Original Article

Enhancing Vision: Evaluating the Effectiveness of Telescopic Devices in Individuals with Retinitis Pigmentosa

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ABSTRACT

Purpose: To evaluate the effectiveness of telescopic Low Vision Devices (LVD) in individuals with retinitis pigmentosa (RP).

Study Design: Retrospective chart review.

Place and Duration of Study: *MTI/Khyber Teaching Hospital*, Peshawar, from January 2020 to December 2022.

Methods: Out of 56 individuals, 45 patients who showed an improvement of four or more letters within the same line, or one or more lines, with a telescopic LVD were provided with device and asked to revisit after one month. The effectiveness of LVD was assessed by an improvement in VA. During the follow-up visit, VA was measured using the same telescope after one month of consistent device use. Subjects were asked to report about the use of devices. Paired sample t-tests were performed to explore the differences between best corrected VA without the telescopic LVD versus the findings at the 1st and 2nd visits.

Results: A significant association between age group and the level of visual impairment of the better-seeing eye at the first visit was noted. There was no significant association between sex, age and the level of visual impairment of the better-seeing eye at the first visit. All 11 subjects who did not show any improvement in distance VA with the telescopic LVDs had constricted visual fields. Correlation analysis indicated a significant positive correlation between baseline best corrected VA and the change in best corrected VA using LVD.

Conclusion: LVDs significantly enhanced VA for individuals with RP, emphasising the importance of early device availability.

Key Words: Binocular Telescopes, Consanguinity, Genetic Counselling, Low Vision Devices, Retinitis Pigmentosa, Visual Acuity.

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INTRODUCTION

Retinitis pigmentosa (RP) is an inherited disease that initially affects the peripheral retina involving rod photoreceptors, causing peripheral visual field (VF) loss and night blindness with mild to moderately affected visual acuity (VA).[1] As the disease progresses, the cone photoreceptors and retinal pigment epithelium become affected, causing moderate to severe visual loss and often leading to blindness.[2]

Across the world, about 2.2 billion people have low vision at distance or near.[3] One million people alone are from Asia and 300,000 are from Africa.[4] The World Health Organization (WHO) defined a person as visually impaired if the best corrected VA in the better-seeing eye (BE) is less than 6/18 to perception of light, even after medical and surgical treatment, or if the visual field is less than 20°.[5]

According to the WHO, the prevalence of childhood blindness is high in low-income countries, and about 1 in 5000 suffer from non-syndromic RP. This condition adversely affects mental health and socio-economic status.[6] Individuals with RP may become unemployed or drop out of school and/or community gatherings due to severely decreased vision or profound blindness leading to depression.[7]

Low vision devices (LVDs) are designed to improve visual function and enhance the quality of life for individuals who previously were negatively affected.[7,8]Visually impaired people require low-vision rehabilitation to execute daily tasks. Each patient requires an individualised rehabilitation plan. LVDs can be used independently or in combination with environmental modifications such as increasing contrast and illumination.[9] The effectiveness of LVDs may vary depending on the severity or type of RP and the ability of the patient to use the device.[10,11] There is a growing interest in the use of LVDs for individuals with RP, but the effectiveness of these devices is not well understood. However, literature indicates that LVDs improved functional vision and the quality of life of visually impaired individuals.[12]

The rationale behind the present study was to address the limited data on the effectiveness of telescopic LVDs in individuals with RP. We sought to evaluate the effect of monocular and binocular telescopes on VA and to determine the preferred design of such devices.

METHODS

The records of 107 individuals with non-syndromic RP were reviewed to investigate the effectiveness of telescopes in individuals with RP who visited the low vision clinic of the MTI/Khyber Teaching Hospital between January 1, 2020, and December 31, 2022. Data from 56 participants who met the inclusion criteria were analysed. A total of 45 patients who showed an improvement of four or more letters within the same line or one or more lines with a telescopic LVD were provided with such a device and asked to return after one month. The effectiveness of LVD was assessed by an improvement in VA. The research was approved by the ethical board of Khyber Medical College (689/DME/KMC). Inclusion and exclusion criteria are described in Figure 1. The 2018 International Classification of vision impairment was used for this purpose:[13]

Distance vision impairment:

- Mild – best corrected VA equal to or worse than 6/12 to 6/18 (0.30-0.50 LogMAR).
- Moderate – best corrected VA worse than 6/18 to 6/60 (0.52-1.00 LogMAR).
- Severe –best corrected VA worse than 6/60 to 3/60 (1.02-1.30 LogMAR).
- Blindness – best corrected VA worse than 3/60 (>1.30 LogMAR).
- Near acuity worse than N6 (M 0.8) at 40cm.

