Topographic Aberrometric Guided PRK For Keratoconus With Accelerated Corneal Cross-Linking Using Schwind AMARIS 750S Laser

NEW VISION EYE CENTER

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Phaco.Refractive.Surgeon

Financial Disclosure

Introduction

- Regularising corneal irregularity with simultaneous combination of TGCA PRK and CXL and its synergetic action (regularising and stabilising cornea) is one of important events in KC treatment that's created by Prof. Kanellopoulos .
- In this study we need to highlight new laser concept using same synergetic action of laser and Accelerated CXL (ACXL) both at one session but using topographic aberrometric guided customised ablation trans epithelial PRK laser TAGCA PRK.
- The treatment profile of this laser is guided by corneal wave front Corneal High Order Aberration (HOA) which is derived from the corneal elevation map incorporated into Zernike Polynomials.

Corneal Regularisation in KC

Corneal Regularisation requires 6 steps to be attained:

1-Detection of the corneal HOA and the ability to select the most clinically significant types and treat them through a highly selective profile.

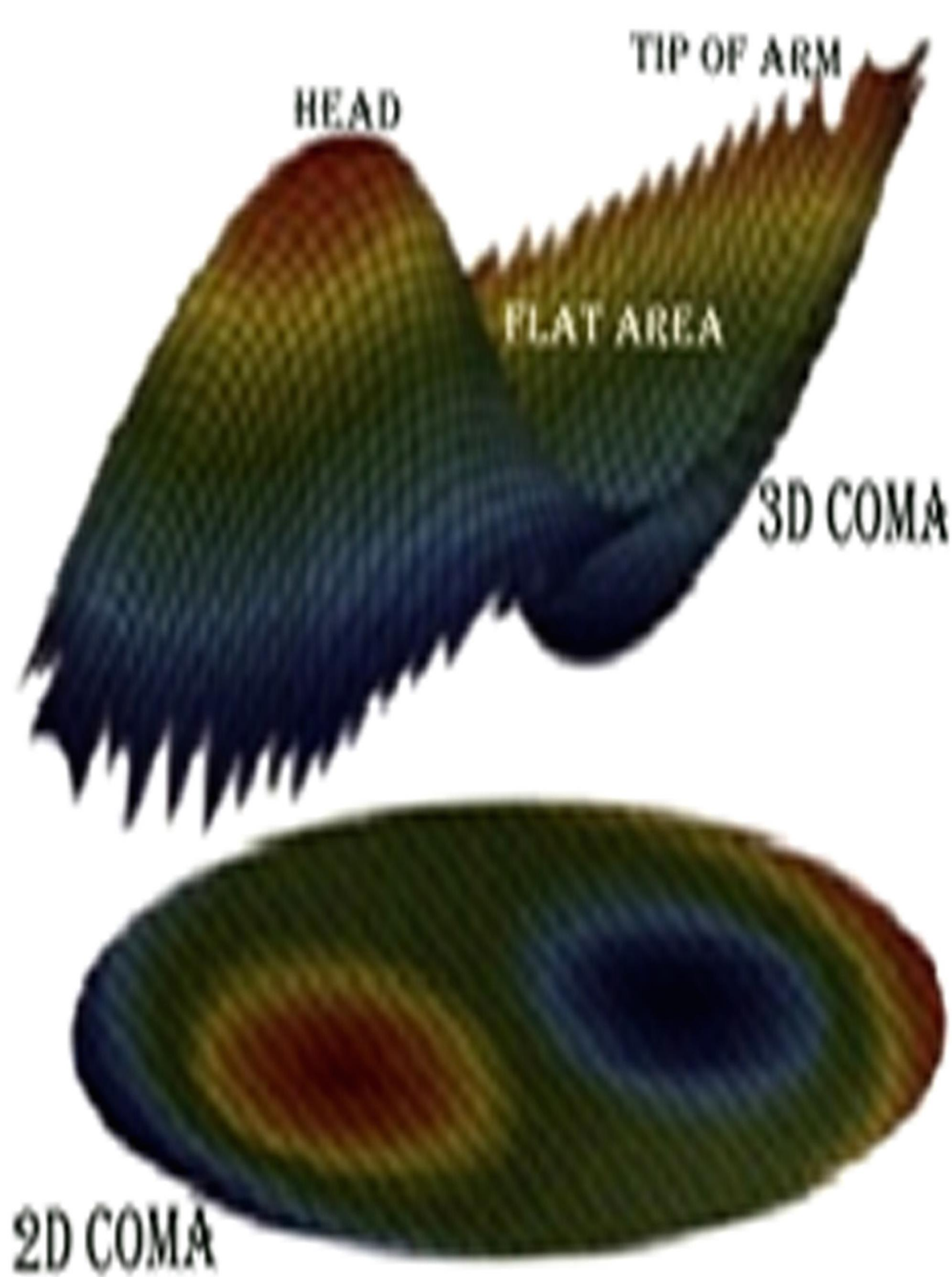
2- TheAbility to incorporate the selected HOA with refractive error algorithmically to prevent any over correction.

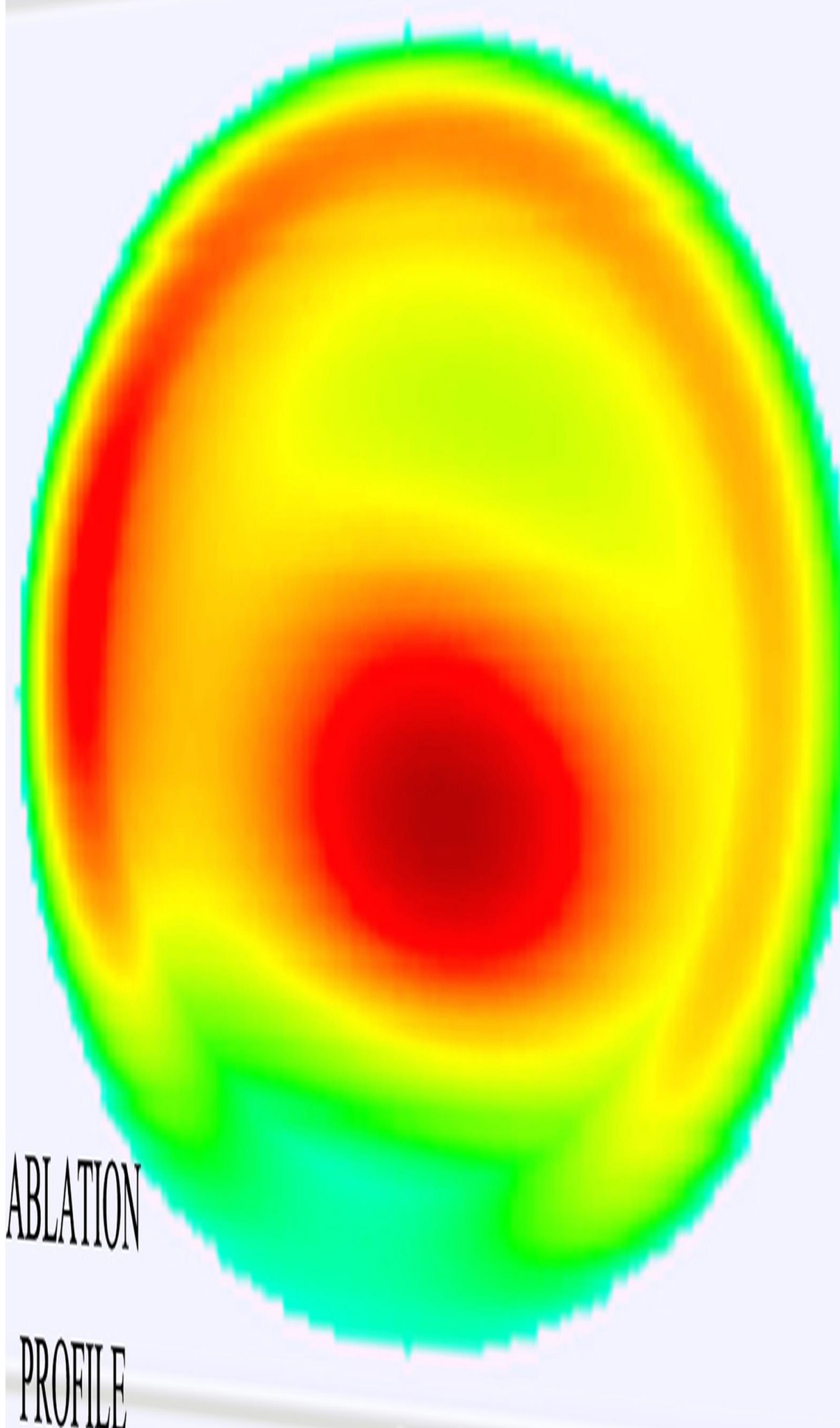
3-The optical zone of the TAGCA PRK should cover the outer border of the cone in relation to the geometrical center of the cornea.

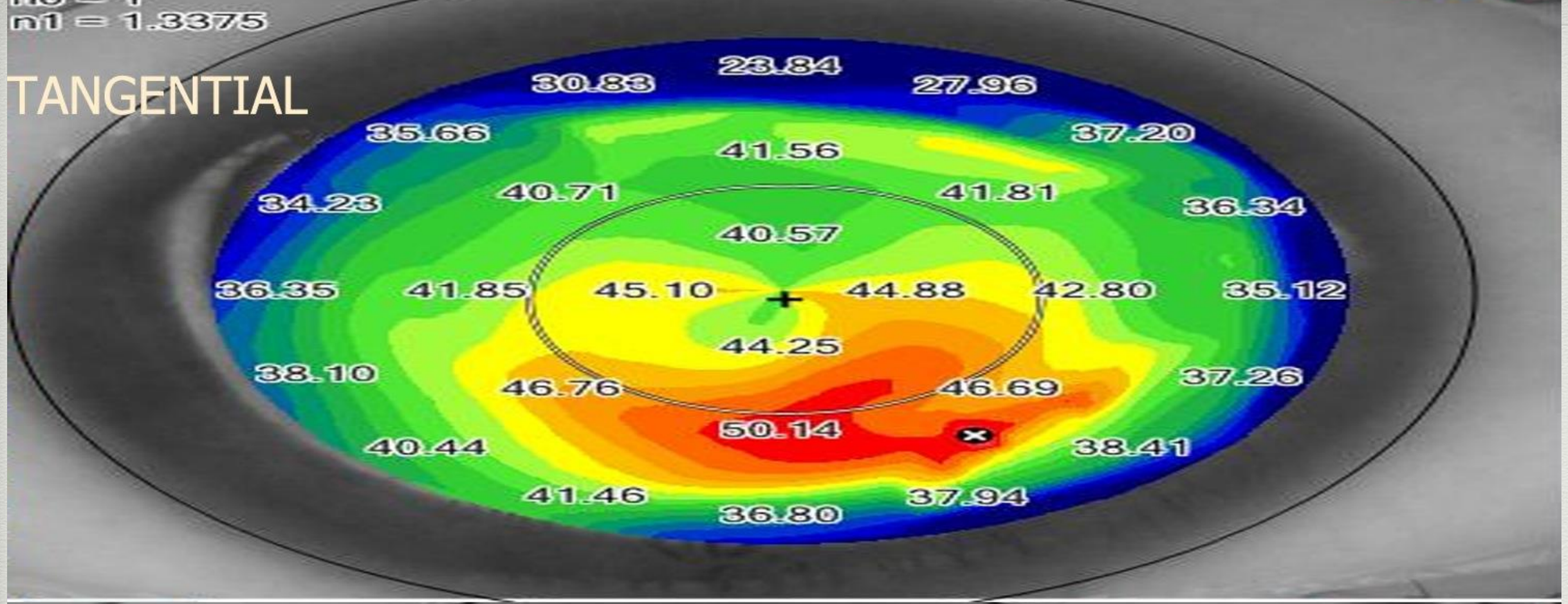
Corneal Regularisation in KC

If the optical zone is not covering the outer border; the regularisation process of the cornea will not be achieved because the principle of this process depends on:

