Evaluating Reading Performance in Different Preferred Retinal Loci in Persian-Speaking Patients with Age-Related Macular Degeneration

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Abstract

Purpose: To evaluate reading performance in different preferred retinal loci (PRLs) using a Persian version of a Minnesota Low Vision Reading (MNREAD) chart in Persian-speaking patients with age-related macular degeneration (AMD).

Methods: In this cross-sectional study, 35 patients with AMD were assessed. The reading performance was investigated by the MNREAD chart without using low vision aids. The location of PRL was determined monocularly using an MP1 microperimeter (Nidek Technologies, Padua, Italy). The anatomical location of the fovea was determined using optical coherence tomography (OCT). Images were taken with the MP1 microperimeter, and Spectralis HRA-OCT device was processed using graphic software to determine the location of the PRL on the retina.

Results: Thirty-five patients (51 eyes) with a mean age of 73.8 ± 7.7 years (range, 54–88 years) were assessed. Mean best corrected distance visual acuity (logMAR) was 0.65 ± 0.35 (range, 0.2–1.3). Mean levels of reading acuity (RA) ($P = 0.009$) and critical print size (CPS) ($P = 0.015$) were significantly different in different locations of PRL. Average scores of maximum reading speed (MRS) ($P = 0.058$) and reading accessibility index (ACC) ($P = 0.058$) were not statistically significant in different locations of PRL. There was a positive correlation between PRL-fovea distance and RA ($P < 0.001$, $r = 0.591$) and CPS ($P < 0.001$, $r = 0.614$). Significant negative correlations were observed between PRL-fovea distance and MRS ($P < 0.001$, $r = -0.519$) and ACC ($P < 0.001$, $r = -0.545$).

Conclusions: This study provides evidence for differences in the reading performance of Persian-speaking patients with AMD in different PRL locations. The average scores of all reading indices obtained in the right-field PRL are lower than those in other areas and are highly correlated with the PRL-fovea distance.

Keywords: Age-related macular degeneration, Microperimetry, Minnesota low vision reading chart, Preferred retinal locus, Reading characteristics

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INTRODUCTION

Age-related macular degeneration (AMD) is the most common cause of vision impairment in the elderly population, the prevalence of which increases with age.[1] Despite available treatments, the disease progression results in central scotoma.[2] Patients use para-central areas of the retina to compensate for lost vision and try to minimize the effect of reduced macular vision.[3] This non-central area is called the preferred retinal locus (PRL).[4,5] Decreased central vision

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severely affects daily living activities such as reading, facial recognition, and driving.[6,7] Reading difficulties are the most common complaint of these patients.[8-10] Problems such as driving, near activities, facial recognition, writing, and watching television are the next priorities.[8]

Reading is a complex phenomenon, including multiple psychophysical and cognitive mechanisms.[11] Reading speed also depends on factors such as visual span, accumulator control, and visual acuity.[12,13] The visual span is the number of adjacent letters that can be seen at a glance during fixation without eye movements. In normal subjects with normal reading speeds, the visual span is between 7 and 11 characters.[14-16] The weakness of oculomotor control reduced visual span, and reduced visual acuity are exacerbated by the increased eccentricity of the fovea.[9,17] Central scotoma is often a consequence of AMD and causes reading difficulty.[18,19] Therefore, reading performance metrics decrease in patients with AMD. As a result, the reading indices in different locations of PRLs may also vary.[20-22] In Persian-speaking patients who read from right to left, if the scotoma is on the left or bottom of the field of vision, it can block letters in front of the reader. Therefore, PRL locations can play an important role in reading skills.[23] Currently, eccentric viewing training is used in the rehabilitation of such patients.[19,24-31] Therefore, it is very important to select an appropriate area on the retina for training. Since there is not any research on reading indices in Persian-speaking patients, as a consequence, the findings of this study may be used to select an appropriate location in the retina for training.

