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Original Research Article

A PROSPECTIVE COMPARATIVE STUDY OF OPTICAL AND ELECTRONIC LOW VISION AIDS IN PATIENTS WITH LOW VISION

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ABSTRACT

Background: Low vision is a major global health burden affecting millions worldwide. Optical low vision aids (OLVAs) and electronic low vision aids (ELVAs) represent two principal rehabilitation strategies, yet comparative data on their functional outcomes remain limited in Indian populations. The objective is to compare visual acuity improvement, contrast sensitivity, reading speed, patient satisfaction, and quality of life outcomes between optical and electronic low vision aids in patients with low vision attending a tertiary ophthalmology centre.

Materials and Methods: A prospective comparative study was conducted over 12 months at a tertiary care ophthalmology centre. One hundred and twenty patients with low vision (BCVA 6/18–3/60 or visual field <20° in the better eye) were enrolled and randomised into two groups of 60 each: Group A (optical aids) and Group B (electronic aids). Visual acuity, contrast sensitivity (Pelli-Robson chart), reading speed (MNRead chart), NEI-VFQ-25 scores, and patient satisfaction were assessed at baseline, 3 months, and 6 months. Statistical analysis used paired t-test, independent t-test, and Chi-square test; $p<0.05$ was considered significant.

Results: Mean LogMAR visual acuity improved significantly in both groups (Group A: 0.92±0.18 to 0.61±0.14; Group B: 0.94±0.20 to 0.44±0.12; $p<0.001$). Electronic aids demonstrated superior improvement in reading speed (58.3±12.1 vs 42.7±9.8 words/minute, $p<0.001$) and NEI-VFQ-25 composite scores (67.4±8.3 vs 58.2±9.1, $p<0.01$). Optical aids showed significantly better compliance (88.3% vs 71.7%, $p=0.02$). Contrast sensitivity improvement was comparable between groups ($p=0.14$).

Conclusion: Both optical and electronic low vision aids significantly improve visual function and quality of life in patients with low vision. Electronic aids offer superior reading speed and overall visual function scores, while optical aids demonstrate better patient compliance and cost-effectiveness. Individualised prescription based on patient needs, age, socioeconomic status, and underlying pathology is recommended.

Keywords: Low vision, optical low vision aids, electronic low vision aids, visual rehabilitation, quality of life, reading speed.

INTRODUCTION

Low vision is defined by the World Health Organization (WHO) as a best-corrected visual acuity (BCVA) of less than 6/18 but better than or equal to 3/60, or a corresponding visual field loss to less than 20° in the better eye.[1] According to the WHO World Report on Vision (2019), an estimated 246 million people worldwide suffer from moderate to severe visual impairment, with a disproportionately high burden in South and South-East Asia.[2] In India alone, low vision affects an

estimated 54 million individuals, constituting a significant public health challenge.[3]

Unlike blindness, low vision is characterised by residual functional vision that, with appropriate rehabilitation, can be maximised to improve patient independence and quality of life. Visual rehabilitation through low vision aids (LVAs) forms the cornerstone of management once medical and surgical interventions have been optimised.[4] LVAs are broadly categorised into optical low vision aids (OLVAs) — including spectacle-mounted magnifiers, hand-held magnifiers, stand magnifiers, and telescopes — and electronic low vision aids (ELVAs), which encompass closed-circuit television (CCTV) systems, portable video magnifiers, and head-mounted display devices.[5,6]

Optical aids have been the traditional mainstay of low vision rehabilitation owing to their simplicity, portability, durability, and cost-effectiveness. They require no power source and are easily prescribed by trained optometrists and ophthalmologists.[7] However, optical aids are limited in their magnification range, often provide restricted fields of view, and may be cosmetically less acceptable to younger patients.[8] Electronic aids, conversely, offer higher magnification, adjustable contrast and colour settings, and broader functional adaptability. Their principal drawbacks include higher cost, dependence on battery or electricity, and a steeper learning curve.[9,10]

Despite a growing body of international literature comparing OLVAs and ELVAs, data from the Indian subcontinent remain sparse. The heterogeneity of low vision aetiologies, socioeconomic constraints, educational levels, and cultural preferences in our population necessitate region-specific comparative evidence to guide clinical practice.[11] This prospective comparative study was therefore undertaken to evaluate and compare the functional and quality-of-life outcomes of optical versus electronic low vision aids in patients attending a tertiary ophthalmology centre in India.