- **Myopic-hyperopic pattern ablation that is unique to the KC, because it simply represents the coma which forms 90% of the corneal HOA** in KC (**myopic part represented by head of the coma, while hyperopic part represented by the tip of the coma's arm which is opposite to the cone**).**The myopic part flattens the cone's apexes while the hyperopic part flattens the corneal periphery** . Flattening the cone's head and the cornea's periphery opposite to the head leads to steepen corneal center, which is in between. This performance will lead to corneal regularisation by recentering the flattened (treated) cone.
- Treating part of the cone (the central part) will not lead to steepen flat corneal area (between the cone and the peripheral part of the cornea).Leaving the cone's peripheral part untreated with laser and CXL leads to progression at this part , and it also leads to steepen it because of the flattening effect of the cone's central part by laser.


TIP OF ARM
HEAD
FLAT AREA
3D COMA
2D COMA


ABLATION
PROFILE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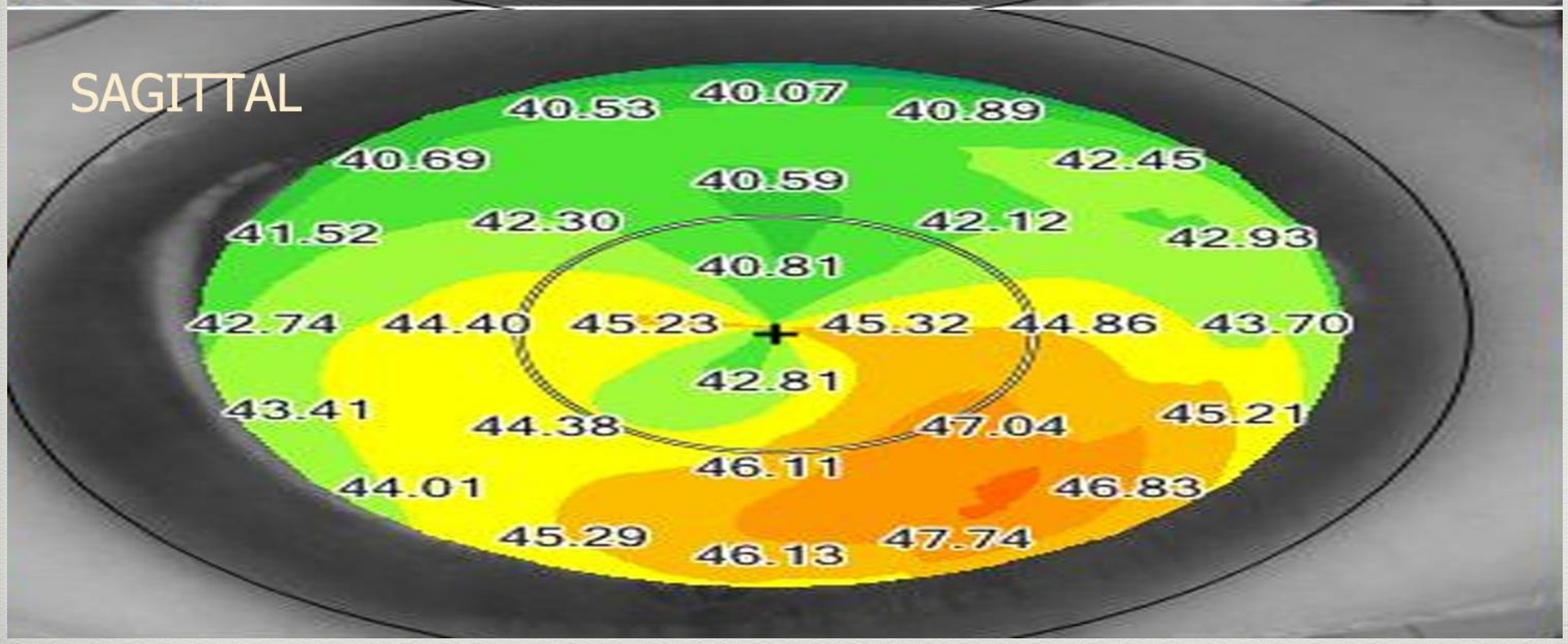
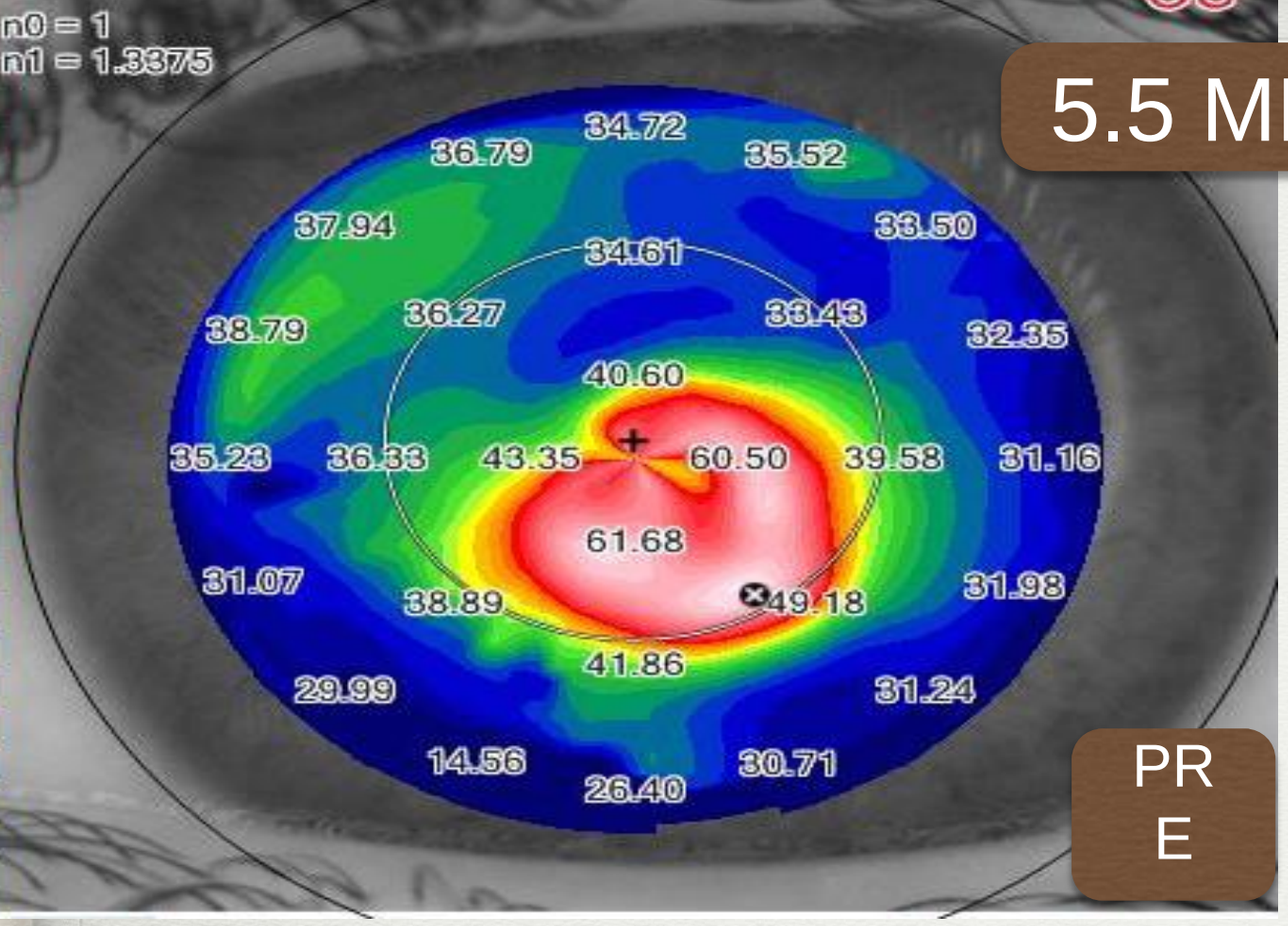
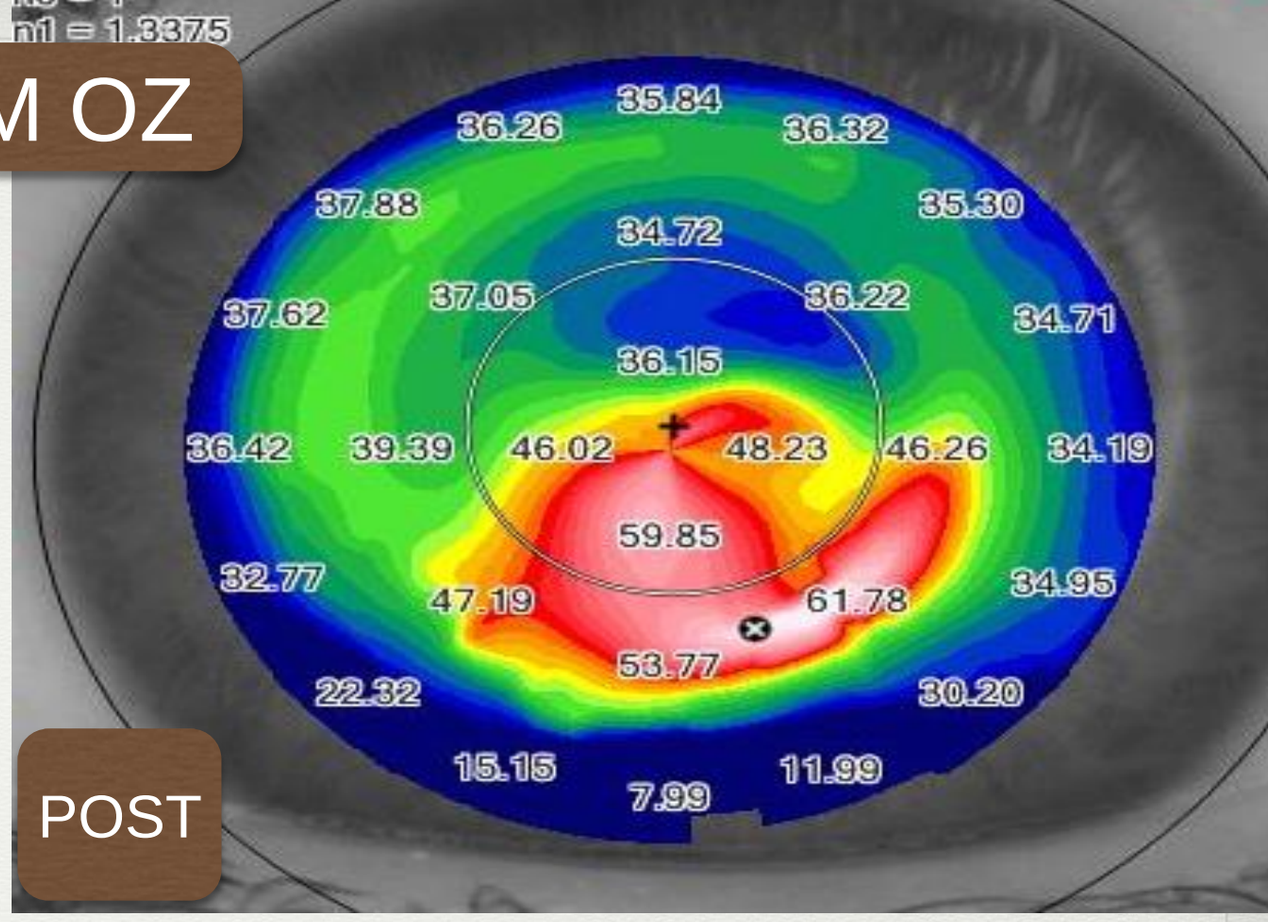
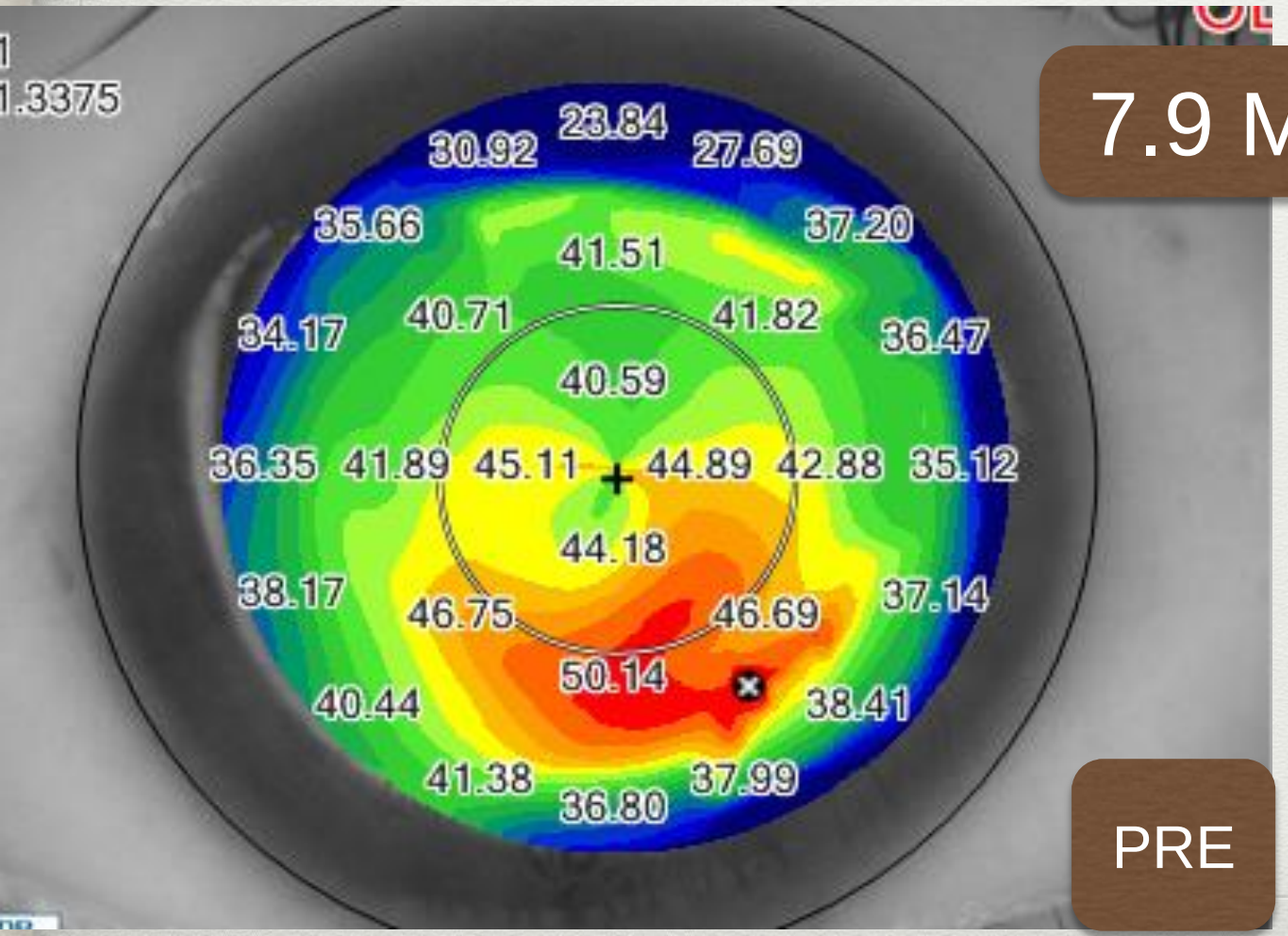
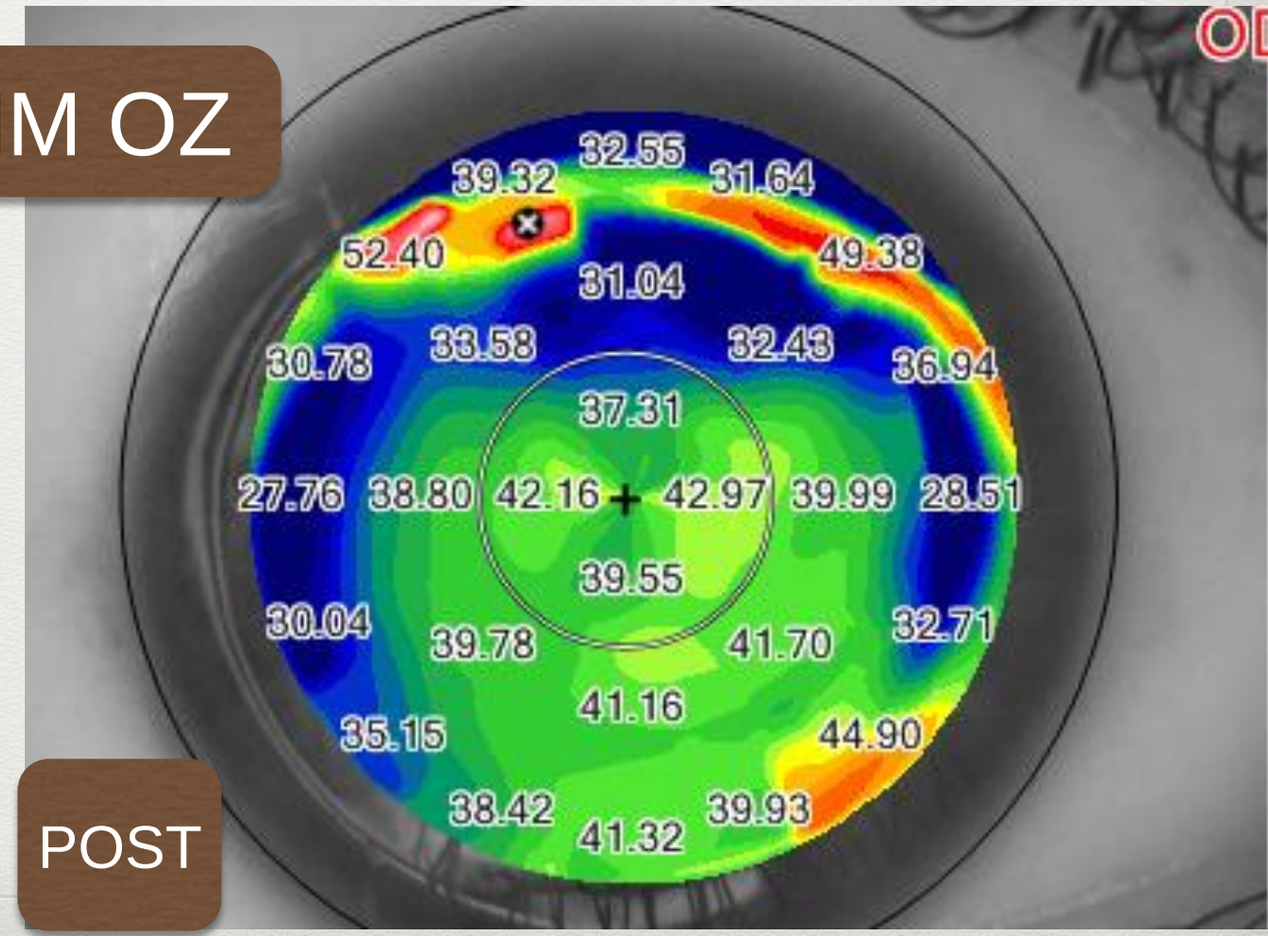
TANGENTIAL
23.84
30.83
27.96
35.66
37.20
41.56
34.23
40.71
41.81
36.34
40.57
36.35
41.85
45.10
44.88
42.80
35.12
44.25
38.10
46.76
46.69
37.26
50.14
40.44
38.41
41.46
37.94
36.80


