

Original research

# Comparison of mechanical debridement and trans-epithelial myopic photorefractive keratectomy: A contralateral eye study

Siamak Zarei-Ghanavati <sup>a</sup>, Javad Heravian Shandiz <sup>b,c</sup>, Mojtaba Abrishami <sup>a</sup>,  
Maliheh Karimpour <sup>c,d,\*</sup>

<sup>a</sup> Eye Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

<sup>b</sup> Department of Optometry, School of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran

<sup>c</sup> Refractive Errors Research Center, School of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran

<sup>d</sup> Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran

Received 10 September 2018; revised 25 December 2018; accepted 4 January 2019

Available online 23 January 2019

## Abstract

**Purpose:** To compare clinical outcomes between mechanical debridement photorefractive keratectomy (m-PRK) and trans-epithelial photorefractive keratectomy (t-PRK) in myopic patients.

**Methods:** Eighty eyes of 40 myopic patients with age between 18 and 55 years were included in this study. In each patient, one eye was randomly assigned for t-PRK, using the Amaris laser's ORK-CAM software and the other eye for m-PRK, using a spatula. Stromal ablation was done by Schwind Amaris 750S. Uncorrected and best corrected visual acuity (BCVA), refractive outcomes, epithelial healing, pain, and discomfort were compared between the groups on day 1, 3, 7 and month 1, 3, and 6.

**Results:** Preoperative spherical equivalent (SE) were  $-3.97 \pm 2.08$  diopter (D) and  $-3.98 \pm 2.06$  D in m-PRK and t-PRK eyes, respectively ( $P = 0.981$ ). Operation time was significantly shorter in the t-PRK group than m-PRK ( $P < 0.001$ ). Postoperative pain was experienced significantly higher in the t-PRK group measured by 11-point numeric scale of pain questionnaire on the first postoperative day ( $P < 0.001$ ). Photophobia, tearing, and vision fluctuation were also significantly higher in the t-PRK group postoperatively. However epithelial defect size and re-epithelialization time were lower in the t-PRK group ( $P = 0.012$  and  $P < 0.001$ , respectively). Postoperative parameters including SE, uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), and contrast acuity did not show any significant difference between the two groups during all intervals.

**Conclusions:** Although epithelial defect size and epithelial healing time were lower in t-PRK, postoperative pain, photophobia, and vision fluctuation were significantly less in the m-PRK group in the first postoperative days. There was no statistically significant difference between the groups after one week, and both mechanical and trans-epithelial techniques were shown to be safe and effective.

Copyright © 2019, Iranian Society of Ophthalmology. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Keywords:** Photorefractive keratectomy; Epithelial debridement; Mechanical PRK; Trans-epithelial PRK

## Introduction

Photorefractive keratectomy (PRK) has commonly been used as an effective and safe technique for refractive surgeries and is well tolerated by the patients.<sup>1–3</sup> In PRK, the corneal epithelium should be removed before stromal ablation.<sup>4</sup> There are several methods for epithelial debridement including mechanical, chemical, rotating brush, and using Excimer laser.

The authors have no financial or proprietary interest in this study.

This study was selected and awarded as one of 50 Outstanding Abstracts in the world ophthalmology congress took place at Spain, 16–19 June 2018.

\* Corresponding author. Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran.

E-mail address: [Karimpour.opt@gmail.com](mailto:Karimpour.opt@gmail.com) (M. Karimpour).

Peer review under responsibility of the Iranian Society of Ophthalmology.

<https://doi.org/10.1016/j.joco.2019.01.003>

2452-2325/ Copyright © 2019, Iranian Society of Ophthalmology. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Previous studies demonstrated that all of these epithelial removal techniques are effective for surgical correction of refractive errors.<sup>5–9</sup> Mechanical debridement seems to be the most common technique for epithelial debridement. Although mechanical technique is effective, it has some problems, especially for surgeons without enough experience. Using alcohol may also have some toxic effects on corneal stem cells.<sup>10</sup> Increased epithelial debridement time can increase patient anxiety and increase stromal dehydration caused by evaporation.<sup>11</sup>

Trans-epithelial PRK removes corneal epithelium and stroma in a single step with one ablation profile. In this technique, laser removes the corneal epithelium using a preset thickness of a normal cornea epithelium (55–65  $\mu\text{m}$ ) based on previous reports.<sup>12</sup> In theory, this technique gives a smoother corneal surface than that achieved with mechanical ablation of the epithelium.<sup>13</sup>

In this study, we aimed to compare clinical, refractive, and visual outcomes of trans-epithelial and mechanical epithelial debridement in a contralateral eye study.

