Original Article

Clinical Impact of Trans-Photorefractive Keratectomy and Femtosecond Laser In-Situ Keratomileusis in patients with Myopia and Astigmatism

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ABSTRACT

Purpose: To compare Visual Acuity (VA), Contrast Sensitivity (CS), and Higher Order Aberrations (HOA) in myopic and astigmatic patients undergoing Trans-Photorefractive Keratectomy and Femtosecond Laser In-Situ Keratomileusis.

Study Design: Quasi experimental study.

Place and Duration of Study: Amer eye hospital Rawalpindi from July 2022 to July 2023.

Methods: A total of 60 patients (120 eyes) were equally divided into two groups; Trans-Photorefractive Keratectomy (TPRK) group, consisting of 30 patients (15 myopic, 15 astigmatic), and the Femtosecond LASIK group, comprising 30 patients (15 myopic, 15 astigmatic).Patients between 18 to 40 years of age with stable myopia or astigmatism seeking refractive correction were included. Individuals with a history of ocular surgery, progressive ocular disease, or systemic conditions affecting ocular health were excluded. The TPRK group underwent non-touch refractive surgery using an excimer laser, while the Femtosecond LASIK group underwent refractive surgery utilizing a femtosecond laser. Preoperative and postoperative assessments included VA, CS and HOA measured using Snellen charts, standardized contrast tests, and wavefront analysis, respectively.

Results: Trans-PRK yielded superior results compared to Femtosecond LASIK ($P < 0.05$) in myopia as well as astigmatism. CS decreased significantly ($P > 0.05$) after both surgeries with Trans-PRK showing better results. Both techniques increased HOAs ($P > 0.05$) in myopic patients, with Trans-PRK outperforming Femtosecond LASIK.

Conclusion: While both Trans-PRK and Femtosecond LASIK improved VA, reduced CS, and increased HOAs, Trans-PRK demonstrated superior outcomes over Femtosecond LASIK in this study.

Keywords: Astigmatism, Femtosecond LASIK, Myopia, Photorefractive keratectomy.

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INTRODUCTION

Myopia places a considerable strain on healthcare systems, the economy, and individuals' quality of life. As a growing global public health concern, it necessitates timely interventions to prevent its onset and slow its progression. Recently, it has emerged as a global public health and socio-economic issue, with a particularly high prevalence in East Asia.[2-4] Concurrently, astigmatism presents another prevalent ocular problem leading to visual disturbances and

compromised visual function, necessitating prompt corrective measures for optimal visual outcomes.[5,6]

Contemporary advancements in ophthalmic technology have introduced the excimer laser, a critical tool in the arsenal of refractive surgeons. This laser, comprising halogen and noble gases, generates highly energized gas complexes upon electric current application, facilitating precise corneal reshaping in procedures such as Trans-Photorefractive Keratectomy (TPRK) and Femtosecond LASIK (Femtosecond Laser-Assisted in situ Keratomileusis) for correcting refractive errors.[7]Femtosecond LASIK stands as a widely adopted refractive procedure employing a femtosecond laser to address ocular refractive anomalies. Conversely, Trans-PRK signifies a non-contact refractive technique utilizing an excimer laser for correcting refractive disorders.[8,9]

Post-refractive surgery alterations in contrast sensitivity (CS) have been recognized, impacting the perception of sharp images and distinctions in patterns or shadows. Additionally, higher order aberrations (HOAs) denote subtle ocular irregularities beyond conventional refractive errors, resulting from diverse etiologies such as ocular anomalies, surgical interventions, or ophthalmic pathologies.[10] Understanding the implications of these refractive procedures on visual parameters like CS and HOAs is crucial in comprehensively evaluating their efficacy, ensuring optimal postoperative visual outcomes, and refining therapeutic strategies.[11,12]

The current study aims to find out the effects of TPRK and Femtosecond LASIK on VA, CS and HOA in individuals with myopia and astigmatism in a tertiary care facility.

METHODS

This was a quasi-experimental study conducted at the Amer eye hospital Rawalpindi from July 2022 to July 2023 to evaluate the effects of TPRK and Femtosecond LASIK on visual functions. The study was conducted following the principles outlined in the Declaration of Helsinki and was approved by the Institutional Review Board **(TUF/Addl Reg /SB/241)**. Informed consent was obtained from all participants before enrollment. Patients aged between 18 to 40 years with stable myopia or astigmatism seeking refractive correction through laser were included. Exclusion criteria involved individuals with a history of ocular surgery, progressive ocular disease, or systemic conditions affecting ocular health. A total of 60 patients (120 eyes) were included by convenient sampling. The participants were split into two groups: TPRK group, consisting of 30 patients (15 myopic, 15 astigmatic), and the Femtosecond LASIK group, comprising 30 patients (15 myopic, 15 astigmatic). The TPRK group underwent non-touch refractive surgery using an excimer laser, while the Femtosecond LASIK group underwent refractive surgery utilizing a femtosecond laser.

Preoperative and postoperative assessments included complete ocular examination including VA, CS and HOA measured using Snellen charts converted to LogMAR, Pelli Robson contrast tests, and wavefront analysis, respectively.