METHODS

This cross-sectional study, which was conducted from July 2019 to March 2020, involved thirty-five volunteers. The statistical population consisted of patients with AMD, who referred to the ophthalmology Clinic of Rassoul Akram Hospital in Tehran, Iran. Inclusion criteria were Persian-speaking patients with AMD having a best corrected distance visual acuity between (0.2 logMAR) and (1.3 logMAR) in the examined eye without other retinal and optic nerve diseases. Excluded patients were those uncooperative for clinical and paraclinical examinations, those with a history of head trauma or cerebral disease-causing scotoma, patients with myopia >6 diopter, and illiterate patients.

Patients over 50 years of age with progressive vision loss and clinical signs of AMD,[30] including medium-large drusen, retinal pigment epithelium changes, retinal pigment epithelium atrophy, and choroidal neovascularization, whose disease was confirmed by a retinal specialist were included in the study.

Full eye examinations, including measurements of refraction and the best corrected distance visual acuity, slit-lamp biomicroscopy, and fundoscopy were performed by attending optometrists and retinal specialists. All patients were assessed for cognitive status using the Mini-mental state examination.[32] Patients with a score of at least 23 were included in the study. Reading indices were measured using the Persian version of the Minnesota Low Vision Reading (MNREAD) chart.[33] Since the MNREAD test was performed at a distance of 40 cm, reading glasses were prescribed for use at this distance. No vision aid was used. PRL location and fixation characteristics were evaluated using an MP1 microprimeter (Nidek Technologies, NAVIS software, version 1.4.1, Padua, Italy). The six anatomical foveal positions of the retina were determined with the infrared optical coherence tomography (OCT) imaging by the Spectralis HRA-OCT device (Heidelberg Engineering, Heidelberg, Germany). To determine the PRL location, the Early Treatment Diabetic Retinopathy Study (ETDRS) grid was located at the center of the fovea.

Reading acuity (RA), maximum reading speed (MRS), critical print size (CPS), and reading accessibility index (ACC) were assessed. The right and left eyes of patients were evaluated with version 1 and version 2, respectively. It was placed within 40 cm of the patient. If the patient was unable to read the words at this distance, the chart was placed at closer distances, and near glasses were corrected for the desired interval. The patient was asked to read the sentences audibly. Reading started above the chart or a few lines above the patient's visual acuity. Words that were misread or lost by the patient were marked on the score sheet. Patients continued reading until they could not read a single word of a sentence. Moreover, if they could not read the words, they were encouraged to guess them. Then the RA (the smallest print that can just be read) was calculated using a formula (RA = 1.4 − [sentences read × 0.1] + [number of words read incorrectly × 0.01]). When the chart was used at a distance other than 40 cm, the RA was considered to be adjusted using a table to account for this value for the viewing distance used.[34]

MRS (the reading speed when performance is not limited by print size) was evaluated with RA. A white card was used to cover the lower part of the chart so that the patient could not see the lower sentence while reading it. To check the reading speed, the chart was positioned at a distance of 40 cm from the patient, who was asked to read the sentences as loudly and as accurately as possible, and the time taken to read each sentence, as well as words that the patient missed or read wrongly, was measured using a stopwatch and recorded on the score sheet. Reading speed was expressed in terms of words per minute (wpm).[34] The reading speed was calculated using a formula (reading speed = 600/time in seconds). The words that were lost or misread were also taken into account, and reading speed was adjusted using another formula (reading speed = 60 × [10 − error]/time in seconds). The reading speed with print larger than the CPS was considered the MRS. This is the reading speed that can be achieved by the patient when print size is not a limiting factor.

The CPS (the smallest print size at which patients can read with their MRS) was determined for each eye using the reading curve, which was plotted by Microsoft Excel software 2016

version 16.0 (Microsoft Corporation, US). The starting point of the graph slope is considered the CPS.[34] The ACC represents an individual's access to text across the range of print sizes found in everyday life. To determine the ACC, the average reading speed in larger print sizes on the MNREAD chart (0.3–1.3 logMAR) was divided by 200.[35]

