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CURRENT CHALLENGES IN Cataract & Refractive SURGERY

23-25 JANUARY 2019

RESEARCH INSTITUTE OF OPHTHALMOLOGY


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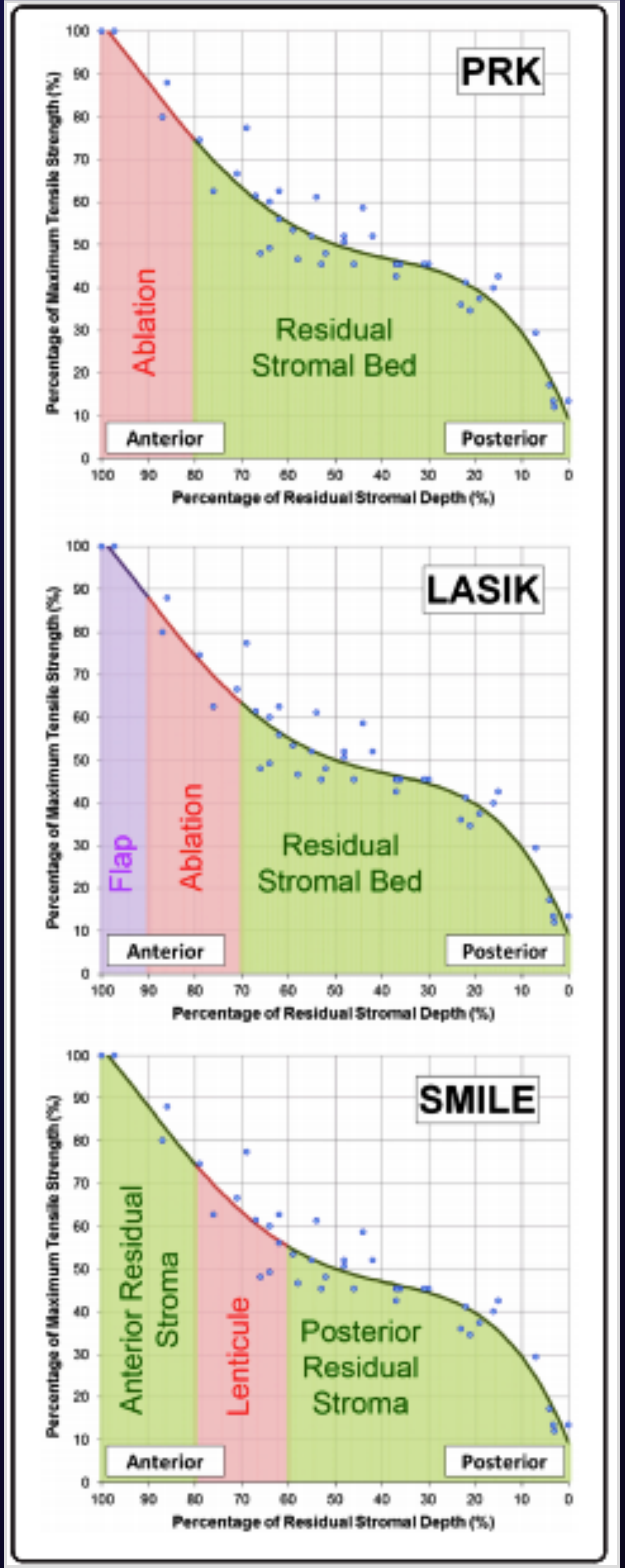
**The Speaker Has No Financial Interest**

# Post-SMILE Ectasia: The Unwritten Chapter

# Post LVC Ectasia

- Our nightmare
- A progressive corneal steepening, usually inferiorly, with an increase in myopia and astigmatism, loss of UDVA/CDVA that can present days to years after LVC
- A rare complication
- Biomechanical Failure!!

# SMILE and Biomechanics of the Cornea




courtesy of Dan Reinstein

ORIGINAL ARTICLE

# Comparison of biomechanical effects of small-incision lenticule extraction and laser in situ keratomileusis: Finite-element analysis

Abhijit Sinha Roy, PhD, William J. Dupps Jr, MD, PhD, Cynthia J. Roberts, PhD

**PURPOSE:** To theoretically compare the corneal stress distribution of laser in situ keratomileusis (LASIK) with the stress distribution of small-incision lenticule extraction.

**SETTING:** Cleveland Clinic Cole Institute, Cleveland, and The Ohio State University, Columbus, Ohio, USA.

**DESIGN:** Computational modeling study.

**METHODS:** A finite-element anisotropic collagen fiber–dependent model of myopic surgery using patient-specific corneal geometry was constructed for LASIK, small-incision lenticule extraction, and a geometry analog model with unaltered material properties from preoperative but with postoperative geometry including thickness. Surgical parameters, magnitude of myopic correction, LASIK flap thickness, and lenticule depth in small-incision lenticule extraction were varied. Two sets of models, 1 with uniform and 1 with depth-dependent material properties, were constructed.

**RESULTS:** Stress distribution between small-incision lenticule extraction simulations and the geometry analog model were similar. In contrast, LASIK consistently reduced stress in the flap and increased stress in the residual stromal bed (RSB) compared with the geometry analog model. An increase in flap thickness or lenticule depth resulted in a greater increase in RSB stress in the LASIK model than in the small-incision lenticule extraction model.

**CONCLUSIONS:** Small-incision lenticule extraction may present less biomechanical risk to the residual bed of susceptible corneas than comparable corrections involving LASIK flaps. Deeper corrections in the stroma may be possible in small-incision lenticule extraction without added risk for ectasia.

**Financial Disclosures:** Proprietary or commercial disclosures are listed after the references.

*J Cataract Refract Surg 2014; 40:971–980* © *2014 ASCRS and ESCRS*

The biomechanical impact of laser in situ keratomileusis (LASIK) on the cornea is a critical component affecting postoperative refractive outcomes.[1,2] The human cornea is an anisotropic soft tissue with a distinct collagen distribution and 3-dimensional (3-D) fiber

rare but serious complication related to postoperative structural and refractive instability.[3,12]

Femtosecond laser–assisted LASIK requires the use of 2 lasers; that is, a femtosecond laser for flap creation and an excimer laser for ablating the tissue

**Table 1. Studies analyzing corneal biomechanics**

| Study* and Year | Instrument(s) |
|---|---|
| LASIK vs LASEK/PRK | |
| Kirwan 2008[61] | |
| Kamiya 2009[62] | |
| Hassan 2014[63] | |
| Shen 2014[64] | |
| SMILE vs LASIK | |
| Shen 2014[64] | |
| Pedersen 2014[65] | |
| Wang 2014[66] | |
| Wu 2014[67] | |
| Agca 2014[68] | |
| Sefat 2016[69] | |
| Osman 2016[70] | |
| Wang 2016[66,71] | |
| Zhang 2016[72] | |
| SMILE vs LASEK/PRK | |
| Shen 2014[64] | |
| Dou 2015[73] | |
| Yıldırım 2016[74] | |
| Chen 2016[75] | |
| Al-Nashar 2017[76] | |
| Technique variations | |
| Kamiya 2014[77] | |
| Shen 2014[78] | |
| Mastropasqua 201 | |
| El-Massry 2015[80] | |
| Leccisotti 2016[81] | |
| Fernández 2016[82] | Corvis |

CCT = central corneal thickness; FLEx = femtosecond le
LASEK = laser-assisted subepithelial keratectomy; LASIK =
tectomy; SMILE = small-incision lenticule extraction; WG = wavefront guided
*P < 0.05.

Giuliano Scarcelli, Roberto Pined

**Purpose.** The mechanical properties of cornea linked to prevalent ocular diseases and therapeutic Brillouin microscopy is a novel optical technology three-dimensional mechanical imaging. In this stu bility of this noncontact technique was tested for titative assessment of the biomechanical propertie nea.

**Methods.** Brillouin light-scattering involves a spect portional to the longitudinal modulus of elasticity A 532-nm single-frequency laser and a custom-dev high-resolution spectrometer were used to measu ouin frequency. Confocal scanning was used to p ouin elasticity imaging of the corneas of whole The longitudinal modulus of the bovine corneas w before and after riboflavin corneal collagen pho ing. The Brillouin measurements were then con conventional stress–strain mechanical test results.

**Results.** High-resolution Brillouin images of the obtained, revealing a striking depth-dependent the elastic modulus across the cornea. Along the the Brillouin frequency shift varied gradually fr in the epithelium to 7.5 GHz near the endotheliu ficients of the down slope were measured to be ap 1.09, 0.32, and 2.94 GHz/mm in the anterior, po innermost stroma, respectively. On riboflavin co linking, marked changes in the axial Brillouin p 0.001) were noted before and after cross-linking.

**Conclusions.** Brillouin imaging can assess the bi properties of cornea in situ with high spatial res novel technique has the potential for use in clinica and treatment monitoring. (*Invest Ophthalmol V* 53:185–190) DOI:10.1167/iovs.11-8281

The current standard of corneal diagnosis is str ysis, by pachymetry[1] and tomography,[2] to mea thickness and curvature. In addition to structure chanical properties of the cornea are also importa of corneal health. Keratoconus is a degenerative c involves a loss of corneal rigidity. Corneal ectasia occur as a rare but serious complication of refrac results from a decrease in corneal stiffness. Co

From the [1]Wellman Center for Photomedicine, General Hospital, Boston, Massachusetts; the [2]Departm tology, Harvard Medical School, Boston, Massachusetts ment of Ophthalmology, Massachusetts Eye and Ear Infir Massachusetts; and [4]Harvard-MIT Health Sciences and Cambridge, Massachusetts.

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Disclosure: **G. Scarcelli**, None; **R. Pineda**, None; **S.**

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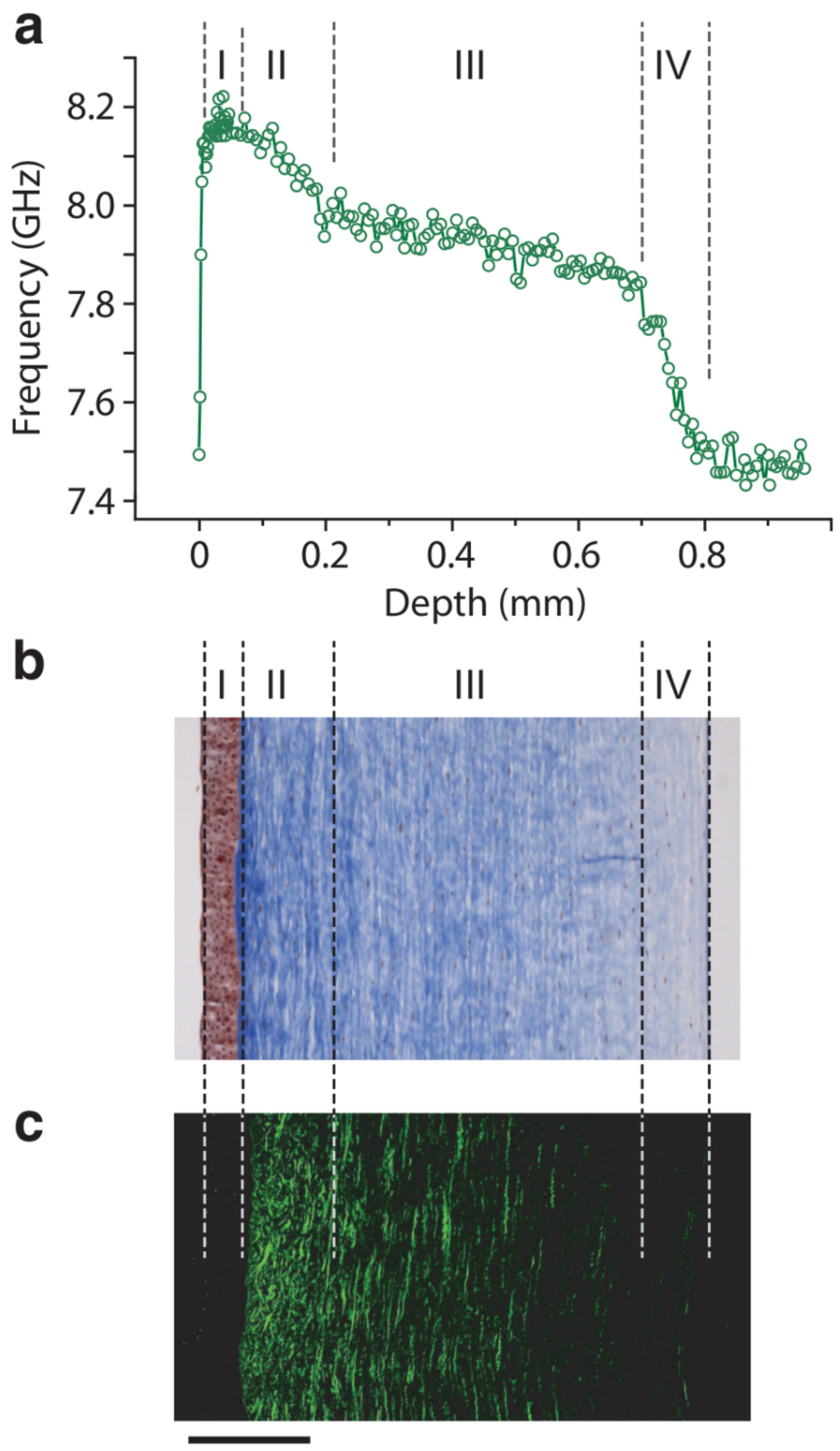



**Figure 3.** Comparison of Brillouin elasticity and structural images. (**a**) Brillouin depth profile of the entire cornea including the epithelium (I), anterior stroma (II), posterior stroma (III), and the innermost region (IV). (**b**) Masson's trichrome–stained image of 5-μm-thick cornea section. (**c**) An SHG image of 5-μm-thick cornea section. Scale bar, 200 μm.

# Tissue Removal

| 6mm Optical Zone | | | |
|---|---|---|---|
| | SMILE | Excimer | % |
| -2.00 | 37 | 27 | 37% |
| -3.00 | 50 | 39 | 28% |
| -5.00 | 75 | 63 | 19% |
| -8.00 | 110 | 97 | 13% |

| 6.5mm Optical Zone | | | |
|---|---|---|---|
| | Smile | Excimer | % |
| -2.00 | 43 | 32 | 34% |
| -3.00 | 59 | 47 | 25% |
| -5.00 | 89 | 75 | 18% |
| -8.00 | 130 | 116 | 12% |

# Post-SMILE Ectasia

# April 2015

CASE REPORT

# Bilateral ectasia after femtosecond laser–assisted small-incision lenticule extraction

Mohamed Tarek El-Naggar, MD, FRCS

This case report describes clinical and topographic features of bilateral corneal ectasia after femtosecond laser–assisted small-incision lenticule extraction. The case suggests that patients with preoperative forme fruste keratoconus or early keratoconus might develop significant progression of corneal ectasia after the small-incision lenticule extraction procedure and shows that the procedure can affect the corneal biomechanics.

