A New Transepithelial Phototherapeutic Keratectomy Mode Using the NIDEK CXIII Excimer Laser

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ABSTRACT

PURPOSE: To evaluate epithelial healing, postoperative pain, and best spectacle-corrected visual acuity (BSCVA) after transepithelial photorefractive keratectomy (PRK) performed with a new phototherapeutic keratectomy (PTK) mode using the NIDEK CXIII excimer laser.

METHODS: Fifteen eyes from 10 patients with myopia underwent transepithelial PRK using a multistage program to perform PTK followed by PRK. The PTK incorporated Flex Scan, which accounts for the loss of radial ablation efficiency on the peripheral cornea. The epithelium was removed with the excimer laser by monitoring the disappearance of blue fluorescence during the ablation. Epithelial healing was evaluated by taking slit-lamp photographs every 24 hours until complete reepithelialization. Postoperative pain was measured according to the Faces Pain Rating Scale. All outcomes are reported for 3 months postoperatively. Haze was graded by two ophthalmologists, each masked to the other’s result.

RESULTS: Mean reepithelialization took 3.50 ± 0.85 days, mean pain score was 3.00 ± 1.20, and BSCVA was 20/20 for 9 eyes, 20/30 for 3 eyes, and 20/40 for 3 eyes. All patients had haze below grade 2.

CONCLUSIONS: The outcomes of the preliminary study show that the incorporation of the Flex Scan algorithm in the PTK mode is as safe and effective as conventional PTK algorithms. The primary advantage of this new PTK mode may be more consistent epithelial removal. Additional studies are needed to determine long-term outcomes. [J Refract Surg. 2009;25:S122-S124.]

The era of excimer laser refractive surgery began approximately two decades ago with the introduction of photorefractive keratectomy (PRK) for the treatment of myopia.1,2 Although successful at reducing refractive error, the technique produced some complications such as pain, epithelial defects due to irregular healing, and corneal haze.3-5 Over time, different techniques of epithelial removal were introduced to address these complications. Hanna et al5 found that laser removal of epithelium did not cause keratocyte apoptosis, reducing the visual rehabilitation time and the risk of corneal haze. Other investigators showed that use of rotary brush- or alcohol-assisted removal of the epithelium resulted in few complications.6,7 Each advancement led to a smoother corneal surface, which contributes to fewer postoperative complications.5,7 Laser epithelial removal using phototherapeutic keratectomy (PTK) ablation may lead to a smoother corneal surface because of its submicron precision. However, because of the curvature of the cornea as well as the lower laser energy delivery and reduced peripheral tissue removal, compared with central tissue removal, associated with PTK,8 the procedure may produce variable ablation depth, leading to irregular epithelial removal and subsequent irregular healing.3

In this study, we report on epithelial healing using transepithelial PRK performed with a new PTK mode that partially accounts for the loss of energy due to angle of incidence incorporated in the NIDEK CXIII excimer laser (NIDEK Co Ltd, Gamagori, Japan).

PATIENTS AND METHODS

The study cohort was composed of 15 eyes from 10 patients with myopia. Mean patient age was 35 ± 17.30 years (range:
21 to 59 years). Preoperative mean manifest refraction spherical equivalent (MRSE) was −4.50 ± 1.70 diopters (D) (range: −2.50 to −7.25 D), and best spectacle-corrected visual acuity (BSCVA) was 20/28.

All procedures were performed with the NIDEK CXIII excimer laser using software version 5.32. The PTK mode using the Flex Scan algorithm was used to remove the epithelium. The Flex Scan ablation delivers more ablation pulses to the corneal periphery than to the central cornea to account for the prolate shape of the cornea. On the day of surgery, the following calibrations were performed in order on a polymethylmethacrylate plate: −3.00-D laser calibration using a 5.0-mm optical zone; a +3.00-D laser calibration using a 10.0-mm optical zone; and a −3.00-D calibration using a 5.0-mm optical zone in Flex Scan mode. A 60-µm PTK was delivered to a polymethylmethacrylate plate to ensure even distribution of laser energy centrally and peripherally based on the manufacturer’s specifications. Each calibration was checked on a lensmeter to verify accuracy within 0.00 D. The polymethylmethacrylate plate was inspected visually to ensure a smooth surface within the ablation zone. Before surgery, asepsis of the eyelids was performed with a 10% povidone scrub. Topical anesthesia was delivered to the eye undergoing surgery, and a lid speculum was inserted followed by three additional drops of topical anesthesia.

