeghpour², BS

¹Department of Ophthalmology, School of Medicine, Baqiyatallah University of Medical Sciences, Tehran, Iran

²Students' Research Committee, Baqiyatallah University of Medical Sciences, Tehran, Iran

³Department of Optometry, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Abstract

Purpose: To investigate the effect of tinted filters on visual acuity (VA), contrast sensitivity and patient satisfaction in diabetic retinopathy associated with low vision.

Methods: In a prospective study, 51 patients with diabetic retinopathy and low vision were assessed. We chose a simple random sampling method and used the patient's files for data collection. LogMAR notations were applied for assessing VA and a contrast sensitivity chart (CSV-1000) was employed for measuring contrast sensitivity. First, measurements were performed without tinted filters and then using them. Appropriate lenses were given to the patients for 2 days, and they were questioned about their satisfaction using them in different places.

Results: A total of 20 male and 31 female patients with mean age of 57.3 years participated in the study. With a 527 ± 10 nm filter, mean VA improved significantly ($P \leq 0.05$). Using the 527 ± 10 nm and 511 ± 10 nm filters, mean contrast sensitivity was improved significantly at 3 and 6 cycles/degree frequencies ($P < 0.05$). The effect of other filters on VA and contrast sensitivity was not significant. Patient satisfaction rate was generally high.

Conclusion: Tinted filters are able to rehabilitate low-vision patients due to diabetic retinopathy. The 527 ± 10 and 511 ± 10 nm wavelength filters improved contrast sensitivity and the 527 ± 10 nm filter improved VA to some extent. Further investigations are recommended to assess the effect of these filters in patients with other causes of low-vision.

Keywords: Contrast Sensitivity; Diabetic Retinopathy; Low Vision; Tinted Filters

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INTRODUCTION

Low vision is a term generally used for long-lasting vision loss uncorrectable by medications, surgery or

glasses. Low vision assistive device technology has progressed over the years to provide a variety of visual aids. These assistive devices make the individuals visually independent.^[1,2] Low vision assistive devices such as telescopic and microscopic lenses, hand and stand magnifiers, and video magnification systems could be used to improve visual acuity (VA) in these patients.^[3] Some assistive visual devices do not have a good appearance and are expensive.

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Correspondence to:

Ali Agha Alishiri, MD. Baqiyatallah Hospital Polyclinic, Mollasadra Street, Vanak Square, Tehran, Iran.

E-mail: alishiri20002000@yahoo.com

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Tinted filters may also be used as assistive devices for low vision.^[3] These filters allow only a certain light wavelength such as 511 ± 10 , 450 ± 10 , 550 ± 10 nm to pass through. They are available in different colors such as yellow and orange.^[4] In general, the effect of color on object identification has been concluded in different studies.^[5] Using colors for enhancing contrast sensitivity in the form of tinted filters is becoming common. Certain colors like yellow and orange are used more frequently.^[4] However, other colors, such as red, have been reported to be effective for visual improvement.^[6] In some cases, mixed-color tinted filters have been used.^[7] If these filters are able to improve the quantity and quality of vision, they could be used practically as visual assistive devices. Different studies have been conducted to determine the effectiveness of tinted filters on the quantity and quality of vision and have shown varying results.^[8,9]

Due to the high prevalence of diabetes mellitus, a large number of people with diabetic retinopathy suffer from significant vision loss.^[10] The aim of this study was to measure the quality and quantity of vision with tinted filters in patients with low-vision due to diabetic retinopathy.

