Case study: Custom LASIK used to treat irregular cornea after radial keratotomy

The procedure corrected hyperopic astigmatism created by hyperopic shift after 10-year-old refractive surgery.

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Special to OCULAR SURGERY NEWS

Wavefront-guided laser vision correction has opened up the possibility of improving irregular corneal optics caused by previous refractive surgery. The advent of Fourier-based wavefront reconstruction has refined the capacity for wavefront surgery to define, and therefore treat, complex optical distortions. A particularly challenging arena for wavefront surgery is presented in the cornea after RK surgery. RK produces a highly oblate cornea characterized by a paracentral knee with multifocal central flattening. This case shows how VISX CustomVue hyperopic Fourier-based wavefront surgery corrected hyperopic astigmatism created by hyperopic shift after RK surgery with both a high degree of accuracy and stability.

History

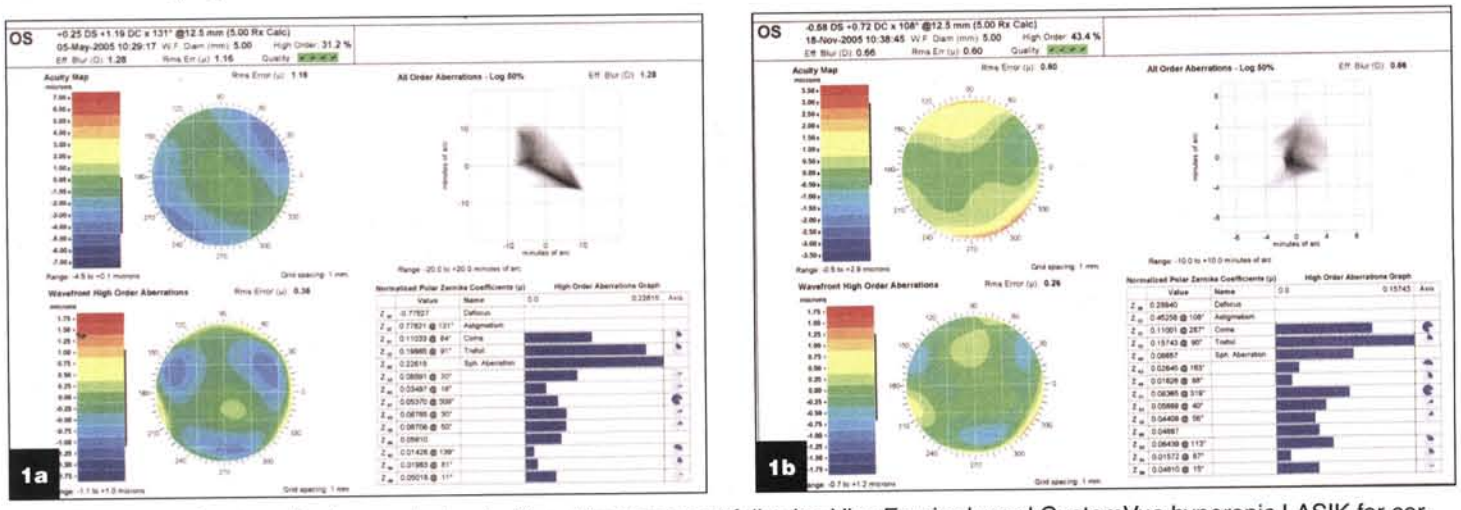
A 64-year-old woman had undergone RK surgery 10 years earlier to correct a preoperative refractive error of –3.00 sphere = 20/20 in her right eye and –4.25 sphere = 20/20 in her left eye. Eight incisions were used with a 4.5-mm clear zone in both eyes for a monovision goal, with the right eye set for distance. By 6 months after RK, the residual refractive error was –0.50 +0.50 × 45 = 20/20 in her right eye and –1.75 +0.50 × 160 = 20/20 (monovision) in her left eye.

The patient presented 10 years after her RK with complaints of decreased distance and near vision. Uncorrected visual acuity was 20/60+2 in her right eye and 20/40–2 in her left eye (monovision eye). Near vision was J7 in her left eye. Manifest refraction was +1.50 +0.75 × 20 = 20/20–2 in her right eye and +0.25 +1.25 × 135 = 20/20–2 in her left eye . Fourier-based WaveScan wavefront analysis revealed a higher-order aberrations root mean square value of 0.52 µm (5.75-mm pupil) in her right eye and a root mean square value of 0.36 µm (5-mm pupil) in her left eye (Figure 1a-b). Pre-LASIK corneal topography revealed a surface regularity index of 1.49 in her right eye and 0.84 in her left eye on the Tomey TMS-1 topography system (Figure 2a-d).

