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Original Article

Changes in Corneal Dynamics and Effective Optical Zone After Transepithelial Photorefractive Keratectomy for Myopia

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Abstract

Objectives: The objective of this study was to analyze the changes in the effective optical zones (EOZ) using topographic techniques on the tangential curvature difference map at post-operative 1-year following transepithelial photorefractive keratectomy (T-PRK) and to identify parameters linked to the EOZ alterations.

Methods: The study comprised 55 eyes of 55 myopic patients who underwent T-PRK. EOZs were measured using the tangential curvature difference map of the Scheimpflug tomography system. Correlations between the EOZ alterations and relevant parameters were assessed.

Results: The EOZ was significantly lower than the programmed optical zone (p<0.001). The decrease in the EOZ was significantly relevant to the decrease in mean keratometry (p=0.01, B/95% confidence interval [CI]: 0.139/0.033 and 0.244, standardized Beta: 0.346) and the increase in maximum keratometry (p=0.003, B/95% CI: 0.072/0.026 and 0.118, standardized Beta: 0.406).

Conclusion: The EOZ decreased in the 1st year after T-PRK in eyes with myopia. The decrease in the EOZ was correlated positively with the decrease in mean and maximum keratometry. T-PRK may be an effective and safe surgery for the correction of mild-to-moderate myopia.

Keywords: Effective optical zone, high-order aberrations, transepithelial photorefractive keratectomy.

Introduction

Myopia is the most common refractive error and has now become an epidemic (1). Transepithelial photorefractive keratectomy (T-PRK), one of the most popular corneal refractive surgical methods, can be used to treat myopia and increase patient comfort (2,3). All-surface laser ablation (SCHWIND eye-tech-solutions GmbH & Co. KG, Mainparkstrasse, Kleinostheim, Germany) used in T-PRK is a relatively new method that combines epithelial and stromal laser ablation in a single stage (2). This refractive procedure exhibits a high level of safety, efficacy, and predictability (4).

The effective optical zone (EOZ), which describes the corneal surface area with the best level of optical quality, is the area of the ablation that completes the full correction (5-7). Recently, several studies have been published with various descriptions of the EOZ measurement (5-14).

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Prior PRK studies have evaluated the correlation between the corneal high-order aberrations (HOAs) and the size of the programmed optical zone (15-17). However, none of these studies evaluated the relationship between HOAs – corneal parameters and regression in the EOZ diameter in comparison to the programmed optical zone.

In the present study, we aimed to analyze the changes in the EOZs using topographic techniques on the tangential curvature difference map at post-operative 1 year, corneal parameters, and HOAs following T-PRK and to determine the relationship between these parameters.

Methods

Myopic patients who had T-PRK at the Beyoglu Eye Hospital between January 2020 and June 2020 were evaluated for this retrospective study. With decision number 26/9 dated December 02, 2022, the Health Sciences University Ethics Committee permitted the study. All processes adhered to the principles of the Helsinki Declaration. Informed consent was obtained from the patients for scanning the file data.

Patients who had refractive error lesser than −4.50 diopters (D) sphere or −0.50 D of astigmatism, pre-operative central corneal thickness (CCT) higher than 480 mm, no history of ocular surgery, trauma, or any other ocular/systemic diseases, had no complications, had a follow-up of at least 1 year, who did not use medications other than preservative-free artificial tears, and who were between the ages of 20 and 35 were included in the study.

At pre-operative and post-operative examinations, all patients underwent these examinations: Uncorrected and corrected distance visual acuities (UDVA and CDVA, respectively) with Snellen charts, cycloplegic and subjective refraction, non-contact intraocular pressure, slit-lamp biomicroscopy, fundus examination with a 90 D lens, corneal topography, and pupillography using the Scheimpflug camera with a Placido disk topographer (Sirius, Costruzioni Strumenti, Oftalmici, Italy). Using the same topographer, horizontal visible iris diameter was measured. The axial length was assessed using optic biometry (EchoScan-US 1800, Nidek Co., Ltd.) (AL). The mean keratometry (Kavg), maximum keratometry (Kmax), CCT, and keratoconus vertex of the back surface (KVb) of the cornea were recorded preoperatively, as well as after 6 months and 1 year after the procedure. Preoperatively, 6 months later, and a year later, the flat radius of curvature (rf), the steep radius of curvature (rs), corneal asphericity (Q value), and HOAs (coma, trefoil, spherical aberration, secondary astigmatism, and higher-order root mean square –[RMS-]) of the anterior corneal surface within the 6.0 mm corneal diameter were measured.