**Financial Disclosure:** The author has no financial or proprietary interest in any material or method mentioned.

*J Cataract Refract Surg 2015; 41:884–888 © 2015 ASCRS and ESCRS*

Corneal ectasia after laser in situ keratomileusis (LASIK) is a well-described, relatively rare complication of corneal refractive surgery.[1,2] Several reports of ectasia after photorefractive keratectomy (PRK) have been published.[3–5] To my knowledge, this is the first report of ectasia after femtosecond laser–assisted small-incision lenticule extraction (SMILE, Carl Zeiss

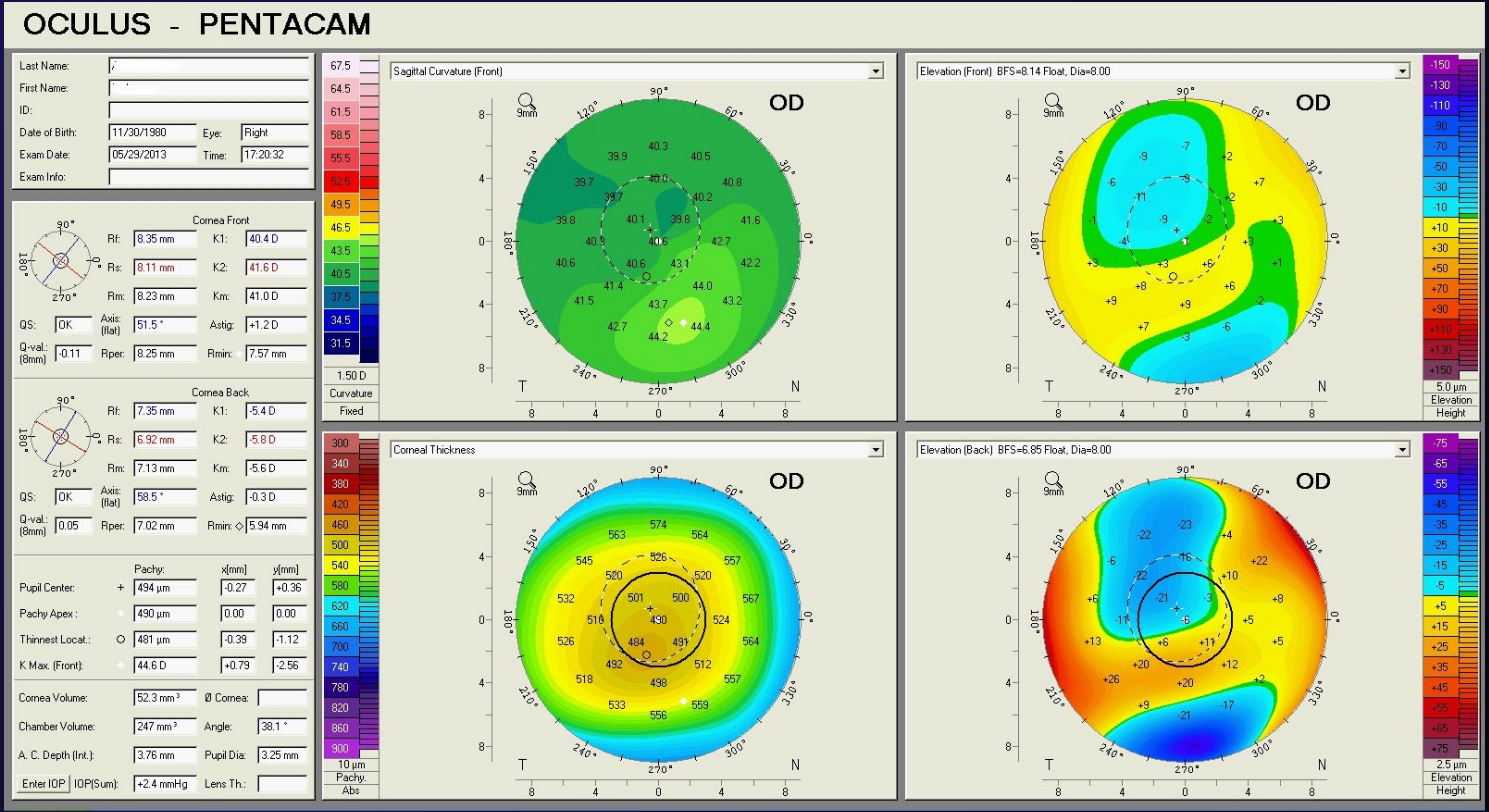
and associated bilateral relative anterior and posterior surface elevation using a best-fit sphere of 8.0 mm diameter. Although the keratometry (K) readings on the anterior corneal surface sagittal map were relatively flat (right eye, 40.4 diopters [D] and 41.6 D; left eye, 40.8 D and 41.6 D), subclinical keratoconus/forme fruste keratoconus was diagnosed and LASIK surgery was not considered an option.

Because the patient had a documented stable refraction for

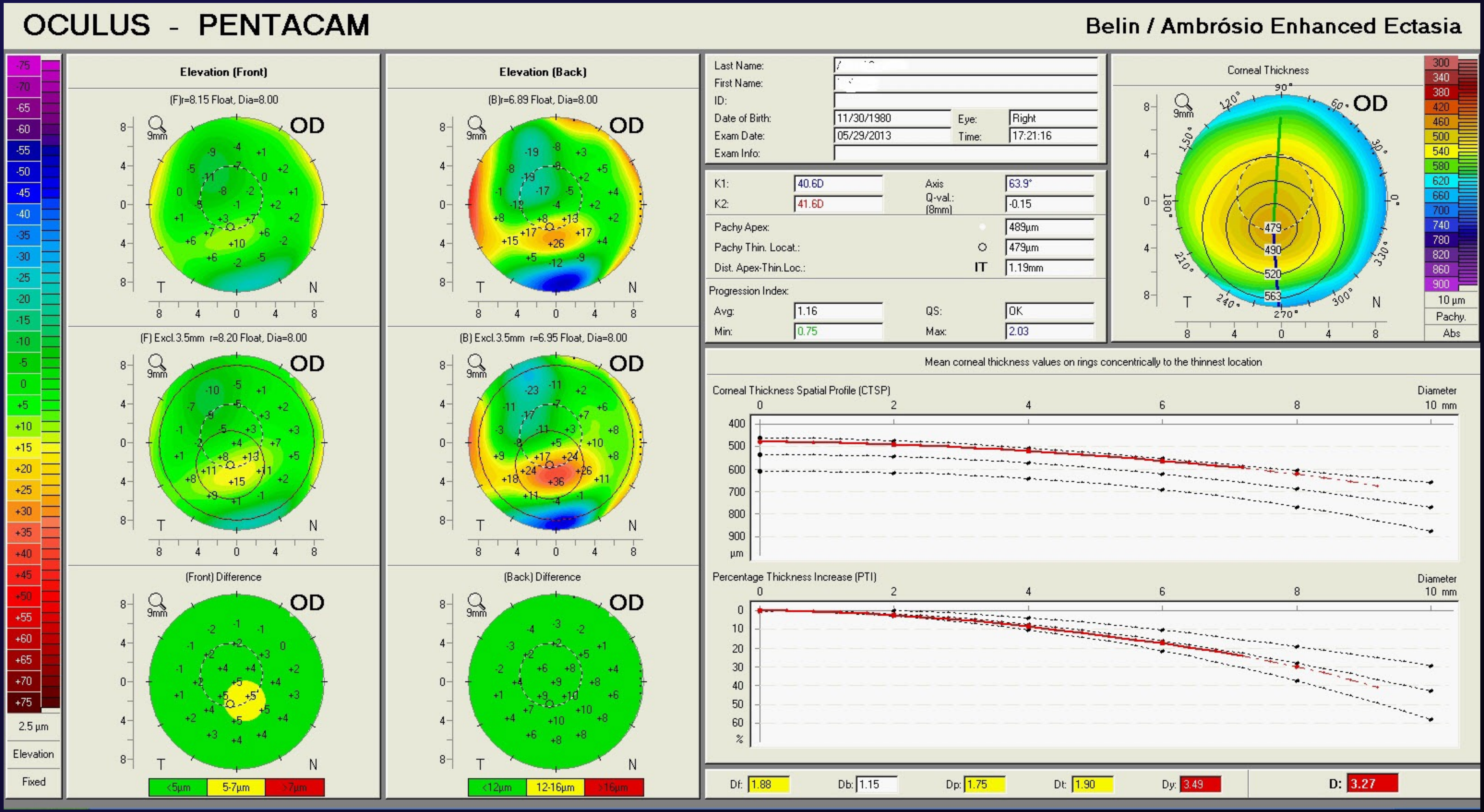
# Case Report

- A 33-year-old Caucasian male patient came to our clinic seeking LASIK surgery
- Manifest refraction:
  - ❑-2.00 -1.00 x 65 OD
  - ❑-2.25 -1.25 x 105 OS
- CDVA: 20/15 in both eyes, separately.
- The patient had no significant ocular history, including trauma, amblyopia, or strabismus; and has no family history of keratoconus.
- After careful full ophthalmological examination, nothing significant was detected.

# Initial Pentacam exam of the right eye

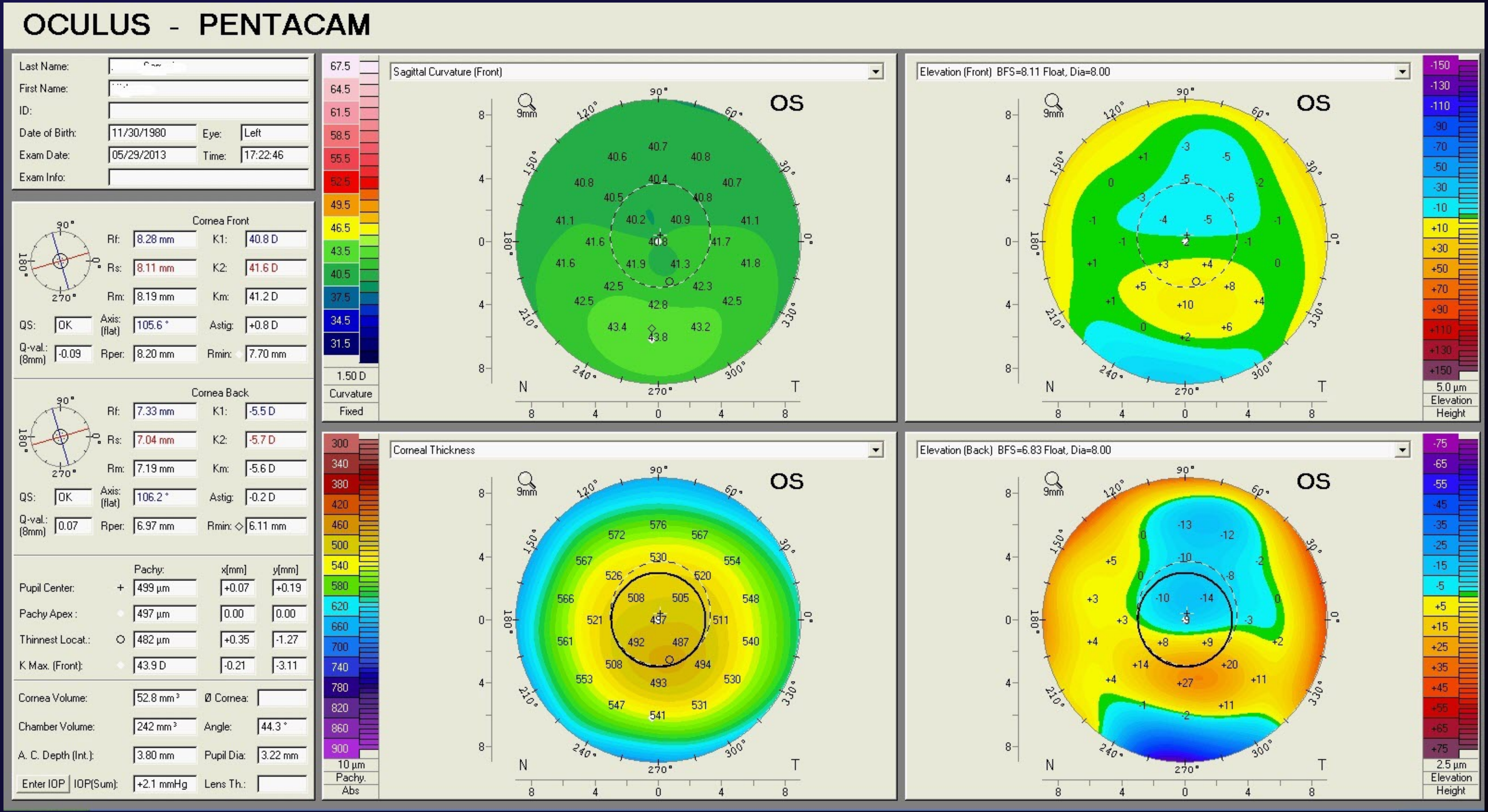


# BAD-D

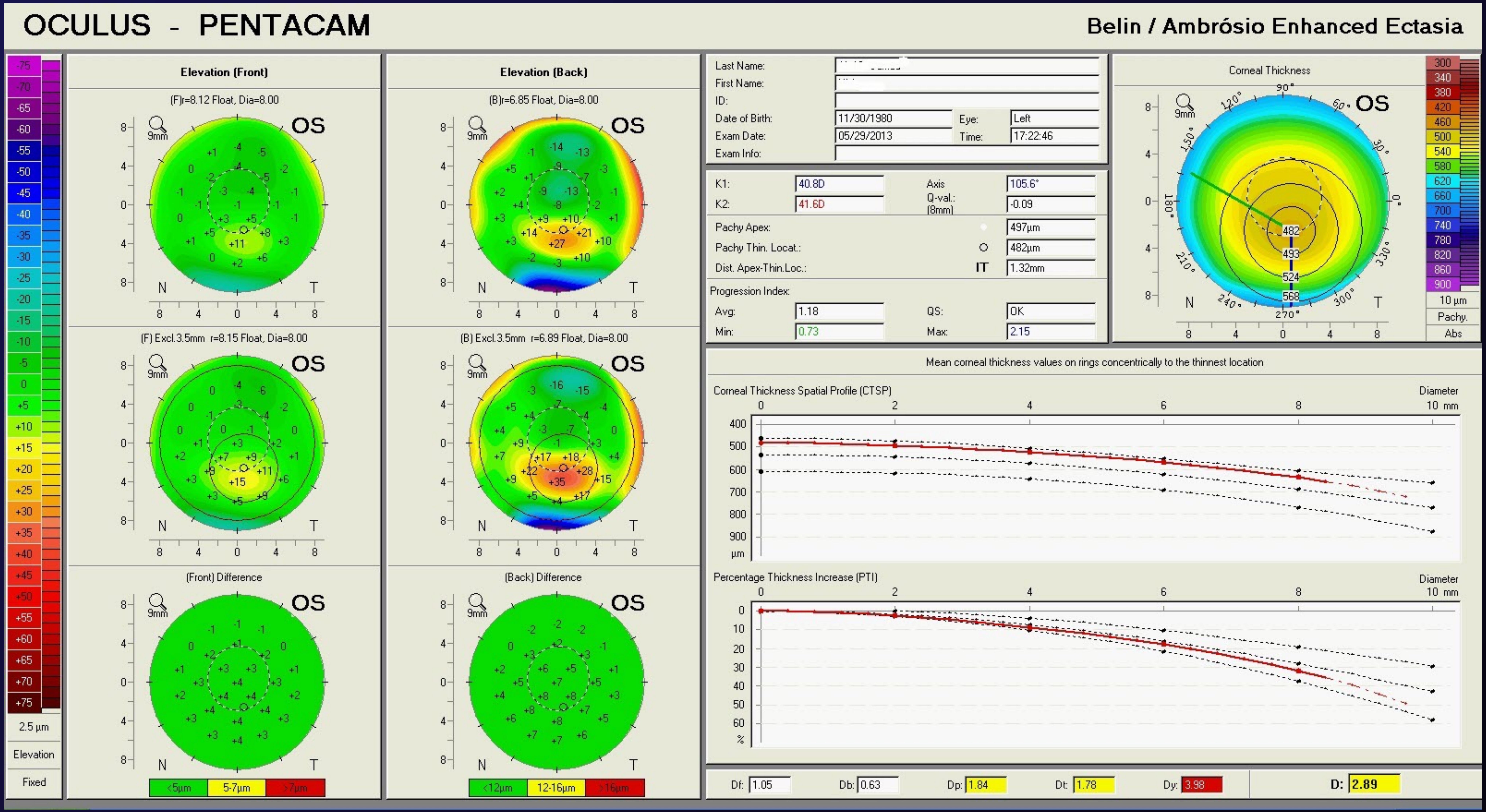


OCULUS - PENTACAM
Belin / Ambrósio Enhanced Ectasia
Elevation (Front)
(F)r=8.15 Float, Dia=8.00
Elevation (Back)
(B)r=6.89 Float, Dia=8.00
(F) Excl.3.5mm r=8.20 Float, Dia=8.00
(B) Excl.3.5mm r=6.95 Float, Dia=8.00
(Front) Difference
(Back) Difference
OD
T
N
9mm
<5µm
5-7µm
>7µm
<12µm
12-16µm
>16µm
2.5 µm
Elevation
Fixed
Last Name:
First Name:
ID:
Date of Birth: 11/30/1980
Eye: Right
Exam Date: 05/29/2013
Time: 17:21:16
Exam Info:
K1: 40.6D
Axis 63.9°
K2: 41.6D
Q-val. (8mm) -0.15
Pachy Apex: 489µm
Pachy Thin. Locat.: 479µm
Dist. Apex-Thin.Loc.: IT 1.19mm
Progression Index:
Avg: 1.16
QS: OK
Min: 0.75
Max: 2.03
Corneal Thickness
479
490
520
563
10 µm
Pachy.
Abs
Mean corneal thickness values on rings concentrically to the thinnest location
Corneal Thickness Spatial Profile (CTSP)
Percentage Thickness Increase (PTI)
Diameter 10 mm
µm
%
Df: 1.88
Db: 1.15
Dp: 1.75
Dt: 1.90
Dy: 3.49
D: 3.27

