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Assessment of Posterior Corneal Surface Changes Following Laser in Situ Keratomileusis Versus Photorefractive Keratectomy

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Abstract

Objectives:

The objective of this study was to examine changes in the posterior corneal surface following laser-assisted in-situ keratomileusis (LASIK) or photorefractive keratectomy (PRK) using Scheimpflug corneal topography.

Methods:

This prospective comparative study was conducted over two years (2017–2019) at the Lasik Scientific Group Center. We included patients over 18 years of age who had stable vision prescriptions, defined as a refractive change of no more than ±0.5 diopters over the previous 12 months. Each patient underwent a thorough evaluation to determine which laser surgery—LASIK or PRK—was appropriate for them.

Results:

The study included 30 patients. The average age was 28.26 years (±4.78) in the LASIK group and 25.86 years (±5.57) in the PRK group. A significant difference was observed between the two groups in terms of intraocular pressure (IOP): in the LASIK group, the mean IOP was 16.17 mmHg (±1.51), while in the PRK group it was 14.80 mmHg (±1.16) (p=0.001). Corneal thickness (pachymetry) was also higher in the LASIK group, with a mean of 560.57 µm (±35.79), compared to 521.23 µm (±23.81) in the PRK group (p=0.001). The mean corneal posterior thickness elevation (CPSE) in the LASIK group was -6.00 µm (±0.69) compared to -5.63 µm (±0.76) in the PRK group (p=0.57). After one month, the LASIK group had a mean CPSE of -6.06 µm (±0.94), while the PRK group had -5.76 µm (±0.77) (p=0.184). After three months, the mean CPSE in the LASIK group was -6.33 µm (±1.12), compared to -5.93 µm (±0.86) in the PRK group (p=0.128). At six months, the LASIK group had a mean CPSE of -6.43 µm (±1.07), while the PRK group had -6.03 µm (±0.76) (p=0.102).

Conclusion:

The results indicate that there was no notable difference in posterior corneal thickness elevation (CPSE) between LASIK and PRK. However, more research is needed to explore potential post-operative complications and changes in the posterior corneal surface, especially in patients who may be at risk for post-LASIK ectasia.

Keywords: LASIK; PRK; Posterior changes

Introduction

The cornea, the eye's outermost clear layer, is vital for normal vision and serves as a protective shield for the iris, pupil, and anterior chamber [1]. It plays key roles in shielding the eye's internal structures, focusing light onto the retina, managing the eye's refractive power, and minimizing optical distortions and scattering [2]. Recently, significant progress has been made in understanding the structural and clinical significance of collagen within the corneal stroma [3]. Individuals with myopia, commonly known as nearsightedness, typically rely on glasses or contact

lenses, as they struggle to see distant objects clearly [1]. However, contact lenses carry a risk of eye infections, and glasses may be uncomfortable or impractical during sports activities. As a result, many people opt for one of two popular surgical procedures: laser-assisted in-situ keratomileusis (LASIK) or photorefractive keratectomy (PRK) [4]. Both techniques use lasers to reshape the cornea by removing tissue.

LASIK tends to offer faster recovery and less discomfort compared to PRK [5], though after a year, the outcomes of both procedures are often similar. That said, LASIK can occasionally lead to complications like iatrogenic keratectasia, which might progress to the point of needing a corneal transplant [5,6]. Factors such as high myopia and increased intraocular pressure (IOP) contribute to corneal shifts following the surgery [7]. Some experts suggest maintaining a 250μm posterior stromal bed to help prevent these issues [8]. As corneal surgery techniques evolve, ongoing research is necessary to determine whether LASIK and PRK are equally safe [6]. This study aimed to examine the changes in the posterior cornea following LASIK and PRK using Scheimpflug corneal topography.

Patients and Methods

Study Design:

This was a prospective comparative study conducted over a two-year period, from 2017 to 2019, at the Lasik Scientific Group Center. To evaluate the participants, we used a Scheimpflug camera to analyze a total of 60 corneas from 30 consecutive patients. Since previous studies have shown that most changes in the posterior corneal surface following surgery occur in myopic eyes, we limited our study to patients with myopia. The study included 30 eyes from 15 patients who underwent LASIK and 30 eyes from 15 patients who underwent PRK. Each eye was evaluated both before surgery and six months after the procedure.