Surgical Technique

All surgeries were made use of the Amaris 750s (SCHWIND eye-tech-solutions GmbH & Co. KG, Mainparkstrasse, Kleinostheim, Germany) device. Using an excimer laser and the device's ORK-CAM software, corneal epithelial removal was performed in a 7–9 mm zone. The excimer laser was then used to ablate the cornea. Ablation zones of at least 6.3 mm were used. The programmed optical zone size was determined based on the scotopic pupil diameter and the planned amount of refraction correction. Following the completion of the ablation, 0.02% mitomycin-C was applied to the stromal bed for 30 s. The medium is then cleared of mitomycin-C using 40 mL of a balanced salt solution. Finally, a soft bandage contact lens was employed.

Measurement of the EOZ

In accordance with previous research, the tangential anterior curvature difference map of the Scheimpflug topography system between the pre-operative and post-operative was used (8,13). The EOZ was the area bounded by a change of zero D on the subtractive map. As shown in Figure 1, the r values indicated in the top left corner of the tangential anterior curvature difference map were recorded at 30° intervals between 0 and 330° while the cursor was positioned at 0 D on the corneal meridian. Six different corneal meridians' summations of the r values at two 180° positions were calculated. EOZ was determined as the average of the values recorded in the six meridians.

The statistical analysis was carried out utilizing the Statistical Package for the Social Sciences (SPSS, v.20, Chicago, IL, USA). The Kolmogorov–Smirnov test revealed that all of the data were normally distributed. The minimum angle of resolution logarithm (LogMAR) was used to convert Snellen visual acuity. Repeated measures analysis of variance was used to make the comparisons. Pairwise comparisons were made using the Bonferroni correction. Comparing optical zones at the 6th month and the 1st year postoperatively was done using a paired sample t-test. To find correlations between the difference between the programmed optical zone and the EOZ and relevant parameters, Pearson correlation and multiple regression analyses were used. Statistical significance was defined as $p<0.05$.

Results

The study included 55 eyes of 55 myopic patients (32 females and 23 males). The patient characteristics are listed in Table 1.

Table 2 shows the refractive and corneal parameters of patients pre-operative, at post-operative 6 months and 1 year. SE, UDVA, CCT, Kavg, rf, and rs were significantly lower at post-operative visits compared to their pre-op-

