techniques to treat ametropias, we must not let our enthusiasm cloud clear vision of the goal: visual function equal to or better than that achieved with spectacles and contact lenses. Second, we must fulfill our obligation to communicate honestly and thoroughly with patients so they have realistic expectations about postoperative use of spectacles and postoperative quality of vision using current techniques.

REFERENCES


Steep Central Islands: Have We Finally Figured Them Out?

Ronald R. Krueger, MD

O f all the potential complications associated with excimer laser photorefractive keratectomy (PRK) and laser in situ keratomileusis (LASIK), steep central islands demonstrated on videokeratography are perhaps the most frustrating. These corneal anomalies are typically evidenced topographically as islands of red, yellow, and green amid a sea of blue, and tend to be associated with loss of spectacle-corrected visual acuity and image ghosting. Curiously, they have not been restricted to these procedures, but also occur after automated lamellar keratoplasty (ALK). "What are these islands?" and "How do they get there?" They seem to appear almost immediately following PRK, with the highest incidence noted within the first postoperative week, and gradually diminish in prevalence during the ensuing months. Their incidence depends on the defining criteria, which range from 1 to 3-mm in diameter and from 1.00 to 3.00 diopters (D) in power, and varies according to the type of excimer laser used, ablation zone diameter and corneal topographic device by which they are recorded. In one study of eyes treated with both the Schwind Keratom I (Schwind, Kleinostheim, Germany) and Summit Omnimed (Summit, Waltham, MA) using a 6-mm ablation zone diameter, steep central islands were discovered at
1 month in 81% of eyes (50 of 62) when using the Technomed C-scan (Technomed, Baesweller, Germany), and 35% of eyes (22 of 62) when using the EyeSys CAS (EyeSys, Houston, Texas)\(^3\) (Fig 1).

These findings demonstrate the variability of corneal topography in identifying this condition, and highlight the frequent presence of steep central islands from excimer laser systems with standard, clinically-accepted ablation zone size.

Steep central islands were first observed in patients treated with the VisX 20/20 excimer laser in early U.S. clinical trials. The VisX laser used a larger and more uniform ablation zone diameter than its contemporary, the Summit Excimer. However, when Summit expanded its zone and uniformity of treatment in the Summit Omnimed and Apex lasers, it too created steep central islands. Today, there are over ten commercially available excimer lasers, which can be divided into three groups: wide beam, scanning slit, and flying spot lasers. Although eyes...
treated with any one of these lasers could potentially develop steep central islands, it is predominantly the wide beam group (VisX, Summit, Schwind, and Technolas Keracor 116) that demonstrate the highest incidence.

Several theories have been proposed to explain why wide beam lasers with a large ablation zone diameter are more prone to the formation of steep central islands. The most accepted explanations have been the shock wave/fluid theory whereby acoustic waves during ablation lead to a central accumulation of stromal fluid which shields further ablation, and the vortex plume theory whereby the ablation products in the ejected plume interfere with the subsequent pulse, shielding further ablation centrally.\(^1\) Inconsistencies exist in these theories, and recently, Thomas Neuhan proposed a new explanation: a high pressure microexplosion on the ablated surface results in overlying low pressure behind the plume which draws air inward, creating turbulence and rotors in the center of a wide beam ablation (Fig 2).\(^4\) The rotors are self contained whirls of air that carry and encase material within them and keep it close to the surface where it is deposited when the low pressure neutralizes. The deposit creates a shielding layer of one-tenth the magnitude of the depth removed and attenuates the ablation centrally with each subsequent pulse.\(^4\)

Although numerous authors have identified the presence of steep central islands and have proposed theories regarding their origin, few have provided a reproducible solution. In this issue of the *Journal of Refractive Surgery*, Shimnack and co-authors\(^8\) (pp 235-245) attempt to define clearly the variables associated with steep central islands and provide a model for modifying the ablation algorithm to eliminate their formation. Using optical profilometry, they demonstrated that steep central islands occur not only as central under-ablation (less than the expected ablation rate), but also peripheral over-ablation (more than the expected ablation rate) of enucleated porcine and live rabbit corneas, as well as polymethylmethacrylate (PMMA) plastic. This spatial variation in ablation, which increases with ablation diameter independent of the dioptic correction, is modeled to modify the ablation algorithm to correct for these conditions in a clinical setting. Although these authors have contributed greatly to the improvement of the ablation algorithm with the VisX excimer laser (VisX, Santa Clara, Calif), other wide beam excimer lasers (Schwind, Technolas) must adopt these principles of relative under- and overcorrection to develop their own algorithms or anti-central island software.

Steep central islands, when they do occur, are relevant to visual function and require careful topographic analysis. Fortunately, the majority resolve with time due to the smoothing effect of epithelial
hyperplasia in the midperipheral over-ablated zone. Steep central islands that persist beyond 1 year can be corrected by one of several strategies of excimer laser retreatment to improve visual function. But treating the symptom of impaired visual function is not as effective as dealing with the source of steep central islands. Consequently, applying the principles of spatial variation within the ablation algorithm espoused by Shimmick and co-authors5 might make steep central islands a thing of the past.

REFERENCES