Original Article

Myopic regression after photorefractive keratectomy: a retrospective cohort study

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ABSTRACT

Background: Myopic regression is a major complication of photorefractive keratectomy (PRK). The rates and causes vary considerably among different studies. This study aimed to investigate myopic regression at six months after myopic PRK.

Methods: In this retrospective cohort study, we included all eligible patients with myopia ranging from - 0.75 to - 9 D, aged 18 to 50 years, who underwent PRK by a single surgeon with the availability of preoperative and postoperative data at six months after the initial procedure. All participants underwent comprehensive ophthalmic examinations preoperatively and at six months post-PRK. Overcorrection was planned based on the participant's age range to achieve the desired refractive result after PRK. All patients received the same postoperative antibiotic and steroid eye drops in a similar dosage regimen, and the contact lenses were removed after complete corneal epithelial healing. Based on the spherical equivalent of refraction six months after PRK, eyes without and with myopic regression were allocated into groups 1 and 2, respectively.

Results: We included 254 eyes of 132 patients who underwent myopic PRK with a mean (standard deviation) age of 30.12 (7.48) years; 82 (62.12%) were women and 50 (37.88%) were men. The frequency of myopic regression was significantly lower in patients with younger age, lower preoperative cylindrical refraction, and lower ablation depth (all $P < 0.05$). Overcorrection was more successful in eyes with low myopia than in eyes with high myopia ($P < 0.05$). The highest frequency of myopic regression occurred in eyes with moderate myopia (25.68%), followed by eyes with high myopia (20.0%) and low myopia (6.54%). Among different age groups, patients aged ≤ 30 years had a lower frequency of myopic regression. The frequency of myopic regression in the different age groups was 5.0% at 18 – 20 years, 7.46% at 26 – 30 years, 12.28% at 21 – 25 years, 21.31% at 31 – 35 years, and 26.53% at 36 – 50 years.

Conclusions: Overcorrection was more successful in eyes with low myopia than in eyes with high myopia. The success rate was higher in younger patients with lower astigmatism and ablation depths. Myopic regression was most frequent in eyes with moderate myopia, followed by those with high and low myopia. Further studies should replicate our findings over a longer follow-up period with a larger sample size before generalization is warranted.

KEYWORDS

myopia, photorefractive keratectomies, myopic regression, laser ablation, age group

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INTRODUCTION

Myopia is a type of refractive error with an increasing worldwide incidence. The National Eye Institute found a significant increase in the prevalence of myopia among individuals aged 12 – 54 years, from 25% in 1971 – 1972 to 41.6% in 1999 – 2004 [1]. Globally, almost 1.6 billion people are affected by myopia, and this number is expected to increase to about 2.5 billion by 2020, with one-third of affected individuals having high myopia [2].

Current treatment modalities for myopia include spectacle correction, contact lens wear, and refractive surgery, either by increasing the anterior corneal radius of curvature using laser refractive surgery or by implanting phakic intraocular lenses [3]. The use of refractive surgery has increased dramatically [4]. Photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK) are the two main refractive surgery techniques [5].

PRK has gained greater attention recently because of the flap complications encountered during LASIK surgery. PRK is the preferred technique in certain scenarios, including thin corneas, recurrent corneal erosion, epithelial dystrophies, and superficial corneal scarring [6]. Patient satisfaction after PRK in low and high myopia groups was reported as 84% and 75%, respectively [7].

Despite promising outcomes [8, 9], postoperative complications of PRK, such as myopic regression, overcorrection, and corneal haze, have been reported over long-term follow-up, causing vision impairment and patient dissatisfaction [10]. The rate of myopic regression varies considerably in different studies and largely depends on preoperative myopic refraction and correction rate. Myopic regression may require retreatment [11, 12]. It stabilizes three to six months after PRK for low to moderate myopia; however, stabilization takes longer for higher-degree corrections [8, 9, 13].

This study aimed to investigate myopic regression at six months after PRK for the correction of myopia and to compare the preoperative and intraoperative characteristics of eyes with and without myopic regression at six months post-PRK.

