Effect of Pre and Post Operative PRK and PRK Stream Light on Tear Film Stability

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ABSTRACT

Background: Tear film instability can lead to dry eye disease, which is a common complication following refractive surgeries such as Photorefractive Keratectomy (PRK) and Transepithelial PRK (Trans-PRK).

Objective: This study aimed to evaluate the effects of PRK and Trans-PRK on tear film stability using the Tear Break-Up Time (TBUT) test and Schirmer II test.

Methods: A quasi-experimental study was conducted at the National Eye Center, Lahore, including 100 patients aged 18-30 years undergoing PRK or Trans-PRK. Tear film stability was assessed before and after surgery using TBUT and Schirmer II tests. Data were analyzed using SPSS version 25, applying paired t-tests to compare pre- and post-surgery outcomes.

Results: Significant reductions were observed in TBUT and Schirmer II test values after PRK (mean difference: 4.80, $p < 0.001$; 4.86, $p < 0.001$) and Trans-PRK (mean difference: 3.06, $p < 0.001$; 2.96, $p < 0.001$), indicating increased eye dryness post-surgery.

Conclusion: Both PRK and Trans-PRK significantly reduced tear film stability, increasing the risk of dry eye symptoms. Proper patient assessment and post-operative care are essential to mitigate these risks.

INTRODUCTION

Tear film, a crucial microscopic layer on the ocular surface, is essential for maintaining eye health by providing moisture and protection against dryness. It comprises three layers: an outer lipid layer, a middle aqueous layer, and an innermost mucous layer. The mucous layer plays a critical role in cell adhesion and preventing ocular surface damage. Instability in the tear film can lead to dry eye disease, which manifests as ocular discomfort due to damage to the ocular surface (1). Various methods can be employed to correct refractive errors, including glasses, contact lenses, and surgical interventions. Among the surgical options, Photorefractive Keratectomy (PRK) has been a well-established procedure for a considerable time. Recently, a more advanced technique known as Transepithelial PRK (Trans-PRK) has gained prominence, offering a more sophisticated approach to corneal reshaping without direct contact with the eye through the use of a laser that swiftly removes the epithelial layer in a single step (2, 3). However, despite the benefits, both PRK and Trans-PRK have been associated with the development of dry eye symptoms, necessitating further evaluation of tear film stability following these procedures (4, 5).

To assess tear film stability and diagnose dry eye disease, two common tests are used: the Tear Break-Up Time (TBUT) test and the Schirmer II test. These tests, although cost-effective and easy to administer, are less specific than other diagnostic methods in evaluating tear fluid dynamics. TBUT measures the time interval between eye opening and the appearance of the first dry spot on the tear film, indicating tear film stability, while the Schirmer II test measures the volume of tear secretion, offering insight into the eye's moisture maintenance capacity (6, 7). Studies have demonstrated that both PRK and Trans-PRK can significantly affect these parameters, leading to increased dry eye symptoms post-surgery. For instance, a previous study comparing LASIK and PRK procedures showed a substantial increase in eye dryness after surgery, attributed to reduced values in both TBUT and Schirmer II tests (8). Similarly, the tear film was found to be less stable after PRK with a laser than after traditional PRK (9). This variability underscores the need for a comprehensive understanding of the factors influencing post-surgical outcomes, including pre-existing ocular conditions and patient-specific variables such as age and gender (10, 11).

This study was designed to evaluate the impact of PRK and Trans-PRK on tear film stability using the TBUT and Schirmer II tests. Given the potential for significant

ocular dryness following these procedures, understanding these impacts is vital for optimizing patient care and outcomes. The significance of this study lies in its potential to inform clinical practices aimed at minimizing post-surgical dry eye risk, thereby enhancing the safety and effectiveness of these refractive surgeries. Understanding the extent to which these surgical procedures affect tear film stability can guide future refinements in surgical techniques and patient management strategies to reduce the incidence of post-operative dry eye disease, ensuring better patient comfort and satisfaction (12, 13).

MATERIAL AND METHODS

A quasi-experimental study was conducted at the National Eye Center, Lahore, Pakistan, from January 9, 2024, to June 21, 2024, to assess the impact of Photorefractive Keratectomy (PRK) and Trans-PRK on tear film stability. The study utilized a non-probability convenient sampling technique to recruit patients with different refractive errors who presented for PRK or Trans-PRK procedures. The sample consisted of 100 patients, with 50 patients undergoing PRK and another 50 undergoing Trans-PRK. All participants were aged between 18 and 30 years. Patients with mild to moderate myopia, ranging from -2.00 to -6.00 diopters or spherical equivalent, and mild astigmatism, ranging from 0.0 to -2.50 diopters, were included. Exclusion criteria encompassed patients with systemic diseases or those on medications that could affect tear film stability, a history of unstable refraction in the past years, those above 30 or below 18 years of age, and those who did not provide informed consent.

