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Suitable Low Vision Device to Enhance the Reading Speed in Dry Age-Related Macular Degeneration

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Abstract:-

- ***Aim:***

This study aims at finding an effective optical low vision device for near, which will enhance the reading speed in patients with dry ARMD.

- ***Objectives:***

To suggest the most suitable optical low vision device for near at reading.

- ***Methods:***

43 patients with dry ARMD were taken with detailed history taken. BCVA done for distance with Log MAR and for near with Bailey Lovie chart. Calculation for magnification done for near. After LVDs trial done for near the MN read chart was given to the patient to read the chart with each given devices (Stand, Hand-held, Bar, Dome and Spectacle magnifiers) for reading and the time taken to read the chart was noted. The reading speed was calculated as a words per minute (WPM). Reading acuity and critical print size were also calculated with each device.

- ***Results:***

The mean magnification for all the five magnifiers (Stand, Hand-held, Bar, Dome and Spectacle magnifiers) was 3.2±0.79. The maximum reading speed in wpm was found with Hand-Held magnifier (127.33 ± 43.25) whereas minimum reading speed was with bar magnifier (89.07 ± 51.46). All these patient (N=43) had a best corrected visual acuity between 0.48 to 1 log MAR in the better seeing eye.

- ***Conclusion:***

All magnifiers shows the better and functional reading speed in all the Dry ARMD patients taken. Although the average reading speed was high with hand-held magnifier. So, we can conclude that every magnifiers are equally better in case of reading speed and any of them can be suggested to these patients depending upon their comfortability.

Key word:- *Reading Speed, Low Vision Device, Dry ARMD, Magnifier, Visual Impairment, Quality of Life*

I. INTRODUCTION

Age-related macular degeneration (ARMD) is one of the leading cause for loss of vision in people above 50 years of age. It causes damage to macula, a part of retina, which is responsible for the central and colour vision and can leads to a loss of central and detailed vision that results in difficulty with tasks such as driving, recognizing faces and also in reading and writing. Globally, there are 246 million people with low vision and ARMD is found to be one of the leading cause of low vision. With the prevalence of 8.7%, it is the third most common cause of blindness worldwide. In India the prevalence of ARMD ranges from 1.8% to 4.7%. In developed countries the incidence and prevalence of ARMD is already high and are likely to be increase dramatically by 50% because of increase in the aging population. [1, 2] Low vision rehabilitation is one of the best option for such condition, when medical, surgical or other conventional treatment are unsuccessful or contradicted. Near related task especially difficulty in reading and writing is a common reason for an individual with low vision to seek rehabilitation services. [3, 4]

II. LITERATURE REVIEW

High-acuity centre vision is usually required for reading and in a condition like ARMD where the central vision is affected the reading becomes difficult. [5, 6] A prescription for a reading aid in low vision might be guided by a reading ability evaluation.[8, 10] Specialised reading tests can be used to measure reading in detail. The reading of many passages with a variety of print sizes, reading accuracy, reading time, reading errors, or reading comprehension is required for these assessments. The threshold print size for which letters may be recognised and corrected for the total number of errors made during the test is called letter acuity (LA). The minimum print size required for word recognition is called reading acuity (RA). A conventional clinical reading test can typically be used to measure reading acuity. Similar to LA, RA is evaluated based on the shortest written text effort that was also rectified for a number of misspelt words. [12] Although RA and LA differ from one another in a number of ways, they have been proven to have a strong correlation.[7] In both normal vision with dioptric blur and low vision with unharmed central vision, RA has been shown to perform better than LA (lower log Mar values). However, there is evidence that when measured by a chart with continuous text and with unrelated words, RA is comparable to or worse than the LA in ARMD, the visual impairment with central vision loss caused by macular deficiency. [8] These