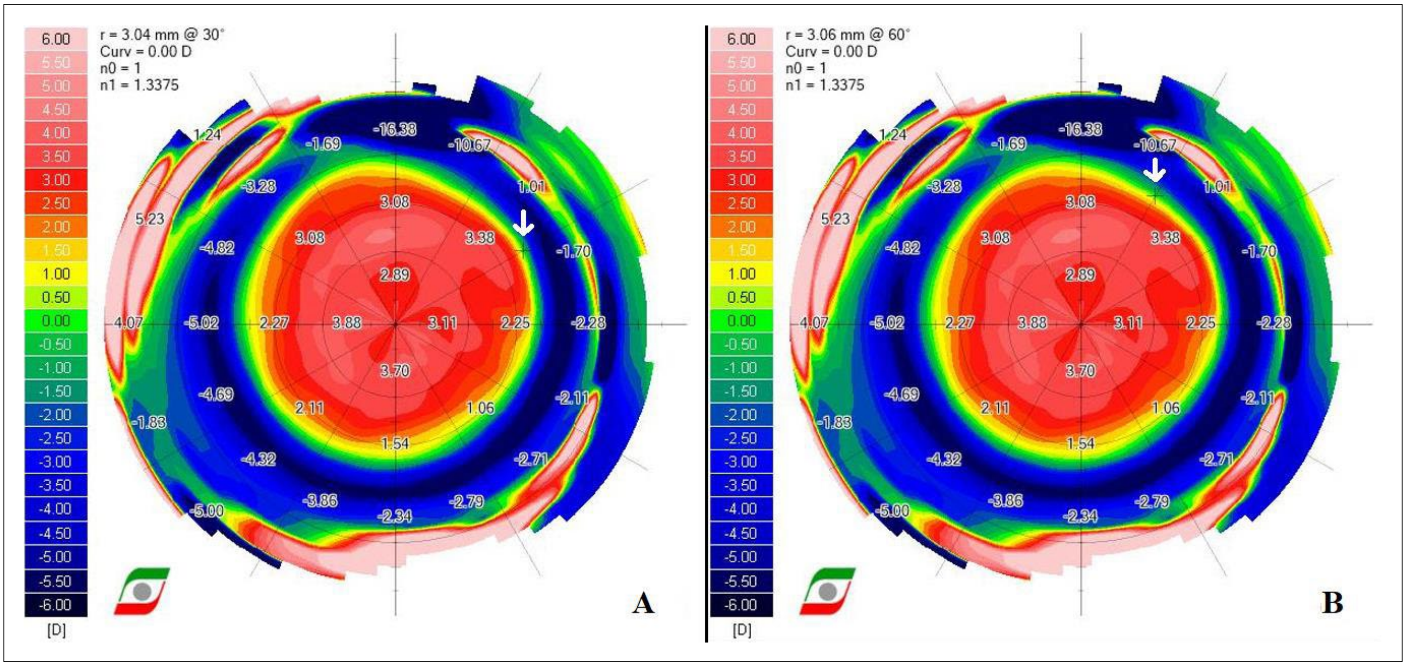

Figure 1. An example of the tangential anterior curvature difference map. When the cursor is at 0 D on 30° (white arrow in a), the r value expressed in the upper left corner of the map is 3.04 mm, which is used to calculate the optical zone at 30–210 corneal meridian. When the cursor is at 0 D on 60° (white arrow in b), the r value expressed in the upper left corner of the map is 3.06 mm, which is used to calculate the optical zone at 60–240 corneal meridian.

Table 1. The characteristics of patients

	Range	Mean
Age (year)	21–34	26.42±3.69
Axial length (mm)	23.48–25.62	24.58±0.55
HVID (mm)	11.30–12.52	11.86±0.33
Scotopic pupil diameter (mm)	5.10–7.47	6.31±0.57

HVID: Horizontal visible iris diameter.

erative values (p<0.001). Kmax was significantly higher at post-operative visits than its pre-operative value (p<0.001). Although spherical aberration increased in the post-operative 6 months compared to its pre-operative value, this increase was not statistically significant (p>0.05). Spherical aberration was significantly decreased at post-operative 1 year compared to its value at pre-operative and post-operative 6 months (p=0.002 and p=0.003, respectively). Although the RMS increased significantly compared to the pre-operative value in the post-operative 6th month (p=0.04), it was at a similar level with the pre-operative value in the post-operative 1st year (p>0.05). There was no significant difference between pre-operative and post-operative values of CDVA, KVb, Q, coma, trefoil, and secondary astigmatism (p>0.05).

Optical zones of the eyes are summarized in Table 3. The EOZ was significantly lower than the programmed optical zone and total ablation zone both at 6 months and 1 year postoperatively (p<0.001). Optical zones of each corneal meridian and EOZs were similar both at 6 months and 1 year postoperatively (p>0.05). Although the optical zone of the vertical axis (90–270 meridian) was narrower than the optical zone of the horizontal axis (0–180 meridian) both at 6 months and 1 year postoperatively, the difference was not significant (p>0.05).

The correlation between the difference between the programmed optical zone and the EOZ and relevant parameters at post-operative 1st year is given in Table 4. The decrease in the EOZ correlated positively with the decrease in CCT and Kavg, and the increase in Kmax (p=0.02, p<0.001, and p<0.001, respectively). These positive correlations were re-evaluated using multiple regression analyses (R2 adjusted: 0.450, p<0.001). The decrease in the EOZ was significantly relevant to the decrease in Kavg (p=0.01, B/95% confidence interval (CI): 0.139/0.033 and 0.244, standardized Beta: 0.346) and the increase in Kmax (p=0.003, B/95% CI: 0.072/0.026 and 0.118, standardized Beta: 0.406). However, the relationship between the decrease in CCT and the decrease in the EOZ lost its significance in multiple regression analyses (p=0.41).

