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CASE REPORT

# Unilateral Corneal Ectasia after Bilateral LASIK: The Thick Flap Counts

Bruno Freitas Valbon, Renato Ambrosio Jr, Juliana Glicéria, Rodrigo Santos, Allan Luz, Milton Ruiz Alves


## ABSTRACT

**Purpose:** To report a case of post-LASIK corneal ectasia due to a thick flap, while the contralateral eye did not develop ectasia after an incomplete deep flap cut, followed by a thinner flap LASIK procedure.

**Methods:** Case report.

**Results:** This 45 years old female patient had bilateral myopic LASIK in 1999. Preoperative anterior curvature map was regular with no signs of keratoconus. Central keratometry was 42.88 × 44.70 @ 163 in OD and 43.43 × 45.24 @ 175 in OS. Ultrasound central corneal thickness was 586 μm and 619 μm in the right eye and left eye, respectively. Corneal OCT identified a deep meniscus-shaped LASIK flap, with a central thickness of a 392 μm in the right eye, and an incomplete deep peripheral cut in the left eye with a thinner meniscus-shaped LASIK flap.

**Conclusion:** Unilateral ectasia after LASIK may occur due to a thick flap which leads to biomechanical failure of the cornea.



**Keywords:** Ectasia, Thick flap, Microkeratome, Tomography, Biomechanics.

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**Conflict of interest:** None declared


## INTRODUCTION

Corneal ectasia is a rare but very severe and widely recognized complication of laser *in situ* keratomileusis (LASIK).[1] Although abnormal corneal topography appears to be the most important preoperative risk factor,[2] progressive corneal ectasia has occurred in eyes with apparently normal topographies.[3] The etiology of iatrogenic keratectasia is related to the insufficient residual corneal bed thickness, which is not capable of maintaining the biomechanical strength of the cornea following LASIK surgery.[4] Underestimation of excimer laser ablation depth, error in measuring corneal thickness (i.e. discrepancy between central ant true thinnest values), and underestimation of flap thickness are recognized as possible causes for mysterious ectasia cases.[5] Flap geometry, thickness, diameter, and hinge length are important characteristics that affect the biomechanical impact on the cornea. Appropriate surgical planning and controlling such characteristics will reduce the risk of ectasia.[6] It has been hypothesized that thick flaps cause postoperative ectasia.[3,5,7-10]

We report a case of unilateral progressive corneal ectasia related to a thick flap LASIK in a patient that had bilateral LASIK, with no identifiable classical preoperative risk factors related to clinical parameters, topography and central thickness.

## CASE REPORT

A 45-year-old woman was referred for a second opinion because of 'a poor result after LASIK in the right eye'. Family history was negative for ocular disorders. Patient referred LASIK procedure 13 years ago, in 1999). A chart review indicated preoperative refraction was –5.00 –0.50 × 140, giving 20/20 in the right eye and –5.00 –0.50 × 10, giving 20/20 in the left eye. Preoperative topopraphy was relatively normal, with no signs of keratoconus. Simulated keratometry was 42.88 × 44.70 @163 in the right eye and 43.43 × 45.24 @175 in the left eye. Preoperative ultrasound central corneal thickness (CCT) measurements were 586 μm in the right eye and 619 μm in the left eye.

In 1999, LASIK procedure with the microkeratome (nonspecified microkeratome, with 160 μm plate) was attempted in both eyes. However, the procedure was aborted in the left eye because of incomplete formation of the flap. A second LASIK flap was created in left eye approximately 3 months later. No direct intraoperative measurements of the flap or residual stromal bed thickness were obtained. The patient mentioned that her uncorrected visual acuity (UCVA) improved after surgery, however she reported progressive deterioration of vision in her right eye over the four last years.

Corneal ectasia was confirmed in April 2013, 13 years after LASIK, when we first saw the patient for second opinion. UCVA was 20/800 in the right eye and 20/60 in the left eye. The best spectacle-corrected visual acuity (BSCVA) was 20/400 with –4.25 –8.00 × 85 in the right eye and 20/25 with +0.75 –0.50 × 165 in the left eye. Slit-lamp biomicroscopy, identified a nasal hinge LASIK flap with a relatively clear cornea, mild presence of particles on the interface which enabled the assumption of a thicker flap in OD, no striae or epithelial ingrowth was identified. Fundoscopic examination found no abnormalities in either eye. Goldmann applanation tonometry, performed at 3 pm, was 7 mm Hg in OD and 10 mm Hg in OS.