METHODS

In this retrospective cohort study, we recruited all eligible patients with myopia who underwent PRK performed by a single surgeon (S.R.) at the Negah Eye Hospital, Tehran, Iran, over a twenty month period, with available preoperative and postoperative data at six months after the initial procedure. This study was approved by the Ethical Committee of Shahid Beheshti Medical University, Tehran, Iran, and adhered to the tenets of the Declaration of Helsinki. All participants provided written informed consent following an explanation of the aims and protocol of the study.

We included patients with myopia ranging from - 0.75 to - 9 diopters (D), aged 18 to 50 years, with a best-corrected distance visual acuity (BCDVA) of 20 / 30 or better, and stable refraction between two visits separated by at least one year. We excluded patients with an intraocular pressure greater than 20 mmHg; a history of trauma, herpetic keratitis, ocular surgery during the three months before PRK, or use of contraindicated medications; pregnant or lactating women; and patients with any ocular or systemic diseases, such as moderate or severe meibomian gland dysfunction, moderate or severe dry eye, any degree of corneal ectasia, corneal scar, neurotrophic keratopathy, retinal degeneration, type I or II diabetes mellitus, and rheumatoid arthritis.

All participants underwent comprehensive preoperative ophthalmic examinations including BCDVA measurement, with the best correction in place, using a Snellen visual acuity chart (CP-690; Nidek Co., Ltd., Gamagori Aichi, Japan), manifest and cycloplegic refraction using 1% tropicamide ophthalmic solution (Mydrax; Sina Darou, Tehran, Iran) and an auto-refractometer (Auto-Kerato-Refractometer KR-8900; Topcon Co., Tokyo, Japan), a detailed anterior segment and fundus examination using a slit lamp (Haag-Streit, Bern, Switzerland), intraocular pressure measurement (Goldmann applanation tonometer, AT-900; Haag-Streit AG, Koniz, Switzerland), pupil size measurements in mesopic luminance, and corneal topography and pachymetry performed using the Orbscan IIz topography device (Bausch and Lomb Inc., Rochester, NY, USA). According to spherical equivalent (SEQ) (sum of sphere + half the cylinder), patients were allocated to one of three subgroups: low myopia (SEQ of - 0.75 D to - 2.99 D), moderate myopia (SEQ of - 3.00 D to - 5.99 D), and high myopia (SEQ of - 6.00 D to - 9.00 D) [14].

To achieve the desired refractive result after PRK, the overcorrections based on participant age ranges of 18 – 20 years, 21 – 25 years, 26 – 30 years, 31 – 35 years, and 36 – 50 years were 0.75 D, 0.50 D, 0.37 D, 0.25 D, and no overcorrection, respectively. All surgeries were performed by a single surgeon (S.R.) using a fixed PRK nomogram and Technolas 217P excimer laser (Technolas Perfect Vision GmbH, Munich, Germany). We designated myopic regression to be a - 0.25 D or more myopic shift documented at the six-month follow-up visit, and this was considered an unsuccessful outcome. We repeated all examinations six months postoperatively [10]. Based on the SEQ of refraction six months after PRK, eyes without and with myopic regression were categorized into groups 1 and 2, respectively.

All eyes underwent PRK under topical anesthesia (0.5% proparacaine hydrochloride, Alcaine; Alcon, Fort Worth, TX, USA). The periocular skin was cleansed using 10% povidone-iodine solution. After proper draping, an eyelid speculum was inserted and a 5% povidone-iodine solution was instilled into the conjunctival sac. A disk of epithelium with a diameter of 8 – 9 mm was removed with a sponge using an alcohol-assisted technique [15]. Excimer laser ablation was performed according to the nomogram prepared by the surgeon and adjusted for patient age and the amount of refraction. Following photoablation, 0.02% mitomycin C [16] was applied, followed by irrigation using 50 mL of balanced saline solution. At the end of the procedure, one drop of chloramphenicol 0.5% eye drops (Chlobiotic 0.5%; Sina Darou) was instilled, and a bandage contact lens (Comfilcon A, Biofinity; CooperVision, San Ramon, CA, USA) [17] was placed over the eye. All patients received the same postoperative antibiotic and steroid eye drops with a similar dosage regimen, and the contact lenses were removed after complete corneal epithelial healing.

