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CASE REPORT

Correlation of Both Corneal Surfaces in Corneal Ectasia After Myopic LASIK

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ABSTRACT

We report a case of corneal ectasia in a 25-year-old man after myopic laser in situ keratomileusis in which a complete characterization of the corneal structure was performed by means of a Scheimpflug photography-based system. The patient presented in the ectatic eye with a subjective refraction of +0.50 to 6.00 × 100°, which with correction gave a visual acuity of 20/25. With the topographic analysis, corneal shapes from both corneal surfaces at the four different quadrants were found to be complementary, maintaining the meniscus-shaped profile of the cornea. This correlation between the anterior and posterior corneal surfaces was also confirmed with an optical tomography evaluation. Corneal biomechanics was also evaluated by means of the Ocular Response Analyzer (Reichert), which confirmed the biomechanical alteration. In summary, biomechanical changes leading to corneal ectasia in this case affected the global corneal structure, inducing alterations in the shape of both anterior and posterior corneal surfaces.
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Key Words: post-LASIK ectasia, Scheimpflug photography, Pentacam, corneal ectasia

Laser in situ keratomileusis (LASIK) has become the most common refractive surgical procedure for the treatment of myopia, hyperopia, and astigmatism because of its ability to correct such refractive errors with efficacy and safety.[1] Despite the great potential of this refractive surgical procedure, several complications have been associated with this procedure, such as post-LASIK corneal ectasia.[2] It consists of a progressive corneal steepening, usually inferiorly, with an increase in all ocular aberrations, loss of uncorrected distance visual acuity, and frequently best-corrected distance visual acuity.[2] Several risk factors have been identified for the development of this corneal condition, such as the presence of a large preoperative myopic refractive error, a low residual stromal bed thickness, or some corneal topographic abnormalities.[3–7]

The clinical signs of post-LASIK ectasia include some combination of corneal thinning, anterior corneal steepening, irregular astigmatism, and visual acuity loss.[8] Although some of these clinical signs are similar to those corresponding to keratoconus, histological changes have been demonstrated to be different.[9] However, there is no reported clinical case or case series showing the type of changes that occur in the posterior corneal surface in this type of iatrogenic ectasia. We report a case of corneal ectasia, after myopic LASIK, in which a complete characterization of the corneal structure has been performed by means of a Scheimpflug photography-based system. We could evaluate the alteration that was present in the anterior and posterior corneal shape as well as how these alterations were correlated. To the best of our knowledge, this is the first report showing the posterior corneal changes in post-LASIK ectasia.

CASE REPORT

A 25-year-old man visited our refractive surgery department in Vissum Alicante in December 2007. He had bilateral LASIK in 2002, with an initial satisfactory outcome. The preoperative topography, pachymetry, refraction, and the description of the surgical procedure were not available. The only preoperative problem he was aware of was a high degree of preoperative myopia. After a period of time with good vision, he began to perceive a significant worsening of the visual acuity in the left eye, with perception of glare and halos, especially at night. Before attending our clinic, he visited another ophthalmologic center where he was diagnosed with left corneal ectasia. He came to our clinic for a second opinion.

On our clinical examination, the left eye presented a subjective refraction of +0.50 to 6.00 × 100°, when corrected giving a visual acuity of 20/25. On slitlamp examination, dry eye signs (punctata keratitis) were observed in addition to the presence of a blepharitis

