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Case Report

Detection of Subclinical Corneal Ectasia after Laser in Situ Keratomileusis: Corvis ST

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Abstract

Described herein are the cases of 2 patients who underwent bilateral femtosecond-assisted laser in situ keratomileusis (FS LASIK) surgery and subsequently developed unilateral postLASIK ectasia. The fellow eye of both patients was topographically normal, their visual acuity was 20/20, and the patients had no visual symptoms. However, a biomechanical assessment using the Corvis ST tonometer (Oculus Optikgerate GmbH; Wetzlar, Germany) revealed remarkable weakness not only in the ectatic eyes, but also in the fellow eye. Arrangements were made to perform corneal crosslinking for the eyes with manifest ectasia and close follow-up of the fellow eyes.

Keywords: Biomechanics, Corvis ST, femtosecond-assisted laser in situ keratomileusis, postlasik ectasia

Introduction

Postoperative corneal ectasia is a rare but serious potential complication of keratorefractive surgery characterized by a loss of best corrected visual acuity (BCVA), localized steepening distortion and thinning of the cornea, and progressive irregular astigmatism (1, 2). Corneal topography and risk assessment systems have been improved to better assess the possibility of corneal ectasia before planning refractive procedures (3-5).

Iatrogenic corneal ectasia can occur due to a biomechanical failure of corneal tissue (6). The removal of corneal tissue during a keratorefractive surgical procedure may trigger subsequent biomechanical decompensation, even in a previously normal eye (7). Biomechanical deterioration may occur before there is a change in topographical parameters and shape indices. Therefore, it is very important to detect mild ectasia before it induces a decrease in visual acuity.

Several techniques have been developed for in vivo assessment of the biomechanical properties of the cornea, but at present, the 2 devices commonly used are the Ocular Response Analyzer (ORA; Reichert Inc., Depew, NY, USA) (8) and the Corvis ST (Oculus Optikgerate GmbH; Wetzlar, Germany) (9). Both of these instruments are tonometers that provide information about corneal deformation using an air pulse. The ORA records the measurements based on the recording of an infrared light signal (10), while the Corvis ST has the advantage of high-speed Scheimpflug visualization (11). The ORA provides 2 basic biomechanical parameters: corneal hysteresis and the corneal resistance factor. The ability to observe dynamic changes in the cornea with the Corvis ST allows for the capture of additional quantitative parameters to describe biomechanical features (12). Recently,

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combined approaches using parameters that describe both the shape and biomechanics of the cornea, such as the Corvis Biomechanical Index (CBI), the Tomographic and Biomechanical Index (TBI), and the Belin/Ambrosio deviation value (BAD-D), have been used to improve the accuracy of keratoconus diagnosis.

Presently described are the cases of 2 patients who underwent femtosecond-assisted laser in situ keratomileusis surgery (FS LASIK) and developed postLASIK ectasia. Clinical and topographical ectasia was observed in 1 eye and subclinical ectasia was noted in the fellow eye of both patients with the Corvis ST tonometer.

Case Report

Case 1 – A 33-year-old male patient presented at the refractive surgery clinic with complaints of decreased visual acuity in the right eye. Bilateral FS LASIK had been performed 12 years earlier. His uncorrected visual acuity (UCVA) was 20/200 in the right eye and 20/20 in the left eye. Manifest refraction values were -1.25 x65 in the right eye and -0.25 in the left eye. The BCVA in his right eye was 20/63. Corneal topography (Pentacam; Oculus Optikgerate GmbH, Wetzlar, Germany) findings were compatible with corneal ectasia in the right eye and a postmyopic ablation pattern in the left eye (Fig. 1). A Corvis ST and Pentacam biomechanical/tomographic assessment was performed. All of the topographic and biomechanical index values are listed in Table 1. Although the topographical and clinical findings were not consistent with corneal ectasia in left eye, the CBI, TBI, and BAD-D values suggested biomechanical weakness (Fig. 2). Corneal crosslinking (CXL) was planned for the right eye. It was not pursued immediately for left eye since the UCVA had not deteriorated. The patient was informed about the possibility of ectasia development in the left eye, follow-up was recommended, and he was advised not to rub his eyes.

Case 2 – A 30-year-old female patient who had undergone bilateral FS LASIK 5 years prior presented at the refractive surgery clinic with the complaint of blurry vision in her right eye ongoing for a few months. Her UCVA was 20/40 in the right eye and 20/20 in the left eye. The autorefractometer values were -0.50 -1.00x 42 for the right eye while the BCVA was 20/40. Pentacam corneal topography findings were consistent with corneal ectasia in the right eye and a postmyopic ablation pattern in the left eye (Fig. 3). Corvis ST and Pentacam biomechanical/tomographic assessment was performed. All of the topographic and biomechanical index values are provided in Table 1. The Corvis ST revealed biomechanical weakness in both eyes (Fig. 4). CXL was planned for the right eye and the patient was warned about the possibility of ectasia development in the left eye. Regular examinations were scheduled and she was recommended not to rub her eyes.