Inclusion criteria: We included patients over 18 years old who had a stable vision prescription, meaning their refractive error (MRSE) had not changed by more than ±0.5 diopters over the past year. For PRK, we required a minimum remaining corneal thickness of 400 µm, while LASIK patients needed at least 300 µm. If the thinnest part of the cornea was less than 500 µm, surgery was generally not performed. Corrections were limited to a maximum of -6.00 D for spherical equivalent and -4.00 D for cylindrical error.

Exclusion criteria: Patients were excluded from the study if they had any of the following: refractive errors beyond the allowed range, were under 18 years of age, or were unwilling to follow post-surgery care and attend follow-up appointments. We also excluded those with unstable vision prescriptions, prior eye surgeries, or any other eye conditions, such as glaucoma, significant cataracts, retinal detachment, or optic nerve disease. Additionally, patients were not considered if they had conditions that could affect the accuracy of the Scheimpflug scan, like corneal opacities or nystagmus, or other issues like poor spectacle vision due to irregular astigmatism, severe dry eye syndrome, or corneal nerve damage.

Methods: Each patient was carefully evaluated to determine which laser surgery they should undergo, based mainly on their central corneal thickness (CCT). Patients with CCT greater than 500 µm were typically selected for LASIK, provided no other contraindications were present. For patients with a CCT less than 500 µm, surface ablation was chosen instead.

LASIK Procedure:

During the LASIK surgery, a precise flying spot excimer laser was used to reshape the cornea. A thin flap, 160 µm thick, was created using a Moria microkeratome. After the corneal reshaping, both the flap and the underlying stromal surface were irrigated with a balanced salt solution and the flap was carefully repositioned.

PRK Procedure:

For the PRK procedure, the excimer laser was applied to reshape the corneal stroma. Afterward, the stromal bed was rinsed and dried. The central 8 mm of the corneal epithelium was removed using an Amoil brush. To aid in healing, a soft bandage contact lens was applied following the use of antibiotic eye drops.

Pre- and Post-Procedure Assessments:

Each patient underwent assessments that measured key factors such as uncorrected and best-corrected visual acuity (UCVA and BCVA), cycloplegic refraction, and intraocular pressure (IOP) using a Goldmann applanation tonometer. Additionally, we used Pentacam imaging to evaluate central corneal thickness (CCT), corneal curvature, and elevations on both the front and back surfaces of the cornea.

Follow-up Visits:

Patients returned for follow-up assessments at 1, 3, and 6 months after the surgery to monitor their recovery and evaluate the results.

Statistical Analysis:

Continuous data were reported as means with standard deviations (± SD), while categorical data were presented as frequencies and percentages. The Student's t-test was used to compare continuous variables, while the chi-square test was applied for categorical data. All analyses were performed using SPSS version 21 (SPSS Inc., Chicago, IL), with a significance level set at $p \leq 0.05$.

Results

Demographic Characteristics:

In this study, we included a total of 30 patients. The average age in the LASIK group was 28.26 years (±4.78), while in the PRK group it was 25.86 years (±5.57). In terms of gender distribution, 60% of the LASIK group were female and 40% were male. For the PRK group, 46.7% were female and 53.3% were male. There was no statistically significant difference in gender distribution between the two groups (see Table 1).

Ophthalmologic Measurements:

There were notable differences between the two groups. The average intraocular pressure (IOP) in the LASIK group was 16.17 mmHg (±1.51), compared to 14.80 mmHg (±1.16) in the PRK group, with a statistically significant difference (p=0.001). For the LASIK group, the mean spherical equivalent was -3.70 D (±1.17), the mean cylindrical error was -1.13 D (±0.86), and the average axis was 83.38° (±58.11). In the PRK group, the mean spherical equivalent was -2.4 D (±0.79), the cylindrical error was -1.09 D (±0.33), and the average axis was 60.71° (±65.28), showing a significant difference between the two procedures (p=0.001). Additionally, the mean corneal pachymetry (corneal thickness) was higher in the LASIK group, with an average of 560.57 µm (±35.79) compared to 521.23 µm (±23.81) in the PRK group (p=0.001) (see Table 2).