SAGITTAL
40.07
40.53
40.89
40.69
42.45
40.59
41.52
42.30
42.12
42.93
40.81
42.74
44.40
45.23
45.32
44.86
43.70
42.81
43.41
44.38
47.04
45.21
46.11
44.01
46.83
45.29
47.74
46.13


n0 = 1
n1 = 1.3375
5.5 MM OZ
34.72
36.79
35.52
37.94
33.50
34.61
38.79
36.27
33.43
32.35
40.60
35.23
36.33
43.35
60.50
39.58
31.16
61.68
31.07
38.89
49.18
31.98
41.86
29.99
31.24
14.56
30.71
26.40
PRE


n1 = 1.3375
35.84
36.26
36.32
37.88
35.30
34.72
37.62
37.05
36.22
34.71
36.15
36.42
39.39
46.02
48.23
46.26
34.19
59.85
32.77
47.19
61.78
34.95
53.77
22.32
30.20
15.15
11.99
7.99
POST


1.3375
7.9 MM OZ
23.84
30.92
27.69
35.66
37.20
41.51
34.17
40.71
41.82
36.47
40.59
36.35
41.89
45.11
44.89
42.88
35.12
44.18
38.17
46.75
46.69
37.14
50.14
40.44
38.41
41.38
37.99
36.80
PRE


32.55
39.32
31.64
52.40
49.38
31.04
30.78
33.58
32.43
36.94
37.31
27.76
38.80
42.16
42.97
39.99
28.51
39.55
30.04
39.78
41.70
32.71
41.16
35.15
44.90
38.42
41.32
39.93
POST

Corneal Regularisation in KC

4-Trans epithelial ablation of our laser machine which is continuous with the refractive ablation, is aspheric (55µm central and 65µm peripheral) enables us to reach up to 8mm without leaving any remnant of epithelial tissues especially in the peripheral part of the cornea,

5-The refractive ablation of our laser is customised which means it treats the induced spherical aberration gives us the ability to reach up to 8 mm optical zone without oblating the cornea (maintain the Q value in prolate form).

6-Advanced tracking system with 6 dimensions.

Purpose

- To assess the effectiveness of TAGCA PRK and ACXL in a single procedure for Keratoconus treatment.

Method

- ***40 eyes with progressive KC with:***

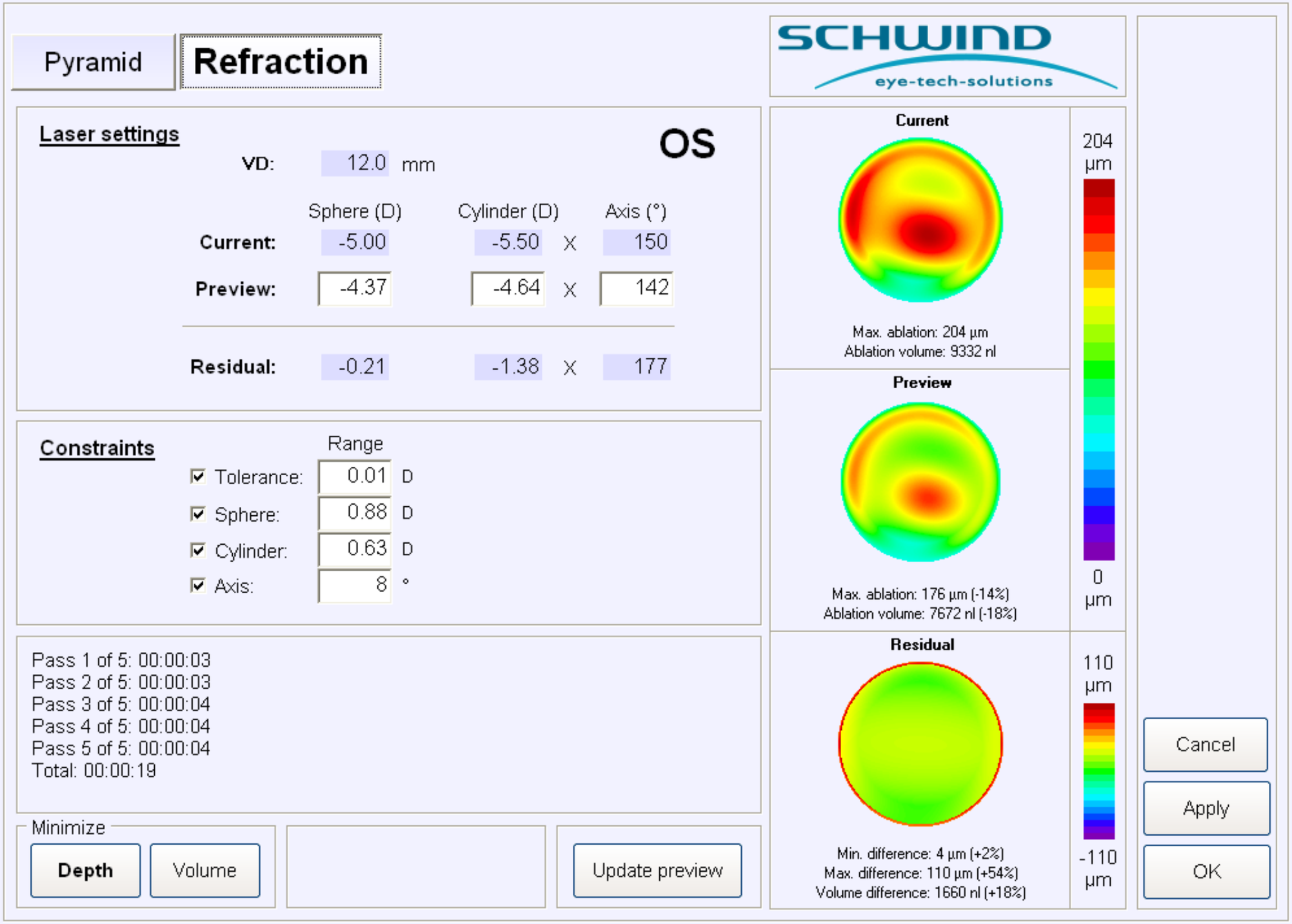
1. Clear cornea no hydrops.
2. Pachymeter is not below 400 µm.
3. k reading is not more than 60 D.

Method

40 eyes underwent trans epithelial TAGCA PRK using Refractive and the pyramid module in the management of HOA of Schwind AMARIS 750S Laser that's able to save tissue and incorporate the corneal wave front with refractive error of the patient taking in consideration to:

- The Optical Zone will be related to the outer-border of the cone from the geometrical point.
- The resulted thinnest point is not less than 300µm post treatment.
- The degree of patient's sphere and cylinder was chosen depending on patient's corneal thinnest point, corneal map cylinder/axis, and outer border of the cone.

Pre-Op Refraction -11.00 / -9.50 @ 161°



OD | OS

Patient-ID: 3167
Comment:

Last name:
First name:

Date of birth: 04/02/1989
Gender: Female

SCHWIND eye-tech-solutions

Pre-Op Refraction -11.00 / -9.50 @ 161°

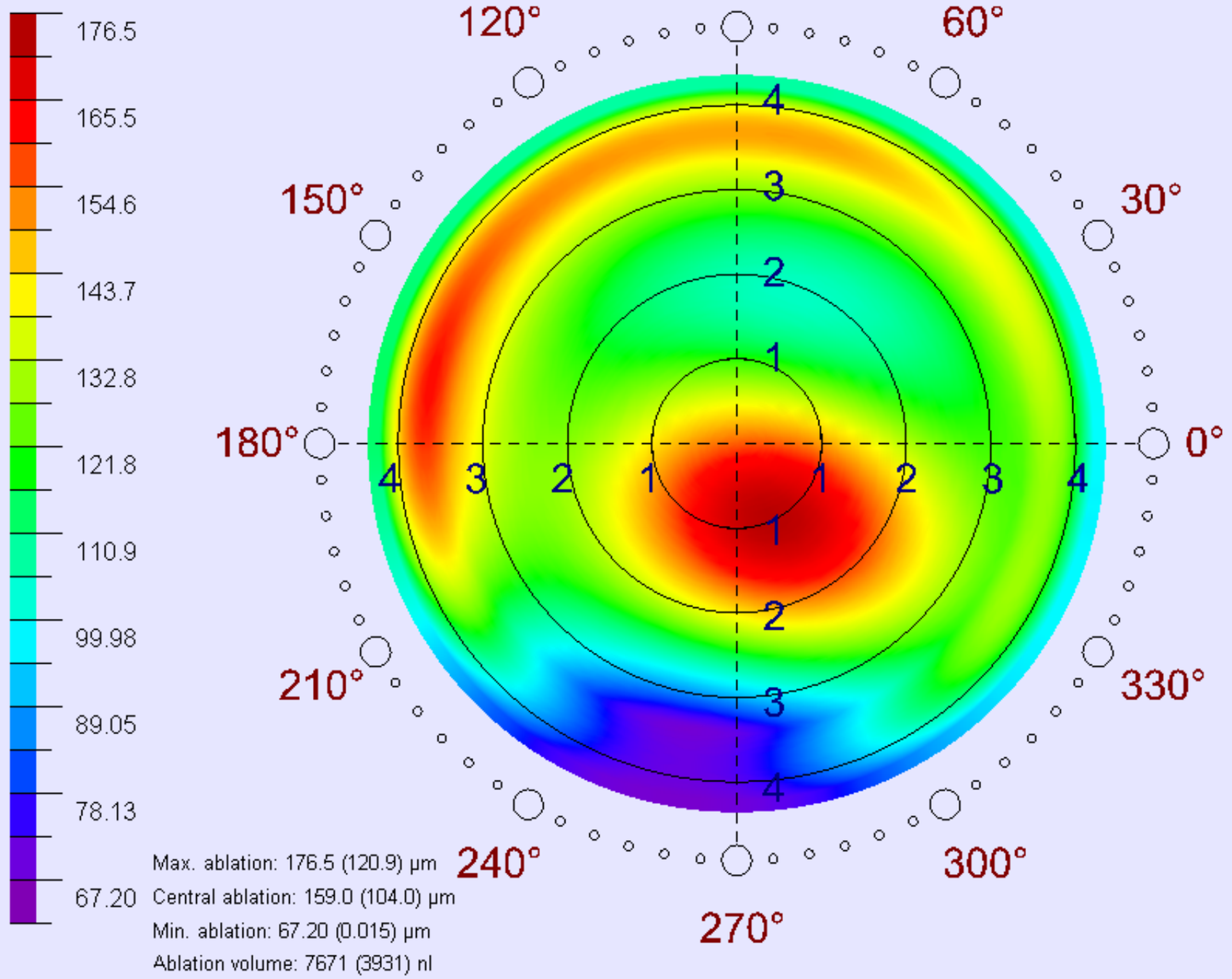
Corneal Wavefront (SIRIUS)

