

Psychosocial Benefits of Visual Rehabilitation with Semi-Scleral Contact Lenses in Adult Patients: A Prospective Questionnaire-Based Study

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ABSTRACT

Background: Visual impairment from corneal ectasia, corneal grafts and ocular surface disease affects the education, employment and social life of young adults. The psychosocial outcomes of semi-scleral contact lens (SSCL) rehabilitation across such mixed indications are reported less often than visual acuity outcomes.

Methods: In this prospective, hospital-based, single-arm pre-post study at PBMA's H.V. Desai Eye Hospital, Pune (July-December 2025), 30 adults aged 18-40 years were fitted with Rose K2 XL 14.9 mm SSCLs. An 11-item bilingual (English/Marathi) questionnaire adapted from the National Eye Institute Visual Function Questionnaire-25 (NEI VFQ-25) was completed before fitting and after 3 months of wear; items were converted to 0-100 domain scores. Changes were tested with Wilcoxon signed-rank tests (Holm-adjusted), with effect sizes, bootstrap confidence intervals, subgroup and regression analyses.

Results: Mean age was 28.7 ± 5.6 years; 18 were male. Diagnoses were keratoconus (n=9), pellucid marginal degeneration (n=8), post-keratoplasty (n=5), post-refractive

ectasia (n=4) and dry eye (n=4). Mean daily wear was 9.4 ± 1.2 hours. The overall vision-targeted composite rose from a median of 48.1 (IQR 33.3-55.6) to 96.3 (82.4-100.0); mean change 46.4 points (95% CI 40.5-52.2), and all 30 participants improved. The psychosocial composite (mental health, social functioning, role difficulties, dependency) rose from 50.0 to 100.0 (mean change 41.1, 95% CI 35.3-47.2). All nine vision-targeted domains improved (Holm-adjusted $p < 0.0001$; effect size r 0.77-0.89). The proportion giving the best response to the four psychosocial items increased from 0-7% to 70-77%. Improvement did not differ across diagnoses (Kruskal-Wallis $p = 0.50$) and was larger in those with lower baseline scores.

Conclusion: Three months of semi-scleral lens wear was associated with large, consistent improvements in vision-specific mental health, social functioning, role participation and independence in young adults with visually disabling corneal conditions. Because the design had no comparison group and relied on self-report, controlled studies with longer follow-up are warranted.

Keywords: semi-scleral contact lens; visual rehabilitation; psychosocial outcomes; quality of life; keratoconus; NEI VFQ-25

INTRODUCTION

Vision loss in young adults carries a disproportionate psychosocial cost because it coincides with education, entry into work and the formation of independent social roles. Corneal ectatic disorders such as keratoconus, pellucid marginal degeneration (PMD) and post-refractive ectasia, irregular astigmatism after keratoplasty, and severe ocular surface disease reduce vision through irregular corneal optics and higher-order aberrations that spectacles and soft lenses cannot correct. The burden extends beyond acuity: in keratoconus, vision-related quality of life is reduced in near and distance vision, general vision, mental health and social functioning [1,2].

Scleral and semi-scleral lenses vault the cornea and rest on the conjunctival-scleral or limbal zone, replacing the irregular anterior corneal surface with a smooth, fluid-filled refracting interface that reduces irregular astigmatism and higher-order aberrations [3]. Prospective and observational series using the NEI VFQ-25 report improved quality of life after scleral lens fitting in keratoconus, including a 3-month Indian series of 14 patients [4], a French series with a mean gain of 19.5 points [5], a mini-scleral series reporting gains on both visual-functioning and socio-emotional scales [6] and a series that included PMD and post-keratoplasty eyes [7]. A systematic review found sustained improvement in acuity and quality of life, with lens-handling difficulty and fogging the commonest problems [8]. Scleral lenses have also shown symptomatic benefit in severe dry eye disease [9] and mini-scleral lenses in mixed corneal disorders [10]. Most of this evidence emphasises keratoconus, reports an overall composite score, and spans a wide age range. To our knowledge, patient-level psychosocial outcomes across several indications within one young-adult cohort have been described

less often. This study therefore examined the psychosocial benefits of semi-scleral lens rehabilitation in adults aged 18-40 years.

Aim and objectives

The primary objective was to quantify the change in vision-specific psychosocial functioning (mental health, social functioning, role difficulties and dependency) 3 months after semi-scleral lens fitting. The secondary objectives were to quantify changes in the visual-function and ocular-pain domains, to compare improvement across diagnostic groups, and to explore whether age, sex, daily wear time and baseline severity were associated with the degree of improvement.