METHODS

This prospective study was approved by the Ethics Committee at Baqiyatallah University of Medical Sciences and conducted at the Baqiyatallah Clinic of Ophthalmology, Tehran, Iran. Fifty-one patients with low vision due to diabetic retinopathy who had VA from 0.5 LogMAR (20/60) to ≤ 1.3 LogMAR (20/400) in the better eye, were selected by simple random sampling. These patients had diabetes mellitus of at least 15 years' duration with an average blood sugar of 150 mg/dl. Diabetic retinopathy was previously diagnosed by an ophthalmologist. Initially, patients with diabetic retinopathy were referred to have their VA assessed using a Snellen chart. They also had their contrast sensitivity measured by CSV-1000 E chart (Vector Vision, Arcanum, OH, USA), the most used contrast sensitivity test in the world. This test has been proven as a reliable tool for measuring contrast sensitivity.^[11] Each row of the test presents a different spatial frequency, and consists of 17 circular patches with a diameter of 1.5 inches. The first patch is on the far left side of the high contrast grating (sample patch). The remaining 16 patches appear in eight columns across the rows. Each column presents a grating patch, and the other patch is blank. The patches that present gratings have descending contrast moving from the left to right across each row. Test-retest reliability of the CSV-1000 test was assessed in a study conducted by Pomerance and Evans, and was considered as a clinically reliable tool for monitoring contrast sensitivity.^[11]

The patients were directed to observe the first sample patch and were asked to look for the grating pattern in each column. Reading across the row, the patient

indicated if the grating appeared in the top patch or the bottom patch in each column. If the grating was not visible in both patches, the patient responded "both blank." The patient was encouraged to guess if a grating was partially visible as the threshold was approached. However, the patient was informed that if no gratings are visible, the response should be "both blank." The contrast level of the last correct response was considered as the contrast threshold. Contrast sensitivity levels in each row ranged from 0.70 to 2.08, 0.91 to 2.29, 0.61 to 1.99, and 0.17 to 1.55 log units for 3, 6, 12, and 18 cycles/degree, respectively. Contrast levels diminish in a uniform logarithmic fashion in steps of 0.15 log units for contrast levels 3 through 8 and 0.17 log units for steps through 3. The contrast change between the sample patch and level 1 is 0.3 log units. Contrast sensitivity was measured under mesopic conditions with binocular vision and recorded in a form. Pupil diameter was kept 3-6 mm. In the next stage, VA and contrast sensitivity were measured again using four types of filters including 527 ± 10 , 511 ± 10 , 450 ± 10 , and 550 ± 10 nm filters. The filters were made of CR-39 and were provided by Eschenbach Company.

The luminous efficiency function describes the average spectral sensitivity of human visual perception of brightness. It is based on subjective judgments in which a pair of different-colored lights is brighter to describe relative sensitivity to lights of different wavelengths. It should not be considered perfectly accurate in every case, but is a very good representation of visual sensitivity of the human eye, and valuable as a baseline for experimental purposes.^[12] It is necessary to note that all four filters were tested one by one, and the patient responses were recorded for all four conditions. The rows of high spatial frequency are not visible for patients with low vision. Therefore our patients were not questioned about them. Only the upper two rows that test spatial frequencies of 3 and 6 cycles/degree were evaluated in our study. All patients were examined using all four types of filters. The filter that had the best result was given to the patients, and then they were asked to wear them in three conditions: at home, outdoor, and while watching TV. They were asked to come back to the clinic after 2 days, at the time which patient satisfaction in these three conditions was assessed.

Quantitative variables were presented as mean \pm standard deviation. Normally distributed variables were analyzed using paired sample *t*-test and non-normal variables were analyzed using Wilcoxon test. *P* values <0.05 were considered as statistically significant. Statistical analyses were performed by Statistical Package for the Social Sciences (SPSS software 17.0 for Windows, SPSS Inc. Chicago, IL, USA).

RESULTS

In the present study, 51 patients including 20 (39%) male and 31 (61%) female subjects with mean age of

57.35 years were included. There was a statistically significant improvement in VA using the 527 ± 10 nm filter ($P = 0.01$), but no evident improvement in VA was reported using other tinted filters [Table 1].

With the 527 ± 10 and 511 ± 10 nm filters, contrast sensitivity improved at spatial frequencies of 3 and 6 cycles/degree [Table 2]. However, no change was observed using the 450 ± 10 and 550 ± 10 nm filters.