All analyses were performed using IBM SPSS Statistics for Windows (version 25.0; IBM Corp., Armonk, NY, USA). The Kolmogorov – Smirnov test was used to examine whether variable data were normally distributed. Data are presented as means, standard deviations (SD), ranges, frequencies, and percentages. Chi-square and *t*-tests were used to compare the results between the groups of eyes with and without myopic regression. A *P*-value < 0.05 was considered statistically significant.

RESULTS

We included 254 eyes of 132 patients with myopia who underwent PRK, 122 (92.43%) of whom underwent bilateral refractive surgery and 10 (7.57%) of whom underwent unilateral refractive surgery. The mean (SD) age of the participants was 30.12 (7.48) years (range: 18 – 50 years); 82 (62.12%) were women, and 50 (37.88%) were men. Table 1 displays the baseline characteristics of the included patients.

Table 2 compares the preoperative and intraoperative variables between eyes with and without myopic regression. The myopic regression rate was lower in patients with younger age, lower preoperative cylindrical refraction, and lower ablation depth (all $P < 0.05$). Other variables were comparable between eyes with and without myopic regression (all $P > 0.05$) (Table 2).

Overcorrection in eyes with low myopia produced a significantly lower myopic regression rate than in eyes with high myopia ($P = 0.002$). The highest frequency of myopic regression occurred in eyes with moderate myopia (25.68%), followed by eyes with high myopia (20.0%) and low myopia (6.54%). Among the different age groups, patients aged ≤ 30 years had a lower frequency of myopic regression. The frequencies of myopic regression according to age group were 5.0% at 18 – 20 years (n = 1 eye), 7.46% at 26 – 30 years (n = 5 eyes), 12.28% at 21 –

Table 1. Baseline characteristics of study participants

Parameters	Values
Age (y), Mean ± SD (Range)	30.12 ± 7.48 (18 to 50)
Number of eyes in each age group, n (%)	
18 – 20 y	20 (7.87)
21 – 25 y	57 (22.44)
26 – 30 y	67 (26.38)
31 – 35 y	61 (24.02)
36 – 50 y	49 (19.29)
Sex (Male / Female), n (%)	50 (37.88) / 82 (62.12)
Laterality (Monocular / Binocular), n (%)	10 (7.57) / 122 (92.43)
Pre-op Sphere (D), Mean ± SD (Range)	- 2.50 ± 1.77 (- 7.50 to + 5.50)
Pre-op Cylinder (D), Mean ± SD (Range)	- 1.11 ± 1.08 (- 5.25 to - 1.00)
Pre-op SEQ (D), Mean ± SD (Range)	- 2.78 ± 1.87 (- 8.00 to + 5.25)
Pre-op Mean K (D), Mean ± SD (Range)	43.89 ± 1.62 (39.3 to 48.9)
Pre-op CCT (µm), Mean ± SD (Range)	525.47 ± 39.43 (448 to 642)

Abbreviations: y, year; SD, standard deviation; n, number; %, percentage; Pre-op, preoperative; D, diopter; Sphere, a spherical component of refractive error in manifest refraction; Cylinder, a cylindrical component of refractive error in manifest refraction; SEQ, a spherical equivalent of refractive error in manifest refraction (sum of sphere + half the cylinder); K, keratometry reading; CCT, central corneal thickness; µm, micrometer.

Table 2. Comparison of parameters between eyes with and without myopic regression six months after myopic photorefractive keratectomy

Variables	Group 1 (n = 215 eye)	Group 2 (n = 39 eyes)	*P*-Value
Age (y), Mean ± SD	29.53 ± 7.29	33.38 ± 7.74	**0.004**
Pre-op Sphere (D), Mean ± SD	- 2.42 ± 1.70	- 2.92 ± 2.10	0.184
Pre-op Cylinder (D), Mean ± SD	- 1.01 ± 1.02	- 1.65 ± 1.24	**0.001**
Pre-op SEQ (D), Mean ± SD	- 2.72 ± 1.83	- 3.15 ± 2.10	0.208
Pre-op Mean K (D), Mean ± SD	43.84 ± 1.58	44.12 ± 1.82	0.443
Pre-op Mean K (≤ 43 D / 43 to 44.6 D / > 44.6 D), n (%)	76 (35.35) / 73 (33.95) / 66 (30.70)	11 (28.20) / 12 (30.77) / 16 (41.03)	0.431
Pre-op CCT (μm), Mean ± SD	526.56 ± 39.43	519.46 ± 39.45	0.265
Pre-op CCT (≤ 500 μm / > 500 μm), n (%)	64 (29.77) / 151 (70.23)	15 (38.46) / 24 (61.54)	0.281
RSB (μm), Mean ± SD	426.60 ± 44.76	408.90 ± 46.66	**0.029**
Ablation depth (μm), Mean ± SD	55.68 ± 21.81	67.79 ± 23.40	**0.003**
Size of optical zone (6 mm / 6.5 mm), n (%)	130 (60.47) / 85 (39.53)	25 (64.10) / 14 (35.90)	0.080