MATERIALS & METHODS

Study design and setting

This was a prospective, hospital-based, single-arm, pre-post questionnaire study conducted at PBMA's H.V. Desai Eye Hospital, Hadapsar, Pune, India, from July 2025 to December 2025. Reporting followed the STROBE recommendations for observational studies [11]. The study was approved by the Institutional Ethics Committee of the Dr. D.Y. Patil Institute of Optometry and Visual Sciences (reference DYPIOVS/CO/78N/2025, 13 May 2025) and conducted in accordance with the Declaration of Helsinki [12]. All participants gave written informed consent, and responses were collected anonymously.

Participants

Thirty consecutive patients referred for semi-scleral lens trial were enrolled by purposive sampling; no formal sample-size calculation was performed. Adults aged 18-40 years with visual impairment due to keratoconus, PMD, post-keratoplasty irregular astigmatism, post-refractive ectasia or dry eye disease, and without significant cognitive or psychiatric disorder, were eligible. Patients who did not comply with the lens-wear protocol, and those with cognitive or neurodevelopmental conditions

that would affect completion of the questionnaire, were excluded.

Lens fitting

Each participant had a comprehensive optometric assessment and contact lens pre-fitting examination. Rose K2 XL semi-scleral lenses (Menicon), diameter 14.9 mm, were fitted after trial lens assessment. In keratoconus, PMD and post-refractive ectasia, the fit aimed at a light feather touch over the thinnest corneal region; in dry eye and post-graft eyes, a central clearance of approximately 20-30 μm was targeted. The landing zone was assessed to confirm an acceptable fit before the final parameters were ordered. Participants were instructed in lens insertion, removal and care, and daily wear time was recorded at follow-up.

Outcome measure

Psychosocial status was assessed with an 11-item self-administered questionnaire in English and Marathi, adapted from the NEI VFQ-25 [13]. The instrument contains one item each for general health, general vision, vision-specific mental health (frequency of feeling discouraged), social functioning, ocular pain, near activities, distance activities, role difficulties and dependency, and two items for driving (daytime in familiar places and at night). Each item had four response options, coded 1 (worst) to 4 (best), and converted to a 0-100 score as $(\text{code}-1) \times 100/3$, where higher scores indicate better function. The driving score was the mean of its two items. Three composites were derived: a psychosocial composite (mental health, social functioning, role difficulties, dependency); a visual-function composite (general vision, near activities, distance activities, driving); and an overall vision-targeted composite (those nine domains plus ocular pain). General health was analysed separately and excluded from the composites. The questionnaire was content-validated by a consultant cornea specialist (certificate dated 27 November 2025). Participants completed it at the first visit before lens

fitting and again after 3 months of lens wear.

Statistical analysis

Continuous data are summarised as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), and categorical data as number (%). Because the domain scores are ordinal with four possible values, the primary comparison of pre- and post-fitting scores used the Wilcoxon signed-rank test (asymptotic, tie-corrected, as implemented in IBM SPSS Statistics) [14]. P-values for the ten domains were adjusted with the Holm procedure [15]. The effect size was $r = |Z|/\sqrt{N}$ [16] together with the matched-pairs rank-biserial correlation [17]; the mean paired change and the Hodges-Lehmann median shift [18] are given with 95% bootstrap percentile confidence intervals (10,000 resamples). For the composites, a paired t-test with Hedges' g was run as a sensitivity analysis after checking the normality of the differences (Shapiro-Wilk). Item-level shifts to the best response category were tested with the exact McNemar test. A change of at least 0.5 SD of the baseline composite was used as the threshold for an individually meaningful improvement [19]. Differences in change across the five diagnoses were tested with the Kruskal-Wallis test, ectatic (keratoconus, PMD, post-refractive ectasia) versus non-ectatic (post-graft, dry eye) groups and sexes with the Mann-Whitney U test, and within-diagnosis changes with exact sign-flip Wilcoxon tests. Associations of age, wear time and baseline score with change were examined with Spearman correlation and a multivariable linear regression with heteroscedasticity-robust (HC3) standard errors. Internal consistency was estimated with Cronbach's alpha [20]. All tests were two-sided with $\alpha=0.05$. Analyses were run in Python 3 (SciPy, statsmodels); the dataset (.sav) and equivalent IBM SPSS syntax are provided as supplementary files.