MATERIALS AND METHODS

Study Design and Setting: This prospective comparative study was conducted in the Low Vision Clinic of the Department of Ophthalmology, Subharti Medical College, Meerut, Uttar Pradesh, India over a period of 12 months (January 2025 to January 2026). Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Study Population: Patients with low vision (BCVA 6/18–3/60 or visual field <20° in the better eye with best correction) presenting to the outpatient department were screened for eligibility.

Inclusion Criteria

(i) Age ≥10 years; (ii) BCVA 6/18–3/60 in the better eye with best spectacle correction; (iii) Ability to understand and follow instructions; (iv) No prior use of any low vision aid; (v) Willingness to complete 6-month follow-up.

Exclusion Criteria

(i) Total blindness (BCVA <3/60 or no light perception); (ii) Significant cognitive impairment; (iii) Severe systemic illness limiting participation; (iv) Concomitant hearing or motor disability precluding aid use; (v) Patients unwilling to give consent.

Sample Size and Randomisation: Based on a pilot study and published literature on reading speed improvement with low vision aids, a minimum sample size of 54 per group was calculated (α=0.05, power=80%, expected difference in reading speed of 10 words/minute, SD=18). To account for 10% attrition, 60 patients per group were recruited (total n=120). Randomisation was performed using a computer-generated random number table with sealed opaque envelopes for allocation concealment. Outcome assessments at all-time points were performed by a masked observer who was unaware of group allocation. Due to the nature of the intervention, blinding of patients was not feasible; however, the outcome assessor remained blinded throughout the study period.

Intervention: Group A (Optical Aids, n=60): Patients were prescribed the most appropriate OLVA based on their distance and near visual requirements following comprehensive low vision assessment. Aids included hand-held magnifiers (2×–10×), stand magnifiers, spectacle-mounted magnifiers, and monoculars/telescopes for distance. Each patient received training from a low vision therapist.

Group B (Electronic Aids, n=60): Patients were prescribed portable video magnifiers (4×–30× adjustable magnification with contrast enhancement) for near tasks, and head-mounted electronic magnification systems for distance or intermediate vision. Training sessions of 30–45 minutes were provided at prescription and at 1-month follow-up.

Outcome Measures: The primary outcome was improvement in LogMAR visual acuity at 6 months. Secondary outcomes included: (i) Contrast sensitivity (Pelli-Robson chart); (ii) Reading speed (MNRead acuity chart – words per minute); (iii) NEI-VFQ-25 composite and subscale scores; (iv) Patient satisfaction score (0–10 visual analogue scale); (v) Aid compliance (self-reported regular use ≥4 days/week at 6 months); (vi) Adverse effects and dropout rates. All assessments were performed at baseline, 3 months, and 6 months by a masked observer.

Statistical Analysis

Data were analysed using SPSS version 25.0 (IBM Corp., USA). Continuous variables are expressed as mean ± standard deviation (SD). Intra-group comparisons used paired t-test; inter-group

comparisons used independent t-test. Categorical variables were compared using Chi-square test. $p<0.05$ was considered statistically significant. Multivariate linear regression was performed to identify predictors of visual acuity improvement.

RESULTS

Demographic and Baseline Characteristics: Of 138 patients screened, 120 met inclusion criteria and were enrolled. No significant loss to follow-up occurred; 118 (98.3%) completed the 6-month assessment (Group A: 59/60; Group B: 59/60). The mean age of participants was 48.6±17.3 years (range 12–78 years). Both groups were comparable at baseline. [Table 1]

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants

Characteristic	Group A – Optical (n=60)	Group B – Electronic (n=60)	p-value
Mean Age (years)	49.2 ± 18.1	48.1 ± 16.7	0.73
Male : Female	34 : 26	32 : 28	0.68
Mean BCVA (LogMAR)	0.92 ± 0.18	0.94 ± 0.20	0.58
Mean Reading Speed (WPM)	18.4 ± 6.2	17.9 ± 5.8	0.65
NEI-VFQ-25 Composite	34.2 ± 7.6	33.8 ± 8.1	0.78
Aetiology of Low Vision			
AMD	18 (30%)	17 (28.3%)	
Diabetic Retinopathy	14 (23.3%)	15 (25%)	0.89
Glaucoma	10 (16.7%)	11 (18.3%)	
Hereditary Retinal Dystrophies	9 (15%)	8 (13.3%)	
Others	9 (15%)	9 (15%)	

(WPM: words per minute; BCVA: best-corrected visual acuity; AMD: age-related macular degeneration; NEI-VFQ-25: National Eye Institute Visual Function Questionnaire-25.