Abbreviations: n, number; y, year; SD, standard deviation; Pre-op, preoperative; Sphere, a spherical component of refractive error in manifest refraction; D, diopter; Cylinder, a cylindrical component of refractive error in manifest refraction; SEQ, a spherical equivalent of refractive error in manifest refraction; K, keratometry reading; %, percentage; CCT, central corneal thickness; μm, micrometer; RSB, residual stromal bed thickness; mm, millimeter. Not: *P*-values < 0.05 are shown in bold; Optical zone [18], the part of the corneal ablation area that receives the full intended refractive correction; Group 1, eyes without myopic regression six months after myopic photorefractive keratectomy; Group 2, eyes with myopic regression six months after myopic photorefractive keratectomy; Myopic regression, we designated myopic regression to be a - 0.25 D or more myopic shift documented at the six-month follow-up visit, and this was considered an unsuccessful outcome.

25 years (n = 7 eyes), 21.31% at 31 – 35 years (n = 13 eyes), and 26.53% at 36 – 50 years (n = 13 eyes).

DISCUSSION

In the current study, overcorrection in eyes with low myopia produced a lower frequency of myopic regression than overcorrection in eyes with high myopia. Similarly, the myopic regression rate was lower in patients with younger age, a lower cylindrical component of preoperative refractive error, and lower ablation depth. Patients aged ≤ 30 years had a lower frequency of myopic regression. The highest frequency of myopic regression was observed in eyes with moderate myopia, followed by those with high and low myopia.

Myopic regression is one of the major complications after PRK [10]. It is affected by factors such as increased irregularity of the 5-mm corneal surface [19], simulated keratoscope readings [19], high preoperative refractive error [12, 13, 19-24], smaller optical zone [22], and unstable fixation during surgery [22]. Table 3 summarizes the outcomes of selected studies on PRK and factors associated with myopic regression over more than two decades [11-13, 19-34].

Overcorrection had a significantly higher success rate in eyes with low myopia than in eyes with high myopia. Eyes with low myopia had a lower frequency of myopic regression (6.54%) than those with moderate (25.68%) or high (20.0%) myopia. Mohammadi et al. [22] found a significant association between a high baseline refractive error and myopia regression after PRK. Similar studies have also found a positive correlation between the degree of preoperative myopia and the rate of myopic regression [12, 19, 21, 23, 24]. Pietila et al. found that a higher number of eyes with low myopia remained within 1.00 D of emmetropia compared to eyes with moderate or high myopia up to eight years post-myopic PRK [13]. Therefore, outcome predictability of refractive surgery could be reduced with a higher level of refractive error [21, 35, 36]. The likelihood of perfect vision was less in the patients with higher myopia than in those with lower myopia. This finding was also observed in the analysis of Food and Drug Administration data on the final uncorrected visual acuity following laser refractive surgery [37]. Perhaps modification of the nomograms to treat high levels of myopia could increase the post-PRK success rate. This proposal should be validated in further trials with longer follow-up periods.

We found a significantly lower frequency of myopic regression in patients with younger age, lower preoperative cylindrical refraction, and lower ablation depth. Similar studies on myopia outcomes after PRK found a higher frequency of regression in patients aged > 30 years [19, 23], with myopic astigmatism or a higher degree of astigmatism [19, 20, 21], and higher ablation depth [21].

