18th International Conference of the
Research Institute of Ophthalmology

RIO 2026

22 -23 JANUARY 2026
ROYAL MAXIM PALACE KEMPINSKI, CAIRO

AI and Ectasia Susceptibility

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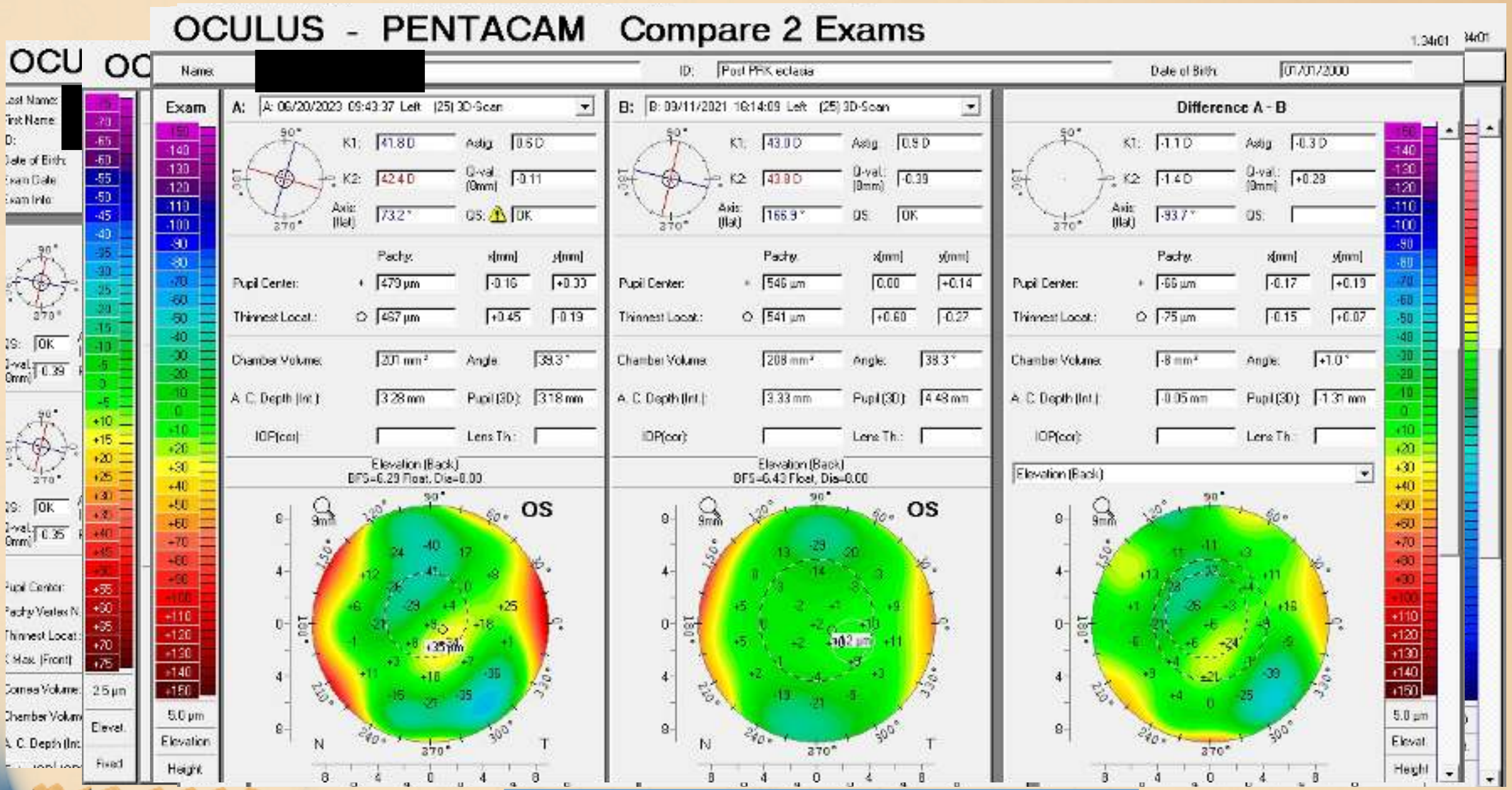
Research Institute of Ophthalmology (RIO)
A. Professor of Ophthalmology
Board member - EgSCRS

The Speaker Has No Financial Interest



MR: -3.00 -0.50x10

112 microns

Clinical Ophthalmology

Dovepress

ORIGINAL RESEARCH

Assessment of Preoperative Risk Factors for Post-LASIK Ectasia Development

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Correspondence: Mohamed Tarek El-Naggar, Email [redacted]

Purpose: To evaluate preoperative risk factors (mainly those related to corneal topography/tomography) for post-LASIK ectasia development.

Methods: A retrospective case review for post-LASIK ectasia for myopia or myopic astigmatism. The evaluated data included preoperative subjective refraction, method of flap creation, and topometric/tomographic parameters from Oculus Pentacam, including subjective curvature pattern, topometric, elevation, and pachymetric indices from the Belin Ambrósio display "BAD", and the Pentacam Random Forest Index (PRFI). Moreover, preoperative ectasia detection indices were calculated (including Percentage of Tissue Altered "PTA" index, Randleman Ectasia Risk Score System "ERSS", and Navarro Index for Corneal Ectasia "NICE").

Results: Twenty-four eyes of 15 patients were enrolled. Concerning the risk factors, age was lower than 26 in 19 eyes (79%); flaps were created using a microkeratome in 17 eyes (70.8%); thinnest pachymetry was lower than 510μm in eight eyes (33%); total deviation from BAD was higher than 1.6 in 50%; Ambrósio's relational thickness (ART) max was lower than 340 in 45.83%; PTA index was higher than 40% in 16%; ERSS was more than 3 points in 62.5%; NICE was higher than 4 points in three eyes (12.5%); PRFI index was more than 0.126 in 87.5%; two eyes (8%) had no identifiable risk factors.

Conclusion: Current ectasia risk assessment criteria were insufficient for detecting a relatively large number of cases. There is an unequivocal need for more information, which may be derived from biomechanical assessment and epithelial thickness mapping. Novel corneal tomography indices derived from artificial intelligence may increase accuracy in characterizing ectasia susceptibility.

Keywords: corneal ectasia, preoperative ectasia risk assessment, LASIK screening, Pentacam

Introduction

Laser in situ keratomileusis (LASIK) is the most frequently performed refractive surgery worldwide, with recognizable efficiency and safety.[1] Post-LASIK corneal ectasia has been regarded as one of the most feared complications since the first report by Seiler in 1998.[2,3] It is considered in patients who develop keratometric steepening, elevated values of posterior corneal elevation, with or without central and paracentral corneal thinning, and/or topographic evidence of asymmetric inferior corneal steepening following LASIK procedure.[4] Its prevention has always been a significant concern for refractive surgeons.[5,6]

In the published literature, the prevalence of post-LASIK ectasia ranges between 0.04% and 0.9%.[7–9] Over the last two decades, the incidence of ectasia has reduced from moderately high levels of 0.66%[9] and 0.57%,[10] down to 0.2%,[11] 0.05%,[12] and 0.033%.[13] Such reduction in this severe complication has resulted from considerable efforts to develop advanced and meticulous preoperative screening strategies.[12,14]

topometric/tomographic parameters including subjective curvature pattern, topometric, elevation, pachymetric indices, BAD-D and PRFI
Preoperative ectasia detection indices: PTA, ERSS and NICE

Conclusion: Current ectasia risk assessment criteria were insufficient for detecting a relatively large number of cases. There is an unequivocal need for more information, which may be derived from biomechanical assessment and epithelial thickness mapping.

Pentacam Random Forest Index (PRFI)

AI and Ectasia susceptibility

- PRFI
- TBI
- BEES RTA

PRFI: Pentacam-Derived Parameters

Tomographic and topometric metrics used in PRFI:

- Comprehensive evaluation based on Pentacam tomography
- Integration of keratometric, topometric, and tomographic indices
- Aimed at early ectasia detection and refractive risk stratification

Keratometric Parameters

Corneal curvature–based metrics

- Central simulated keratometry (Sim K)
- Maximum keratometry (Kmax)
- Vertical decentration of Kmax (KmaxY)

Topometric Indices (Anterior Surface)

Anterior corneal surface irregularity

- Index of Surface Variance (ISV)
- Index of Vertical Asymmetry (IVA)
- IS value
- Keratoconus Index (KI)
- Central Keratoconus Index (CKI)
- Index of Height Asymmetry (IHA)
- Index of Height Decentration (IHD)

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Elevation & Asphericity Parameters

Shape- and elevation-based tomography

- Anterior elevation at the thinnest point (AETP)
- Posterior elevation at the thinnest point (PETP)
- Anterior asphericity (AsphQFront)
- Posterior asphericity (AsphQBack)

Pachymetric Parameters

Corneal thickness distribution

- Pachymetry at the thinnest point (TP)
- Vertical decentration of the thinnest point (TPy)

Pachymetric Progression Indices (PPI)

Thickness progression from center to periphery

- PPI-Average (PPI-Ave)
- PPI-Maximum (PPI-Max)
- PPI-Minimum (PPI-Min)

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Ambrosio’s Relational Thickness (ART)

Thickness relative to pachymetric progression

- ART-Average (ART-Ave)
- ART-Maximum (ART-Max)
- ART-Minimum (ART-Min)

Belin–Ambrosio Deviation Display

Integrated ectasia assessment

- Belin–Ambrosio Deviation Index (BAD-D)

OCULUS - PENTACAM 4 Maps Selectable

1.22r09

Last Name:	Khaled
First Name:	Ahmed
ID:	
Date of Birth:	01/08/1992
Eye:	Right
Exam Date:	11/29/2021
Time:	12:09:02
Exam Info:	