Microperimetry was performed in all patients through a dilated pupil via a 4–2 threshold strategy and central 10° pattern using an automated program. The contralateral eye was patched during the test. Forty stimuli were presented on the fundus in about 200 ms against a dim white background with the luminance of 1.27 cd/m^2 (=4 apostilb or asb). The size of the stimulus was Goldmann III (4 mm^2). A 3° single cross fixation target was also used for all eyes. Larger sizes or other targets (e.g., four crosses) were used if the patient was not able to see the 3° cross fixation target. The image processing technique was described in another paper.[36] Briefly, the images taken with the Microperimeter and OCT instruments and the ETDRS grid were processed using AutoCAD 2018 software version 28.0 (Autodesk Inc., US), ImageJ, and Photoshop CC 2019 software version 20.0 (Adobe Inc., US) to determine precisely the PRL position [Figure 1]. The macula is divided into five fields, including central, inferior, superior, nasal, and temporal, using the ETDRS grid (6 × 6 mm). PRL location in the visual field was reported as central, left-field, right-field, superior-field, and inferior-field. The central PRL is the PRL that is located inside the central ring of the EDTRS grid (with a diameter of 1 mm or 3.3°). If the size of the central scotoma is <3.3°, the PRL will be placed inside the central ring of the EDTRS grid, in which case it will be called the central PRL, while those located outside the central ring were reported as left-field, right-field, superior-field, and inferior-field.
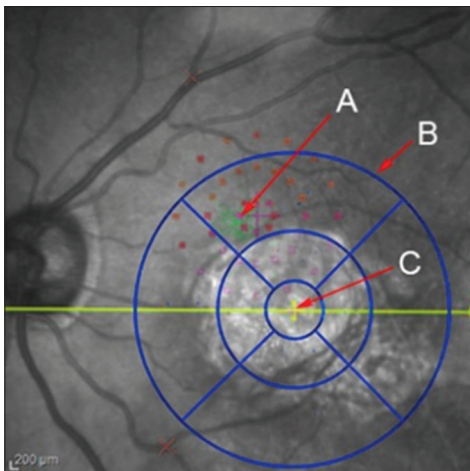

Figure 1: The left eye of a patient with neovascular age-related macular degeneration (A) preferred retinal locus (PRL) (B) Early Treatment Diabetic Retinopathy Study (ETDRS) grid (C) anatomical fovea. PRL is located in zone 6 of ETDRS grid in the superior quadrant, corresponding to the inferior quadrant of the visual field. PRL was considered inferior-field in the visual field. PRL-fovea distance was 2.36 mm (7.8°)

Data analysis
Data were analyzed using SPSS software version 26 (IBM, Chicago, IL, USA) at a significance level of 0.05. Tables, graphs, mean, and standard deviation were used to describe the data. A one-way analysis of covariance was conducted to compare the mean values of the reading metrics in different locations of PRL while controlling for educational level. Levene's test and normality checks were carried out, and the assumptions met. Scheffé's method was used for pairwise comparisons. Pearson correlation test was used to investigate the correlation between PRL-fovea distance and RA, MRS, CPS, and ACC.

Ethical issues
The Ethics Committee of Iran University of Medical Sciences approved the study protocol (Ethics approval: IR.IUMS.REC.1397.1257). The study adhered to the tenets of the Declaration of Helsinki. All participants signed written informed consent.

RESULTS
Of 51 eyes from 35 AMD patients (26 males and 9 females), 60.8% (31 eyes) were better (dominant), and 39.2% (20 eyes) were worse (non-dominant). Furthermore, 35.3% (18 eyes) and 64.7% (33 eyes) had dry and neovascular AMD, respectively. The mean age of the patients was 73.8 ± 7.7 years (range, 54–88 years). Mean distance corrected visual acuity (logMAR) was 0.65 ± 0.35 (range, 0.2–1.3). The refractive error ranged from −4.00 to +4.25 D. Out of 35 patients in this study, 13.7% had a bachelor's degree and above, followed by 3.9% associate, 17.6% diploma, and 51% high school degrees, with 13.7% capable of reading and writing.

