CENTRE d'OPHTALMOLOGIE de RABAT

EGYPTIAN OPHTHALMOLOGICAL SOCIETY EOS

Accuracy of the indices of MS-39 anterior segment optical coherence tomography in diagnosis of keratoconic corneas

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** Orthoptist

FINANCIAL DISCLOSURES

None

What is MS39?

- Anterior segment High Resolution Spectral domain OCT coupled with placido discs.
- Corneal Topography studied by Placido (22 rings).
- Elevations studied by OCT (not Scheimpflug) : better resolution , more accuracy , faster captures , less misalignement , non sensible to opacities / scars / Haze …

Accuracy of the indices of MS-39 anterior segment optical coherence tomography in the diagnosis of keratoconic corneas

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EJO European Journal of Ophthalmology
Original research article

PURPOSE:

To determine the normative and the cut-off values of various indices available in the MS 39 Anterior Segment Optical Coherence Tomography (MS-39 AS-OCT) for keratoconus (KC) diagnosis, and to detect the accuracy of the variable available parameters.

METHODS:

This cross sectional observational study was conducted at Dr Rifay Ophthalmology Center, Rabat, Morocco, on 172 eyes with KC (group I) and 248 eyes of healthy controls (group 2). Participants were screened using MS-39 AS-OCT (CSO, Firenze, Italy). The investigated indices included: keratometric indices, pachymetric indices, elevation indices, Keratoconus Summary Indices (KSI), aberration indices, and epithelial mapping evaluation.

WHY OCT TOPOGRAPHY ?

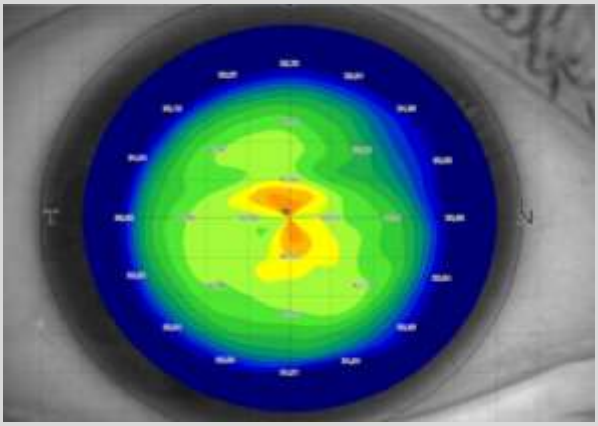
1/ Limitations of Placido based topography :

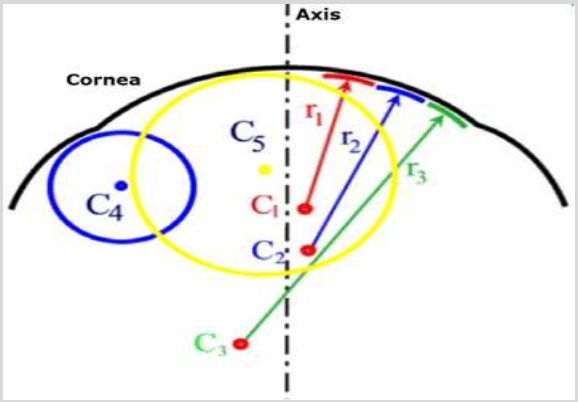
- Tear film Disturbance
- Do not analyse post surface
- Do not analyse epithelium

2/ Limitations Of Scheimplug based Tomography :

- Tomography not topography : reconstruction of Ant surface from elevations
- Misalignments not detected
- Limited in : Haze / scars / tear film disturbance / capture take time some seconds (difficult in Children)