RESULT

Participants

All 30 enrolled patients completed both assessments. Mean age was 28.7 ± 5.6 years (range 18-38); 18 (60.0%) were male and 12 (40.0%) female. The diagnoses were

bilateral keratoconus in 9 (30.0%), PMD in 8 (26.7%), post-keratoplasty in 5 (16.7%), post-refractive ectasia in 4 (13.3%) and dry eye in 4 (13.3%). Mean daily lens wear at follow-up was 9.4 ± 1.2 hours (range 8-12) (Table 1).

Table 1: Baseline characteristics of the participants (n=30)

Characteristic	Value
Age, years, mean $\pm$ SD (range)	28.7 ± 5.6 (18-38)
Male sex, n (%)	18 (60.0)
Female sex, n (%)	12 (40.0)
Diagnosis, n (%)	
Bilateral keratoconus	9 (30.0)
Pellucid marginal degeneration	8 (26.7)
Post-keratoplasty (post-graft)	5 (16.7)
Post-refractive ectasia	4 (13.3)
Dry eye disease	4 (13.3)
Daily lens wear at 3 months, hours, mean $\pm$ SD (range)	9.4 ± 1.2 (8-12)

SD: standard deviation. Lens: Rose K2 XL semi-scleral, 14.9 mm.

Overall and psychosocial outcomes

The overall vision-targeted composite increased from a median of 48.1 (IQR 33.3-55.6) before fitting to 96.3 (IQR 82.4-100.0) after 3 months (Wilcoxon $Z=-4.78$, $p<0.0001$; $r=0.87$). The mean change was 46.4 points (95% bootstrap CI 40.5 to 52.2; Hodges-Lehmann shift 46.3, 95% CI 40.7 to 53.7), and the paired t-test gave the same conclusion (Hedges' $g=2.73$, $p<0.0001$). Every participant improved (range of individual change 14.8 to 77.8 points), and all exceeded the 0.5-SD threshold of 7.3 points (Figure 1A). By 3 months, 47% of participants had reached the maximum composite score of 100.

The psychosocial composite rose from a median of 50.0 (IQR 33.3-64.6) to 100.0 (IQR 83.3-100.0); mean change 41.1 points (95% CI 35.3 to 47.2; $Z=-4.79$, $p<0.0001$, $r=0.88$), with all 30 participants improving.

The visual-function composite rose from 41.7 to 100.0 (mean change 51.5, 95% CI 44.6 to 58.1). Changes in the two composites were strongly correlated (Spearman $\rho=0.70$, $p<0.0001$).

Domain-level outcomes

All nine vision-targeted domains improved significantly after Holm adjustment (adjusted $p<0.0001$ for each; effect size r from 0.77 for driving to 0.89 for distance activities; Table 2, Figure 2). Near and distance activities showed the largest mean gains (+61.1 and +64.4 points) and driving the smallest (+37.2), partly because three participants already reported no driving difficulty at baseline. General health, which is not vision-specific, also rose (median 50.0 to 66.7; mean change 22.2; adjusted $p=0.0004$).

Table 2: Vision-specific domain and composite scores (0-100) before and after 3 months of semi-scleral lens wear (n=30)

Domain	Before: median (IQR)	After: median (IQR)	Mean change (95% CI)	Better / same / worse	Z	Holm p	r
General vision	33.3 (33.3-66.7)	100.0 (100.0-100.0)	43.3 (35.6 to 51.1)	27/3/0	-4.63	<0.0001	0.84
Ocular pain	33.3 (33.3-66.7)	100.0 (66.7-100.0)	46.7 (37.8 to 56.7)	27/3/0	-4.59	<0.0001	0.84
Near activities	33.3 (8.3-33.3)	100.0 (66.7-100.0)	61.1 (51.1 to 70.0)	29/0/1	-4.81	<0.0001	0.88