Retrospective calculation of the ectasia risk score system (ERSS),[7] identified low risk in both eyes. Patient was

31 years in 1999 (0 points), CCT was higher than 510 µm in both eyes (0 points), topography revealed normal/symmetric bow tie in both eyes (0 points), manifest refraction was less myopic than –8D in both eyes (0 points). However, while the calculated predicted residual stromal bed would be higher than 300 µm in both eyes (0 points), the post hoc measurement with OCT identified lower RSB.

Placido-disk based topography (Oculus Keratograph 5). Pentacam HR corneal tomography (Oculus Optikgeräte GmbH, Wetzlar, Germany) and anterior segment optical coherence tomography (OCT RTVue, Optovue, Fremont, CA, USA) were evaluated. The Ocular Response Analyzer (ORA; Reichert Ophthalmic Instruments, Depew, New York) and Corvis ST (Scheimpflug Technology, Oculus Optikgeräte GmbH, Wetzlar, Germany) were used for biomechanical assessments in both eyes.

In the right eye, corneal curvature by Placido and Scheimpflug revealed marked inferior steepening, with keratometric values higher than 59 D, hyperprolate shape (Q-value in 6 mm = –1.08) and marked asymmetry (Fig. 1A). In the left eye, curvature maps revealed an oblate (Q-value in 6 mm = 0.93) shape with low regular toricity and no signs of natural ectasia. Central keratometric values were 39.3 D @ 1.5 (K1), 41.2 D (K2), and 40.2 D (Km) in OS (Fig. 1B). The elevation maps (back) referenced to floating BFS for the 8 mm zone demonstrated an island pattern with 80 µm in the right eye and –4 µm in the left eye (Figs 1C and 1D, respectively).

The LASIK flaps were identified by high resolution, spectral domain AS-OCT imaging. In the right eye, a meniscus-shaped LASIK flap was seen with a central thickness of 392 µm and RSB thickness of 117 µm (Fig. 2). In the left eye, two meniscus-shaped LASIK flaps were found. One formed during the aborted attempt measured 384 µm in the periphery. The other flap measured 180 µm in the center, showing a central RSB thickness of 306 µm (Fig. 3).

Biomechanical measurements taken by ORA were considered (Fig. 4). The corneal hysteresis (CH) was 9.7 and 11.3 mm Hg in the right eye and left eye, respectively. The corneal resistance factor (CRF) was 9.7 mm Hg and