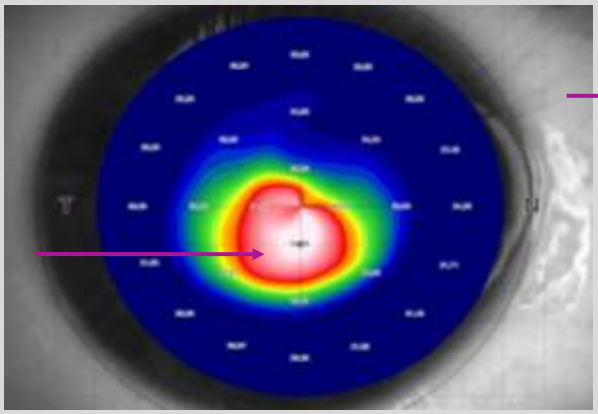
ANTERIOR TANGENTIAL MAP

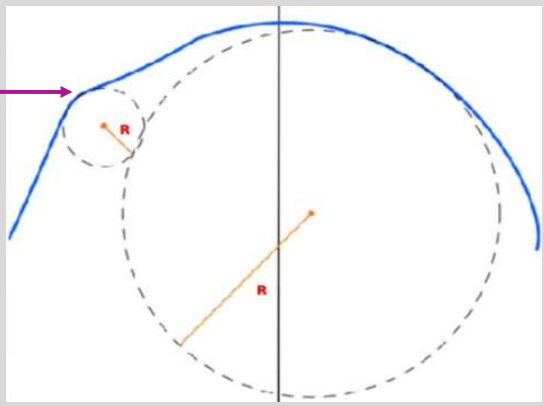




Normal

TANGENTIAL MAP

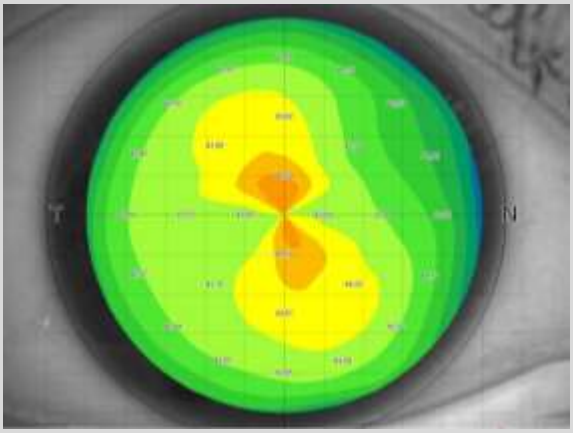


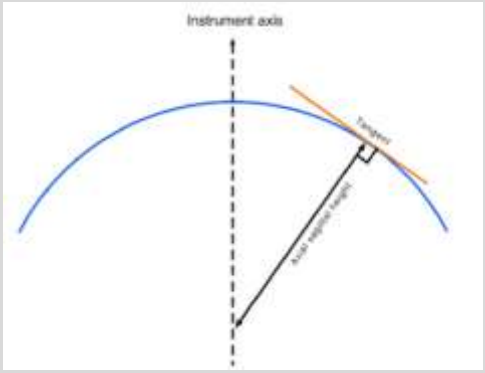


Keratoconus

For better location of the cone

AXIAL MAP

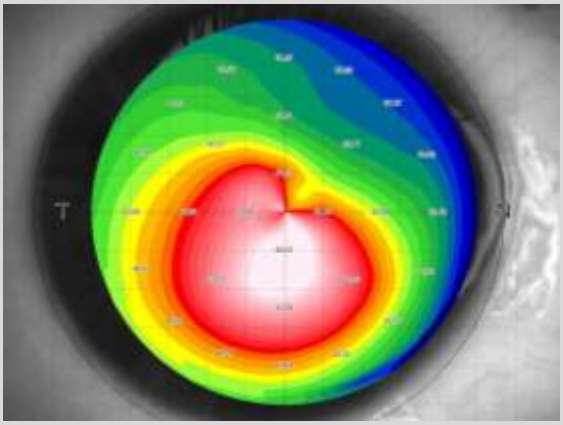


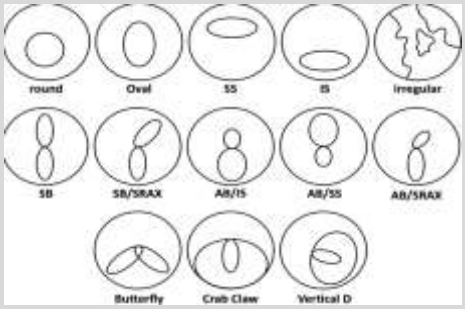


Study Symetry / Asymetry and Shape :

- Symetric bow-tie (astigmatism)
- Round or oval (no astigmatism)
- SRAX : to be confirmed par anterior hemi meridians .