Distance visual acuity (DVA) was tested using a Bailey-Lovie LogMAR chart. These charts have letter-to-letter sensitivity of 0.02. An improvement of four or more letters in the same line or a one line improvement was considered as an improvement in vision.[14,15] The VA chart was positioned at a distance of 4 metres; if the patient was unable to read the largest print size (1.0 LogMAR), the chart was moved closer to the patient and 0.3 was added for each half of the test distance.[15] Each subject underwent retinoscopy and subjective refraction.

Central VF was examined using Amsler grid and confrontation method was used to assess the peripheral VF (hand disc perimeter or a tangent screen was not available at the Khyber Teaching Hospital). For participants with VA > 0.90 LogMAR and unable to respond appropriately with the Humphrey VF analysers, model 720in (Carl Zeiss Meditec, zeiss.com), confrontation VF was used. For peripheral confrontation testing, the patient was asked to count fingers in all four quadrants and for central confrontation testing, red test object was used to compare sensitivity across the vertical meridian.

Monocular, binocular and clip-on telescope designs were used. The magnification power ranged from 2.5x to 10x. Subjects with higher refractive errors were advised to use glasses in conjunction with the telescopes for supplementary visual assistance. During the follow-up visit, VA was measured using the same telescope after one month of consistent device use. Subjects were asked to report about the use of devices. (Telescopic low vision devices used in the study were manufactured by the Hong Kong Society for the Blind-HKSB-https://bfahk.com.hk/en/assistive-equipment/low-vision-resource-centre)

Magnification power was determined using the formulae specified in equations 1 and 2, namely:

Equation 1: Telescopic power using Snellen acuity charts = actual vision/desired vision.[16]

Equation 2: Telescopic power using LogMAR charts = 1.25n.[17]

(Where n quantified the number of lines that the subject needed to improve in order to reach the target VA, counting from the last line read up to the desired goal).

Age, sex, consanguinity, best corrected VA without and with the telescopic LVD at the 1st and 2nd visits, as well as the type of telescopic LVD used (monocular, binocular/spectacle mounted or clip-on) were recorded. A properly designed proforma was used to record the participant's biodata and visual functions, needs and demands. Data were saved on a Microsoft Excel spreadsheet. Fundus examination was performed by an ophthalmologist, while the low vision assessment and training were undertaken by the authors.

The G*power 3.1 analysing tool was used to calculate the sample size. (gpower.hhu.de/), focusing on the paired sample t-test, which is appropriate for comparing visual acuity (VA) before and after the use of telescopic LVDs. The following formula was used to determine the required sample size:

$$n = (Z\alpha/2 + Z\beta / d)^2$$

Where:

n= required sample size

$Z\alpha/2$ = critical value for a two-tailed test (1.96 for a 95% confidence level)

$Z\beta$ = critical value corresponding to the desired power (0.84 for 80% power, but adjusted for 95% power in this case)

d = effect size (Cohen's d), representing the standardized mean difference between the paired observations.

Statistical Package for Social Sciences (SPSS, ibm.com) version 23 software was used for data analyses. Descriptive statistics (means, standard deviations, cross tabulation and frequencies) were used to analyse the effectiveness of the LVDs. Correlation analysis examined association between age, baseline best corrected VA and the change in VA with the LVD. After descriptive statistics were calculated, the association between age group and the level of visual impairment of the better-seeing eye at the first visit was examined using Pearson and Likelihood Ratio Chi-Square tests. Paired sample t-tests were performed to explore the differences between best corrected VA without the telescopic LVD versus the findings at the 1st and 2nd visits.

