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ORIGINAL RESEARCH

Preoperative Suboptimal Correction and Early Visual Recovery After SMILE: How Full vs Under/Over-Correction Shapes Outcomes

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Background: Preoperative suboptimal correction (under/over-correction) is prevalent among myopic SMILE candidates. Existing studies lack data on its impact on early visual recovery and binocular function. This study aims to investigate the impact of preoperative suboptimal correction on early visual recovery in myopes undergoing SMILE and to compare these outcomes to normal values.

Methods: Visual results of 148 eyes with preoperative suboptimal correction were compared with 72 full-corrected eyes after SMILE. Assessments included uncorrected distance visual acuity (UDVA), refraction, visual quality parameters (strehl ratio (SR), the modulation transfer function (MTF) curves), and binocular visual function (perceptual eye position, vergence-divergence dynamic and stereovision) at baseline and 1 week, 1 month and 3 months postoperatively.

Results: UDVA improved significantly faster in the full-correction group (1-week follow-up) versus the suboptimal group (1-month follow-up). The full-correction group exhibited superior SR ($P = 0.02$) and MTF performance at 4-mm pupil ($P < 0.05$ at 5 and 10 cycles/degree) at 1 month. Horizontal perceptual deviation transiently increased at 1 month but normalized by 3 months in the suboptimal group. Convergence function decreased at 1 month but returned to baseline at 3 months in the suboptimal correction group, while improved at both 1-month and 3-month visits in the full-correction group. Divergence function improved in both groups with no intergroup differences (all $P > 0.05$).

Conclusion: Myopic subjects with preoperative suboptimal correction exhibit delayed visual recovery (notably UDVA and binocular function) compared to fully corrected peers after SMILE. These findings confirm SMILE's safety and efficacy even in eyes with suboptimal presenting visual acuity (PVA), while indicating the need for preoperative counseling to align patient expectations and targeted postoperative visual training to accelerate recovery—strategies that may enhance patient satisfaction.

Keywords: myopia, refractive surgery, suboptimal presenting visual acuity, visual quality, visual recovery

Introduction

Myopia is a significant cause of unilateral visual impairment, and uncorrected refractive error, accompanied by cataract, is the leading cause of visual impairment in China.[1] The WHO's Blindness and Vision Impairment Report reveals that only 36% of individuals with refractive error-related distance vision impairment globally use appropriate spectacles.[2] Presenting visual acuity (PVA), defined as the visual acuity with currently available refractive correction (if any), is considered presenting vision impairment (PVI) when <0.3 logMAR (20/40 Snellen).[3,4] PVA is often more clinically relevant than corrected distance visual acuity (CDVA), as it directly reflects an individual's actual visual experience in daily activities.[5] Notably, many patients exhibit suboptimal correction patterns (e.g., inconsistent spectacle use, outdated prescriptions). Such inadequate correction can lead to increased risks of PVI, binocular dysfunction, and stereoscopic vision deficits.[3]

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Small Incision Lenticule Extraction (SMILE), a minimally invasive femtosecond laser-based refractive procedure, restores unaided vision in ametropic patients.[6] While visual acuity improvement following refractive surgery has been widely studied,[7] some patients report ongoing dissatisfaction despite achieving Snellen acuity of 20/20 or better.[8] Thus, evaluating success of a vision-restoring surgery demands a multidimensional assessment encompassing visual acuity improvement, visual quality and binocular visual perceptual balance—particularly in patients with suboptimal preoperative correction. Recent advancements in computational ophthalmology have introduced binocular perceptual analytics tools, such as visual perception software platforms, to quantitatively evaluate higher-order visual functions. To quantify these parameters, we assessed horizontal/vertical perceptual eye position, vergence-divergence dynamics and stereovision using dichoptic motion coherence threshold technology (Guangdong Nuoyide Biomedical Technology Development Co., Ltd).[9]

While existing research on SMILE has extensively focused on validating the procedure's efficacy or optimizing nomograms, a critical gap remains in understanding how preoperative correction status affects postoperative recovery trajectories.[6,7] Many myopic patients present with outdated or suboptimal corrections (eg, ≥0.75D spherical equivalent deviation from target refraction), but the relationship between such preoperative non-optimal correction and post-operative recovery remains unexplored systematically. This study investigates whether preoperative refractive correction status (full vs suboptimal) influences early SMILE surgical outcomes, aiming to inform personalized surgical protocols and postoperative visual rehabilitation strategies.