Visual Acuity Outcomes: Both groups demonstrated statistically significant improvement in mean LogMAR BCVA from baseline to 6 months. [Table 2, Figure 1] Group B (electronic) showed a greater absolute improvement (0.50 LogMAR units) compared to Group A (optical) (0.31 LogMAR units), and inter-group comparison at 6 months was statistically significant (p=0.001).

Table 2: Comparison of Visual Acuity (LogMAR) at Baseline, 3 Months, and 6 Months

Time Point	Group A (Optical)	Group B (Electronic)	p-value (inter-group)	p-value (intra-group A / B)
Baseline	0.92 ± 0.18	0.94 ± 0.20	0.58	—
3 Months	0.72 ± 0.16	0.56 ± 0.15	<0.001	<0.001 / <0.001
6 Months	0.61 ± 0.14	0.44 ± 0.12	0.001	<0.001 / <0.001
Mean Improvement	0.31 ± 0.09	0.50 ± 0.11	0.001	—

Values expressed as Mean ± SD (LogMAR units). Lower LogMAR = better visual acuity.

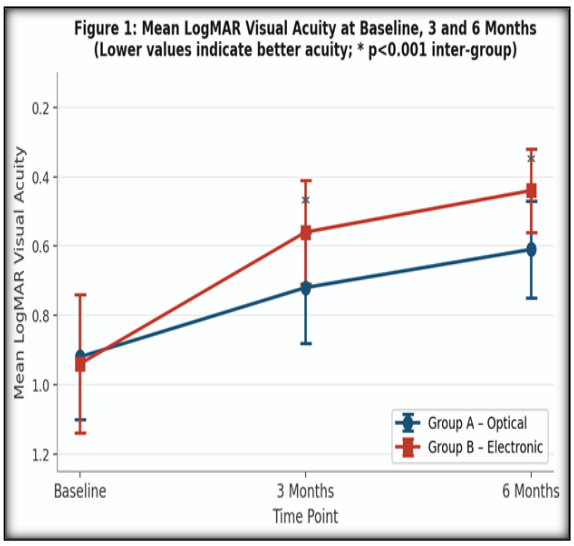

Figure 1: Mean LogMAR Visual Acuity at Baseline, 3 Months, and 6 Months (error bars = ±1 SD; * p<0.001 inter-group)

Reading Speed and Contrast Sensitivity

At 6 months, reading speed improved significantly from baseline in both groups. [Table 3, Figure 2] Group B demonstrated markedly superior reading speed (58.3±12.1 WPM) compared to Group A (42.7±9.8 WPM) ($p<0.001$). Contrast sensitivity improvement was comparable between groups at 6 months (p=0.14 inter-group).

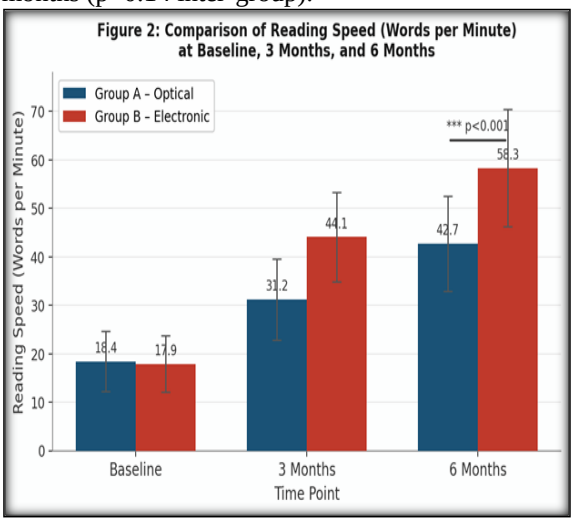

Figure 2: Comparison of Reading Speed (Words per Minute) at Baseline, 3 Months, and 6 Months (error bars = ±1 SD; *** p<0.001 inter-group at 6 months)

Quality of Life and Patient Satisfaction

NEI-VFQ-25 composite scores improved significantly in both groups at 6 months. [Table 4, Figure 3] Electronic aid users achieved significantly higher composite scores (67.4±8.3 vs 58.2±9.1, p<0.01). Subscale analyses revealed electronic aids were particularly superior in near activities (p=0.003), mental health (p=0.02), and role difficulties (p=0.01) subscales. Optical aids were non-inferior in distance activities and peripheral vision subscales.

Patient satisfaction was higher in the electronic aid group (7.6±1.2 vs 6.8±1.4, p=0.003); however, aid compliance at 6 months was significantly better in the optical aid group (88.3% vs 71.7%, p=0.02). Reasons cited for non-compliance in the electronic group included difficulty with battery charging (n=8), weight or ergonomics (n=6), and cost of accessories (n=3).