Descriptive statistics were used to summarize demographic data. Continuous variables were expressed as means ± standard deviations (SD), while categorical variables were presented as frequencies and percentages. Paired t-tests and analysis of variance (ANOVA) were employed to analyze within-group and between-group differences, with significance set at $p < 0.05$.

RESULTS

The mean age in this study was 25.4±3.07 years. The mean age for TPRK patients was 25.4 ± 3.07 (range 20-32) years, while for Femto-LASIK patients it was 24.63 ± 2.36 years (range 21-32).There were 40% (N=12) males and 60% (N=18) females in TPRK group and 33.3% (N=10) males and 66.66% (N=20) females in FM –LASIK group.

The mean baseline VA in TPRK myopic group was 1.096±0.17 which improved to 0.37±0.77 after one week and 0.2±0.61 after one month (P=0.000). The mean baseline CS was 2.0±0.00 which was 1.99±0.027 after one week and 1.99±0.39 after one month of treatment (p= 0.036). There was a substantial decrease in CS between baseline and post-surgery. However, pairwise comparison of myopic patients regarding CS showed that the difference among the groups was insignificant (p>0.05). The mean baseline HOA was 0.53±0.04 which increased to 0.62±0.09 after one week and 0.62±0.87 after one month (P =0.00). Pairwise comparison of HOA in this group showed significant difference among the groups (p= 0.000).

Among the TPRK astigmatic group, the mean baseline VA was 1.09±0.17 which improved to

0.37±0.77 after one week 0.2±0.61 after one month(P=0.000). Pairwise comparison of showed that significant difference was present (p=0.00). The mean baseline CS in this group was 2.0±0.00, which was 1.99±0.03 after one week and 1.99±0.39 after one month (P=0.069). Pairwise comparison showed that significant difference was not present among the groups (p>0.05).Similarly, mean baseline HOA was 0.53±0.04, 0.60±0.04 at one week and 0.62±0.04 at one month (P= 0.000). Pairwise comparison of astigmatic patients that significant difference was present among the groups (p=0.00).

In the FM-LASIK myopic group, mean baseline VA was 0.84 ±0.27 which improved to 0.13±0.11 after one week and 0.23±0.08 after one month (P=0.000). Pairwise comparison showed that significant differences were present among the groups (p=0.000). The mean baseline CS was 2.0±0.00, which decreased to 1.99±0.05 after one week and 1.94±0.05 after one month (P = 0.069). Pairwise comparison of VA at different intervals showed a statistically insignificant difference. The mean baseline HOA was 0.52±.026, 0.64±0.05 after one week and 0.76±0.09 after one month (P= 0.000). Pairwise comparison showed that significant difference was present (p=0.00).

In the FM-LASIK astigmatic group, the mean VA was 0.84±0.27, which improved to 0.13±0.11 after one week and 0.23±0.08 after one month (P=0.000). Pairwise comparison of VA showed significant difference. The mean baseline CS was 2.0±0.00, which was 1.99±0.05 after one week and 1.94±0.05 after one month (P=0.071) showing statistically insignificant difference between baseline and after surgery. Pairwise comparison of astigmatic patients CS showed insignificant difference (p>0.05). The mean baseline HOA was 0.52±0.02, which increased to 0.64±0.03 after one week and 0.75±0.03 after one month (P=0.000). Pairwise comparison showed that significant difference was present.

The mean and SD at first follow-up were 0.006±.0253 and 0.867±.1105. At second follow-up was .0200±0.0610 and 0.867±.1105 P<0.05 (0.000) showed that there was significant of difference present. That showed that both surgeries improve visual acuity in myopic patients. But this showed that TPRK gave batter results as compared to FMLASIK. It was shown in the table 4.39 and 3.40.

Comparison between the TPRK and FM-LASIK showed that at both 1 week and 1-month follow-ups, myopic patients who underwent TPRK had significantly better visual acuity (VA) compared to those who had Femto-LASIK (p = 0.001). Contrast sensitivity (CS) was also significantly better in the TPRK group at 1 week (p = 0.009), while no significant difference was observed at 1 month (p = 0.26). At 1 week postoperatively, there was no significant difference in higher-order aberrations (HOA) between the TPRK and Femto-LASIK groups (p = 0.196). However, at 1 month, the TPRK group demonstrated significantly lower HOA compared to the Femto-LASIK group (p = 0.001). Details are in Table 1.

