

Topography-guided neutralization technique for the management of flap complication in laser *in situ* keratomileusis

Rohit Shetty, Rushad Shroff, Tushar Grover, T Roshan, Chaitra Jayadev

A 29-year-old male was referred following a flap loss after the creation of a thin, irregular flap with a visual acuity of logMAR 0.1 with -2.0 DS- 2.75 DC $\times 175^\circ$. Corneal topography and anterior segment optical coherence tomography revealed an irregular corneal curvature and epithelial profile. Phototherapeutic keratectomy (PTK) followed by Topography - Guided Custom Ablation Treatment (TCAT), as a modification of the topographic neutralization technique protocol, was planned to regularize the corneal surface and treat the residual refractive error. Postoperatively, the patient showed a best-corrected visual acuity of logMAR 0 with a refractive error of -1 DC $\times 90^\circ$. Regularization of topography and epithelial thickness was seen along with a reduction in astigmatism and higher order aberrations. We report the use of PTK followed by TCAT as a novel method to treat a case of intraoperative flap loss during laser *in situ* keratomileusis.

Key words: Flap loss, laser *in situ* keratomileusis, TCAT

Laser *in situ* keratomileusis (LASIK) is the most popular surgical procedure for the correction of myopia, hyperopia, and astigmatism.^[1] Using a lamellar flap, LASIK provides faster visual recovery and comparatively less pain than photorefractive keratectomy. Although flap-related complications such as partial flap, thin/irregular flap, buttonholing, and free cap are uncommon with an incidence ranging from 0.3% to 10%, they can adversely affect outcomes.^[1,2] Flap loss is potentially devastating and can lead to haze formation and irregular epithelial growth. The accompanying irregular astigmatism is difficult to manage and leads to poor visual acuity and quality. Topography - Guided Custom Ablation Treatment (TCAT) has been used to correct irregular astigmatism in highly aberrated and irregular corneas associated with keratoconus and post-LASIK ectasia.^[3] The use of topography-guided treatment in the management

of irregular astigmatism associated with flap loss has not been described in literature so far. In this case report, we describe the use of TCAT as a secondary procedure to improve refractive outcomes after intraoperative flap loss.

Case Report

A 29-year-old male was referred to us with complaints of diminution of vision in the right eye for the past 4 months after having undergone LASIK with a 90 μ Moria-microkeratome head (Moria, Antony, France). While the surgery in the left eye had been uneventful, there was a flap loss in the right eye. Excimer laser ablation had not been performed, and a bandage contact lens placed until the epithelium healed before the referral.

On presentation, his uncorrected distance visual acuity was 1.0 logMAR in the right eye and 0 logMAR in the left eye. Manifest refraction in the right eye was -2.0 DS- 2.75 DC $\times 175^\circ$ with a corrected distance visual acuity (CDVA) of 0.1 logMAR. Anterior segment optical coherence tomography (ASOCT, Optovue, Inc., USA) showed an irregular epithelial thickness profile on epithelium thickness mapping and hyperreflectivity in the area of flap loss [Fig. 1a]. On Pentacam HR (Oculus Optikgerate GmbH, Wetzlar, Germany), the right eye showed irregular corneal topography on the axial curvature map [Fig. 2a]. On iTrace (Tracey Technologies, USA) aberrometry, there was increased astigmatism along with increased higher order aberrations in the right eye [Fig. 3a and c].

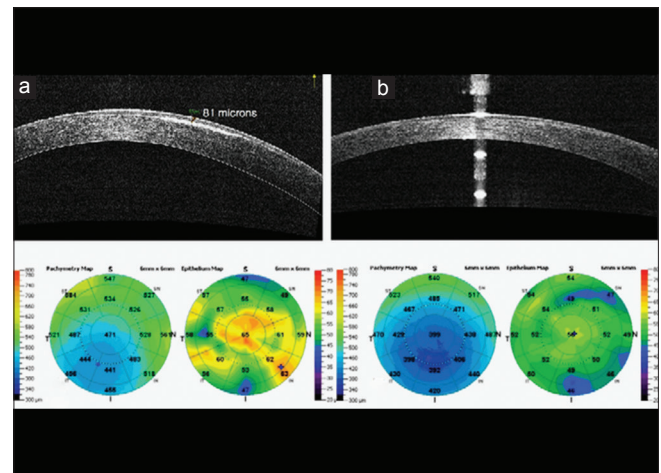


Figure 1: (a) Anterior segment optical coherence tomography (Optovue, Inc., USA) reveals a hyperreflective zone in the area of flap loss, 81 μ from the epithelial surface, (b) regularization of the epithelial surface 6 months postoperatively, along with disappearance of hyperreflective layer