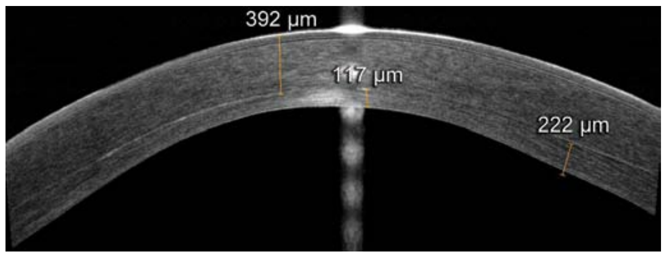
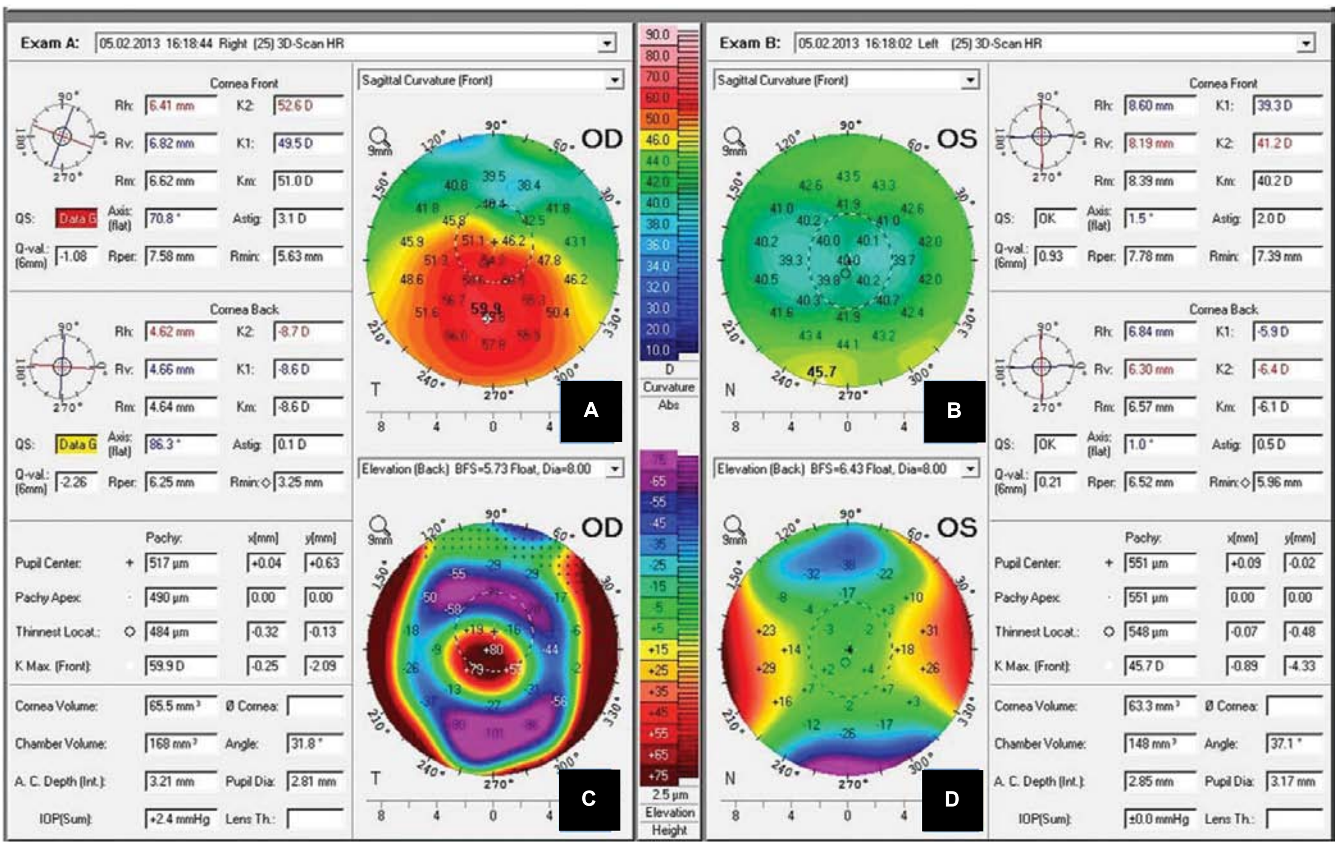



**Fig. 2:** Anterior segment OCT of the right eye showing a flap thickness of 394 µm and a minimum residual stromal bed of 117 µm




**Figs 1A to D:** Pentacam curvature sagittal maps. Note a pattern of ectasia with inferior steepening and keratometric values > 59.00 D in right eye (A) and the normal corneal asphericity with low toricity and observed myopic ablation profile in left eye (B). Elevation maps (back) referenced to floating BFS for the 8 mm zone demonstrated an island pattern with 80 µm in the right eye (C) and –4 µm in the left eye (D)

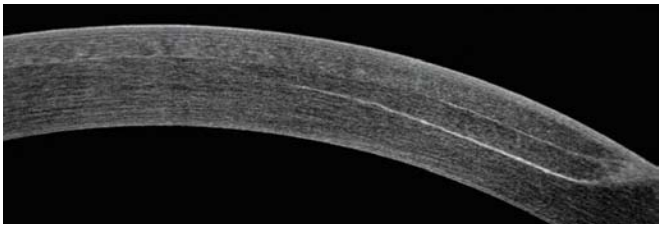


**Fig. 3:** Anterior segment OCT of the left eye showing a two meniscus-shaped LASIK flaps. The flap measured 180 μm in the center and a central RSB thickness of 306 μm

10.3 mm Hg in the right eye and left eye, respectively. We observed that CH and CRF were lower in the right eye than in the left eye, identifying biomechanical failure in right eye. In right eye the IOPg was 14.8 mmHg and IOPcc was 16.1 mm Hg. In left eye, the IOPg and IOPcc were 12.5 mm Hg and 12.4 mm Hg, respectively.

The Corvis ST also was used on both eyes (Fig. 5). This device integrates ultra-high-speed Scheimpflug imaging with a noncontact tonometer (NCT) and has enormous potential as a research and clinical tool to retrieve *in vivo* biomechanical properties of the cornea. In the right eye, the deformation amplitude, which takes into account the total displacement of the corneal apex during the measurement was 1.04 mm and in left eye it was 1.02 mm. The deflection amplitude, which subtracts the whole eye movement from the deformation amplitude was 0.95 mm in OD and 0.7 mm in OS. 1st A time (i.e. the time from start until the first applanation) was 7.86 ms in the right eye and 7.56 ms in the left eye. The 1st A length (i.e. the cord length of the first applanation) was 1.47 mm in the right eye and 2.16 mm in the left eye, and the highest concavity-time (i.e. the time from start until highest concavity is reached) was 15.94 ms in the right eye and 17.79 ms in the left eye. These differences indicate that the right eye is weaker (biomechanical failure) than the left eye. Interestingly, the IOP is same in both eyes (14.5 and 13.0 mm Hg in the right eye and left eye, respectively).