Ablation Map | Wavefront Map | HO Wavefront Map

Depth (µm)

Normalized

OS



Max. ablation: 176.5 (120.9) µm
Central ablation: 159.0 (104.0) µm
Min. ablation: 67.20 (0.015) µm
Ablation volume: 7671 (3931) nl

Refraction RZ @ 4.00 mm

VD (mm): 12.0

	Sph. (D)	Cyl. (D)	Axis (°)
Manifest:	-4.37	-4.64 x	142
Target:	0	0 x	142
Laser:	-4.37	-4.64 x	142
Offset:	R: 0.00 mm / Angle: 0 °		

Optical zone

Total ablation zone: 8.83 mm
Selected OZ: 6.80 mm
min.: 4.00 mm max.: 7.55 mm
Imported Ø: 8.50 mm

RST manager

	centr. (µm)	@ 2.05mm (µm)
Pachy:	477	723
Epith.thickn.:	0	0
Abl. depth:	160	177
RST (>250)	317	546

Treatment status

Compound Myopic Astigmatism
TransPRK

ORK-CAM
PresbyMAX
PALK-CAM
PTK-CAM
Comparison
Open
Save *
Print
Settings
Help
Info
Exit

Patient data | Zernike list | Aberration info | Manager | Keyboard on | Apply | Summary

Pre-Op Refraction -11.00 / -9.50 @ 161°

Pyramid | **Refraction**

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Laser settings — **OS**

VD: 12.0 mm

	Sphere (D)	Cylinder (D)		Axis (°)
Current:	-5.00	-5.50	X	150
Preview:	-4.86	-5.17	X	145
Residual:	+0.16	-0.82	X	4

Constraints

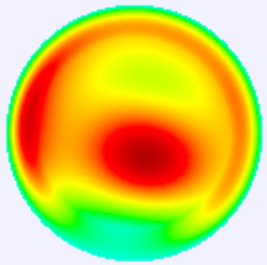
	Range	
☑ Tolerance:	0.01	D
☑ Sphere:	0.25	D
☑ Cylinder:	0.25	D
☑ Axis:	5	°

Pass 1 of 5: 00:00:03
Pass 2 of 5: 00:00:03
Pass 3 of 5: 00:00:04
Pass 4 of 5: 00:00:04
Pass 5 of 5: 00:00:04
Total: 00:00:19

Minimize: **Depth** | Volume

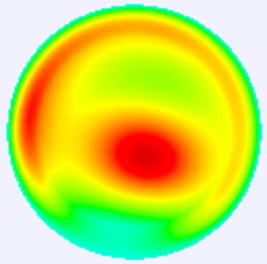
Update preview

Current



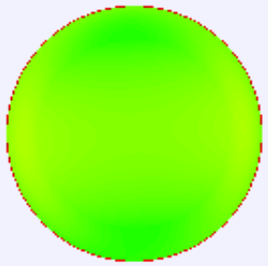
Max. ablation: 204 µm
Ablation volume: 9332 nl

Preview



Max. ablation: 193 µm (-5%)
Ablation volume: 8641 nl (-7%)

Residual



Min. difference: 1 µm (+0%)
Max. difference: 81 µm (+40%)
Volume difference: 690 nl (+7%)

204 µm
0 µm
81 µm
-81 µm

Cancel
Apply
OK

OD OS

Patient-ID: 3167
Comment:
Last name:
First name:
Date of birth: 04/02/1989
Gender: Female

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Pre-Op Refraction -11.00 / -9.50 @ 161°

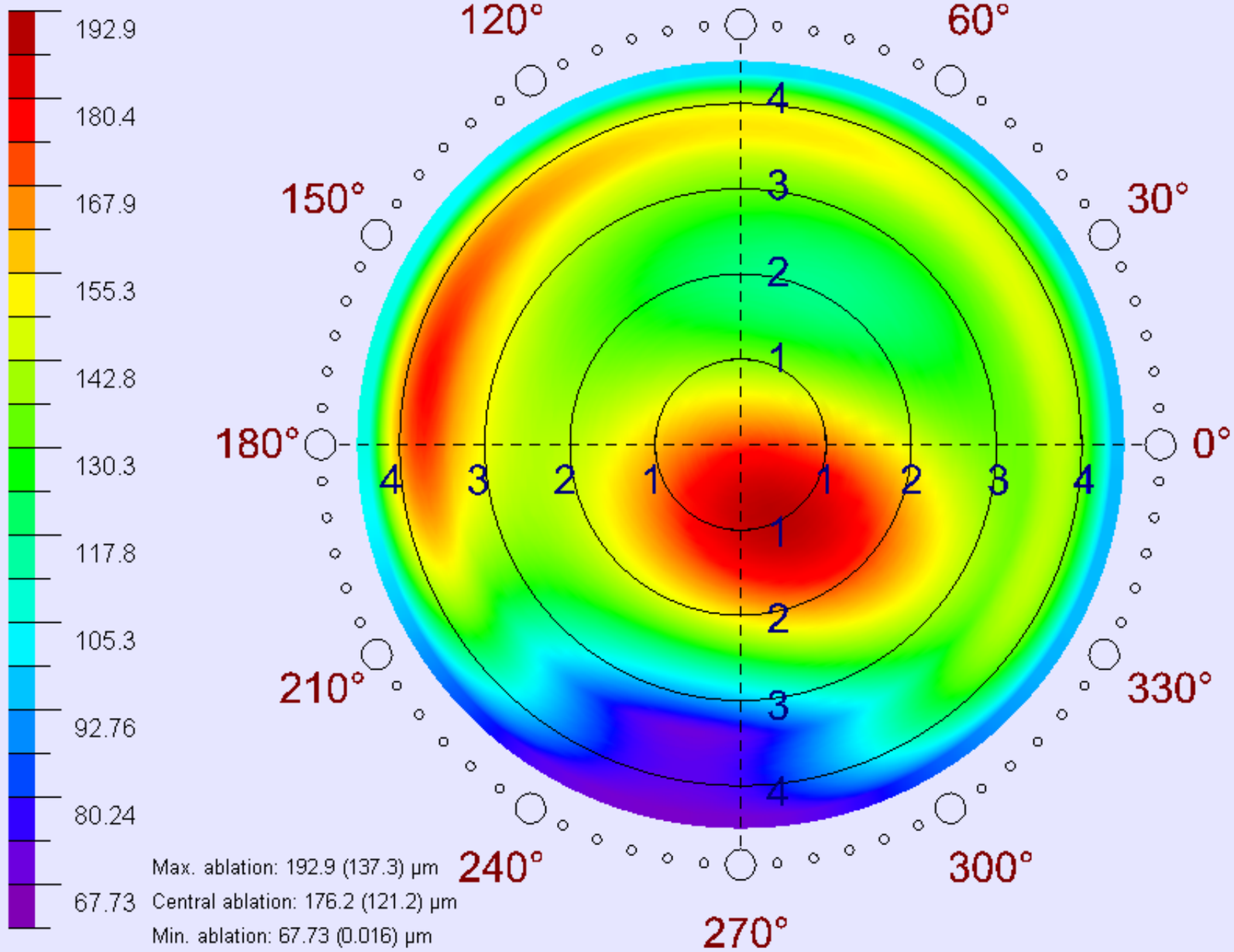
Corneal Wavefront (SIRIUS)

Ablation Map | Wavefront Map | HO Wavefront Map

Depth (µm)

Normalized

OS



Max. ablation: 192.9 (137.3) µm
Central ablation: 176.2 (121.2) µm
Min. ablation: 67.73 (0.016) µm
Ablation volume: 8641 (4715) nl

Refraction RZ @ 4.00 mm

VD (mm): 12.0

	Sph. (D)	Cyl. (D)	Axis (°)
Manifest:	-4.86	-5.17 x	145
Target:	0	0 x	145
Laser:	-4.86	-5.17 x	145

Offset: R: 0.00 mm / Angle: 0 °

Optical zone

Total ablation zone: 9.02 mm
Selected OZ: 6.80 mm
min.: 4.00 mm max.: 7.50 mm
Imported Ø: 8.50 mm

RST manager

	centr. (µm)	@ 1.92mm (µm)
Pachy:	477	723
Epith.thickn.:	0	0
Abl. depth:	177	193
RST (>250)	300	530

