Inadvertent stromal dissection during mechanical separation of the corneal epithelium using an epikeratome

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Epithelial flap complications occurred in 2 patients during epithelial separation using a Centurion SES epikeratome (Norwood Eye Care) in epi-laser in situ keratomileusis (LASIK). The complications consisted of stromal dissection at the margin of the pupil and an epithelial free cap including the superficial stroma. The epithelial flaps were repositioned without laser ablation. Three months postoperatively, the best corrected visual acuity in both patients was 20/20 and neither complained of visual discomfort. Slitlamp biomicroscopic examination showed that both corneas were completely healed with trace opacity, and topographic examinations revealed that irregularities in the stromal cutting sites were decreased. The patients had successful photorefractive keratectomy after complete healing of the dissected stroma. Stromal dissection during mechanical separation of the epithelium with an epikeratome is a potential complication of the epi-LASIK procedure, but proper management can result in good recovery without severe visual impairment.

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Currently, surface ablation in photorefractive surgery seems to get more interest from a viewpoint of flap-related complications of laser in situ keratomileusis (LASIK).[1] Laser-assisted subepithelial keratectomy (LASEK), which involves the use of dilute alcohol or other chemical agents to loosen the epithelial adhesion, has less postoperative pain, less subepithelial haze, and a more rapid visual recovery than photorefractive keratectomy (PRK).[2] However, the preparation with alcohol is considered toxic to the corneal epithelium.[3]

Pallikaris et al.[4] have described an epi-LASIK technique in which an epikeratome is used to create an epithelial sheet mechanically. This mechanical separation is less invasive to epithelial integrity and has no risk for chemical toxicity, unlike the chemical separation in LASEK.[5] To date, no intraoperative complications associated with mechanical separation have been reported. We describe 2 cases of inadvertent stromal dissection during mechanical separation of the epithelium using a Centurion SES epikeratome (Norwood EyeCare) in the epi-LASIK procedure.

CASE REPORTS

Case 1

An epi-LASIK procedure was attempted in the left eye of a 24-year-old man whose best corrected visual acuity (BCVA) in that eye was 20/20 with $-6.50\ -0.50 \times 90$. The central corneal power was 45.00/46.25×109 and the central corneal thickness, 560 µm. There were no remarkable findings on slitlamp examination or corneal topography.

The procedure was performed after topical anesthesia with proparacaine hydrochloride 0.5% and standard aseptic preparation. The handpiece of the Centurion SES epikeratome was applied to the cornea after oscillation of the EpiEdge separator was verified. After adequate suction pressure was confirmed by a Barraquer tonometer, the oscillating separator was advanced at a rate of 4.0 mm/min with an oscillation rate of 10 800 rpm. After the suction was released, a 4.0 mm × 1.5 mm crescent-shaped superficial stromal dissection adjacent to the inferior margin of the pupil was seen (Figure 1, *A*). The epithelial sheet was repositioned with a moistened Merocel sponge (Medtronics),