In Persian-speaking patients with AMD, inferior-field, left-field, central-field, right-field, and superior-field PRL were detected in 49%, 33.3%, 7.8%, 5.9%, and 3.9% of the participants, respectively. Most of the PRLs were inferior-field, and superior-field PRLs were in the minority. Furthermore, the mean values for RA, MRS, CPS, and ACC in 35 patients (51 eyes) were 0.69 logMAR, 70.6 wpm, 0.78 logMAR, and 0.23, respectively.

There was a significant difference in the mean RA score between different locations of PRL ($P = 0.009$). *Post hoc* tests showed there was a significant difference in mean RA score between central and the right field ($P = 0.001$), between central and the left-field PRLs ($P = 0.041$), between the right-field and superior-field PRLs ($P = 0.015$), between the right-field and inferior-field PRLs ($P = 0.002$), and between the right-field and left-field PRLs ($P = 0.016$). Comparing the estimated marginal means showed that the best (0.44 logMAR) and the worst (1.13 logMAR) mean RA levels were in subjects with central and right-field PRLs, respectively.

There was a non-significant difference in mean MRS score between different locations of PRL ($P = 0.058$). *Post hoc* tests showed there was a significant difference in mean

MRS between central and the right-field PRLs ($P = 0.028$), between the right-field and inferior-field PRLs ($P = 0.011$), between the right-field and left-field PRLs ($P = 0.006$), and between the right-field and superior-field PRLs ($P = 0.011$). Comparing the estimated marginal means showed that maximum (119 wpm) and minimum (29.3 wpm) reading speed belong to those with superior-field and right-field PRLs, respectively.

There was a significant difference in the mean CPS score between different locations of PRL ($P = 0.015$). *Post hoc* tests showed there was a significant difference in mean CPS between central and the right-field PRLs ($P = 0.001$), between central and the inferior-field PRLs ($P = 0.037$), between central and the left-field PRLs ($P = 0.008$), and between the right-field and inferior-field PRLs ($P = 0.017$). Comparing the estimated marginal means showed that the best (0.42 logMAR) and the worst (1.13 logMAR) CPS were recorded in those with central and right-field PRLs.

There was a non-significant difference in mean ACC between different locations of PRL ($P = 0.058$). *Post hoc* tests showed there was a significant difference in mean ACC between central and right-field PRLs ($P = 0.006$), between the right-field and superior-field PRLs ($P = 0.028$), between the right-field and inferior-field PRLs ($P = 0.008$), and between the right-field and left-field PRLs ($P = 0.01$). Comparing the estimated marginal means showed that the highest (0.37) and the lowest (0.04) ACC were found in superior-field and right-field PRLs, respectively.

The mean and standard deviation of reading indices are shown in Table 1, and the mean differences and *P* values are shown in Table 2.

Table 3 and Figures 2-5 illustrate that the highest and the lowest correlations were observed between the PRL-fovea distance and CPS, and between the PRL-fovea distance and MRS, respectively. There was a positive correlation between the PRL-fovea distance and RA and between the PRL-fovea distance and CPS. Significant negative correlations were observed between the PRL-fovea distance and MRS, and between the PRL-fovea distance and ACC. Pearson correlation coefficients and *P* values are reported separately in Table 3.

DISCUSSION

Reading ability is an important component of vision function. Reading is a widely expressed goal of patients with vision loss. One of the standard charts to assess the reading performance metrics is the MNREAD chart. Its curve of reading speed versus print size has a typical shape for normally-sighted persons and many low-vision individuals. This curve is characterized by 3 summary values. At large print sizes, reading speed remains fairly constant, forming a plateau that represents the MRS. As the print size decreases, a CPS is reached, at which reading speed begins to decline rapidly. Finally, the smallest print size that can be read is defined as the RA. The results of this study showed that the location of PRL has an impact on reading performance.