variations suggested the prospect that RA might serve as a more accurate gauge of how central vision affects reading. Larger print sizes are required to achieve "spot reading" (40 wpm) for short text, like price labels, "fluent reading" (80 wpm) for long text, like newspapers, and maximal reading speed, which varies among individuals. LA and RA determine the smallest print for letter and word recognition. [21] "Critical print size" refers to the print size needed for the fastest possible reading speed. [12, 14] In low vision, RA has been proven to be a more accurate predictor of crucial print size than LA. In a patient with low vision, measuring near visual acuity (VA) just by letter size that can be read is insufficient. Reliable and valid text based reading charts are required to access reading performance in patient with central vision defect like in ARMD. MNREAD chart from Minnesota is a text based chart used to evaluate the reading performance for near. [17] The reading performance of patients can be evaluated by calculating the reading acuity, critical print size and maximum reading speed with these charts. In this study, the evaluation of the reading performance in patient with dry ARMD by MNREAD reading chart and compare the reading speed with different optical devices for low vision has been done. The reading performance is measured by reading speed, critical print size and near visual acuity, which provides an objective evaluation and monitoring in clinical practice. Reading difficulty in patient with low vision can be resolved by providing an appropriate optical low vision devise and rehabilitation. The low vision aids include both optical and non-optical devices, including low optical magnifiers to high video magnifiers. There are various types of low vision devices being used for near. A disorder like ARMD can have effect on the ability to carry out daily living tasks especially for near tasks, which also can profound effects on individual's quality of life. These patients have difficulty in reading and writing, so various optical low vision devices are prescribed to improve their ability to do near tasks and these devices are easily available and also very cost effective. In this study, five low vision devices have been selected such as bar magnifier, stand magnifier, spectacle magnifier, hand held magnifier and dome magnifier.

III. MATERIALS AND METHODS

Total 43 dry ARMD patients (22 male and 21 female) with mild visual impairment (6/60 to 6/18) were taken from the retina OPD. A written informed consent was taken from each participant prior to their enrolment in the study. Details preliminary examination and low vision workup was done which included: demographic data, ocular and systemic, personal and economic history. Duration of vision loss, education/occupation/marital status/dependents/literacy/economic status, difficulty regarding near work or daily living skill etc.

The near vision was checked with the sollen chart under adequate room illumination and over head lamp and calculate the magnification near magnification= BCVA * 100,

TVA DISTANCE

Where, BCVA= Best corrected visual acuity

TVA= Target visual acuity

On the basis of magnification calculated, magnifiers of same value is selected. For this study 5 magnifiers were selected: Dome, stand, Hand-Held, Bar and spectacle magnifier. Handling of the magnifiers were taught to all the patient. Reading speed is now checked using MN read chart with all the 5 Magnifiers separately.

- *Set Up for Checking Reading Speed using MN Read Chart:*

The chart was kept properly so that no shadows or glare can interfere with reading. The intensity of luminance was 100 cd/m2. The MN read chart was kept at standard viewing distance of 40cm from the patient. The range of print sizes was extended to larger values for low vision by testing at a shorter viewing distance. The head rest was advised to be maintain constant for viewing the chart.

- *Testing procedure:*

Each patient was instructed to read the sentence aloud and as quickly as they can without making errors but if the error was made or missed a word then they must continue to read till the end of the sentence and then go back and correct themselves. A stop watch was used to record the time in seconds for each sentence. Patient start reading with the largest sentence and move onto the subsequent sentences in decreasing order and keep going until patient cannot read any words in a sentence. Reading time and errors were recorded on a data sheet. A blank card was used to cover the sentence that is about to read. The sentence is uncovered at the same time as the examiner instructs the patient to start reading. This gives an objective means to determine when the reading process starts

- *Reading Measures:*

- *Calculation of Reading Acuity*

An estimate of reading acuity was given by the smallest print size at which the patient can read the entire sentence without making significant errors After the patient read as much of the chart as possible, the print size (in logMAR) of the smallest sentence that the patient read or attempted to read was noted. The number of reading errors made by the patient (i.e., the number of words that patient skipped over or read incorrectly was counted and reading acuity (in logMAR) was calculated by using the following formula:

Reading acuity = size of smallest sentence read + 0.01 x number of errors

- *Scoring for Non-Standard Viewing Distance:*

If the reading chart was used at a distance other than 40 cm (16 inches), the reading acuity and critical print size need to be adjusted according to the value given in Table1. Example:

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The patient is tested using a 20cm viewing distance and reads (or attempts to read) all the sentences down to the –0.2 logMAR sentence but makes a total of 12 reading errors.

Acuity = –0.2 logMAR + 12 errors × 0.01 + 0.30 logMAR (distance correction from Table 2) = 0.22 logMAR.

- *Calculation of Reading Speed:*

It is calculated by formula,

Reading speed (wpm) = 60 × (10 – errors) / (reading time in seconds)

- *Determining the Critical Print Size:*

The critical print size is the smallest print size at which patients can read with their maximum reading speed.