The study was approved by the ethical committee of Superior University, Lahore, and was conducted following the Declaration of Helsinki. The reference number for ethical approval is IRB/FAHS/DPTRS/2/24/MS/RS-3420. Informed consent was obtained from all patients prior to their inclusion in the study. To assess tear film stability, two tests were employed: the Tear Break-Up Time (TBUT) test and the Schirmer II test. The TBUT test was conducted first to avoid excessive reflex tearing that could interfere with the results of subsequent tests. During the TBUT test, a slit lamp with a blue filter was used to provide red-free illumination. Patients were asked to blink and then keep their eyes open without blinking. The time interval between the last blink and the first appearance of a dry spot on the tear film was measured using a stopwatch. This process was repeated three times for each patient, and the average time was recorded. A TBUT time of less than 10 seconds was considered indicative of tear film instability (14).

The Schirmer II test was conducted using commercially available Whatman filter paper strips. The strips were folded at one end and placed on the lower palpebral conjunctiva after the application of topical anesthesia. The procedure was performed in a dimly lit room, and patients were instructed to keep their eyes open and blink normally without stimulation. After two minutes, the strips were removed, and the length of wetting, less than 15 millimeters, was measured and recorded (15). Both tests were conducted before and after the PRK and Trans-PRK procedures to evaluate the changes in tear film stability.

Data collection was meticulously performed by trained personnel, ensuring consistency and accuracy in administering the TBUT and Schirmer II tests. All data were entered into a pre-designed proforma for analysis. Statistical analysis was carried out using SPSS version 25. Descriptive statistics were computed to determine the frequencies of demographic variables such as gender distribution and age among the patients undergoing PRK and Trans-PRK. The effect of the surgeries on pre- and post-operative TBUT and Schirmer II test outcomes was compared using the paired t-test. The results were presented as mean ± standard deviation, with a p-value of less than 0.05 considered statistically significant.

The methodology ensured that all ethical considerations, including patient confidentiality and data protection, were strictly adhered to throughout the study. The study aimed to provide robust data on the impact of PRK and Trans-PRK on tear film stability, contributing to the understanding of post-operative outcomes and helping to optimize patient management strategies to minimize the risk of dry eye disease.

RESULTS

The results of this study examined the effects of Photorefractive Keratectomy (PRK) and Trans-PRK on tear film stability by evaluating the outcomes of the Tear Break-Up Time (TBUT) test and the Schirmer II test before and after surgery. A total of 100 patients were included in the study, with 50 patients undergoing PRK and another 50 undergoing Trans-PRK. The results were analyzed for gender and age distribution, as well as the differences in TBUT and Schirmer II test values before and after the surgical procedures.

Patient Demographics and Characteristics

Among the patients who underwent PRK, there was an equal distribution of males and females, with 25 (50%) males and 25 (50%) females. The mean age of these patients was 24.92 years, with a standard deviation of ±2.82. The highest percentage of patients was aged 24

years (18%), while the lowest percentage was 20 years old (2%). For patients who underwent Trans-PRK, there were 27 (54%) males and 23 (46%) females. The mean age was 26.22 years, with a standard deviation of ±3.17. The most frequent age was 30 years (28%), while the lowest frequency was noted for patients aged 19, 20, and 21 years, each comprising only one patient.

Table 1 Gender and Age Distribution in Patients Subjected to PRK and Trans-PRK

Parameter	PRK	Trans-PRK
Male (%)	50% (25/50)	54% (27/50)
Female (%)	50% (25/50)	46% (23/50)
Mean Age (Years)	24.92 ± 2.82	26.22 ± 3.17
Most Frequent Age (%)	24 years (18%)	30 years (28%)
Least Frequent Age (%)	20 years (2%)	19, 20, 21 years (2%)

Comparison of Pre- and Post-Operative Test Results

The outcomes of the TBUT and Schirmer II tests were analyzed using paired t-tests to compare pre- and post-operative values. For PRK patients, the mean Schirmer II test value decreased significantly from 9.14 ± 3.36 before surgery to 4.28 ± 1.63 after surgery, with a mean difference of 4.86 ($p < 0.001$). The TBUT test values also showed a significant reduction from 8.90 ± 2.87 before surgery to 4.10 ± 1.61 after surgery, with a mean difference of 4.80 ($p < 0.001$). Additionally, there was no significant difference between the Schirmer II and TBUT test values after surgery ($p = 0.366$).

For Trans-PRK patients, the Schirmer II test values decreased from 9.08 ± 3.81 before surgery to 6.12 ± 2.85 after surgery, with a mean difference of 2.96 ($p < 0.001$). Similarly, the TBUT test values dropped from 8.82 ± 3.85 before surgery to 5.76 ± 2.94 after surgery, with a mean difference of 3.06 ($p < 0.001$). The comparison between Schirmer II and TBUT test values after surgery showed no significant difference ($p = 0.151$).