RESULTS

Out of 56 RP subjects with mean age of 24±14 years (range 7 to 67 years), 40 (71.4%) were adults (age range, 16-67 years) and 16 (28.6%) were children (age range, 7-15 years). Most of the adults (28 out of 40) and 13 out of the 16 children were moderately visually impaired at the first visit; details can be seen in Table 1. The Pearson and Likelihood Ratio Chi-Square tests both indicated a significant association between age group and the level of visual impairment of the better-seeing eye at the first visit. Details are shown in Table 2.

These groups were further subdivided into male and female adults and children (see Figure 2). There was no significant association between sex, age and the level of visual impairment of the better-seeing eye at the first visit. Details can be found in Table 2.

Pakistan has the highest frequency of consanguineous marriages in the world,[18] thus placing inhabitants at higher risk of RP. In this study, 43 patients (76.8%) were progeny of consanguineous marriages.

Fifteen subjects (26.8%) in the current study were myopic, while seven (12.5%) had both myopia and astigmatism. Details of other refractive errors are shown in Table 3.

Out of the 56 participants, 45 (80.4%) showed an improvement in distance VA with telescopes. Upon further analysis, all 11 subjects who did not show any improvement in distance VA with the telescopic LVDs had constricted visual fields. Correcting the refractive error resulted in slightly improved VA in the fellow eye, i.e., an improvement of one or more letters, but less than a complete line of improvement. These individuals were prescribed correcting spectacles. Details of the visual field restrictions are shown in Table 4.

Mean (SD) values of best corrected VA without and with the telescope at the first visit were 0.90 (0.22) and 0.60 (0.25) LogMAR, respectively. The respective values at the second visit were 0.90 (0.22) and 0.58

(0.25) LogMAR. In the analysis of best corrected VA, it is important to note that no significant difference was found between the first and second visits of the better-seeing eye without a telescopic LVD. Therefore, only the best corrected VA values from the first visit were used as variables in the analyses. The improvement produced by the LVD was significant ($p < 0.001$). Number (percentage) of individuals showing improvement in visual acuity are shown in Table 5.

Correlation analysis indicated a significant positive correlation ($r = 0.54$, $p < 0.01$) between baseline best corrected VA and the change in best corrected VA with the LVD, indicating that individuals with better baseline VA were more likely to experience greater improvements with the use of a telescope. However, no significant correlation was found between age and either the baseline best corrected VA ($r = -0.14$, $p=0.37$) or the change in best corrected VA produced by the LVD ($r= 0.02$, $p = 0.90$), indicating that age may not.

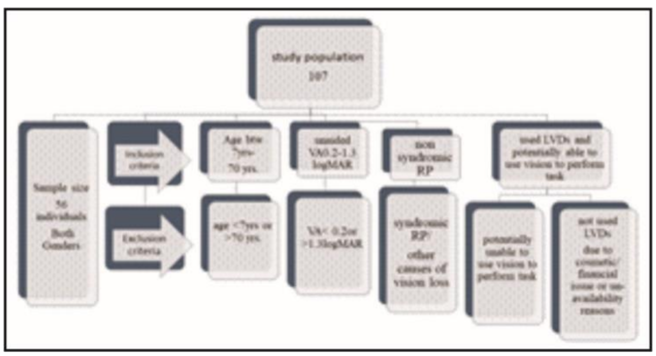

Figure 1: Flow chart showing inclusion and exclusion criteria. LVD, low vision device; RP, retinitis pigmentosa; VA, visual acuity; VL, visual loss.

Among the participants, 29 individuals (51.78%) expressed a preference for a binocular telescope while 16 participants (28.57%) preferred monocular telescopes (see figure 3). Most of these individuals used their telescopic LVDs for spotting and/or short duration. Five subjects needed a higher-powered telescope due to reduced VA. Furthermore, 11 participants did not exhibit an improvement in the VA of their better-seeing eye with the telescopic LVD. Consequently, they were prescribed glasses for the fellow eye.