Cornea Front

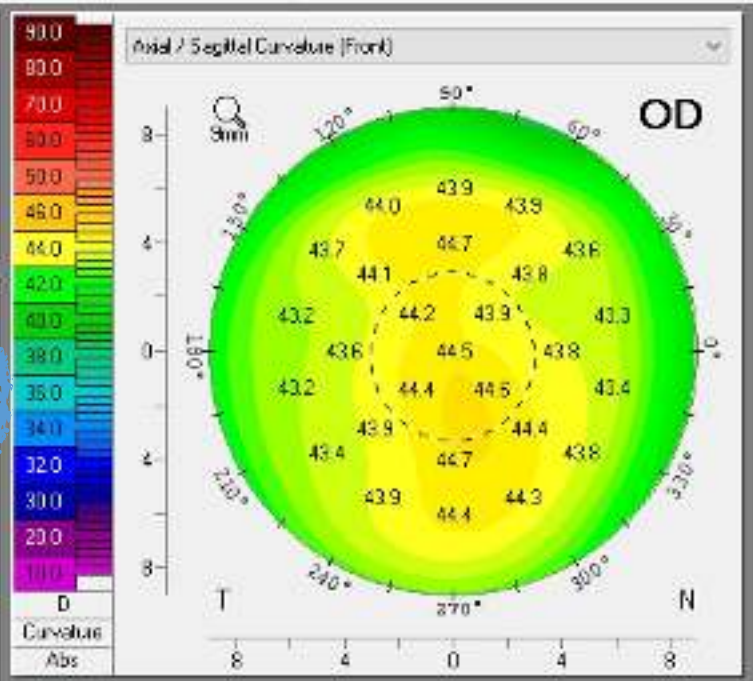
Rf:	7.66 mm	K1:	43.3 D
Rs:	7.55 mm	K2:	44.7 D
Rm:	7.62 mm	Km:	44.3 D
QS:	OK	Axis (Rel):	14.2 °
		Astig:	0.7 D
Q-val (30°):	-0.46	Rper:	8.01 mm
		Rmin:	7.52 mm

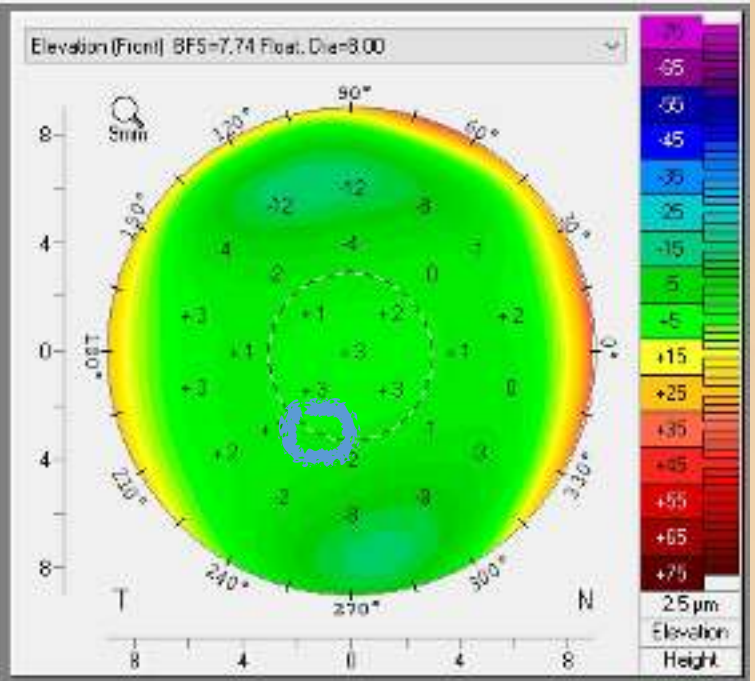
Cornea Back

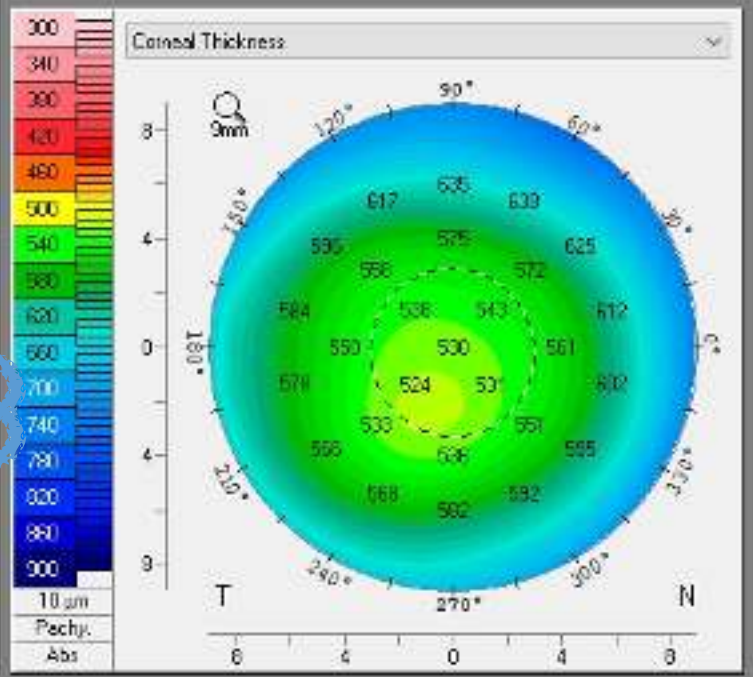
Rf:	6.55 mm	K1:	-6.1 D
Rs:	6.43 mm	K2:	-6.2 D
Rm:	6.49 mm	Km:	-6.2 D
QS:	OK	Axis (Rel):	33.2 °
		Astig:	0.1 D
Q-val (30°):	-0.09	Rper:	6.76 mm
		Rmin:	6.07 mm

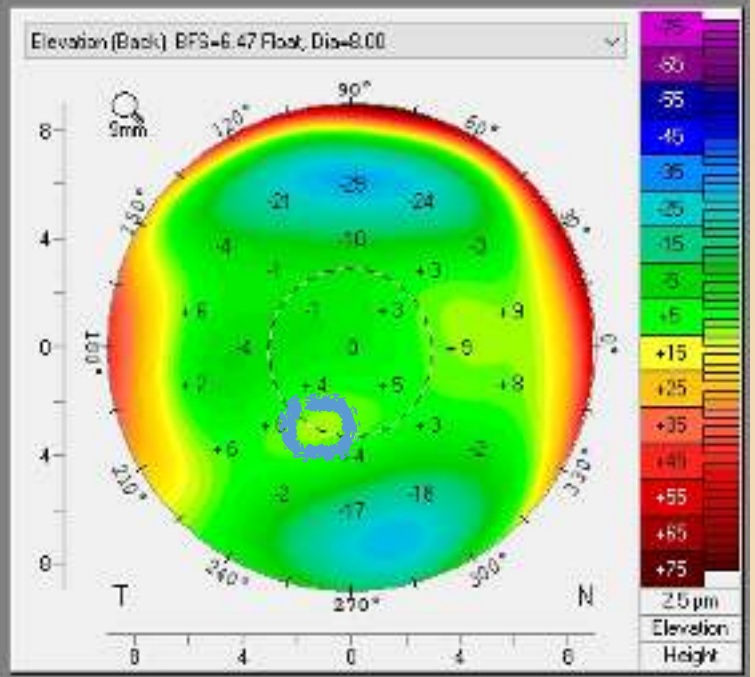
		Pachy:	x[mm]	y[mm]
Pupil Center:	+	529 µm	-0.01	-0.10
Pachy Apex:	:	530 µm	0.00	0.00
Thinnest Local.:		521 µm	-0.40	-1.03
K Max (Front):		44.9 D	+0.27	-1.14

Cornea Volume:	57.8 mm³	HWTW:	11.9 mm
Chamber Volume:	195 mm³	Angle:	39.9 °
A. C. Depth (Int.):	3.18 mm	Pupil Dia:	3.05 mm
Enter IOP	IOP(Sum):	-1.1 mmHg	Lens Th.:









OCULUS - PENTACAM Topometric/KC-Staging

1.22r09

Last Name:	Khaled		
First Name:	Ahmed		
ID:			
Date of Birth:	01/03/1992	Eye:	Right
Exam Date:	11/23/2021	Time:	12:09:02
Exam Info:			

Cornea Front

Rf:	7.68 mm	K1:	43.9 D
Rs:	7.55 mm	K2:	44.7 D
Rm:	7.62 mm	Km:	44.3 D
Axis: (Rat)	14.2 °	Astig:	0.7 D
Rper:	8.01 mm	Rmin:	7.52 mm
QS:	OK		
Q-val: (30°)	-0.48		

Cornea Back

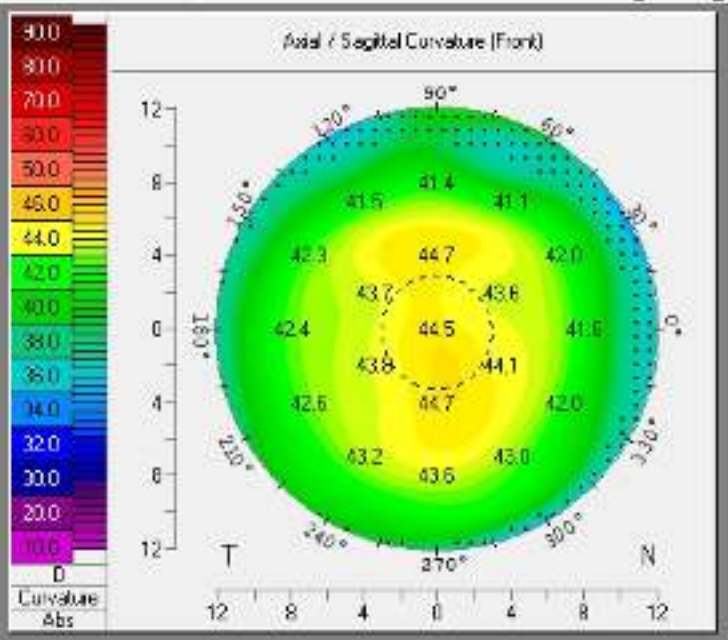
Rf:	6.55 mm	K1:	-6.1 D
Rs:	6.43 mm	K2:	-6.2 D
Rm:	6.49 mm	Km:	-6.2 D
Axis: (Rat)	33.2 °	Astig:	0.1 D
Rper:	6.76 mm	Rmin:	6.07 mm
QS:	OK		
Q-val: (30°)	-0.09		