Table 2. The refractive and corneal parameters of patients pre-operative, at post-operative 6 months and 1 year

	Pre-operative	Post-operative 6th month	Post-operative 1st year	p[a]	P1	P2	P3
SE (D)	-2.39±0.72	-0.02±0.27	-0.02±0.26	<0.001	<0.001	<0.001	1.0
UDVA (logMAR)	0.99±0.39	0.002±0.008	0.001±0.006	<0.001	<0.001	<0.001	0.97
CDVA (logMAR)	0.002±0.009	0.002±0.009	0.001±0.006	0.69	1.0	1.0	0.97
CCT (µm)	554.52±30.63	493.0±44.35	495.0±43.70	<0.001	<0.001	<0.001	0.32
Kavg (D)	43.63±1.10	41.04±1.15	41.17±1.17	<0.001	<0.001	<0.001	0.07
Kmax (D)	44.61±1.21	46.40±2.26	46.13±2.21	<0.001	<0.001	<0.001	0.10
KVb (µm)	10.29±2.68	11.45±3.34	11.17±3.42	0.06	0.08	0.13	1.0
rf (D)	43.45±1.03	40.95±1.10	41.04±1.13	<0.001	<0.001	<0.001	0.43
rs (D)	44.17±1.12	41.61±1.21	41.70±1.22	<0.001	<0.001	<0.001	0.64
Q	-0.19±0.11	-0.21±0.26	-0.17±0.25	0.47	1.0	1.0	0.30
Coma (µm)	0.23±0.10	0.24±0.12	0.22±0.11	0.87	1.0	0.88	0.74
Trefoil (µm)	0.17±0.09	0.20±0.12	0.19±0.10	0.12	0.21	1.0	0.51
Spherical aberration (µm)	0.19±0.08	0.21±0.15	0.08±0.20	<0.001	1.0	0.002	0.003
Secondary astigmatism (µm)	0.05±0.03	0.06±0.03	0.05±0.04	0.19	0.23	1.0	0.66
RMS (µm)	0.39±0.11	0.44±0.15	0.38±0.15	0.01	0.04	1.0	0.02

SE: Spherical equivalent; UDVA: Uncorrected distance visual acuity; CDVA: Corrected distance visual acuity; CCT: Central corneal thickness; Kavg: Mean keratometry; Kmax: Maximum keratometry; KVb: Keratoconus vertex of the back surface; rf: Flat radius of curvature; rs: Steep radius of curvature; Q: Corneal asphericity; RMS: Higher-order root mean square. [a]Comparisons were performed using repeated measures analysis of variance with Bonferroni adjustment. p1: Comparison between pre-operative and post-operative 6th month. p2: Comparison between pre-operative and post-operative 1st year. p3: Comparison between post-operative 6th month and post-operative 1st year.

Discussion

In this study, we analyzed EOZs of eyes undergone T-PRK utilizing topographic methods on the tangential curvature difference map at post-operative 1 year. We also revealed parameters linked to the changes in the EOZ. We detected a significant decrease in the EOZ compared to the programmed optical zone. The decrease in the EOZ was correlated positively with the decrease in Kavg and the increase in Kmax according to the regression analysis.

The refractive and visual acuity outcomes of our study are consistent with what has been reported in the literature (18-20). In comparison to their pre-operative values, SE and UDVA were significantly decreased at post-operative visits. There was a significant decrease in Kavg and CCT at both post-operative 6 months and 1 year similar to the results of Zhan et al., Salouti et al. and Lee et al. (21-23). In our study, rf and rs were also decreased significantly. We observed that Kmax increased significantly in post-operative follow-ups, like Shin et al. (24) After myopic ablation, the topography device recognizes the corneal ablation transition zone as the steepest part of the cornea and measures the Kmax value accordingly. This situation caused Kmax values to be found to be higher postoperatively. On the other hand, KVb and Q did not show any significant change. This may be due to the fact that our refractive correction included low-moderate myopic patients.

Al-Mohaimeed noticed that HOAs increased to some extent 6 months after T-PRK (15). Ozulken and Gokce reported an increase in spherical aberration 6 months after PRK in their study including 15 high myopic eyes also (17). Yildirim et al. declared that HOAs' total RMS, spherical aberration, coma, and trefoil were increased after T-PRK (25). According to Lee et al., whereas coma remained stable following T-PRK, the total corneal HOAs, and spherical aberration both considerably increased (23). On the other hand, it should be noted that this study included cases with cylindrical refractive errors up to −4.00 D (23). In contrast to these studies, Yilmaz et al. and Beser et al. did not observe any statistically significant difference between pre-operative and post-operative corneal aberrations in eyes undergoing T-PRK (18,26). Hosseini et al. concluded that the total HOA in the eyes undergoing PRK had not changed significantly at post-operative 1-year (27). Even they detect an increase in spherical aberration after 1 year, it was not significant (27). According to Lee et al., while RMS and coma were similar 6 months after PRK, coma was decreased (28). However, they reported that this decrease was not statistically signifi-