## Methods

Patients with myopia and myopic astigmatism who were referred for refractive surgery entered this study. The study followed the principles of the Declaration of Helsinki. Every participant was appropriately notified at the beginning of the study, briefed on the risks and benefits, and signed written informed agreement. We obtained full Institutional Review Board (IRB) approval from the Ethics Committee of Mashhad University of Medical Sciences (code: 960156). Inclusion criteria were age between 18 and 55 years, myopia less than 8.00 diopters (D) and 4.00 D or less astigmatic error, fixed refraction for at least 1 year, and preoperative corrected distance visual acuity (CDVA) of 20/32 or better. Exclusion criteria for this study were any presence of ocular pathologies, visual function disturbances, any corneal dystrophies or abnormalities, keratoconus or keratoconus suspect, any previous ocular surgery, glaucoma or glaucoma suspect, diabetes mellitus, auto-immune diseases, pregnancy, breast feeding, and moderate to severe dry eye. We excluded all cases with mesopic pupil diameter more than 6.5 mm. Contact lens wear was stopped at least 3 weeks before refraction and topographic assessment.

All participants had PRK in both eyes, and the eyes were randomly assigned for mechanical epithelial debridement (m-PRK) and the contralateral eye for trans-epithelial (laser epithelial) debridement (t-PRK). This designation was irrespective of the ocular dominance, refraction, or aberrations. All patients caught right eye treatment first with m-PRK or t-PRK. The patients and the examiners were blind to the type of surgery. The goal refraction was emmetropia for all eyes and all patients.

### Preoperative assessment

Before surgery, a careful eye examination was accomplished, including uncorrected distance visual acuity (UDVA),

CDVA, slit-lamp examination, non-contact tonometry (Topcon non-contact tonometer, CT-11 P, Tokyo, Japan), indirect ophthalmoscopy, manifest refraction, cycloplegic refraction, keratometry (Topcon KR1 Auto-kerato-refractometer, Tokyo, Japan), corneal topography (Tomey TMS-4n corneal topography, USA), Pentacam HR (OCULUS, Germany), contrast acuity (Vector Vision CSV 1000, Haag-Streit, Harlow, UK), aberrometry (Ocular Wavefront Analyzer, Schwind Eye – Tech - Solutions GmbH, Germany), and Schirmer I tear test. Visual acuity measurements were converted to logMAR for analysis.

### Surgical technique

All surgeries were accomplished with Amaris excimer laser 750S (SCHWIND eye-tech-solutions, Kleinostheim, Germany) by one surgeon (S.Z.G.). In the Amaris excimer laser, the laser energy has two values. The first value is for epithelial removal at which level laser ablates more tissue per pulse, and the second value is for stromal ablation.

Before starting surgery, the eyelids were disinfected with betadine 5% solution for 3 min, and the eyes were draped. Then the cornea was anesthetized with tetracaine 1% eye drops. After controlling fixation and head position of the patient by the surgeon and Schwind system, the operation was started.

Before stromal ablation, one of two epithelial debridement methods was randomly assigned to the first eye. The contralateral eye had the opposite technique. Patients and all who were participants in measurement and analysis process were masked for all features. For m-PRK, the cornea was marked with an 8.5 mm trephine. After irrigation of ocular cornea with balanced salt solution (BSS), the epithelium was cleared with a hockey-stick spatula. In trans-epithelial laser ablation method, The ORK-CAM software module (SCHWIND eye-tech-solutions, Kleinostheim, Germany) computes the mass of epithelium to be removed into the refractive ablation profile automatically and compensates for the minimal differences between stromal and epithelial tissue. Immediately after epithelial debridement in both methods, stroma was ablated with laser. Ablation zone was selected 6.5 mm for all eyes. Laser frequency was 750 HZ with 193 nm wavelength. After stromal ablation, cornea was chilled with balanced solution for 30 s. For all surgeries, a sponge soaked with 0.02% MMC (Mitomycin C Kyowa, Biochem Pharmaceutical Industries, India, under license of Kyowa Hakko Co. Ltd., Japan) was employed over the ablated area for 5 s for each diopter of ablation. A bandage contact lens (PureVision, Bausch & Lomb, Rochester, NY) was placed following BSS irrigation of the ocular surface.