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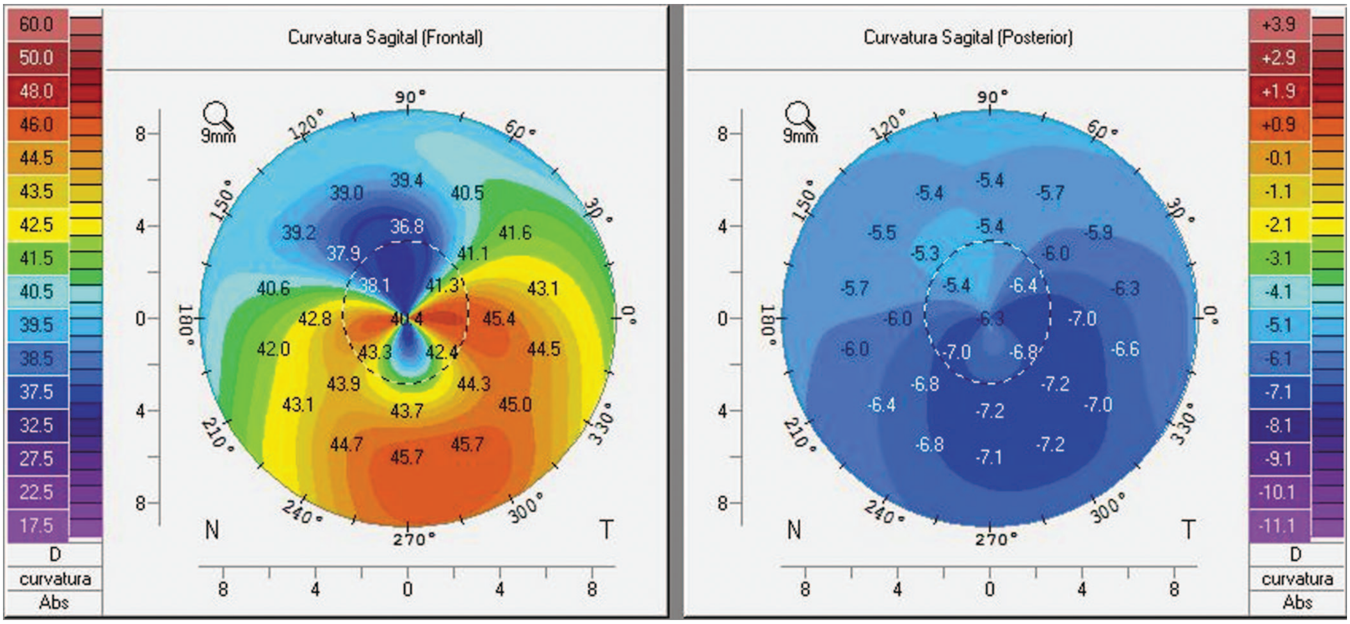

FIGURE 1.

Sagittal corneal topographic maps of the anterior (left) and posterior (right) corneal surfaces. A color version of this figure is available online at www.optvissci.com.

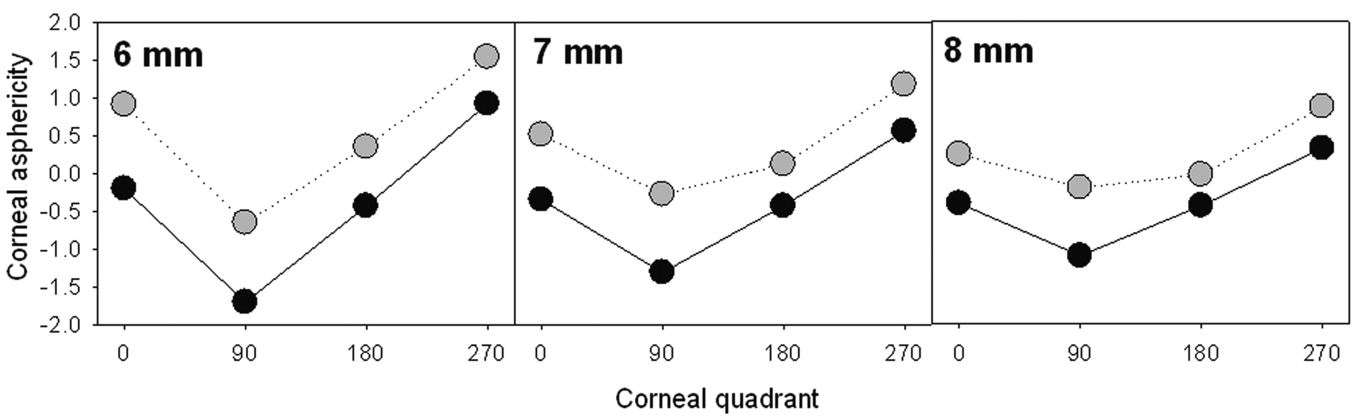

FIGURE 2.

Corneal asphericity for 6, 7, and 8 mm diameters. The gray points represent data from the anterior corneal surface whereas the black points show those data corresponding to the posterior corneal surface.

and an allergic conjunctivitis. A complete evaluation of the corneal structure was performed by means of the Scheimpflug photography-based system Pentacam (Oculus GmbH). Fig. 1 shows a picture of the anterior and posterior corneal topographic maps. As shown, a similar corneal profile was detected for both corneal surfaces ("butterfly" pattern), which was similar to that observed in corneas with pellucid marginal degeneration. The steepest keratometric meridian in the anterior corneal surface was located at 7.1° and the mean power (AK2) corresponding to this meridian was 45.0 D, whereas the flattest keratometric power (AK1) was 38.0 D. The steepest keratometric meridian in the posterior corneal surface was located at 15.9° and the mean power (PK2) corresponding to this meridian was −6.8 D, whereas the flattest keratometric power (PK1) was −5.9 D. The ratio of AK1 to PK1 was 6.62 whereas the ratio of AK2 to PK2 was 6.44.