Table 3. Optical zones of the eyes

	Range (mm)	Mean (mm)
Programmed optical zone	6.3–7.3	6.69±0.23
Total ablation zone	6.79–8.20	7.42±0.32
Post-operative 6th month		
0–180 meridian	4.87–6.98	5.65±0.45
30–210 meridian	4.88–6.88	5.67±0.39
60–240 meridian	4.80–6.65	5.64±0.43
90–270 meridian	4.52–6.69	5.62±0.43
120–300 meridian	5.03–6.73	5.63±0.38
150–330 meridian	4.92–6.82	5.64±0.39
EOZ	4.93–6.75	5.64±0.38
Δ-OZ	0.52–1.67	1.07±0.29
Post-operative 1st year		
0–180 meridian	4.64–6.71	5.69±0.46
30–210 meridian	4.66–6.52	5.71±0.41
60–240 meridian	4.14–6.71	5.64±0.46
90–270 meridian	4. 22–6.79	5.61±0.48
120–300 meridian	4.39–6.45	5.66±0.42
150–330 meridian	4.58–6.61	5.67±0.47
EOZ	4.63–6.53	5.66±0.41
Δ-OZ	0.61–1.87	1.03±0.30

EOZ: effective optical zone; Δ-OZ: difference between the programmed optical zone and effective optical zone.

Table 4. The correlation of Δ-OZ and relevant parameters in the post-operative 1st year

	r	p
Δ-SE	-0.119	0.42
Total ablation zone	-0.164	0.27
Δ-CCT	0.336	0.02
Δ-Kavg	0.587	<0.001
Δ-Kmax	0.614	<0.001
Δ-rf	-0.96	0.52
Δ-rs	-0.122	0.42
Δ-Spherical aberration	0.206	0.17

Δ-OZ: difference between the programmed optical zone and effective optical zone; Δ: change of parameters according to their pre-operative values at post-operative 1st year; SE: Spherical equivalent: CCT: Central corneal thickness: Kavg: Mean keratometry: Kmax: Maximum keratometry: rf: Flat radius of curvature: rs: Steep radius of curvature.

cant (28). Jun et al. found that coma and trefoil remained at pre-operative levels 6 months after T-PRK (29). In another study, it was observed that after 6 months following T-PRK, coma, spherical aberration, and RMS reduced, whereas trefoil did not change (16). In our study, although coma, trefoil, spherical aberration, and secondary astigmatism increased 6 months after T-PRK, this increase was not statistically significant. In the 1st year after T-PRK, except for spherical aberration, there was no significant change according to the pre-operative values, while spherical aberration decreased significantly. Although the RMS increased significantly in the post-operative 6th month, it was at a level similar to its pre-operative value in the post-operative 1st year. One reason why the results of the studies differ from each other may be the differences in the manifest refraction in the studies. We excluded eyes with more than 0.50 D astigmatism and/or high myopia. We believe that this has an effect on the fact that aberrations did not increase post-operative 1-year.

To the best of our knowledge, although the effect of the differences in the programmed optical zone in T-PRK has been examined in several studies, there is no study evaluating the change in the EOZ after T-PRK. This is the first study to evaluate changes in the EOZ after T-PRK using topographic techniques on the tangential curvature difference map. We detected a significant decrease in the EOZ both at 6 months and 1 year postoperatively. Moreover, this decrease was correlated significantly with the decrease in Kavg and the increase in Kmax. Although the EOZ decreased after T-PRK, we did not observe any significant changes in HOAs. Although the EOZ decreased after T-PRK, we did not observe any significant changes in HOAs. Although this suggests that the reduction in the EOZ after T-PRK does not have the potential to affect visual quality, it is difficult to make a definitive conclusion since we did not objectively test visual quality parameters such as contrast sensitivity. In addition, we should emphasize again that all eyes in our study had a maximum astigmatism of 0.50 D and a maximum of −4.25 D of (mild-to-moderate) myopia.