### Postoperative evaluation and follow-ups

Postoperatively, the patients were given levofloxacin 5 mg/ml (Oftaquix, Santen Pharmaceutical, Japan), betamethasone 0.1% (Betasonate, Sina Daru, Iran) eye drops every 6 h, and preservative free artificial tears (Artelac Advanced, Bausch &

Lomb, France) every 3 h. After complete re-epithelialization, the bandage contact lens was removed. Levofloxacin was stopped after one week. Betamethasone was used for one month and then fluorometholone 0.1% (Flucort, Sina Darou, Iran) eye drop was started every 6 h and tapered over 2 months. Preservative free artificial tears were ordered repeatedly in the first month and then diminished according to the ocular surface statue.

Patients were examined daily until the epithelial defect was completely healed. Size of epithelial defect was recorded daily for both eyes. Because all epithelial defects were roughly circular, the defect was measured horizontally daily, and this measurement was correlated with the horizontal diameter of the patient's cornea. The defect size was expressed as a percentage of the horizontal diameter of the cornea.<sup>14</sup> We used an 11-point numeric scale of pain questionnaire to express postoperative pain severity in each eye on a scale of 0–10, where 0 represented no pain and 10 represented the worst pain.<sup>15</sup> We also used Eye Sensation Scale questionnaire to record severity of pain, foreign body sensation, photophobia, tearing, and visual fluctuation in each eye. In this scale, response category choices were none, mild, moderate, severe, and extreme.<sup>16,17</sup> Full refractive and visual evaluation was performed at week 1 and month 1, 3, and 6 postoperatively. Schirmer I test was performed to evaluate tear quantity. Contrast acuity was measured at contrasts of 10% and 100% according to Tanabe et al. by Vector Vision CSV-1000LanC10%.<sup>18</sup> Sub-epithelial corneal haze was identified by slit-lamp bio microscopy, and subjectively graded according to Hanna's method. It was classified from 0 to 4 as follows: 0, absolutely clear; 0.5, a faint corneal opacity seen only by oblique indirect illumination; 1, a low dense opacity seen difficulty with direct and diffuse illumination; 2, easily visible opacity; 3, denser opacity that considerably reduced the visualization of intraocular structures such as the iris and lens; 4, an opaque cornea.<sup>19</sup>

### Statistical analysis

Statistical testing was done using SPSS for Windows software (version 16, SPSS, Inc.). Variables were presented as the mean  $\pm$  standard deviation. Kolmogorov-Smirnov test was used to determine correlation of each variable, after which we used paired sample *t*-test to compare dependent variables and Man-Whitney test for independent ones. Differences were assumed statistically significant when the *P* value was 0.05 or less.

### Results

40 patients (13 males and 27 females) with mean age of  $31.22 \pm 8.7$  years (range, 20–55 years) were included. Preoperative data is shown in Table 1. There were no significant differences between two groups.

Intra and postoperative clinical findings are summarized in Table 2. Operation time was significantly shorter for the t-PRK group. Epithelial defect size was significantly smaller in the t-PRK group, and re-epithelialization time was considerably

Table 1  
Preoperative data.

Parameter	m-PRK	t-PRK	<i>P</i> value
Sphere (D)	$-3.30 \pm 2.27$	$-3.31 \pm 2.26$	0.990
Cylinder (D)	$1.34 \pm 1.23$	$1.25 \pm 1.20$	0.752
SE (D)	$-3.97 \pm 2.08$	$-3.98 \pm 2.06$	0.981
UDVA (logMAR)	$0.78 \pm 0.38$	$0.79 \pm 0.36$	0.905
CDVA (logMAR)	$0.027 \pm 0.08$	$0.024 \pm 0.07$	0.873
K1 (D)	$45.02 \pm 1.57$	$45.01 \pm 1.68$	0.990
K2 (D)	$43.43 \pm 1.47$	$43.52 \pm 1.50$	0.778
IOP (mmHg)	$15.55 \pm 4.29$	$15.65 \pm 3.97$	0.914
CCT ( $\mu$ m)	$524.48 \pm 25.81$	$525.25 \pm 27.28$	0.896
Schirmer I (mm)	$11.95 \pm 2.04$	$12.40 \pm 2.19$	0.345

All values are presented in Mean  $\pm$  Standard Deviation. m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy; SE: Spherical equivalent; UDVA: Uncorrected distance visual acuity; CDVA: Corrected distance visual acuity; K1: Steep keratometry; K2: Flat keratometry; IOP: Intraocular pressure; CCT: Central corneal thickness.