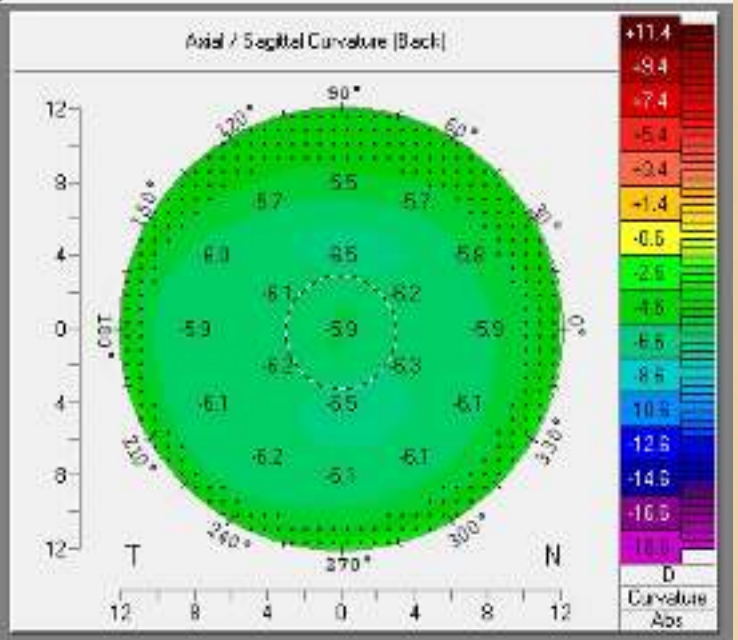
True Net Power

Astig:	0.7 D	K1:	42.8 D
Axis: (flt.)	12.3 °	K2:	43.5 D
P.Max:	44.0 D	Km:	43.1 D

		Pachy:	x[mm]	y[mm]
Pupil Center:	+	529 µm	-0.01	-0.10
Pachy Apex:	·	530 µm	0.00	0.00
Thinnest Local.:	○	521 µm	-0.40	-1.03
K Max. (Front):		44.9 D	+0.27	-1.14

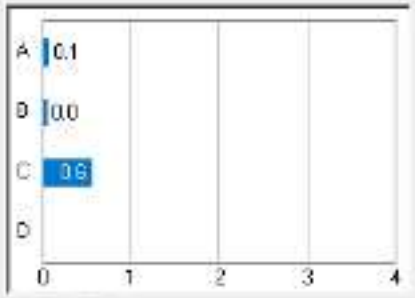
Cornea Volume:	57.8 mm³	HW/TW:	11.9 mm
Chamber Volume:	195 mm³	Angle:	33.0 °
A. C. Depth (Int.):	3.18 mm	Pupil Dia:	3.05 mm
IOP(Sum):	+1.1 mmHg	Lens Th.:	





Belin ABCD Keratoconus Staging

ARC (3mm Zone):	7.62 mm
PRC (3mm Zone):	6.13 mm
Thinnest Pachy:	521 µm
DDVA:	



A0 B0 C0 D

Asphericity (Front) of Major Meridians

(Q-val.)	Degrees peripheral 20°	25°	30°	35°	40°
Nas.	-0.25	-0.37	-0.55	-0.77	-1.00
Temp.	-0.31	-0.29	-0.34	-0.44	-0.49
Inf.	-0.19	-0.23	-0.30	-0.36	-0.53
Sup.	-0.30	-0.55	-0.74	-0.61	-0.72
Mean	-0.26	-0.35	-0.48	-0.59	-0.44

Front:
- (●) Asphericity
- ( ) Axial/Sag. Curvat

Back:
- ( ) Asphericity
- ( ) Axial/Sag. Curvat

Indices (in 8mm zone)

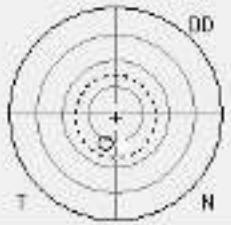
ISV:	16	IHA:	0.9
IVA:	0.07	IHD:	0.004
I:	1.04	RMin:	7.52
KI:	1.01	TK:	[redacted]
KI:	1.233	IS:	0.12

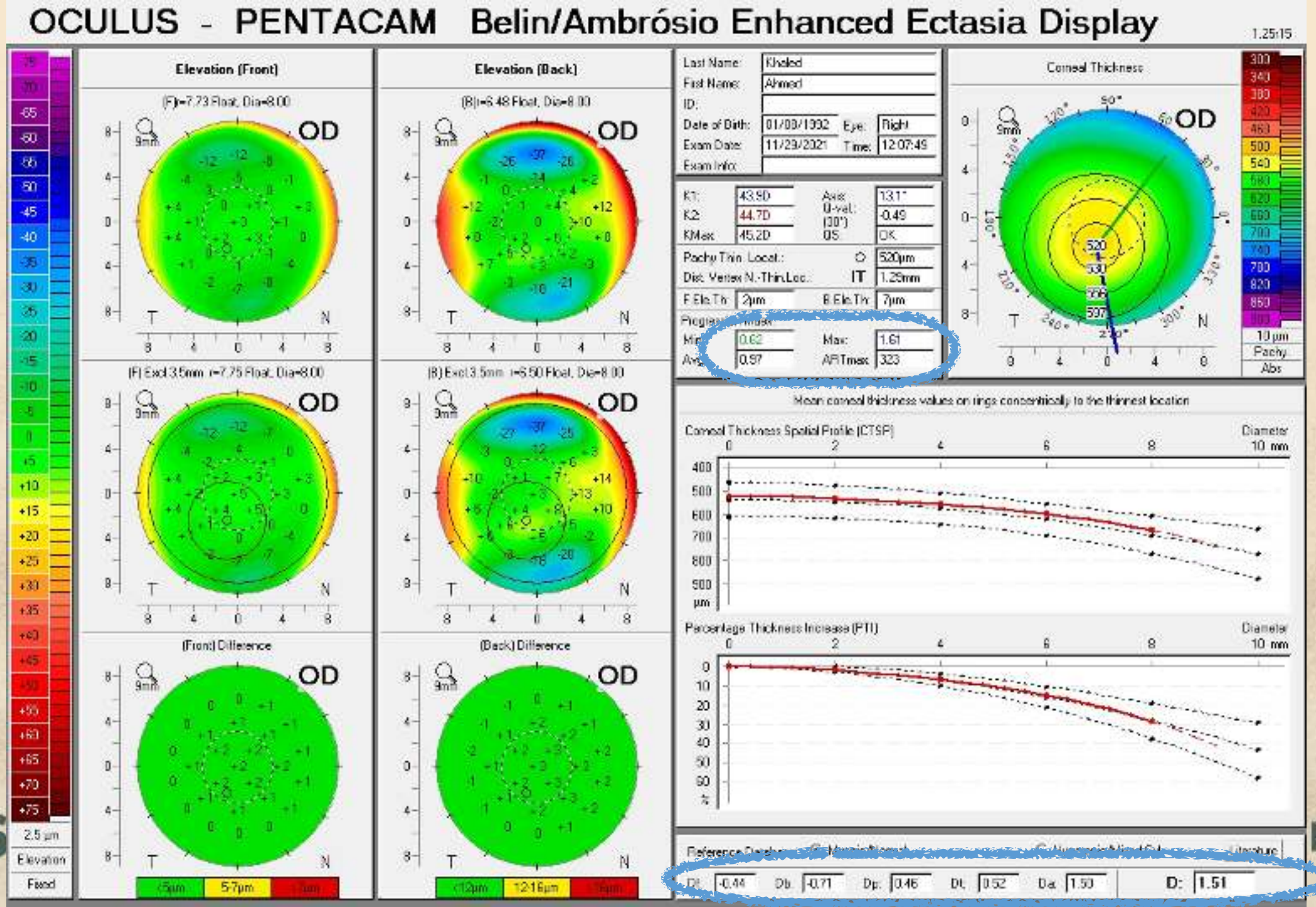
Asphericity (Front) at 30°

Hor.: -0.44
Vert.: -0.52

Spot locations in 8mm zone (polar coordinates)

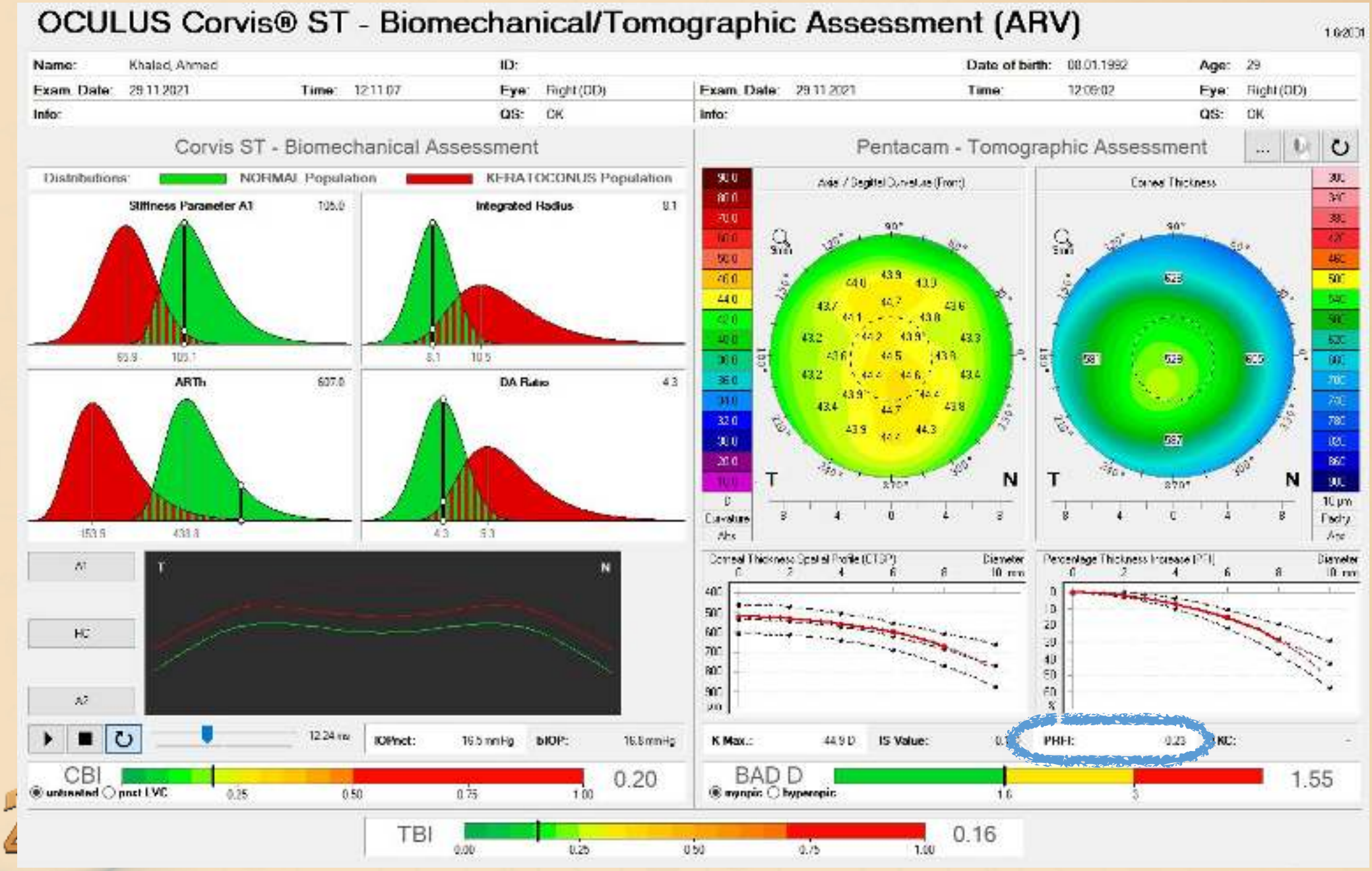
Pupil Center:	+	0.10mm (261.8°)
Thinnest Local.:	○	1.15mm (249.4°)
K Max. (Front):		1.19mm (283.2°)