Table 3: Reading Speed, Contrast Sensitivity, Satisfaction and Compliance at 6 Months

Parameter	Group A Baseline	Group A 6 Months	Group B Baseline	Group B 6 Months	Inter-group p (6 Mo)
Reading Speed (WPM)	18.4 ± 6.2	42.7 ± 9.8*	17.9 ± 5.8	58.3 ± 12.1*	<0.001
Contrast Sensitivity (log units)	1.42 ± 0.21	1.68 ± 0.19*	1.40 ± 0.23	1.72 ± 0.20*	0.14
Satisfaction Score (0–10)	—	6.8 ± 1.4	—	7.6 ± 1.2	0.003
Aid Compliance (%)	—	88.3%	—	71.7%	0.02

* p<0.001 vs baseline (paired t-test). WPM: words per minute. Inter-group comparison by independent t-test.

Table 4: NEI-VFQ-25 Subscale Scores at Baseline and 6 Months

Subscale	Gr A Baseline	Gr A 6 Mo	Gr B Baseline	Gr B 6 Mo	p†
General Vision	36.4±8.2	52.1±9.4	35.9±7.8	54.6±8.9	0.17
Near Activities	28.3±7.1	55.4±10.2	27.8±6.9	68.7±11.4	0.003
Distance Activities	31.2±9.0	50.8±9.8	30.9±8.6	51.3±10.1	0.79
Mental Health	42.1±10.3	59.2±9.7	41.7±9.8	66.8±10.2	0.02
Role Difficulties	30.4±8.4	52.3±10.1	31.2±7.9	62.4±9.6	0.01
Social Function	44.2±9.6	60.1±10.4	43.9±9.1	64.2±9.8	0.08
Composite Score	34.2±7.6	58.2±9.1	33.8±8.1	67.4±8.3	0.009

† P-value for inter-group comparison at 6 months. Gr A: Group a (Optical); Gr B: Group B (Electronic). Scores range 0–100, higher = better.

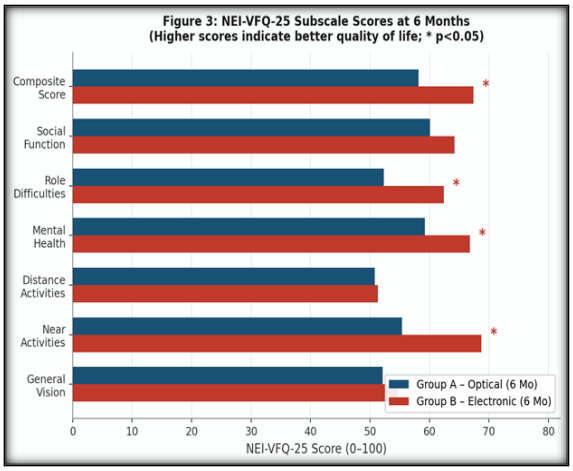

Figure 3: NEI-VFQ-25 Subscale Scores at 6 Months — Comparison between Groups (Higher scores indicate better quality of life; * p<0.05 inter-group)

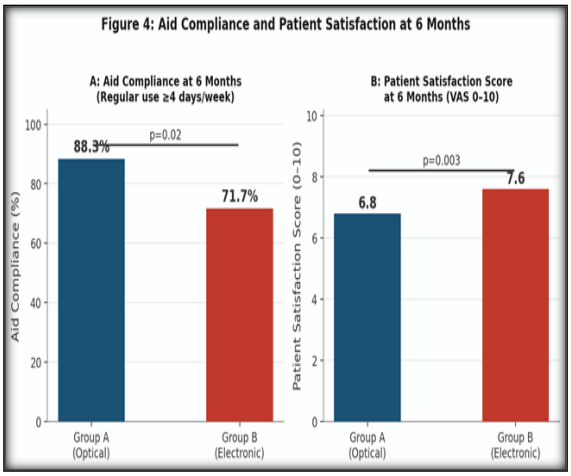

Figure 4: Aid Compliance at 6 Months (Panel A) and Patient Satisfaction Score (Panel B) — Comparison between Groups

DISCUSSION

This prospective comparative study evaluated optical and electronic low vision aids in 120 patients over 6 months and demonstrated significant functional improvements with both modalities. Our findings are largely consistent with the existing international literature while providing novel data pertinent to the Indian clinical context.