One question about reading performance is whether reading indices differ between English-speaking and Persian-speaking people. Therefore, comparing reading indices can be somewhat helpful. The obtained mean values for the RA, MRS, CPS, and ACC were 0.69 logMAR, 70.6 wpm, 0.78 logMAR, and 0.23, respectively. In a similar study,[22] Altinbay *et al.* evaluated reading performance in patients with AMD and mean visual acuity value of 0.58
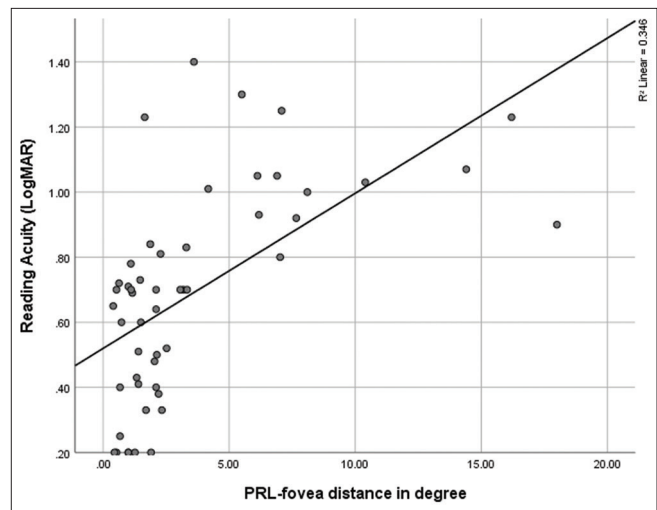

Figure 2: Correlation between the preferred retinal locus-fovea distance and reading acuity in Persian-speaking patients with age-related macular degeneration

Table 1: Comparison of reading acuity, maximum reading speed, critical print size, and reading accessibility index in different preferred retinal loci in Persian-speaking patients with age-related macular degeneration

Location of PRL in the visual field	Mean±SD			
	RA (logMAR)	MRS (wpm)	CPS (logMAR)	ACC
Central	0.44±0.27	73.3±34.9	0.42±0.19	0.30±0.19
Superior-field	0.45±0.35	119±48.1	0.72±0.32	0.37±0.22
Right-field	1.13±0.17	29.3±23.1	1.13±0.12	0.04±0.05
Inferior-field	0.65±0.29	67.5±37.7	0.75±0.29	0.22±0.16
Left-field	0.75±0.32	76.2±51.6	0.85±0.31	0.23±0.20

RA: Reading acuity, MRS: Maximum reading speed, CPS: Critical print size, ACC: Reading accessibility index, PRL: Preferred retinal locus, SD: Standard deviation

Table 2: Pairwise comparisons of mean reading acuity, maximum reading speed, critical print size, and reading accessibility index in different preferred retinal loci in Persian-speaking patients with age-related macular degeneration

PRL (I)	PRL (J)	RA (logMAR)		MRS (wpm)		CPS (logMAR)		ACC	
		MD (I-J)	*P*	MD (I-J)	*P*	MD (I-J)	*P*	MD (I-J)	*P*
Central	Superior	−0.12	0.614	−22.5	0.425	−0.38	0.131	0.02	0.864
	Right	−0.75*	0.001	55.5*	0.028	−0.75*	0.001	0.31*	0.006
	Inferior	−0.20	0.172	3.40	0.842	−0.32*	0.037	0.07	0.347
	Left	−0.32*	0.041	−2.30	0.897	−0.43*	0.008	0.08	0.334
Superior-field	Central	0.12	0.614	22.5	0.425	0.38	0.131	−0.02	0.864
	Right	−0.63*	0.015	78.0*	0.011	−0.37	0.151	0.28*	0.028
	Inferior	−0.08	0.685	25.9	0.283	0.05	0.807	0.05	0.631
	Left	−0.20	0.343	20.2	0.408	−0.06	0.788	0.05	0.607
Right-field	Central	0.75*	0.001	−55.6*	0.028	0.75*	0.001	−0.31*	0.006
	Superior	0.63*	0.015	−78.0*	0.011	0.37	0.151	−0.28*	0.028
	Inferior	0.54*	0.002	−52.1*	0.011	0.42*	0.017	−0.23*	0.008
	Left-	0.43*	0.016	−57.9*	0.006	0.32	0.078	−0.23*	0.010
Inferior-field	Central	0.20	0.172	−3.40	0.842	0.32*	0.037	−0.07	0.347
	Superior	0.08	0.685	−25.9	0.283	−0.05	0.807	−0.05	0.631
	Right	−0.54*	0.002	52.1*	0.011	−0.42*	0.017	0.23*	0.008
	Inferior	−0.11	0.189	−5.70	0.571	−0.11	0.224	0.00	0.922
Left-field	Central	0.32*	0.041	2.30	0.897	0.43*	0.008	−0.08	0.334
	Superior	0.20	0.343	−20.2	0.408	0.06	0.788	−0.05	0.607
	Right	−0.43*	0.016	57.9*	0.006	−0.32	0.078	0.23*	0.010
	Inferior	0.11	0.189	5.70	0.571	0.11	0.224	0.00	0.922