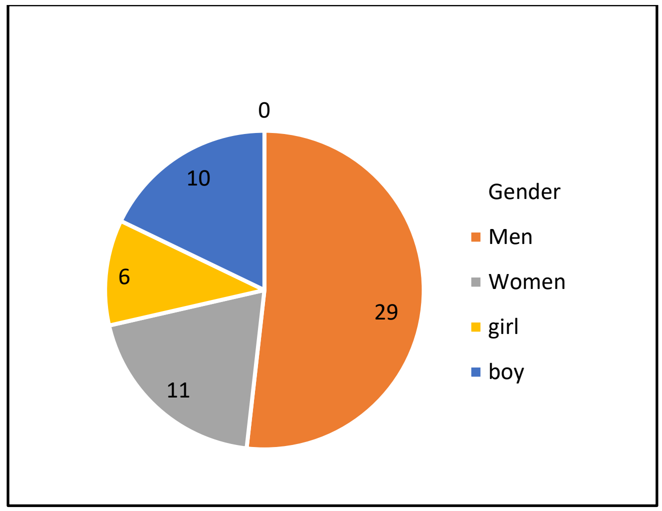

Figure 2: Demographic distribution by sex and age group: Boys and girls were 7-15 years of age. Men and women were 16-67 years of age.

DISCUSSION

Out of the 56 study participants, 39 (69.6%) were males. The high representation of males in this cohort could be due to the low level of healthcare access among females in this area.[19] Telescopic LVDs were effective in improving distance VA in 80.4% of individuals with RP. In contrast, Aziz observed that only 16.7% of RP patients benefited from LVDs.[19] The marked difference in outcomes could have been due to differences in the level of vision loss and telescopic magnification. Aziz included adults with VA worse

Table 1: *Cross-tabulation of age groups and levels of visual impairment in the Better-seeing eye at the first visit.*

	Best corrected VA of the better seeing eye				
	Severe visual impairment	**Moderate visual impairment**	**Mild visual impairment**	**Normal**	**Total**
Children (7-15 years of age)	2	13	1	0	16
Adults (16-67 years of age)	8	28	3	1	40
Total	10	41	4	1	56

Normal visual acuity (VA)<0.30 LogMAR; Mild visual impairment (VI), VA 0.30 to 0.40 LogMAR; Moderate visual impairment (VI) VA, 0.50 to 1.00 LogMAR, Severe visual impairment (VI) >1.00 LogMAR.

Table 2: *Associations between age, baseline best corrected (BC) distance visual acuity (VA) in the better seeing eye and the change in the BCVA with the low vision device (LVD).*

		Age	Baseline BCVA	BCVA with LVD at the first visit
Age	Pearson Correlation		-0.14	0.02
	p-value (2-tailed)		0.37	0.90
	N		45	45
Baseline BCVA	Pearson Correlation	-0.14		0.54
	p-value. (2-tailed)	0.37		<0.01
	N	45		45
Change in the BCVA with the LVD	Pearson Correlation	0.02	0.54	
	p-value. (2-tailed)	0.90	<0.01	
	N	45	45	