OCULUS - PENTACAM Belin/Ambrósio Enhanced Ectasia Display
1.25r15
Elevation (Front)
Elevation (Back)
OD
Last Name: Khaled
First Name: Ahmed
ID:
Date of Birth: 01/03/1992 Eye: Right
Exam Date: 11/23/2021 Time: 12:07:49
Exam Info:
K1: 43.9D Axis: 131°
K2: 44.7D
Kmax: 45.2D
Pachy Thin. Locat.: 520µm
Dist. Vertex N.-Thin.Loc.: 1.25mm
F Ele.Th: 2µm B Ele.Th: 7µm
Min: 0.62 Max: 1.61
Avg: 0.97 ARTmax: 323
Corneal Thickness
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: -0.44 Db: -0.71 Dp: 0.46 Dt: 0.52 Da: 1.50 D: 1.51
2.5 µm
Elevation
Fixed
10 µm
Pachy
Abs

EgS

EgSCRS


OCULUS Corvis® ST - Biomechanical/Tomographic Assessment (ARV)
Name: Khalad, Ahmad
ID:
Date of birth: 08.01.1992
Age: 29
Exam. Date: 29.11.2021
Time: 12:11:07
Eye: Right (OD)
Info:
QS: OK
Exam. Date: 29.11.2021
Time: 12:09:02
Eye: Right (OD)
Info:
QS: OK
Corvis ST - Biomechanical Assessment
Distributions:
NORMAL Population
KERATOCONUS Population
Stiffness Parameter A1
105.0
Integrated Radius
9.1
ARTh
607.0
DA Ratio
4.3
A1
HC
A2
T
N
12.24 ms
IOPnct:
16.5 mmHg
bIOP:
16.8 mmHg
CBI
uncorrected
post LVC
0.20
Pentacam - Tomographic Assessment
Axial / Sagittal Curvature (Front)
Corneal Thickness
Corneal Thickness Spatial Profile (CTSP)
Percentage Thickness Increase (PTI)
Diameter
K Max.:
44.9 D
IS Value:
PHI:
0.23
KC:
BAD D
myopic
hyperopic
1.55
TBI
0.16

Clinical Scenario	Cutoff Value	Sensitivity (True Positive Rate)	Specificity (True Negative Rate)	Clinical Application
Keratoconus (KC)	0.37	79.5%	95.2%	Used for confirming a diagnosis. High specificity means if it's over 0.37, it is very likely KC.
Subclinical (VAE-NT)	0.27	58.9%	86.2%	Used for detecting early changes in eyes that look "normal" but have a keratoconic fellow eye.
Enhanced Screening	0.12	85.2%	96.6%	Optimized for refractive surgery screening (like LASIK/PRK) to ensure the highest safety margin.

OCULUS - PENTACAM 4 Maps Refractive

1.34r01

Last Name: [redacted]
First Name:
ID:
Date of Birth: 12/06/1990 Eye: Right
Exam Date: 09/22/2025 Time: 13:38:19
Exam Info:

Cornea Front

Rf: 7.75 mm K1: 43.5 D
Rs: 7.55 mm K2: 44.7 D
Rm: 7.65 mm Km: 44.1 D
QS: Pupil [Axis: 13.7 ° (flt.) Astig: 1.1 D
Q-val.: -0.42 (8mm) Rper: 8.01 mm Rmin: 7.45 mm

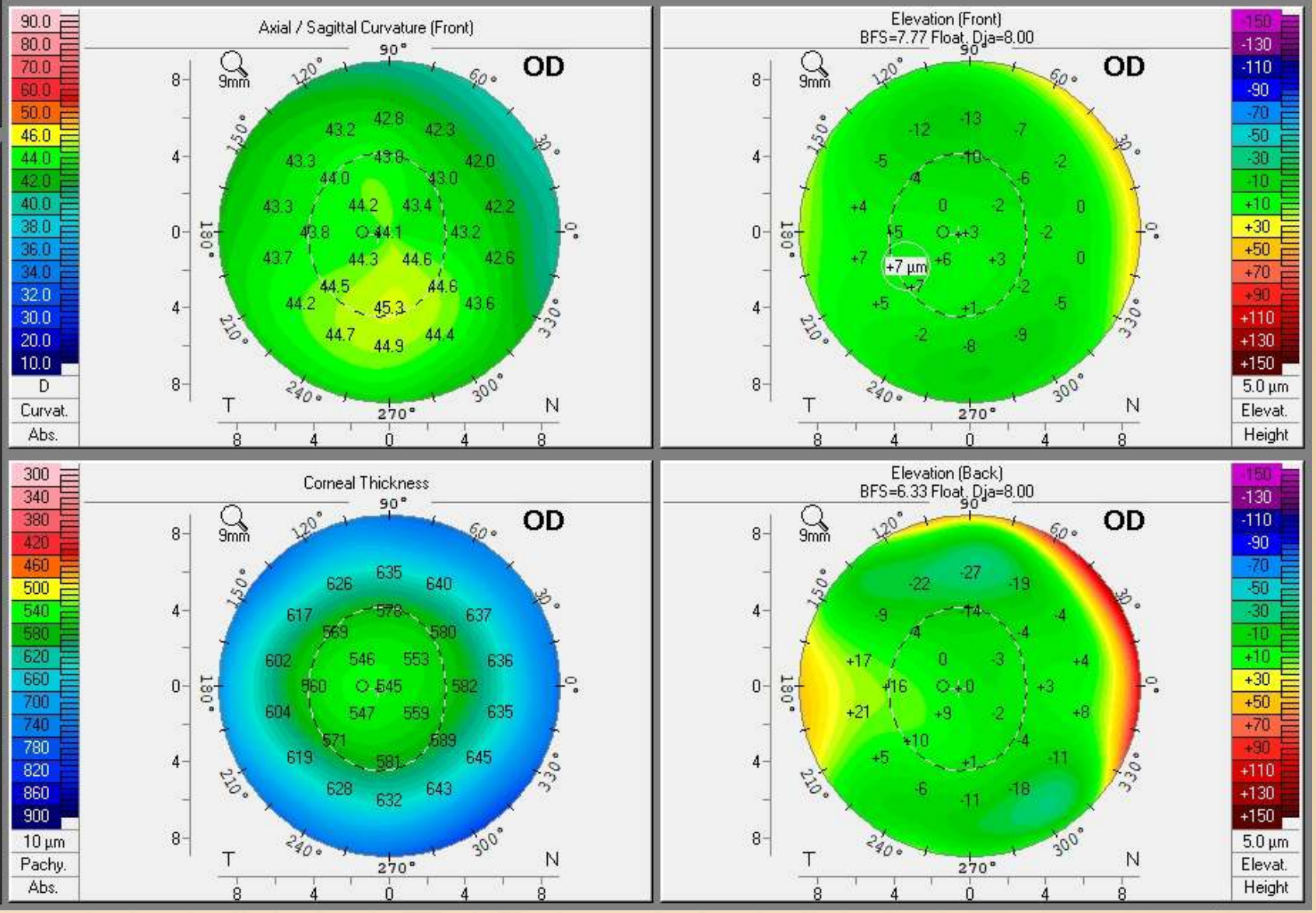
Cornea Back

Rf: 6.52 mm K1: -6.1 D
Rs: 6.18 mm K2: -6.5 D
Rm: 6.35 mm Km: -6.3 D
QS: Pupil [Axis: 14.2 ° (flt.) Astig: 0.3 D
Q-val.: -0.40 (8mm) Rper: 6.67 mm Rmin: 6.06 mm

	Pachy:	x[mm]	y[mm]
Pupil Center: +	543 µm	-0.30	-0.08
Pachy Vertex N.: ·	545 µm	0.00	0.00
Thinnest Locat.: ○	542 µm	-0.70	0.00
K Max. (Front):	45.3 D	+0.07	-1.97

Cornea Volume: 61.0 mm³ HWTW: 12.1 mm
Chamber Volume: 152 mm³ Angle: 24.4 °
A. C. Depth (Int.): 2.83 mm Pupil (3D): 3.94 mm
Enter IOP IOP(Sum): +0.2 mmHg Lens Th.:

Refractive



OCULUS - PENTACAM 4 Maps Refractive

1.34r01

Last Name: [redacted]
First Name:
ID:
Date of Birth: 12/06/1990 Eye: Right
Exam Date: 09/22/2025 Time: 13:38:19
Exam Info:

Cornea Front

Rf: 7.75 mm K1: 43.5 D
Rs: 7.55 mm K2: 44.7 D
Rm: 7.65 mm Km: 44.1 D
QS: Pupil [Axis: (flt.) 13.7 ° Astig: 1.1 D
Q-val.: (8mm) -0.42 Rper: 8.01 mm Rmin: 7.45 mm

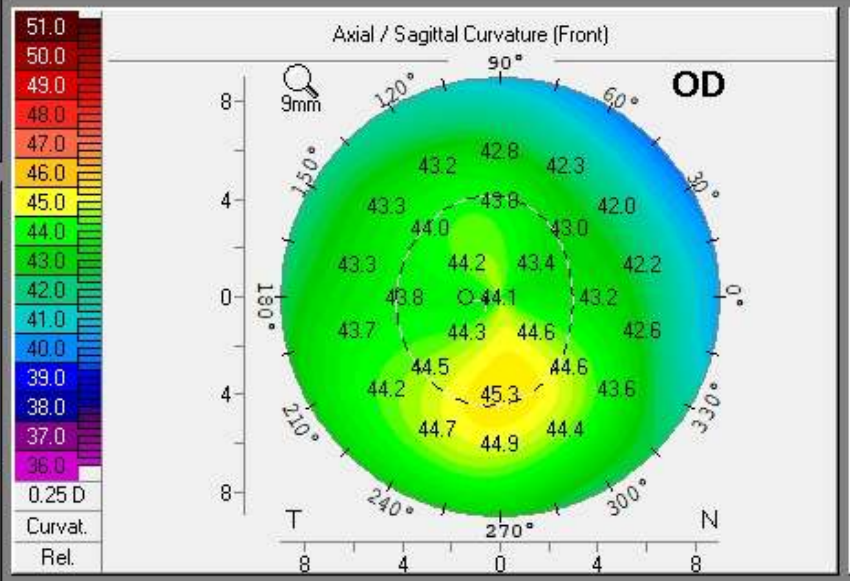
Cornea Back

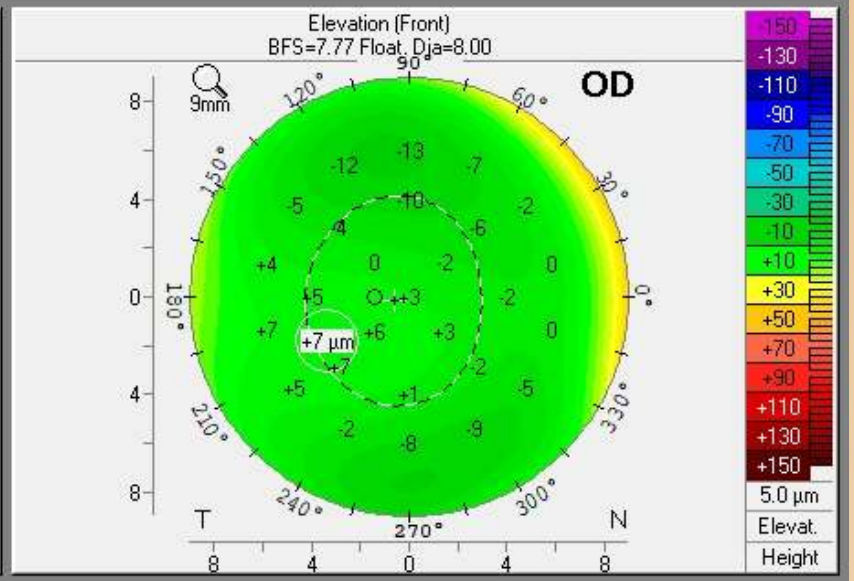
Rf: 6.52 mm K1: -6.1 D
Rs: 6.18 mm K2: -6.5 D
Rm: 6.35 mm Km: -6.3 D
QS: Pupil [Axis: (flt.) 14.2 ° Astig: 0.3 D
Q-val.: (8mm) -0.40 Rper: 6.67 mm Rmin: 6.06 mm

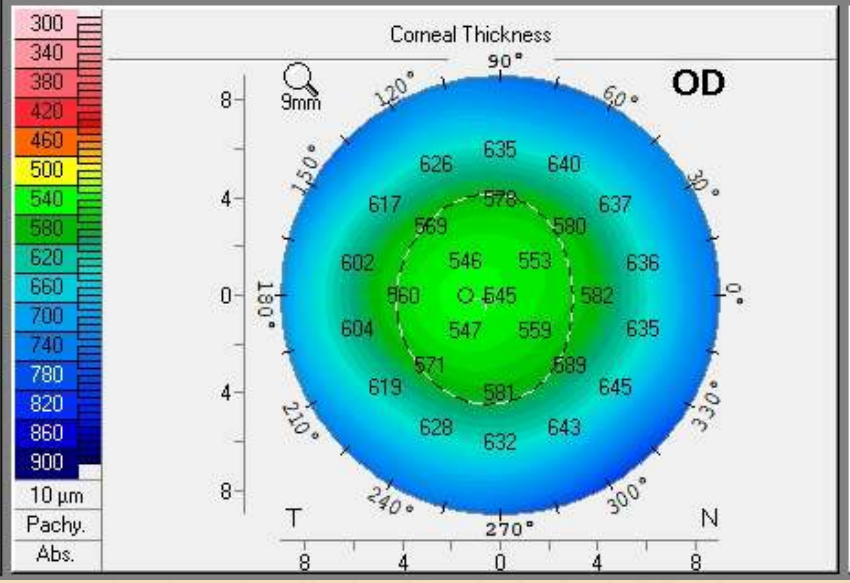
	Pachy:	x[mm]	y[mm]
Pupil Center: +	543 µm	-0.30	-0.08
Pachy Vertex N.: ·	545 µm	0.00	0.00
Thinnest Locat.: ○	542 µm	-0.70	0.00
K Max. (Front):	45.3 D	+0.07	-1.97

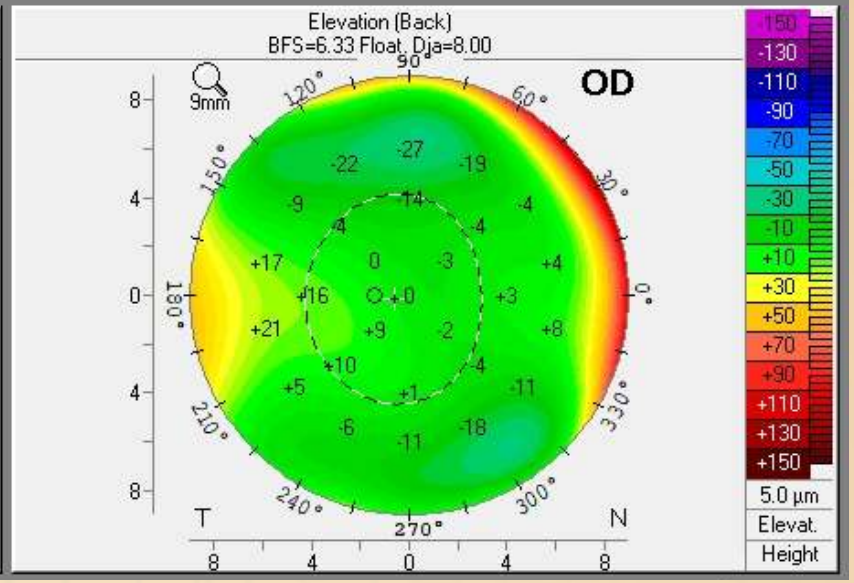
Cornea Volume: 61.0 mm³ HWTW: 12.1 mm
Chamber Volume: 152 mm³ Angle: 24.4 °
A. C. Depth (Int.): 2.83 mm Pupil (3D) 3.94 mm
Enter IOP IOP(Sum) +0.2 mmHg Lens Th.:

Refractive









OCULUS - PENTACAM Topometric/KC-Staging

1.34r01

Last Name:	[redacted]
First Name:	
ID:	mr steepening
Date of Birth:	12/06/1990
Eye:	Right
Exam Date:	09/22/2025
Time:	13:38:19
Exam Info:	

Cornea Front

Rf:	7.75 mm	K1:	43.5 D
Rs:	7.55 mm	K2:	44.7 D
Rm:	7.65 mm	Km:	44.1 D
Axis: (flt.)	13.7 °	Astig:	1.1 D
Rper:	8.01 mm	Rmin:	7.45 mm

QS: Pupil (3
Q-val.: (8mm) -0.42

Cornea Back

Rf:	6.52 mm	K1:	-6.1 D
Rs:	6.18 mm	K2:	-6.5 D
Rm:	6.35 mm	Km:	-6.3 D
Axis: (flt.)	14.2 °	Astig:	0.3 D
Rper:	6.67 mm	Rmin:	6.06 mm

