# Topography-guided Transepithelial Surface Ablation in Treatment of Recurrent Epithelial Ingrowths

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## ABSTRACT

**PURPOSE:** To describe a new, single-step, transepithelial and trans-LASIK flap topography-guided surface ablation technique in a case of recurrent epithelial ingrowth with visual disturbances caused by irregular astigmatism, scattering, and decreased corneal transparency after LASIK.

**METHODS:** Custom ablation through both the epithelium and the LASIK flap was performed by 1-KHz flying spot excimer laser was used to transform an irregular corneal surface into a regular aspheric surface and in the same continuous process to ablate the epithelial ingrowth causing the irregularity.

**RESULTS:** Visual rehabilitation was achieved, the corneal surface was regularized, and epithelial ingrowth was removed within the ablation.

**CONCLUSIONS:** The transepithelial topography-guided surface ablation technique was safe and effective in this case of visually disturbing epithelial ingrowth after LASIK, and may also be applied to treat other types of flap/interface complications. [*J Refract Surg.* 2010;xx:xxx-xxx.] doi:10.3928/1081597X-

After LASIK, patients with serious flap/interface complications who show failure to improve or inability to be treated by common techniques such as flap re-lift, re-cut, or surface ablation, are faced with the poor alternatives of accepting the visual disturbances or undergoing corneal transplantation. Our aim is to describe a new, single-step, topography-guided custom transepithelial "no touch" ablation technique used in a case of recurrent epithelial ingrowth with visual disturbances due to irregular astigmatism, scattering, and decrease of transparency.

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Due to epithelial remodeling (thickening over depressed stroma and thinning over elevated stroma), the irregularity seen on topography is only a part of stromal irregularity.[1] Hence, a topography-guided ablation (applied to the stroma) can only correct the irregularity that has not been compensated by the epithelium, whereas the irregularity that was compensated would be left untreated. On the other hand, smoothing of the stromal surface by transepithelial phototherapeutic keratectomy (PTK)[2] will correct only the compensated irregularity, whereas the topography-detectable irregularity would be left untreated. An integration of the two treatments provided by a topography-guided transepithelial ablation technique is intended to correct both irregularities by not differentiating corneal epithelium from stroma and ablating the two as a common structure based on their similar ablation rates.

Topography-guided transepithelial ablation is performed by iVIS Suite, which is an integrated system consisting of the Precisio (Scheimpflug-based) topographer, pMetrics pupillometer, Corneal Interactive Programmed Topographic Ablation (CIPTA) planning software, and iRES excimer laser (iVIS Technologies, Taranto, Italy). Refraction, corneal anterior elevation and pachymetry map, and pupillometry, as well as the patient's pupil, iris, and scleral registration information are imported into the CIPTA software for interactive ablation design. The maximum ablation depth is adjusted by adding a lamellar component (equal depth across the ablation area) to the custom ablation plan until the depth immediately below the pathology is reached. The ablation plan is then transferred to the dual flying-spot, 0.6-mm, 250-mJ/cm$^2$ iRES laser, which delivers a maximum effective frequency of 1 KHz (2 × 500 Hz) at the corneal plane and uses a synchronized eye-tracker for x, y, and cyclotorsional tracking.

## CASE REPORT

A 37-year-old woman was treated by LASIK in 2002. The left eye, which was treated for refractive error of +1.00 −1.50 × 92° with corrected distance visual acuity (CDVA) of 20/20, was found on postoperative day 1 to have an epithelial defect, followed by DLK, which was treated by flap lift and irrigation on day 2. Epithelial ingrowth was found on postoperative day 4 and repeatedly recurred over the ensuing 6 years, despite treatment by flap re-lifts with simple mechanical epithelial removal, PTK, epithelial removal combined with alcohol, flap suturing, and fibrin glue application. The recurrent epithelial ingrowth steadily increased in size, causing visually disturbing irregular astigmatism, as well as visual disturbances that could be ascribed to scattering and decreased transparency. The patient complained of blurred vision, halos, multiple