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A topography-guided treatment for regularization of corneal topography was planned to correct the refractive error using the topographic neutralization technique (TNT) protocol.^[4] Corneal topography data were obtained from the Placido-based Allegretto Topolyzer. Phototherapeutic keratectomy (PTK) was chosen as the procedure of choice to remove the corneal epithelium before the topography-guided

treatment.^[4] Topography-guided excimer ablation was performed with the EX500 WaveLight (Alcon Inc., Fort Worth, Texas, USA). A refractive correction of -3.25 DS and -2.75 DC $\times 70^\circ$ was entered into the machine as the target to regularize the cornea and treat the residual refractive error as per our modification of the TNT protocol. The patient was followed up closely after the procedure. One week later, the patient

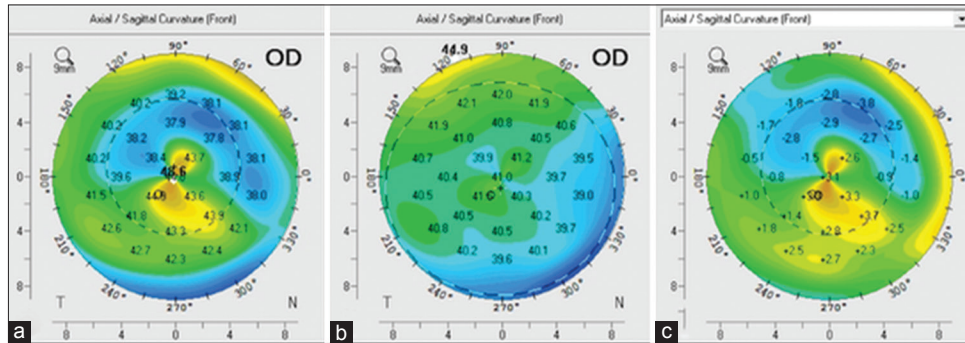


Figure 2: (a) Pentacam axial curvature map shows irregular corneal topography, (b) 6 months postoperative axial curvature map reveals regularization of the corneal topography, (c) difference map between preoperative and 6 months postoperative axial curvature maps