QS: Pupil (3
Q-val.: (8mm) -0.40

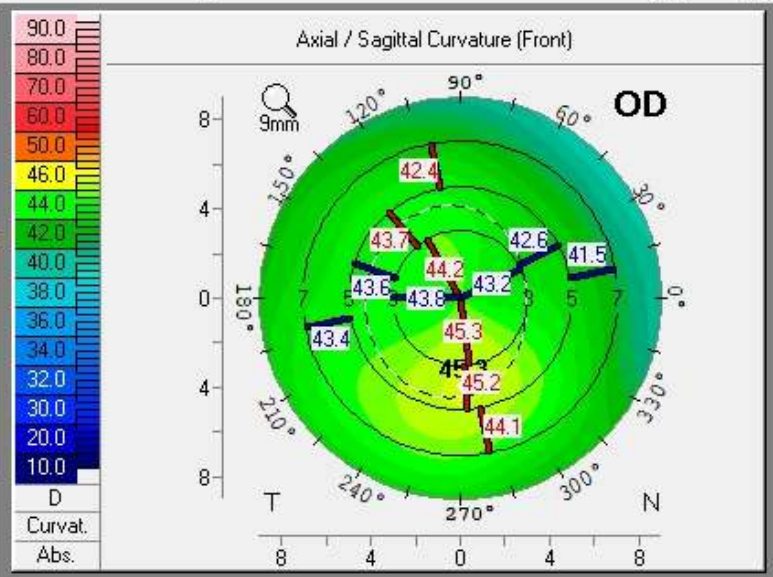
True Net Power

Astig:	0.9 D	K1:	42.4 D
Axis: (flt.)	14.4 °	K2:	43.3 D
P.Max.:	44.0 D	Km:	42.8 D

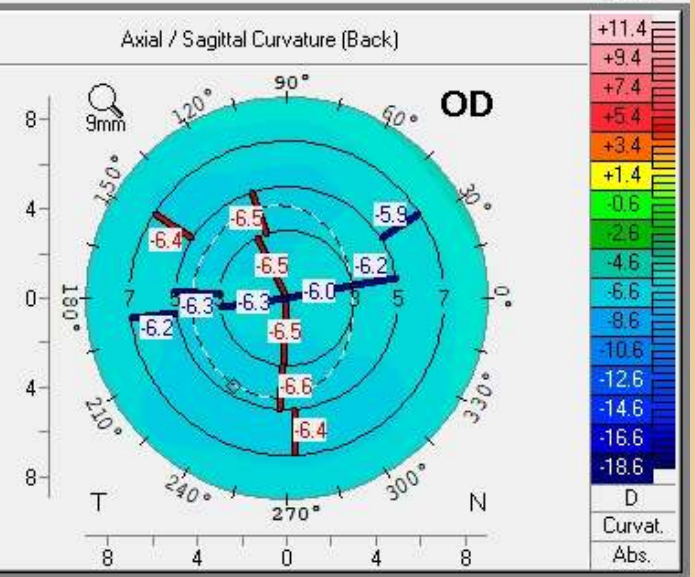
		Pachy:	x[mm]	y[mm]
Pupil Center:	+	543 µm	-0.30	-0.08
Pachy Vertex N.:	·	545 µm	0.00	0.00
Thinnest Locat.:	○	542 µm	-0.70	0.00
K Max. (Front):		45.3 D	+0.07	-1.97

Cornea Volume:	61.0 mm³	HWTW:	12.1 mm
Chamber Volume:	152 mm³	Angle:	24.4 °
A. C. Depth (Int.):	2.83 mm	Pupil (3D):	3.94 mm
IOP(Sum):	+0.2 mmHg	Lens Th.:	

Axial / Sagittal Curvature (Front)

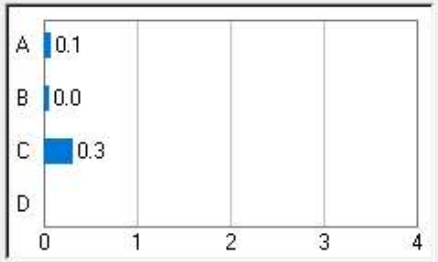


Axial / Sagittal Curvature (Back)



Belin ABCD Keratoconus Staging

ARC (3mm Zone):	7.63 mm
PRC (3mm Zone):	6.24 mm
Thinnest Pachy:	542 µm
DCVA:	



A0 B0 C0 D

Asphericity (Front) of Major Meridians

	Peripheral mm-Rings (Dia)				
(Q-val.)	6mm	7mm	8mm	9mm	10mm
Nas	-0.53	-0.56	-0.56	-0.56	-0.56
Temp	-0.12	-0.16	-0.20	-0.24	-0.28
Inf	-0.29	-0.36	-0.40	-0.44	-0.49
Sup	-0.50	-0.53	-0.53	-0.53	-0.55
Mean	-0.36	-0.40	-0.42	-0.44	-0.47

Front:
- (•) Asphericity
- ( ) Axial/Sag. Curva

Back:
- ( ) Asphericity
- ( ) Axial/Sag. Curva

Indices (in 8mm zone)

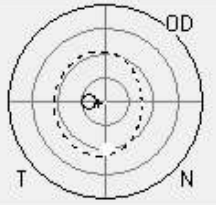
ISV:	25	IHA:	11.0
IVA:	0.24	IHD:	0.026
KI:	1.07	RMin:	7.45
CKI:	1.01	TKC:	-
KISA:	10.704	IS:	1.52

Asphericity (Front) at 8mm

Hor.: -0.38
Vert.: -0.46

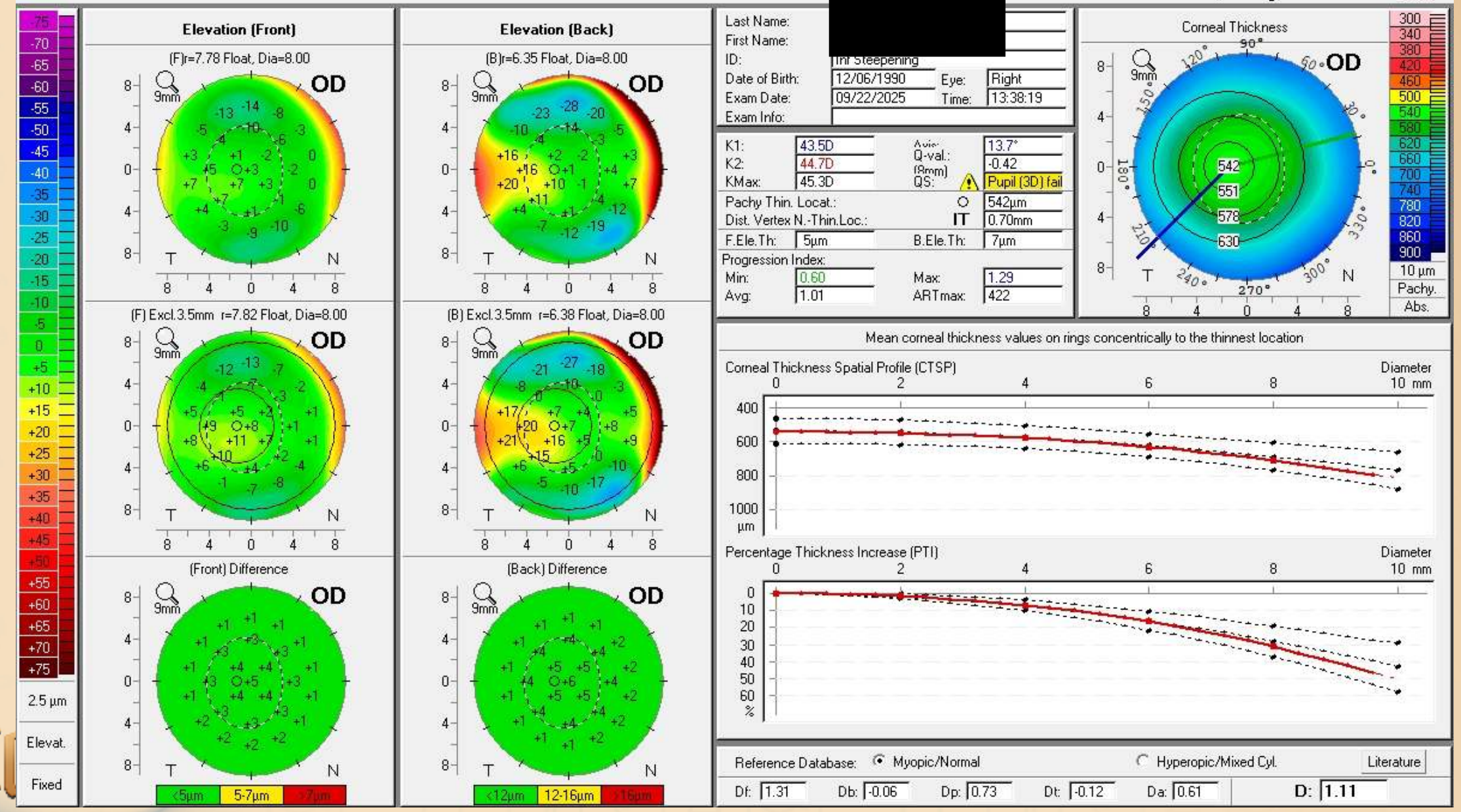
Spot locations in 8mm zone (polar coordinates)

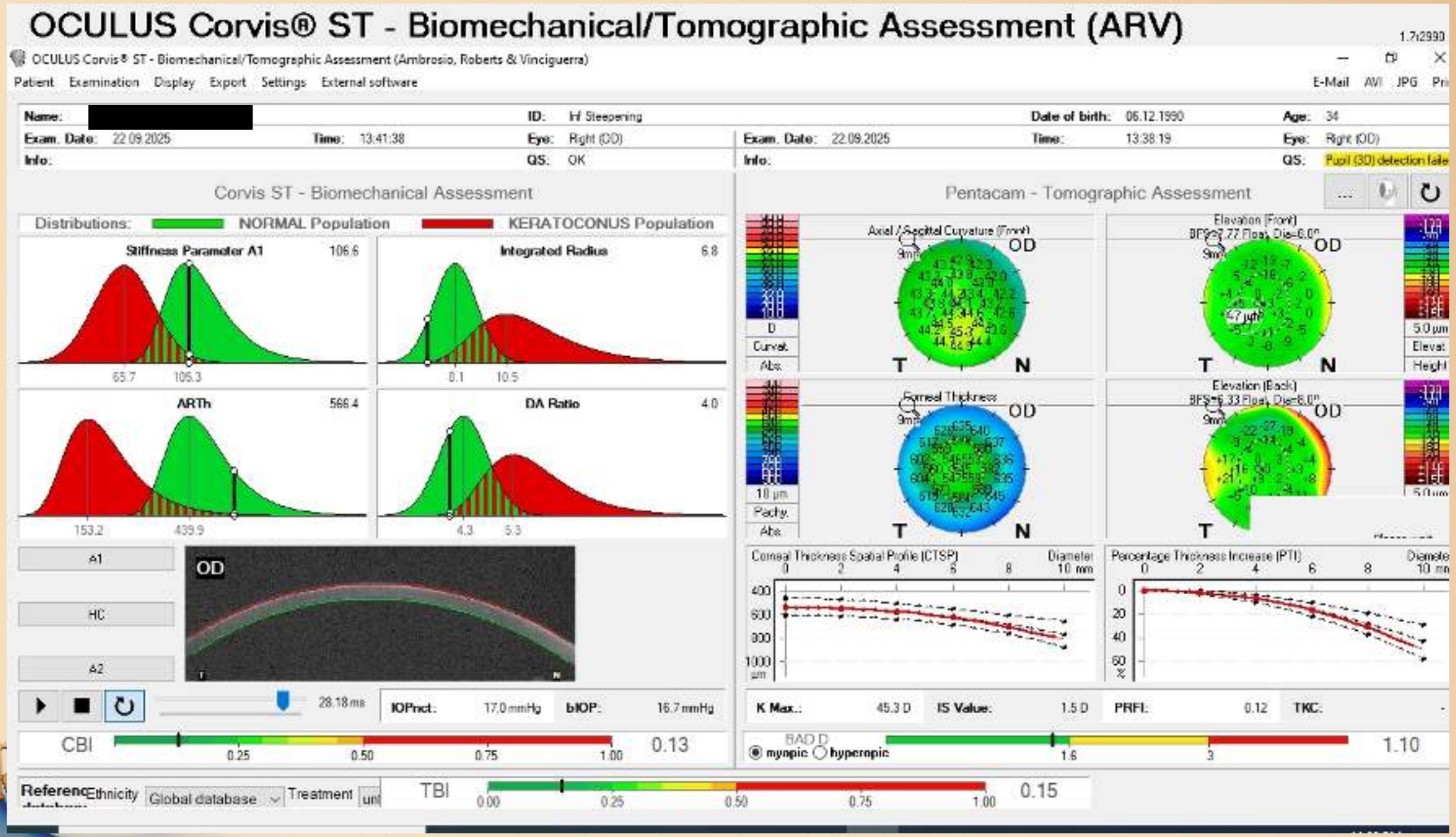
Pupil Center:	+	0.31mm (195.1°)
Thinnest Locat.:	○	0.70mm (180.0°)
K Max. (Front):		1.97mm (272.0°)