# Initial Pentacam exam of the left eye



# BAD D

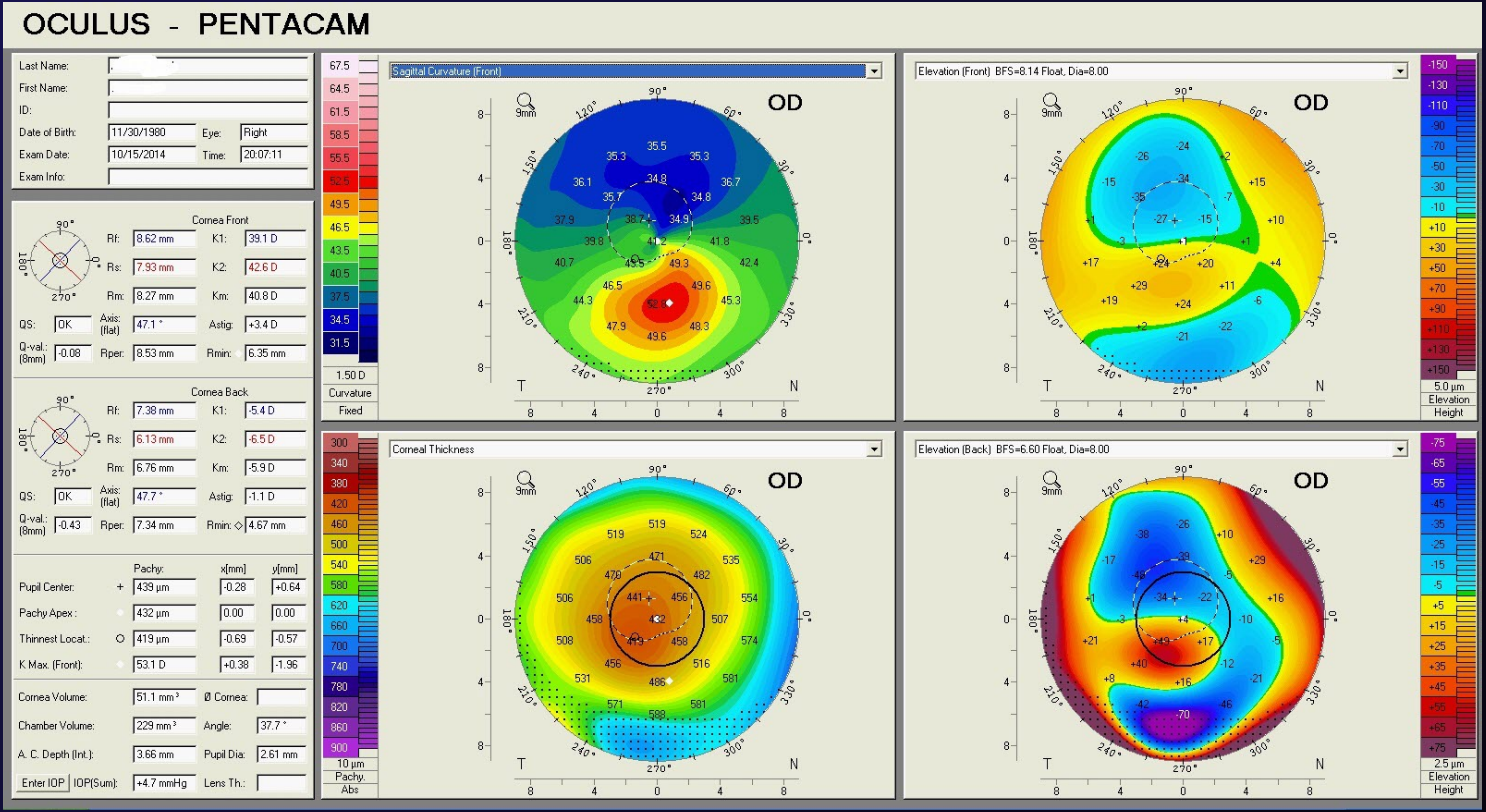

OCULUS - PENTACAM
Belin / Ambrósio Enhanced Ectasia
Elevation (Front)
Elevation (Back)
Corneal Thickness
Last Name:
First Name:
ID:
Date of Birth: 11/30/1980
Eye: Left
Exam Date: 05/29/2013
Time: 17:22:46
Exam Info:
K1: 40.8D
K2: 41.6D
Axis 105.6°
Q-val.: (8mm) -0.09
Pachy Apex: 497µm
Pachy Thin. Locat.: 482µm
Dist. Apex-Thin.Loc.: IT 1.32mm
Progression Index:
Avg: 1.18
Min: 0.73
QS: OK
Max: 2.15
Mean corneal thickness values on rings concentrically to the thinnest location
Corneal Thickness Spatial Profile (CTSP)
Percentage Thickness Increase (PTI)
Df: 1.05
Db: 0.63
Dp: 1.84
Dt: 1.78
Dy: 3.98
D: 2.89

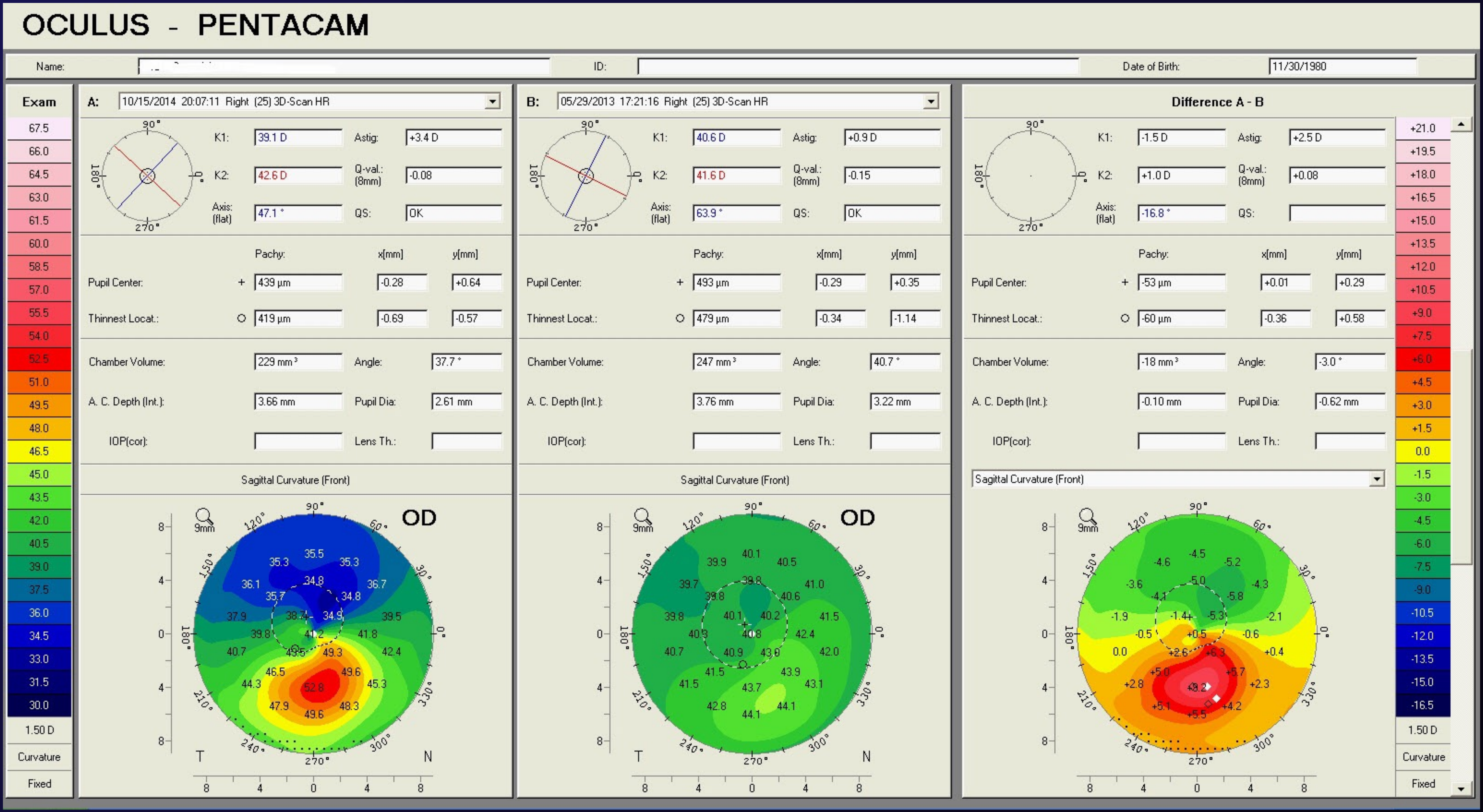
- Since the patient had a documented stable refraction for the past few years, and considering the patient age and gender, corneal collagen cross linking was deferred until documented progression can be detected.
- He was advised not to do any corneal refractive surgery and be followed up after 6 months to detect any further progression of the condition.

# One and a half year later

- The patient came complaining of diminution of vision
- He reported that he underwent a Femtosmile procedure in a different center 6 months earlier
- Manifest refraction:
  - OD: -0.50 -2.75 x 35 correcting to 20/30
  - OS:  -2.00 -3,00 x 120 correcting to 20/30
- The cornea was centrally clear apart from superior faint scar related to the operation and circumferential faint opacity related to the operation in both eyes

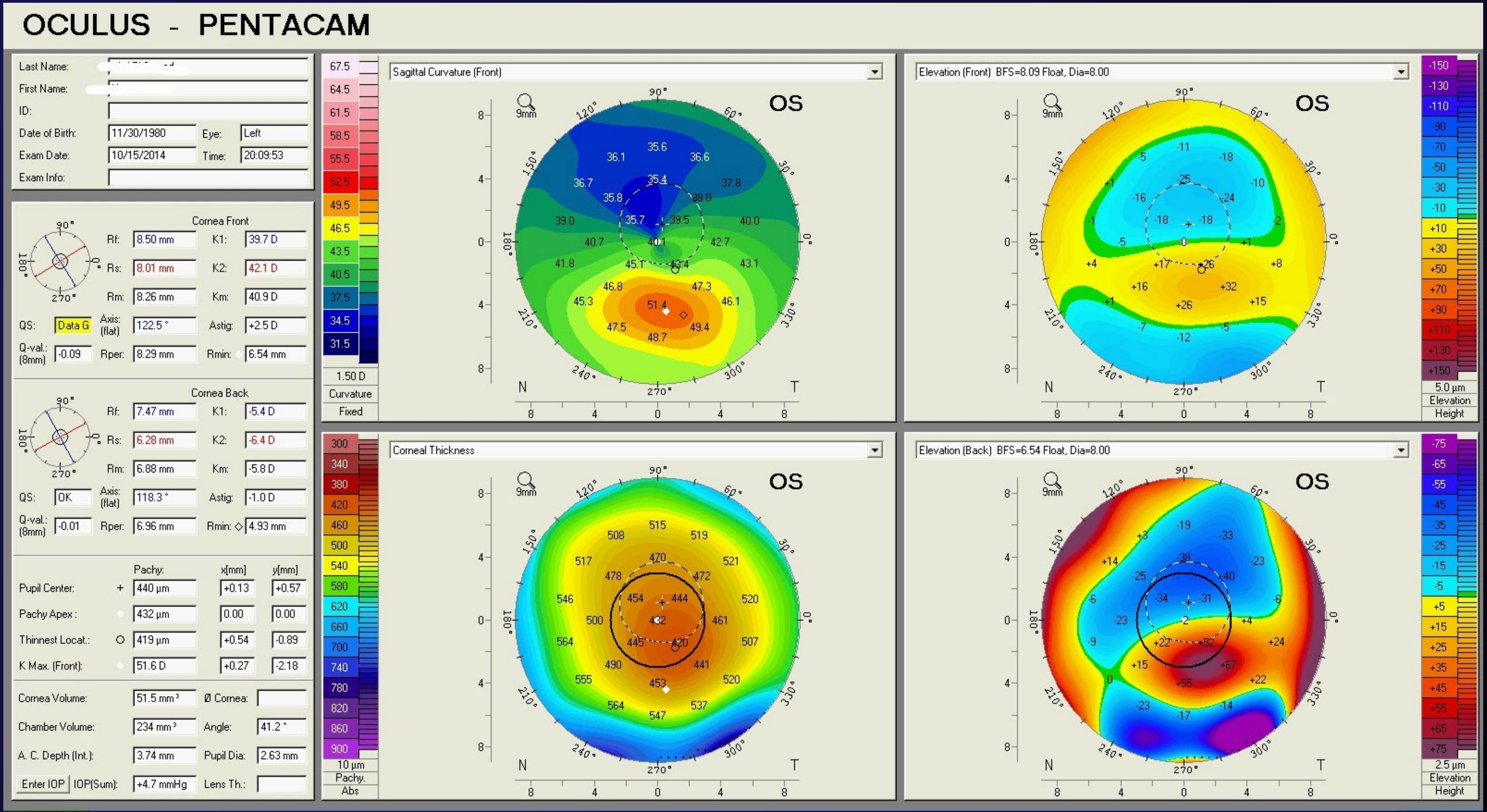
# OD Post-SMILE

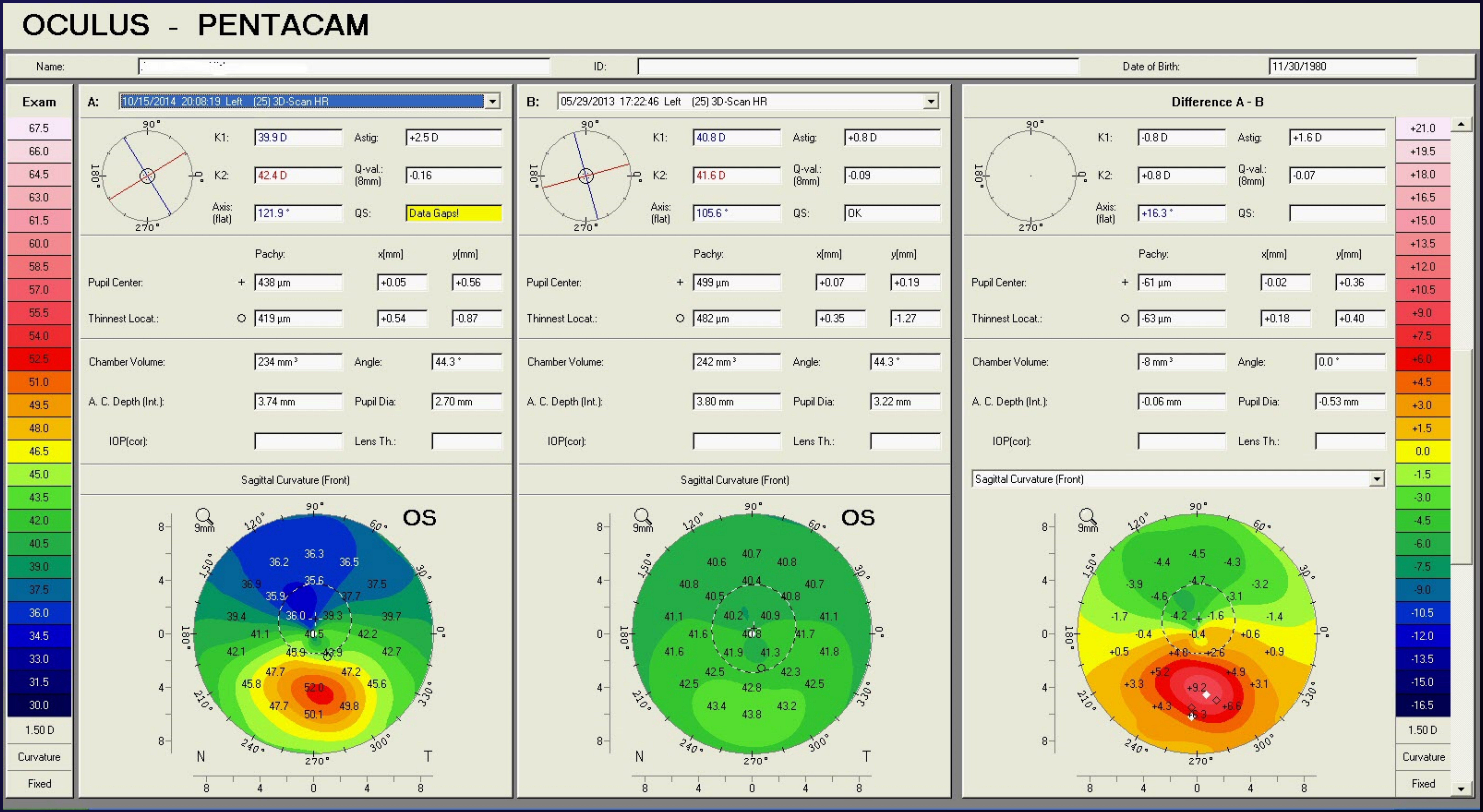




OCULUS - PENTACAM
Name:
ID:
Date of Birth: 11/30/1980
Exam
A: 10/15/2014 20:07:11 Right (25) 3D-Scan HR
K1: 39.1 D
K2: 42.6 D
Axis: (flat) 47.1 °
Astig: +3.4 D
Q-val.: (8mm) -0.08
QS: OK
Pachy: x[mm] y[mm]
Pupil Center: + 439 µm -0.28 +0.64
Thinnest Locat.: O 419 µm -0.69 -0.57
Chamber Volume: 229 mm³
Angle: 37.7 °
A. C. Depth (Int.): 3.66 mm
Pupil Dia: 2.61 mm
IOP(cor):
Lens Th.:
Sagittal Curvature (Front)
OD
B: 05/29/2013 17:21:16 Right (25) 3D-Scan HR
K1: 40.6 D
K2: 41.6 D
Axis: (flat) 63.9 °
Astig: +0.9 D
Q-val.: (8mm) -0.15
QS: OK
Pachy: x[mm] y[mm]
Pupil Center: + 493 µm -0.29 +0.35
Thinnest Locat.: O 479 µm -0.34 -1.14
Chamber Volume: 247 mm³
Angle: 40.7 °
A. C. Depth (Int.): 3.76 mm
Pupil Dia: 3.22 mm
IOP(cor):
Lens Th.:
Sagittal Curvature (Front)
OD
Difference A - B
K1: -1.5 D
K2: +1.0 D
Axis: (flat) -16.8 °
Astig: +2.5 D
Q-val.: (8mm) +0.08
QS:
Pachy: x[mm] y[mm]
Pupil Center: + -53 µm +0.01 +0.29
Thinnest Locat.: O -60 µm -0.36 +0.58
Chamber Volume: -18 mm³
Angle: -3.0 °
A. C. Depth (Int.): -0.10 mm
Pupil Dia: -0.62 mm
IOP(cor):
Lens Th.:
Sagittal Curvature (Front)
67.5 66.0 64.5 63.0 61.5 60.0 58.5 57.0 55.5 54.0 52.5 51.0 49.5 48.0 46.5 45.0 43.5 42.0 40.5 39.0 37.5 36.0 34.5 33.0 31.5 30.0
1.50 D
Curvature
Fixed
+21.0 +19.5 +18.0 +16.5 +15.0 +13.5 +12.0 +10.5 +9.0 +7.5 +6.0 +4.5 +3.0 +1.5 0.0 -1.5 -3.0 -4.5 -6.0 -7.5 -9.0 -10.5 -12.0 -13.5 -15.0 -16.5
1.50 D
Curvature
Fixed