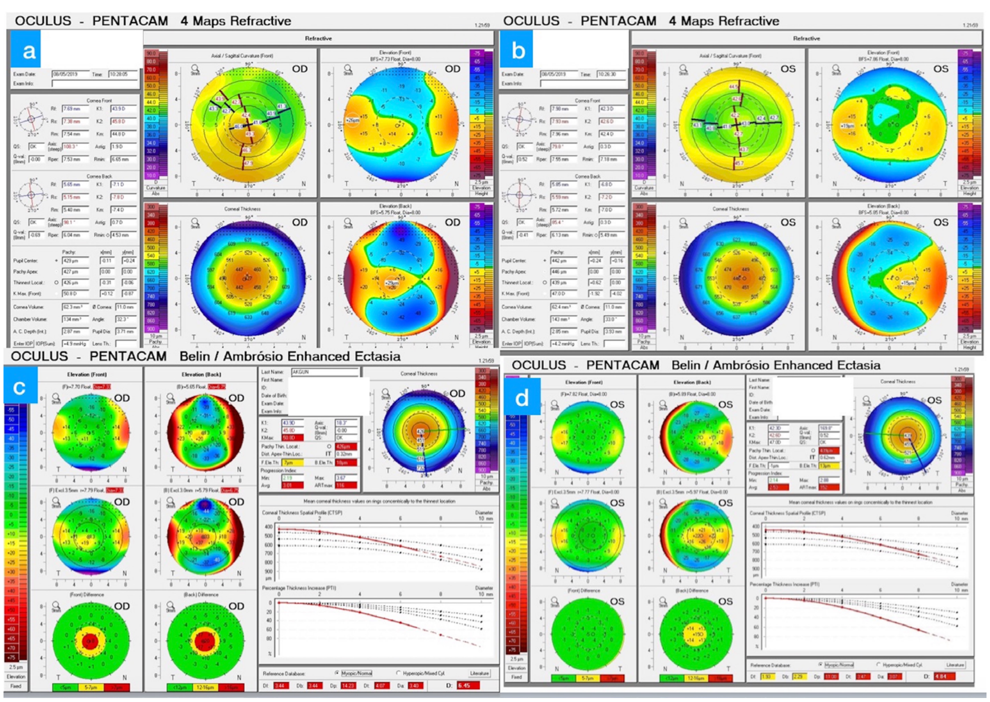

Figure 1. Case 1. **(a, b)** Axial curvature, pachimetry, and elevation maps of the corneal surface of both eyes obtained with Pentacam HR corneal tomography and **(c)** Belin/Ambrosio enhanced ectasia display (BAD) of the right eye and **(d)** the left eye.

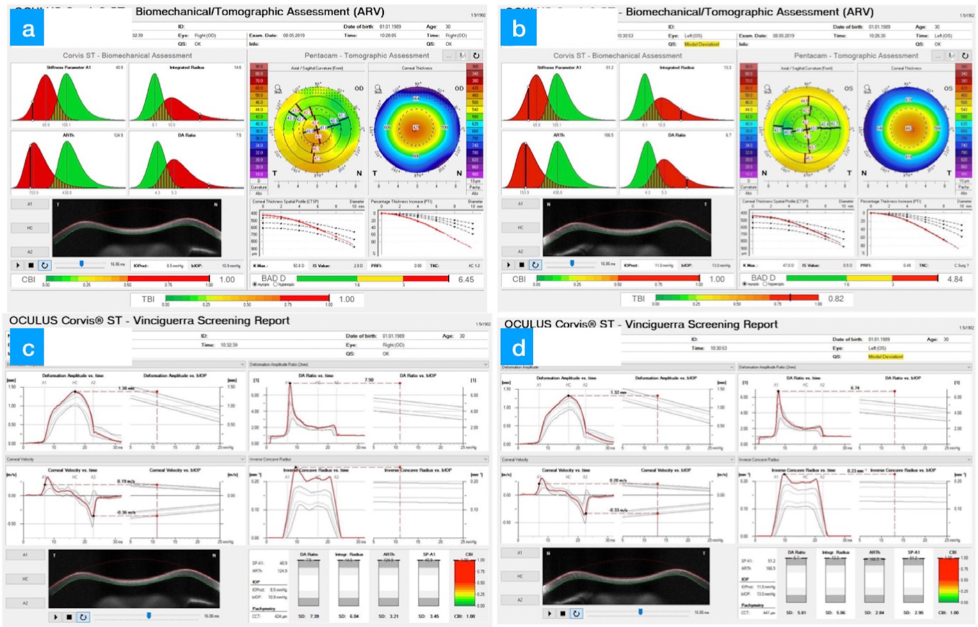

Figure 2. Case 1. **(a)** Tomographic and Biomechanical Index (TBI) assessment of the right eye and **(b)** the left eye, and **(c)** Corvis Biomechanical Index (CBI) display of the right eye and **(d)** the left eye.