*Statistically significant. RA: Reading acuity, MRS: Maximum reading speed, CPS: Critical print size, ACC: Reading accessibility index, PRL: Preferred retinal locus in the visual field, MD: Mean difference

Table 3: Correlation between the preferred retinal locus-fovea distance and reading characteristics in Persian-speaking patients with age-related macular degeneration

PRL to fovea distance	RA	MRS	CPS	ACC
Pearson correlation	0.59	−0.52	0.61	−0.54
P	<0.001	<0.001	<0.001	<0.001

RA: Reading acuity, MRS: Maximum reading speed, CPS: Critical print size, ACC: Reading accessibility index, PRL: Preferred retinal locus

logMAR. Their results indicated that average scores on RA, MRS, and CPS were 0.47 logMAR, 37.7 wpm, and 0.56 logMAR, respectively. The ACC, however, was not assessed in this study. This is because such an index has been added to the MNREAD chart in recent years.[35] Altinbay *et al.*[22] evaluated reading performance with the Turkish version of the MNREAD chart and reported a lower MRS and a higher RA and CPS in comparison to those in the present work. One possible reason behind these differing results could be the use of low vision aids these researchers[22] used to assess the reading performance (Telescopic glasses with both Kepler and Galileo systems). Although an increased RA and CPS were reported in their work, the MRS reduced based on limitations in the visual field. In another study,[37] the calculated value of the mean reading speed of patients with AMD and a mean visual acuity of 0.93 logMAR was 73 wpm, similar to the findings of our work. Cacho *et al.*[37] tested near RA using the Bailey-Lovie Word Reading Chart. Therefore, the
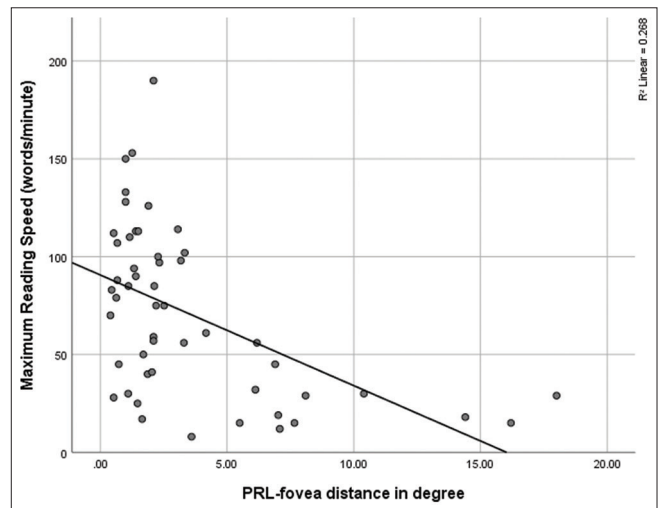

Figure 3: Correlation between the preferred retinal locus-fovea distance and maximum reading speed in Persian-speaking patients with age-related macular degeneration