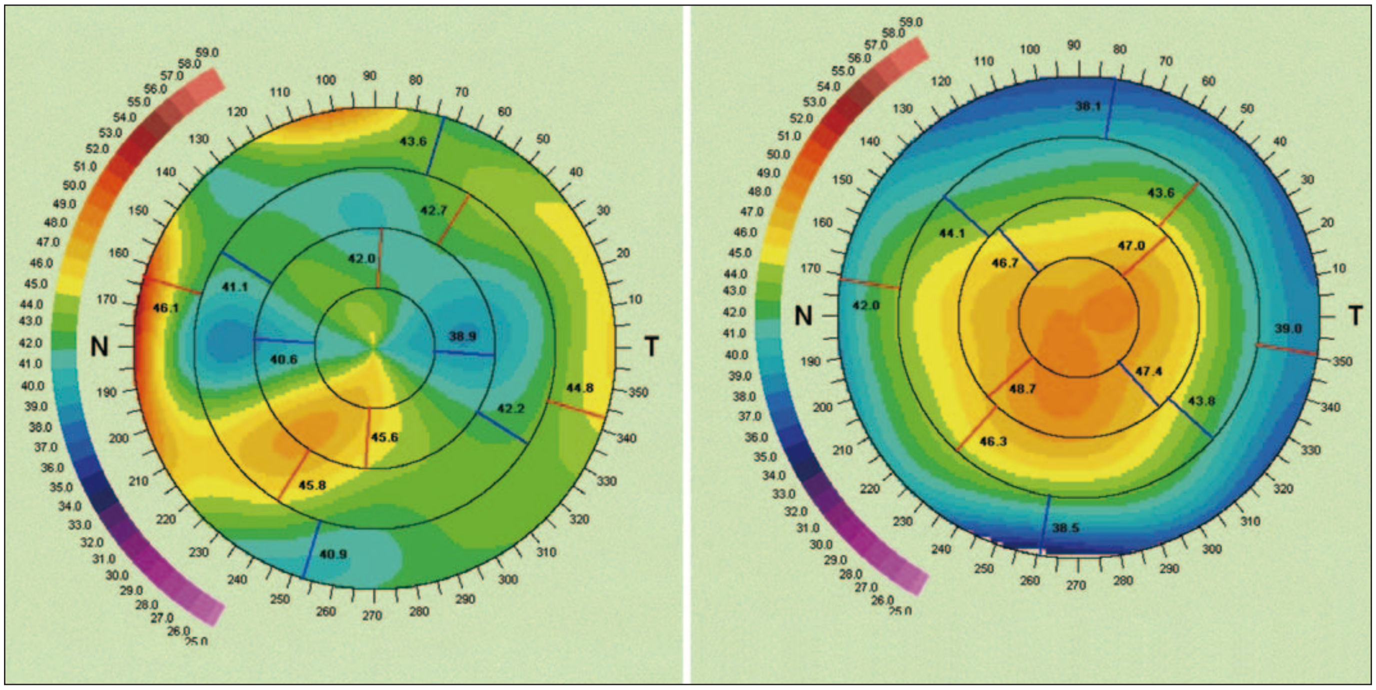


**Figure 1.** Preoperative axial map (left) shows irregular astigmatism and postoperative axial map (right) shows a regularized surface.

images, and constant foreign body sensation in the eye.

The current treatment was performed in February 2008. Preoperatively, the patient's uncorrected distance visual acuity (UDVA) and CDVA were 20/63 and 20/25, respectively. Subjective refraction was +3.50 −3.50 × 164°. Central ultrasound pachymetry (Corneo-Gage Plus, Sonogage Inc, Cleveland, Ohio) was 600 µm. Slit-lamp microscopy showed paracentral