69% of patients were satisfied or very satisfied with their vision after using their tinted filters indoors on the other hand 31% of patients reported that the tinted filters had no effect or even had worsened their problem. Overall, 78% of patients were satisfied and 22% of them were not satisfied with their vision using tinted filters outdoors. were not satisfied with their vision using tinted filters outdoors. In 49% of individuals, better vision was reported subjectively when watching TV, but the remaining 51% were not satisfied with using tinted filters while watching TV and there was not significant difference between these two conditions.

DISCUSSION

Our results showed that the 527 ± 10 nm filter could significantly improve VA by 0.015 LogMAR in patients with low vision due to diabetic retinopathy. However, the other three filters had no effect on VA. Therefore this filter can be used as a visual assistive device. Our results are in line with those reported by Rosenblum et al^[8] who studied the effect of yellow tinted filters on VA in low- vision patients. They demonstrated that all patients with congenital macular dystrophy showed an 11% improvement in vision quality by

orange filters. In another study, Langagergaard et al^[9] reported that contrast sensitivity in patients with macular degeneration showed slight improvement with use of a 527 ± 10 nm filter. However, no information about the color of filters was presented. Leat et al^[13] concluded that the effect of tinted lenses on patients with diabetic retinopathy is less than people with other causes of low vision, the results of that study about patients with diabetic retinopathy was consistent with our study. In a similar study by Mahjoob^[14] the author used yellow and red filters, but in our study the filter we employed was yellow (450 ± 10 nm filter) and had no effect on VA. Mahjoob concluded that tinted filters had no effect on VA, but the results of the present study showed that the 527 ± 10 nm filter was effective. In the current study, the effects of 511 ± 10 and 527 ± 10 nm filters on contrast sensitivity were significant, and hence it is possible to use these two filters for visual improvement in patients with low vision due to diabetes as a visual assistive device. Our results also indicate that a considerable number of patients were satisfied with their vision after using these filters, which is consistent with the results of Morrissette et al,^[15] and Nguyen and Hoeft.^[16] In the study Nguyen and Hoeft, diabetic persons preferred the 511 ± 10 nm filter over other filters, and in Morrissette et al's report, the 550 ± 10 nm filter was the only filter used. The results of our study show that VA and contrast sensitivity improved significantly with the 527 ± 10 nm filter, and contrast sensitivity also improved significantly with the 511 ± 10 nm filter. These effects may be due to the ability of filters in preventing diffusion of light.

Patient satisfaction with their vision was considerably higher using the filters indoors and outdoors. However, satisfaction with their use watching TV was equivocal. Further investigations are necessary to assess the effect of these types of filters on quantity and quality of vision in patients with other causes of low-vision, and further studies are suggested in order to find better devices for rehabilitation of low-vision patients.

In summary, the results of our study indicate that colored filters are able to contribute substantially to rehabilitation of low-vision patients due to diabetic retinopathy. The 527 ± 10 nm filter was effective in improving visual performance of patients with low vision due to diabetic retinopathy and can be used as a visual assistive device.

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Table 1. Mean and standard deviation of visual acuity using different filters

Filters (nm)	Mean±SD	P
450	0.699±0.2035	1
511	0.655±0.2033	0.063
527	0.630±0.2216	0.01
550	0.675±0.2072	0.157

nm, nanometre; SD, standard deviation

Table 2. Mean and standard deviation for contrast sensitivity using different filters

Filters (nm)	Frequency A		Frequency B	
	Mean±SD	P	Mean±SD	P
Without filter	1.21±0.23	-	1.17±0.26	-
450	1.21±0.23	1	1.175±0.225	1
511	1.27±0.265	0.01	1.27±0.31	<0.0005
527	1.37±0.25	0.0005	1.36±0.27	<0.0005
550	1.21±0.227	0.317	1.17±0.26	1

nm, nanometre; SD, standard deviation; Frequencies A, spatial frequencies of 3 cycle/degree; Frequencies B, spatial frequencies of 6 cycle/degree

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CONCLUSION

Filter 527 nm is effective on improving the visual performance of patients with low vision due to diabetic retinopathy and can be used as a visual assistive device.

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Nil.

Conflicts of Interest

There are no conflicts of interest.

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