Original Article

Improvement in distance and near visual acuities using low vision devices in diabetic retinopathy

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Purpose: The aim of this study is to elucidate the causes and level of visual impairment (VI) in patients with different pathologies of diabetic retinopathy (DR) who presented to a low vision care (LVC) clinic, to analyze the type of distant and near devices prescribed to them and the visual benefits thereof. **Methods:** A retrospective chart review was done for 100 consecutive patients with DR who were referred to the LVC clinic from June 2015 to June 2016. The reason for referral was assessed from the electronic medical records and available fundus photographs, fundus fluorescein angiograms, and optical coherence tomography images by a retina specialist. The details of low-vision devices and subsequent improvements were noted. **Results:** Of the 100 patients, 52% had moderate VI, 19% mild VI, 16% severe VI, and 13% had profound VI or blindness. The most commonly prescribed low vision device was half-eye spectacles (38.4%). The pathologies which had statistically significant improvement ($P < 0.05$) in distance vision with low vision devices were DR with disc pallor (4.4% improvement), ischemic maculopathy (11.9% improvement), and plaque of hard exudate (10.1% improvement). However, in all pathologies, there was statistically significant improvement ($P < 0.05$) in near vision. **Conclusion:** Usually, the patients with DR presented to the LVC clinic with moderate VI. The use of low vision devices can help these patients in cases where medical and surgical treatment have no or a limited role in restoring useful vision.

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Despite advancements in medical and surgical management, the patients with vision loss from sight-threatening diabetic retinopathy (DR) continue to make up a significant part of the low vision rehabilitation clinic. Due to unique problems such as early onset, fluctuations in vision loss and its overall complex nature, visual demands of disease management, and associated multisystem losses, their visual rehabilitations are often challenging.[1,2] Our past reports show the prevalence of visual impairment (VI) (<6/12) in a population-based study with type 2 diabetes >40 years to be 4% and the prevalence of legal blindness at 0.5% (defined as 6/60 or worse).[3]

Some stages in DR where therapeutic interventions have limited role in improving vision include macular ischemia, burnt-out retinopathy, chronic cystoid macular edema (CME), chronic tractional retinal detachment (TRD), macular scarring secondary to chronic ischemia and edema, long-standing plaque of hard exudate at the fovea, and DR with optic nerve pallor. Nilsson[4] has shown visual rehabilitation, including prescription of devices and training, has proven to be the most successful in advanced DR (proliferative DR). Likewise, Kloevekorn-Fischer *et al*.[5] showed that with the use of low vision devices, satisfactory visual improvement in >90% of the cases could be attained. However, the effect of low vision devices for distance and near vision in different DR pathologies has not been studied.

The aim of this study is to elucidate the causes and level of VI in patients with DR who presented to a low vision care (LVC) clinic at a tertiary eye care center, to analyze the type of distant and near devices prescribed to these patients, and to compare the visual benefit in different pathologies in DR responsible for low vision.

Methods

Study population

A retrospective review of 100 case records of people with DR who were referred to the LVC clinic between June 2015 and June 2016 at a tertiary eye care institute in India was done. Of the cases that had DR, those for whom therapeutic interventions played a limited role in improving vision were sent to the LVC clinic. The reason for referral was assessed from the electronic medical records, available fundus photographs, fundus fluorescein angiograms, and optical coherence tomography images by a retina specialist (RR). Institutional review board approval was obtained to analyze the hospital-based data and the tenets of Helsinki were followed. Collected data included presenting logarithm of the minimum angle of resolution (LogMAR) distant and near visual acuity in the better eye, details of the low vision devices prescribed and final LogMAR distant and near visual acuity with the low vision

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device. The low vision assessment and trial were conducted by two experienced optometrists.

Low vision devices used

Distance optical devices were used to magnify objects up to 3 m or more, whereas near optical devices were used to magnify printed materials and near objects.