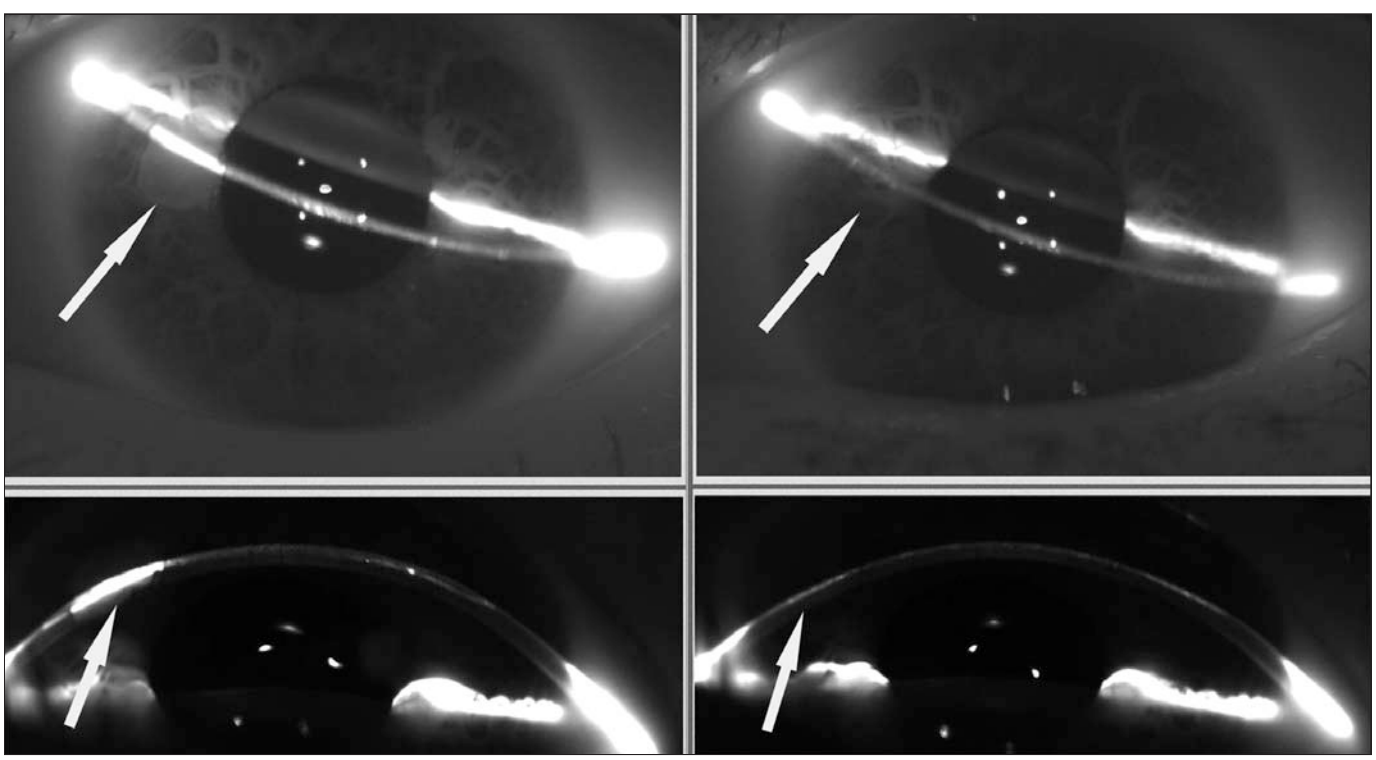

**Figure 2.** Preoperative Scheimpflug image (left) shows epithelial ingrowth (arrow) and postoperative Scheimpflug image (right) shows no epithelial ingrowth (arrow) at the same location.