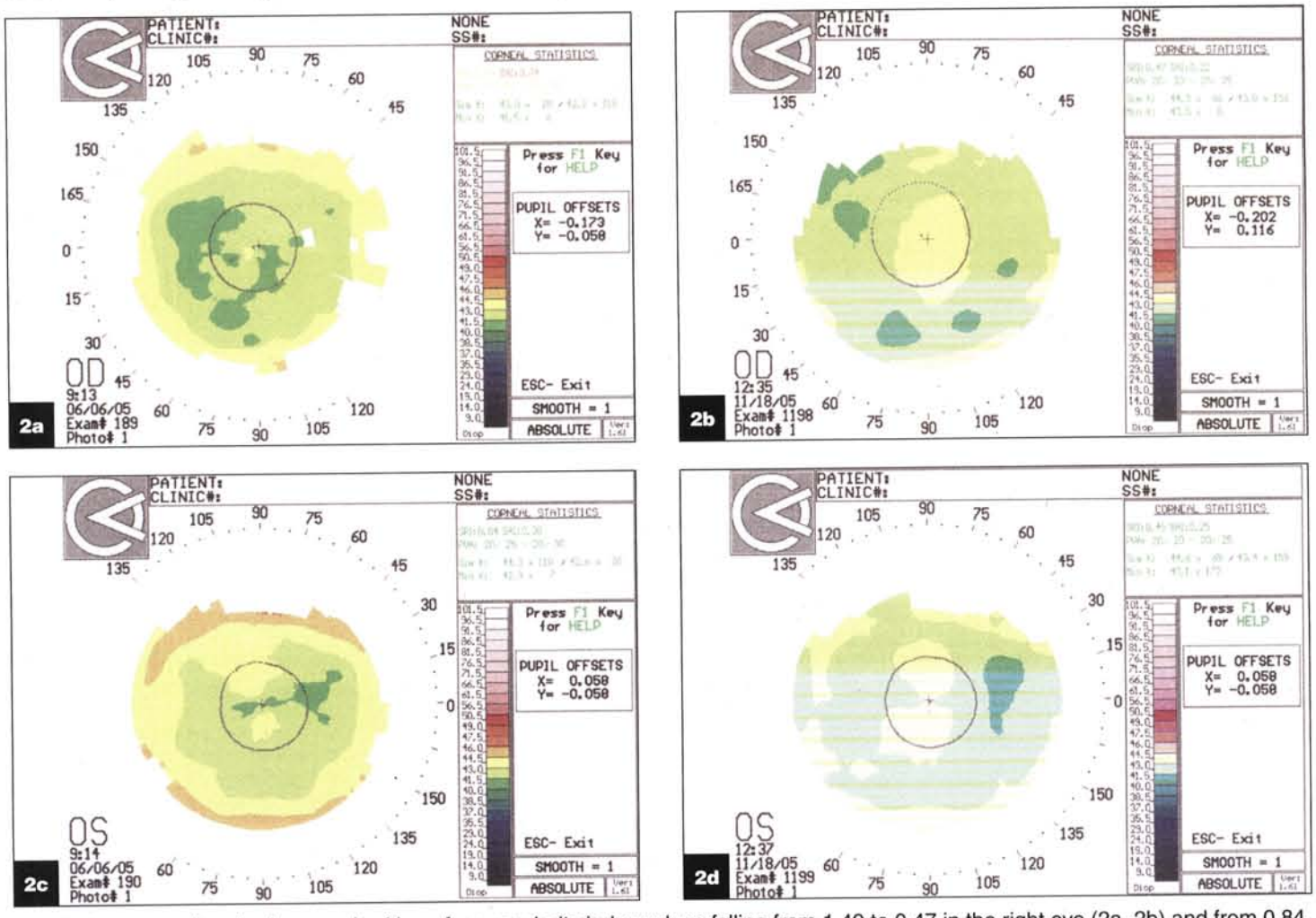
The patient underwent Fourier-based hyperopic wavefront LASIK using the VISX CustomVue system and the Hansatome microkeratome with a 160 µm head and a 9.5-mm intended flap diameter. A monovision goal was again established with the right eye for distance. The physician adjustment feature was used on the left eye to create an offset of +0.75 D.

By the first day after surgery, the uncorrected visual acuity had improved to 20/20–2 in her right eye and 20/25–2 in her left eye (monovision eye). Near vision was J6 in her right eye and J4 in her left eye. By 1 month after Fourier-based wavefront LASIK, uncorrected acuity was 20/20 in her right eye and 20/30 in her left eye. Uncorrected near vision was J10 in her right eye and J1 in her left eye. The residual refractive error was –0.25 + 0.50 × 22 = 20/15+1 in her right eye and –1.00 +0.50 × 90 = 20/15 in her left eye.

At 5.5 months after LASIK, her vision remained quite stable. Her uncorrected visual acuity was 20/20–2 in her right eye and 20/30+2 in her left eye. Uncorrected near vision was J4 in her right eye and J1 in her left eye. Manifest refraction was –0.25 +0.50 × 15 = 20/15–1 in her right eye and –1.00 +0.50 × 120 = 20/15–3 in her left. Fourier-based WaveScan analysis showed a dramatic improvement of RMS to 0.27 µm in her right eye with a 5.75-mm pupil and to 0.26 µm in her left eye with a 5-mm pupil (Figure 1). Post-LASIK topography taken at this time showed an improvement of surface regularity index to 0.47 in her right eye and 0.45 in her left eye (Figure 2). The patient was extremely happy with the results of her surgery, citing dramatically improved vision and visual quality.



WaveScan wavefront analysis revealed a significant improvement following Visx Fourier-based CustomVue hyperopic LASIK for correction of consecutive hyperopia produced by RK surgery. Note how root mean square scores fell from 0.36 µm to 0.26 µm (5-mm pupil) in the left eye. *Images: Shapiro D*



Corneal topography also improved, with surface regularity index values falling from 1.49 to 0.47 in the right eye (2a, 2b) and from 0.84 to 0.45 in the left eye (2c, 2d).

Discussion

The cornea after RK presents a particular challenge to wavefront laser vision correction due to its complex geometry, which is characterized by a paracentral knee with central multifocal flattening. Centration, which was manually performed, is often imperfect as well. Wavefront-guided surgery until recently has employed Zernicke polynomials to reconstruct the aberration pattern. Typically, Zernicke-based wavefront laser systems have been able to treat only to the fourth order Zernicke polynomials. Treating to the fourth order creates a mathematical "smoothing" effect with loss of intricate detail. By stacking sine waves, the CustomVue Fourier-based system allows a more detailed reconstruction of the wavefront aberration map, equivalent in detail to working beyond the 20th order Zernicke polynomials. BSM

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