OCULUS - PENTACAM Belin/Ambrósio Enhanced Ectasia Display

1.34r01




OCULUS Corvis® ST - Biomechanical/Tomographic Assessment (ARV)
OCULUS Corvis® ST - Biomechanical/Tomographic Assessment (Ambrosio, Roberts & Vinciguerra)
Patient Examination Display Export Settings External software
E-Mail AVI JPG
Name: [redacted] ID: Inf Steepening Date of birth: 06.12.1990 Age: 34
Exam. Date: 22.09.2025 Time: 13:41:38 Eye: Right (OD) Exam. Date: 22.09.2025 Time: 13:38:19 Eye: Right (OD)
Info: QS: OK Info: QS: Pupil (3D) detection fail
Corvis ST - Biomechanical Assessment
Distributions: NORMAL Population KERATOCONUS Population
Stiffness Parameter A1 106.6
65.7 106.3
Integrated Radius 6.8
8.1 10.5
ARTh 566.4
153.2 439.9
DA Ratio 4.0
4.3 5.3
A1
HC
A2
OD
28.18 ms
IOPnct: 17.0 mmHg bIOP: 16.7 mmHg
CBI 0.13
0.25 0.50 0.75 1.00
Reference Ethnicity Global database Treatment
TBI 0.15
0.00 0.25 0.50 0.75 1.00
Pentacam - Tomographic Assessment
Axial / Sagittal Curvature (Front)
Elevation (Front)
Elevation (Back)
Corneal Thickness
Corneal Thickness Spatial Profile (CTSP)
Percentage Thickness Increase (PTI)
K Max.: 45.3 D IS Value: 1.5 D PRFI: 0.12 TKC:
BAD D 1.10
myopic hyperopic
1.6 3

Key concept

- PRFI integrates multi-parametric Pentacam data
- Combines curvature, elevation, pachymetry, and progression metrics
- Enhances early detection of ectasia risk
- Essential for safe refractive surgery screening

Tomographic-biomechanical index (TBI)

TBI

- The TBI is not a single formula you can calculate manually.
  It’s a machine-learning–derived index that integrates Scheimpflug tomography (Pentacam) with Corvis ST biomechanical data to improve ectasia detection—especially subclinical keratoconus.

Tomographic inputs (Pentacam)

- Anterior & posterior elevation (especially at thinnest point)
- Pachymetry distribution & progression indices
- Corneal thickness at thinnest location
- Curvature asymmetry
- BAD-D–related components

Biomechanical inputs (Corvis ST)

- A1 & A2: time, velocity, and length
- Highest Concavity (HC) parameters
- Deformation Amplitude (DA)
- Integrated Radius
- SP-A1 (Stiffness Parameter at A1)
- ARTh (Ambrósio Relational Thickness – horizontal)
- CBI-related variables

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	Parameter	Origin	Definition
1	BADDb	Pentacam	Deviation from normality of the enhanced posterior elevation best-fit-sphere
2	BFSFront Thinnest 3mm	Pentacam	Best-fit sphere for anterior 3 mm centered at the thinnest point
3	ISValue	Pentacam	Inferior-superior axial steepening
4	KMaxFrontY	Pentacam	Vertical deviation of the point with maximal keratometry (Kmax) from the apex
5	Pac_Asymm_ApexVert8.0mm	Pentacam	Vertical asymmetry of the pachymetry at 8 mm
6	PRFI	Pentacam	Pentacam Random Forest Index
7	SphRMin	Pentacam	The minimal mean radius of a ring based on Fourier analysis (zero-order component)
8	TiltMinAxis MVP	Pentacam	Axis location of maximal decentration based on Fourier analysis (first-order wave component)
9	TiltMinMVP	Pentacam	The maximum decentration based on Fourier analysis (first-order wave component)
10	Ele. BBFTE 8mm @ Thinnest	Pentacam	Back (posterior) elevation at the thinnest point considering a best-fit toric ellipsoid for 8 mm

	Parameter	Origin	Definition
1	CBI	Corvis ST	Corvis Corneal Biomechanical Index
2	DA Ratio 2mm	Corvis ST	Ratio of the deformation amplitude at 2 mm
3	DensitoIncreaseMax	Corvis ST	The maximal change in backscattering of the cornea during the exam
4	HC Deformation Amp_mm	Corvis ST	Highest concavity deformation amplitude
5	MaxInverseRadius	Corvis ST	Minimal radius of curvature during the concave phase of deformation
6	PeakDist_mm	Corvis ST	Horizontal distance between the 2 highest points (nasal and temporal) of the cornea at the time of maximum deformation
7	SP-A1	Corvis ST	Stiffness parameter at the first applanation
8	SP-HC	Corvis ST	Stiffness parameter at the highest concavity

TBI Calculation

- TBI is generated using a supervised machine learning model (originally a Random Forest–based classifier)
- Inputs: dozens of tomographic + biomechanical variables
- Training set:
  - Normal eyes
  - Clinical keratoconus
  - Subclinical / forme fruste KC
- Output: single probability score

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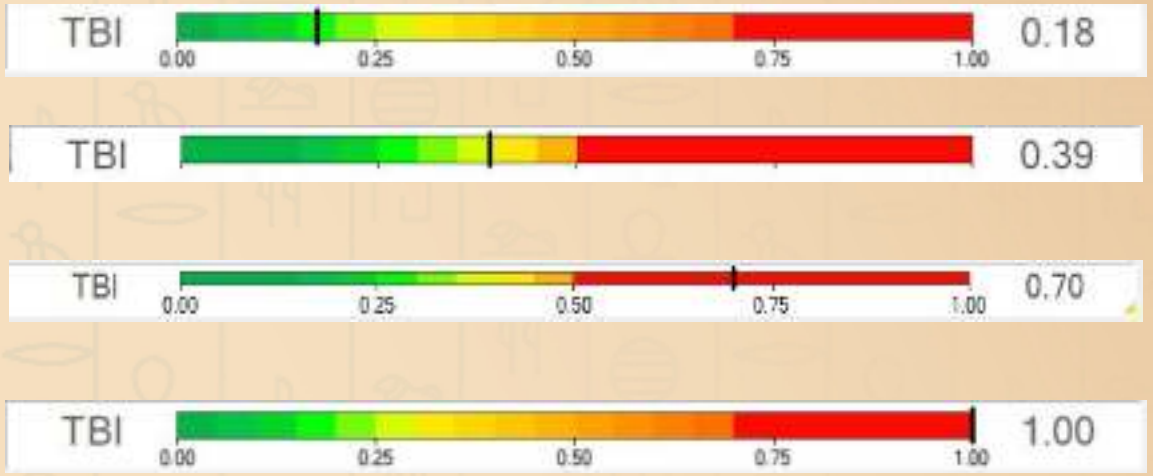
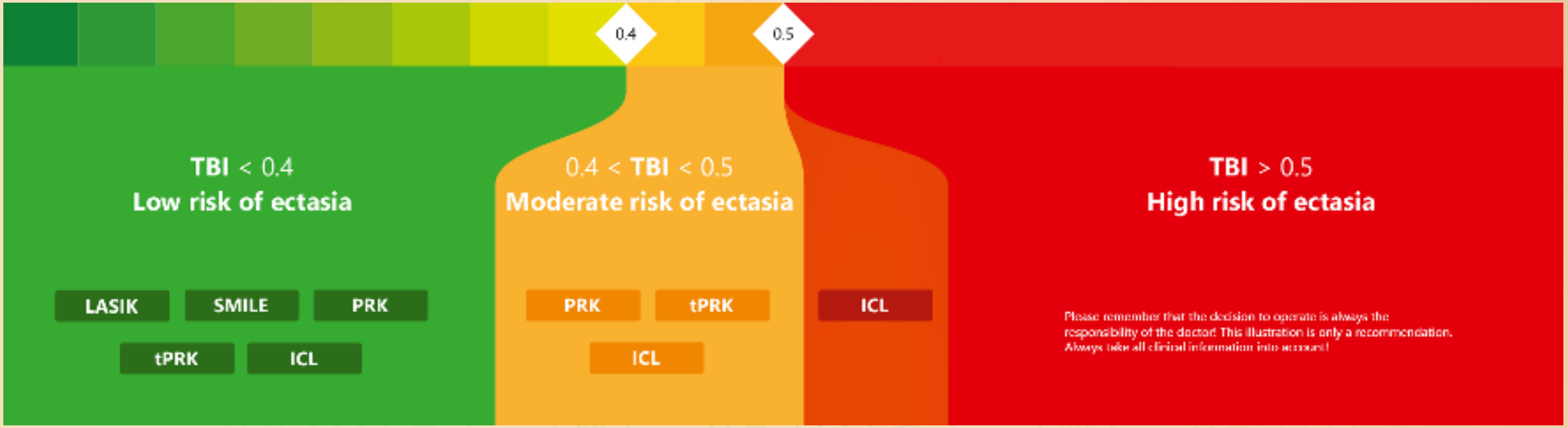
TBI interpretation

TBI Range	Interpretation
< 0.29	Normal
0.29 – 0.47	Suspicious
0.48 – 0.78	Subclinical Keratoconus / High Ectasia Risk
≥ 0.79	Manifest Keratoconus



(Exact cutoffs may vary slightly by study and population)

RIO 2026


0.4
0.5
TBI < 0.4
Low risk of ectasia
LASIK
SMILE
PRK
tPRK
ICL
0.4 < TBI < 0.5
Moderate risk of ectasia
PRK
tPRK
ICL
ICL
TBI > 0.5
High risk of ectasia
Please remember that the decision to operate is always the responsibility of the doctor! This illustration is only a recommendation. Always take all clinical information into account!