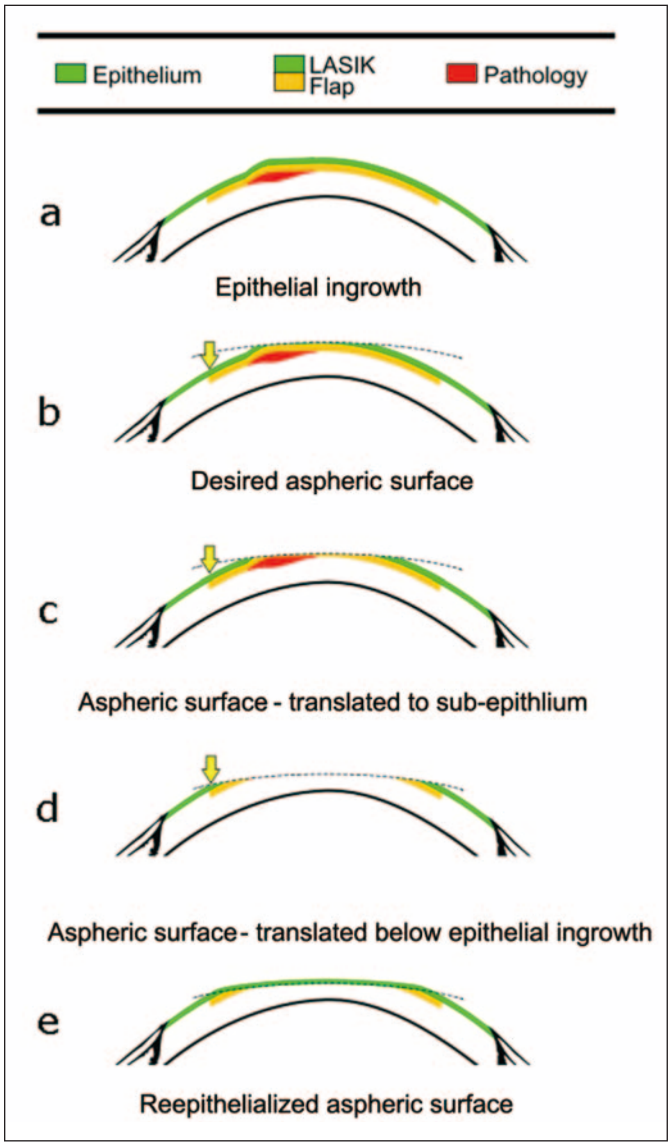


**Figure 3.** Cross-section drawing of the topography-guided transepithelial ablation technique for treatment of epithelial ingrowth.

epithelial ingrowth at the 10- and 3-o'clock positions. Axial curvature and Scheimpflug images showed irregular astigmatism and epithelial ingrowth (Figs 1 and 2 left). Wavefront aberrations were outside the measurable range of the Analyzer (WaveLight, Erlangen, Germany).

Our aim was to achieve an aberration-free surface below the epithelial ingrowth using a single ablation involving the epithelium, flap, and epithelial ingrowth (Fig 3). The postoperative target refractive was emmetropia. After the importation of the patient's Scheimpflug topography/tomography and manifest spherocylindrical refraction, the ablation planning software computed the desired regular aspheric postoperative shape with a curvature change (see Fig 3B), which compensated for the whole manifest spherocylindrical error. The ablation profile was calculated by subtraction of that shape from the actual irregular corneal shape. The ablation plan showed maximum ablation depth of 213 µm, coinciding with the position of the epithelial ingrowth, where the pachymetry measured 694 µm, leaving the minimal residual corneal thickness of 481 µm. An additional lamellar component of 100 µm was added to the ablation plan to translate our calculated aspheric shape below the epithelial ingrowth (see Fig 3D), the depth of which was estimated by visually examining the Scheimpflug images. The final maximum ablation depth was 313 µm and the final minimal residual corneal thickness was 381 µm. Hence, the flap in its entire depth within the treatment zone was ablated. A detailed surgical protocol is described elsewhere.[3]

Twelve months after treatment, slit-lamp microscopy showed a clear cornea, no scarring, and no sign of recurrent epithelial ingrowth. The patient's UDVA and CDVA were 20/25 and 20/20, respectively, and manifest refraction was $-0.50$ $-0.75 \times 85°$. Wavefront aberrometry showed total root-mean-square higher order aberration of 0.64 µm (coma 0.59 µm and spherical aberration 0.21 µm) for a 6-mm diameter. The axial curvature and Scheimpflug images of the postoperative regularized cornea are shown in Figures 1 and 2 (right). The ablation profile (Fig 4 left) was similar to the pre- and postoperative difference map (see Fig 4 right). The patient's complaints of visual disturbances resolved and she was able to go back to work after 5 years of sick leave.

