ABSTRACT

PURPOSE: To compare corneal reepithelialization, pain scores, ocular discomfort, and tear production after photorefractive keratectomy (PRK) and butterfly laser epithelial keratomileusis (LASEK).

METHODS: This prospective, randomized, double-masked study comprised 102 eyes of 51 patients who underwent laser refractive surgery. Each patient was randomized to have one eye operated on with PRK and the other with butterfly LASEK. Patients were followed for 1 year.

RESULTS: The mean reepithelialization time in the PRK group was 4.35 ± 0.48 days (range: 4 to 5 days) and 4.75 ± 0.72 days (range: 4 to 6 days) in the butterfly LASEK group (P < .002). Pain scores and ocular discomfort were not statistically different between groups, although a trend towards a lower pain level with PRK was noted (3.31 ± 4.09 vs 4.43 ± 4.27; P = .18). Schirmer test values were significantly reduced from preoperative levels through 12 months with both PRK (23.6 ± 8.1 vs 19.4 ± 10.1; P < .002) and butterfly LASEK (22.4 ± 8.7 vs 18.9 ± 9.7; P = .01); however, no difference between groups was noted at any time.

CONCLUSIONS: Photorefractive keratectomy showed a modest but statistically significant shorter reepithelialization time and a tendency towards lower pain scores than butterfly LASEK. The reepithelialization time was strongly associated with the duration of surgery in both techniques. A similar reduction of Schirmer test values was observed up to 1 year postoperatively in both groups. [J Refract Surg. 2008;24:591-599.]

Laser epithelial keratomileusis (LASEK) was developed with the intent to accelerate visual recovery and to reduce postoperative discomfort and haze formation associated with photorefractive keratectomy (PRK). Laser epithelial keratomileusis has become a viable alternative to PRK and LASIK in select cases. However, some studies have not shown the expected benefits of LASEK when compared to PRK. To improve the results of LASEK, Vinciguerra and Camesasca published a new LASEK technique, butterfly LASEK, in 2002. This technique consists of the creation of two epithelial semi-discs after making a linear epithelial abrasion from 8 to 11 o’clock (paracentral to the visual axis). As a consequence, there is less epithelial damage, preserving in great part the connections between the flap epithelial cells and the limbal cells. In 2003, Vinciguerra et al published the results of their 1-year study of 542 eyes. The surgeries were performed in patients with myopia up to 22.50 diopters (D) (mean preoperative spherical equivalent refraction was −5.30 ± 3.70 D). The authors stated that the butterfly LASEK technique reduced the damage to the epithelial cells, which allowed faster reepithelialization, accelerated the visual recovery, and reduced postoperative pain. It was shown to be a safe technique with excellent results, comparable to or even better than results obtained with PRK and LASIK.

No study in the literature compares PRK and butterfly LASEK to determine their actual differences. The aim of this study is to compare corneal reepithelialization time, pain, postoperative discomfort, and Schirmer test values between both techniques.
**PATIENTS AND METHODS**

This prospective, randomized, double-masked study comprised 102 eyes of 51 patients who underwent excimer laser refractive surgery at the Sadalla Amin Ghanem Eye Hospital, São Paulo, Brazil, performed by the same surgeon (V.C.G.) during the months of August, September, and October 2004. The surgeon had performed more than 50 butterfly LASEK procedures before starting this study. Each patient was randomized to have one eye operated on with PRK and the other with butterfly LASEK. Best spectacle-corrected visual acuity was 20/20 in all eyes. All patients had stable refractions for at least 1 year.

Inclusion criteria were patients aged 21 to 36 years, with 1.50 to 5.50 D of myopia and negative astigmatism of up to 1.50 D, with spherical anisometropia 1.50 D or less and with minimum 1-year follow-up. Patients who presented with any ocular illness, including strabismus, or patients who had previously undergone ocular surgery were excluded. Patients suffering from systemic autoimmune illness or diabetes or women who were pregnant or breastfeeding were also excluded.