Materials and Methods

Ethical Approval

The study was approved by the ethical standards of the Ethics of Committee of the Shanghai General hospital and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Study Participants

This study included consecutive patients who underwent bilateral or monocular SMILE at the refractive surgery center of the Shanghai General hospital between January and September 2024. Patients were required to meet the general SMILE surgical eligibility criteria, including normal corneal topography, stable refraction (≤0.50 D change) for at least 12 months, no contact lens wear for the required period and an age range of 18–36 years. Patients were excluded if they had any ocular diseases or injuries, previous refractive or intraocular surgeries, or patients with follow-up duration <1-month. All patients were informed of full descriptions of the SMILE procedure, including potential benefits, risks, side effects and complications and signed the informed consent prior to treatment.

Patients were categorized into two groups according to their preoperative daily prescription: the full-correction group and the suboptimal correction group. Within the suboptimal correction group (defined as equivalent spherical error (SE) deviation ≥0.75D from the target refraction, encompassing sphere-only, cylinder-only, or combined deviations),[10,11] patients were further subdivided by correction laterality and magnitude: only one eye met the suboptimal correction criterion, with further distinction between dominant and non-dominant eyes; and both eyes met the suboptimal correction criterion. Additionally, subgroups of under-correction and over-correction were also analyzed. PVI was defined as spectacle-corrected visual acuity 0.3 logMAR (20/40 Snellen) or worse, which could be alleviated through appropriate subjective refraction.

Data Collection

Patients' demographics (age, gender) were obtained. Preoperative ophthalmic examination included measurement of uncorrected distance visual acuity (UDVA), PVA, CDVA (assessed using a standard logarithmic visual acuity chart at 5 meters under 300–500 lux illumination, following the standard protocol), manifest and cycloplegic refraction by a single experienced optometrist, slit-lamp biomicroscopy, corneal topography (Pentacam; Oculus Optikgerate GmbH) and dilated fundus evaluation. Objective visual quality parameters, including strehl ratio (SR) of point spread function (PSF), ratios between normal ocular regions of modulation transfer function (MTF) with 4.0-mm pupils and MTF curves were measured with the aberrometer OPD-Scan III (Nidek Inc., Tokyo, Japan). Binocular visual perceptual function, including horizontal/vertical perceptual eye position, vergence-divergence dynamics and stereovision, was acquired with a dichoptic motion coherence threshold technology (Guangdong Nuoyide Biomedical Technology Development Co., Ltd).

Patients were followed up at 1 day, 1 week, 1 month and 3 months postoperatively. At each visit, UDVA, slit-lamp biomicroscopy for corneal assessment, non-contact tonometry and manifest refraction were performed. At the 1-month and 3-month visits, supplementary data acquisition comprised postoperative corneal topography parameters, aberrometer OPD-Scan III measurements, and binocular perceptual function assessments.

Surgical Technique

All SMILE procedures were performed by a single experienced surgeon (YZ) using the VisuMax femtosecond laser system (Carl Zeiss Meditec AG, Jena, Germany) with standardized parameters: 500 Hz frequency; 29 energy-cutting index; 110~130-μm cap thickness, 6.0 to 6.8 mm optical zone of lenticule with 0.1 mm transition zone, 7.6-mm cap diameter, 145 nJ laser power with side cut angles at 120°, and 2.0-mm incision length. A lamellar dissector (Asico, Westmont, IL) was used to gently separate the anterior/posterior lenticule lamellae, followed by intact lenticule extraction from a single incision (circumferential length, 2 mm).

Statistical Analysis

Statistical analyses were conducted using IBM SPSS version 25.0 (IBM Corp, Armonk, NY, USA). Visual acuity was converted into logMAR units for analysis. A two-level multilevel linear model was applied to account for the multilevel data structure with measurements nested within preoperative correction type and follow-up time points. Independent variables (group and follow-up time) were treated as fixed effects. Pairwise comparisons were performed with adjusted Bonferroni correction. The independent *t*-test or Wilcoxon ranked-sum test (based on normality assumption) was used for comparisons between continuous variables across different visits. For independent group comparisons (full-correction and suboptimal correction groups), the unpaired *t*-test or Mann–Whitney *U*-test was applied. Independent t-tests were used to evaluate differences between visual subgroups (full-correction and subgroups). A P value <0.05 was considered statistically significant.