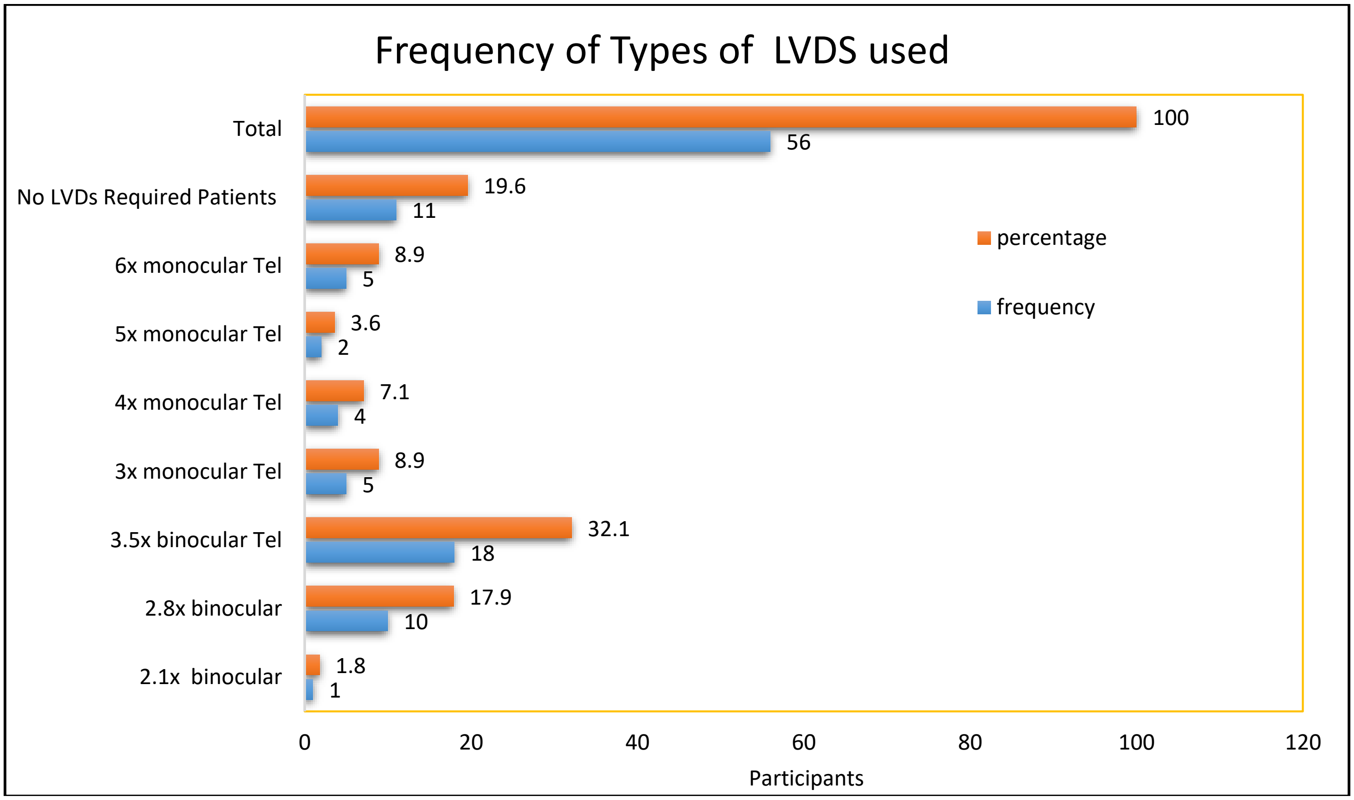

Figure 3. Frequency of telescopic (Tel) low vision device (LVD)designs and powers chosen.

Table 3: *Refractive errors of individuals with retinitis pigmentosa.*

Refractive Error	Frequency	Percentage
Myopia	15	26.8%
Hypermetropia	9	16.1%
Astigmatism	5	8.9%
No refractive error	9	16.1%
Myopia and astigmatism	7	12.5%
Hypermetropia and astigmatism	11	19.6%
Total	56	100%

than 6/18 (0.48 LogMAR). In contrast, the current study included subjects with VAs between 0.20 and 1.30 LogMAR. Additionally, while Aziz only used a 2.5x telescope, the current study included a range of telescopic magnifications from 2.1x to 10.0x. Even though we specifically selected the better-seeing eye in this study, 11(19.6%) individuals did not demonstrate any improvement in this better-seeing eye with either telescopes or glasses. However, the fellow eye showed improved VA with glasses. This finding leads us to recommend glasses to enhance the VA of the poorer-seeing eye.

Additionally, we found that 51.8% of participants preferred a hands-free design, such as a bioptic

Table 4: *Association between the location of the visual field defect and visual impairment (VI) in the better seeing eye at the first visit.*

Location of the visual field defect	BCVA Level of better seeing eye				
	Severe VI	**Moderate VI**	**Mild VI**	**Normal**	**Total**
Peripheral	5	18	1	0	24
Temporal Inferior	1	3	0	0	4
Constricted	0	7	3	1	11
Temporal superior and inferior	3	9	0	0	12
Nasal superior and inferior	0	1	0	0	1
Nasal inferior, temporal, superior	1	3	0	0	4
Total	**10**	**41**	**4**	**1**	**56**

BCVA, best corrected visual acuity. Normal VA <0.30 LogMAR; Mild VI, VA 0.30 to 0.40 LogMAR; Moderate VI, VA, 0.50 to 1.00 LogMAR, Severe VI VA > 1.00 LogMAR.