Method of randomization was carried out by having a box containing 26 pieces of paper (13 written PRK and 13 written butterfly LASEK) and a second box containing 26 pieces of paper (13 written right eye and 13 written left eye). When the patient arrived at the hospital, the assistant picked from each box; thus, indicating the technique used and the eye to be operated.

Two (3.9%) of the 51 butterfly LASEK eyes had to be converted to PRK because the epithelial flap disintegrated. Butterfly LASEK was able to be performed in the second eye.

Ophthalmologic exam consisted of: 1) monocular visual acuity for distance, with and without correction; 2) near monocular visual acuity without correction, using Jaeger chart at a distance of 40 cm; 3) distant and near cover test; 4) external ocular examination; 5) slit-lamp microscopy; 6) type 1 Schirmer test without anesthetic; 7) computerized corneal topography; 8) Orbscan (Bausch & Lomb, Rochester, NY); 9) manifest and cycloplegic refractions; 10) ultrasonic central corneal pachymetry; 11) applanation tonometry with Goldmann tonometer; and 12) indirect ophthalmoscopy including examination of the retinal periphery under mydriasis.

The results of these tests were registered in a standard record, as well as the following data: patient’s initials, age, gender, race, and profession.

Patients signed a written consent, and the study was approved by the Sadalla Amin Ghanem Eye Hospital Ethics Council.

**SURGICAL TECHNIQUES**

Topical anesthesia of the operated eye was performed with three drops of proximetacaine cloridrate (Anestal; Alcon, São Paulo, Brazil) eye drops distilled at 5-minute intervals 20 minutes before surgery, and one drop of tetracaine cloridrate with phenylephrine cloridrate and boric acid (Anestesico; Allergan, Guarulhos, Brazil) 5 minutes before surgery. Afterwards, asepsis of the hemi-face of the operated eye was performed with povidone 10%, without direct contact on the ocular surface. This was washed with sterile physiologic saline solution for approximately 10 seconds. A sterile drape and blepharostat with aspiration were used.

Photoablation was performed with the MEL 70 G-scan excimer laser (Carl Zeiss Meditec, Jena, Germany). This is a flying-spot excimer laser (193 nm) with a Gaussian ablation profile (2-mm diameter, 50 Hz, pulse duration 15 ns, energy level on the cornea 200 mJ/cm²) incorporating an active eye-tracker. The treatment zone diameter was 6 mm and the blend zone was 1 mm. The maximum ablation depth was 88 µm.

In both techniques described below, one drop of gatifloxacin 0.3% (Zymar; Allergan, Irvine, Calif) and one drop of ketorolac tromethamine 0.5% (Acular, Allergan) were administered after photoablation. A therapeutic contact lens (disposable Acuvue 2; Johnson & Johnson, Limerick, Ireland) was placed at the end of the surgery.

**Photorefractive Keratectomy.** After marking the ocular axis with a Sinskey hook, the corneal epithelium for removal was delineated using an 8.5-mm ring centered on the previous mark. The epithelium was removed with a blunt spatula and photoablation was performed.

**Butterfly LASEK.** After the visual axis was marked, a linear abrasion was created in the corneal epithelium with a fine Sinskey hook from 8 to 11 o’clock (paracentral to the visual axis). With the 8.5-mm ring centered on the mark, pressure was applied to the cornea and two drops of 20% diluted alcohol in balanced saline solution were administered, which remained in contact with the epithelium for 20 seconds until removal with a surgical sponge (Merocel; Medtronic Ophthalmics, Jacksonville, Fla). Two epithelial semi-discs were created using a blunt spatula, maintaining the broadest possible joint area between the semi-discs and peripheral epithelium, leaving the Bowman membrane exposed in the 8-mm center. Following photoablation, the epithelial semi-discs were repositioned and the surface was allowed to dry for 3 minutes.