Domain	Before: median (IQR)	After: median (IQR)	Mean change (95% CI)	Better / same / worse	Z	Holm p	r
Distance activities	33.3 (8.3-33.3)	100.0 (100.0-100.0)	64.4 (54.4 to 73.3)	29/0/1	-4.86	<0.0001	0.89
Driving	66.7 (33.3-66.7)	100.0 (100.0-100.0)	37.2 (27.2 to 46.7)	23/6/1	-4.21	<0.0001	0.77
Mental health	66.7 (33.3-66.7)	100.0 (100.0-100.0)	41.1 (32.2 to 48.9)	25/5/0	-4.48	<0.0001	0.82
Social functioning	50.0 (33.3-66.7)	100.0 (100.0-100.0)	38.9 (30.0 to 47.8)	25/5/0	-4.43	<0.0001	0.81
Role difficulties	33.3 (33.3-66.7)	100.0 (100.0-100.0)	44.4 (36.7 to 52.2)	27/3/0	-4.63	<0.0001	0.84
Dependency	33.3 (33.3-66.7)	100.0 (100.0-100.0)	40.0 (31.1 to 47.8)	27/2/1	-4.55	<0.0001	0.83
General health (non-vision)	50.0 (33.3-66.7)	66.7 (66.7-66.7)	22.2 (14.4 to 31.1)	18/11/1	-3.56	0.0004	0.65
Psychosocial composite	50.0 (33.3-64.6)	100.0 (100.0-100.0)	41.1 (35.3 to 47.2)	30/0/0	-4.79	<0.0001	0.88
Visual-function composite	41.7 (27.1-50.0)	100.0 (100.0-100.0)	51.5 (44.6 to 58.1)	29/1/0	-4.72	<0.0001	0.86
Overall composite	48.1 (33.3-55.6)	96.3 (82.4-100.0)	46.4 (40.5 to 52.2)	30/0/0	-4.78	<0.0001	0.87

IQR: interquartile range; CI: bootstrap percentile confidence interval; Z: Wilcoxon signed-rank statistic; Holm p: Holm-adjusted p-value across the ten domains (composites unadjusted); $r = |Z|/\sqrt{30}$. Higher scores indicate better function. Driving is the mean of two items. Domains are ordinal with four levels, so medians take values 0, 33.3, 66.7 or 100 (or midpoints for driving).

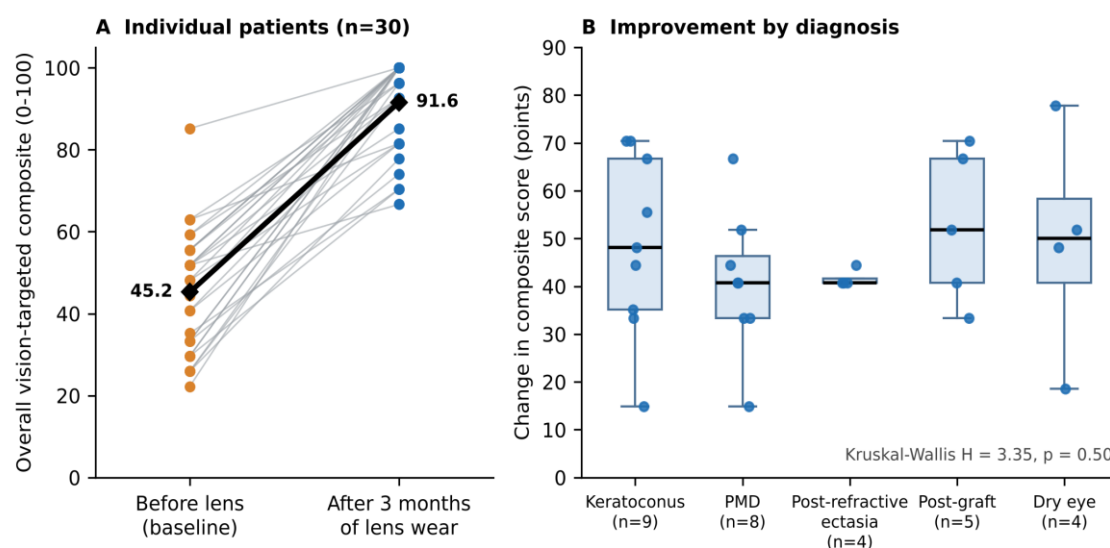


Figure 1: Change in the overall vision-targeted composite score. (A) Individual trajectories before and after 3 months of lens wear; the thick line joins the means. (B) Change in composite score by diagnosis (box: median and IQR; points: individual patients).