Among the different age groups, patients aged ≤ 30 years had a lower frequency of myopic regression. Those

Table 3. Summary of selected studies on PRK and myopic regression conducted over more than two decades

Author (Year)	Participant characteristics	Conclusions
Li et al. (2022) [25]	Included 45 eyes (25 patients) in the femtosecond LASIK treatment group and 44 eyes (24 patients) in the tPRK treatment group.	Postoperative myopic regression was investigated from 8 to 21 months. When regression occurred, corneal epithelial thickness was significantly increased compared with preoperative values in both treatment groups. When myopic regression subsided three months after steroid therapy, corneal epithelial thickness was significantly decreased compared to values at treatment onset.
Shin et al. (2020) [26]	Ninety-five eyes underwent PRK with a 6.0-mm OZ (n = 40 eyes) or a 6.5-mm OZ (n = 55 eyes).	No significant differences were found in the SEQ of manifest refraction, simulated K value, UCDVA, or regression between 6.0-mm OZ and 6.5-mm OZ over one year post-PRK. The 6.5-mm OZ eyes had a better root mean square of higher-order aberrations, spherical aberration, and Q value measured in the 8.0-mm zone (mean follow-up was 20.71 versus 17.47 months in the 6.0-mm and 6.5-mm OZ group, respectively).
Naderi et al. (2018) [19]	Of 293 eyes of 150 participants who underwent PRK, the numbers of eyes with myopic astigmatism, hyperopic astigmatism, myopia, astigmatism, and hyperopia were 223, 37, 16, 14, and 3, respectively.	The prevalence of regression was higher in women (21.1% in women versus 15.9% in men), in the > 30-year age group (21.4% in > 30 versus 17.4% in < 30-year group), myopic astigmatism (78.1% in myopic astigmatism versus 10.5% in hyperopic astigmatism), and myopia (5.9% in myopia versus 1.3% in hyperopia). The Generalized Estimating Equations of the independent variable of regression after PRK showed that the simulated K value, 5-mm irregularity, and sphere value were significantly related to refractive error regression. For myopic astigmatism, the 5-mm irregularity, simulated K value, and increase in the SEQ increased the likelihood of refractive error regression.
Pokroy et al. (2017) [20]	A total of 9699 consecutive patients (9699 eyes) underwent myopic PRK with mitomycin-C.	The likelihood of retreatment increased significantly with astigmatism ≥ 3.5 D and surgeon factor. tPRK and high astigmatism were associated with increased myopic PRK retreatment rates.
Alio et al. (2016) [21]	Outcomes of PRK for 33 eyes of 33 patients with myopia up to -10.00 D and - 4.50 D of astigmatism at 15 years follow-up.	Preoperative SEQ and ablation depth were significantly correlated with refractive regression. Regression depended on both sphere and cylinder, and the combination of these two parameters should be considered to predict changes in refraction. The model predicted 2.00-D myopic regression for an ablation depth of 130 µm at 15 years after PRK.
Nakamura et al. (2016) [27]	Postoperative outcomes of 23 eyes with LASIK and 23 eyes with tPRK were evaluated between six months and seven years and compared.	Slight myopia developed in the LASIK (- 0.18 D)- and tPRK (- 0.36 D)-treated eyes and was significantly greater in the tPRK group. A significant difference in corneal power change was found between the LASIK (0.23 D steeper)- and tPRK (0.57 D steeper)-treated eyes. Myopic regression was more pronounced in the tPRK-treated eyes than in the LASIK-treated eyes.
Mohammadi et al. (2015) [22]	Comparing 70 eyes requiring re-treatment versus 158 control eyes not requiring re-treatment, at least nine months after PRK for myopia or myopic astigmatism.	Preoperative SEQ of > -5.00 D, intended OZ < 6.00 mm, and ocular fixation instability during laser ablation were significantly associated with under-correction and regression, and their significance remained in the multiple logistic regression model.
Guerin et al. (2012) [28]	Outcomes of myopic PRK for 120 eyes (80 patients) over 2 - 16-year follow-up.	Postoperative manifest refraction changed in all eyes over the 16 years. Initially, there was a hyperopic shift, with subsequent sharp regression over the first 12 months, followed by stabilization of refraction. At 12 and 16 years post-PRK, 81% and 79.5% of eyes were within 1.00 D of emmetropia, respectively. No correlation was found between keratometric data analyzed for postoperative ectasia and myopic regression, probably implying a latent lenticular etiology in eyes with myopia.
Na et al. (2012) [29]	LASIK-treated eyes (n = 577) and 577 propensity score-matched surface-ablated eyes i.e. LASEK, epi-LASIK, and PRK were included in this three-year follow-up study.	Myopic regression was observed in the surface ablation-treated eyes through postoperative years 1 and 2, yet this difference had no significant effect on visual acuity.
Koshimizu et al. (2010) [30]	Outcomes of myopic PRK for 42 eyes of 29 patients with > 10-year follow-up.	At the 10-year follow-up, 55% and 76% of the eyes were within 1.0 D and 2.0 D, respectively. All eyes had a mild myopic regression with a mean change of - 0.51 ± 1.78 D in refraction.