# OS Post-SMILE




OCULUS - PENTACAM
Name:
ID:
Date of Birth: 11/30/1980
Exam
A: 10/15/2014 20:08:19 Left (25) 3D-Scan HR
K1: 39.9 D
K2: 42.4 D
Axis: (flat) 121.9 °
Astig: +2.5 D
Q-val.: (8mm) -0.16
QS: Data Gaps!
Pachy: x[mm] y[mm]
Pupil Center: + 438 µm +0.05 +0.56
Thinnest Locat.: O 419 µm +0.54 -0.87
Chamber Volume: 234 mm³
Angle: 44.3 °
A. C. Depth (Int.): 3.74 mm
Pupil Dia: 2.70 mm
IOP(cor):
Lens Th.:
Sagittal Curvature (Front)
OS
B: 05/29/2013 17:22:46 Left (25) 3D-Scan HR
K1: 40.8 D
K2: 41.6 D
Axis: (flat) 105.6 °
Astig: +0.8 D
Q-val.: (8mm) -0.09
QS: OK
Pachy: x[mm] y[mm]
Pupil Center: + 499 µm +0.07 +0.19
Thinnest Locat.: O 482 µm +0.35 -1.27
Chamber Volume: 242 mm³
Angle: 44.3 °
A. C. Depth (Int.): 3.80 mm
Pupil Dia: 3.22 mm
IOP(cor):
Lens Th.:
Sagittal Curvature (Front)
OS
Difference A - B
K1: -0.8 D
K2: +0.8 D
Axis: (flat) +16.3 °
Astig: +1.6 D
Q-val.: (8mm) -0.07
QS:
Pachy: x[mm] y[mm]
Pupil Center: + -61 µm -0.02 +0.36
Thinnest Locat.: O -63 µm +0.18 +0.40
Chamber Volume: -8 mm³
Angle: 0.0 °
A. C. Depth (Int.): -0.06 mm
Pupil Dia: -0.53 mm
IOP(cor):
Lens Th.:
Sagittal Curvature (Front)
67.5 66.0 64.5 63.0 61.5 60.0 58.5 57.0 55.5 54.0 52.5 51.0 49.5 48.0 46.5 45.0 43.5 42.0 40.5 39.0 37.5 36.0 34.5 33.0 31.5 30.0
1.50 D
Curvature
Fixed
+21.0 +19.5 +18.0 +16.5 +15.0 +13.5 +12.0 +10.5 +9.0 +7.5 +6.0 +4.5 +3.0 +1.5 0.0 -1.5 -3.0 -4.5 -6.0 -7.5 -9.0 -10.5 -12.0 -13.5 -15.0 -16.5
1.50 D
Curvature
Fixed
N
T
9mm

# Ectasia risk: A multifactorial conundrum

Ectasia after corneal refractive surgery remains one of the most insidious and perplexing problems in the day-to-day practice of the refractive surgeon. Although the incidence of ectasia is low, it is the raison d'être for most of the measurements and history obtained in the course of screening patients for refractive surgery.

In this issue of the journal, Ziaei and a group of coauthors representing the Cornea Committee of the American Society of Cataract and Refractive Surgery (ASCRS) present a major review of surgical approaches to managing ectasia (pages 842–872). They summarize key advances in treatment, including combinations of treatments aimed at improving corneal optics and stabilizing progressive disease. Although great progress continues to be made on the therapeutic side of this problem, reliable characterization of ectasia risk remains a challenge. And from every vantage point, avoidance or prevention of ectasia at the preoperative planning stage is much preferred to treating it later.

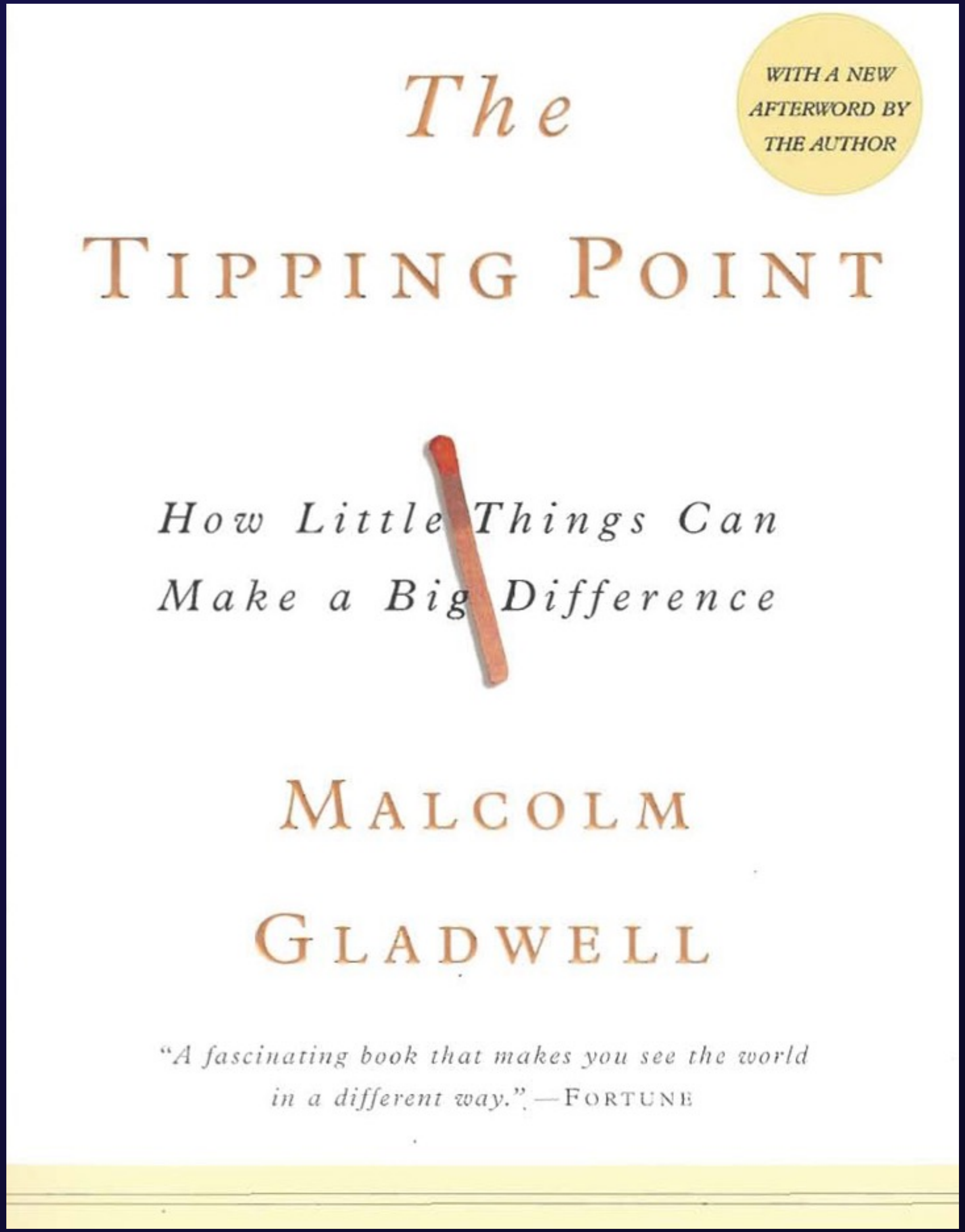
Clinicians can easily assess predisposition for a disorder when a single highly predictive marker is available, such as a specific genetic mutation in a hereditary disease with high expressivity and high penetrance. Unfortunately, refractive surgeons do not have access to a single high-probability marker for ectasia. Ectasia in the setting of refractive surgery is a multifactorial problem, as Randleman et al.[1] illustrated through their landmark retrospective analysis of patient- and procedure-specific risk factors. This reality complicates efforts to quantify risk in the setting of the screening examination, where our ability to both measure and synthesize the major components of risk for a given patient is still incomplete.

Acknowledging the multivariate nature of the problem and appealing to structural principles are critically important for properly conceptualizing risk. From the vantage point of the cornea as a structure, material failure is the final common pathway of ectasia.[2–5] The cor-

The key challenge, then, is to determine—with a limited amount of information and proxy variables—just where on the spectrum of structural behavior a given eye currently resides and how surgical intervention will change that.

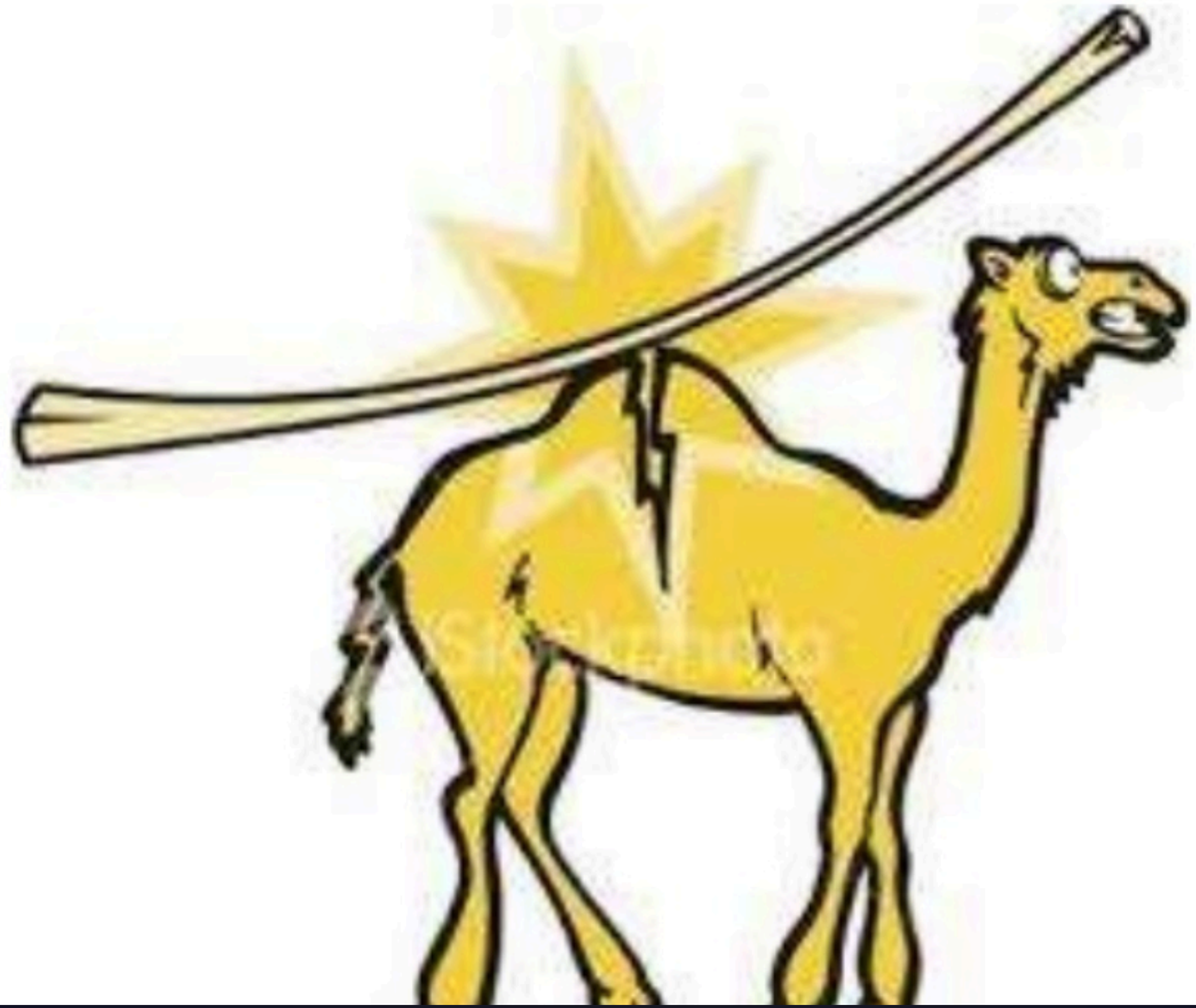
The Case Reports section of this issue features a cautionary example of this process and the clinical stakes of different interpretations of apparent risk. El-Naggar (pages 884–888) presents what might be the first reported cases of corneal ectasia in a patient who had femtosecond small-incision refractive lenticule extraction, an intrastromal procedure that largely preserves the integrity of the anterior stromal collagen structure. Previous publications[8,9] have presented a biomechanical rationale for the potential structural advantages of this approach, and at first glance, the case report could be taken as an indictment of this claim. However, the preoperative tomography showed bilateral evidence of ectatic predisposition suggested by asymmetric inferior topographic steepness, posterior corneal elevation, decentered thinnest corneal points, and low overall corneal thickness. The patient was advised by the author that he was not a laser in situ keratomileusis (LASIK) candidate but then had small-incision refractive lenticule extraction performed elsewhere and returned to the author's clinic 6 months later with evidence of marked progression of inferior steepening and manifest ectasia.

This case offers several learning points. First, ectasia risk assessment is currently sufficiently imprecise that the presence of even 1 perceived risk factor (particularly a topographic risk factor such as inferior steepness) should bias the surgical decision toward observation or tissue-sparing procedures. In the reported case, the patient's older age, low absolute corneal curvatures, refractive stability, and low level of myopic refractive error might have been factored into the decision to proceed with surgery despite the concerns apparent on tomography. This point is


WITH A NEW AFTERWORD BY THE AUTHOR
The
TIPPING POINT
How Little Things Can Make a Big Difference
MALCOLM GLADWELL
"A fascinating book that makes you see the world in a different way." —FORTUNE


TIPPING
POINT

# *The straw that broke the camel's back*



May 2015

CASE REPORT

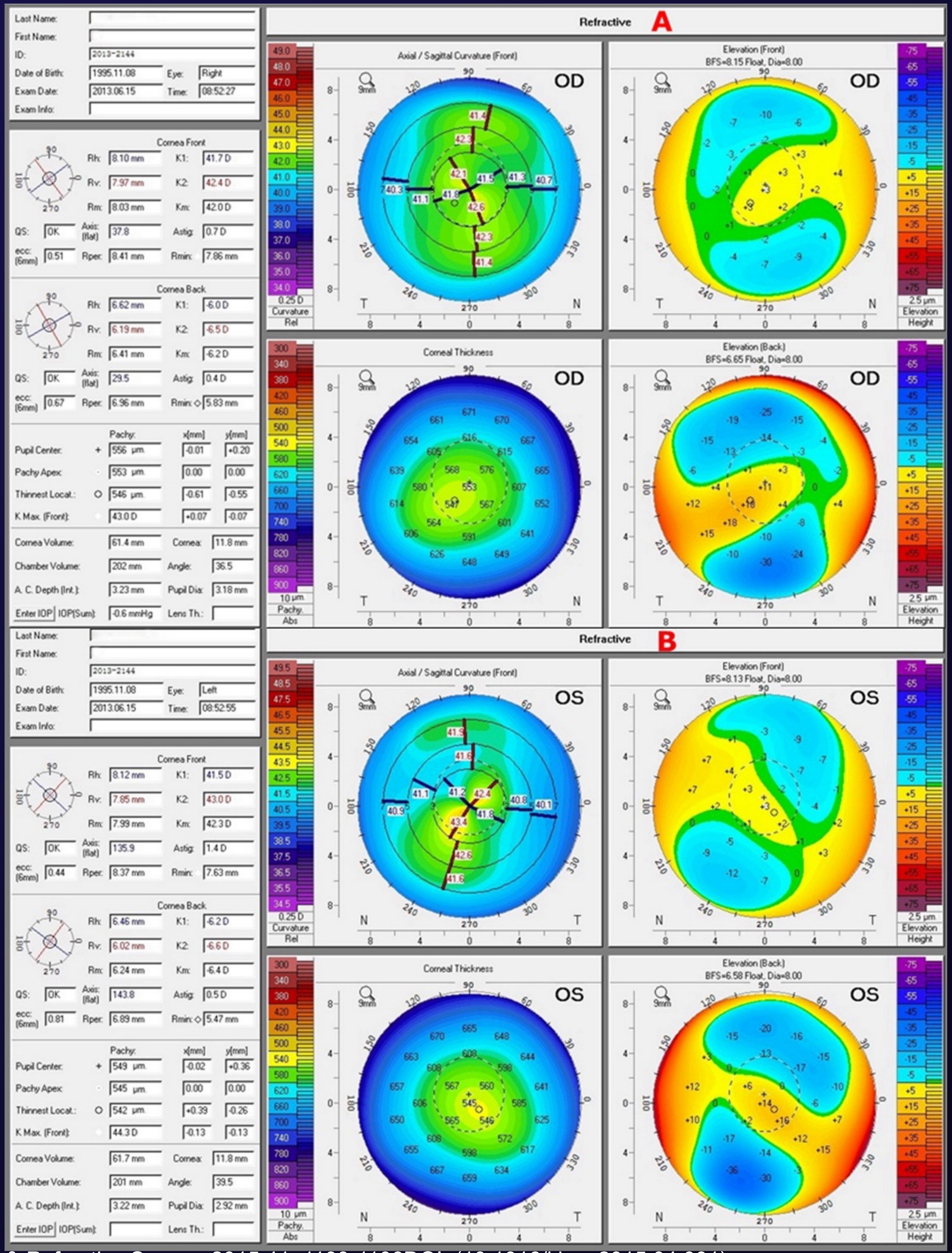
# Corneal ectasia 6.5 months after small-incision lenticule extraction

Yumeng Wang, MM, Chuanbo Cui, MD, Zhiwei Li, PhD, Xiangchen Tao, MD, Chunxiao Zhang, MM, Xiao Zhang, MM, Guoying Mu, MD

Our case involves a 19-year-old patient with forme fruste keratoconus. Small-incision lenticule extraction was performed, and 6.5 months after surgery, corneal ectasia was diagnosed. Preoperatively, the minimum central corneal thickness was 546 μm in the right eye and 542 μm in the left eye; the refractive correction was −6.75 −1.00 × 45 and −6.75 −0.75 × 140, respectively; the lenticular thickness was 137 μm and 135 μm, respectively. At 6.5 months, ectasia was diagnosed based on anterior and posterior surface keratometry of 38.4/39.5 diopters (D) and −6.3/−6.8 D, respectively, in the right eye and 38.6/40.8 D and −7.1/−6.6 D, respectively, in the left eye. The keratometry increased gradually and the corneal thickness decreased after surgery, and these trends continued during the 13-month follow-up. This report documents corneal ectasia as a complication of small-incision lenticule extraction and highlights the importance of preoperative evaluation and the need for long-term follow-up.