## DISCUSSION

The most commonly used technique in the treatment of visually disturbing irregular astigmatism due to LASIK flap/interface complications involves re-lift of the flap and custom ablation of the stroma underneath the flap. However, if the causative pathology resides on the flap side of the interface or in the flap itself (especially if it causes scattering and/or decreased transparency), the problem will not be solved by flap re-lift and stromal ablation underneath the pathology. A similar problem may also occur if the flap re-cut technique is attempted, unless the cut is strategically placed at an exact depth above the pathology to allow its ablation. However, both re-lifts and re-cuts have been shown to increase the risk of secondary complications.[4]

Custom photorefractive keratectomy (PRK) on top of the flap is another commonly used technique to treat irregular astigmatism.[5-7] This approach saves corneal tissue, does not significantly compromise corneal biomechanical stability, and may also solve the scattering and/or transparency problems if the flap/interface pa-

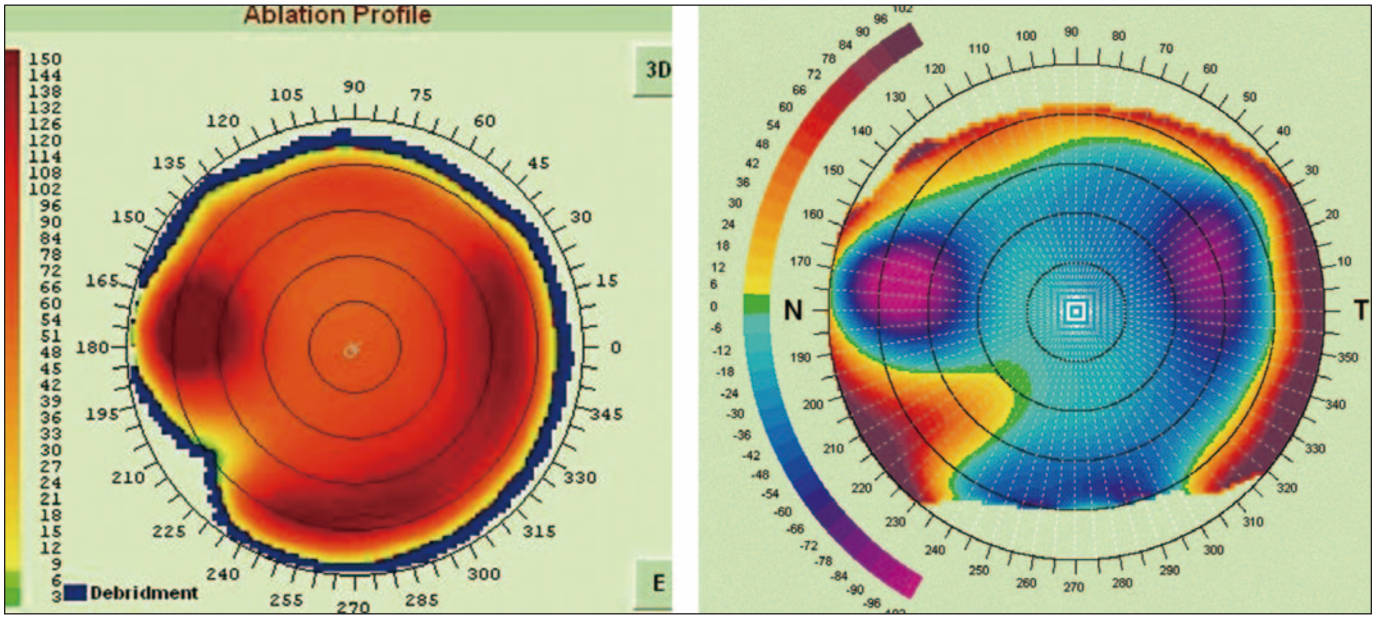


**Figure 4.** Ablation profile (left) was similar to pre- and postoperative difference map (right).

thology is included in the tissue to be ablated. However, epithelial remodeling will most likely occur in such cases,[8,9] resulting in mismatch between the epithelial and stromal morphology. If topography-guided PRK is performed after mechnical/alcohol epithelial removal, a significant ablation error may occur. The current technique, however, does not distinguish the epithelium from the stroma, allowing the topography-detected surface to be used as a true basis for custom ablation, circumventing the problem of epithelial remodeling. The epithelial removal is programmed together with stromal ablation into a single ablation plan and executed as an integral part of an uninterrupted laser treatment. Moreover, the area of the epithelial ablation fits exactly the outer edges of the stromal ablation and therefore removes only the absolutely necessary amount of epithelium, generating less trauma to the cornea and resulting in faster and less uncomfortable reepithelialization.