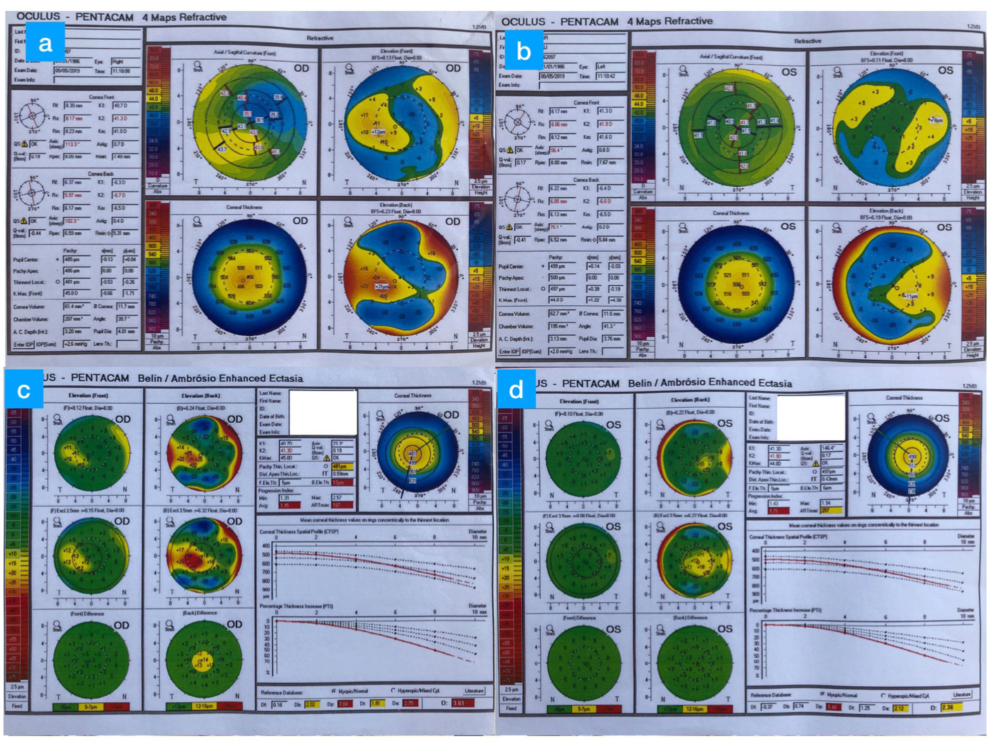

Figure 3. Case 2. **(a, b)** Axial curvature, pachimetry, and elevation maps of the corneal surface of both eyes obtained with Pentacam HR corneal tomography and **(c)** Belin/Ambrosio enhanced ectasia display (BAD) of the right eye and **(d)** the left eye.

Discussion

Corneal ectasia, first reported by Seiler et al. (13), continues to be one of the most serious potential complications to occur after LASIK surgery. It is defined as a progressive structural deformation with clinical features that usually involve a loss of UCVA and changes in manifest refraction values (1). CXL can be used to strengthen and stabilize the cornea and avoid substantial irregularity if mild corneal ectasia is detected early (14).

Roberts et al. (15) noted that curvature, elevation, and

Table 1. Topographical and Biomechanical Index values of both cases

	Case 1		Case 2	
	Right (ectasia)	Left (fellow)	Right (ectasia)	Left (fellow)
K1 (D)	43.9	42.3	40.7	41.3
K2 (D)	45.8	42.6	41.3	41.9
Kmax (D)	50.8	47	45	44
Thinnest CT (µm)	426	439	481	497
Back elevation thickness (µm)	18	13	17	6
BAD-D	6.45	4.84	3.73	2.33
CBI	1.0	1.0	1.0	1.0
TBI	1.0	0.82	1.0	0.78

BAD-D: Belin/Ambrosio deviation value; CBI: Corvis Biomechanical Index; CT: Corneal thickness; D: Diopter; TBI: Tomographic and Biomechanical Index.