Table 2  
Postoperative findings.

	m-PRK	t-PRK	<i>P</i> value
Operation time (s)	$44.45 \pm 12.14$	$33.95 \pm 7.55$	0.000
Epithelial defect size at 24 h (mm)	$6.4 \pm 0.9$	$5.8 \pm 1.3$	0.012
Epithelial defect size at day 3	$2.54 \pm 1.01$	$0.56 \pm 0.99$	<0.001
Epithelial defect size at day 5	$0.54 \pm 0.79$	0.00	<0.001
Complete re-epithelialization time (Day)	$5.10 \pm 0.81$	$3.28 \pm 0.60$	0.000
Pain Score at day 1	$2.52 \pm 2.21$	$5.12 \pm 2.49$	0.000
Pain Score at day 3	$1.78 \pm 0.3$	$3.08 \pm 2.36$	0.010
Pain Score at week 1	$0.65 \pm 1.05$	$1.65 \pm 1.98$	0.060
IOP (mm Hg) at month 6	$17.48 \pm 3.48$	$17.32 \pm 3.68$	0.852
Schirmer I (mm)			
Month 1	$7.40 \pm 1.86$	$7.20 \pm 1.62$	0.610
Month 3	$7.75 \pm 1.70$	$7.70 \pm 1.40$	0.886
Month 6	$10.17 \pm 1.78$	$10.52 \pm 1.93$	0.403

m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy; IOP: Intraocular pressure.

shorter in the t-PRK. Schirmer I test showed that reduction of tear secretion was similar in the two groups. Although patients reported more dry eye symptoms in t-PRK eye, there was no significant difference between the two groups.

The 11-point numeric scale pain questionnaire and Eye Sensation Scale showed that pain, photophobia, tearing, foreign body sensation, and visual fluctuation were significantly more severe for the t-PRK group during the first postoperative week ( $P < 0.001$ ). Patients reported more discomfort with t-PRK eye for one week. Although it continued for the second week, it was not statistically significant. Table 3 shows results of Eye Sensation Scale at postoperative day 1, 3, and 7. Fig. 1 shows comparison of pain results between the two groups.

There was no significant difference between residual sphere and cylinder in either group at all postoperative intervals. Refractive changes over time are shown in Fig. 2. Mean refractive astigmatism were  $1.34 \pm 1.23$  D in m-PRK and  $1.25 \pm 1.20$  D in t-PRK, preoperatively. These values changed to  $0.32 \pm 0.48$  D for m-PRK and  $0.26 \pm 0.41$  D for t-PRK at

Table 3  
Eye Sensation Scale results.

Parameter	Mean rank Day 1		P value	Mean rank Day 3		P value	Mean rank Day 7		P value
	m-PRK	t-PRK		m-PRK	t-PRK		m-PRK	t-PRK	
Pain	29.89	51.11	<0.001	33.22	47.78	0.004	35.35	45.65	0.023
Tearing	30.18	50.82	<0.001	30.62	50.38	<0.001	36.36	44.64	0.071
Foreign body sensation	30.19	50.81	<0.001	31.11	49.89	<0.001	35.16	45.84	0.021
Visual fluctuation	31.94	49.06	0.001	29.19	51.81	<0.001	33.52	47.48	0.003
Light sensitivity	32.21	48.79	0.001	29.49	51.51	<0.001	32.18	48.82	0.001

m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

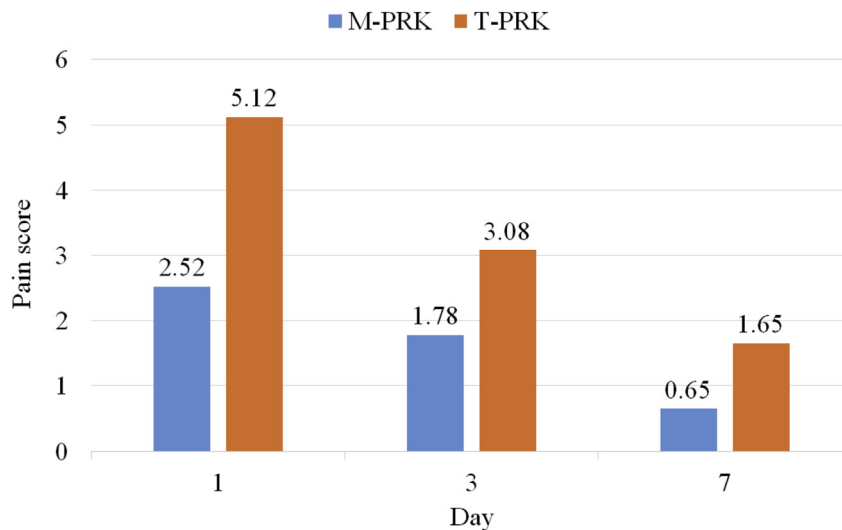


Fig. 1. Postoperative pain assessment in the mechanical debridement photorefractive keratectomy (m-PRK) and trans-epithelial laser ablation photorefractive keratectomy (t-PRK). m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