Results

The suboptimal correction cohort (n = 94; 148 eyes) comprised 54 patients undergoing bilateral surgery (108 eyes) and 40 with monocular interventions (40 eyes). The fully corrected group (n = 38; 72 eyes) comprised 34 bilateral cases (68 eyes) and 4 monocular cases (4 eyes), with all participants completing ≥3 months of follow-up. Table 1 displays the demographic features of two groups.

Table 1 Demographic Data for Eyes with Preoperative Suboptimal Correction and Full-Correction

Characteristic	Suboptimal Correction	Full-Correction	P Value
No. patients (eyes)	148	72	
Age, mean (SD)	29.17 ± 5.01	26.17 ± 5.72	0.37
UDVA (logMAR)	0.93 ± 0.35	0.99 ± 0.36	0.24
PVA (logMAR)	0.25 ± 0.30	0.03 ± 0.08	**<0.01**
CDVA (logMAR)	−0.02 ± 0.08	−0.05 ± 0.06	0.05
SE, D	−4.55 ± 1.99	−4.73 ± 1.78	0.50

Notes: Data are shown as the mean ± standard deviation, and P-values were determined using independent samples *t*-test. Bold text indicates statistical significance.
Abbreviations: UDVA, uncorrected distance visual acuity; PVA, presenting visual acuity; CDVA, corrected distance visual acuity.

Clinical Outcomes

Mean PVA was 0.25 ± 0.31 in the suboptimal correction group and 0.03 ± 0.07 logMAR in the full-correction group. In suboptimal correction group, 20.27% of eyes exhibited preoperative PVI (defined as PVA <0.3 logMAR). One week postoperatively, 92 eyes (62.16%) in the suboptimal correction group and 26 eyes (36.11%) in the full-correction group gained ≥2-line UDVA improvement, and the percentage was 71.62% and 36.11%, 72.97% and 40.28% for two groups at 1- and 3-month follow-up visits, respectively. The percentage of eyes achieving postoperative UDVA equal or better than that of the preoperative PVA was 75.00% (111 eyes) in the suboptimal correction group and 87.50% (63 eyes) in the full-correction group at 1-week follow-up (P = 0.032). At 1-month and 3-month follow up, the percentage was 91.22% (135 eyes) vs 91.67% (66 eyes) (P = 0.911), and 97.97% (145 eyes) vs 97.30% (70 eyes) (P = 0.726) for two groups, respectively. The mean postoperative UDVA was −0.04 ± 0.01 and −0.11 ± 0.01 logMAR (P < 0.01), −0.08 ± 0.01 and −0.11 ± 0.01 (P < 0.01), and −0.09 ± 0.01 logMAR and −0.12 ± 0.01 logMAR (P < 0.01) for two groups at three follow-up times, respectively. Significant UDVA improvement appeared at 1-month and 1-week follow-up for suboptimal correction and full-correction groups, respectively. (Figure 1A).

At the 1-week follow-up visit, 76.35% (113 eyes) of eyes in the suboptimal correction group and 79.17% (57 eyes) in the full-correction group achieved a manifest spherical equivalent within ±0.50D (P = 0.64). At 1-month and 3-month follow up, the percentage was 81.76% (121 eyes) vs 83.33% (60 eyes) (P = 0.774), and 83.78% (124 eyes) vs 86.11% (62 eyes) (P = 0.654) for two groups, respectively. No significant differences were found in the SE between two groups preoperatively or at any follow-up visits (P = 0.337, preoperatively; P = 0.902, 1 week postoperatively; P = 0.140, 1 month postoperatively; P = 0.05, 3 month postoperatively) (Figure 1B). The change of SE was significant in both groups (both P < 0.01).

UDVA and SE changes in the suboptimal correction group were subdivided by preoperative daily prescription patterns (dominant eye inappropriate-corrected, 18 eyes; non-dominant eye inappropriate-corrected, 22 eyes; bilateral suboptimal correction, 108 eyes). Significant differences of UDVA were found between three subgroups and full-correction group at 1-week and 1-month follow-up visits (all P < 0.01), and at 3-month follow-up visit, UDVA differed significantly only between both eyes preoperatively suboptimal correction group and full-correction group (P < 0.01). No significant differences of SE were found between subgroups (all P > 0.01). Subgroups of under/over-correction were also analyzed (59 over-corrected eyes, 89 under-corrected eyes). UDVA differed significantly only between preoperatively under/over-correction and full-correction groups at three follow-up points (all P < 0.01). No significant SE differences were found between subgroups (all P > 0.01).