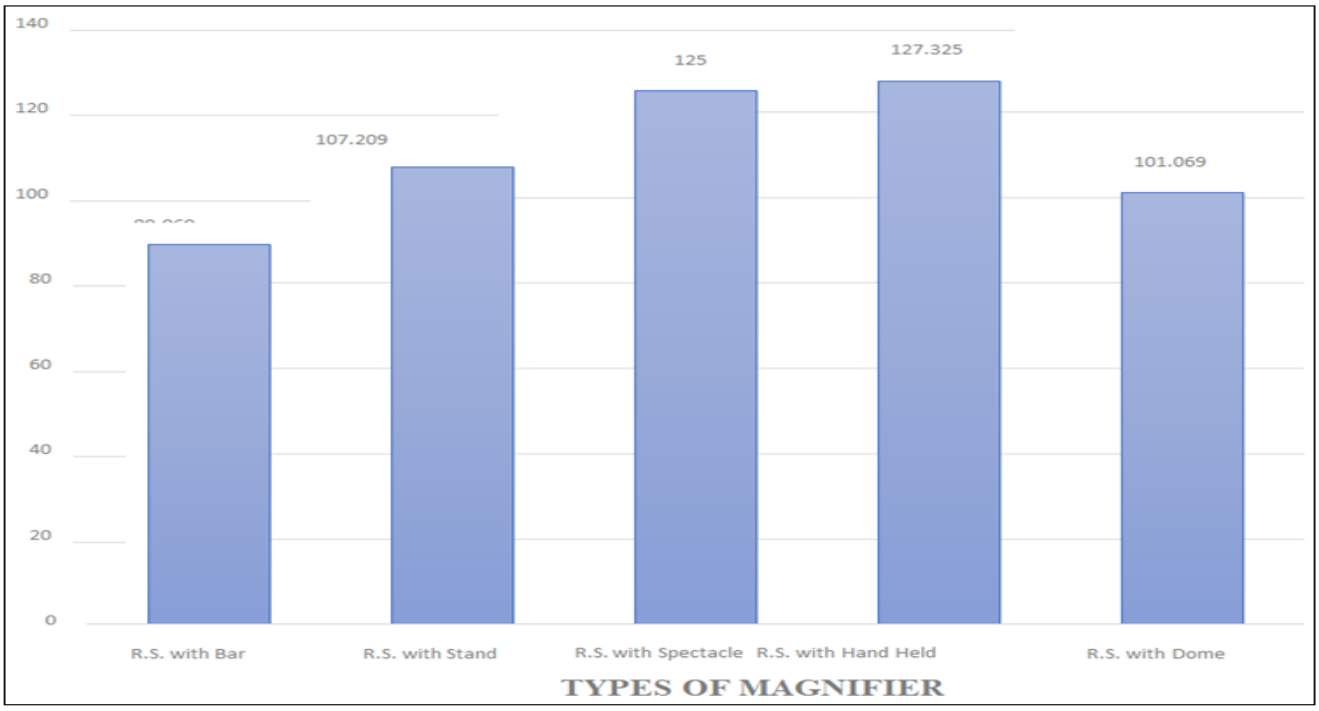
IV. RESULTS/ DATA ANALYSIS

The data was analysed descriptively. Continuous variables were expressed as mean and standard deviation and category data were expressed in percentage. The paired sample t- test was used to compare the differences in different magnifiers. All the analysis was carried out by using the SPSS software version 21.0 and a two-tailed p value <0.005 was considered to be statistically significant.

A total of 43 patients of Dry ARMD were enrolled in this study with mean (±standard deviation) 58.4±6.5 years. Twenty-one were male and twenty-two were female. The mean magnification for all the five magnifiers (Bar, Stand, Hand-Held, Dome and Spectacle magnifiers) was 3.2±0.79.

Table 1 Descriptive Statistics of the Demographic and other Characteristics.

Characteristics	
Age (Mean ± SD)	58.4 ± 6.5
Gender	**(%)**
Male	21 (48.8%)
Female	22 (51.2%)
Magnification (Mean ± SD)	3.2 ± 0.79



Graph 1 Average Reading Speed with Different Types of Magnifiers

Graph 1, shows the average reading speed with different types of magnifiers. Here, the reading speed was found to be highest with the Hand-held magnifier (127 wpm) and lowest with the Bar magnifier (89.069 wpm).