One important improvement of the current approach would be the use and integration of technology that will increase the accuracy of measurements of the epithelial thickness and the depth of pathology, such as the Artemis VHF scanner (ArcScan Inc, Golden, Colo).

The topography-guided transepithelial ablation technique was safe and effective in this case, and may also be applicable in other types of flap/interface complications assuming sufficient amount of residual corneal tissue.

### AUTHOR CONTRIBUTIONS

*Study concept and design (X.C., A.S.); data collection (X.C.); analysis and interpretation of data (T.A.N.); drafting of the manuscript (X.C., A.S.); critical revision of the manuscript (X.C., T.A.N.); administrative, technical, or material support (X.C.); supervision (A.S.)*

### REFERENCES


1. Reinstein DZ, Silverman RH, Sutton HF, Coleman DJ. Very high-frequency ultrasound corneal analysis identifies anatomic correlates of optical complications of lamellar refractive surgery: anatomic diagnosis in lamellar surgery. *Ophthalmology*. 1999;106:474-482.
2. Ashrafzadeh A, Steinert RF. Results of phototherapeutic keratectomy in the management of flap striae after LASIK before and after developing a standardized protocol: long-term follow-up of an expanded patient population. *Ophthalmology*. 2007;114:1118-1123.
3. Stojanovic A, Jankov MR. Treatment of irregular astigmatism: developing an ideal corneal surface with the iVIS suite. In: Wang M, ed. *Irregular Astigmatism: Diagnosis and Treatment*. Thorofare, NJ: SLACK Incorporated; 2008:211-218.
4. Sharma N, Ghate D, Agarwal T, Vajpayee RB. Refractive outcomes of laser in situ keratomileusis after flap complications. *J Cataract Refract Surg.* 2005;31:1334-1337.
5. Shaikh NM, Wee CE, Kaufman SC. The safety and efficacy of photorefractive keratectomy after laser in situ keratomileusis. *J Refract Surg.* 2005;21:353-358.
6. Utz VM, Krueger RR. Management of irregular astigmatism following rotationally disoriented free cap after LASIK. *J Refract Surg.* 2008;24:383-391.
7. Weisenthal RW, Salz J, Sugar A, Mandelberg A, Furlong M, Bagan S, Kandleman S. Photorefractive keratectomy for treatment of flap complications in laser in situ keratomileusis. *Cornea.* 2003;22:399-404.
8. Huang D, Tang M, Shekhar R. Mathematical model of corneal surface smoothing after laser refractive surgery. *Am J Ophthalmol.* 2003;135:267-278.
9. Smirennaia E, Sheludchenko V, Kourenkova N, Kashnikova O. Management of corneal epithelial defects following laser in situ keratomileusis. *J Refract Surg.* 2001;17:S196-S199.

AUTHOR QUERIES

The Abstract Purpose and Methods were edited per Dr Waring. Okay as written?

Please clarify figure 4 caption and text as it indicates the right image is of pre- and postoperative difference map but only one image is shown.

In Case Report, please clarify **followed by DLK** and advise meaning of DLK. “The left eye, which was treated for refractive error of +1.00 −1.50 × 92° with corrected distance visual acuity (CDVA) of 20/20, was found on postoperative day 1 to have an epithelial defect, **followed by DLK**, which was treated by flap lift and irrigation on day 2.”

Second paragraph of Case Report, please advise the model of the Analyzer. Is it ALLEGRETTO?

Please indicate the different views in figure 2 caption.