**POSTOPERATIVE FOLLOW-UP**

Gatifloxacin 0.3% (Zymar, Allergan) and ketorolac
tromethamine 0.5% (Acular, Allergan) eye drops were used every 6 hours, tobramycin 0.3% and dexamethasone 0.1% (Tobradex, Alcon) every 8 hours, as well as several drops of physiologic saline solution (PSS) 0.9% every 2 hours (while awake) until the therapeutic contact lens was removed. The PSS flasks were changed daily. Hypromellose (Genteal; Ciba, Annonay, France) eye drops were administered four times daily until the fl ask was emptied, and fluorometholone acetate 0.1% (Florate, Alcon) was administered four times daily for 1 month, three times daily for 1 month, and two times daily for 1 month. The hypromellose eye drops were maintained according to patient discomfort after having finished the first fl ask. Patients were advised to maintain a minimum interval of 15 minutes between the eye drops and to keep the eyes closed for 1 minute, except in the case of the hypromellose. Paracetamol 750 mg (Tylenol; Jansen-Cilag, São José dos Campos, Brazil) pills were given to patients 30 minutes before surgery and 500 mg ascorbic acid pills (vitamin C) every 12 hours for 4 months. The postoperative evaluations were performed after 2 and 4 days, 2 weeks, and 1, 3, 6, and 12 months. Just before surgery, each patient received a follow-up schedule, which included a detailed postoperative regimen. Patients were also reoriented at each new visit.

Follow-up examination was performed by the operating surgeon (V.C.G.) without access to the patient’s chart.

If any visible epithelial defect was present at the end of the fourth day, the therapeutic contact lens was maintained and daily evaluations were performed until reepithelialization was complete. Before therapeutic contact lens removal, several drops of PSS were applied.

Patients were asked to look downwards while McPherson tying forceps were used to grasp the therapeutic contact lens by its edge. Following this, it was gently slid upwards. If any epithelial defect was observed after therapeutic contact lens removal, the lens was replaced with a new one, which remained until reepithelialization was complete.

Corneal reepithelialization time was evaluated on days 2 and 4. If the reepithelialization was not complete on the fourth day, the patient was followed daily. Postoperative ocular pain level was evaluated during the immediate postoperative period (approximately 30 minutes postoperatively). Patients received a chart with 6 drawn faces, “Faces Pain Scale,” each representing a pain level. Pain level was rated according to a graduated scale from 0 to 5: 0 = absence of pain, 1 = discomfort, 2 = light pain, 3 = moderate, 4 = intense, and 5 = unbearable. At the end of each day, patients were asked to record the degree of pain felt in each eye, from the day of surgery to the day of therapeutic contact lens removal. Postoperative ocular discomfort was evaluated at 2 weeks and 1, 3, 6, and 12 months. Patients were asked to report any discomfort in either eye. Discomfort included symptoms such as ocular pain, itching, burning, and foreign body sensation. Type 1 Schirmer test without anesthesia after 5 minutes with both eyes closed was performed at 1, 3, 6, and 12 months. Patients were asked to refrain from instilling any eye drops 2 hours prior to the appointment.

**Statistical Analysis**

The data of this work were analyzed against a 5% significance level (α=0.05). Therefore, the calculated values of error probability (P) when <.05 were considered statistically significant.

Parametric calculations were used for the numerical variables and non-parametric calculations were used for categorical or nominal variables and proportions.

The statistical programs used were Microsoft Excel 2000 (Microsoft Corp, Redmond, Wash), Statistics for Windows (version 5.0 A; StatSoft Inc, Tulsa, Okla), Minitab (version 14.2; Minitab Inc, State College, Pa), SPSS for Windows (version 10.0.1; SPSS Inc, Chicago, Ill), and NCSS (version 2000; Kaysville, Utah).

**Results**

In this study, 102 eyes of 51 patients (18 [35.3%] men and 33 [64.7%] women) were evaluated. Mean patient age was 28.06±4.13 years (range: 21 to 36 years). Of the PRK eyes, 24 (47%) were right eyes and 27 (53%) were left eyes. When these proportions were compared, the non-parametric chi-square test, corrected for continuity, according to Yates, did not reveal a statistically significant difference (χ²=0.16, P=.692).