The limitations of the present study are its retrospective methodology and relatively small sample size. The study lacked epithelial mapping, a valuable tool in evaluating T-PRK outcomes. The association between the EOZ and visual quality could not be analyzed with numerical data as the visual quality and the contrast sensitivity could not be evaluated with objective tests. Nevertheless, we believe that the findings are noteworthy because this is the first study to analyze changes in the EOZs using topographic techniques on the tangential curvature difference map following T-PRK. In our study, we demonstrated the narrowing of the EOZ in eyes that underwent T-PRK; however, we did not compare conventional PRK with T-PRK in terms of the EOZ. Future studies comparing the reduction in the EOZ of T-PRK and conventional PRK may be planned.

Conclusion

Although the EOZ decreased in the 1st year after T-PRK in eyes with mild–to-moderate myopia and astigmatism <0.50, we did not detect any significant change in corneal aberrations, except for spherical aberrations. There was also a significant decrease in spherical aberration. We conclude that T-PRK may be an effective and safe surgery for the correction of mild-to-moderate myopia.

Disclosures

Ethics Committee Approval: Myopic patients who had T-PRK at the Beyoglu Eye Hospital between January 2020 and June 2020 were evaluated for this retrospective study. With decision number 26/9 dated December 02, 2022, the Health Sciences University Ethics Committee permitted the study. All processes adhered to the principles of the Helsinki Declaration.

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Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept – I.C., B.K.Y.; Design – G.Y.C., B.K.Y.; Supervision – B.K.Y., Y.Y.; Resource – B.K.Y.; Materials – G.Y.C., I.C.; Data Collection and/or Processing – G.Y.C., I.C.; Analysis and/or Interpretation – G.Y., B.K.Y.; Literature Search – G.Y.C., I.C.; Writing – G.Y.C.; Critical Reviews – I.C., Y.Y.