A multistage program was used to perform the PTK followed by the PRK. A 200-Hz infrared eye tracker centered on the pupil was used for both PTK and PRK ablations. The mean fluence ranged from 120 to 130 mJ/cm², and the programmed ablation diameter was 9.5 or 10 mm, based on the optical zone planned for the PRK. Epithelial removal was performed by monitoring the disappearance of blue fluorescence, which occurred at between 50 and 60 µm. After laser ablation, a high-oxygen-content (>50%) soft contact lens was placed on the cornea, followed by one drop each of a topical antibiotic, a topical steroid, and a topical nonsteroid.

Epithelial healing was observed using slit-lamp examinations. The healing response was recorded using slit-lamp photography immediately after surgery and every 24 hours until complete reepithelialization of the cornea occurred. Postoperative pain was measured according to the Faces Pain Rating Scale, a self-reported subjective questionnaire measuring pain intensity on a scale from 0 (no pain) to 10 (worst pain), until complete epithelial healing had occurred. Three-month postoperative BSCVA is also reported. Postoperative haze was graded separately, using slit-lamp microscopy, by two ophthalmologists (L.B., A.L.) masked to the other’s results.

RESULTS

Mean time to complete reepithelialization was 3.50 ± 0.85 days (range: 2 to 5 days). Mean pain score was 3 ± 1.2 (range: 1 to 6), and 3-month postoperative BSCVA was 20/24 (range: 20/40 to 20/20). No eyes lost more than two lines of BSCVA. At 1 month postoperatively, a mean hyperopic shift <1.00 D was noted, and a subsequent reduction of MRSE to 0.15 ± 0.30 D was observed by 3 months postoperatively. All patients had a haze grade below 2.

DISCUSSION

Ghadhfan et al compared the visual outcome and complications of LASIK, laser epithelial keratomileusis (LASEK), PRK with mechanical epithelial removal, and transepithelial PRK performed using the NIDEK excimer laser. They reported better visual outcomes using transepithelial PRK (PTK mode; 7.0- to 9.0-mm optical zone and 45 to 55 µm of ablation) partially due to the accurate and smooth removal of the epithelium.

Lee et al evaluated epithelial healing, postoperative pain, and visual refractive outcomes after PRK using three epithelial removal techniques: mechanical, alcohol-assisted, and excimer laser-assisted. Six months postoperatively, no significant differences were observed among the three groups. In the study by Lee et al, transepithelial PRK was performed with an initial ablation of 45 µm, whereas the remaining epithelium was removed until autofluorescence, used to monitor possible ablation of the basal lamina, disappeared. As in this study, 1 month after transepithelial PRK, patients experienced a hyperopic shift. Lee et al reported a reduction in the hyperopic shift within 6 months, with better uncorrected visual acuity in the transepithelial PRK group compared with the LASEK and mechanical PRK groups. During PTK, some regions of the basal lamina and Bowman’s layer may be unintentionally ablated, which may explain the hyperopic shift reported in this study. However, 3 months postoperatively, the MRSE stabilized close to emmetropia.

By using the Flex Scan algorithm that accounts for radial laser energy loss peripherally, the volume of ablation may be more consistent compared with PTK laser algorithms that do not address this phenomenon. By creating a smoother corneal surface epithelium, it is likely to heal in a consistent manner, reducing the risk of complications such as pain and haze.

Confocal microscopy after PRK shows a thicker epithelial layer postoperatively compared with preoperatively. Stromal surface irregularity has been linked to corneal haze. Creating a smooth surface for wound healing may aid in reducing focal areas of thicker or thinner epithelium, which can increase light scatter.
causing a reduction in visual performance. Surface irregularities have been linked to decreased low contrast visual acuity due to increased light scatter across the retina.14,15

The reepithelialization times reported in this study are similar to those reported in previous studies.11 A study of transepithelial PRK on a cohort with a similar preoperative MRSE (−5.11 D)11 compared with this study reported a mean reepithelialization time of 2.49 days, which is 1 day less than the 3.5 days reported herein. However, ablation volumes of the VISX conventional algorithms (VISX, Santa Clara, Calif) used in the study by Lee et al11 are lower than the ablation volumes of the aspheric algorithms used with this NIDEK laser, accounting for the difference in healing times.

The outcomes of this pilot study suggest that this new PTK mode of epithelial removal is as safe and effective at removing corneal epithelium as conventional PTK algorithms. The primary advantage is related to the regularity of epithelial removal that produces a homogeneous perilimbal ring of intact epithelium. Additional studies with larger sample sizes are required to investigate long-term results in myopic and hyperopic populations. Additional studies using confocal microscopy are required to determine the consistency of the epithelial layer postoperatively.

REFERENCES