**Corneal Reepithelialization**

The mean reepithelialization time of the 102 eyes was 4.55±0.64 days (range: 4 to 6 days). In the PRK group, it was 4.35±0.48 days (range: 4 to 5 days), and in the butterfly LASEK group it was 4.75±0.72 days (range: 4 to 6 days). A statistically significant difference was noted between groups (t=3.24, P=.002). Butterfly LASEK presented slower reepithelialization than PRK. Of the 40 (39.2%) eyes that healed in 5 days, 18 (17.6%) were from the PRK group and 22 (21.6%) were from the butterfly LASEK group. The 8 (7.8%) eyes that healed in 6 days belonged to the butterfly LASEK group.

In 1 (1.96%) eye from the PRK group and in 17 (33.33%) eyes from the butterfly LASEK group, the
cornea seemed to be healed in 4 days; however, the epithelium opened after therapeutic contact lens removal. In those cases, the lens was put back until healing was complete, which occurred on day 5 in 12 eyes and day 6 in 6 eyes. In 13 butterfly LASEK eyes, the epithelium was slightly edematous near the center of the cornea and at the edge of the junction line. The other eyes had a clear epithelium. In 5 (9.8%) eyes in the butterfly LASEK group, difficulties were encountered regarding creation of the epithelial flaps during surgery, causing a rupture of more than 100° in the epithelial junction between the flap and peripheral epithelium. However, the rupture did not exceed 150° in any eye.

**Correlation Between Corneal Reepithelialization Time and Surgery Time.** The corneal reepithelialization time was directly related to surgery time ($r=0.357; N=51; P<.001$), i.e., the longer the surgery, the longer the reepithelialization time (Fig 1, Table 1). Surgery time was considered from just after the blepharostat was put in place until it was removed. This procedure was officially timed. The mean surgical times of PRK and butterfly LASEK were significantly different ($F=8.19, P=.001$). If only the eyes in which the surgery lasted between 350 and 550 seconds were taken for comparison, no statistical difference between techniques was observed in reepithelialization time ($z=0; P=1.00$).

**POSTOPERATIVE OCULAR PAIN**

The level of postoperative ocular pain in the two groups is shown in Table 2 and Figure 2. Considering the ocular pain level from the day of surgery to postoperative day 5, no statistically significant difference was noted among eyes treated with PRK and those treated with butterfly LASEK. The pain level was higher on the day of surgery, gradually decreasing until postoperative day 5. Only on the third day after surgery was pain level observed to be higher in the PRK group; however, without a statistically significant difference. The mean total pain (sum of 5 days for each group separately) for PRK was $3.31\pm4.09$ (N=51 eyes) and $4.43\pm4.27$ (N=51 eyes) for butterfly LASEK. The butterfly LASEK technique showed a tendency for a higher pain level than PRK, although the $t$ test did not show a significant difference ($t=1.35; P=.18$).

Of the 561 postoperative readings of the 102 eyes regarding ocular pain until removal of the therapeutic contact lens, only 18 (17.6%) eyes showed a pain level of 4 (intense pain) or 5 (unbearable pain). Ten (9.8%) eyes were from the PRK group and 8 (7.8%) eyes were from the butterfly LASEK group. Approximately 92% (91.8%, 515 readings) of eyes had an ocular pain score...
of 2 (light pain) or less and 61.5% (345 readings) had no pain. Thirty-one (30.4%) eyes did not have postoperative pain from the day of surgery to therapeutic contact lens removal (17 [16.7%] eyes in the PRK group and 14 [13.7%] eyes in the butterfly LASEK group).

**Correlation Between Postoperative Ocular Pain and Patient Age.** An inverse proportion between the mean total pain and patient age was observed. The younger the patient, the higher the mean pain and conversely, the older the patient, the lower the mean pain. When the 102 eyes were divided into two groups, it was observed that in the group aged 21 through 27 years (N=54, mean age: 24.85±1.77 years) the mean total pain was 4.70±4.32; and in the group aged 28 through 36 years (N=48, mean age: 31.67±2.76 years) it was 2.94±3.88. The mean total pain was statistically different between these two groups (t=2.16; P=.033).