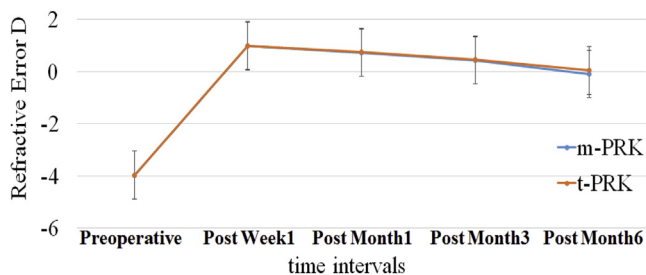


Fig. 2. The mean spherical equivalent changes of the mechanical debridement photorefractive keratectomy (m-PRK) and trans-epithelial laser ablation photorefractive keratectomy (t-PRK). m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

the sixth month, postoperatively ( $P = 0.310$ ). There were no significant differences between groups at all intervals during follow-up periods.

UDVA increased from mean value of  $0.34 \pm 0.16$  logMAR (around 20/40) at first week to  $0.06 \pm 0.09$  logMAR (around 20/20) at the sixth month in m-PRK and from  $0.33 \pm 0.14$  (around 20/40) to  $0.05 \pm 0.08$  (around 20/20) in t-PRK eyes. The difference was not statistically significant ( $P = 0.358$ ). Fig. 3 shows these changes.

The efficacy index (mean postoperative UDVA/mean preoperative CDVA) was similar in both groups. Table 4 shows

the efficacy index changes for the six-month follow-up, postoperatively.

For the safety of the procedures (mean postoperative CDVA/mean preoperative CDVA), please refer to Table 5. There is no significant difference between the two groups.

Contrast acuity measurements at contrasts of 10% and 100% in the two treatment groups at 6-month follow-up visit did not show any statistically significant difference. At contrast of 10%, visual acuity was  $0.16 \pm 0.11$  logMAR (around 20/32) in m-PRK and  $0.15 \pm 0.10$  in t-PRK ( $P = 0.832$ ). At contrast of 100%, it was  $0.06 \pm 0.08$  (around 20/20) and  $0.05 \pm 0.07$  for m-PRK and t-PRK, respectively ( $P = 0.673$ ).

Postoperative corneal haze was evaluated in all follow-up sessions. There was no clinically severe haze in either group, and the haze was not significantly different between the two groups after 6 months ( $P = 0.726$ ). At month 6, 7.5% of both the m-PRK and t-PRK group had grade 1 corneal haze. We did not see any corneal haze of grade 2 or more. Fig. 4 shows the percentage of corneal haze in its grade at month 6 after surgery.

## Discussion

In the literature, there are studies that compared different methods of epithelial debridement in PRK. These studies

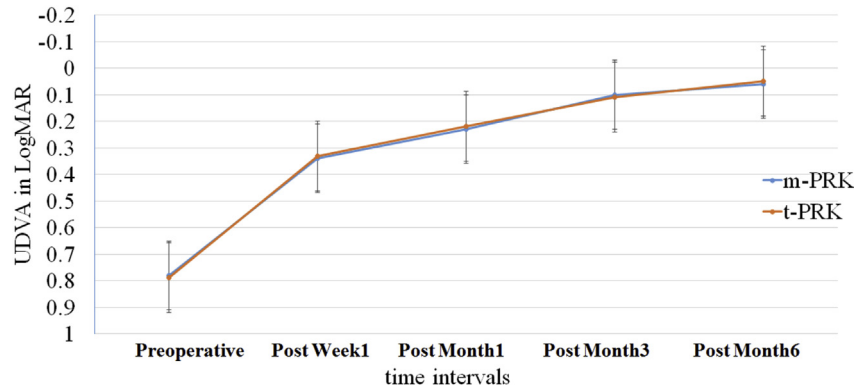


Fig. 3. The mean uncorrected visual acuity (UCVA) changes of the mechanical debridement photorefractive keratectomy (m-PRK) and trans-epithelial laser ablation photorefractive keratectomy (t-PRK) during follow-up. m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

Table 4

Efficacy index for mechanical debridement photorefractive keratectomy (m-PRK) and trans-epithelial laser ablation photorefractive keratectomy (t-PRK) groups during follow-up.