References

1. Baird PN, Saw SM, Lanca C, Guggenheim JA, Smith Iii EL, Zhou X, et al. Myopia. Nat Rev Dis Primers 2020;6:1–20. [CrossRef]
2. Adib-Moghaddam S, Soleyman-Jahi S, Moghaddam AS, Hoorshad N, Tefagh G, Haydar AA, et al. Efficacy and safety of transepithelial photorefractive keratectomy. J Cataract Refract Surg 2018;44:1267–79. [CrossRef]
3. Özülken K, İlhan Ç. Comparison of higher-order aberrations after single-step transepithelial and conventional alcohol-assisted photorefractive keratectomy. Turk J Ophthalmol 2020;50:127.
4. Wen D, McAlinden C, Flitcroft I, Tu R, Wang Q, Alió J, et al. Postoperative efficacy, predictability, safety, and visual quality of laser corneal refractive surgery: A network meta-analysis. Am J Ophthalmol 2017;178:65–78. [CrossRef]
5. Nepomuceno RL, Wachler BS, Scruggs R. Functional optical zone after myopic LASIK as a function of ablation diameter. J Cataract Refract Surg 2005;31:379–84. [CrossRef]
6. Wachler BS, Huynh VN, El-Shiaty AF, Goldberg D. Evaluation of corneal functional optical zone after laser in situ keratomileusis. J Cataract Refract Surg 2002;28:948–53. [CrossRef]
7. Tabernero J, Klyce SD, Sarver EJ, Artal P. Functional optical zone of the cornea. Invest Ophthalmol Vis Sci 2007;48:1053–60.
8. Hou J, Wang Y, Lei Y, Zheng X. Comparison of effective optical zone after small-incision lenticule extraction and femtosecond laser-assisted laser in situ keratomileusis for myopia. J Cataract Refract Surg 2018;44:1179–85. [CrossRef]
9. Qian Y, Huang J, Zhou X, Hanna RB. Corneal power distribution and functional optical zone following small incision lenticule extraction for myopia. J Refract Surg 2015;31:532–8. [CrossRef]
10. Sun L, Lin HN, Jhanji V, Ng TK, Ji RF, Zhang R. Changes in effective optical zone after small-incision lenticule extraction in high myopia. Int Ophthalmol 2022;42:3703–11. [CrossRef]
11. Holladay JT, Janes JA. Topographic changes in corneal asphericity and effective optical zone after laser in situ keratomileusis. J Cataract Refract Surg 2002;28:942–7. [CrossRef]
12. Racine L, Wang L, Koch DD. Size of corneal topographic effective optical zone: Comparison of standard and customized myopic laser in situ keratomileusis. Am J Ophthalmol 2006;142:227–32. [CrossRef]
13. Partal AE, Manche EE. Diameters of topographic optical zone and programmed ablation zone for laser in situ keratomileusis for myopia. J Refract Surg 2003;19:528–33. [CrossRef]
14. Huang Y, Ding X, Han T, Fu D, Yu Z, Zhou X. Effective optical zone following small incision lenticule extraction for myopia calculated with two novel methods. J Refract Surg 2022;38:414–21. [CrossRef]
15. Al-Mohaimeed MM. Effect of the optical zone ablation diameter on higher order aberrations after transepithelial photorefractive keratectomy: A cohort study. Cureus 2021;13:e17630.
16. Jun I, Kang DS, Arba-Mosquera S, Jean SK, Kim EK, Seo KY. Clinical outcomes of mechanical and transepithelial photorefractive keratectomy in low myopia with a large ablation zone. J Cataract Refract Surg 2019;45:977–84. [CrossRef]
17. Ozulken K, Gokce SE. Evaluation of the effect of optic zone diameter selection on high-order aberrations in photorefractive keratectomy excimer laser treatment. Lasers Med Sci 2020;35:1543–7. [CrossRef]
18. Yilmaz BS, Agca A, Taskapili M. Comparison of long-term visual and refractive results of transepithelial and mechanical photorefractive keratectomy. Beyoglu Eye J 2022;7:121.
19. Moon CH. Four-year visual outcomes after photorefractive keratectomy in pilots with low-moderate myopia. Br J Ophthalmol 2016;100:253–7. [CrossRef]
20. Hashemi M, Amiri MA, Tabatabaee M, Ayatollahi A. The results of photorefractive keratectomy with Mitomycin-C in myopia correction after 5 years. Pak J Med Sci 2016;32:225. [CrossRef]
21. Zhan S, Pang G, Jin Y, Sun Y, Li W. Excimer laser photorefractive keratectomy for lower to moderate myopia: 5 year follow-up. Zhonghua Yan Ke Za Zhi 1999;35:277–9.
22. Salouti R, Kamalipour A, Masihpour N, Zamani M, Ghoreyshi M, Salouti K, et al. Effect of photorefractive keratectomy on agreement of anterior segment variables obtained by a swept-source biometer vs a Scheimpflug-based tomographer. J Cataract Refract Surg 2020;46:1229–35. [CrossRef]
23. Lee H, Kang DS, Reinstein DZ, Arba-Mosquera S, Kim EK, Seo KY, et al. Comparing corneal higher-order aberrations in corneal wavefront-guided transepithelial photorefractive keratectomy versus small-incision lenticule extraction. J Cataract

Refract Surg 2018;44:725–33. [CrossRef]

24. Shin DH, Lee YW, Song JE, Choi CY. Comparison of refractive outcomes after photorefractive keratectomy with different optical zones using Mel 90 excimer laser. BMC Ophthalmol 2020;20:270. [CrossRef]
25. Yildirim Y, Olcucu O, Alagoz N, Agca A, Karakucuk Y, Demirok A. Comparison of visual and refractive results after transepithelial and mechanical photorefractive keratectomy in myopia. Int Ophthalmol 2018;38:627–33. [CrossRef]
26. Beser BG, Yildiz E, Vural ET. Prognostic factors of visual quality after transepithelial photorefractive keratectomy in patients with low-to-moderate myopia. Indian J Ophthalmol 2020;68:2940–4. [CrossRef]
27. Chung SH, Lee IS, Lee YG, Lee HK, Kim EK, Yoon G, et al. Comparison of higher-order aberrations after wavefront-guided laser in situ keratomileusis and laser-assisted subepithelial keratectomy. J Cataract Refract Surg 2006;32:779–84. [CrossRef]
28. Lee H, Park SY, Kang DS, Ha BJ, Choi JY, Kim EK, et al. Photorefractive keratectomy combined with corneal wavefront-guided and hyperaspheric ablation profiles to correct myopia. J Cataract Refract Surg 2016;42:890–8. [CrossRef]
29. Jun I, Kang DS, Tan J, Choi JY, Heo W, Kim JY, et al. Comparison of clinical outcomes between wavefront-optimized versus corneal wavefront-guided transepithelial photorefractive keratectomy for myopic astigmatism. J Cataract Refract Surg 2017;43:174–82. [CrossRef]