TECHNIQUES

Two-step procedure to enlarge small optical zones after photorefractive keratectomy for high myopia

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We describe a method for the visual rehabilitation of patients with small optical zones and related complaints after photorefractive keratectomy (PRK) and laser in situ keratomileusis for high myopia. In many of these cases from the early 1990s, low central corneal thickness in combination with residual myopia did not allow for enlargement of the small optical zone by a topography-guided treatment in the first instance. We therefore perform, as a first step, a clear lens exchange aiming at hyperopia. This enables us to perform, as a second step, a topography-guided customized PRK with marked enlargement of the optical zone. Such 2-step procedures may be of great benefit to patients with small optical zones and low central corneal thickness.

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In the early and mid 1990s, photorefractive keratectomy (PRK) for myopia of more than −7.0 diopters (D) sphere was a frequently performed procedure.[1] By that time, relatively little was known about corneal wound healing and the procedures often led to corneal scarring, decentered ablations, regression, and, in the case of excessive surface ablation, to iatrogenic central keratectasia.[2,3] Even if none of these complications occurred, the treatment was associated with small optical zones with resulting halos and glare under mesopic conditions and in some cases, monocular diplopia.[4,5] Many of these former refractive patients are seeking help from recently developed techniques such as customized ablations.[6] However, many have residual myopia combined with critically low central corneal thickness. Here, a primary topography-guided treatment to enlarge the optical zone is obsolete because of distinct keratectasia risk (Figure 1).[2,3] We have, therefore, developed a 2-step procedure for the treatment of such cases. In the first step, a clear lens exchange shifts the patient to hyperopia. After this procedure, calculation of a topography-based ablation profile now shows that ablation in the center of the cornea is minimal (Figure 2), thus enabling the second step of customized topography-guided treatment (Figure 3). In the past 2 years, we have used this technique in a total of 5 patients. Here, the procedure is described in the case of a 41-year-old man.

SURGICAL TECHNIQUE

The patient was examined in October 2003. He had a history of PRK in 1996 for −9.0 D sphere in both eyes. Uncorrected visual acuity (UCVA) was 0.5 in the right eye and 0.7 in the left eye. Best spectacle-corrected visual acuity (BSCVA) was 0.8 in both eyes with −1.0 D sphere. Corneal topographies (axial representation) showed bilateral small optical zones of approximately 2 mm (right eye, Figure 3, *A*) and central corneal thicknesses of 280 μm in the right eye and 270 μm in the left eye. He reported massive glare and halos under mesopic conditions (pupil size ≥5.0 mm), especially in the right eye.

Symptoms were more pronounced in the right eye, so the decision was made to treat this eye first until the patient's symptoms markedly improved. Central corneal pachymetry was 280 μm and prohibited further central ablation.

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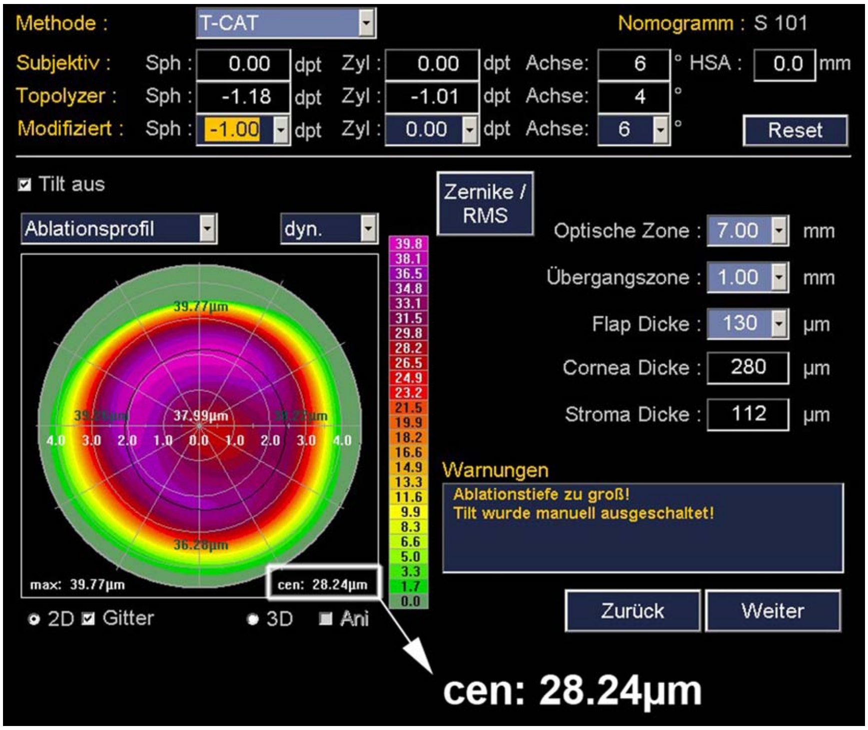