Optical Quality Outcomes

The full-correction group had statistically significant higher SR than the suboptimal correction group for 4-mm pupil 1 month postoperatively (P = 0.02) (Table 2). At 3 months postoperative, the value was 0.07 ± 0.06 and 0.08 ± 0.04 (P = 0.21), respectively. No significant differences between groups for total and HO MTF were noted (1-month, total MTF, P = 0.10, HO MTF, P = 0.28; 3-month, total MTF, P = 0.13, HO MTF, P = 0.34).

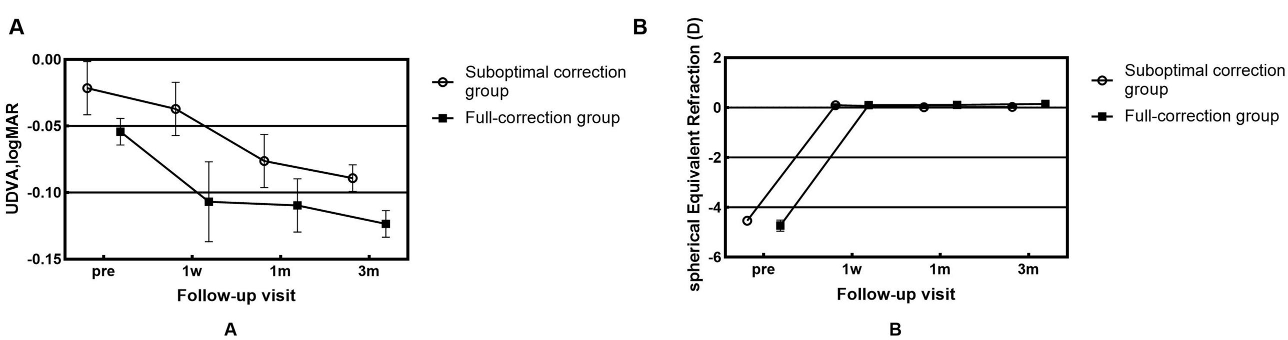

Figure 1 Visual outcomes measured preoperatively and at 1 week, 1 month and 3 months postoperatively (**A**) Change of UDVA, (**B**) Change of SE.
Abbreviations: UDVA, uncorrected distance visual acuity; SE, spherical equivalent refractive.

Table 2 Modulation Transfer Function Data at 1 Month and 3 Months Postoperatively in Patients with Preoperative Full-Correction and Suboptimal Correction

	1 Month			3 Months		
	Suboptimal Correction	**Full-Correction**	**P Value**	**Suboptimal Correction**	**Full-Correction**	**P Value**
Strehl Ratio	0.06 ± 0.04	0.08 ± 0.06	**0.02**	0.07 ± 0.06	0.08 ± 0.04	0.21
MTF						
Total (%)	42.29 ± 13.74	45.52 ± 16.93	0.10	44.42 ± 15.05	40.17 ± 13.54	0.13
HO (%)	66.67 ± 21.29	69.43 ± 18.32	0.28	68.88 ± 19.96	66.07 ± 13.62	0.34
MTF curve						
5cpd	0.57 ± 0.19	0.60 ± 0.23	**0.04**	0.59 ± 0.19	0.52 ± 18.44	**0.02**
10cpd	0.28 ± 0.14	0.32 ± 0.16	**0.03**	0.31 ± 0.15	0.27 ± 0.13	0.23
15cpd	0.17 ± 0.09	0.19 ± 0.11	0.22	0.19 ± 0.10	0.16 ± 0.09	0.12
20cpd	0.13 ± 0.06	0.14 ± 0.08	0.18	0.14 ± 0.07	0.12 ± 0.06	0.08
25cpd	0.10 ± 0.05	0.11 ± 0.05	0.35	0.10 ± 0.06	0.08 ± 0.05	0.06
30cpd	0.08 ± 0.04	0.09 ± 0.05	0.40	0.08 ± 0.05	0.06 ± 0.05	0.06

Notes: Data are shown as the mean ± standard deviation. Bold text indicates statistical significance.