Bailey-Lovie Word Reading and the MNREAD charts can be used interchangeably to assess reading performance in visually impaired patients.[38,39] In the study by Fletcher *et al.*,[21] the value of mean MRS in patients with AMD and a mean visual acuity of 0.97 logMAR was 112 wpm. Although the mean visual acuity in the Fletcher study[21] was lower than the average visual acuity of the participants in the present study, the mean MRS was higher in their study. One explanation for this difference could be that our study included patients from
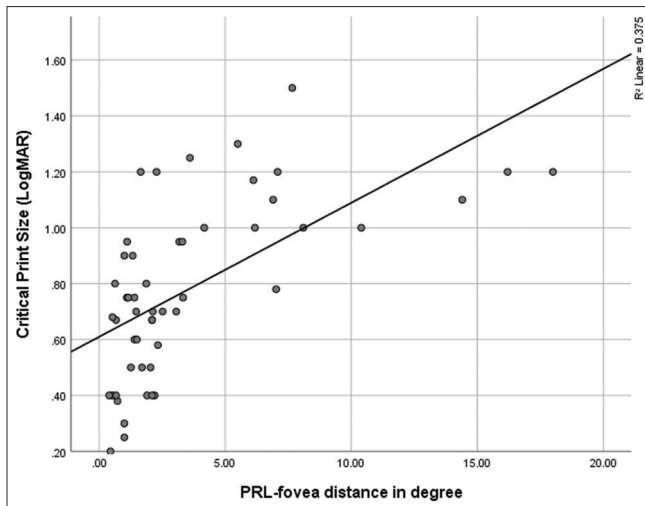
Figure 4: Correlation between the preferred retinal locus-fovea distance and critical print size in Persian-speaking patients with age-related macular degeneration

Figure 5: Correlation between the preferred retinal locus-fovea distance and reading accessibility index in Persian-speaking patients with age-related macular degeneration

different educational backgrounds. The educational level, as a confounding factor, can influence the results of the study.[40-44]

Our findings showed that mean RA was significantly different for all of the various locations of PRL. In cases of the central and right-field PRLs, the best and the worst mean scores were observed, respectively. Furthermore, pairwise comparisons of five PRL locations showed that there is a significant difference between the right visual field area and the central, left, superior, and inferior areas. In this respect, the results of our study are consistent with that of Fletcher *et al*.[21] In their study, mean RA was worse at the right-field PRL than at other retinal locations. This difference is either due to the better performance of the central, left, superior, and inferior areas than the right visual field or because of the reading difficulty in right-field PRL. The retinal sensitivity was higher in the right visual field than in other areas,[36] but the RA in the right visual field was significantly worse. It seems that individuals with macular degeneration try to place the scotoma in an area of the visual field that improves their visual function. In other words, the position of the PRL may be determined voluntarily by the individual. From the above explanations, it can be concluded that points that are located on the left or inferior of the visual field need to be selected when doing the eccentric viewing training[25,45] to improve the RA of patients.

Based on the results of the study, the pairwise comparisons showed that the mean MRS at the right area of the visual field is significantly lower from that in the central, left, superior, and inferior fields. This revealed differences between our results and those of similar studies conducted on English-speaking patients with AMD[21,46] as the PRL position in these studies failed to affect reading speed. Vertical PRLs show positive effects on both Persian and English speakers since letters are not blocked by the scotoma through reading. The inferior-field PRL, however, reveals more influence on reading than the superior-field PRL as the scotoma in a reader
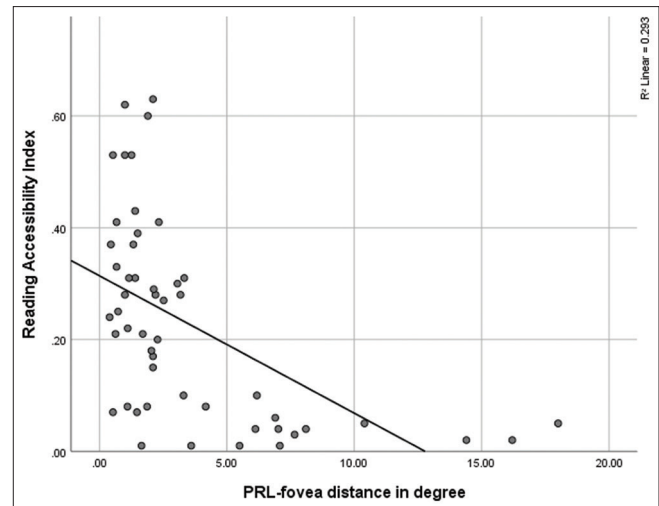
with the inferior-field PRL is above the line, and the person is more attentive to the words at the bottom of the line. The results of our study showed that reading speed in patients with left-field PRL was significantly higher than in those of right-field PRL (76.24 vs. 29.33 wpm). The effect of horizontal PRLs on reading performance appeared different in English and Persian speakers. In Persian, left-field PRL is preferable to right-field PRL, whereas the opposite is true for English speakers. It is therefore recommended not to use points in the right area of the visual field during vision training[28,31] despite greater visual acuity and sensitivity. Among other areas, it is advisable to consider a point that is closer to the center of the visual field. Functionally, according to the description, the preferred locations are the left and lower regions of the visual field.