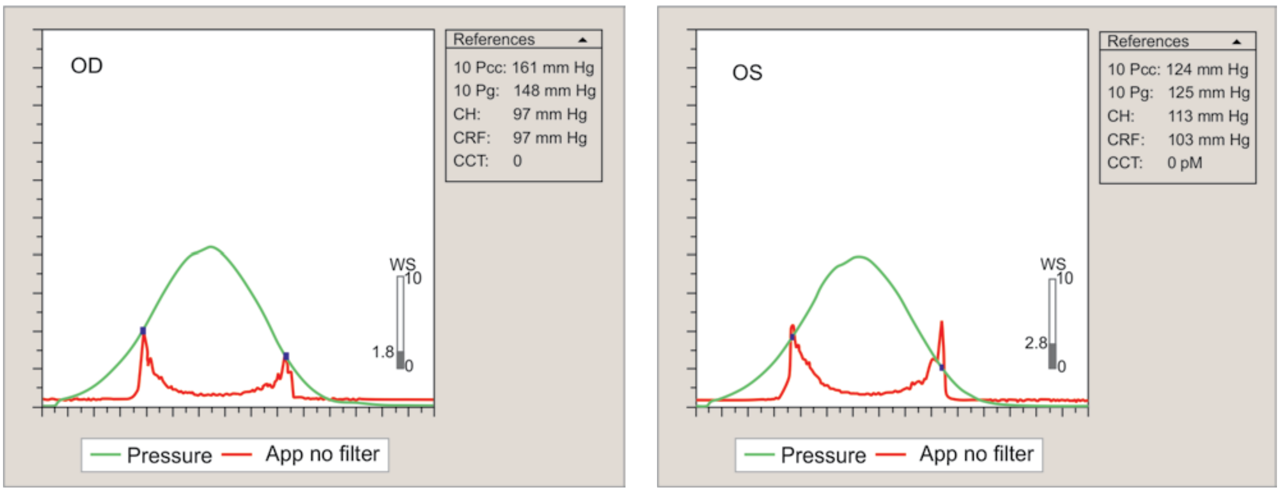



**Fig. 4:** ORA biocorneagram. Note that ORA signals in right eye were lower than in left eye

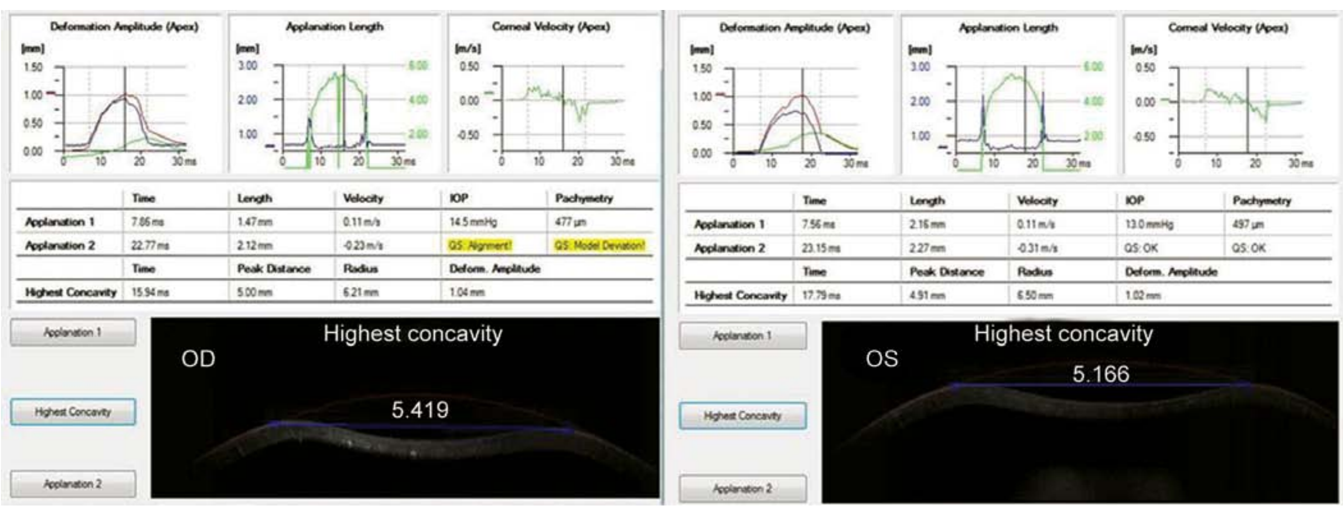



**Fig. 5:** The Corvis Scheimpflug technology in both eyes were measured. Note that the significant increase in deformation amplitude and of oscillation of the cornea after the air pulse in right eye is greater than that left eye