Values of MTF for different spatial frequencies (5,10,15,20,25 and 30 cycles/degree, cpd) were also evaluated (Figure 2). Eyes with preoperatively full-correction performed better for 4-mm pupils at low spatial frequencies ($P < 0.05$ at 5 and 10 cpd) compared eyes with preoperatively suboptimal correction at 1 month postoperatively. At 3 months postoperative, there showed no significant differences between groups (all $P > 0.05$).

In subgroup analysis, eyes with preoperatively full-correction showed superior performance with 4-mm pupils at low spatial frequencies (all $P < 0.05$ except at 10 cpd) compared those with preoperatively under-correction at 3 month postoperatively.

Binocular Visual Function Outcomes

No baseline differences were found in horizontal/vertical visual perception deviation, convergence and divergence ability between groups at baseline. Significant vertical perceptual eye position differences emerged at 1 month ($P = 0.01$) and persisted at 3 months ($P < 0.01$) postoperatively, with the full-correction group demonstrating sustained reduction (from 3.64 ± 0.44 px at 1 month to 1.08 ± 0.57 px at 3 months). Convergence ability diverged significantly at 3 months ($P = 0.01$), though preoperative and 1-month differences were non-significant. Horizontal perception and divergence remained comparable throughout (Table 3). Horizontal visual perception deviation increased slightly at 1 month postoperatively, and then returned to the baseline at 3-month follow-up visit in the suboptimal correction group, however, no significant difference was found between groups (Figure 3A, 1-month: $P = 0.65$, 3-month: $P = 0.72$). The amount of vertical visual

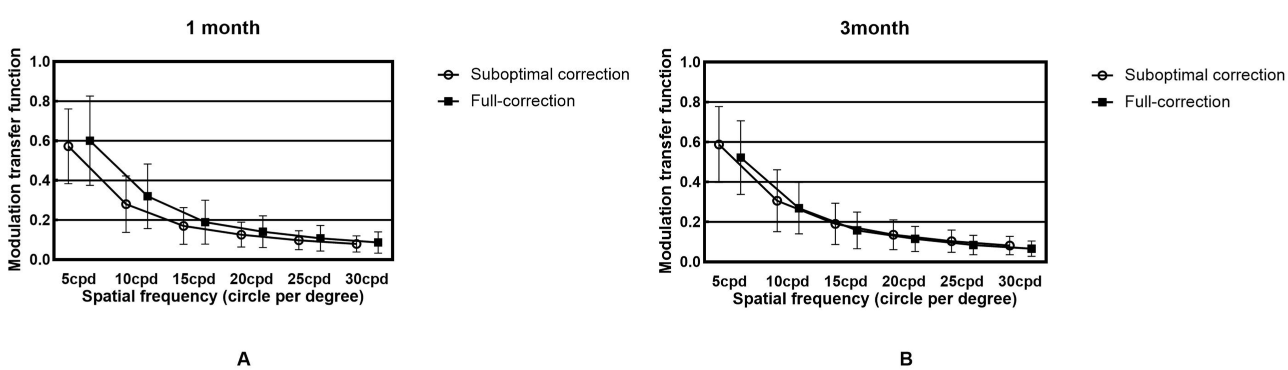

Figure 2 The modulation transfer function (MTF) curves (**A**) Values of MTF for different spatial frequencies at 1 month postoperatively, (**B**) Values of MTF for different spatial frequencies at 3 months postoperative.

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Table 3 Binocular Visual Perception Outcomes Preoperatively, at 1 Month and 3 Months Postoperatively in Patients with Preoperative Full-Correction and Suboptimal Correction Group

	Preoperative	**Postoperative**	
		1 Month	**3 Months**
Horizontal Visual Perception (px)			
Suboptimal correction Group	19.29 ± 4.38	23.64 ± 3.08	20.73 ± 3.41
Full-correction Group	15.71 ± 6.89	16.37 ± 4.84	11.26 ± 5.38
P value	0.61	0.91	0.60
Vertical Visual Perception (px)			
Suboptimal correction Group	3.80 ± 0.79	3.64 ± 0.44	2.87 ± 0.36
Full-correction Group	2.03 ± 1.24	1.76 ± 0.69	1.08 ± 0.57
P value	0.05	**0.01**	**<0.01**
Convergence (px)			
Suboptimal correction Group	5.50 ± 0.31	4.77 ± 0.24	5.83 ± 0.27
Full-correction Group	5.41 ± 0.49	5.92 ± 0.38	7.58 ± 0.43
P value	0.36	0.20	**0.01**
Divergence (px)			
Suboptimal correction Group	6.33 ± 0.37	6.76 ± 0.31	6.72 ± 0.29
Full-correction Group	6.63 ± 0.57	7.67 ± 0.48	7.20 ± 0.45
P value	0.74	0.18	0.36