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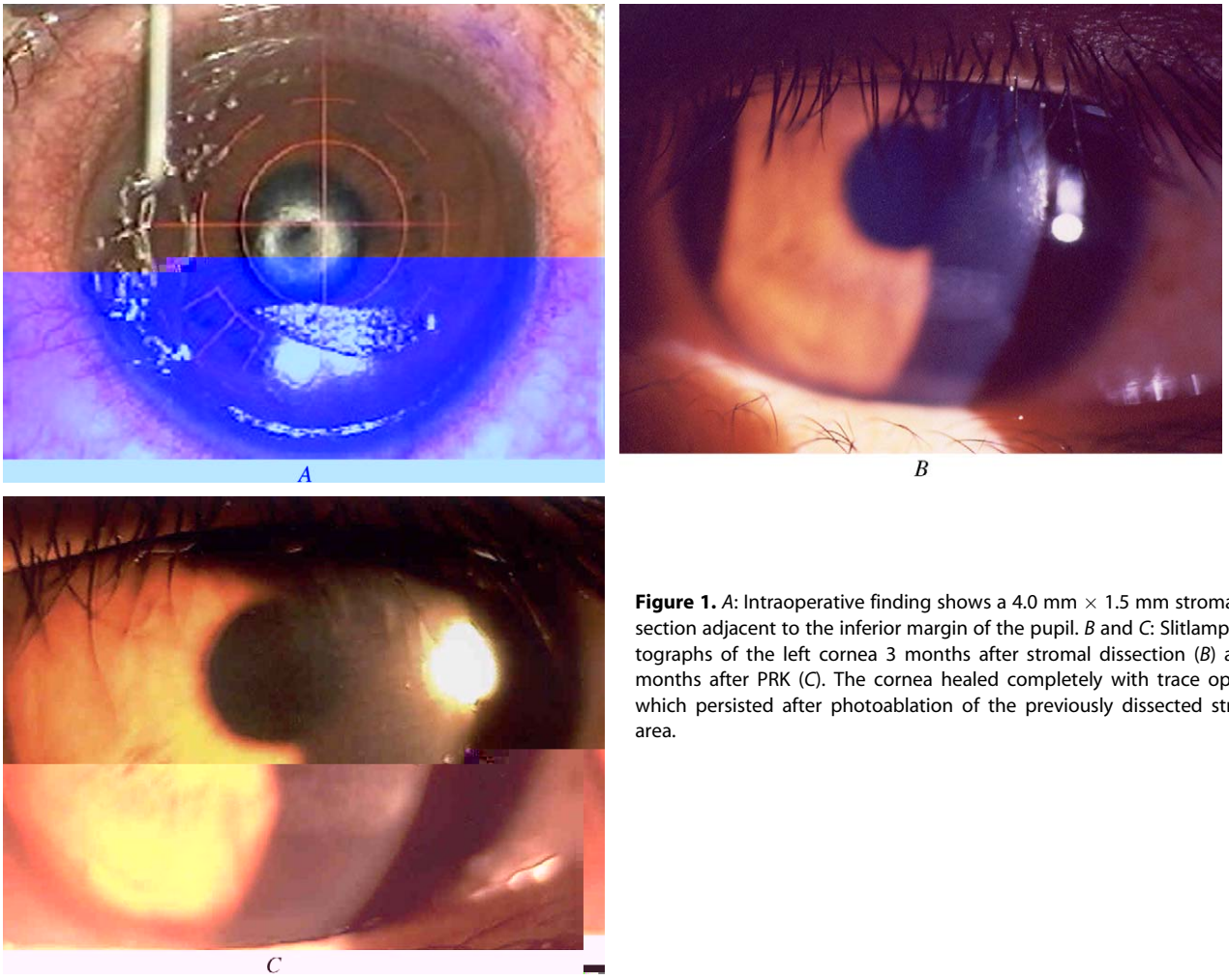


Figure 1. *A*: Intraoperative finding shows a 4.0 mm × 1.5 mm stromal dissection adjacent to the inferior margin of the pupil. *B* and *C*: Slitlamp photographs of the left cornea 3 months after stromal dissection (*B*) and 3 months after PRK (*C*). The cornea healed completely with trace opacity, which persisted after photoablation of the previously dissected stromal area.

and a bandage contact lens was applied. The procedure was finished without laser ablation.

Ofloxacin 0.3% and fluorometholone 0.1% eyedrops were instilled following the procedure. The bandage contact lens was removed after 5 days when reepithelialization was complete. Three months after the procedure, the BCVA was 20/20 and the cornea had healed completely, with trace opacity on slitlamp biomicroscopic examination (Figure 1, *B*). Serial topographic images using Orbscan revealed an irregularity at the dissected stromal site, which decreased progressively over time (Figure 2, *A* and *B*).

Eight months after the procedure, the patient had PRK in the left eye with a Visx Star S2 excimer laser and an optical zone of 6.0 mm. During deepithelialization with a hockey knife, the previous separated stroma was taken off along with the epithelium. Photoablation was performed despite the existence of superficial stromal loss. Reepithelialization was completed with a patch for 4 days. The wound healing did not differ from that in uneventful PRK. Three months after PRK, the corneal opacity on the previous stromal cut area and topographical irregularities persisted (Figure 1, *C* and Figure 2, *C*). However, the uncorrected visual acuity (UCVA) was 20/20 with a refractive error of +0.25 −0.25 × 160 and no visual discomfort was reported.

Case 2

A 24-year-old woman requested epi-LASIK for myopia. The refractive error in the left eye was −4.50 diopters and the BCVA was 20/20. The central corneal power and the ultrasonic central corneal pachymetry were 42.50/43.50×9 and 505 µm. No abnormal findings were noted on slitlamp examination or corneal topography.

Epithelial separation was attempted with a blunter blade that was used in Case 1. The oscillation rate was raised from 10 800 rpm to 12 000 rpm, the advancement speed was reduced from 4 mm/min to 2 mm/min, and the suction vacuum was raised from 630 mm Hg to 640 mm Hg to optimize epithelial separation with a modified blade. After the handpiece was released, a 4.0 mm × 2.0 mm stromal cutting was detected (Figure 3, *A*). The epithelial sheet was promptly repositioned without another procedure, and a bandage contact lens was applied. Postoperative treatment was the same as in Case 1. The bandage contact lens was kept in place for 5 days.