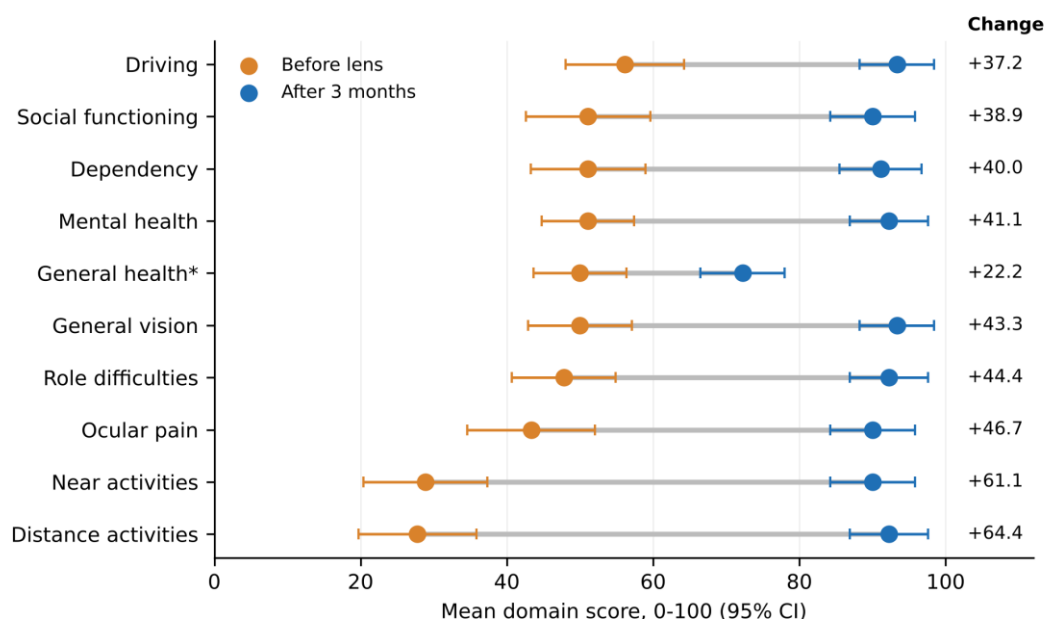


Figure 2: Mean domain scores (0-100) before and after 3 months of semi-scleral lens wear, with 95% confidence intervals; numbers at right show the mean change. *General health is not a vision-specific domain.

Item-level responses showed the same pattern (Figure 3). Before fitting, only 0-7% of participants gave the best response to the four psychosocial items; after 3 months 70-77% did (mental health 0% to 77%; social functioning 7% to 70%; role difficulties 3% to 77%; dependency 7% to 73%; exact McNemar $p < 0.0001$ for each). At baseline, 14 participants (47%) reported feeling

discouraged "sometimes", 18 (60%) were limited "somewhat" in work or activities, and one reported extreme limitation of social activities; no participant gave a worst-category response to any psychosocial item after fitting. Ocular pain improved in 27 of 30 participants, with the best response (no pain) rising from 0% to 70%.

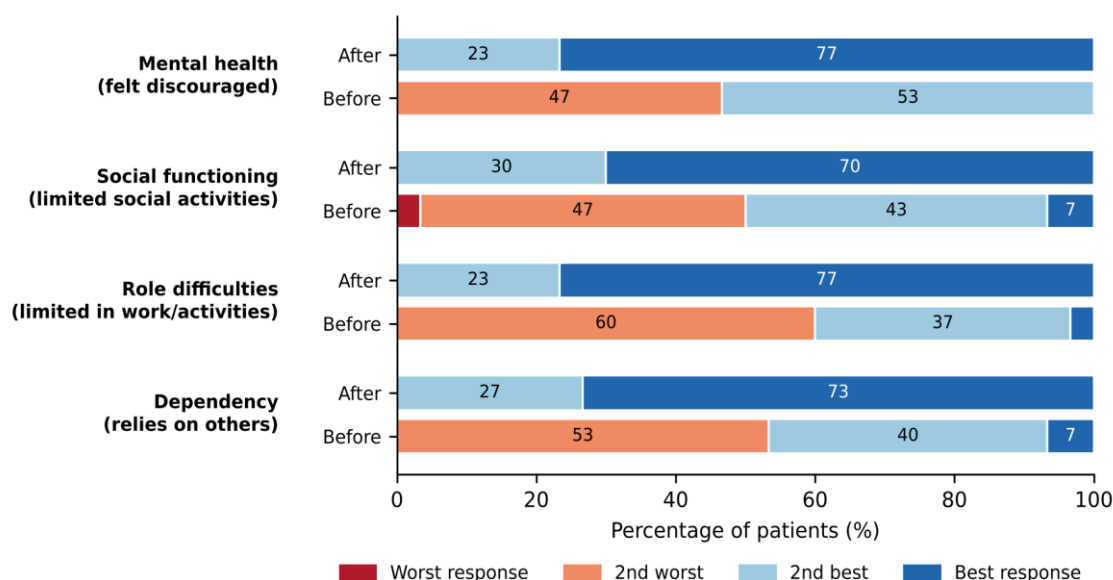


Figure 3: Distribution of responses to the four psychosocial items before and after 3 months of semi-scleral lens wear (percentage of 30 participants; values under 6% are not labelled).