**Correlation Between Postoperative Ocular Pain and Corneal Reepithelialization Time.** When the sum of the postoperative pain values for each eye was calculated and the mean was taken in relation to the three healing times (days 4, 5, and 6), a higher pain level was observed in early healing (4 days; mean total pain: 4.19±4.71) whereas a lower pain level was observed in late healing (6 days; mean: 2.50±2.62).

**POSTOPERATIVE OCULAR DISCOMFORT**

When analyzing the postoperative ocular discomfort after day 14, no statistically significant difference was observed between groups (Table 3). There was a reduction in the number of patients (eyes) with symptoms of approximately 20% to 7% from postoperative day 14 to postoperative day 30, although with a new increase at 6 and 12 months. The main complaints were foreign body sensation, itching, burning, and ocular pain when touched. No patient reported intense symptoms that interfered with daily activities.

<table>
<thead>
<tr>
<th>Days Postop</th>
<th>PRK No. of Eyes</th>
<th>Mean±SD</th>
<th>Butterfly LASEK No. of Eyes</th>
<th>Mean±SD</th>
<th>Paired t Test</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative day</td>
<td>51</td>
<td>0.82±1.29</td>
<td>51</td>
<td>1.18±1.26</td>
<td>1.77</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>0.73±1.08</td>
<td>51</td>
<td>1.14±1.23</td>
<td>1.88</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>51</td>
<td>0.77±1.19</td>
<td>51</td>
<td>0.88±1.05</td>
<td>0.58</td>
<td>.57</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>51</td>
<td>0.63±1.02</td>
<td>51</td>
<td>0.53±0.86</td>
<td>0.65</td>
<td>.52</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>51</td>
<td>0.31±0.84</td>
<td>51</td>
<td>0.51±0.97</td>
<td>1.22</td>
<td>.23</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>22</td>
<td>0.14±0.35</td>
<td>29</td>
<td>0.35±0.72</td>
<td>1.90</td>
<td>.08</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.** Mean ocular pain values in PRK and butterfly LASEK (BLASEK) on the surgery day (0) and from postoperative days 1 to 5.
SCHIRMER TEST

Schirmer test values were significantly reduced from preoperative levels through 12 months in both PRK (23.6 ± 8.1 vs 19.4 ± 10.1; P = .002) and butterfly LASEK (22.4 ± 8.7 vs 18.9 ± 9.7; P = .01), except on postoperative days 30 and 180 in the butterfly LASEK group (P = .794 and P = .057, respectively); however, no difference was noted between groups at any other time point (Fig 3).

A reduction in the Schirmer values was observed at 1 month, reaching the lowest values at 3 months, with a rise at 6 months and a slight reduction at 12 months.

When comparing patients who presented with postoperative symptoms at two or more postoperative evaluations with patients with symptoms in one or no evaluations, in relation to Schirmer values, no differences between groups were observed. Patients with more frequent symptoms did not present statistically lower Schirmer values (P = .548).

DISCUSSION

In PRK and LASEK, ocular discomfort and slow visual recovery are limiting factors. Associated symptoms such as tearing, photophobia, burning, and foreign body sensation are common until reepithelialization is complete. In this study, it was observed that reepithelialization was faster in eyes treated with PRK (4.35 ± 0.48 days) compared with eyes that underwent butterfly LASEK (4.75 ± 0.72 days) (P = .002). All 8 (7.8%) eyes that healed in 6 days belonged to the butterfly LASEK group. Although this difference was modest (0.4 days), 59% of eyes in the butterfly LASEK group took more than 4 days to heal compared to 35% in the PRK group. This difference can be considered clinically significant, as comfort is much improved after therapeutic contact lens removal. Moreover, after lens removal on postoperative day 4, epithelial rupture occurred in one third of the butterfly LASEK group eyes, meaning that the epithelial flap was not appropriately adhered, either because of a failure in the basal membrane adherence process or because of a lack of cellular viability. Unfortunately, epithelial closure is hard to judge in butterfly LASEK and LASEK. Even with no visible epithelial defect, the epithelial sheet may not be viable and detach after therapeutic contact lens removal. Most of the eyes seemed to lack cellular viability, as the epithelium was slightly edematous and opened easily even with careful removal of the lens. This decreased cellular viability observed in the butterfly LASEK group was most likely due to the intraoperative use of alcohol and epithelium manipulation required in this technique.8,9