Table 2 Paired T-Test Results for PRK and Trans-PRK

Comparison	Mean Difference	Standard Deviation	t	p-Value
PRK				
Schirmer II Test (Pre-PRK - Post-PRK)	4.86	1.93	17.83	< 0.001
TBUT Test (Pre-PRK - Post-PRK)	4.80	1.53	22.25	< 0.001
Schirmer II Test vs. TBUT Test (Post-PRK)	0.18	1.40	0.91	0.366
Trans-PRK				
Schirmer II Test (Pre-Trans-PRK - Post-Trans-PRK)	2.96	1.26	16.60	< 0.001
TBUT Test (Pre-Trans-PRK - Post-Trans-PRK)	3.06	1.38	15.72	< 0.001
Schirmer II Test vs. TBUT Test (Post-Trans-PRK)	0.36	1.75	1.46	0.151

The results indicate a significant reduction in tear film stability following both PRK and Trans-PRK surgeries, as evidenced by decreased values in the Schirmer II and TBUT tests. This decline in tear film stability suggests a higher risk of developing dry eye symptoms post-surgery. The findings underscore the need for strategies to mitigate the risk of dry eye disease in patients undergoing these refractive surgeries.

DISCUSSION

The study aimed to evaluate the effects of Photorefractive Keratectomy (PRK) and Trans-PRK on tear film stability using the Tear Break-Up Time (TBUT) and Schirmer II tests. The results indicated a significant reduction in tear film stability after both PRK and Trans-PRK, as shown by decreased TBUT and Schirmer II test values. These findings align with previous research indicating that refractive surgeries such as PRK and LASIK are associated with an increased risk of dry eye symptoms due to disruption in tear film dynamics (14, 15). The reduction in tear film stability post-surgery suggests that both PRK and Trans-PRK can cause ocular surface damage and decrease tear production, leading to dry eye disease.

The study revealed that the reduction in tear film stability was more pronounced following PRK compared to Trans-PRK. This is consistent with previous studies that showed a significant decrease in tear secretion and tear film stability after PRK with laser compared to conventional methods (16). The more invasive nature of PRK, which involves the removal of the corneal epithelium, might explain this reduction. Trans-PRK, a newer technique, involves less manipulation of the corneal surface, which could account for the comparatively lesser reduction in tear film stability (17). Nonetheless, both techniques showed a significant decline in tear stability, indicating that eye dryness remains a concern regardless of the surgical approach.

The study's findings also emphasized that while age and gender were not significantly associated with variations in post-surgical dry eye symptoms, there was considerable variability in the severity of these symptoms among patients. This variability aligns with existing literature that indicates dry eye disease's multifactorial nature, involving not only surgical trauma but also pre-existing conditions, environmental factors, and individual patient responses (18). Factors such as baseline tear film stability, patient compliance with post-operative care, and the presence of pre-existing dry eye conditions likely influenced the study outcomes. Some studies have reported that pre-existing dry eye can worsen after refractive surgery, necessitating a comprehensive pre-operative assessment (19).

The strengths of this study include its focus on a significant clinical issue related to post-surgical complications in refractive surgery patients. The study's findings contribute to the understanding of the impact of PRK and Trans-PRK on tear film stability and offer valuable insights for clinicians in predicting and managing post-operative dry eye symptoms. However, the study also had several limitations. The small sample size and short duration limited the generalizability of the findings. A longer follow-up period could provide more comprehensive data on the long-term effects of these surgeries on tear film stability. Additionally, the Schirmer II test, while widely used, is not the most specific test for dry eye evaluation as it can be influenced by several factors such as environmental conditions, patient compliance, and examiner variability (20, 21). Future studies could consider using more advanced diagnostic tools, such as tear osmolarity and ocular surface staining, to provide more specific insights into tear film changes post-surgery.

Recommendations for improving clinical practice based on these findings include a thorough pre-operative assessment to identify patients at high risk for post-operative dry eye disease. Using techniques to minimize corneal trauma during surgery and providing adequate post-operative care, including artificial tears and anti-inflammatory medications, may help reduce the incidence of dry eye symptoms. Additionally, modifications to surgical techniques, such as optimizing the laser ablation profile and minimizing epithelial removal, could further decrease the risk of tear film instability and enhance patient comfort and satisfaction (22). Continued research is needed to explore the potential benefits of these modifications and develop new strategies to improve patient outcomes following refractive surgeries.

CONCLUSION

In conclusion, this study demonstrated a significant reduction in tear film stability following PRK and Trans-PRK, highlighting the need for effective management strategies to mitigate the risk of post-operative dry eye disease. These findings contribute to the growing body of evidence on the ocular surface's response to refractive surgeries and underscore the importance of individualized patient care to improve surgical outcomes and patient quality of life.

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