Single or multiple optical devices of the following kinds were used to improve the visual acuity of patients with low vision: SEE TV binocular telescopes (Eschenbach, Germany) are spectacle model telescopes mostly suitable for recognizing faces and watching television in the adult population. Half-eye spectacles are high-powered reading glasses that allow both the eyes to read together. These are hands-free magnifiers which provide a greater field of view and make it more comfortable for users to read and write.[6] Hand-held magnifiers (Low Vision Resource Centre [LVRC]-Hong Kong Society for the Blind [HKSB]) are magnifiers which are more comfortable for spotting and give a better working distance and portability. Stand magnifiers (LVRC, HKSB) are magnifiers which give a comparatively wider range of magnification with limited field of view. Dome magnifiers (LVRC, HKSB) are those which are more comfortable for continuous reading tasks with a convenient working distance. Pocket magnifiers (LVRC, HKSB) are those with a wide range of magnification and mostly used for spotting. Additional illumination was suggested in most cases for comfortable reading. Portable video magnifiers (Freedom Scientific Company, USA) with closed-circuit television (CCTV) have a wide range of magnification from ×2 to ×25, offer the option of contrast change, and freezing of images. Notex is a currency identifier for identifying notes using tactile cues. Clip-on filters are colored filters that are useful for patients with photophobia.

The patients were given a trial of single or combination of low vision optical and nonoptical devices depending on their presenting visual acuity, and the maximum improvement in the visual acuity was noted. A detailed explanation of the use of the device and adaptation training with the preferred device was given to patients to enable them to handle the device independently. Worst cases of DR needed multiple devices (optical and nonoptical) for better visual improvement. In addition to the LVD prescription, the instruction manual of the prescribed device was provided to help the patients.

Definition

Ischemic maculopathy

Ischemic maculopathy was defined by the presence of foveal avascular zone abnormalities seen with fundus fluorescence in angiography and/or thinning of inner retina on spectral domain optical coherence tomography.[7,8]

Involutional or burnt-out retinopathy

This is the quiescent last stage of DR with featureless retina, both arteriolar and venular narrowing with marked ischemia.[9]

Macular scar

Retinal pigment epithelium atrophic scar or the presence of subretinal fibrosis is involving the macular area.

Diabetic retinopathy associated with disc pallor

DR that is associated with sequel of optic neuropathy with reduced vision attributed to it.

Plaque of hard exudate at macula

DR with plaque of hard exudate at fovea associated with foveal thinning.

Chronic tractional retinal detachment

DR with long-standing TRD is involving the fovea where surgical choice was deferred due to the poor visual prognosis and those cases with residual TRD involving the fovea where further surgical intervention was deferred.

Chronic cystoid macular edema

Long-standing CME in DR with associated schitic changes seen on OCT and was unresponsive or poorly responsive to present treatment modalities.[10]

Levels of visual impairment

Low vision was defined in the study based on recommendations by the World Health Organization relating to visual acuity of the better eye with the best possible correction: Category 0: Mild VI with visual acuity better than 6/18, Category 1: Moderate VI with worse than 6/18–6/60, Category 2: Severe VI with worse than 6/60–3/60, Categories 3 and 4: Profound VI with worse than 3/60 to perception of light, and Category 5: Blindness with no perception of light.[11-13]

Results

The mean age of the patients was 55.65 ± 13.07 years. Out of 100 patients, 78% were male. The mean duration of diabetes was 13.85 ± 8.28 years.

Of the 100 cases which were referred, 52% had moderate VI, 19% had mild VI, 16% had severe VI, and 13% had profound VI or blindness. All of the pathologies in DR had predominantly moderate VI; DR with disc pallor (21%), ischemic maculopathy (68.2%), macular scar (55.6%), burnt-out retinopathy (69.2%), plaque of hard exudate at fovea (62.5%), chronic TRD (25%), and chronic CME (33.3%) as discussed in Table 1. A total of 66% of the patients were diagnosed to have proliferative DR (PDR), and 34% were classified under moderate to severe nonproliferative DR.