Visual acuity improvement was significantly greater in the electronic aid group (0.50 LogMAR units) compared to the optical aid group (0.31 LogMAR units) at 6 months. This is concordant with the

findings of Nguyen et al,[13] who demonstrated superior visual acuity outcomes with electronic magnification in AMD patients, and Culham et al,[14] who reported superior clinical performance of electronic magnification aids over optical aids for reading tasks in age-related macular degeneration. The superior performance of electronic aids is attributable to their wider adjustable magnification range, contrast enhancement, and colour-inversion features, which are particularly beneficial for patients with central scotomas and contrast sensitivity deficits.[15]

Reading speed improvement was markedly superior in the electronic aid group (58.3 WPM vs 42.7 WPM, p<0.001). This finding mirrors that of Virgili et al,[16] in a Cochrane systematic review, which found that reading speed with electronic aids was 1.5–2 times faster than with optical aids, particularly for patients with macular degeneration. The ability to adjust text size, contrast, and viewing angle electronically likely facilitates more comfortable and sustained reading.[17] Optical aids, while effective, impose greater demands on working distance maintenance and depth of focus, which can fatigue patients during prolonged near tasks.[18]

Contrast sensitivity improvement was comparable between both groups (p=0.14), a finding consistent with Stelmack et al,[19] who noted that aid type did not significantly influence contrast sensitivity gains, which may depend more on the underlying pathology and preserved retinal function. Notably, patients with retinitis pigmentosa and peripheral field loss showed better contrast enhancement with electronic aids utilising high-contrast display modes.[20]

Quality of life, assessed by NEI-VFQ-25, improved significantly in both groups. The electronic aid group demonstrated higher composite scores (67.4 vs 58.2, p=0.009), with particular advantage in near activities, mental health, and role difficulties subscales. This aligns with data from Stelmack et al,[21] and Binns et al,[22] who reported superior patient-reported outcomes with magnification technology. The mental health subscale improvement likely reflects the greater functional independence and reduced reading difficulty achieved with electronic aids, translating into improved psychological wellbeing.[23]

Despite superior functional outcomes, the electronic aid group demonstrated significantly lower compliance at 6 months (71.7% vs 88.3%, p=0.02). This is a clinically important finding. Optical aids are lightweight, immediately available without charging, and straightforward to use — attributes that facilitate habitual use, particularly among elderly patients.[24] Electronic aids, while functionally superior, have a steeper learning curve and require regular charging and maintenance. Our compliance data are consistent with those reported by Culham et al,[25] who observed that complexity of electronic devices was a barrier to adoption in older adults.

The cost differential between optical and electronic aids is substantial. In the Indian context, basic optical magnifiers are available for ₹200–₹2000, whereas portable electronic video magnifiers cost ₹15,000–₹80,000. This economic barrier has profound implications for prescribing practice in a resource-limited setting. Our data suggest that for patients with moderate low vision (BCVA 6/18–6/60) and good near task requirements, well-fitted optical aids may represent an equally effective and more accessible option. For patients with severe low vision (BCVA 6/60–3/60) and high reading demands, electronic aids may justify the additional cost.[26,27]

Subgroup analysis revealed that patients with age-related macular degeneration and diabetic macular oedema demonstrated the greatest benefit from electronic aids, while patients with peripheral field loss (glaucoma, retinitis pigmentosa) showed comparable outcomes with both modalities. Age was a significant predictor of compliance — patients above 60 years were 2.3 times more likely to be compliant with optical aids (OR 2.3, 95%CI 1.1–4.8, p=0.03), consistent with reports by Harper et al.[28] These observations support a stratified, patient-centred prescribing approach.

The strengths of this study include its prospective design, allocation concealment, masked outcome assessment, high follow-up rate (98.3%), and use of validated outcome measures including NEI-VFQ-25 and MNRead acuity charts. Limitations include the single-centre design, relatively short 6-month follow-up, lack of a crossover design, and inability to blind patients to their aid allocation. Future multi-centre randomised controlled trials with longer follow-up periods, health economic analyses, and patient-reported experience measures are warranted.[29,30]

CONCLUSION

Both optical and electronic low vision aids confer significant improvements in visual acuity, reading speed, contrast sensitivity, and quality of life in patients with low vision. Electronic aids demonstrate superior outcomes in reading speed, near activities, and overall NEI-VFQ-25 composite scores, while optical aids exhibit better patient compliance and cost-effectiveness. An individualised, need-based approach — considering the patient's age, underlying aetiology, socioeconomic status, educational requirements, and visual goals — remains the optimal strategy for low vision rehabilitation in clinical practice.

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