Notes: Data are shown as the mean ± standard deviation. Bold text indicates statistical significance.

perception deviation decreased at both 1-month and 3-month follow-up visits, and there was no significant difference between two groups (Figure 3B, 1-month: P = 0.92, 3-month: P = 0.98). In the suboptimal correction group, convergence function decreased at 1 month and then returned to the baseline at 3-month follow-up visit, while improved at both 1-month and 3-month follow-up visits in full-correction group (Figure 3C, 1-month: P = 0.01, 3-month: P < 0.01). Postoperative divergence function improved at both 1-month and 3-month follow-up visits, no significant difference was found between groups (Figure 3D, 1-month: P = 0.24, 3-month: P = 0.71). In the suboptimal correction group, 4 among 5 subjects with preoperatively abnormal stereopsis acuity achieving normal stereopsis acuity at 1-month follow-up visit.

Further analysis of subgroups revealed significant differences in convergence function (P = 0.032) and vertical visual perception deviation (P = 0.005) at the 3-month follow-up between the bilateral suboptimal correction of the suboptimal correction group and the full-correction group. Subgroups analysis of under/over-correction showed significant differences in convergence between the preoperatively under-correction/over-correction groups and the full-correction group at 1-month and 3-month follow-up visits (all P < 0.01). Vertical visual perception deviation also differed between the over-correction and full-correction groups postoperatively at 1 month (P = 0.028) and 3 months (P = 0.003).

Discussion

It has been widely proved by previous studies that binocular vision in myopic patients gradually improved following corneal refractive surgeries, with resolution of near-work discomfort and enhanced visual quality,[12–14] however, these investigations have not addressed whether longstanding preoperative suboptimal correction (under/over-correction) impacts postoperative recovery of visual outcomes, quality, or binocular function. The current study therefore compares short-term visual results after SMILE between myopic subjects with chronic preoperative suboptimal correction and those with full preoperative correction, a design that directly targets the unaddressed question.

PVI, resulting from uncorrected or inadequately corrected refractive errors, is characterized as visual acuity of less than 6/18 in the better eye that could be improved to 6/18 or better via refraction or pinhole.[4] For patients with PVI (20.27% (30 eyes) of the suboptimal correction group), SMILE surgery demonstrated high efficacy: 97.97% achieved ≥2 logMAR line improvements at the 3-month postoperative visit, with a mean visual acuity of −0.09 ± 0.01 logMAR, indicating its effectiveness in correcting PVI.