In 73% of the cases, a single low vision device was sufficient, whereas in 27% of the cases, two or more devices were necessary. SEE TV binocular telescope was the most commonly prescribed device for distance (14.8%). The most commonly prescribed single low vision device for near sightedness was half-eye spectacles (38.4%) followed by portable video magnifier (13.7%). Of the many options, the most commonly prescribed devices overall were half-eye spectacle and bifocals spectacles (22.2%) which are listed in Table 2.

The pathologies which showed a statistically significant improvement ($P < 0.05$) in distance vision with low vision devices were DR with disc pallor (4.4% improvement), ischemic maculopathy (11.9% improvement), and plaque of hard exudate (10.1% improvement). However, in all pathologies, there was a statistically significant improvement ($P < 0.05$) for those with near vision. Improvements in near vision were seen in DR with disc pallor (54.1% improvement), ischemic maculopathy (71.3% improvement), macular scar (72.6% improvement), burnt-out retinopathy (71.4% improvement), plaque of hard exudate at fovea (64.9% improvement),

chronic TRD (51.2% improvement), and chronic CME (59.5% improvement) as shown in Table 3.

Low contrast acuity was tested using Bailey-Lovie 10% contrast chart for 32 patients. It was found that contrast acuity was impaired for all of them and the mean low contrast acuity was found to be 1.2 LogMAR. The field of vision was assessed by confrontation method. It was noted to be constricted in 27 patients and normal in 35 patients with DR. These tests were carried out only in participants who were able to perform the tests.

Discussion

The study reports preponderance of moderate VI (52%) in people with DR. The majority benefited from a single low vision device (73%). The most common low vision devices prescribed were half-eye spectacles and bifocals. There

Table 1: Baseline characteristics of diabetic retinopathy patients attending the low vision care clinic based on levels of visual impairment

Characteristics	Mild (%)	Moderate (%)	Severe (%)	Profound and blindness (%)
Cause of VI				
DR with disc pallor	5 (26.3)	8 (42.1)	3 (15.8)	3 (15.8)
Ischemic maculopathy	3 (13.6)	15 (68.2)	2 (9.1)	2 (9.1)
Macular scar	2 (22.2)	5 (55.6)	2 (22.2)	0
Burnt-out retinopathy	2 (15.4)	8 (61.5)	1 (7.7)	2 (15.4)
Plaque of hard exudate at macula	4 (25)	10 (62.5)	2 (12.5)	0
Chronic TRD	0	3 (25)	4 (33.3)	5 (41.6)
Chronic CME	3 (33.3)	3 (33.3)	2 (22.2)	1 (11.1)

SD: Standard deviation, VI: Visual impairment, DR: Diabetic retinopathy, TRD: Tractional retinal detachment, CME: Cystoid macular edema

Table 2: Low vision devices used in the patients with diabetic retinopathy

Single LVD (73%)		Multiple LVD (27%)	
Device	*n* (%)	Devices	*n* (%)
Half eyes	28 (38.4)	Half-eye and bifocal glasses	6 (22.2)
Bifocal glasses	20 (27.4)	Bifocal glasses and portable video magnifier (CCTV)	4 (14.8)
Portable video magnifier (CCTV)	10 (13.7)	Bifocal glasses, SEE TV binocular telescope and half eyes	4 (14.8)
Nil LVD	6 (8.2)	Half-eye and pocket magnifier	3 (11.1)
×6 cut away stand magnifier	4 (5.5)	Half-eye and cut away stand magnifier	2 (7.41)
Dome magnifier	2 (2.8)	Bifocal glasses and cut away stand magnifier	1 (3.7)
Handheld magnifier	1 (1.4)	Half-eye and SEE TV binocular telescope	1 (3.7)
Pocket magnifier	1 (1.4)	Half-eye and clip on filters	1 (3.7)
Clip on filters	1 (1.4)	Dome magnifier and half eyes	1 (3.7)
		Portable video magnifier (CCTV) and Notex	1 (3.7)
		Bifocal glasses and pocket magnifier	1 (3.7)
		Portable video magnifier (CCTV), handheld magnifier, and pocket magnifier	1 (3.7)
		Bifocal glasses, half-eye and portable video magnifier (CCTV)	1 (3.7)