Table 2 Frequency Distribution of Magnification.

Magnification	**Frequency**	**Percent**
2.5	17	39.5
3.0	11	25.6
4.0	12	27.9
5.0	3	7.0
Total	43	100.0

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Table 3 Comparison of One Magnifier with others in RA Group.

Magnifiers (RA)	Magnifiers	Mean ± SD	P value
Spectacle (0.66 ± 0.14)	Bar Stand	0.66 ± 0.14	**0.004**
	Handheld	0.66 ± 0.14	1.000
	Dome	0.65 ± 0.15	0.279
		0.66 ± 0.14	0.176
Bar	Stand Handheld	0.66 ± 0.14	**0.003**
	Dome	0.65 ± 0.15	0.019
		0.66 ± 0.14	0.026
Stand	HandheldDome	0.65 ± 0.15	0.251
		0.66 ± 0.14	0.346
Handheld	Dome	0.66 ± 0.14	0.134

Table 3, shows the comparison of reading acuity between the different magnifiers.

When spectacle magnifier was compared with Bar magnifier the reading acuity was found to be better with spectacle magnifier with significant p value (p= 0.004). When bar magnifier was compared with stand magnifier, stand magnifier was found to have better reading acuity than Bar. P value was found to be significant for this group (p=0.003). Remaining all the magnifiers when compared among one another were found to have similar reading acuity with non-significant p value.

Table 4 Comparison of One Magnifier with others in CPS Group.

Magnifiers (CPS)	Magnifiers	Mean ± SD	P value
Spectacle (1.20± 0.25)	Bar Stand	1.25± 0.23	0.185
	Handheld	1.19 ± 0.23	0.738
	Dome	1.19 ± 0.24	0.702
		1.22 ± 0.23	0.729
Bar	Stand	1.19± 0.23	0.043
	HandheldDome	1.19 ± 0.24	0.098
		1.22 ± 0.23	0.340
Stand	HandheldDome	1.19± 0.24	0.886
		1.22 ± 0.23	0.553
Handheld	Dome	1.22± 0.23	0.386

Table 4, shows the comparison of critical print size between the different magnifiers.Here, all the magnifiers when compared among one another were found to have the similar critical print size. The p value was not significant for any group.

Table 5 Comparison of One Magnifier with others in RT Group.

Magnifiers (RT)	Magnifiers	Mean ± SD	P value
Spectacle	Bar	88.59± 20.98	**<0.0001**
(63.26± 20.32)	Stand Hand held Dome	66.49 ± 14.59	0.274
		58.49 ± 16.41	0.047
		70.22 ± 14.93	0.012
Bar	Stand Hand held Dome	66.49± 14.59	**<0.0001**
		58.49 ± 16.41	**<0.0001**
		70.22 ± 14.93	**<0.0001**
Stand	HandheldDome	58.49± 16.41	**0.005**
		70.22 ± 14.93	0.119
Handheld	Dome	70.22± 14.93	**<0.0001**

Table 5, shows the comparison of reading time between different magnifiers.

When spectacle magnifier was compared with Bar magnifier, spectacle magnifier was found to have less reading time than Bar magnifier with the p value highly significant (p <0.0001). When Bar magnifier was compared with stand, Hand-Held and Dome magnifiers, Bar magnifier was found to have more reading time with the P value highly significant (p <0.0001). When stand magnifier was compared with Hand-Held, Hand-Held was found to have less reading time than stand with p value (p<0.005) and when Hand-Held was compared with dome magnifier Hand-held was found to have less reading time with p value (p<0.0001). Remaining magnifiers when compared were having similar reading speed.

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Table 6 Comparison of One Magnifier with others in RS Group.

Magnifiers (RS)	Magnifiers	Mean ± SD	P value
Spectacle (125.0± 49.81)	Bar Stand	89.07± 51.46	**<0.0001**
	HandheldDome	107.21 ± 35.0	**<0.0001**
		127.33 ± 43.25	0.670
		101.07 ± 31.32	**<0.0001**
Bar	Stand	107.21± 35.0	0.012
	HandheldDome	127.33 ± 43.25	**<0.0001**
		101.07 ± 31.32	0.085
Stand	HandheldDome	127.33± 43.25	**0.002**
		101.07 ± 31.32	0.144
Handheld	Dome	101.07± 31.32	**<0.0001**

Table 6, shows the comparison of reading speed between the different magnifiers.