**Financial Disclosure:** No author has a financial or proprietary interest in any material or method mentioned.

*J Cataract Refract Surg 2015; 41:1100–1106 © 2015 ASCRS and ESCRS*




*Journal of Cataract & Refractive Surgery* 2015 41, 1100-1106DOI: (10.1016/j.jcrs.2015.04.001)

## Treatment data

**OD**

| | |
|---|---|
| Treatment pack size: | S |
| Suction time [hh:mm:ss]: | 00:00:29 |

**Cap data**

| | |
|---|---|
| Diameter [mm]: | 7.60 |
| Thickness [µm]: | 120 |
| Side cut angle [°]: | 120 |
| Incision position [°]: | 90 |
| Incision angle [°]: | 53 |
| Incision width [mm]: | 3.52 |

Nomogram info

**Refraction, Version 3.0**

**Lenticule data**

| | | | | |
|---|---|---|---|---|
| Optical zone [mm]: | | 6.60 | | |
| Transition zone [mm]: | | 0.10 | | |
| Thickness [µm]: | Min: 15 | | Max: | 137 |
| Side cut angle [°]: | | 110 | | |
| Refractive correction | | | | |
| Sphere [D]: | | -6.75 | | |
| Cylinder [D]: | | -1.00 | | |
| Axis [°]: | | 45 | | |

## Treatment data

**OS**

| | |
|---|---|
| Treatment pack size: | S |
| Suction time [hh:mm:ss]: | 00:00:29 |

**Cap data**

| | |
|---|---|
| Diameter [mm]: | 7.60 |
| Thickness [µm]: | 120 |
| Side cut angle [°]: | 120 |
| Incision position [°]: | 90 |
| Incision angle [°]: | 53 |
| Incision width [mm]: | 3.52 |

Nomogram info

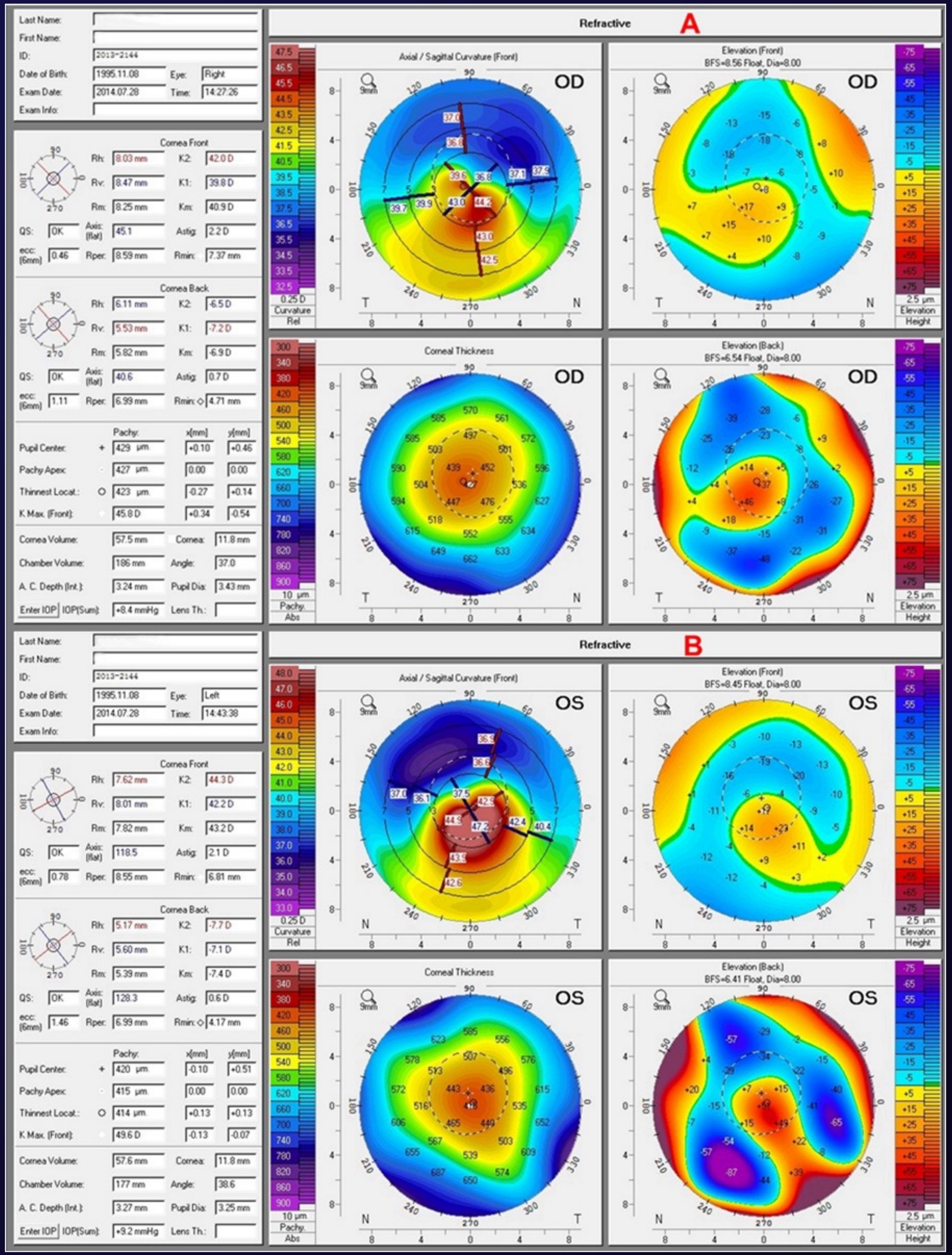
**Refraction, Version 3.0**

**Lenticule data**

| | | | | |
|---|---|---|---|---|
| Optical zone [mm]: | | 6.60 | | |
| Transition zone [mm]: | | 0.10 | | |
| Thickness [µm]: | Min: 15 | | Max: | 134 |
| Side cut angle [°]: | | 110 | | |
| Refractive correction | | | | |
| Sphere [D]: | | -6.75 | | |
| Cylinder [D]: | | -0.75 | | |
| Axis [°]: | | 140 | | |

ELSEVIER

*Journal of Cataract & Refractive Surgery* DOI: (10.1016/j.jcrs.2015.04.001)




*Journal of Cataract & Refractive Surgery* DOI: (10.1016/j.jcrs.2015.04.001)

September 2015

# Unilateral corneal ectasia following small-incision lenticule extraction

Gitansha Sachdev, MS, FICO, Mahipal S. Sachdev, MD, Ritika Sachdev, MS, Hemlata Gupta, MS, DNB, FAICO

We describe a case of unilateral corneal ectasia in a 26-year-old man following small-incision lenticule extraction. The preoperative corneal topography was normal, with a minimum corneal thickness of 511 μm and 513 μm in the right eye and left eye, respectively. Lenticules of 85 μm and 82 μm were fashioned to offer a refractive correction of −3.75 −1.50 × 180 and −3.50 −1.50 × 165 in the right eye and left eye, respectively. Twelve months after small-incision lenticule extraction, the patient presented with early signs of ectasia in the left eye on corneal topography, which had worsened at the 18-month examination. Intrastromal corneal ring segment implantation with corneal collagen crosslinking was performed to arrest further progression and to improve uncorrected distance visual acuity. On the last examination, the corrected distance visual acuity was $20/20^{-2}$.

**Financial Disclosure:** Dr. Mahipal S. Sachdev receives travel grants from Carl Zeiss Meditec AG. No author has a financial or proprietary interest in any material or method mentioned.

*J Cataract Refract Surg 2015; 41:2014–2018* © *2015 ASCRS and ESCRS*

Iatrogenic corneal ectasia, although rare, is possibly the most dreaded complication following refractive surgery. It has been reported after laser in situ keratomileusis (LASIK) and photorefractive keratectomy.[1–4] Two cases of bilateral ectasia following small-incision lenticule extraction (SMILE, Carl Zeiss Meditec AG) were reported in patients with forme fruste keratoconus.[5,6] We report a case of unilateral ectasia following small-incision lenticule extraction in a patient with normal corneal topography.

## CASE REPORT

A 26-year-old man presented to our cornea clinic requesting

(CDVA) was 20/20 in both eyes. The patient had no family history of keratoconus. The complete preoperative workup was within normal limits. Scheimpflug imaging (Pentacam, Oculus Optikgeräte GmbH) revealed a normal topography with a maximum keratometry (K) value of 44.9 diopters (D) in the right eye and 45.1 D in the left eye, with minimal thickness of 511 μm and 513 μm, respectively. The anterior and posterior elevation maps were also unremarkable (Figure 1). No significant inferior–superior asymmetry was noted on the curvature maps (Figure 2).

Uneventful femtosecond laser small-incision lenticule extraction was performed. The cap thickness was 110 μm with an optical zone of 6.0 mm and a corneal side cut of 3.0 mm. The lenticule thickness in the right eye and left eye was 85 μm and 82 μm, respectively, with a residual stromal bed (RSB) of 304 μm and 305 μm, respectively

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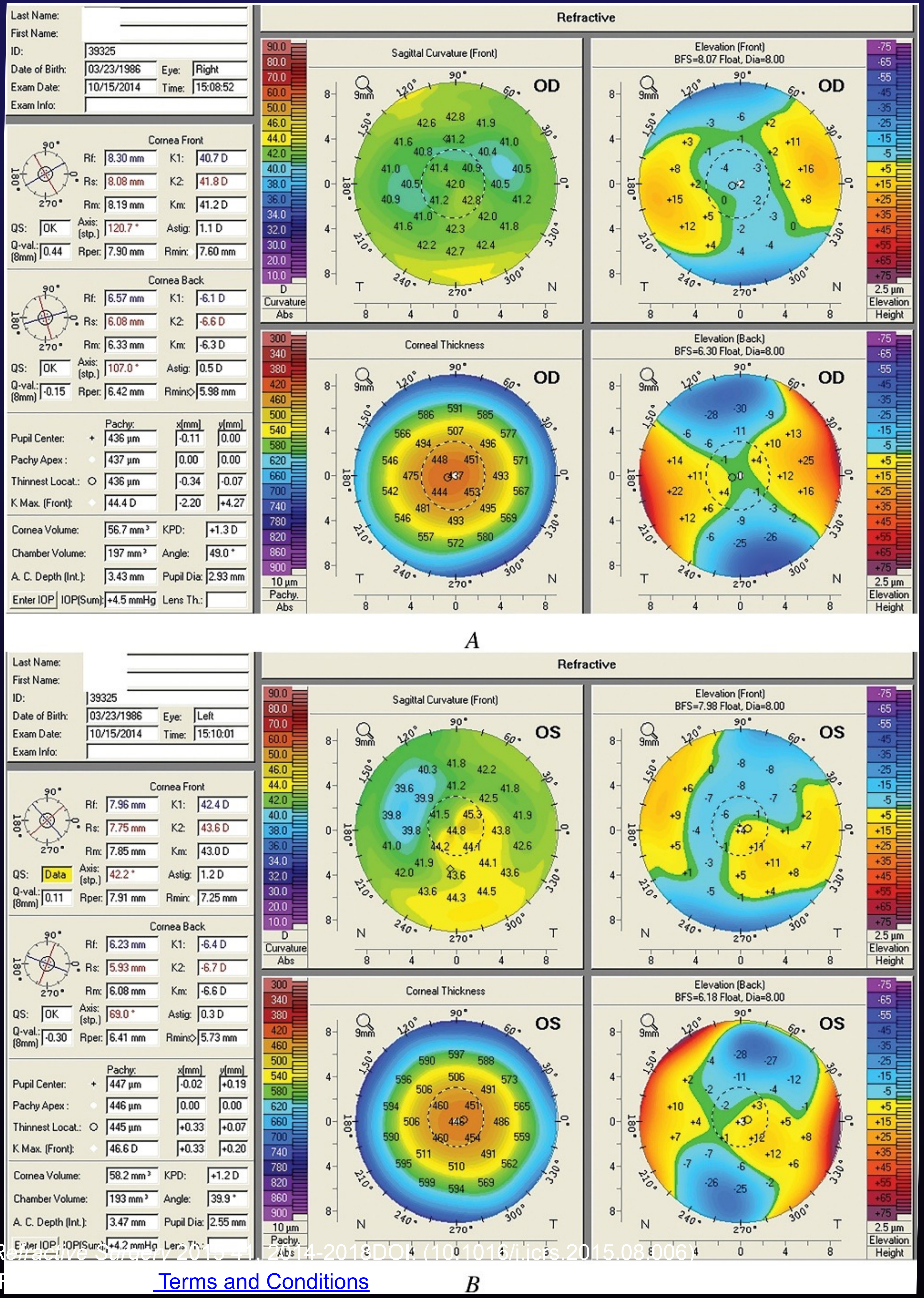
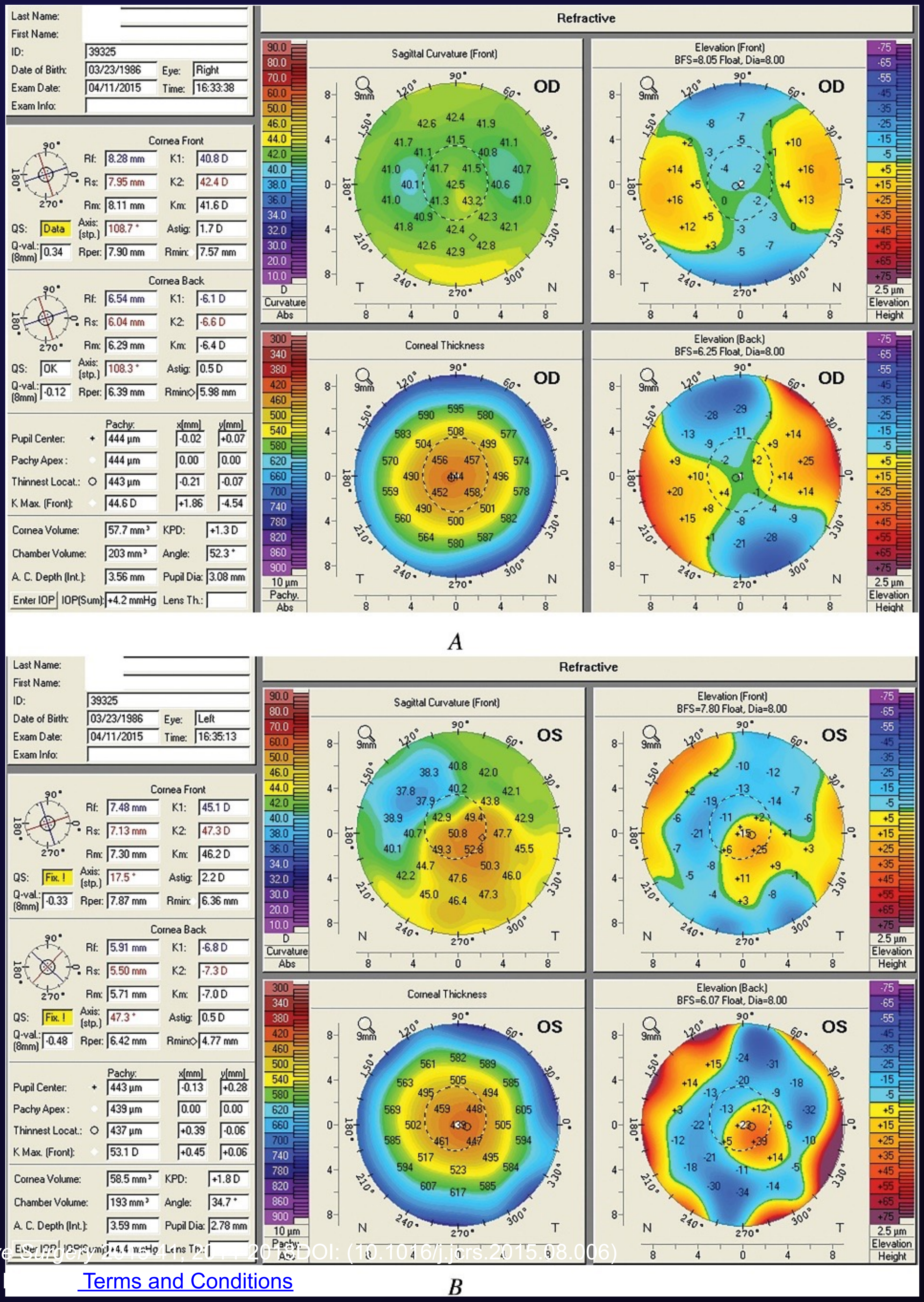
*Journal of Cataract & Refractive Surgery* 2015 41, 2014-2018DOI: (10.1016/j.jcrs.2015.08.006)