Figure 1. Ablation profile approximated by Zernike polynomials based on topographies taken before any procedure. Enlargement of the optical zone cannot be performed because residual central corneal thickness would be dangerously low.

Enlarging the optical zone even refractively neutral would require a central (phototherapeutic keratectomy) ablation, further thinning the cornea centrally (Figure 1). Based on corneal topography, the ablation pattern (T-Cat software, Wavelight Technologies) for expanding the optical zone to a diameter of 5 mm to 6 mm was calculated. Then, the spherical part of the ablation was optimized so that the central keratectomy depth was zero, which happened at a spherical

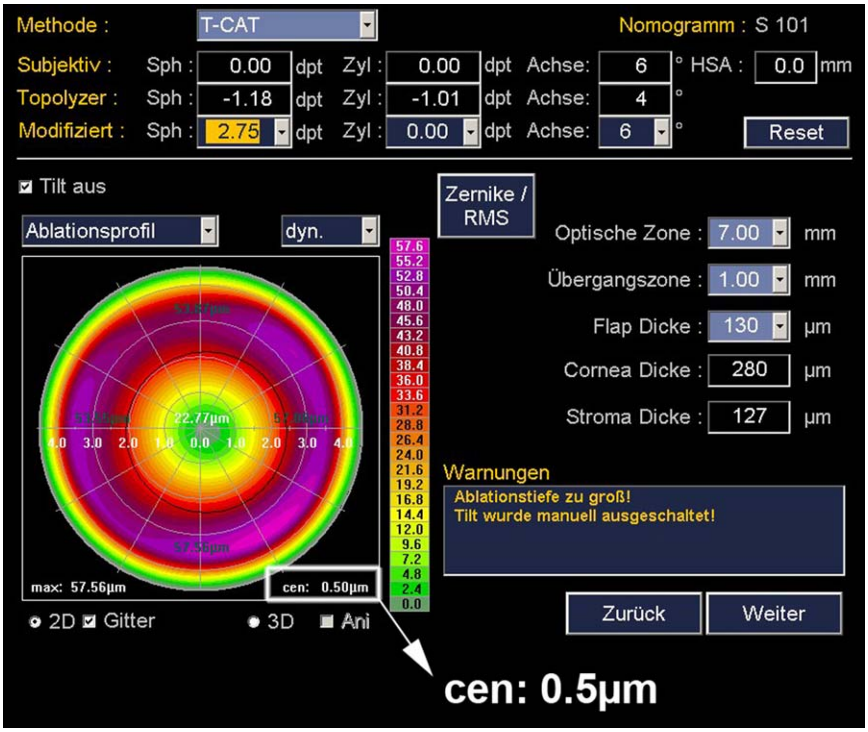

Figure 2. Ablation profile approximated by Zernike polynomials based on topographies taken after a clear lens exchange (same patient as in Figure 1). Now, the ablation profile focuses on the peripheral cornea, whereas central corneal thickness remains unchanged.