Table 5: *Number (percentage) of individuals showing improvement in visual acuity (VA).*

Level of Visual Impairment	Normal	Mild VI	Moderate VI	Severe VI	Total
Best corrected VA without LVD at 1st visit	0 (0%)	5(8.9%)	41(73.2%)	10(17.85%)	56
Best corrected VA with LVD at 1st visit	8(17.77%)	12(26.66%)	24(53.33%)	1(2.2%)	45
Best corrected VA with LVD at 2nd visit	7(15.55 %)	16 (35.55%)	20(44.44%)	2(4.44%)	45

Normal VA <0.30 LogMAR; Mild visual impairment (VI), VA 0.30 to 0.40 LogMAR; Moderate VI, VA, 0.50 to 1.00 LogMAR, Severe VI, VA > 1.00 LogMAR. LVD, low vision device.

comprising a binocular telescope mounted on a pair of spectacles. The reason for preference mentioned by participants was being able to use both hands. It was also noted that with proper training and counselling, participants were able to use their LVDs and live independently. This finding can be supported by the recent research which highlights the benefits of personalised telerehabilitation.[20]

Based on the results, increased awareness and access to genetic counselling services would benefit couples considering consanguineous marriages. Some 70% of marriages in Pakistan are consignees and this practice is more common in the tribal, rural area of Khyber Pakhtunkhwa.[21] Not surprisingly, there is a high rate of congenital disorders in this tribal belt. Community leaders and healthcare providers should provide education and resources regarding the risks of genetic disorders associated with consanguinity, as well as offering premarital genetic testing and counselling to help couples make informed decisions about their health and the health of their future children.

Strengths of this study is that it provides understanding about patient preferences for hands-free telescopic low vision devices. This enriches the existing literature by providing insight into practical rehabilitation strategies. This study underscores the importance of increasing awareness and access to genetic counselling for couples in consanguineous marriages. Additionally, it advocates proper training and counselling for telescopic low vision device users.

One limitation of this study is that it only examined the short-term effects of LVDs on vision and the quality of life. A limited range of telescopes was offered due to availability and cost. Future research should investigate the long-term effects of LVDs on both VA and the quality of life for individuals with RP, as well as factors that may influence the effectiveness of these devices, such as the patient's age and the severity of their visual impairment. A longitudinal investigation with extended follow-up periods to monitor the development of RP within various demographic cohorts is recommended. This approach would facilitate future assessments of the efficacy in diverse patient populations, allowing for a thorough evaluation to determine which factors such as age, contrast sensitivity, presenting VA and visual fields lead to the greatest benefits. Proper training and familiarisation with the device, along with the patient's motivation and compliance, are key factors in achieving a positive outcome. Long-term evaluation can provide valuable insights into the natural course of the disease.

CONCLUSION

LVDs are essential to improve the visual function of patients with RP. Most participants preferred hand free devices such as binocular telescopes or bioptics.

However, it is important to note that not all individuals will show the same pattern of improvement. Therefore, individualised rehabilitation plans may be necessary.

Funding: This study was not funded by any organization.

Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(689/DME/KMC)**.

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Nazli Gul; *Assistant Professor:* Concepts, Design, Literature search, Data acquisition, Manuscript editing.

Kainat Syed; *Optometrist:* Design, Literature search, Data acquisition, Manuscript editing.

Ume Farwa;*Optometrist:*Design, Literature search, Data acquisition, Manuscript editing.

Shahzeb Ahmad; *TMO:* Literature search, Data acquisition, Data analysis, Manuscript preparation.

Asif Mehmood; *Assistant Professor:* Literature search, Data acquisition, Data analysis, Manuscript preparation.