Figure 3


*Journal of Cataract & Refractive Surgery* 2015 41, 2014-2018DOI: (10.1016/j.jcrs.2015.08.006)




Journal of Cataract & Refractive Surgery 2015 41, 2014-2019DOI: (10.1016/j.jcrs.2015.08.006)




Journal of Cataract & Refractive … DOI: (10.1016/j.jcrs.2015.08.006)

REPORT

# Bilateral Ectasia After Femtosecond Laser-Assisted Small Incision Lenticule Extraction (SMILE)

Jaakko S. Mattila, MD; Juha M. Holopainen, MD, PhD

**Journal of Refractive Surgery. 2016;32(7):497-500** https://doi.org/10.3928/1081597X-20160502-03

Posted July 13, 2016

ABSTRACT | FULL TEXT | FIGURES/TABLES | REFERENCES | VIEW PDF

## Abstract

**PURPOSE:**

To describe a case of bilateral ectasia after small incision lenticule extraction (SMILE) in a patient with early keratoconus.

**METHODS:**

Case report.

**RESULTS:**

Bilateral SMILE was performed on a patient even though preoperative topographies showed changes indicating early keratoconus. The right eye underwent further photorefractive keratectomy enhancement 18 months later. The patient developed a bilateral corneal ectasia.

**CONCLUSIONS:**

This case underlines the importance of thorough preoperative assessment for possible keratoconus suspect changes with corneal topography to avoid postoperative ectasia.

**[*J Refract Surg*. 2016;32(7):497–500.]**

# Ectasia After Corneal Refractive Surgery: Nothing to SMILE About

J. Bradley Randleman, MD

Since the first reports in 2011,[1,2] small incision lenticule extraction (SMILE) has dramatically entered the landscape of corneal refractive surgical procedures. With offerings of a single laser system, less disruption of the corneal surface, and relative preservation of the anterior lamellar fibers, SMILE has promised excellent refractive outcomes and possible advantages over previous iterations of laser refractive surgery.

One of the postulated advantages is biomechanical. Through maintenance of the anterior lamellae, SMILE in theory maintains a stronger cornea postoperatively. Mathematical modeling[3] and finite element analysis[4] lend some support to this view. Clinically, the extent of this biomechanical benefit remains to be determined.

Postoperative ectasia remains a feared complication of corneal refractive surgery and has driven the development of technology and patient screening protocols for more than a decade. Although there remains controversy in some aspects of screening,[5-8] there are many identified topographic and tomographic patterns that have been shown to place patients at higher risk for postoperative ectasia and that are recognized as at least relative contraindications for excimer laser procedures, including LASIK and surface ablation.[9,10]

Although a relatively new procedure, there are already a handful of reports of ectasia developing after SMILE.[11-14] In this issue, the Journal is contributing an additional case to the literature.[15] To date, all of these cases have exhibited abnormal preoperative topographic patterns, and most if not all would have been excluded from LASIK during screening by most surgeons. *And that is the point of this editorial.*

*From Emory Eye Center and Emory Vision, Atlanta, Georgia.*

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*doi:10.3928/1081597X-20160613-01*

## LESSONS FROM THE PAST

Corneal refractive surgery has provided immense benefit to our patients worldwide for more than 50 years, with greatest adoption of a few procedures: radial keratotomy, followed by photorefractive keratectomy (PRK), followed by LASIK. Each of those procedures offered unique benefits to patients, and each came with unique risks. With each technique, initial treatment parameters proved too broad and each saw a narrowing of their scope. There were several patients with 16 or more radial keratotomy incisions until surgeons realized that eight cuts or less proved significantly more stable over time. There are many early reports of outcomes for PRK or LASIK up to -20.00 diopters or more, whereas today's excimer lasers are not approved for that range and most surgeons stop well short of treating that degree of myopia. And topographic patterns that placed patients at risk for ectasia were clarified in part through evaluating cases with these patterns that developed the complication.[16,17]

We now have amassed extensive knowledge about how the cornea responds to laser surgical alteration, how preoperative corneal biomechanics, determined through screening topography and tomography, affect candidacy and long-term stability, and how the amount of tissue altered through surgery affects risk.[18] So, let us use this information to our advantage as we perform and study the novel surgical approach that is SMILE.

## STARTING CONSERVATIVELY

With SMILE we have an opportunity to do things a better way from the outset, during the phase of possible widespread use of the procedure. This better way includes using a cautious, conservative, and scientific approach relying on evidence-based medicine to drive surgical decision-making. We can use the information from screening patients for 20 years for PRK and LASIK, especially what we've learned in the past 10 years, and apply those standards to SMILE.

We have identified many abnormal topographic patterns as contraindications for LASIK. We know from

 

Clinical Ophthalmology

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REVIEW

# Ectasia following small-incision lenticule extraction (SMILE): a review of the literature

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Clinical Ophthalmology
15 September 2017
Number of times this article has been viewed

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Julio C Albarracin[3]
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**Purpose:** Four cases of corneal ectasia after small-incision lenticule extraction (SMILE) have been reported. In this review, we provide an overview of the published literature on corneal ectasia after SMILE and risk factors associated with this complication.

**Methods:** Case reports were identified by a search of seven electronic databases for pertinent heading terms between 2011 and July 2017. We identified patient characteristics and surgical details including preoperative topography, central corneal thickness, and anterior keratometry (Km). Residual stromal bed (RSB) values not reported were computed using VisuMax ReLEx SMILE software Version 2.10.10. Preoperative ectasia risk was measured using the Randleman Ectasia Risk Score System (ERSS). Percent tissue alteration was calculated for each patient as described by Santhiago et al.

**Results:** Seven eyes of four patients developed corneal ectasia post SMILE. Two patients had abnormal topography in both eyes. One patient had abnormal topography in one eye. Only one patient was noted to have normal topography in both eyes and later developed ectasia in one eye in the absence of any known risk factors. The mean Randleman ectasia risk score was 4±3 (range: 1–8). The mean calculated percent tissue altered (PTA) was 38%±6% (range: 30%–47%).

**Conclusion:** A majority of reported ectasia cases occurred in patients with subclinical keratoconus. These conditions may be exacerbated by SMILE and should be considered abso-

# Misinterpretation of topographic early keratoconus, with consequent post small-incision lenticule extraction ectasia

Sherif A. Eissa

Department of Ophthalmology, Cairo University, Cairo, Egypt

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**Accepted** 27 April 2017

**Delta Journal of Ophthalmology**
2017, 18:182–184

The purpose of this paper is to describe an infrequent complication of small-incision lenticule extraction. Bilateral corneal ectasia that was discovered 6 months postoperatively is described here. The case has shown that the procedure can aggravate early keratoconus cases without any advantage over laser in-situ keratomileusis or surface ablation procedures. Placido disk imaging with correct scaling and color coding of Scheimpflug images is essential in the preoperative assessment of small-incision lenticule extraction patients.

**Keywords:**
ectasia, keratoconus, placido, Scheimpflug, SMILE

DJO 18:182–184

1110-9173

## Introduction

Femtosecond lenticule extraction and small-incision lenticule extraction (SMILE) have not been thoroughly investigated. However, they have shown encouraging results in the treatment of myopia and myopia with mild to moderate astigmatic error [1,2]. SMILE represents a less invasive alternative to laser in-situ keratomileusis (LASIK) for the correction of myopic error, without disruption of the Bowman's layer. However, microdistortions have been observed in the Bowman's layer in patients who had SMILE, which resulted from unavoidable tissue compression from shortening of the cap's arc length, without adversely affecting vision [3].

## Case history

A 26-year old Egyptian male patient presented with a history of previous SMILE (Carl Zeiss Meditec AG, Jena, Germany) procedure in Egypt 5 months earlier. He complained of progressively decreasing vision in his left eye with glare and halos in both eyes (OU). His visual acuity was 20/30 in the right eye that corrects to 20/25 with −0.75/−0.75×10. Left eye visual acuity was 20/400

Corneal thickness spatial profile showed normal pattern both eyes. Keratometry readings on the anterior corneal surface sagittal map were relatively flat (right eye: 41.9 and 42.5 D and left eye: 43.0 and 43.6 D), which tempted the surgeon to proceed with SMILE, especially with cold color code and wrong scaling on the posterior elevation map (5 µm). However, the surgeon overlooked suspicious indices, especially in the absence of placido disk imaging on preoperative assessment. Suspicious findings included posterior elevation of +20 µm in both eyes at the border of the central 5 mm circle, high index of height decentration and index of height asymmetry, especially in the left eye, and high I–S ratio on sagittal map left eye, with an early vortex pattern.

## Discussion

Although Wu and Wang [4] have found a statistically significant elevation in corneal hysteresis and corneal resistance factor in SMILE, compared with femtosecond laser-assisted LASIK, the superiority of biomechanical stability with SMILE has not been convincingly demonstrated and future analysis should clarify this aspect [4].

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DOI: 10.1002/jbio.201800253

Journal of BIOPHOTONICS

FULL ARTICLE

# Corneal tomographic features of postrefractive surgery ectasia

Pooja Khamar[1] | Ritika Dalal[1] | Rachana Chandapura[2] | Mathew Francis[2] | Rohit Shetty[1] | Everette J. R. Nelson[3] | Rudy M. M. A. Nuijts[4] | Abhijit Sinha Roy[2*]

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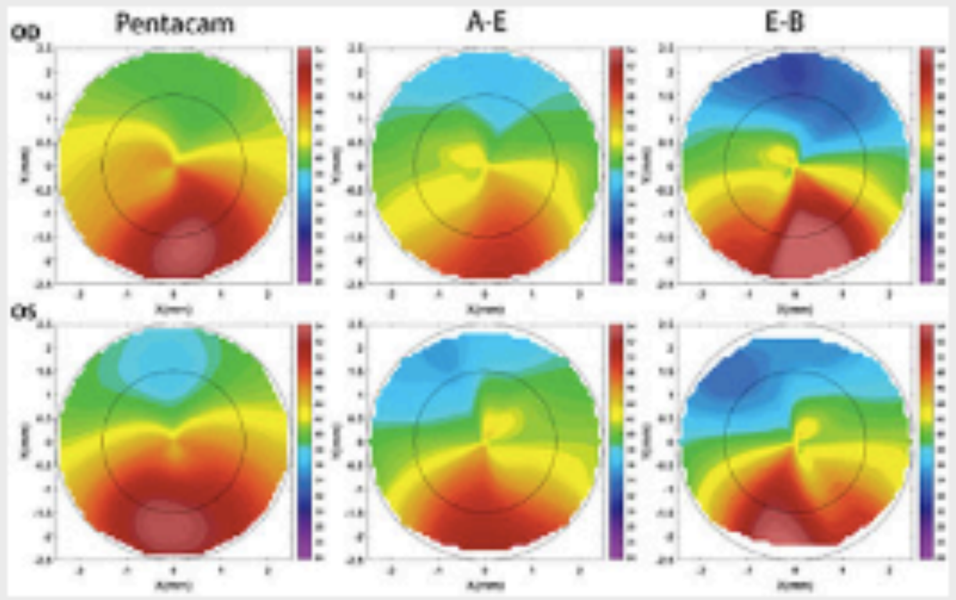
Indo-German Science and Technology Center, Grant/Award Number: SIBAC

The purpose of this study was to evaluate the tomographic features of postrefractive surgery eyes. This was a retrospective evaluation of clinical data. Three patients with post-LASIK (laser-assisted in situ keratomileusis) and two patients with post-SMILE (small incision lenticule extraction) ectasia were imaged with Scheimpflug imaging (SI, Pentacam) and optical coherence tomography (OCT, RTVue). Curvature and wavefront aberrations of the air-epithelium interface (A-E) and epithelium-Bowman's layer interface (E-B) were derived. OCT of normal and keratoconic eyes from an earlier study were compared with the data of the ectasia eyes. Curvature and aberrometry of the A-E interfaces were statistically similar between SI and OCT. However, OCT revealed a steeper and more aberrated E-B interface than A-E though correlation between them was inferior to the correlation for keratoconic eyes. Furthermore, the magnitude of differences between the A-E and E-B interfaces was greater in the ectasia eyes than the keratoconic eyes. OCT could possibly assist better in selecting appropriate treatment plan for postrefractive surgery ectasia eyes than conventional tomographers.




KEYWORDS
ectasia, cornea, SMILE, LASIK, tomography, OCT, Bowman's layer

September 2018

CASE REPORT

# Unilateral corneal ectasia after small-incision lenticule extraction in a 43-year-old patient

*Jean Christophe Gavrilov, MD, Raphael Atia, MD, Vincent Borderie, MD, PhD, Laurent Laroche, MD, Nacim Bouheraoua, MD, PhD*

Unilateral corneal ectasia developed after small-incision lenticule extraction for mild myopia in a 43-year-old man with preoperative asymmetric astigmatism. The ectasia was diagnosed 4 years postoperatively. Preoperative data showed asymmetric astigmatism with no signs of forme fruste keratoconus. Inferior anterior curvature steepening exceeded 2.00 diopters without bulging of the posterior curvature, and pachymetric thickness exceeded 515 μm. Corneal ectasia can occur after small-incision lenticule extraction in patients older than 40 years with preoperative asymmetric astigmatism.

*J Cataract Refract Surg 2018; 44:403–406 © 2018 ASCRS and ESCRS*

March 2018

Since the first description of small-incision lenticule extraction (SMILE, Carl Zeiss Meditec AG) in 2011 by Sekundo et al.,[1] the number of procedures performed to correct myopia and astigmatism with this new technique has steadily increased. The incidence of corneal ectasia after laser in situ keratomileusis (LASIK) has been estimated at 1 in 2500.[2] Because small-incision lenticule extraction is a flapless procedure, it has been suggested that the risk for corneal ectasia after small-incision lenticule extraction is lower than after LASIK.[3] To date, 4 reports of corneal ectasia have been published.[4–8] We report a case of unilateral corneal ectasia 4 years after small-incision lenticule extraction for mild myopia in a patient older than 40 years with preoperative asymmetric

eyes, representing a steepening of more than 2.00 diopters (D) in the right eye and 1.80 D in the left eye. Moreover, Scheimpflug camera images showed an absence of posterior curvature bulging and no correspondence between the steeper anterior curvature and the thinner points of the cornea.

Small-incision lenticule extraction was performed uneventfully with the Visumax femtosecond laser system (Carl Zeiss Meditec AG). The caps were 7.30 mm in diameter and 120 μm thick in both eyes. The diameter of the optical zone was 6.50 mm in both eyes. The maximum and minimum lenticule thicknesses were 94 μm and 15 μm, respectively, in the right eye and 109 μm and 15 μm, respectively, in the left eye, with a residual stromal bed (RSB) of 308 μm in the right eye and 286 μm in the left eye. The immediate postoperative course was uneventful, with an uncorrected distance visual acuity of 20/20 in both eyes at the 1-month examination.