Treatment group	Week 1	Month 1	Month 3	Month 6
m-PRK	0.69 ± 0.14	0.84 ± 0.14	0.92 ± 0.15	0.99 ± 0.06
t-PRK	0.70 ± 0.13	0.83 ± 0.12	0.93 ± 0.14	0.99 ± 0.06
P value	0.686	0.732	0.725	0.980

m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

Table 5

Safety index for mechanical debridement photorefractive keratectomy (m-PRK) and trans-epithelial laser ablation photorefractive keratectomy (t-PRK) groups during follow-up.

Treatment group	Week 1	Month 1	Month 3	Month 6
m-PRK	0.80 ± 0.06	0.89 ± 0.08	0.99 ± 0.06	1.02 ± 0.04
t-PRK	0.80 ± 0.05	0.92 ± 0.11	1.00 ± 0.06	1.02 ± 0.05
P value	0.962	0.156	0.663	0.593

m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

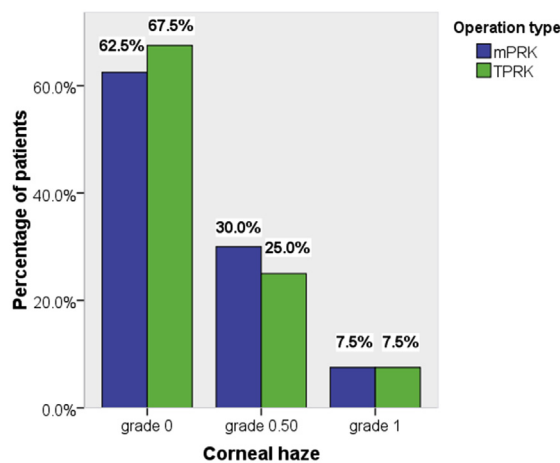


Fig. 4. Corneal haze percentage at month 6. m-PRK: Mechanical debridement photorefractive keratectomy; t-PRK: Trans-epithelial laser ablation photorefractive keratectomy.

reported various results. In this contralateral eye study, both groups had similar preoperative features. We used Amaris excimer laser (Schwind-tech-solutions) for trans-epithelial PRK. All the operations were done by one surgeon because surgeon's experience and operation speed could affect results particularly in the mechanical-debridement method. In addition to pain, vision, and refractive statuses that were assessed in other similar studies, we evaluated other important post-operative outcomes including epithelial defect, contrast acuity, and tear quantity during 6 months follow-up examination. We found that both techniques are safe, effective, and have predictable results.

Our study showed less operation time in t-PRK method. This is the same as what resulted from other previous studies.<sup>20–22</sup> Theoretically, decreased operation time might reduce the probability of stromal dehydration, disappearance of anterior stromal keratocytes, and patient anxiety during surgery.<sup>23</sup> Epithelial defect and re-epithelialization time were also lower in t-PRK eye. This was probably the cause of smooth, regular, and uniform epithelial debridement in trans-epithelial technique.<sup>24</sup> In our study, re-epithelialization was completed maximally up to 7 days in all eyes in both groups except one m-PRK eye that had complete re-epithelialization on day 10, postoperatively.

Lee et al.<sup>9</sup> evaluated corneal healing after PRK using mechanical and laser scrap techniques and reported that there is no significant difference in the corneal wound healing response between these two techniques. In another study by Lee et al.,<sup>22</sup> epithelial healing and clinical outcomes in PRK following mechanical and trans-epithelial techniques were evaluated using Visx Star S3. There were no significant differences in spherical equivalent (SE), uncorrected visual acuity (UCVA), and best corrected visual acuity (BCVA); however, epithelial healing was better in the mechanical (alcohol) group despite our findings.

We measured the postoperative pain by using questionnaires validated in several previous studies.<sup>15,21,22</sup> Patients reported more pain in t-PRK treated eye at first week post-operatively. Tearing, photophobia, foreign body sensation, and visual fluctuation were also worse in t-PRK eye. This is in

agreement with Kanitkar et al. who showed pain after ethanol-assisted mechanical PRK was lower than trans-epithelial technique.<sup>25</sup> However, other studies like Fadlallah et al.<sup>15</sup> found that mean subjective postoperative pain score at 48 h was less in the t-PRK group. In another study, Celik et al.<sup>21</sup> found that patients treated by m-PRK eyes reported more pain based on the 11-point numerical rating scale and Visual Analog Scale (VAS).