Besides the keratometric analysis, a comprehensive study of the corneal asphericity in different corneal quadrants (nasal, temporal, superior, and inferior) was performed (Fig. 2). In the anterior corneal surface, an oblate shape (positive corneal asphericity) was observed in the nasal, temporal, and inferior corneal quadrants, whereas in the superior quadrant, a slightly negative corneal asphericity or even 0 depending on the diameter of the corneal area analyzed was observed. In the posterior corneal surface, negative corneal asphericity was detected in the nasal, temporal, and superior quadrants, whereas a positive asphericity was observed in the inferior corneal area. As shown in Fig. 2, corneal shapes from both surfaces in the four different quadrants were complementary (corneal meniscus-shaped profile). The correlation between the anterior and posterior corneal surfaces was also confirmed with the scans obtained by means of optical coherence tomography (Fig. 3).

According to the Pentacam data, the central pachymetry was 472 μm and the minimum pachymetry was 459 μm. This minimum pachymetric reading was located on an infero-nasal position (Cartesian coordinates from corneal geometric center, x: +0.37

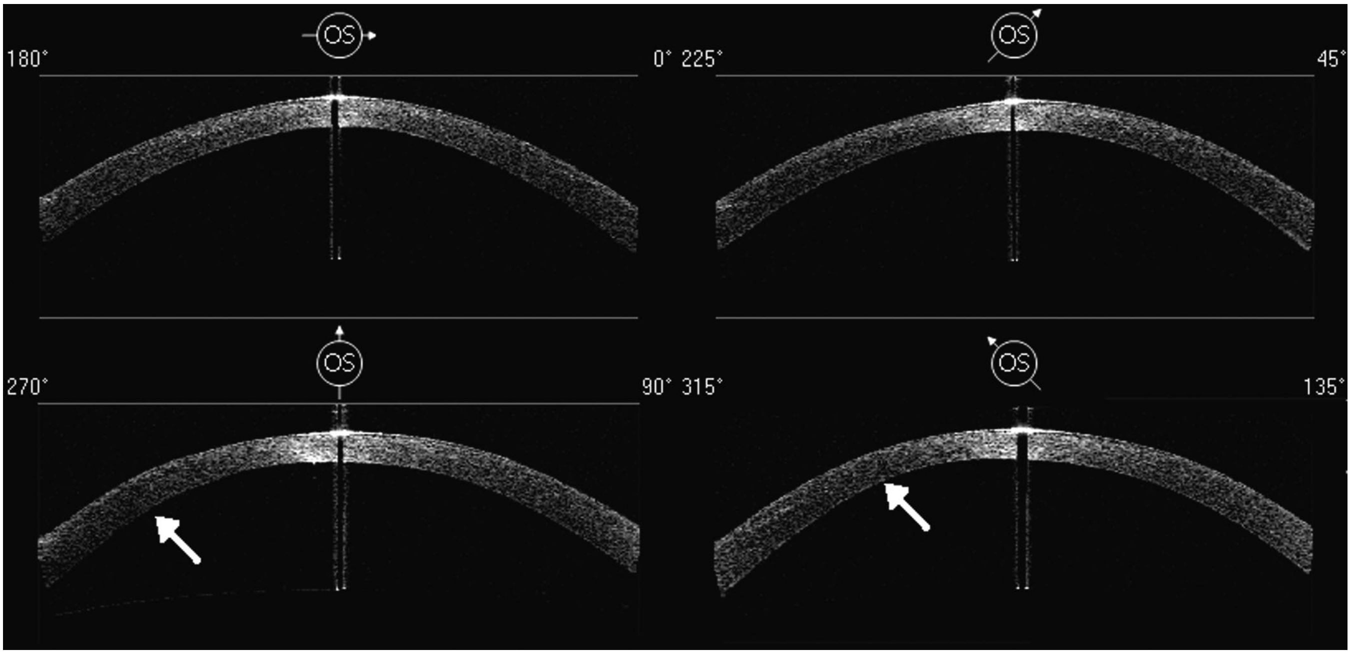

FIGURE 3.
Corneal scans obtained by means of the Visante optical coherence tomography at four different corneal meridians: 0° to 180° (up left), 45 to 225° (up right), 90° to 270° (down left), and 135° to 315° (down right). White arrows are showing the area a maximum thinning in the cornea.

mm, y: −0.73 mm). Additionally, the thickness of the central stromal residual bed was 309 μm as measured by optical coherence tomography, with values over this value throughout the rest of the cornea. Finally, corneal biomechanics was evaluated by means of the Ocular Response Analyzer (Reichert). This system provided the following measurements: corneal hysteresis (CH) of 7.6 mm Hg and corneal resistance factor (CRF) of 6.1 mm Hg.