Four years after the initial small-incision lenticule extraction,

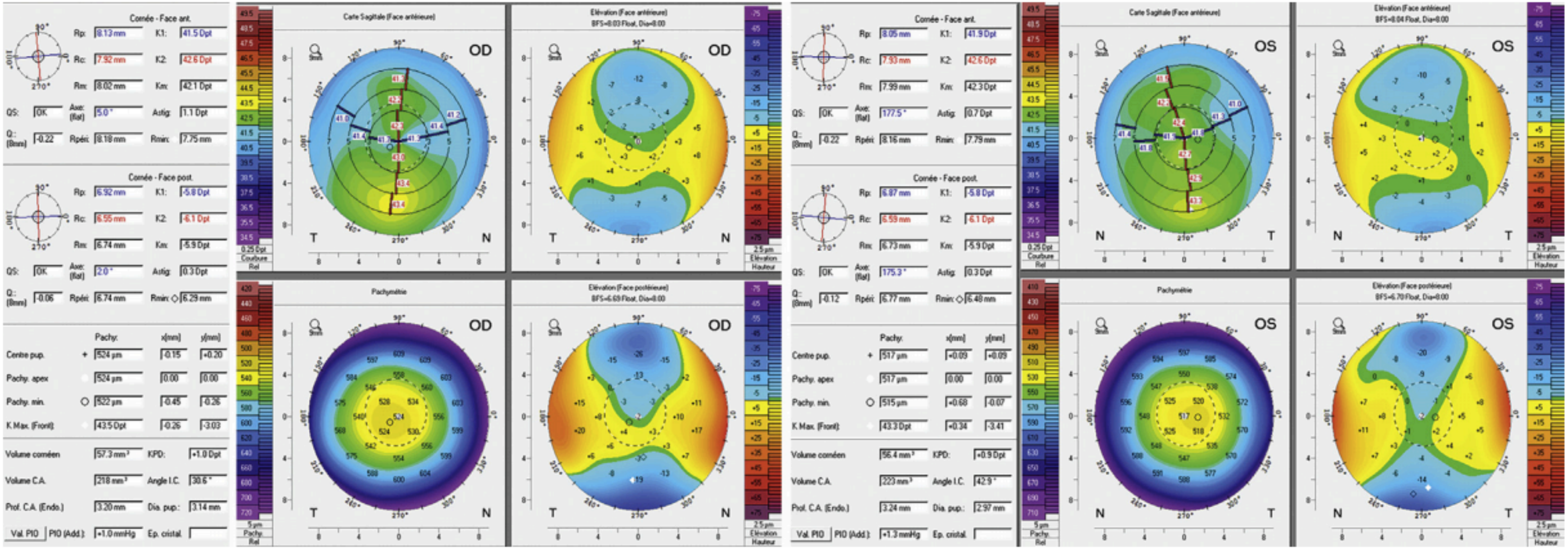



**Figure 1.** Scheimpflug-based corneal topography showing sagittal map, pachymetry map, anterior elevation map, and posterior elevation map before small-incision lenticule extraction (N = nasal; T = temporal).

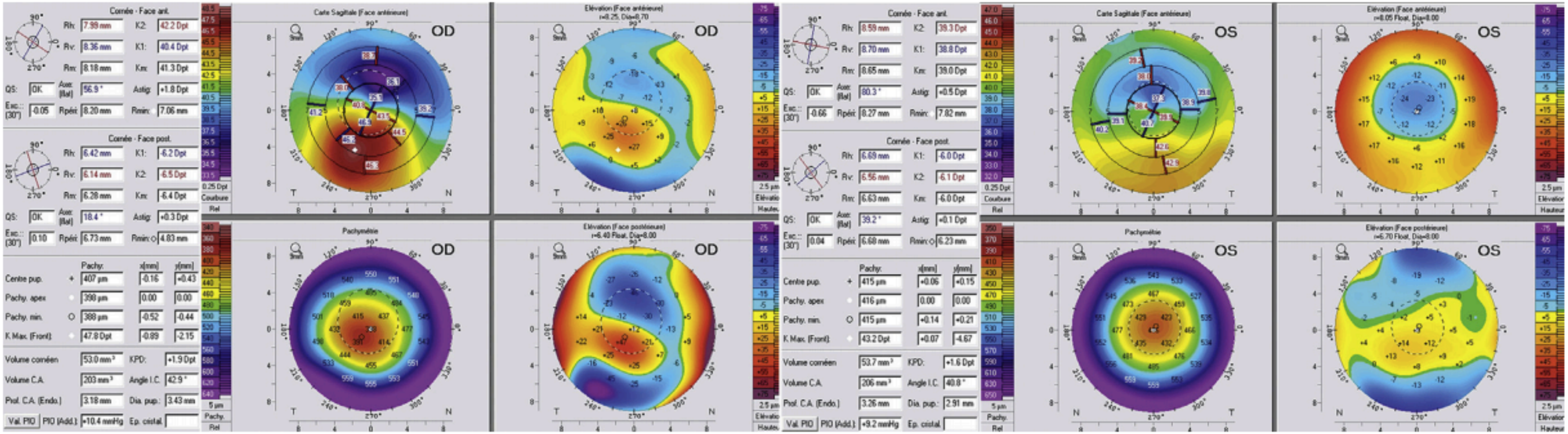


**Figure 3.** Scheimpflug-based corneal topography showing sagittal map, pachymetry map, anterior elevation map, and posterior elevation map 4.5 years after small-incision lenticule extraction (N = nasal; T = temporal).

CASE REPORT

# Unilateral ectasia after small-incision lenticule extraction

Eric E. Pazo, MSc, MD, PhD, Richard N. McNeely, BSc, PhD, Samuel Arba-Mosquera, MSc, PhD, Christoph Palme, MD, Jonathan E. Moore, PhD, FRCOphth

December 17, 2018

A 23-year-old man developed unilateral corneal ectasia after bilateral small-incision lenticule extraction (SMILE). The preoperative corneal topography was normal, with a minimum corneal thickness of 582 μm and 586 μm in the right eye and left eye, respectively. The refractive correction was –3.00 diopters (D) sphere in the right eye and –3.50 D sphere in the left eye. At the 12-month postoperative visit, corneal topography showed early signs of ectasia in the right eye; the ectasia had deteriorated by the 15-month examination. Corneal crosslinking was performed to arrest further progression. At the last examination, the uncorrected distance visual acuity in the right eye was 0.1 logarithm of the minimum angle of resolution (logMAR) and the corrected distance visual acuity, –0.1 logMAR.

*J Cataract Refract Surg 2018; ■:■–■* © 2018 ASCRS and ESCRS

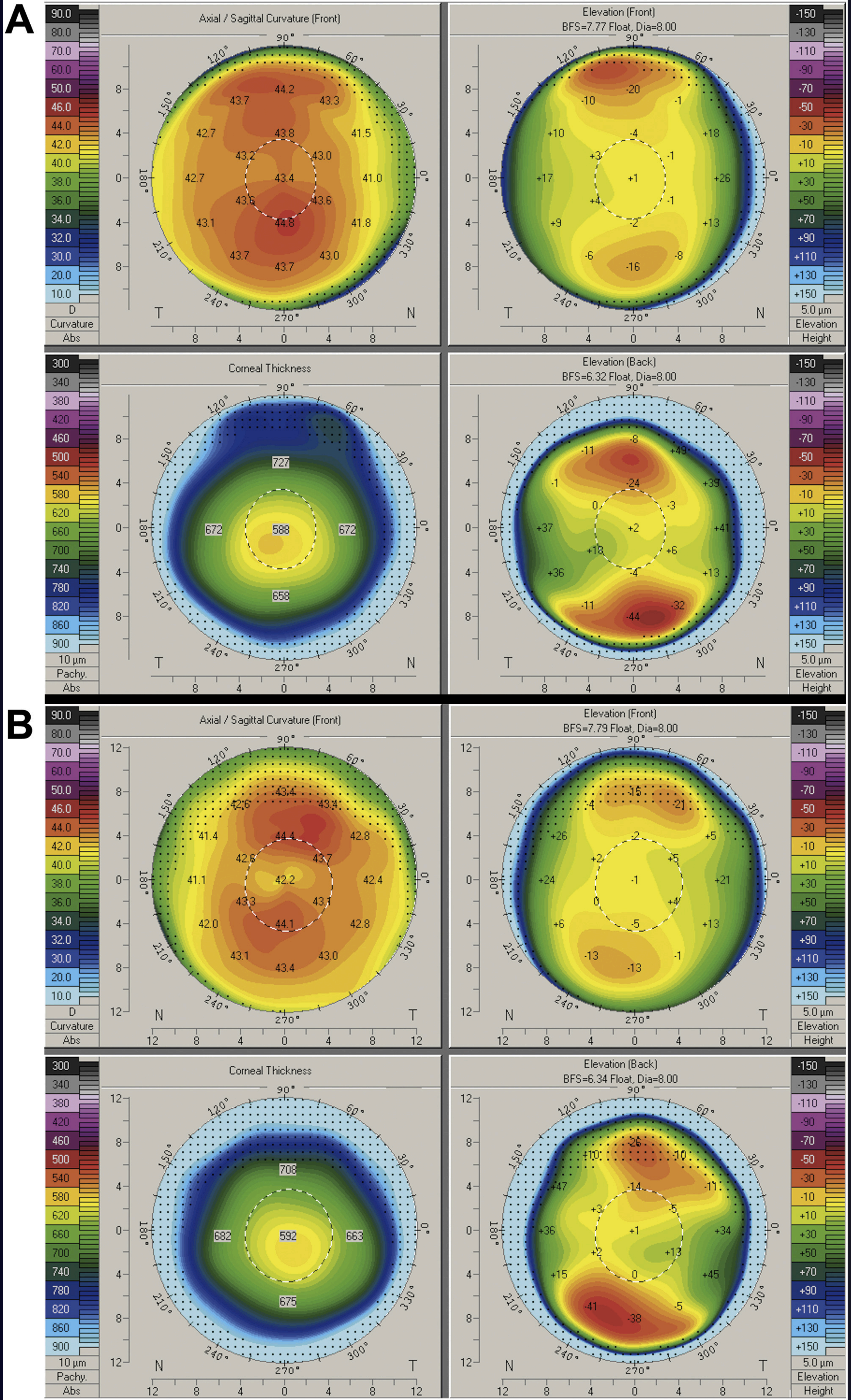
At present, the prevalence of ectasia after laser in situ keratomileusis (LASIK) has been estimated to be between 0.04% and 0.6%.[1] A review article by Moshirfar et al.[2] found that at the time of publication, only 4 cases of corneal ectasia after small-incision lenticule extraction (SMILE, Carl Zeiss Meditec AG) had been documented and reported.[3–6] A proposed advantage of small-incision lenticule extraction is a stronger postoperative biomechanical effect as a result of the anterior stromal lamellae being maintained. This theory is supported by mathematical modeling[7] and finite element analysis[8]; however, the practicality of this benefit remains to be proven clinically.

## CASE REPORT

A 23-year-old man presented to the clinic requesting corneal refractive surgery for myopic correction. He had no history or symptoms of dry eye, atopy, or allergies of which he was aware. The preoperative refractive error was

family history of keratoconus and had a stable refraction for more than 2 years. A complete preoperative ophthalmologic examination was performed and all parameters were within normal limits. Scheimpflug imaging (Pentacam, Oculus Optikgeräte GmbH) showed normal topography with a maximum keratometry (K) value of 44.9 D in the right eye and 45.0 D in the left eye and a minimum thickness of 582 μm and 586 μm, respectively. The anterior and posterior elevation maps were also unremarkable (Figure 1). No significant inferior–superior asymmetry was noted on the curvature maps. The fluorescein tear breakup time (TBUT) was 15 seconds in the right eye and 14 seconds in the left eye.

Uneventful bilateral small-incision lenticule extraction was performed. The cap thickness was 135 mm with an optical zone of 6.50 μm and a corneal side cut of 2.41 mm. The lenticule thickness was 63 μm in the right eye and 71 μm in the left eye with a residual stromal bed (RSB) of 384 μm and 380 μm, respectively (Figure 2).


A
Axial / Sagittal Curvature (Front)
Elevation (Front)
BFS=7.77 Float, Dia=8.00
Corneal Thickness
Elevation (Back)
BFS=6.32 Float, Dia=8.00
B
Axial / Sagittal Curvature (Front)
Elevation (Front)
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Corneal Thickness
Elevation (Back)
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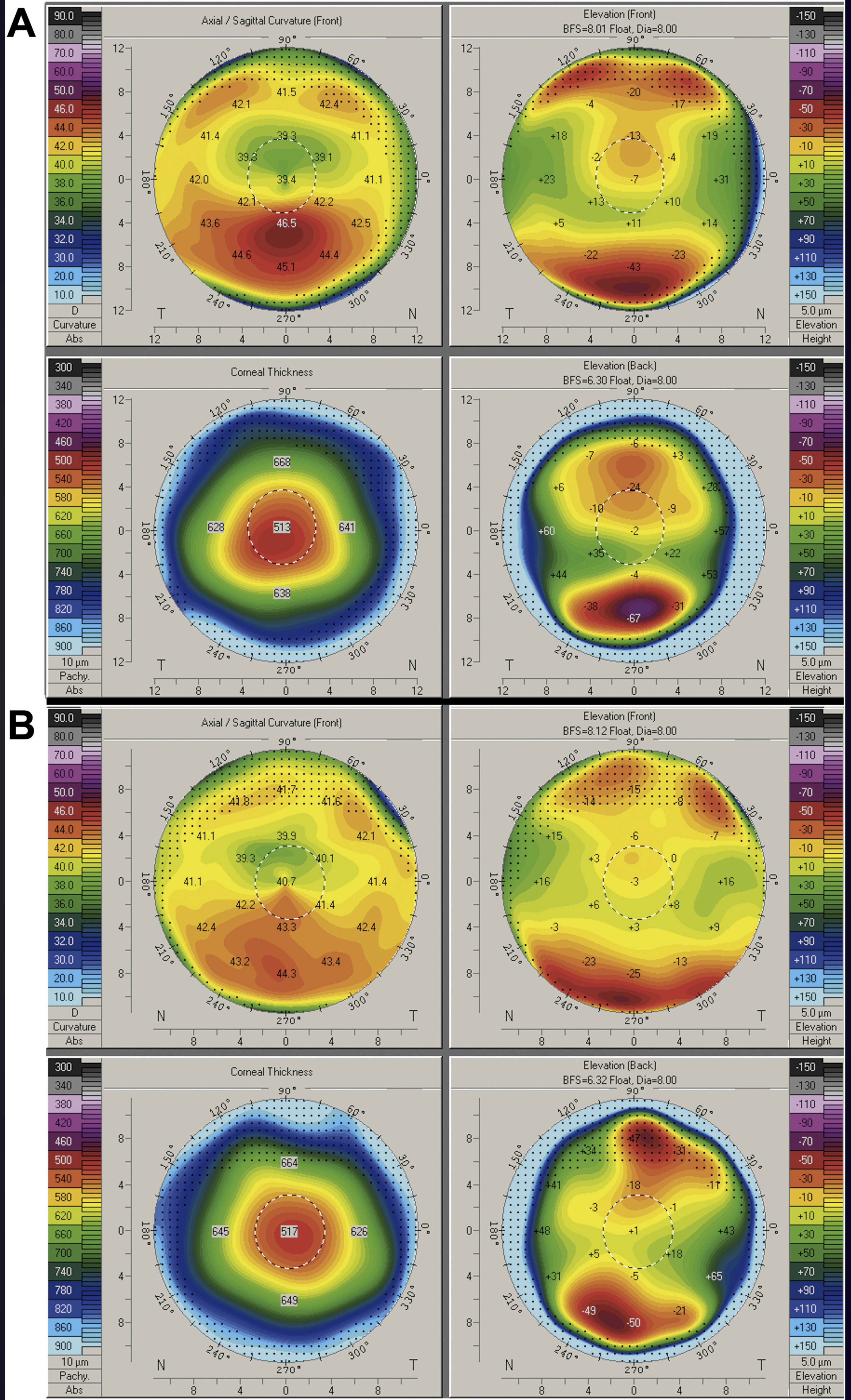

A
Axial / Sagittal Curvature (Front)
Elevation (Front)
BFS=8.01 Float, Dia=8.00
Corneal Thickness
Elevation (Back)
BFS=6.30 Float, Dia=8.00
B
Axial / Sagittal Curvature (Front)
Elevation (Front)
BFS=8.12 Float, Dia=8.00
Corneal Thickness
Elevation (Back)
BFS=6.32 Float, Dia=8.00

TRANSLATIONAL SCIENCE

# Bilaterally Asymmetric Corneal Ectasia Following SMILE With Asymmetrically Reduced Stromal Molecular Markers

*Rohit Shetty, MD, FRCS, PhD; Nimisha Rajiv Kumar, MSc; Pooja Khamar, MS; Matthew Francis, M.Tech; Swaminathan Sethu, PhD; J. Bradley Randleman, MD; Ronald R. Krueger, MD; Abhijit Sinha Roy, PhD; Arkasubhra Ghosh, PhD*

January 14, 2019

**ABSTRACT**

**PURPOSE:** To evaluate extracellular matrix regulators and inflammatory factors in a patient who developed ectasia after small incision lenticule extraction (SMILE) despite normal preoperative tomographic and biomechanical evaluation.