Our result showed that epithelial defect size and epithelial healing time were more in the m-PRK group. However, patients in the t-PRK group reported more pain and discomfort based on questionnaires. Therefore, it might indicate that pain in the t-PRK group has another mechanism than mechanical stimulation of mechano-nociceptors due to lack of epithelium and the bare corneal nerve dendrites.<sup>26</sup> We believe that more pain reported in the t-PRK group might be due to the polymodal nociceptors stimulation in this treatment. Only 20% of corneal nerves which are mechano-nociceptors become activated with mechanical stimulus during m-PRK. However, polymodal-nociceptors (70% of corneal nerve) are not only activated by mechanical energy but also respond to heat, and they begin to fire at temperatures over 39–40 °C.<sup>19,26,27</sup> Epithelial debridement by laser in the t-PRK group could generate more heat and stimulate poly modal nociceptors that are much more than mechano-nociceptors in quantity.<sup>27</sup> We also think that other pain mediators are released with t-PRK mechanism, and it takes more time to be washed out completely in comparison with m-PRK. The corneal wound healing response is a complex process involving cytokine-mediated interactions between the epithelial cells, keratocytes of the stroma and corneal nerves.<sup>26–28</sup> Considering all these facts, trans-epithelial PRK might release more or different cytokines that could stimulate corneal nerve.

Visual acuity became better during six-month follow-up visits, and we did not find any significant difference between the two groups. Postoperative SE, UDVA, and CDVA between the two groups did not show any significant differences in 6-month follow-up similar to what was shown in Fadlallah et al. and Celik et al. studies.<sup>15,21</sup> However, in a study by Clinch et al.,<sup>20</sup> they showed that at all postoperative intervals, the mechanical group had better refractive results.

We also compared postoperative tear quantity and contrast acuity between t-PRK and m-PRK. Visual acuity measurements at contrasts of 10% and 100% at month 6 postoperatively,<sup>18</sup> showed that postoperative contrast acuity results are lower in comparison with preoperative values; however, there was no significant difference between two groups before and after surgery. This is what was compared between these two epithelial debridement techniques for the first time.

Similar to other studies, our finding shows that dry eye increased or happened after PRK.<sup>29,30</sup> There was a significant decrease in Schirmer I results, postoperatively. Although patients reported more dry eye symptoms in t-PRK eye, Schirmer I test showed no significant differences between the two eyes at any follow-up visit.

Both mechanical and trans-epithelial epithelial debridement are reliable and safe methods for correcting myopia using

PRK. Our study has shown that mechanical method is more comfortable for patients in the first postoperative days; however, trans-epithelial method caused faster corneal epithelial healing.

## References

1. Ang EK, Couper T, Dirani M, Vajpayee RB, Baird PN. Outcomes of laser refractive surgery for myopia. *J Cataract Refract Surg.* 2009;35(5): 921–933.
2. Kempen JH, Mitchell P, Lee KE, et al. The prevalence of refractive errors among adults in the United States, Western Europe, and Australia. *Arch Ophthalmol.* 2004;122(4):495–505.
3. Resnikoff S, Pascolini D, Etya'Ale D, et al. Global data on visual impairment in the year 2002. *Bull World Health Organ.* 2004;82(11): 844–851.
4. Weiss RA, Liaw LH, Berns M, Amoils SP. Scanning electron microscopy comparison of corneal epithelial removal techniques before photorefractive keratectomy. *J Cataract Refract Surg.* 1999;25(8):1093–1096.
5. Fattah MA, Antonios R, Mosquera SA, Abiad B, Awwad ST. Epithelial erosions and refractive results after single-step transepithelial photorefractive keratectomy and alcohol-assisted photorefractive keratectomy in myopic eyes: a comparative evaluation over 12 months. *Cornea.* 2018; 37(1):45–52.
6. Abad JC, Talamo JH, Vidaurri-Leal J, Cantu-Charles C, Helena MC. Dilute ethanol versus mechanical debridement before photorefractive keratectomy. *J Cataract Refract Surg.* 1996;22(10):1427–1433.
7. Pallikaris IG, Karoutis AD, Lydataki SE, Siganos DS. Rotating brush for fast removal of corneal epithelium. *J Refract Surg.* 1994;10(4): 439–442.
8. Kitazawa Y, Maekawa E, Sasaki S, Tokoro T, Mochizuki M, Ito S. Cooling effect on excimer laser photorefractive keratectomy. *J Cataract Refract Surg.* 1999;25(10):1349–1355.
9. Lee YG, Chen WY, Petroll WM, Cavanagh HD, Jester JV. Corneal haze after photorefractive keratectomy using different epithelial removal techniques: mechanical debridement versus laser scrape. *Ophthalmology.* 2001;108(1):112–120.
10. Lee HK, Kim JK, Kim SS, et al. Effect of amniotic membrane after laser-assisted subepithelial keratectomy on epithelial healing: clinical and refractive outcomes. *J Cataract Refract Surg.* 2004;30(2):334–340.
11. Oh JY, Yu JM, Ko JH. Analysis of ethanol effects on corneal epithelium. *Invest Ophthalmol Vis Sci.* 2013;54(6):3852–3856.
12. Shapira Y, Mimouni M, Levartovsky S, et al. Comparison of three epithelial removal techniques in PRK: mechanical, alcohol-assisted, and transepithelial laser. *J Refract Surg.* 2015;31(11):760–766.
13. Kaluzny BJ, Cieslinska I, Mosquera SA, Verma S. Single-step transepithelial PRK vs alcohol-assisted PRK in myopia and compound myopic astigmatism correction. *Medicine (Baltim).* 2016;95(6):e1993.
14. Paysse EA, Hamill MB, Koch DD, Hussein MA, Brady McCreery KM, Coats DK. Epithelial healing and ocular discomfort after photorefractive keratectomy in children. *J Cataract Refract Surg.* 2003;29(3): 478–481.
15. Fadlallah A, Fahed D, Khalil K, et al. Transepithelial photorefractive keratectomy: clinical results. *J Cataract Refract Surg.* 2011;37(10): 1852–1857.
16. Sobas EM, Videla S, Vázquez A, Fernández I, Maldonado MJ, Pastor JC. Pain perception description after advanced surface ablation. *Clin Ophthalmol.* 2017;11:647–655.
17. Caudle LE, Williams KA, Pesudovs K. The Eye Sensation Scale: an ophthalmic pain severity measure. *Optom Vis Sci.* 2007;84(8):752–762.
18. Tanabe T, Miyata K, Samejima T, Hirohara Y, Mihashi T, Oshika T. Influence of wavefront aberration and corneal subepithelial haze on low-contrast visual acuity after photorefractive keratectomy. *Am J Ophthalmol.* 2004;138(4):620–624.
19. Tomás-Juan J, Larranaga AM, Hanneken L. Corneal regeneration after photorefractive keratectomy: a review. *J Optom.* 2015;8(3):149–169.