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Why TBI outperforms single parameters

- Captures structure + biomechanics
- Less dependent on Kmax
- Detects preclinical ectasia
- More robust than CBI or BAD-D alone
- This is why TBI is now considered one of the strongest screening tools before refractive surgery

Key concept

- TBI is not biomechanics alone and not tomography alone It is a synergistic risk probability

Relational Tissue Altered (RTA)

RTA

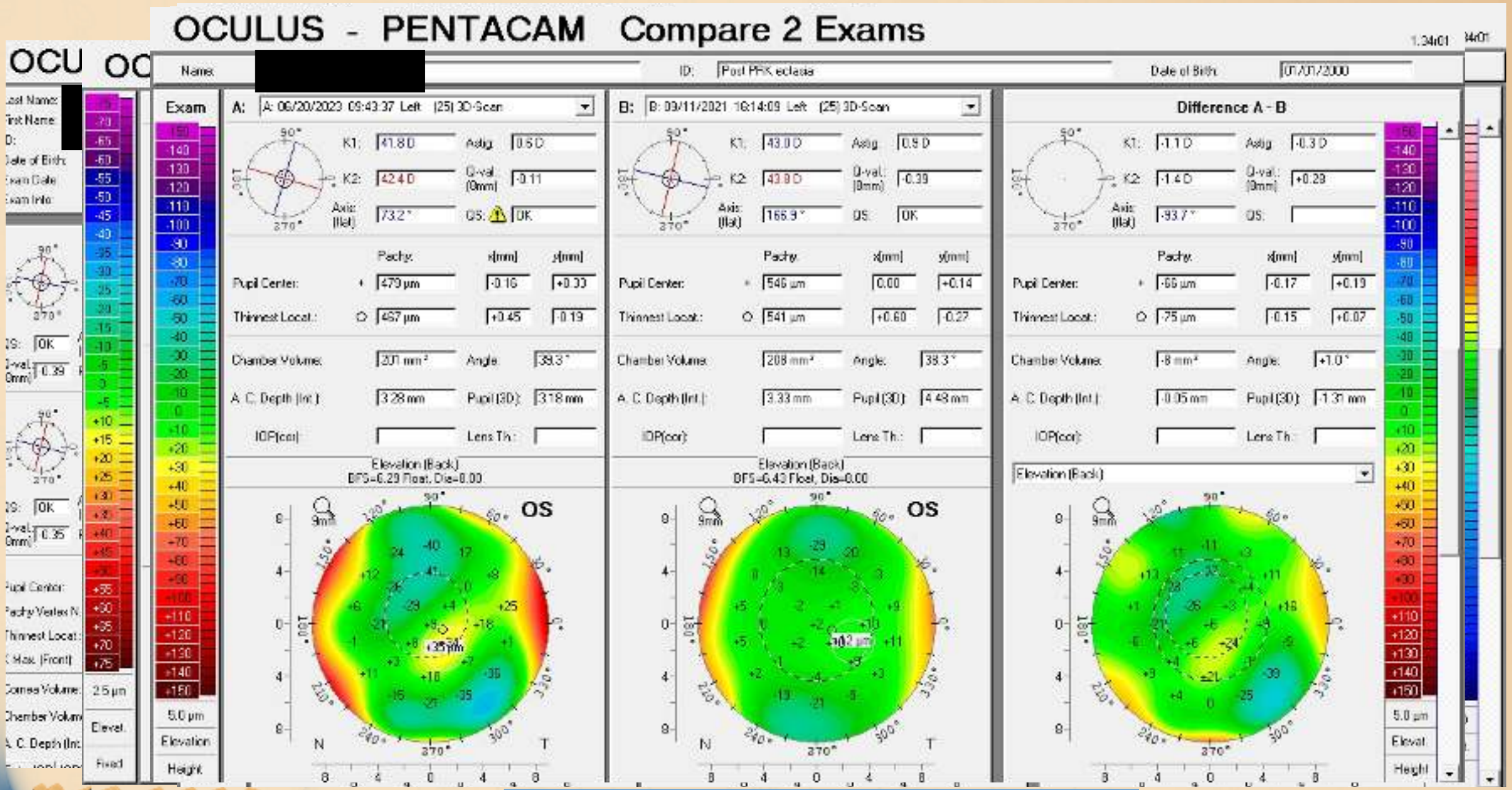
- An artificial intelligence-based metric designed to quantify the biomechanical impact of different LVC procedures on the cornea.
- Developed to improve upon traditional safety metrics like Residual Stromal Bed (RSB) and Percent Tissue Altered (PTA) that focus solely on thickness,
- RTA integrates multiple data points to assess biomechanical disruption. it provides a more accurate assessment of how surgery alters corneal structure.

Key Features and Performance

- Superior Accuracy: In clinical studies, RTA demonstrated a higher area under the curve (AUC 0.913) compared to RSB (0.832) and PTA (0.805), indicating better diagnostic performance in identifying eyes with significant surgical impact.
- Predictive Model: It uses a neural network algorithm that incorporates variables such as pachymetry (thinnest point), flap thickness, ablation depth, and patient age.
- Clinical Threshold: An RTA value above 0.24 typically indicates a significant biomechanical impact.

Integration in BEES Software

- The BEES (BrAIN Enhanced Ectasia Software) platform implements the "Two-Hit Hypothesis"—the theory that ectasia occurs when a cornea with inherent susceptibility (Hit 1) is further destabilized by the impact of surgery (Hit 2).
- The software merges three advanced indicators into a single unified risk profile:
  - BAD-D v4
  - TBIv2: The Tomographic and Biomechanical Index.
  - RTA Index: Quantifies the surgical impact.
- By displaying these together, the BEES interface allows surgeons to see if a high-impact procedure (High RTA) is being planned for a cornea that is already vulnerable (High TBI), enabling a safer surgical planning.



MR: -3.00 -0.50x10

112 microns

File View Help

Patient data

Exam ID	Patient	Age / Birthdate	Eye	Ethnicity
2628	[redacted]	25 years / 2000-01-01	Left	○ Global ○ Chinese

Combined tomographic and biomechanical assessment

BrAIN TBI

Biomechanics

CBI	SP-A1	DA Ratio (2mm)

Tomography

BAD Dv4 | BAD DI	ART max	Ele B BFS 8mm Thinnest
0.99 | 0.22	447.0	8.0

IVA	Pachy apex	Pachy min	IS value
0.14	545.0	541.0	0.05

Refractive surgery parameters

You want to indicate: ○ Refractive Parameters (Sph, Cyl, OZ) ◉ Ablation depth

Optical zone	Spherical	Cylinder	Ablation depth
			62

Age	Type of surgery	Corneal Epithelium	
20	PRK	50	Calculate

Refractive surgery impact

RTA

Relational Tissue Altered (RTA)	RSB min	RSB apex
0.401	429	433

PTA min	PTA apex
0.21	0.21

RIO 2026

Combined tomographic and biomechanical assessment
BrAIN TBI
0.10
Biomechanics
CBI
0.31
SP-A1
117.0
DARatio (2mm)
4.45
Tomography
BAD Dv4 | BAD DI
0.85 | 0.15
ARTmax
363.0
Ele B BFS 8mm Thinnest
4.0
IVA
0.1
Pachy apex
531.0
Pachy min
528.0
IS value
0.11
Refractive surgery parameters
You want to indicate: Refractive Parameters (Sph, Cyl, OZ) Ablation depth
Optical zone
6.7
Spherical
-6
Cylinder
0
Ablation depth
90
Age
35
Type of surgery
LASIK
Flap thickness
110
Calculate
Refractive surgery impact
RTA
Relational Tissue Altered (RTA)
0.039
RSB min
328
RSB apex
331
PTA min
0.38
PTA apex
0.38

Combined tomographic and biomechanical assessment
BrAIN TBI
0.10
Biomechanics
CBI
0.31
SP-A1
117.0
DARatio (2mm)
4.45
Tomography
BAD Dv4 | BAD DI
0.85 | 0.15
ARTmax
363.0
Ele B BFS 8mm Thinnest
4.0
IVA
0.1
Pachy apex
531.0
Pachy min
528.0
IS value
0.11
Refractive surgery parameters
You want to indicate: Refractive Parameters (Sph, Cyl, OZ) Ablation depth
Optical zone
6.7
Spherical
-6
Cylinder
0
Ablation depth
90
Age
21
Type of surgery
LASIK
Flap thickness
110
Calculate
Refractive surgery impact
RTA
Relational Tissue Altered (RTA)
1.000
RSB min
328
RSB apex
331
PTA min
0.38
PTA apex
0.38

RIO 2026

Take-home message

- AI has transformed ectasia susceptibility screening by integrating subtle tomographic, and biomechanical derived signals that are often missed by a single parameter.
- PRFI, TBI, and RTA represent complementary AI-driven indices:
  - PRFI enhances detection of early and subclinical ectasia by combining refractive, pachymetric, and elevation data.
  - TBI fuses corneal biomechanics with tomography
  - RTA quantifies the biomechanical impact of LVC procedures on the cornea
- The greatest value comes from using these indices together rather than alone

Disclaimer

Disclaimer:
AI-based indices are decision-support tools and should be interpreted in conjunction with clinical judgment and comprehensive corneal evaluation, not as standalone diagnostic criteria

Thank you

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