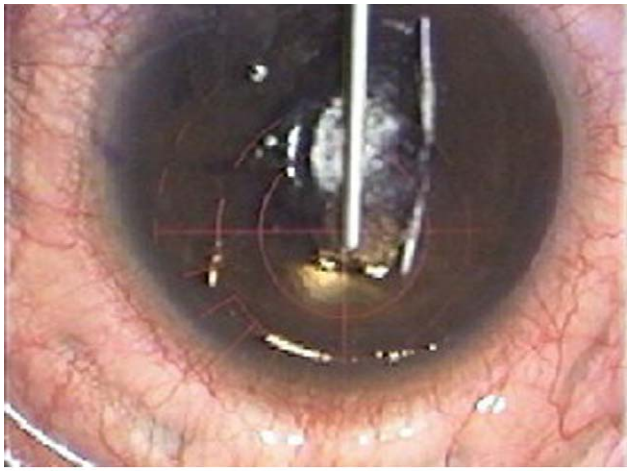
Three months later, the BCVA was 20/20 and no visual discomfort was reported. The cornea healed completely, with trace opacity on slitlamp biomicroscopic examination (Figure 3, *B*). A

topographic image showed no irregularity at the dissected stromal site (Figure 4, *A*).

Eight months after the initial surgery, PRK was performed in the left eye using the excimer laser system that was used in Case 1. The dissected stromal flap was not detached again during epithelial removal with a hockey knife. Three months after PRK, the previous corneal opacity disappeared and no topographical irregularity was found (Figure 3, *C*, and Figure 4, *B*). The UCVA was 20/20 with a refractive error of $+0.75-0.75 \times 90$. The patient did not report visual discomfort.

DISCUSSION

First described by Pallikaris et al.,[4] the epi-LASIK technique uses an epikeratome to create an epithelial sheet mechanically before photoablation. This is performed in a manner similar to that of using a microkeratome to create a flap in the LASIK procedure, providing a short learning curve for LASIK surgeons. In addition, mechanica323.7(8-a0.2(epi ort1-270.5(cocha)2(romal)-207.5(ep)-7.epithuLASaaloaaleport1-27



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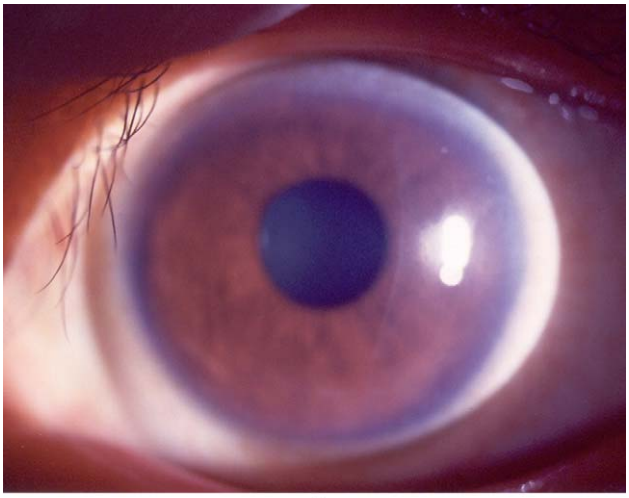

B

Figure 3. *A*: Intraoperative finding shows a 4.0 mm × 2.0 mm stromal dissection. *B* and *C*: Slitlamp photographs of the left cornea 3 months after stromal dissection (*B*) and 3 months after PRK (*C*). The corneal opacity disappeared after laser ablation.

suction pressure is verified, epithelial separation is achieved by advancement of the oscillating blade. To provide an ideal epithelial flap, suction pressure, sharpness of the blade, oscillation frequency, and speed of advancement of the head must be optimized.

From August 2004 to December 2005, epithelial separation with the Centurion SES epikeratome was performed in 91 eyes (53 patients) at the Anam Hospital and Han-il General Hospital. Stromal damage during epithelial separation occurred in only the 2 cases presented. A separator of an early model was used in the patient in Case 1, in which the free cap with the superficial stroma occurred after the epithelial separation was completed. To avoid a free epithelial sheet or incomplete separation, the manufacturer redesigned the angle of the blade to be more obtuse and adjusted the recommendations for other parameters. The oscillation rate was raised from 10 800 rpm to 12 000 rpm, the speed of the head advancement was lowered from 4 mm/min to 2 mm/min, and the vacuum pressure was raised from 630 mm Hg to 640 mm Hg to enhance the separation of the corneal epithelium from the stroma with the blunter blade. Although a modified separator was used, stromal dissection occurred in Case 2.