20. Clinch TE, Moshirfar M, Weis JR, Ahn CS, Hutchinson CB, Jeffrey JH. Comparison of mechanical and transepithelial debridement during photorefractive keratectomy. *Ophthalmology*. 1999;106(3):483–489.
21. Celik U, Bozkurt E, Celik B, Demirok A, Yilmaz OF. Pain, wound healing and refractive comparison of mechanical and transepithelial debridement in photorefractive keratectomy for myopia: results of 1 year follow-up. *Contact Lens Anterior Eye*. 2014;37(6):420–426.
22. Lee HK, Lee KS, Kim JK, Kim HC, Seo KR, Kim EK. Epithelial healing and clinical outcomes in excimer laser photorefractive surgery following three epithelial removal techniques: mechanical, alcohol, and excimer laser. *Am J Ophthalmol*. 2005;139(1):56–63.
23. Kohnen T, Bühren J, Kasper T, Terzi E. Quality of vision after refractive surgery. *Cataract Refract Surg*. 2005;303–314.
24. Lee H, Kang DS, Ha BJ, Choi JY, Kim EK, Seo KY. Comparison of outcomes between combined Transepithelial photorefractive keratectomy with and without accelerated corneal collagen cross-linking: a 1-year study. *Cornea*. 2017;36(10):1213–1220.
25. Kanitkar KD, Camp J, Humble H, Shen DJ, Wang MX. Pain after epithelial removal by ethanol-assisted mechanical versus transepithelial excimer laser debridement. *J Refract Surg*. 2000;16(5):519–522.
26. Garcia R, de Andrade DC, Teixeira MJ, Nozaki SS, Bechara SJ. Mechanisms of corneal pain and implications for postoperative pain after laser correction of refractive errors. *Clin J Pain*. 2016;32(5):450–458.
27. Belmonte C, Acosta MC, Gallar J. Neural basis of sensation in intact and injured corneas. *Exp Eye Res*. 2004;78(3):513–525.
28. Wilson SE, Mohan RR, Mohan RR, Ambrosio Jr R, Hong J, Lee J. The corneal wound healing response cytokine-mediated interaction of the epithelium, stroma, and inflammatory cells. *Prog Retin Eye Res*. 2001;20(5):625–637.
29. Quinto GG, Camacho W, Behrens A. Postrefractive surgery dry eye. *Curr Opin Ophthalmol*. 2008;19(4):335–341.
30. Li W, Graham AD, Lin MC. Understanding ocular discomfort and dryness using the pain sensitivity questionnaire. *PLoS One*. 2016;11(5):e0154753.