AXIAL MAP

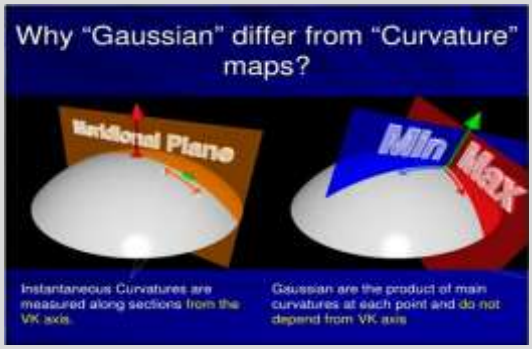




In keratoconus

- Asymetry > 1.5 d in the circle of 5MM
- Skewed shape , other shapes (asymetric bow tie ….)

GAUSSIAN MAP



- T.Turner (Orbscan, 1995) – Mean curvature maps
- M.Tang et alt (AJO Dec. 2005) – Mean curvature maps
- R.Mattioli (Keratron, Refractive-on-line 2007) - Gaussian maps

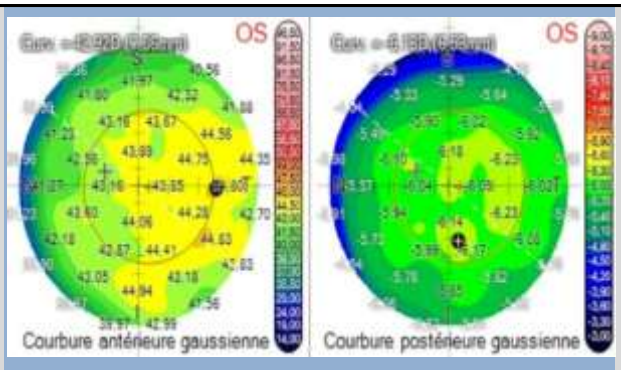
Mean is local curvature arithmetic average (D).
Gaussian is curvature geometric average (D):

$$\text{Mean} = (C1+C2)/2 \qquad \text{Gaussian} = \sqrt{C1 \times C2}$$

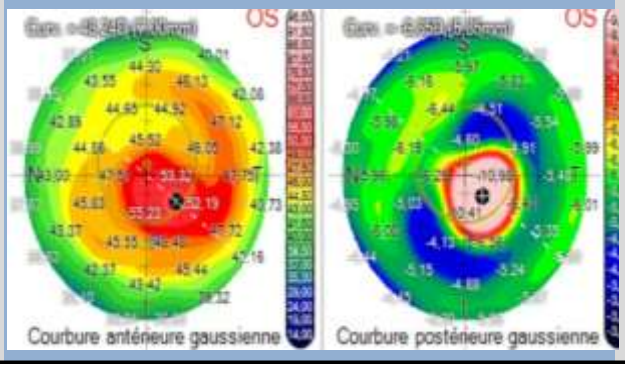
It can be shown that:

$$(\text{Gaussian})^2 = (\text{Mean})^2 + |\text{Astigmatism}|^2$$

Gaussian maps: **Cancel astigmatisms** but preserves ectasia



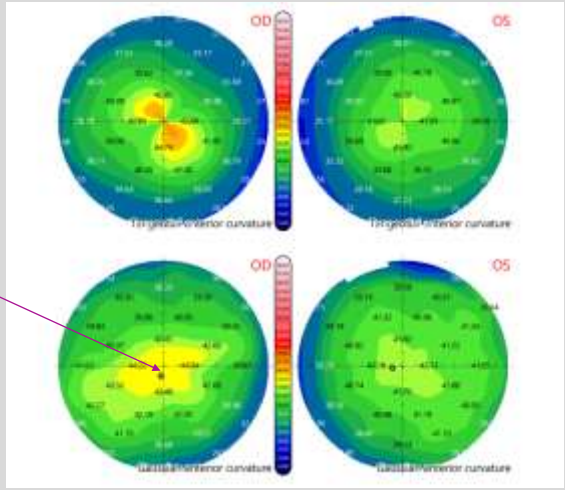
Normal GAUSSIAN MAP



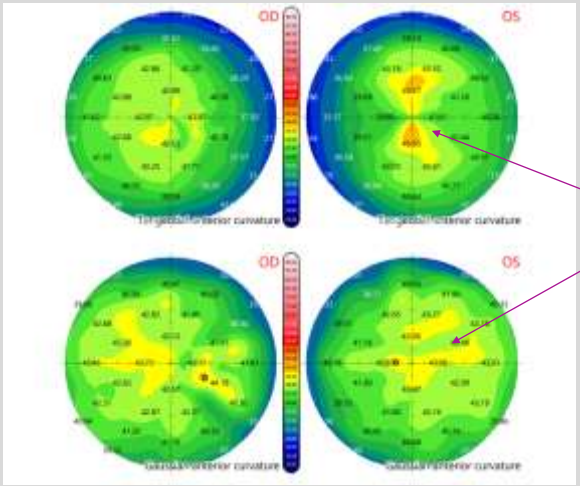
KC GAUSSIAN MAP

GAUSSIAN MAP

Keratoconus

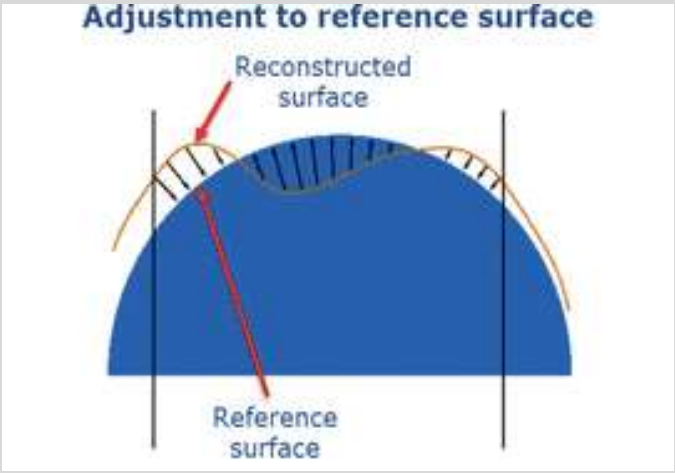


GAUSSIAN MAP



Astigmatism

ELEVATION MAP



The reference surface is done in a manner to minimise the mean square errors

BFS

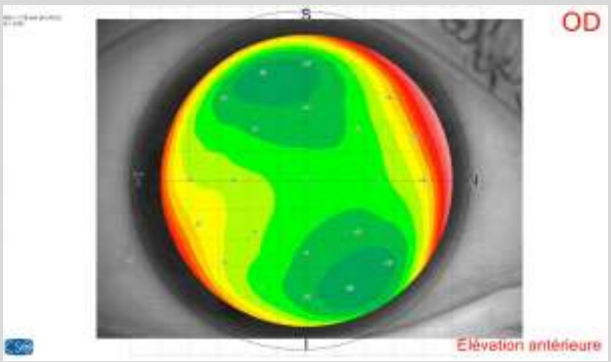
Example