If an incomplete flap develops during the LASIK procedure, recutting with ablation of the planned treatment zone after several months is recommended to obtain an excellent result.[7] However, in both of these cases, retreatment by LASIK was not recommended because the new cut by the microkeratome could intersect with the preexisting stromal flap. Therefore, we propose that PRK or transepithelial phototherapeutic keratectomy is more suitable for such patients. In Case 2, because the dissected stromal flap was attached to the stroma on one side, removal of the epithelium could be performed without separation of the stromal flap. However, in Case 1, the stromal flap was dislodged during epithelial removal. This might result in uneven photoablation and postoperative irregular astigmatism according to

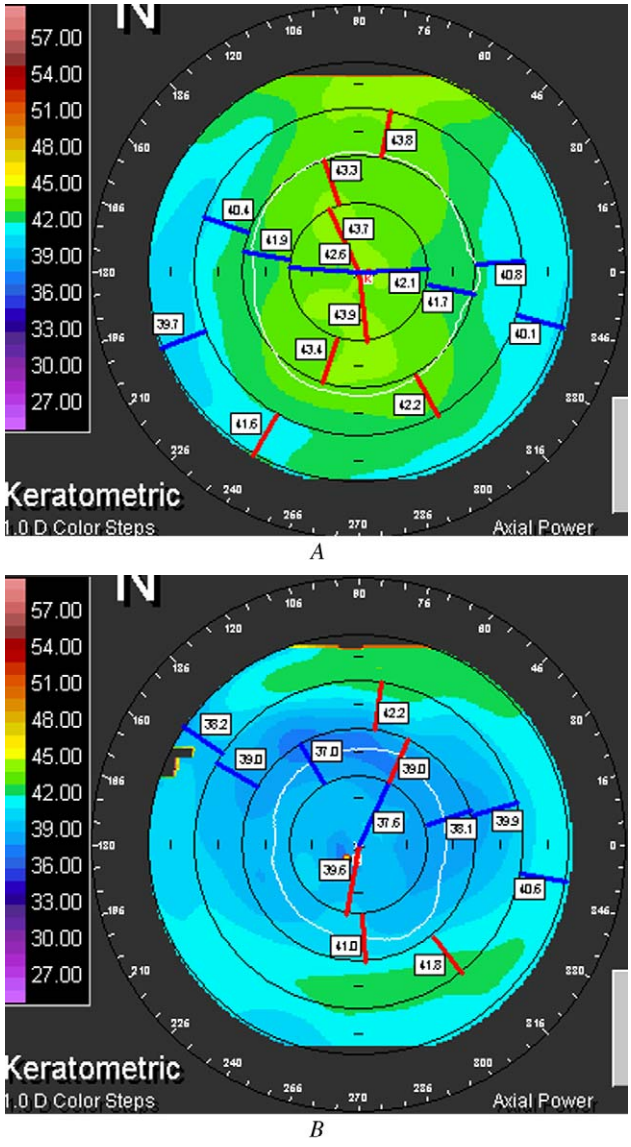

Figure 4. Topographic images using Orbscan of the left cornea a week after stromal dissection (*A*) and 3 months after PRK (*B*) show no irregularity.

the thickness and dimension of the stromal loss. We suppose that photoablation from the epithelium can decrease the likelihood of the stromal loss in such cases.

Adjunctive use of mitomycin-C (MMC) is regarded as a successful method for the treatment and prevention of corneal opacity after PRK.[8,9] Surface ablation over a stromal flap that was made during a previous LASIK procedure showed a higher risk for significant corneal haze.[10] In this condition, MMC can reduce the risk for subepithelial fibrosis.[11] Surface ablation over the inadvertent stromal flap as in our 2 cases also has a risk for corneal opacity and prophylactic use of MMC may be helpful.

Mechanical separation of the corneal epithelium using an epikeratome is still evolving to improve reproducibility and reduce complications associated with epithelial separation. Of the complications, incomplete separation and a free cap do not have a significant effect on the postoperative visual prognosis. However, stromal damage during epithelial separation may lead to significant visual loss. Both cases showed good UCVA after PRK without visual discomfort. To assess the visual disability more accurately, evaluations for various visual functions such as contrast sensitivity or higher-order aberrations are necessary.

Until recently, the oscillating PMMA blade seemed to be relatively safe to the stroma and the cleavage plane was regarded as superior to chemical separation. However, the possibility of stromal damage is not completely eliminated, and careful attention must be given to the possible occurrence of these complications. Additionally, detailed modulation of the parameters of the epikeratome may be required to perform an ideal epithelial separation without stromal damage.

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