Outcomes by diagnosis, sex and other factors

Improvement in the overall composite was seen in every participant in every diagnostic group (Table 3). The change did not differ significantly across the five diagnoses (Kruskal-Wallis $H=3.35$, $p=0.50$), between ectatic ($n=21$; median change 40.7) and

non-ectatic eyes ($n=9$; 51.9; Mann-Whitney $p=0.21$), or between men (median change 46.3) and women (40.7; $p=0.15$). Within-group exact p -values for the three smallest groups cannot fall below 0.0625 ($n=5$) or 0.125 ($n=4$) with two-sided testing, so their values in Table 3 reflect sample size rather than absence of effect.

Table 3: Overall composite score (0-100) before and after 3 months of lens wear by diagnosis

Diagnosis	n	Before: median (IQR)	After: median (IQR)	Median change	Improved	Exact p*
Bilateral keratoconus	9	44.4 (33.3-51.9)	100.0 (81.5-100.0)	48.1	9/9	0.004
PMD	8	51.9 (33.3-56.5)	92.6 (83.3-100.0)	40.7	8/8	0.008
Post-graft	5	29.6 (29.6-40.7)	92.6 (92.6-96.3)	51.9	5/5	0.062
Post-refractive ectasia	4	55.6 (51.9-56.5)	98.1 (92.6-100.0)	40.7	4/4	0.12
Dry eye	4	50.0 (41.7-54.6)	100.0 (95.4-100.0)	50.0	4/4	0.12
All participants	30	48.1 (33.3-55.6)	96.3 (82.4-100.0)	44.4	30/30	<0.0001

*Exact sign-flip Wilcoxon test within each diagnosis (all participants: asymptotic Wilcoxon). Between-diagnosis comparison of change: Kruskal-Wallis $p=0.50$.

Greater improvement was seen in participants with lower baseline scores (Spearman ρ between baseline composite and change = -0.72, $p<0.0001$). Age was not associated with change ($\rho=0.21$, $p=0.26$). Longer daily wear was weakly associated with smaller improvement ($\rho=-0.39$,

$p=0.033$), but this association was not significant after adjustment (Table 4). In the multivariable model, baseline composite was the only independent factor, and the model explained 67% of the variance in change.

Table 4: Multivariable linear regression of change in the overall composite score ($n=30$)

Factor	B (points)	95% CI	p
Baseline composite, per 10-point increase	-7.96	-10.95 to -4.96	<0.0001
Age, per year	0.06	-1.51 to 1.63	0.94
Female sex (vs male)	2.21	-7.52 to 11.94	0.66
Daily wear time, per hour	-3.95	-8.32 to 0.43	0.077
Non-ectatic diagnosis (vs ectatic)	0.99	-18.40 to 20.37	0.92

B: change in composite points per unit of the factor; HC3 robust standard errors. $R^2=0.67$, adjusted $R^2=0.60$. Exploratory analysis in a small sample; estimates are imprecise.

Internal consistency was good: Cronbach's alpha for the ten vision-specific items was 0.89 before and 0.88 after fitting, and for the four psychosocial items 0.78 and 0.82.

DISCUSSION

In this prospective series of 30 young adults with corneal ectasia, post-keratoplasty irregular astigmatism or dry eye disease, 3 months of semi-scleral lens wear was accompanied by large improvements in every vision-targeted domain. The psychosocial composite increased by a mean of 41.1 points and every participant improved. The proportion reporting no

limitation in social activities, work or independence, and feeling discouraged by vision never or rarely, rose from a small minority to roughly three-quarters.