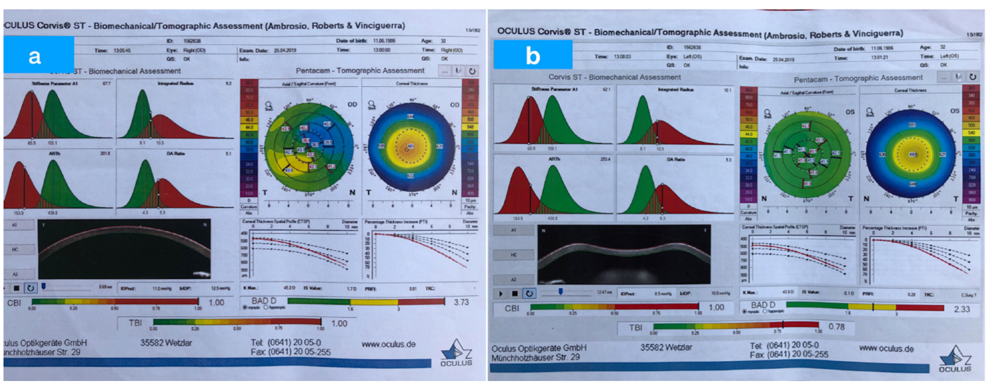

Figure 4. Case 2. **(a)** Tomographic and Biomechanical Index (TBI) assessment of the right eye and **(b)** the left eye.

pachymetric changes are secondary signs of corneal ectasia, and that the earliest changes occur in the biomechanical properties. Corneal biomechanical effects, such as corneal stiffness, are more severe in cases of primary keratoconus and postLASIK ectasia (16). Although the literature contains several descriptions of a biomechanical interruption in subclinical keratoconus, to the best of our knowledge, the present report is the first to describe corneal biomechanical features and the detection of subclinical ectasia after a LASIK procedure using the Corvis ST device. The topographical and clinical findings of the right eye of both patients revealed manifest ectasia. The Corvis ST also demonstrated biomechanical weakness in the fellow eyes without ectasia findings and 20/20 UCVA. This suggested that the fellow eyes were strong candidates for ectasia and warranted close follow-up.

The Corvis ST is a new, non-contact device used to examine corneal deformation properties and record several quantitative parameters with a high-speed Scheimpflug camera. These parameters are geometrical measurements that are generated during inward and outward corneal movement after a puff of air. They include: a stiffness parameter–A1 (SP-A1); time, length and velocity parameters during flattening with first applanation (AT1: time of the first applanation, AL1: first applanation length, AV1: velocity of movement at first applanation); and second applanation recovery (AT2: time from start to second applanation, AL2: second applanation length, AV2: velocity of movement at second applanation). Integration of the Corvis ST with Pentacam corneal tomography increases the capability to distinguish normal corneas from those with keratoconus and allows for the recording of TBI, BAD-D, and CBI data. Vinciguerra et al. (17) reported that the CBI was a very valuable predictive tool in the diagnosis of corneal ectasia. They stated that a CBI value of ≥0.5 indicated a greater possibility of corneal ectasia. In our cases, the CBI of both the ectatic and the fellow eyes was 1.0.

Some reports have found that the TBI offered better accuracy in the detection of corneal ectasia than the CBI and the BAD-D (18, 19). Koh et al. (20) compared these indices in normal controls and the ectatic eyes and fellow eyes with normal tomography. They observed that 39.1% of the fellow eyes were classified as normal by the BAD-D, CBI, and TBI, and that 60.9% were considered abnormal according to at least 1 of the measures (BAD-D >1.60 [39.1%], CBI >0.5 [26.1%], or TBI >0.29 [43.5%]. In our cases, the measurements of the fellow eyes were quantitively higher than the cut-off values reported in that study. Therefore, the fellow eyes in our patients could be classified as abnormal.

CXL is the gold standard procedure to halt the progression of corneal ectasia (21), but it should be kept in mind that this intervention may have some intraoperative and postoperative complications (22). The precise etiopathogenesis of postLASIK ectasia is still uncertain (23). We elected to arrange for a CXL procedure for the eyes with manifest ectasia based on the observations of the corneal topography and decreased visual acuity, but preferred to pursue a strategy of close follow-up for the fellow eyes for the time being. Biomechanical instability without visual symptoms requires additional triggers to be considered chronic disease (23). The clinical features of the fellow eyes of our patients met the definition of predisease condition. Derakhshan et al. (24) examined the short-term results of CXL in 31 eyes with early keratoconus and observed that since that the corneal rigidity was only slightly less than that of normal eyes, CXL had a milder effect when the disease was less advanced and induced little change in the structure. They recommended corneal CXL for early keratoconus only in cases of eyes that cannot be optically corrected and those that demonstrate recent progression. In our cases, the visual acuity of the fellow eyes was 20/20. Although the most appropriate treatment plan for these patients is debatable, we elected to wait and monitor them closely for progression or visual symptoms. Comprehensive follow-up is important. The lack of long-term follow-up data is a limitation of this report.

In conclusion, the combined use of tomographic and biomechanical parameters appeared to provide greater capability to differentiate between normal and ectatic corneas than tomography alone.

Disclosures

Informed consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Involved in design and conduct of the study (FOY, BKY, AD); preparation and review of the study (FOY, BKY, AD); data collection (FOY, BKY).

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