Table 1: *Difference in VA, CS and HOA in the myopic groups of TPRK and FM-LASIK*

	Surgery Type	Mean±SD	P value
VA of myopic groups 1 week	TPRK	0.007±0.025	0.001
	FM-LASIK	0.087±0.11	
VA of myopic groups at 1 month	TPRK	0.02±0.06	0.001
	FM-LASIK	0.21±0.07	
CS of myopic group at 1 week	TPRK	1.97±0.04	0.009
	FM-LASIK	1.94±0.05	
CS of myopic group at 1 month	TPRK	1.96±0.07	0.26
	FM-LASIK	1.94±0.05	
HOA of myopic group at 1 week	TPRK	0.62±0.087	0.196
	FM-LASIK	0.64±0.05	
HOA of myopic group at 1 month	TPRK	0.62±0.087	0.001
	FM-LASIK	0.76±0.087	

Table 2: *Difference in VA, CS and HOA in the astigmatic groups of TPRK and FM-LASIK.*

	Surgery Type	Mean±SD	P value
VA of astigmatic groups 1 week	TPRK	0.007±0.025	0.001
	FM-LASIK	0.13±0.106	
VA of astigmatic groups 1 month	TPRK	0.02±0.06	0.001
	FM-LASIK	0.23±0.08	
CS of astigmatic groups 1 week	TPRK	1.99±0.028	0.264
	FM-LASIK	1.90±0.03	
CS of astigmatic groups 1 month	TPRK	1.99±0.04	0.001
	FM-LASIK	1.79±0.07	
HOA of astigmatic groups 1 week	TPRK	0.60±0.04	0.196
	FM-LASIK	0.64±0.03	
HOA of astigmatic groups 1 month	TPRK	0.63±0.04	0.001
	FM-LASIK	0.75±0.031	

In astigmatic patients, TPRK resulted in significantly better visual acuity (VA) than Femto-LASIK at both 1 week and 1 month (p = 0.001). Contrast sensitivity (CS) differences were not significant at 1 week (p = 0.264), but TPRK showed significantly better CS at 1 month (p = 0.001). Higher-

order aberrations (HOA) did not differ significantly at 1 week (p = 0.196); however, TPRK had significantly lower HOA than Femto-LASIK at 1 month (p = 0.001). Details are in Table 2.

DISCUSSION

The current study showed that TPRK yielded superior results compared to FM-LASIK (P < 0.05) in myopia as well as astigmatism. CS decreased significantly (P > 0.05) after both surgeries with TPRK showing better results. Both techniques increased HOAs (P > 0.05) in myopic patients, with TPRK outperforming FM-LASIK. The clinical effectiveness of TPRK and FM-LASIK for the treatment of myopia and astigmatism has been widely investigated, showing comparable results in terms of visual acuity and astigmatic correction. Both techniques are considered safe and effective, though they exhibit slight variations in specific performance outcomes. According to Sun L. et al, both TPRK and FM-LASIK achieved similar uncorrected distance visual acuity and corrected distance visual acuity at three months post-surgery, indicating effective refractive correction.[13,14] According to another study, TPRK had a mean manifest refraction spherical equivalent of 0 ± 0.20 D, slightly lower than Femto-LASIK's 0.11 ± 0.25 D, suggesting a marginally better performance in astigmatic correction by Femto-LASIK.[15]

In our study, contrast sensitivity reduction occurred following both surgeries; however, TPRK appeared to have a slightly more favorable impact on CS as FM-LASIK. In contrast to this, another study reported that quality of vision recovered at postoperative 1 week after LASIK and at postoperative 1 month after PRK-MMC.[16] In another study, after evaluating the outcomes from 140 eyes of 70 patients, the researchers concluded that both PRK and FM-LASIK were effective in enhancing vision.[17] However, PRK demonstrated slightly superior results in uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) at both the 6-month and 24-month post-surgery marks.

In terms of HOA, a previous study with TPRK demonstrated a more notable increase in HOA as compared to FM-LASIK, indicating potential differences in their impact on ocular aberrations.[18] It was also reported that FM-LASIK was a more effective and safer option than TPRK for patients with low to moderate myopia, leading to better visual outcomes. Ads far as the recovery is concerned, the studies have shown that although TPRK outcomes 1 year postoperatively were equivalent to those of FM-LASIK, TPRK had a longer recovery time than the FM-LASIK.[19]

The results of our study were also supported by Zhang et al, that TPRK and FS-LASIK showed good safety, efficacy and predictability for correction of myopia. However, clinical outcomes of TPRK were slightly better than FM-LASIK.[20] Whereas, according to a meta-analysis, there were no statistically significant differences in visual outcomes (efficacy and safety) or visual quality (higher-order aberrations and contrast sensitivity). However, FM-LASIK showed better predictability compared to other surgical techniques.[21]

The limitations of this study include challenges in follow-up adherence and the affordability of procedures which resulted in smaller sample size. However, the study provides valuable insights into the comparative outcomes of TPRK and FM-LASIK in myopic and astigmatic patients.

CONCLUSION

In summary, both TPRK and FM-LASIK surgeries significantly improved visual acuity but led to reduced contrast sensitivity and increased higher order aberrations. TPRK exhibited slightly superior outcomes in VA and CS, while both procedures had comparable effects on increasing HOA.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(TUF/Addl Reg /SB/241)**.

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Authors Designation and Contribution

Muhammad Zubair Nazar; Optometrist: *Concepts, Design, Data Acquisition, Data Analysis, Manuscript Preparing, Manuscript Editing.*

Khalid Mehmood; Professor: *Concepts, Manuscript Editing.*

Khalid Shabbir; Optometrist: *Statistical Analysis.*

Muhammad Asrar Yousaf; Senior Lecturer: Saad Ullah; Optometrist: *Literature Search. Manuscript Review.*