DISCUSSION

Ectasia is a dilation or structural deformation of the cornea that may produce refractive instability. This ectatic corneal process can occur after a refractive surgery procedure with excimer laser as a result of mechanisms that are not fully understood.[10] There is a corneal weakening as a result of the tissue ablation by the excimer laser that makes the cornea more susceptible to the effect of intraocular pressure.[11] As a result, the cornea becomes progressively deformed and then significantly more aberrated.[12] Several case reports and series of post-LASIK ectasia have confirmed the presence of a more irregular corneal profile in the anterior corneal surface in this ectatic condition.[4,6–8,12] However, there are no reports showing and characterizing the type of changes occurring in the posterior corneal surface. The aim of this case report is to show a complete characterization of the corneal structure in a corneal ectasia after myopic LASIK using a Scheimpflug photography-based system, which allows a precise characterization of the anterior and posterior corneal surfaces.[11,13]

The analyzed eye in this case report presented a manifest astigmatism of large magnitude (6 D) that was consistent with the astigmatism of the anterior corneal surface. An acceptable visual acuity could be achieved with a spectacle spherocylindrical correction in this case and this suggests a reduced level of anterior corneal irregularity. Furthermore, a large posterior astigmatism was present with a similar configuration to that observed in the anterior surface. Indeed, similar correlation was found between the anterior and posterior steepest and flattest keratometric powers (AK1/PK1 6.62, AK2/PK2 6.44). Therefore, the posterior corneal surface does not have a compensation effect of the posterior corneal astigmatism, as it normally does.[14]

The sectorial analysis of corneal asphericity revealed that there was a significant vertical asymmetry. Specifically, the cornea tends to become steeper in the inferior area for both corneal surfaces. Therefore, it appears possible that there may be a correlation between anterior and posterior corneal changes in those eyes developing corneal ectasia after myopic LASIK. We have recently shown that this correlation among anterior and posterior corneal shape was also present in keratoconic corneas, especially in the less advanced cases.[15] Probably, corneal geometric changes occurring in both types of ectasia have the same behavior, but this is a topic that should be addressed in future studies.

The central corneal thickness and residual stromal bed were not extremely reduced, as expected after a LASIK procedure for high myopia (significant central tissue ablation). Reduced central stromal bed and corneal thickness after myopic LASIK should be considered risk factors for the development of a corneal ectasia.[3,5] Therefore, we hypothesize that the cornea could present a previous biomechanical alteration that was not detected preoperatively. Possibly, a fruste forme or an undetected pellucid marginal degeneration was present in this case preoperatively. There are published reports of post-LASIK ectasia cases with the same "butterfly" topographic pattern that had preoperative topographies compatible with pellucid marginal degeneration.[16] In any case, until recently, there was no clinical device allowing a characterization of the biomechanical behavior in vivo. We have evaluated corneal biomechanics by means of the ocular response analyzer devices, obtaining values of CH and resistance factor (CRF) significantly reduced when compared with those found in normal healthy and post-LASIK eyes (reported range for post-LASIK CH: 9.3 ± 1.9 mm Hg; reported range for post-LASIK CRF: 8.1 ± 1.9 mm Hg; corrected spherical equivalent ranging from -13 to -1.25 D).[17] Kerautret et al.[18] also reported significantly reduced values of CH and CRF in a case of post-LASIK ectasia.

In summary, biomechanical changes leading to corneal ectasia after myopic LASIK appear to affect to the global corneal structure and then induce alterations in the shape of both anterior and posterior corneal surfaces. These changes occurring in the corneal structure in post-LASIK ectasia can be monitored with a Scheimpflug photography-based system, which provides information about the anterior and posterior corneal surfaces, the corneal thickness distribution, and even corneal volume. It is difficult to be conclusive or a propose a model from this single case report. However, in this case, it appears that there is a forward displacement over a large region of the entire corneal structure, not only of the anterior or posterior corneal surface. This could be consistent with the model of posterior corneal changes in post-LASIK ectasia studied by Grzybowski et al.[19] This is an interesting topic for future research. Future studies including corneal aberrometric data from both corneal surfaces and also biomechanical data from a large case series are needed for a more detailed characterization of this corneal ectatic disorder.

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