Anterior Segment Optical Coherence Tomography Imaging of Central Toxic Keratopathy

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ABSTRACT
The authors report anterior segment optical coherence tomography (OCT) imaging findings in a case of central toxic keratopathy following laser in situ keratomileusis (LASIK) surgery for low hyperopia. OCT imaging 1 month after surgery demonstrates that the flap thickness is maintained and the location of stromal tissue loss is just posterior to the flap in the stromal bed in the affected area. This corresponds to the clinical observation of interface opacity extending posteriorly into the stroma as first described by Sonmez and Maloney in their initial description of the syndrome. Follow-up OCT imaging 3 months later revealed interval decrease in stromal thinning. The etiology of this syndrome is unknown.

INTRODUCTION
Central toxic keratopathy is a recently described syndrome of acute vision loss following laser in situ keratomileusis (LASIK) or photorefractive keratectomy (PRK). The syndrome has been best characterized by Sonmez and Maloney, who have labeled the syndrome as central toxic keratopathy. They described 23 cases of central interface opacification extending posteriorly into the stromal bed. Associated striae, corneal thinning, and hyperopic shift were characteristic findings. The syndrome was often preceded by diffuse lamellar keratitis. The authors believed that the infiltrates were non-inflammatory in nature, and resolution occurred without treatment over the course of 2 to 18 months. Enhancement surgery was performed after resolution without recurrence in all cases. The etiology of the condition is unknown. The authors proposed an etiology of keratocyte apoptosis with possible enzymatic degradation of the stromal matrix due to unknown inciting factors.

We report a case of central toxic keratopathy including anterior segment optical coherence tomography (OCT) imaging that has not been previously documented in the literature.

CASE REPORT
A 46-year-old woman was seen in consultation 28 days after receiving simultaneous uncomplicated bilateral LASIK surgery with mechanical keratome for the correction of low hyperopia (+1.00 in the right eye, +1.00 +0.50 x 70 in the left eye). On postoperative day 1, she developed a mild diffuse lamellar keratitis in the right eye, for which she had received topical steroid treatment. She complained of severe blurred vision and photophobia in her right eye. On examination, she was noted to have an unaided visual acuity of 20/200 in the right eye and 20/20 in the left eye. Manifest refraction of the right eye was +7.75 +1.00 at axis 160, with a visual acuity of 20/30. Refraction of the left eye was -0.50 sphere, yielding a visual acuity of 20/20. Slit-lamp examination of the right eye revealed interface haze with multi-direc-
tional striae with a mud crack appearance centrally (Fig. 1A). Associated thinning was noted in this area. Corneal topography (Keratron; OPTIKON, Rome, Italy) demonstrated central flattening of the right eye (Fig. 2A) and central steepening of the left eye. Anterior segment OCT imaging revealed stromal thinning with stromal loss posterior to the flap in the affected area (Fig. 3A) (Visante OCT; Carl Zeiss Meditec, Inc., Dublin, CA).

The patient was seen in follow-up 3 months later. Her unaided visual acuity was 20/100 in the right eye, with a best-corrected visual acuity of 20/25 with a rigid gas permeable lens. Manifest refraction of the right eye was +3.25 +1.25 at axis 165, yielding an acuity of 20/25. On slit-lamp examination, the right eye demonstrated only mild resolving central haze (Fig. 1B). Corneal topography demonstrated interval decrease in central flattening (Fig. 2B). Anterior segment OCT imaging revealed interval decrease in stromal thinning of the affected area (Fig. 3B).

DISCUSSION
The clinical findings in our case of central interface opacity with multidirectional striae, stromal thinning, and hyperopic shift, with preceding diffuse lamellar ker-
Receptor systems such as the Fas/Fas-ligand system. Apoptosis is likely mediated by more specific cytokine-modulation of keratocyte apoptosis. This control of platelet activating factor inflammation is most consistent with an apoptotic process confined to the ablated area, which results in entity as a process involving a non-inflammatory opacification confined to the involved area of the temporal cornea show the flap thickness is maintained in the involved nasal cornea (yellow arrows). This localizes the tissue loss to just posterior to the flap in the residual stromal bed (red arrows). This corresponds to the clinical observation of the interface opacity extending posteriorly into the stroma as reported by Sonmez and Maloney. This follow-up scan showing interval decrease in stromal thinning.

Our case represents the first reported anterior segment OCT imaging of central toxic keratopathy. The imaging findings show that the flap was relatively unaffected, and the area of tissue loss is located just posterior to the flap in the stromal bed in the affected area with resultant stromal thinning. Follow-up scan showed interval decrease in the stromal thinning. These OCT findings support the clinical observations of central interface opacity extending posteriorly into the stroma as reported by Sonmez and Maloney.

The underlying etiology of this condition remains unclear. Prior reports cited above best support this entity as a process involving a non-inflammatory opacification confined to the ablated area, which results in stromal tissue loss of the affected area. The lack of inflammation is most consistent with an apoptotic process rather than tissue necrosis as previously hypothesized.

Interleukin-1, tumor necrosis factor-alpha, and platelet activating factor have been implicated in modulation of keratocyte apoptosis. This control of apoptosis is likely mediated by more specific cytokine-receptor systems such as the Fas/Fas-ligand system. It has been shown that a lamellar cut across the cornea triggers keratocyte apoptosis anteriorly and posteriorly from the flap across the entire cut surface of the cornea. This syndrome could represent an aberrant augmentation of the normal apoptotic response in certain individuals. It could also represent an abnormal hypersensitivity in select individuals to substances such as mediators in the tear film, which some studies suggest can trigger keratocyte apoptosis. This syndrome could also represent a reaction to a photo-activated toxin, as previously proposed by Sonmez and Maloney.

Doxycycline has been shown to decrease expression of IL-1 and TNF-alpha, but no investigation has assessed its effect on keratocyte apoptosis. Decreased keratocyte apoptosis has been observed with topical vitamin E application immediately after photorefractive keratectomy. As of yet, there has been no successful pharmacologic inhibition of keratocyte apoptosis demonstrated in patients, although future development of such an agent could potentially be used early in cases of central toxic keratopathy.

REFERENCES