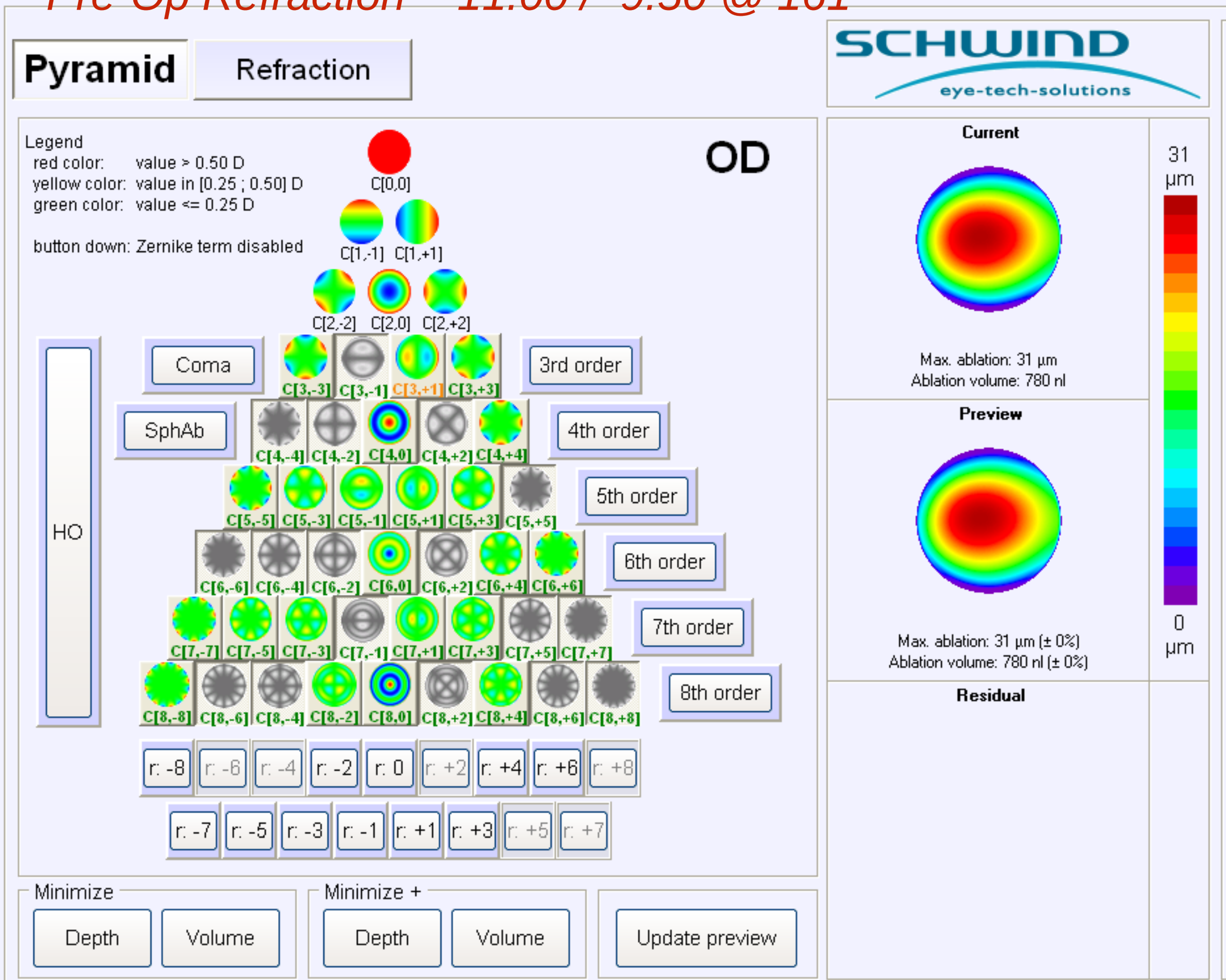
Treatment status

Compound Myopic Astigmatism
TransPRK

ORK-CAM
PresbyMAX
PALK-CAM
PTK-CAM
Comparison
Open
Save *
Print
Settings
Help
Info
Exit

Patient data | Zernike list | Aberration info | Manager | Keyboard on | Apply | Summary

Pre-Op Refraction -11.00 / -9.50 @ 161°



Pre-Op Refraction -11.00 / -9.50 @ 161°

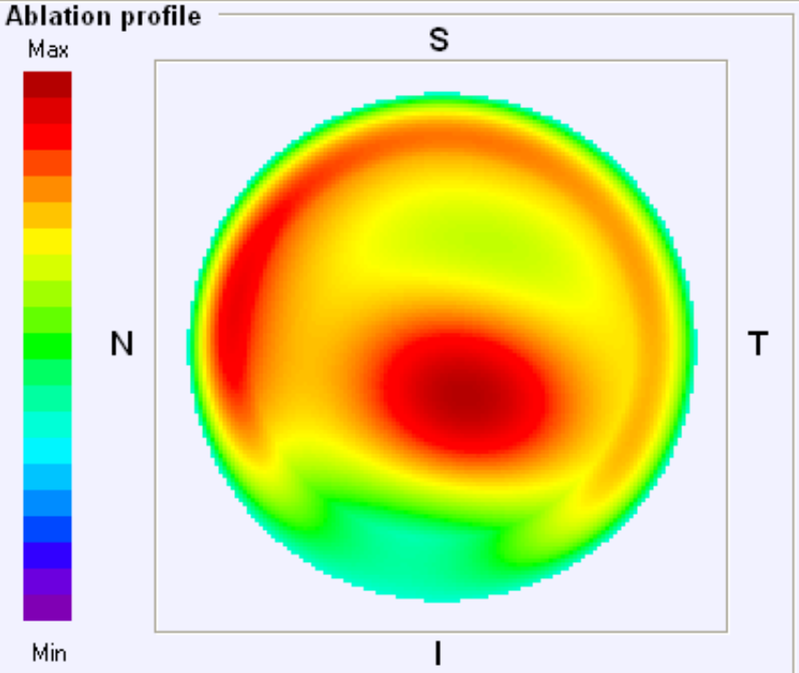
Patient-ID:	Last name:	First name:	Date of birth:	Age:	Gender:
3167			04/02/1989	24	Female

Comment:

SCHWIND eye-tech-solutions

OD | **OS**

Ablation profile



Main info

Type of treatment:	Corneal Wavefront (SIRIUS)
Treatment method:	TransPRK
Type of refraction:	Compound Myopic Astigmatism
Imported file:	
Import diameter:	8.50 mm

Optical zone:	6.80 mm
Transition zone:	2.22 mm
Ablation zone (max. 10 mm):	9.02 mm
Max. ablation depth:	192.9 µm
Central ablation depth:	176.2 µm
Min. ablation depth:	67.73 µm
Ablation volume:	8641 nl

SCC device	Status	SCC info
Sirius	✓	SCC data suitable

Offset info

Pupil diameter:	3.40 mm
Radius:	0.00 mm
Angle:	0 °

Summary of aberrations @ OZ = 6.80 mm

Coma:	5.03 µm / 4.92 D @ 100°	P-V:	46.96 µm
Trefoil:	1.53 µm / 0.50 D @ 76°	RMS HO:	5.75 µm / 5.33 D
SphAb:	-1.80 µm / -1.39 D	RMS total:	8.27 µm / 6.25 D

Cancel

Print

Refraction @ VD = 12.0 mm; RZ = 4.00 mm

	Sphere	Cylinder		Axis
Manifest:	-4.86 D	-5.17 D	x	145°
Target:	0 D	0 D	x	145°
Laser:	-4.86 D	-5.17 D	x	145°

K-Readings

					Avg K:
Pre:	K1:	53.14 D	@	159°	
	K2:	59.03 D	@	69°	56.08 D
Target:	K1:	48.90 D	@	177°	
	K2:	52.02 D	@	87°	50.46 D

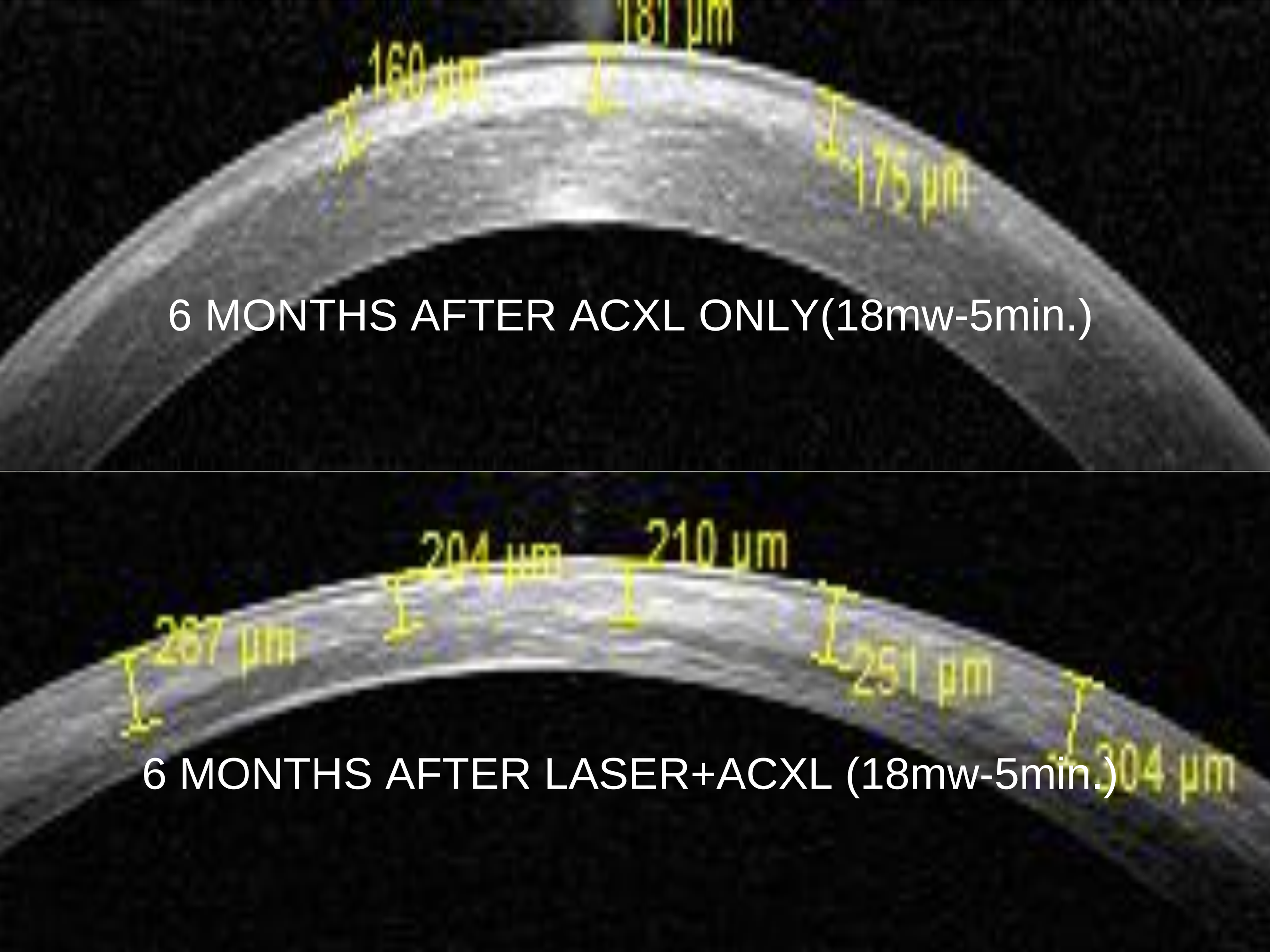
RST manager

	Central	@ 1.92mm
Pachy:	477 µm	723 µm
Epith.thickn.:	0 µm	0 µm
Max. abl.:	177 µm	193 µm
RST (>250)	300 µm	530 µm

Export

Method

- After laser, Mitomycin-c in a concentration of 0.02% for 20 seconds.
- Followed immediately by ACXL with Riboflavin 0.1 % drops every 2 minutes for 20 minutes then exposed to mean of 365 nm ultraviolet light UV at 18mW/cm² for 5 minutes with the use of hyperbaric oxygen.
- This protocol using Schwind AMARIS 750S Laser with accelerated CXL(18mw-5min.) is to be named **"Emirates Protocol"** to differentiate it from other protocols that use PRK/CXL in KC treatment.
- Pre & Post operative evaluations include: manifest refraction, UDVA, CDVA, topo-tomographic corneal map which uses Placido Scheimpflug corneal map with corneal pachymetric map and slit-lamp examination of the corneal clarity with minimum follows up of 12 months.