Mean reepithelialization time usually ranges from 3 to 5 days.5,10-13 Other studies show that it can take up to 1 week.14,15 Litwak et al2 and Lee et al10 reported
similar results between the techniques, whereas Autrata and Rehurek\textsuperscript{16} described a more prolonged reepithelialization in the PRK group and Pirouzian et al\textsuperscript{4} in the LASEK group. The butterfly LASEK study published by Vinciguerra et al\textsuperscript{6} showed complete reepithelialization by day 4 in all eyes. Epithelium rupture following therapeutic contact lens removal did not occur in any case.

Corneal reepithelialization was significantly related to duration of surgery ($P<.001$). It is interesting to note that, if we compare only the eyes in which surgery time was between 350 and 550 seconds, no statistical difference was observed ($P=1.00$). Although there were few eyes (8 PRK and 10 butterfly LASEK) for comparison, this result suggests that the difference is not the surgical technique on the cornea, but the time it takes to perform the procedure. The prolonged surgical time usually occurs in cases of higher adherence of the epithelial flap on the stromal bed, consequently needing more manipulation. This can expose the epithelium to higher dryness, in addition to reducing the number of live cells. This may explain the longer reepithelialization time following longer procedures, especially in butterfly LASEK.

Postoperative pain is due to the exposure of corneal nerves and release of inflammatory mediators, especially prostaglandins and neuropeptides.\textsuperscript{17} Although in this study ketorolac of tromethamine was used every 6 hours until therapeutic contact lens removal, of the 566 reported pain ratings, there were 18 (3.2%) instances of high intensity pain (degrees 4 and 5) during the postoperative period. This can be partly justified, as oral pain-killer medication was not routinely prescribed during the postoperative period. Patients were advised to use it if necessary. Even so, this incidence can be considered low. If the use of a nonsteroidal anti-inflammatory drug had been standardized, an even more comfortable postoperative period could have occurred.

In our study, no statistically significant difference was observed in the pain level until postoperative day 5, although a tendency for higher pain levels was noted in butterfly LASEK. Some studies suggest that LASEK reduces postoperative pain when compared to PRK.\textsuperscript{10,16,18,19} However Litwak et al\textsuperscript{2} showed that LASEK presented higher postoperative pain than PRK. The higher pain levels with LASEK were attributed to the possible effect of the epithelial flap, which many times has no adherence and becomes loose. Blake et al\textsuperscript{20} compared the postoperative pain level between PRK with mechanical epithelial debridement and PRK with alcohol. They also showed higher ocular pain on postoperative day 1 in eyes submitted to epithelium removal with alcohol. There was no significant difference at 3 days postoperatively. Yet it is not known whether this higher pain is due to the alcohol cytotoxic effect or to other unknown factors. Nevertheless, Leccisotti\textsuperscript{3} did not show more comfort postoperatively with LASEK performed without alcohol when compared to PRK, and Kanitkar et al\textsuperscript{21} showed that PRK with alcohol for the epithelial debridement was significantly less painful than epithelial removal with excimer laser (transepithelial ablation). An interesting finding of our study was the inverse proportion between the mean total pain and age of the patient. The younger the patient (group aged 21 through 27), the higher the mean pain score. This suggests that, apparently, the elder have less pain “sensitivity”; however, it is not possible to state this as a fact. To contradict such data, Paysse et al\textsuperscript{22} reported little postoperative discomfort and pain in children submitted to PRK, including two cases in which they lost the therapeutic contact lens before healing was complete.

The mean total pain (the sum of the pain values of all postoperative days for each eye) observed for the three healing times (days 4, 5, and 6) was higher for early healing (4 days), and consequently lower for late healing (6 days). This occurred because the pain level was higher in both techniques on the first 2 days, being the last reepithelialization days less painful, thus decreasing the mean.