## DISCUSSION

Iatrogenic corneal ectasia is a relatively rare but sever complication after laser *in situ* keratomileusis.[8] Possible mechanisms for post-LASIK ectasia are pre-existing corneal pathology primarily in the form of keratoconus (or form fruste of keratoconus) or chronic biomechanical failure due to inadequate residual stroma bed, which may be related to excessive ablation or excessively thick corneal flap.

Cases of ectasia have occurred in eyes with normal topographies, and Binder reports that eyes with a preoperative CCT greater than 591 µm may developed ectasia.[9] Pallikaris et al[10] indicates this in six eyes with a residual bed thickness greater than 250 µm and Comaish et al[11] points to the regularity of the cut of the flap made by the microkeratome. However, the cause of the corneal ectasia after LASIK seems to be enigmatic and mysterious in some cases. Cases of corneal ectasia without risk factors should be investigated for biomechanical properties of the cornea. Irregular flaps with thicker peripheral depths could theoretically negatively affect corneal biomechanics and could be a cause for postoperative ectasia.[3] Spadea et al[5] reports a case of the keratectasia after thick flap (260 µm) LASIK with microkeratome and concludes that the excessive flap thickness and excessive ablation produced progressive keratectasia. Giledi et al[12] demonstrates that a thicker-than-expected flap can lead to a thinner-than-anticipated residual cornea and subsequent ectasia, and showed that reports of ectasia after LASIK in normal-thickness corneas reflect thicker-than-anticipated flaps.

In this case report, we provide an example of unilateral corneal ectasia after LASIK due to a thick lamellar cut in the right eye with a low ERSS score and without preoperative risk factors. The contralateral eye did not develop corneal ectasia after a deep incomplete cut which was not lifted so that LASIK procedure was aborted. A second thinner flap was successfully created for the completion of LASIK procedure in OS. AS-OCT was utilized to identify a meniscus-flap configuration that measured 392 µm and an RSB that measured 117 µm in the right eye. In the left eye, the AS-OCT identified two meniscus-flap configurations, a thicker and incomplete one in the periphery and a thinner one.

This case illustrates that the flap plays a major role in the biomechanical weakening impact of LASIK. The thick flap was considered the cause of the corneal ectasia after LASIK in this case. The type of microkeratome used was not specified. However, this is known that novel microkeratomes such as the Moria OUP (Moria SA, Antony, France) enable flap creation with lower variability than older instruments, such as the M2 (Moria SA, Antony, France).[13] However, the advent of femtosecond lasers definetively enhanced the accuracy, by reducing the standard deviation for flap thickness, as well as improving geometry of the lamellar cut.[13-17] Every surgeon should be alert about such complication and be aware about the standard deviation of the thickness of the flap from the instrumentation he or she has available.

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## ABOUT THE AUTHORS

### Bruno Freitas Valbon (Corresponding Author)

Postgraduate Student, Department of Ophthalmology, University of São Paulo, Brazil, Phone: 552180137117, e-mail: valbonbruno@ig.com.br

### Renato Ambrosio Jr

Founder and Research Director, Rio de Janeiro Corneal Tomography and Biomechanics Study Group – Rio de Janeiro, RJ, Brazil; Associate Professor, Department of Ophthalmology, Federal University of São Paulo, Brazil

### Juliana Glicéria

Resident, Department of Ophthalmology, Hospital da Piedade (RJ); Research Associate, Rio de Janeiro Corneal Tomography and Biomechanics Study Group – Rio de Janeiro, RJ, Brazil

### Rodrigo Santos

Fellow, Department of Ophthalmology, Federal University of São Paulo, Brazil

### Allan Luz

Postgraduate Student, Department of Ophthalmology, Federal University of São Paulo, Brazil

### Milton Ruiz Alves

Professor, Department of Ophthalmology, University of São Paulo São Paulo, Brazil