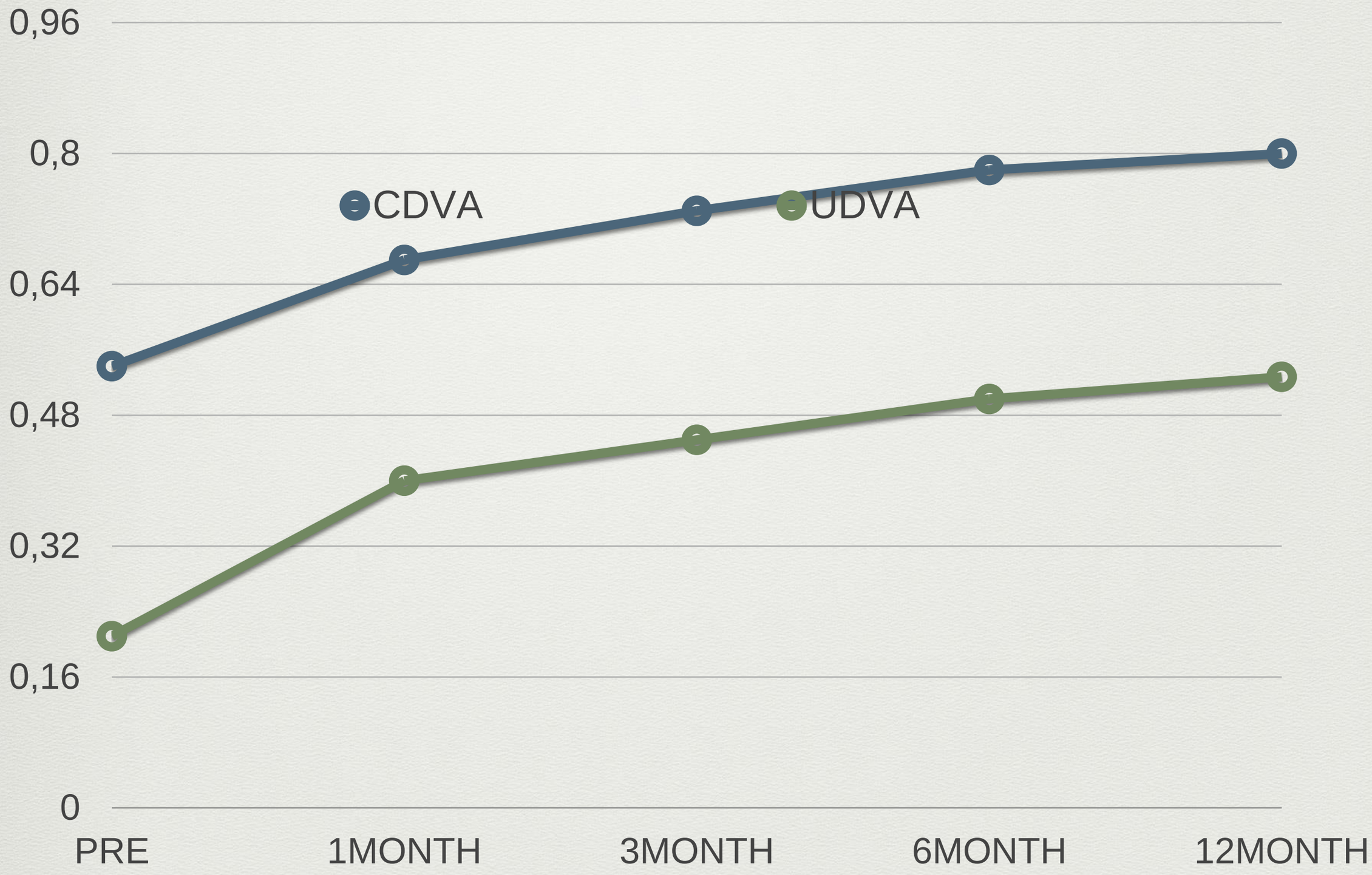

160 µm
181 µm
175 µm
6 MONTHS AFTER ACXL ONLY(18mw-5min.)
267 µm
204 µm
210 µm
251 µm
304 µm
6 MONTHS AFTER LASER+ACXL (18mw-5min.)

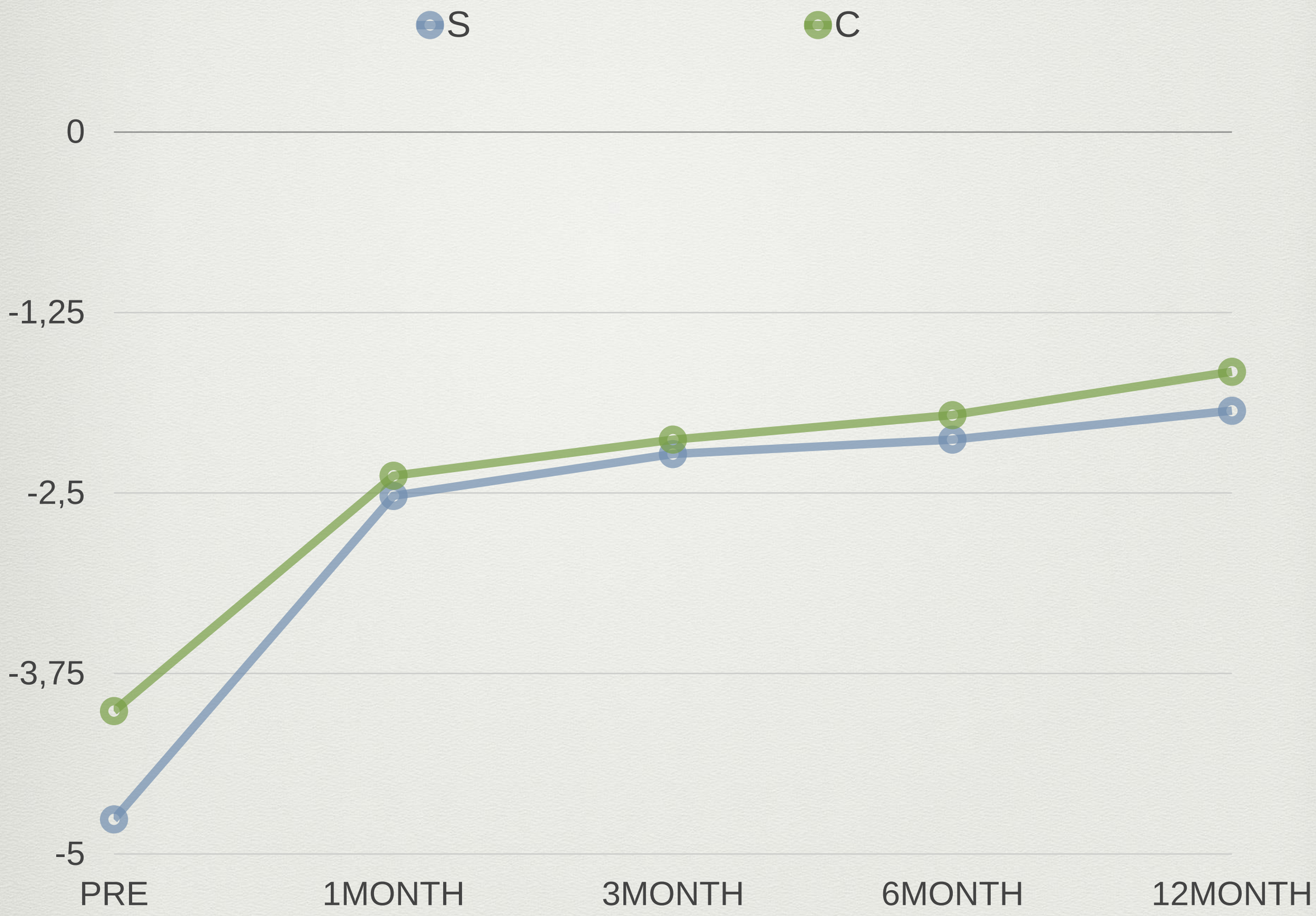
Results

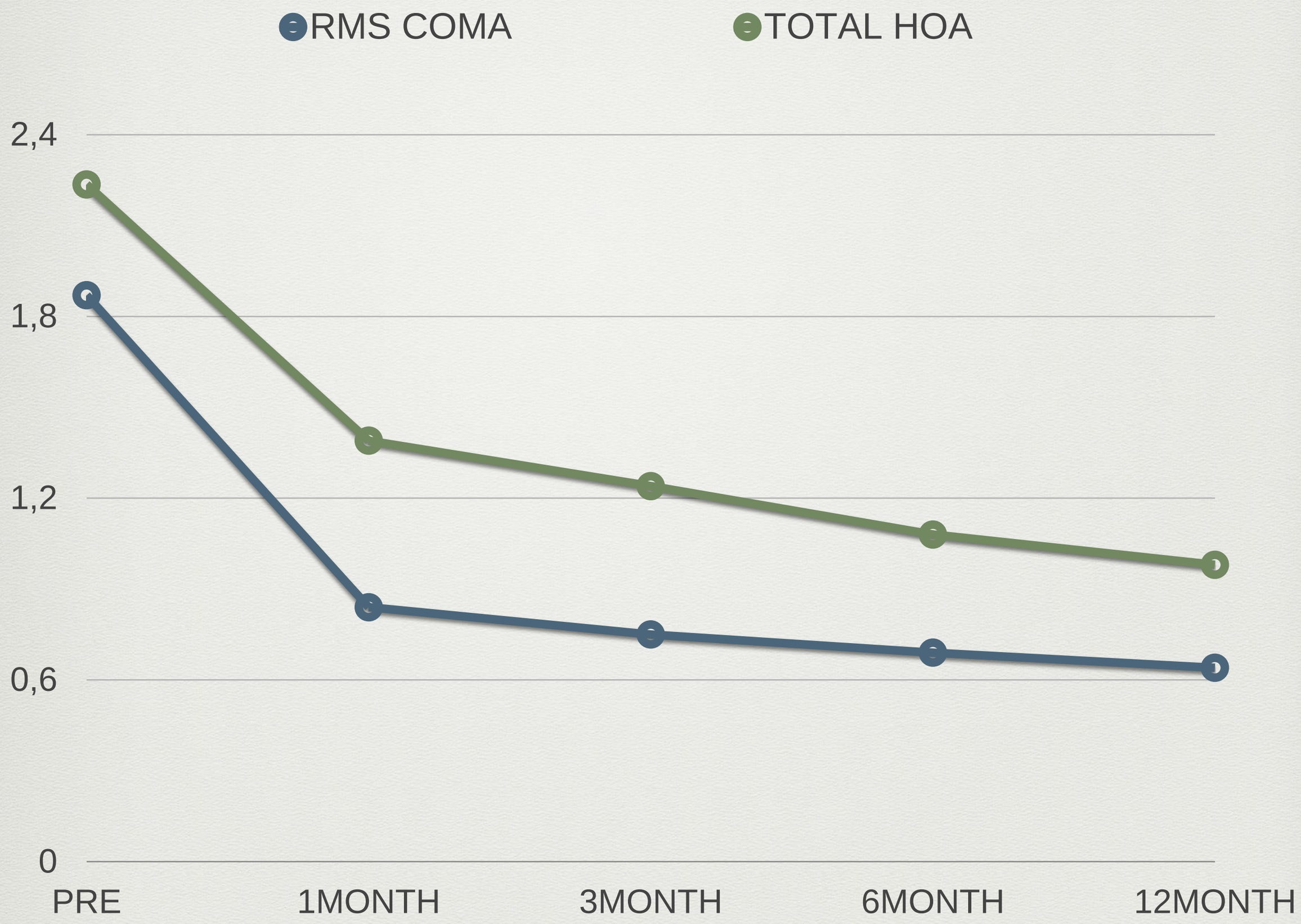
- 38 treated eyes showed rapid healing of the epithelial surface within one week.
- All eyes showed gradual vision improvement within the first month All treated eyes showed spherical equivalent improvement and remarkable improvement in corneal wave front (coma, spherical aberration and trefoil).