The direction of this finding agrees with the published scleral lens literature. A Pune series of 14 keratoconus patients using the NEI VFQ-25 reported higher overall scores and improved mental health, social functioning, distance and near activities and driving after 3 months [4]; a French series reported a mean gain of 19.5 points [5]; mini-scleral lenses improved visual-functioning and socio-emotional scales in 50 keratoconus patients [6]; and scleral lens

wear improved the NEI VFQ score in patients with keratoconus, PMD and post-keratoplasty astigmatism [7]. Gains of broadly similar size were reported in a French retrospective series (+32.1) [21], a Moroccan series (42.6 to 80.5; +38.1) [22] and a Moroccan hospital cohort of 98 eyes (39.9 to 87.3, +47.3, at 6 months) [23]. The mean change of about 46 points on our 0-100 composite lies within this range. Direct comparison is limited, because our instrument had a single four-option item per domain, so each step in response moves the score by 33 points, and because up to 80% of participants reached the best response at follow-up. The magnitude should therefore be read as a consistent direction of benefit rather than a precise effect estimate.

Several results help interpret the psychosocial gains. First, changes in psychosocial and visual-function composites were strongly correlated ($\rho=0.70$), consistent with psychosocial benefit following from better functional vision, although shared method variance cannot be excluded. Second, improvement did not differ significantly across diagnoses. This supports a common mechanism, in which a smooth refracting surface and tear reservoir improve vision and comfort whatever the underlying cause [3,8], and agrees with reports of benefit in dry eye [9] and in mixed corneal disorders [10]. The subgroup comparisons are underpowered, however, and do not establish equivalence. Third, ocular pain improved in 27 of 30 participants, which may reflect protection of the ocular surface by the fluid reservoir in dry eye and post-graft eyes; this was not examined clinically here.

Two findings call for caution. Baseline severity was the strongest correlate of improvement (B -8.0 points per 10-point higher baseline), which is expected where scores are bounded and many participants reach the ceiling, and part of it may reflect regression toward the mean. In addition, the non-vision-specific general health item also rose (mean +22.2), although a contact lens is not expected to alter general health. This

suggests that some of the measured benefit may reflect expectancy or a general positive response set rather than a lens-specific effect, and it argues for including a non-vision-specific control item or a comparison group in future work. Daily wear time averaged 9.4 hours, comparable with 9.9 hours in the Moroccan hospital series [23] and lower than in some mini-scleral series [10]; wear time is considered a marker of scleral lens success [24]. In our data longer wear was not independently associated with greater gain.

Some baseline responses differ from keratoconus-only studies. Al Zabadi et al. found that role difficulties and dependency were not significantly impaired in keratoconus [2], whereas these domains were affected at baseline here, possibly because our cohort included post-graft and dry-eye patients and because baseline was a visually disabled, lens-seeking group.

Strengths and limitations

Strengths are the prospective pre-post design with complete follow-up, a patient-reported outcome covering psychosocial as well as functional domains, a mixed-indication cohort restricted to young adults, and a statistical approach appropriate to ordinal data, with multiplicity control, effect sizes and sensitivity analyses. The main limitations are the absence of a comparison group, the small single-centre sample without a formal power calculation, a 3-month follow-up, and reliance on self-report, all of which can inflate benefit through expectancy and social-desirability effects. The questionnaire was an 11-item adaptation of the NEI VFQ-25 with coarse four-level items, content-validated by a single expert, and without formal psychometric validation in this population; it omits the colour vision and peripheral vision domains, and a ceiling effect limits the ability to detect further gain. Anxiety, depression and self-esteem were not measured. Visual acuity, habitual correction before fitting, lens-related adverse events and discontinuation were not analysed in

this report. Larger, multicentre, controlled studies with longer follow-up, validated psychosocial measures and clinical correlates are needed.

CONCLUSION

Over 3 months, semi-scleral contact lens rehabilitation was associated with large and consistent improvements in vision-specific mental health, social functioning, role participation and independence in young adults with visually disabling corneal ectasia, post-keratoplasty irregular astigmatism and dry eye disease. The gains were similar across diagnoses and were greatest in those with the lowest baseline function. Semi-scleral lenses should be considered a form of visual rehabilitation with psychosocial as well as optical benefit; controlled studies with longer follow-up are needed to confirm the size and durability of the effect.

Declaration by Authors

Ethical Approval: Approved by the Institutional Ethics Committee, Dr. D.Y. Patil Institute of Optometry and Visual Sciences, Pimpri, Pune (Ref. DYPIOVS/CO/78N/2025, dated 13 May 2025). Written informed consent was obtained from all participants.

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