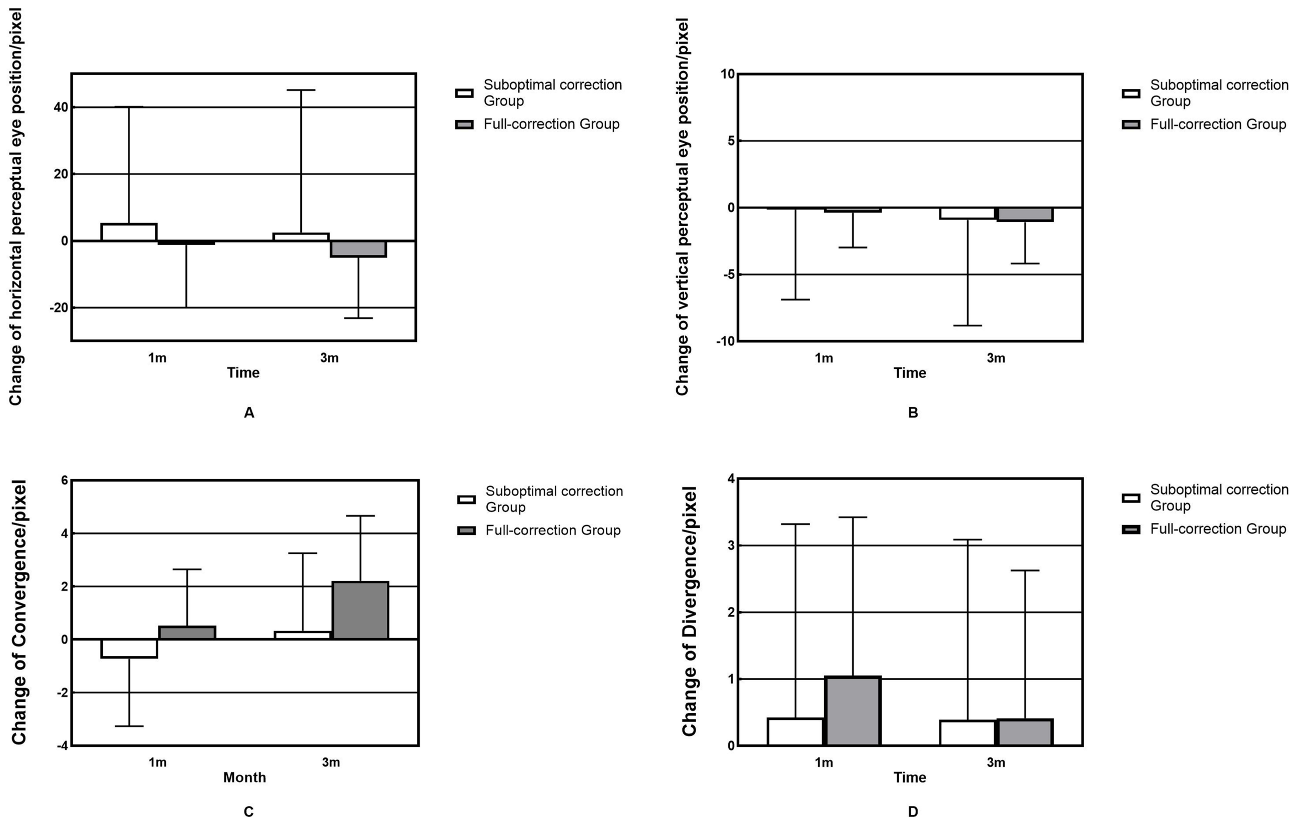

Figure 3 Postoperative change of binocular visual function outcomes at 1 and 3 months compared to baseline data (**A**) Change of horizontal perceptual eye position, (**B**) Change of vertical perceptual eye position, (**C**) Change of convergence, (**D**) Change of divergence.

The results of this study revealed that myopic eyes with suboptimal spectacles preoperatively recovered visual results more slowly than those with full-corrected after refractive surgery. Both groups showed improvement in UDVA post-operatively, consistent with previous research on visual acuity enhancement after refractive surgery.[15–17] However, the suboptimal correction group demonstrated slower UDVA improvement, with significant gains observed at 1 month (versus 1 week in the full-correction group). Subgroup analysis further revealed that both the under-correction and over-correction subgroups showed slower UDVA recovery compared to the full-correction group. The long-term preoperative under-correction or over-correction keeps the retina in a state of unclear imaging, and chronic preoperative stimulation of the retina by blurred images may induce adaptive remodeling of the visual cortex. Although the restoration of retinal clear imaging after SMILE may activate the cortex's responsiveness to new visual inputs, this activation process requires time, leading to a prolonged recovery period. While existing studies suggest such cortical plasticity exists, analogous to observations in retinal detachment,[18] myopic anisometropic[19] or amblyopic[20] after refractive surgery, the specific pathways remain unclear and require validation by basic research. Notably, 83.78% and 86.11% of suboptimal and fully corrected eyes, respectively, achieved SE within ±0.50D at 3 months, with no intergroup differences in SE across all follow-up intervals ($P > 0.05$), suggesting comparable refractive outcomes between cohorts. This result indicates that delayed visual recovery is unrelated to postoperative refractive differences. Although postoperative refraction is corrected to target, lag in cortical functional reorganization due to chronic blurred imaging may require time for readaptation to new clear inputs, thus manifesting as delayed recovery.