Continued Table 3. Summary of selected studies on PRK and myopic regression conducted over more than two decades

Author (Year)	Participant characteristics	Conclusions
Shojaei et al. (2009) [12]	Outcomes of myopic PRK for 371 eyes of 203 patients with eight-year follow-up.	They detected myopic regression in 31 eyes (15.97%), which was significant in 11 eyes and required retreatment. Most refractive regressions were detected in the first 18 months and had a significant positive correlation with preoperative spherical refraction. Refractive regressions stabilized within two years.
Alio et al. (2008) [31]	Evaluation of 267 eyes of 191 patients with myopia (SEQ > - 6 D) treated with myopic PRK at three months, one year, two years, five years, and 10 years postoperatively.	At 10 years, 156 (58%) eyes were within 1.00 D and 209 (78%) were within 2.00 D, and retreatment was performed for 124 eyes (46.4%) because of overcorrection, regression, or both.
Alio et al. (2008) [11]	Evaluation of 225 eyes of 138 myopic patients (SEQ: 0 to - 6 D) treated with myopic PRK, 10 years postoperatively.	At 10 years, 169 (75%) of 225 eyes were within 1.00 D and 207 (92%) were within 2.00 D, and retreatment was performed for 95 (42%) eyes because of overcorrection, regression, or both.
Kuo et al. (2004) [32]	The incidence of myopic regression ≥ -1.0 D in 542 consecutive patients, ≥ 3 months after myopic PRK.	In ten eyes of eight patients, they observed late-onset haze with myopic regression > - 1.00 D, for a prevalence of 1.8%. The mean SEQ regression was - 2.01 ± 0.79 D (ranging from - 1.00 to - 3.00 D). Regression stabilized at 6 to 15 months postoperatively. The amount of regression was not correlated with the magnitude of the attempted correction but was correlated with topographic steepening. The study suggested at least 10 months of follow-up for stabilization of refraction post-PRK.
Honda et al. (2004) [33]	Retrospective evaluation of 15 PRK-treated eyes of eight patients after five years.	There was a tendency toward myopic regression within the first postoperative year, and mean manifest refraction changed significantly from + 0.80 ± 1.62 D at 1 week to - 0.45 ± 0.70 D at 1 year. The tendency for regression continued after the second year. They found a significant difference between the mean manifest refraction at two years (- 0.36 ± 0.75 D) and 5 years (- 1.11 ± 1.12 D). Thus, myopic regression was detected in the first year, and a mild regression of approximately - 0.75 D continued between two and five years.
Pietila et al. (2004) [13]	Eight-year outcomes of myopic PRK with a 5.0-mm ablation zone in 92 eyes of 55 patients.	At eight years post-PRK, the percentages of eyes within 1.00 D of emmetropia for low, moderate, and high myopia were 78.3%, 68.8%, and 57.1%, respectively. In all subgroups of myopia, change in myopic regression stabilized within 12 months, yet a small myopic shift was detected up to eight years postoperatively.
Wu et al. (2000) [23]	Two-year outcomes of myopic PRK for 214 eyes of 121 patients with myopia of - 1.00 D to - 6.00 D in 124 eyes and - 6.25 to - 16.00 D in 90 eyes.	Myopic regression had a significant positive correlation with degree of attempted correction (rate of regression: 9.7% versus 27.8% in mild to moderate myopia compared with high myopia). Those in the older age group had a significantly higher regression rate than younger patients. Nearly severe subepithelial haze often coincided with the regression. The main factors causing post-PRK myopia regression were the degree of attempted correction, patient age, and presence of corneal haze.
Katlun et al (2000) [24]	Outcomes of myopic PRK for 338 eyes of 212 patients with myopia ranging from - 1.25 D to -11.25 D up to 12-month follow-up.	Regression and persistent haze were observed in 17 eyes with preoperative refraction > - 6.0 D and mean regression of - 1.67 D at 12 months post-PRK. Haze ≥ grade 1 - 2 at 12 months post-PRK was correlated with regression and a loss of best-corrected visual acuity.
Haw et al. (2000) [34]	Outcomes of photoastigmatic refractive keratectomy in 93 eyes of 56 patients with primary compound myopic astigmatism who had baseline sphere of - 1.0 to - 7.0 D and cylinder of - 1.0 to - 5.0 D were reported up to 12 months postoperatively.	Between 1 and 12 months of postoperative evaluation, a mean myopic regression of 0.27 D was detected.