Pre- and Post-operative Corneal Posterior Thickness Elevation (CPSE) Scores: Before surgery, the mean CPSE score was -6.00 (±0.69) in the LASIK group, and -5.63 (±0.76) in the PRK group, with no significant difference (p=0.57). One month post-operatively, the LASIK group had a mean CPSE of -6.06 (±0.94), while the PRK group had -5.76 (±0.77) (p=0.184). After three months, the mean CPSE was -6.33 (±1.12) in the LASIK group and -5.93 (±0.86) in the PRK group (p=0.128). At six months, the LASIK group had a mean CPSE of -6.43 (±1.07), and the PRK group had -6.03 (±0.76), with no statistically significant difference (p=0.102) (see Figure 1).

Discussion

The goal of LASIK surgery is to reshape the cornea and adjust its refractive power [9]. While the procedure doesn't directly impact the surface of the cornea, it does bring about noticeable visual changes on the front surface [10]. LASIK alters the cornea’s refractive power by removing tissue through photoablation. This process disrupts the cornea's structure, specifically affecting the Bowman membrane after the excimer laser treatment [11]. Additionally, the posterior curvature of the cornea often increases after surgery due to forward bulging. Monitoring intraocular pressure (IOP) after LASIK, particularly in myopic patients, is crucial as myopia is a key risk factor for

open-angle glaucoma. It's also important to note that IOP measurements can be underestimated following LASIK due to reduced corneal thickness and the creation of a corneal flap [12–16].

In our study, we found that the average IOP in the right eye for the LASIK group was 16.20 mmHg (±1.42) compared to 14.73 mmHg (±1.33) in the PRK group (p=0.007). For the left eye, the LASIK group had an average IOP of 16.13 mmHg (±1.64), while the PRK group had 14.86 mmHg (±0.99) (p=0.015). In a separate prospective study involving 100 eyes from 50 patients with myopia, 50 eyes underwent LASIK and the other 50 underwent PRK. Pre-surgery, the mean IOP for both groups was similar, with 15.86 ± 1.99 mmHg in the LASIK group and 15.62 ± 2.12 mmHg in the PRK group. However, postoperatively, both groups experienced a significant drop in IOP to 12.98 ± 1.83 mmHg for LASIK and 12.98 ± 2.03 mmHg for PRK (p<0.001) [17]. Furthermore, Shemesh and colleagues found that LASIK patients showed reduced IOP when measured with Goldmann Applanation Tonometry (GAT), but no such reduction was noted when using dynamic contour tonometry (DCT), which is not influenced by corneal thickness [18]. Similarly, Shousha et al. found a significant reduction in IOP after LASIK when measured using both GAT and a non-contact tonometer [19].

In terms of visual outcomes, our results showed significant differences between the LASIK and PRK groups. For the right eye, there was a notable difference in spherical error (p=0.001) and axis (p=0.003). In the left eye, the difference was only seen in spherical error (p=0.012). A meta-analysis also supported better results with LASIK compared to PRK, with an odds ratio of 5.89 (95% CI, 3.34 to 10.39).

When it comes to corneal thickness (pachymetry), the LASIK group had an average corneal thickness of 560.66 µm (±35.74) in the right eye, compared to 520.33 µm (±25.18) in the PRK group (p=0.002). In the left eye, the LASIK group had an average thickness of 560.46 µm (±37.09), while the PRK group measured 522.13 µm (±23.19) (p=0.002). According to Settas et al., LASIK patients generally recover their vision faster than PRK patients, although both procedures ultimately lead to similar levels of uncorrected visual acuity (UCVA). They also observed that LASIK patients are less likely to experience a loss of two or more lines of visual acuity compared to those who undergo PRK [20].

Regarding preoperative corneal posterior surface elevation (CPSE), there was no significant difference between the two groups. For the right eye, the mean CPSE in the LASIK group was -5.86 (±0.74) compared to -5.60 (±0.82) in the PRK group (p=0.081). For the left eye, the LASIK group had a mean CPSE of -6.13 (±0.63), while the PRK group had -5.66 (±0.72) (p=0.015). Over the follow-up period, no significant differences were observed between the groups at any time point. Aristeidou et al. also found that post-LASIK patients showed changes in the posterior curvature radius, primarily in the vertical direction [21].