MTF and PSF values are vital metrics for evaluating retinal image quality from an incoming object.[21] The MTF indicates how an optical system modulates contrast sensitivity as a function of spatial frequency, while MTF curves reflect the contrast between retinal images and actual objects at different spatial frequencies. SR refers to the ratio of the PSF value to the theoretical diffraction displayed at the same pupil diameter. Higher MTF and SR values indicate clearer imaging by the optical system and better visual quality.[21,22] Our findings revealed that the full-correction cohort exhibited significantly elevated SR and MTF values at low spatial frequencies (5 and 10 cycles/degree) at 1 month post-SMILE, with intergroup differences attenuated by 3 months. Bühren et al[23] studied the predictive effect of optical quality metrics, including higher-order aberrations and SR, on visual quality after refractive surgery, and the finding was that maintaining high retinal image quality is essential for good subjective visual quality. Our results suggest that the visual quality of myopics with preoperatively suboptimal correction gradually approached that of the full-correction group. As the two groups showed no significant difference in postoperative refractive status (both reaching target correction), this indicates that the more likely reason is the completion of cortical functional reorganization and establishment of an efficient visual pathway, which leads to the final convergence of visual quality.

Binocular accommodation and convergence function alters in myopic patients before and after refractive surgery, with direct implications for daily visual tasks.[24,25] Previous studies observing myopia patients following SMILE surgery found that the accommodation facility increased at 1 and 3 months postoperatively, while accommodation decreased at 1 week followed by gradual recovery at 1 and 3 months.[26,27] Additionally, the AC/A ratio decreased at 1 month but gradually increased between 3 and 9 months postoperatively.[27] Methodological heterogeneity complicates cross-study comparisons of binocular visual outcomes, as our study employed a novel computer-based brain imaging bio-stimulation protocol to quantify perceptual eye position and binocular vergence-divergence dynamic in a dichoptic state. Suboptimal correction eyes exhibited reduced convergence amplitude at 1 month (returning to baseline by 3 months), whereas fully corrected peers showed sustained improvements at both 1- and 3-month visits. This disparity likely stems from preoperative accommodative underutilization in suboptimal correction cohorts, despite similar convergence demands, these eyes historically relied less on accommodation for near tasks (eg, reading or using smartphones), creating dyssynergia between accommodative and vergence systems.[24] Postoperatively, emmetropization in previously undercorrected eyes necessitated enhanced accommodative drive to match convergence requirements, temporarily destabilizing binocular coordination. This manifests as subtle horizontal heterophoria (evidenced as 1-month horizontal visual perception deviation slightly increased, returned to baseline by 3 months) and may explain patient reports of transient eye strain or difficulty focusing during near-work tasks. While short-term binocular visual function of patients in both groups improved postoperatively, the rate of change was closely related to the preoperative refractive state.

In addition, subgroup analysis provides further insight into how preoperative correction status influences post-operative recovery. UDVA recovery was significantly delayed in the dominant-eye suboptimal correction subgroup (1-week/1-month follow-up) and bilateral suboptimal correction subgroup (1-week/1-month/3-month follow-up) compared with the full-correction group, whereas the non-dominant suboptimal subgroup caught up by 3 months—likely attributed to the dominant eye's visual dominance and interocular competition.[28] The visual cortex preferentially processes inputs from the dominant eye, and its postoperative optical disturbances may pose greater adaptive challenges to visual processing.[29] Notably, this analysis is limited by uneven subgroup sample sizes (18 eyes in dominant-eye, 22 in non-dominant-eye, and 108 in bilateral subgroups), necessitating larger cohorts for robust validation.

One limitation of our study is the relatively small number of eyes included. Eyes with preoperative PVI only constituted only a portion of the suboptimal correction group, making the direct efficacy of SMILE on eyes with preoperative PVI not clear enough. Additionally, the limited 3-month follow-up period limits our ability to assess the long-term safety and stability of SMILE in myopic patients with preoperative PVI. This underscores the necessity for longer-term follow-up (≥6 months) to comprehensively assess these outcomes.

Conclusion

In conclusion, this study highlights the critical role of preoperative correction status—a previously underappreciated clinical variable—in shaping recovery trajectories after SMILE in myopic patients: those with chronic suboptimal correction (under/over-correction) exhibit slower visual recovery. These findings may underscore the critical role of preoperative correction optimization in accelerating visual rehabilitation and guiding personalized refractive management strategies.

Data Sharing Statement

The corresponding author will make available the datasets used in or analysed during the current study on reasonable request.

Ethical Approval

The study was approved by the ethical standards of the Ethics of Committee of the Shanghai General hospital and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. REC number 20240115105313293, date of approval 28/01/24. All patients were informed of full descriptions of the SMILE procedure, including potential benefits, risks, side effects and complications and signed the informed consent prior to treatment.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that there is no conflict of interest in this work.

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