LVD: Low vision device, CCTV: Closed-circuit television

Table 3: Distant vision and near vision improvements after low vision devices in different causes of visual impairment among people with diabetic retinopathy

Cause of VI	Distance visual acuity (LogMAR)				Near visual acuity			
	Pre	Post	Percentage improvement	*P*	Pre	Post	Percentage improvement	*P*
DR with disc pallor	1.14	1.09	4.4	0.03	19.8	8.9	54.1	0.004
Ischemic maculopathy	0.92	0.81	11.9	0.004	20.9	6	71.3	0.000041
Macular scar	1.03	0.95	7.7	0.17	21.9	6	72.6	0.01
Burnt-out retinopathy	0.99	0.85	14.1	0.28	20.3	5.8	71.4	0.02
Plaque of hard exudate at macula	0.69	0.62	10.1	0.03	17.1	6	64.9	0.0007
Chronic TRD	1.53	1.52	0.65	0.16	29.1	14.2	51.2	0.001
Chronic CME	0.91	0.82	9.9	0.10	14.8	6	59.5	0.01

DR: Diabetic retinopathy, TRD: Tractional retinal detachment, CME: Cystoid macular edema, VI: Visual impairment, LogMAR: Logarithm of the minimum angle of resolution

was significant improvement in the near visual acuity in almost all the categories of DR because of the latest available electronic portable devices (CCTV) with higher range of magnification (more than ×20) and with options of reverse contrast which were comfortable for patients with low vision. Pathologies such as DR with disc pallor, ischemic maculopathy, and those with plaque of hard exudate at macula also showed a significant improvement in distance vision.

A majority of studies describing VI among people with diabetes are population-based and have reported varying rates of VI. It has been earlier reported that prevalence of VI among type-2 diabetes is 4%.[14] In the United States, it was estimated that 12% of all new blindness was attributable to DR.[15] However, the vision loss associated with DR is associated with a substantial decrease in patients' utility value and quality of life.[16] It has been found that all the pathologies in DR had more cases with moderate VI.

Similar to the present study, Nilsson[4] reported successful use of low-vision devices in advanced DR. In their series of 79 patients, devices for near and intermediate vision was near addition in 45.6% and 70.1% of cases, respectively. Likewise, Eleanor[17] have reported the use of plus spheres and high plus lenses in 55% of cases with retinopathy. Fonda[6] also found that half-eye spectacles improved the vision of 45% of cases in a series of 101 participants.

The study found significant distance vision improvement in DR with disc pallor (4.4% improvement), ischemic maculopathy (11.9% improvement), and plaque of hard exudate (10.1% improvement). The probable reason for it could be the sectoral retinal damage seen in these conditions. The low vision devices for distance could probably improve this peripheral residual vision in cases of DR. All pathologies showed an improvement in near vision following the use of low vision devices.

The strengths of the study are the reasonable good sample (100 patients) and standard procedures at the LVC clinic. To the best of our knowledge, the correlation between different pathologies in DR and consequent improvements by low vision devices has not been done before. There are some limitations to this study. The fundus photographs, contrast sensitivity, and field of vision assessment were not performed in all the participants. The retrospective design of the study was an inherent limitation. Eleanor[17] have emphasized the need for long-term training with the use of low vision devices, which gives better improvements. This effect of training was not analyzed in the current study.

Conclusion

Visual rehabilitation prescription of devices is successful in pathologies of DR. The use of low vision devices can help these patients, at least those with residual vision, where medical and surgical treatments have none or a limited role in restoring useful vision.

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Conflicts of interest

There are no conflicts of interest.

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