**METHODS:** The SMILE lenticules from both eyes of the patient with ectasia and three control patients (5 eyes) matched for age, sex, and duration of follow-up were used for gene expression analysis of lysyl oxidase (LOX), matrix metalloproteinase 9 (MMP9), collagen types I alpha 1 (COLIA1) and IV alpha 1 chain (COLIVA1), transforming growth factor-beta (TGF-beta), bone morphogenetic protein 7 (BMP7), interleukin-6 (IL-6), cathepsin K, cluster of differentiation 68, integrin beta-1, and tissue inhibitor of metalloproteinase-1 (TIMP1). Furthermore, the functional role of LOX was assessed in vitro by studying the collagen gel contraction efficiency of LOX overexpressing in primary human corneal fibroblast cells.

**RESULTS:** Preoperatively, manifest refraction was -9.25 diopters (D) in the right eye and -10.00 D in the left eye. Corneal thickness, Pentacam (OCULUS Optikgeräte GmbH, Wetzlar, Germany) tomography, and Corvis biomechanical indices (OCULUS Optikgeräte GmbH) were normal. The ectatic eye lenticule (left) had reduced expression of LOX and COLIA1 compared to controls without ectasia. Increased mRNA fold change expression of TGF-beta, BMP7, IL-6, cathepsin K, and integrin beta-1 was noted in the ectatic left eye compared to controls; however, MMP9 and TIMP1 levels were not altered. Ectopic LOX expression in human corneal fibroblast induced significantly more collagen gel contraction, confirming the role of LOX in strengthening the corneal stroma.

**CONCLUSIONS:** Reduced preexisting LOX and collagen levels may predispose clinically healthy eyes undergoing refractive surgery to ectasia, presumably by corneal stromal weakening via inadequately cross-linked collagen. Preoperative molecular testing may reveal ectasia susceptibility in the absence of tomographic or biomechanical risk factors.

[*J Refract Surg*. 2019;35(1):6-14.]

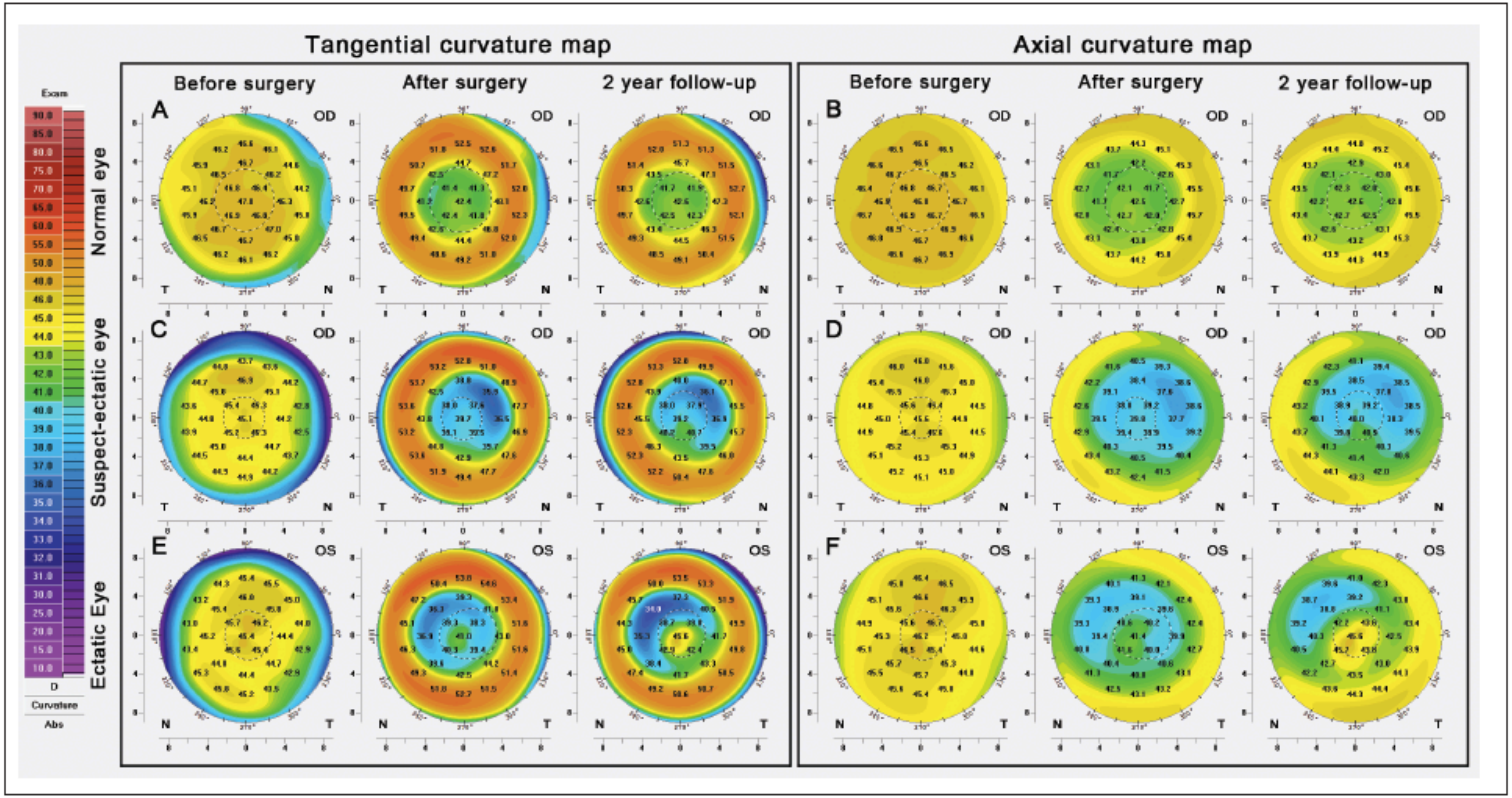
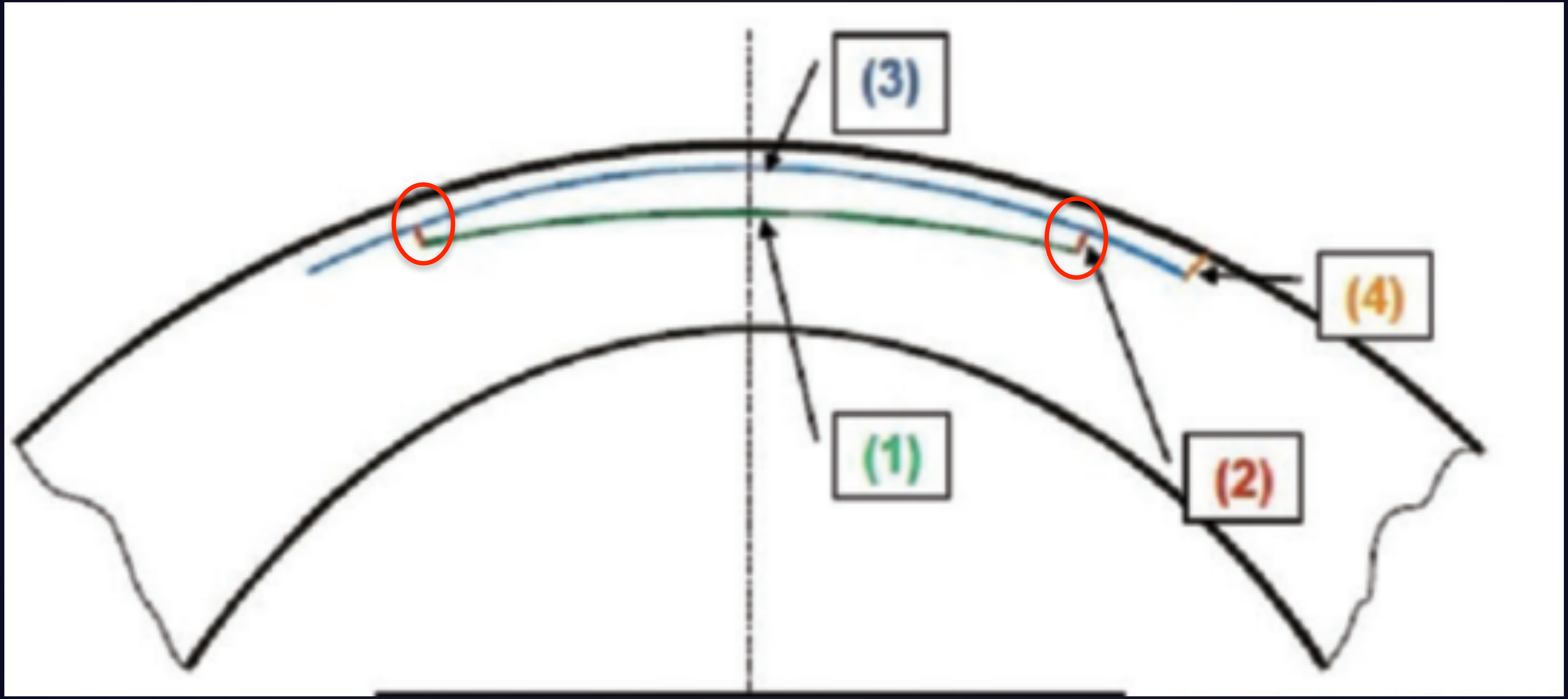



**Figure A.** Tangential (A, C, and E) and axial (B, D, and F) anterior curvature maps from Pentacam HR (OCULUS Optikgeräte, Wetzlar, Germany) (absolute American style color bar in diopters) for before surgery, after surgery, and 2-year follow-up time points, respectively. (A and B) Normal eye curvature maps are shown in the first row, (C and D) suspect-ectatic eye curvature maps are shown in the second row, and (E and F) ectatic eye curvature maps are shown in the third row.

# Why?




Vertical sidecuts/Empty space/Eye rubbing

# Management of post-SMILE Ectasia

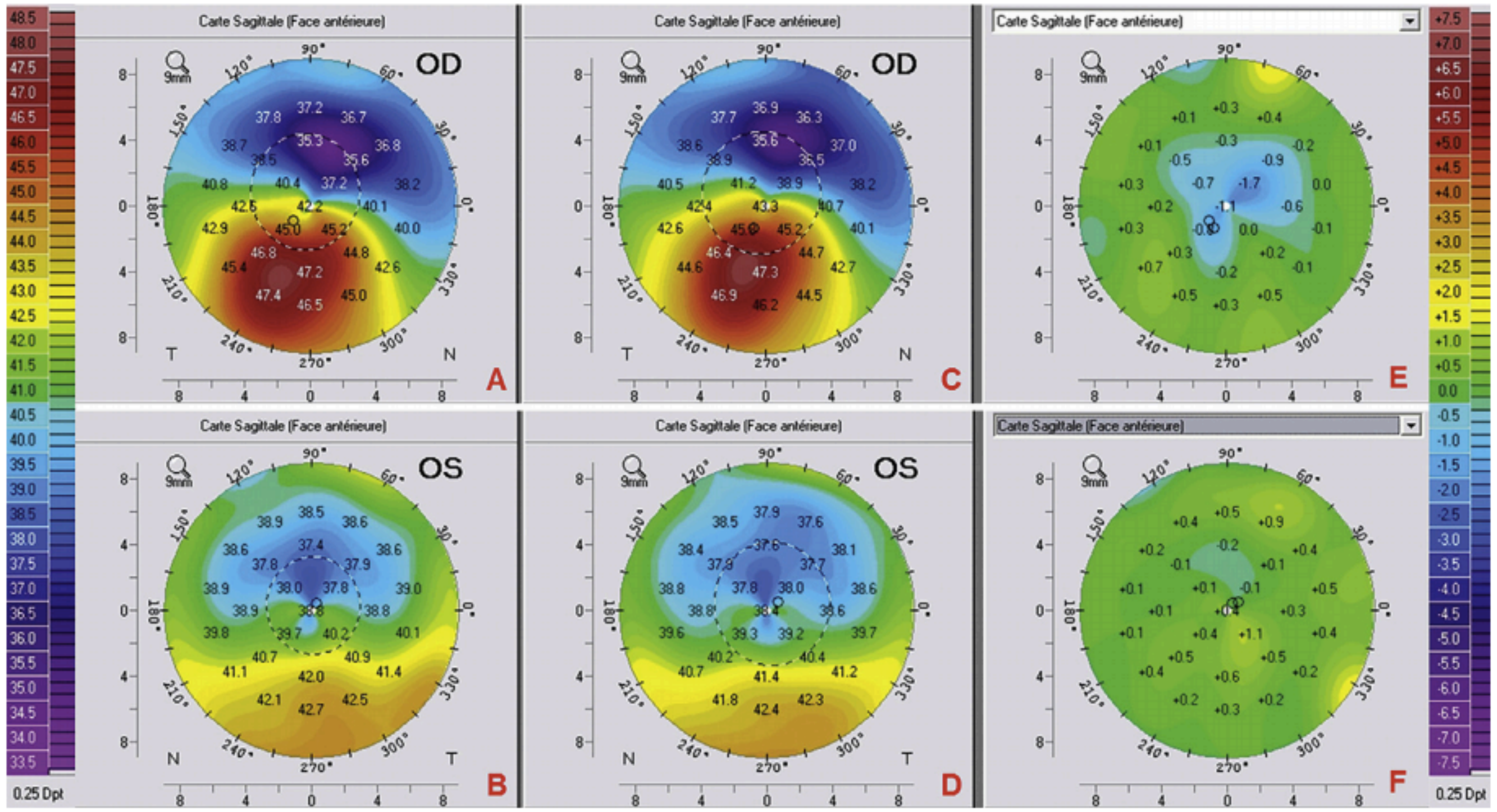



**Figure 4.** Scheimpflug-based corneal topography showing sagittal map. *A* and *B*: Sagittal maps performed 6 months after standard CXL in the right eye. *C* and *D*: Sagittal maps performed before standard CXL in the right eye. *E* and *F*: Comparative sagittal maps. Topographies are stable (N = nasal; T = temporal).

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BMC Ophthalmology

CASE REPORT Open Access

# Combined transepithelial phototherapeutic keratectomy and corneal collagen cross-linking for corneal ectasia after small-incision lenticule extraction—preoperative and 3-year postoperative results: a case report

Qingman Ge[1,2*], Chuanbo Cui[3], Jing Wang[2] and Guoying Mu[1]

**Abstract**

**Background:** Corneal ectasia after small-incision lenticule extraction (SMILE) is uncommon. To our knowledge, this is the first report of 3-year results of combined phototherapeutic keratectomy (PTK) and corneal collagen cross-linking (CXL) for corneal ectasia after SMILE.

**Case presentation:** Herein, we describe a case of prominent corneal ectasia after SMILE treated with PTK combined with CXL 3 years ago. After surgery, maximum corneal keratometry, mean corneal keratometry, spherical equivalent and uncorrected distance visual acuity were significantly improved at follow-up intervals.

**Conclusions:** Transepithelial PTK combined with CXL for corneal ectasia after SMILE may be an effective and safe treatment in the long term.

**Keywords:** Corneal collagen, Corneal ectasia, Cross-linking, Phototherapeutic keratectomy, Small-incision lenticule extraction

## Background

Corneal ectasia after small-incision lenticule extraction (SMILE) is uncommon. While in theory SMILE preserves a stronger cornea postoperatively, there are some previous reports of ectasia developing after SMILE [1–5]. We have never seen any treatment about corneal ectasia after SMILE. Herein, we describe a case of prominent corneal

## Case presentation

In June 2013, a 19-year-old male patient underwent SMILE for myopia in both eyes. He had a history of eye rubbing and allergic conjunctivitis, and before SMILE he had no history of pellucid marginal corneal degeneration and no family history of keratoconus or high myopia. Preoperative characteristics and parameters are summa-

Journal of Refractive Surgery

REPORT SUPPLEMENTAL DATA

# Corneal Scarring and Hyperopic Shift After Corneal Cross-linking for Corneal Ectasia After SMILE

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Posted November 26, 2018

ABSTRACT | FULL TEXT | FIGURES/TABLES | REFERENCES | VIEW PDF

## Abstract

**PURPOSE:**

To report a case of severe corneal scarring and hyperopic shift after corneal cross-linking (CXL) for the treatment of ectasia following small incision lenticule extraction (SMILE).

**METHODS:**

Case report and literature review.

**RESULTS:**

A 35-year-old man was referred with severe unilateral corneal haze that developed after CXL. The patient had undergone SMILE 4 years earlier in both eyes. Nineteen months postoperatively, the patient presented with bilateral decrease in vision and corneal topography revealed corneal ectasia in the right eye. CXL was performed in the right eye and a deep stromal haze was observed 1 year later. Comparative maps showed progressive corneal thinning with corresponding flattening that induced hypermetropization and astigmatism.

**CONCLUSIONS:**

CXL after SMILE in this original case resulted in severe deep corneal haze and corneal flattening with hyperopic shift.

**[*J Refract Surg.* 2018;34(11):779–782.]**

# Conclusion

- No procedure is absolutely safe
  - Corneal refractive procedures that require tissue removal must be prohibited in keratoconus and forme fruste keratoconus.
- Avoid abusing of new techniques
- Be cautious!!

# Take Home Message

Not fit for LASIK=Not fit for SMILE
If you are facing a suspicious cornea

# Thank You