Results

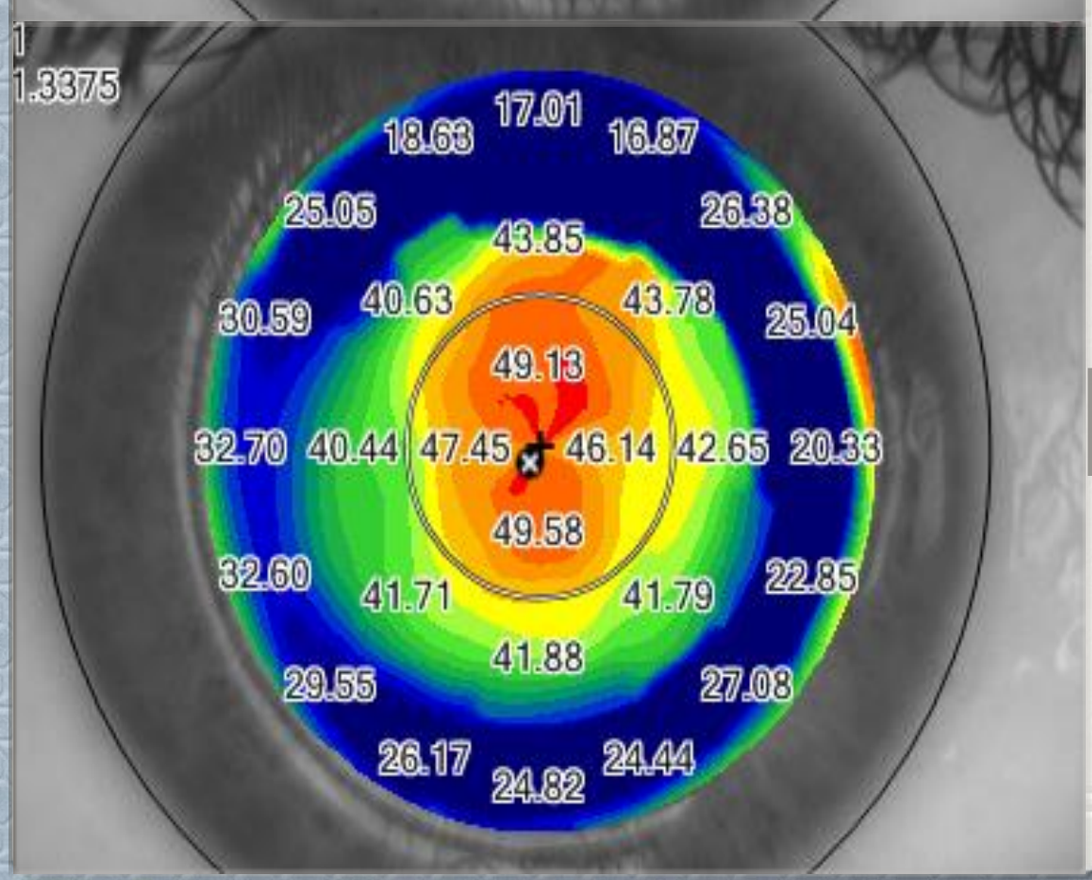
MEAN	S	C	SEQ	UDVA	CDVA	K1	K2	PACHY	RMS COMA	H.O.A TOTAL	Q	AKF	KVF
PRE	-4.76	-4.01	-6.67	0.21	0.54	45.4	48.83	458.35	1.87	2.23	-1.10	55.58	30.35
POST 12 MONTHS	-1.93	-1.66	-2.81	0.53	0.8	44.56	45.29	351.15	0.64	0.98	-0.34	47.41	15.50


0,96
0,8
0,64
0,48
0,32
0,16
0
CDVA
UDVA
PRE
1MONTH
3MONTH
6MONTH
12MONTH


S
C
0
-1,25
-2,5
-3,75
-5
PRE
1MONTH
3MONTH
6MONTH
12MONTH


RMS COMA
TOTAL HOA
2,4
1,8
1,2
0,6
0
PRE
1MONTH
3MONTH
6MONTH
12MONTH


K2
AKF
60
45
30
15
0
PRE
1MONTH
3MONTH
6MONTH
12MONTH



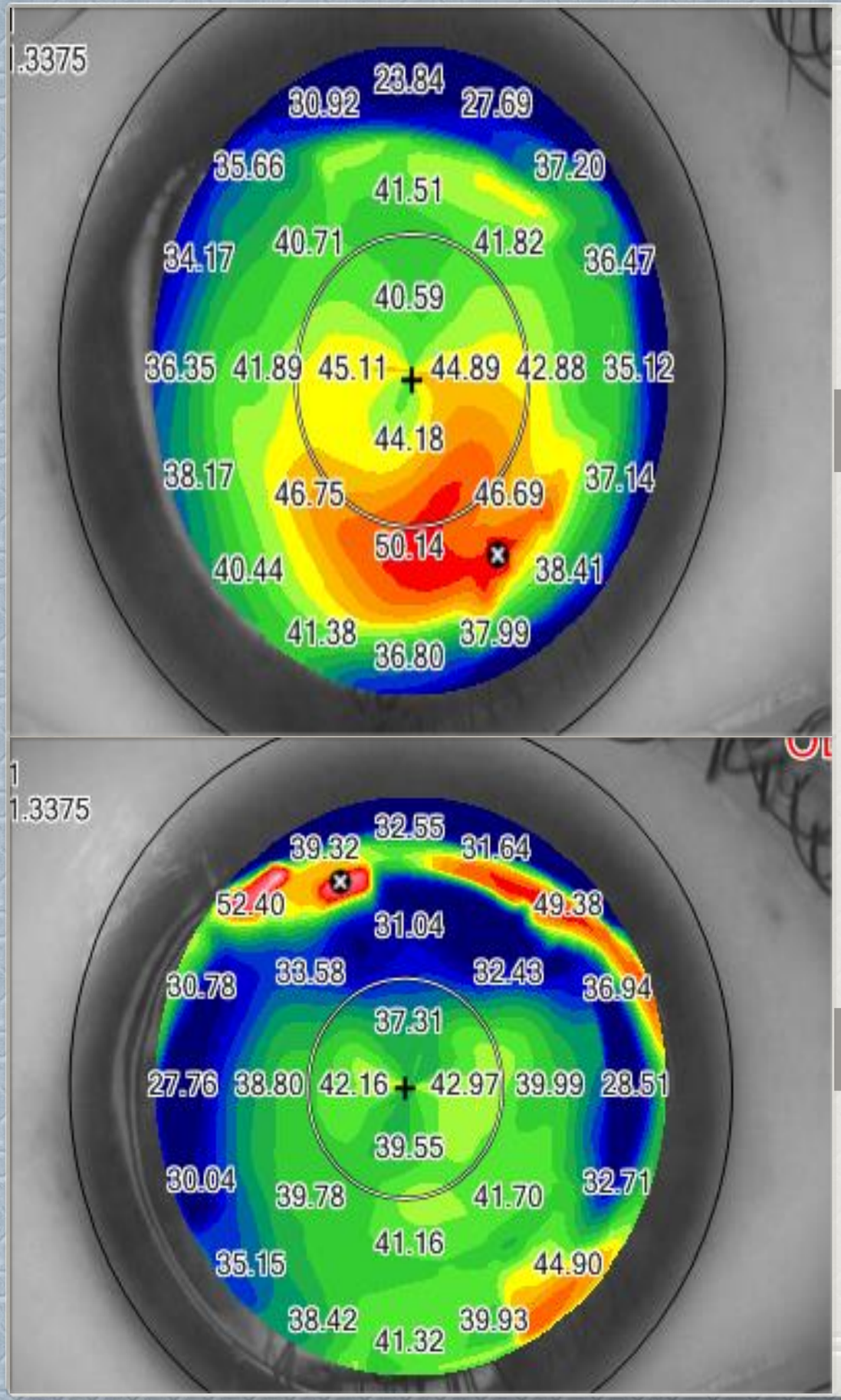
OD

Case One
32 years old male

Pre-Op -7.50/ -9.00 @ 3°
UDVA 20/400 CDVA 20/80
RMS Coma 1.63 Eq.D
RMS High Orders 2.34 Eq.D

Treated Refraction -2.25/-5.50 @13°
Treated Optical Zone 7.00mm

Post-Op -4.87/ -0.75 @ 16°
UDVA 20/80 CDVA 20/30
RMS Coma 0.18 Eq.D
RMS High Orders 0.66 Eq.D



OD

Case Two

31 years old male

Pre-Op -5.75/ -5.25 80°
UDVA 20/200 CDVA 20/50
RMS Coma 1.35 Eq.D
RMS High Orders 1.62 Eq.D

Treated Refraction -2.89/-2.73 @70°
Treated Optical Zone 7.97mm

Post-Op -1.25/ -3.50 98°
UDVA 20/40 CDVA 20/25
RMS Coma 0.95 Eq.D
RMS High Orders 1.03 Eq.D

Conclusion

- TAGCA PRK through its Refractive module of the HOA management in the treatment profile of the High-Tech Laser followed by ACXL 18mw/cm² is safe and effective therapy that regularise the ectatic corneal surface, reduce spherical equivalent and corneal HOA in a remarkable way to improve the visual function of progressive Keratoconic eye without over correction nor increase of existence myopia.


THANK YOU