By evaluating the possible association of postoperative discomfort with lower values of the Schirmer test, no correlation was found. It should be remembered that patients were questioned about any ocular symptoms. As the evaluated symptoms are common in the normal population, to obtain a more realistic conclusion, the preoperative symptoms would also have to be evaluated.

Dry eye is one of the most common complications after excimer laser refractive surgery.\textsuperscript{23,24} The lacrimal secretion is dependent on the sensorial nerves, especially the corneal nerves, which are damaged by PRK.\textsuperscript{25,26} This partial denervation may reduce the lacrimal secretion and cause dry eye symptoms. In our study, Schirmer test values were significantly reduced from preoperative levels through 12 months with both PRK (23.6±8.1 vs 19.4±10.1; $P=.002$) and butterfly LASEK (22.4±8.7 vs 18.9±9.7; $P=.01$). However, there was no difference between groups at any time point. Even after 1 year, there was no recovery of normal tear production in any group. These findings cannot solely be attributed to a reduction in corneal sensitivity, as some studies show a recovery in the first three postoperative months.\textsuperscript{27,28} and only in a few cases does it become impaired for a prolonged period. Herrmann et al\textsuperscript{29} showed that even 3 months after LASEK there was
a reduction of the type I Schirmer test without anesthesia, despite a normal corneal sensitivity. Nevertheless, Horwath-Winter et al did not find significant changes in Schirmer test results in 37 myopic eyes with 6-month follow up.

Hovanesian et al did not find relevant differences between ocular dryness symptoms after PRK and LASIK. The incidence of symptoms in both groups was approximately 9%. Patients in the PRK group had significantly higher pain scores, soreness, and eyelid sticking. There was no comparison of the complaints with Schirmer values or any other clinical tests. In this study, although some patients presented low Schirmer values pre- and postoperatively, no patient developed important dry eye signals or symptoms. These results are similar to those of Chen et al, who published a series of nine cases of dry eyes successfully operated using LASEK.

It is important to point out that the patients in this study group were younger than those in other refractive surgery studies. We intentionally selected patients for our study aged 36 years and younger to avoid the issue of monovision as the amount of ablation is different between eyes in older patients. Even with a higher tear production expected in this young group of patients when compared to an older age group, 15.7% of the eyes had Schirmer test values less than 15 mm in the preoperative evaluation. Furthermore, Schirmer test values were significantly reduced by the last follow-up. Therefore, surface ablations have proven to be safe even in patients with low preoperative Schirmer test values over the short-term, but over the long-term many of these patients may begin showing significant signs and symptoms of dry eyes.

In our study, intra-patient comparison was made between two techniques of surface refractive surgery with excimer laser performed by the same surgeon (V.C.G.) (using the same laser, same postoperative medication, and similar diopters between eyes). In addition, the study presents high relevance and strength, because it was prospective, paired, comparative, masked, and randomized. The following limitations can be observed. First, the two eyes were not treated on the same day, but a 2-day difference does not appear to represent a significant alteration to the results. The postoperative evaluation schedule was the same for each eye. Furthermore, the technique performed in the first eye was randomized and the patients were asked to complete the Faces Pain Scale chart for each eye independently. Discomfort was only evaluated after postoperative day 14, when this 2-day difference is no longer significant. Second, the surgeon performed the postoperative evaluation in all patients without access to the patient’s chart. Although the study was masked for the patient and the ophthalmologist that performed the postoperative follow-up, it was possible to identify the technique used in the first postoperative days. Nevertheless, such identification is possible for any ophthalmologist performing the postoperative evaluation. In addition, the 102 surgeries were performed in a short period of time (3 months), making it almost impossible to correlate the technique performed with the operated eye after the first postoperative days.

In the present study, PRK showed a modest but statistically significant shorter reepithelialization time and a tendency towards lower pain scores than butterfly LASEK. The reepithelialization time was strongly associated with the duration of the surgery in both techniques. A similar reduction of Schirmer test values was observed up to 1 year postoperatively in both groups.

REFERENCES
13. Lee JB, Ryu CH, Kim J, Kim EK, Kim HB. Comparison of tear secretion and tear film instability after photorefractive keratec-