The results showed that the mean CPS was significantly different at various PRL locations. Our findings are consistent with that of the study by Fletcher *et al*.[21] When reading speed is worse in the right area of the visual field than in other areas, the CPS is expected to be worse in this area. This finding is justified in Persian-speaking people who read from right to left because in these individuals if the scotoma is on the left side of the visual field, the reading speed and then the CPS will be worse. However, it is not possible to justify the worsening of the CPS in the right area of the visual field in English-speaking people with the above explanations. The CPS is used to prescribe magnifiers and other visual aids. This is an important measure because in prescribing magnifiers and other visual aids, devices with the minimum magnification are recommended to avoid confining the patient's visual field and for effortless reading.[47] The present study results suggest the use of points in the visual field for eccentric viewing training[27,29] due to the presence of the best CPS. Also, points in the left or inferior area of the visual field should be as close as possible to the center of the visual field to improve the CPS.

Calabrèse *et al.*[35] introduced the ACC in 2017. In comparison to three main indices, this index should be evaluated to fully evaluate reading performance. Based on the pairwise comparisons, the highest difference was found between the superior-field PRL (0.37) and right-field PRL (0.04). The mean ACC in the right visual field area was lower than the central, superior, inferior, and left areas of the visual field. Despite the general use of magnifiers and other visual aids to enhance the accessibility of visually impaired patients to small texts, our study investigated the reading performance metrics without the use of low vision aids. As mentioned in our findings, the RA and the MRS of Persian-speaking patients with AMD were worse in the right visual field area than the other four areas. On the other hand, with enhanced reading speed and RA, improved ACC was observed. Thus, improving reading accessibility and consequently, reading performance are necessary for patients who have not naturally chosen a suitable point for reading. Furthermore, for eccentric viewing training,[24,29] selecting points in the inferior or left areas of the visual field that are as close as possible to the center of vision is recommended.

A high correlation was observed between reading indices and PRL-fovea distance. Increasing distance between PRL and fovea resulted in a worse outcome for all indices, including RA, MRS, CPS, and ACC. This implies that the closest point to fovea always is the best choice for the trained retinal locus (TRL)[9,31] regardless of the PRL location. Because in the right area of the visual field, all reading indices are lower than in other areas of the visual field. It is presumed that increasing the distance between PRL and fovea in this area will have a greater impact on reading indices. However, our findings do not provide a solid basis for this claim, and further studies are needed to prove it.

Some limitations of this study are acknowledged. First, the sample size was small in different subgroups of PRLs, and a larger sample size is needed for a more accurate evaluation of reading performance. Second, the results of the present work might be influenced by the educational level of patients. Participants in this study had lower educational attainment than the population with AMD. Furthermore, it was assumed that the AMD patients used was the same PRL in the MNREAD test and microperimetry, while the patients may use different PRLs in these two cases. With this in mind, it is worth using a method that can determine the PRL location to read.

In conclusion, this study provides evidence for differences in the reading performance of Persian-speaking patients with AMD in different PRL locations. The mean scores of all reading indices obtained in the right-field PRL are lower than those in other areas and are highly correlated with the PRL-fovea distance. These findings could be helpful in selecting the TRL. The inferior and left quadrants of the visual field are predicted to be more suitable for the TRL to improve reading performance. More work is needed in future to prove this assertion.

Conflicts of interest

There are no conflicts of interest.

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