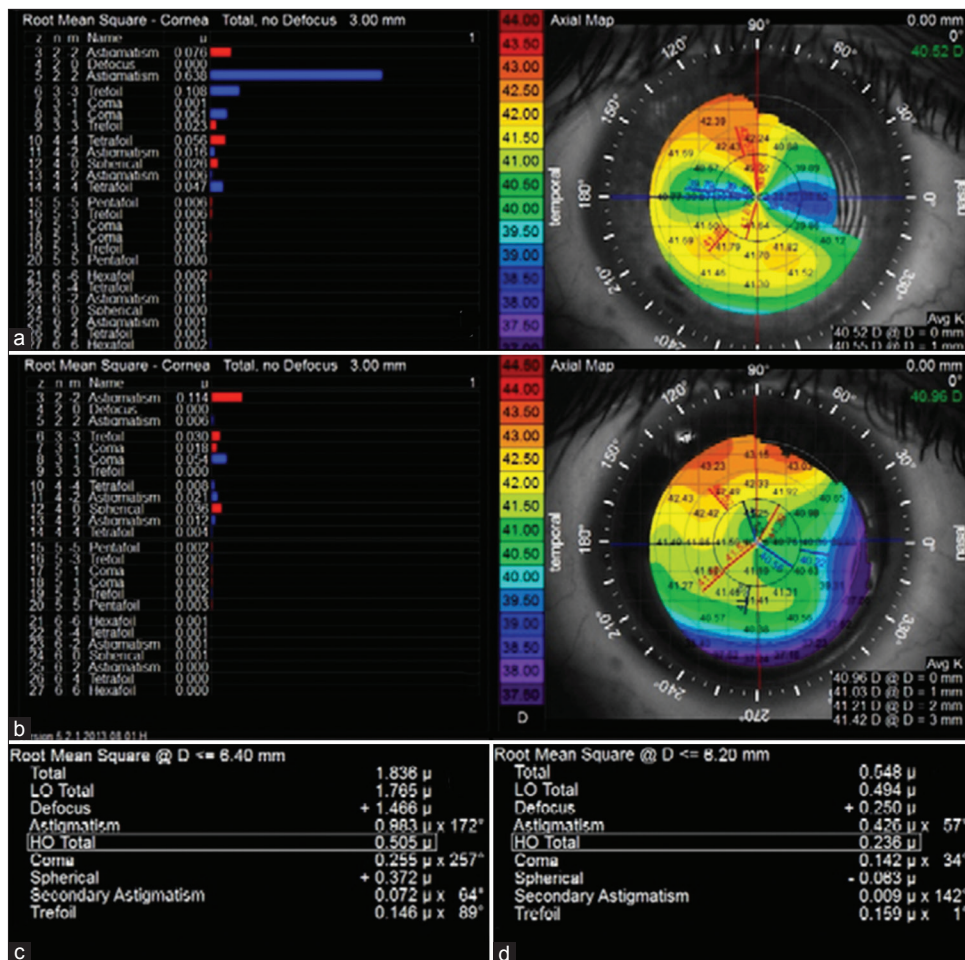


Figure 3: (a) Preoperative root mean square values on Chang analysis in iTrace show increased astigmatism and higher order aberrations, (b) 6 months postoperative root mean square values on Chang analysis in iTrace. Reduction in astigmatism and in higher order aberrations can be seen along with regularization of the corneal topography on axial curvature map, (c) preoperative total root mean square values in iTrace show increased astigmatism and higher order aberrations, (d) 6 months postoperative total root mean square values in iTrace show reduction in astigmatism and higher order aberrations

reported improvement in vision and the CDVA was logMAR 0 with 1.25 DC \times 105°. Six months following the procedure, the patient had a CDVA of logMAR 0 with -1 DC \times 90°. Tomography, epithelial profiling, and aberrometry were performed 6 months after the procedure. Epithelial mapping revealed a regular epithelial profile with disappearance of the subepithelial hyperreflective layer [Fig. 1b]. Pentacam showed regularization of the corneal topography [Fig. 2b and c]. iTrace revealed a reduction in astigmatism and higher order aberrations [Fig. 3b and d].

Discussion

Although LASIK is a safe and effective procedure for refractive correction, it is not completely free from complications with flap-related ones being the most dreaded. These are more common with microkeratomes as compared to femtosecond laser-assisted surgery.^[5] Although flap displacement has been reported frequently,^[6,7] flap loss is relatively rare and seen following trauma^[8] or accidental self-removal.^[9] It is prudent not to go ahead with ablation in such cases and wait for the epithelium to heal. However, the healed epithelium and underlying stroma are often irregular with an altered epithelial profile and topography. Due to the ensuing irregular astigmatism, management of flap loss is a great challenge. Methods that have been tried with varying degrees of success include PTK with sodium hyaluronate, a masking agent used to fill the irregularities and provide a smoother surface for ablation and wavefront-guided treatment, though it fares poorly in highly aberrated corneas.^[10,11] Topography-guided treatment of irregular astigmatism has been found to be fairly accurate even in highly irregular corneas.^[11] Hence, we opted for a topography-guided treatment to treat the refractive error and regularize the corneal topography in our patient.

A single-step or two-step approach can be planned in the management of such cases. In the latter, an initial topography regularization is followed by a refractive correction.^[12] Since our patient was not willing for a two-step surgical plan, a single-sitting procedure, as a modification of Dr. Lin's TNT protocol was scheduled. First, the cornea was imaged to assess for regularity. As the epithelial profile of this patient was highly irregular, a decision was taken to proceed with PTK for epithelial removal. Ablation depth using a "minimal" thickness of the epithelium on ASOCT was calculated and was set as 50 μ in our case.

Topography-guided treatment was planned to regularize this patient's cornea and provide appropriate refractive correction. In irregular corneas such as in this case, Zernike-based customization is done for treatment planning. First, the refractive correction as per the patients' manifest refraction was entered in the T-CAT software, along with the corneal pachymetry, following which we studied the change in the ablation profile after reducing the modified sphere and cylinder to zero. Subsequently, the defocus (C4) and spherical aberration (C12) were looked at and compensated for each other by changing the modified refraction, to get a final target refraction of -3.25 DS and -2.75 DC \times 70°, which is a combination of the subjective refraction and the induced change by corneal regularization.^[4] Following treatment, both the topography and epithelial profile were found to be

regular. Visual acuity and ocular aberrations also showed marked improvement, and a satisfactory refractive outcome was obtained.

Topography-guided ablation has been successfully used to treat irregular astigmatism due to trauma, keratoconus, and ectasia following LASIK.^[11-13] However, its use in irregular astigmatism due to flap-related complications has not been described so far. In our patient, TCAT was found to be effective in regularizing the epithelial profile and topography as well as treating irregular astigmatism and ocular aberrations which occurred secondary to flap loss. Further studies with a larger case series are required to validate the use of the TNT protocol for treating irregular corneas.

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Conflicts of interest

There are no conflicts of interest.

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