In an analysis by Khayrat et al., a clear link was identified between refractive error and changes in the posterior corneal elevation at the 4 mm mark (r = 0.43, p=0.001). Additionally, there was a significant correlation between refractive error and posterior elevation changes at 7 mm, with r = 0.35 and p=0.01 at one week, and r = 0.35 and p=0.04 at three months [22].

Our study had a few limitations, such as the lack of detailed reporting on post-operative complications for both groups. Additionally, we did not examine the correlation between posterior corneal elevation and refractive error in depth.

Conclusion:

Our findings suggest that there was no significant difference between LASIK and PRK in terms of CPSE. However, more research is needed to explore post-operative complications and changes in the posterior corneal surface, particularly in patients who may be at risk for post-LASIK ectasia.

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Variables		**LASIK**	**PRK**	**P value**
Gender	Female	9(60%)	7(46.7%)	0.464
	Male	6(40%)	8(53.3%)	
Age	Mean (SD)	28.26 (4.78)	25.86 (5.57)	0.252
	Median (Rang)	30(19-34)	25(19-36)	

Table 1: Demographic characteristics

Table 2: Intra ocular pressure (IOP), Pachy, and refraction in both groups.

Variable		LASIK	PRK	P value
IOP	Mean (SD)	16.17 (1.51)	14.80 (1.16)	0.001
	Range	13 to 19	13 to 18	
Sphere	Mean (SD)	-3.70 (1.17)	-2.4 (0.79)	0.001
	Range	-6 to -2	-3.5 to -1	
Cylinder	Mean (SD)	-1.13 (0.86)	-1.09 (0.33)	0.852
	Range	-3.5 to 0.75	-1.5 to -0.5	
Axis	Mean (SD)	83.38 (58.11)	60.71 (65.28)	0.267
	Range	5 to 180	5 to 180	
Pachy	Mean (SD)	560.57 (35.79)	521.23 (23.81)	0.001
	Range	511 to 639	492 to 563	

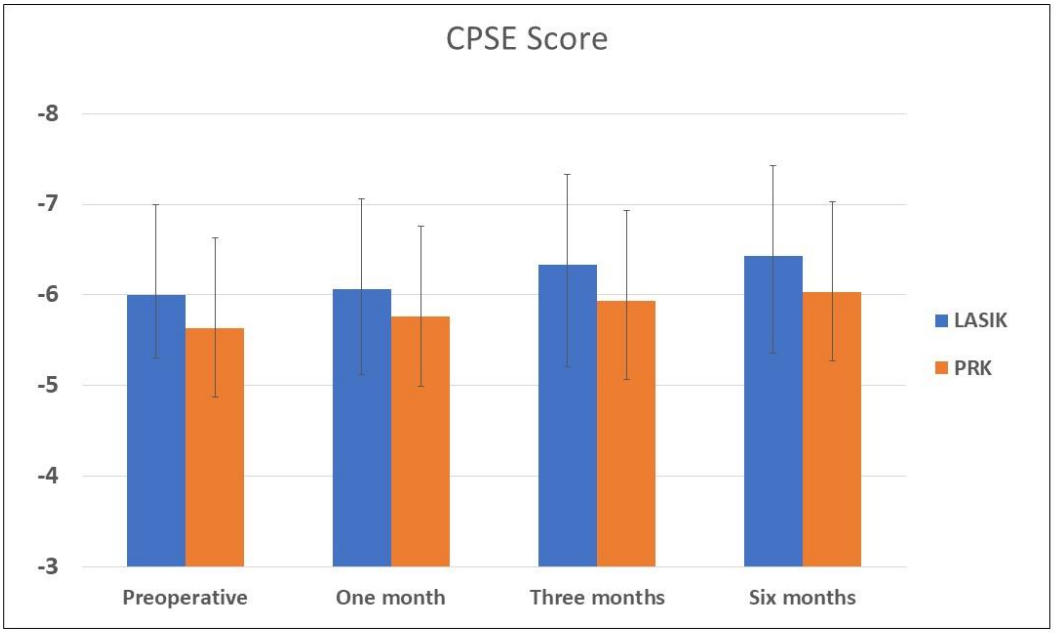

Figure (1) following up the CPSE score in both groups