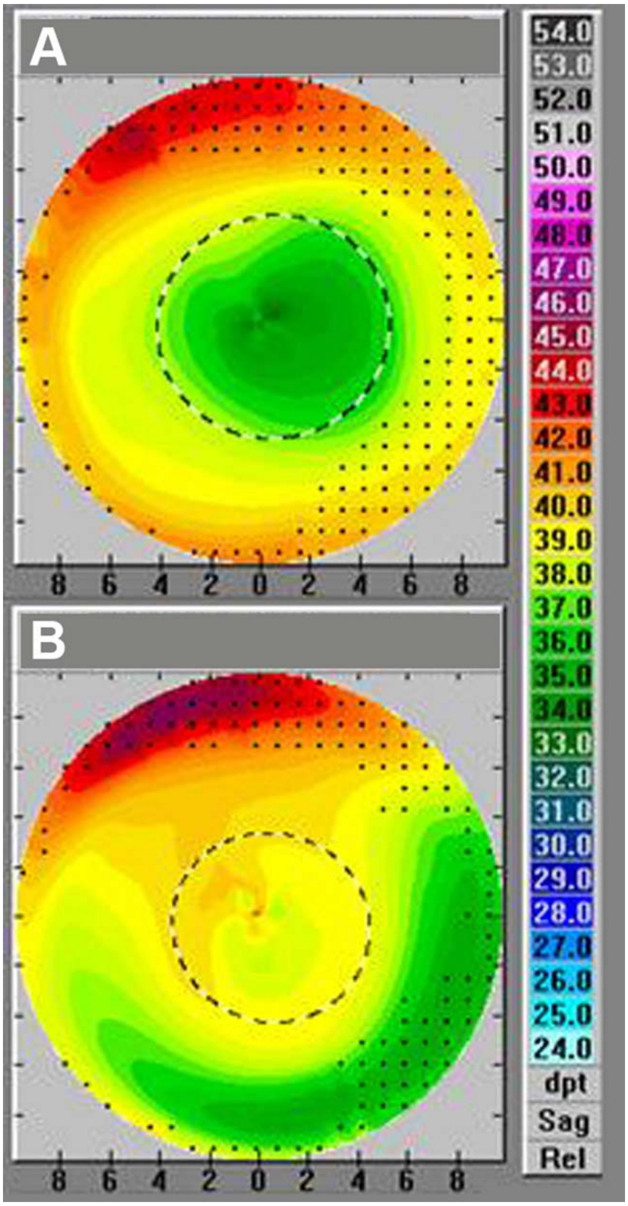

Figure 3. Topographies (axial representation) taken before (*A*) and 3 months after (*B*) the 2-step procedure. A significant enlargement of the optical zone from 2 mm to 5 mm to 6 mm was achieved despite low central corneal thickness.

correction of +2.0 D. Therefore, a clear lens exchange was performed in this prepresbyopic patient with intended hyperopia of +2.0 D. Inclusion criteria for the clear lens exchange in this patient were age (prepresbyopic) and the absence of stromal scars as a complication of the former surface ablation. The Haigis formula was used for calculation of the refractive power of the intraocular lens (IOL)[7]; an AcrySof (Alcon) IOL was used. Two months after the first procedure, UCVA was 0.4 and BSCVA was 0.8 with +2.75 D sphere. Again, ablation profiles were calculated now leaving the central cornea unaltered (Figure 2). Six months later, PRK was performed for correction of hyperopia and the optical zone was enlarged. Three months later, the UCVA was 0.8. Zernike analysis of the preoperative and postoperative corneal topographies revealed virtually identical coma-like aberrations; however, there was an improvement in spherical aberrations by a factor of 2.7, and accordingly, halos and glare were massively reduced. The optical zone was distinctly enlarged from 2 mm before the 2-step procedure to 5 mm to 6 mm (Figure 3, *A* and *B*).

DISCUSSION

Topography-guided customized PRK has been repeatedly used for the enlargement of small optical zones after initial PRK for high myopia.[6] However, small optical zones with low residual corneal thicknesses were a frequently encountered entity after PRK for high myopia performed in the early and mid 1990s.[1] Here, the risk for induction of postoperative keratectasia[3,8] often prohibits further central ablation or does not allow for full spherical correction. This dilemma may be solved by first performing a clear lens exchange, thus shifting the patient to hyperopia. The second step in visual rehabilitation is a customized topography-guided PRK treatment for hyperopia, ablating the peripheral cornea where sufficient corneal thickness is still present. In this way, enlargement of the optical zone up to 7 mm in diameter is possible. Such 2-step procedures may be of general benefit in the visual rehabilitation of presbyopic patients with small optical zones in the absence of corneal scars after PRK for high myopia.

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