Abbreviations: PRK, photorefractive keratectomy; LASIK, laser-assisted in situ keratomileusis; tPRK, transepithelial photorefractive keratectomy; mm, millimeters; OZ, optical zone; n, numbers; SEQ, a spherical equivalent of refractive error in refraction; K, keratometry reading; UCDVA, uncorrected distance visual acuity; Sphere, a spherical component of refractive error in refraction; D, diopter; Cylinder, a cylindrical component of refractive error in refraction; µm, micrometers; LASEK, laser sub-epithelial keratomileusis; epi-LASIK, epithelial laser-assisted in situ keratomileusis.

aged within the 36 – 50-year group had the highest frequency of myopic regression (26.53%), followed by those in the 31 – 35-year age group (21.31%). Age is a controversial factor, as some studies have reported a higher frequency of regression in older patients after PRK [19, 23] or LASIK [38], yet other studies found no effect of age on the outcome [8, 39]. Nomograms use average values, and inaccuracies are inevitable. Therefore, surgeons could adjust the nomograms for different age ranges [40] and refractive errors [22].

We found no significant differences in the frequency of PRK-treated eyes with optic zones of 6 or 6.5 mm between those with and without myopic regression. Shin et al. found no significant differences in regression between the 6.0-mm optical zone and the 6.5-mm optical zone over one year post-PRK [26]. This is inconsistent with the findings of Mohammadi et al., who reported a significant association between an intended optical zone < 6 mm and regression [22]. They had a dissimilar proportion of eyes with an optic zone of < 6 mm (n = 25 eyes, 36%) versus ≥ 6 mm (n = 45, 64%) [22]. Further studies with similar proportions of included eyes with optic zones < 6 mm and ≥ 6 mm, and matched for other variables, are required for conclusive results.

This retrospective cohort study included eyes that underwent myopic PRK performed by a single surgeon. We verified some factors associated with myopic regression reported in the literature. However, this was a retrospective chart review, and because of the uncertainty created by missing or partially missing data, we excluded a considerable number of eyes. Therefore, we included postoperative data from a six-month follow-up. Studies with larger sample sizes and longer follow-up periods are needed to verify our findings. Moreover, we recommend assessing the effects of other factors, such as overcorrection by age group, on the myopia regression rate.

CONCLUSIONS

In the current study, overcorrection in eyes with low myopia produced a lower frequency of myopic regression than overcorrection in eyes with high myopia. The highest frequency of myopic regression was observed in eyes with moderate myopia, followed by those with high and low myopia. The myopic regression rate was higher in patients with older age, higher astigmatism, and deeper ablation depth. Patients aged ≤ 30 years had a lower frequency of myopic regression. Further studies with larger sample sizes should replicate our findings over longer follow-up periods before generalization is warranted.

ETHICAL DECLARATIONS

Ethical approval: This study was approved by the Ethical Committee of Shahid Beheshti Medical University, Tehran, Iran, and adhered to the tenets of the Declaration of Helsinki. All participants provided written informed consent following an explanation of the aims and protocol of the study.
Conflict of interest: None.

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