Spectacle magnifier when compared with Bar, stand, and Dome magnifiers, spectacle was found to have more reading speed with (125.0 ± 49.81) wpm with p value highly significant ($p<0.0001$). But when spectacle magnifier was compared with Hand-Held, both were found to have similar reading speed with p value non-significant. When Bar was compared with Hand-Held magnifier, Hand-Held was found to have more reading speed with (127.33 ± 43.25) wpm. But when Bar magnifier was compared with stand and Dome, all of them were having similar reading speed with non-significant p value. When stand magnifier was compared with Hand-held, Hand-Held was having more reading speed but when compared with Dome both stand and dome have the similar reading speed. When Hand-Held was compared with Dome magnifier, Hand-Held was having more reading speed with p value highly significant ($p<0.0001$).

V. DISCUSSION

ARMD is a degenerative disorder which affects the macular region and lead to a progressive loss of central vision and reading ability and often resulting in an irreversible central scotoma. Low vision aid devices can help them to improve their ability to do their daily living tasks for distance and near which is hampered because of visual impairment due to various etiologic conditions which cannot be improved with standard corrections. There are almost 60% of cases comes to the low vision centre due to reading difficulties. Several other factors like weakening of oculomoter control, poor fixation stability, narrowing in visual space retardation in the understanding process of information, impaired visual acuity for near and the reading print size can influence the reading performance. Providing an appropriate low vision devices for near is very important for a successful visual rehabilitation and improved patient compliance. The selection of the system which is necessary to ensure fast and fluent reading for low vision patients cannot be achieved by solely measuring a near VA. But, it is important to measure the reading performance, not the letter size, for evaluating the reading fluency. Therefore, text-based logarithmic near vision chart is needed.

Previous study suggested that there is increase in reading performance after low vision aids were given to patient with ARMD. Before the provision of low vision aids, only 16% of the patients were able to read and in contrast, the reading ability was achieved in 94% of patients after the provision of low vision aids.

In this study the reading speed has been checked with MNREAD chart for different magnifiers and also compared the reading speed between them.

In reading, print size is one of the most important factors which affects the reading performance in patient with low vision and by using the MNREAD chart, the reading performance can be evaluated by calculating the reading acuity, critical print size and maximum reading speed. According to a study, when MNREAD reading chart was used in normal people, the average reading speed was 153.69±9.52 word per minute (wpm). A maximum reading speed was reported as 157 wpm and in the patients with early ARMD with an average visual acuity of 6/9 (0.66 Log MAR). [9] Another study reported a reading speed of 73 wpm with a MNREAD chart in ARMD patients with a mean VA of 0.93 LogMAR. [10]

According to a study, when MNREAD reading chart was used in normal patients, average reading speed was 153.69±9.52 wpm. Maximum reading speeds with MNREAD chart were reported as 157 wpm in the cases with stable early ARMD with average VA of 6/9 (0.66) by Snellen.[9] Another study reported reading speed was 73 wpm according to MNREAD chart in patients with ARMD with mean VA of 0.93 LogMAR.[10] A study by Carver reported that reading speed below 80 wpm is consider as a slow reading, reading speed between 80 to 160 wpm is consider as a functional reading and reading speed above 160 wpm is consider as a fluent reading. In this study, the maximum reading speed in wpm was found with Hand-Held magnifier (127.33 ± 43.25) whereas minimum reading speed was with Bar magnifier (89.07 ± 51.46). All these patient (N=43) had a best corrected visual acuity between 0.48 to 1 logMAR in a better seeing eye. So, in the present study, we found that all the ARMD patient have functional reading speed with all the magnifiers used.

VI. SUGGESTIONS AND RECOMMENDATIONS

Larger sample size can be included. A patient with wet ARMD patients can be included in the study and higher magnification devices can be used.

VII. CONCLUSIONS

In this study all magnifiers (Bar, stand, Hand-Held, spectacle and dome) shows the better and functional reading speed in all the Dry ARMD patients taken although the average reading speed was high with hand-held magnifier. So, the conclusion is that every magnifiers are equally better in case of reading speed and any of them can be suggested to the Dry ARMD patient depending upon the patient comfort ability.

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