Rbf = 7,25 mm (46,55 D)
Q = 0,00

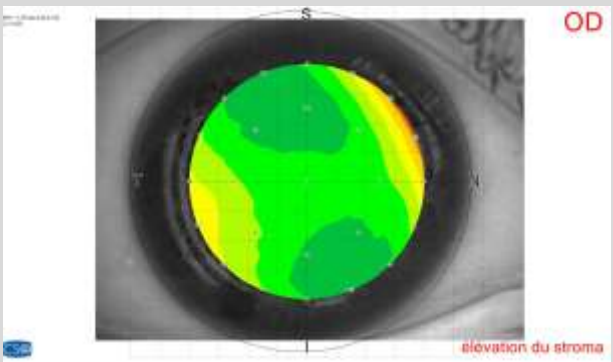
ELEVATION maps

NORMAL

Anterior elevation **with epithelium**



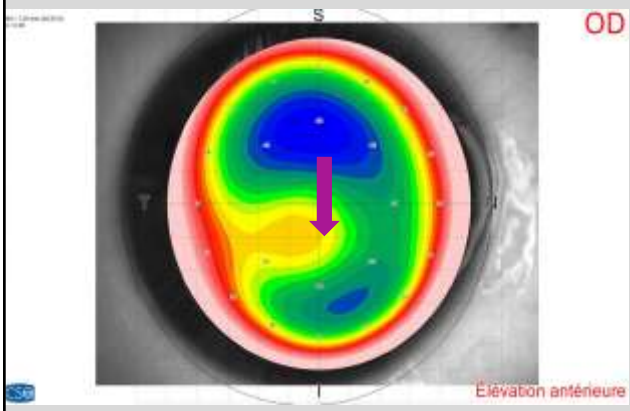
Stromal elevation **without epithelium**



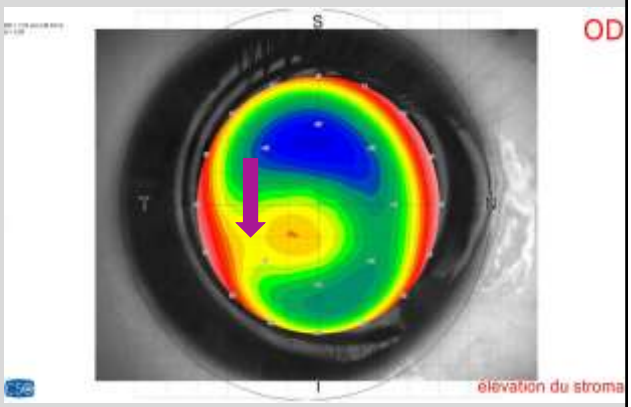
ANTERIOR ELEVATION

KERATOCONUS

Anterior elevation **with epithelium**

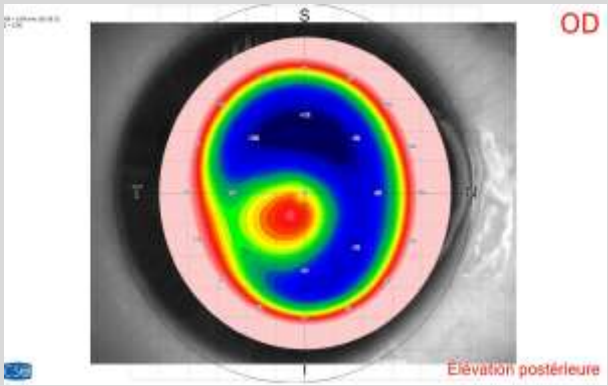


Anterior stromal elevation **without epithelium**

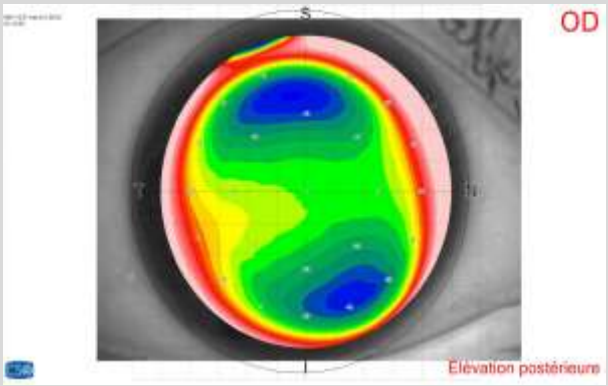


POSTERIOR ELEVATION

Normal



Keratoconus

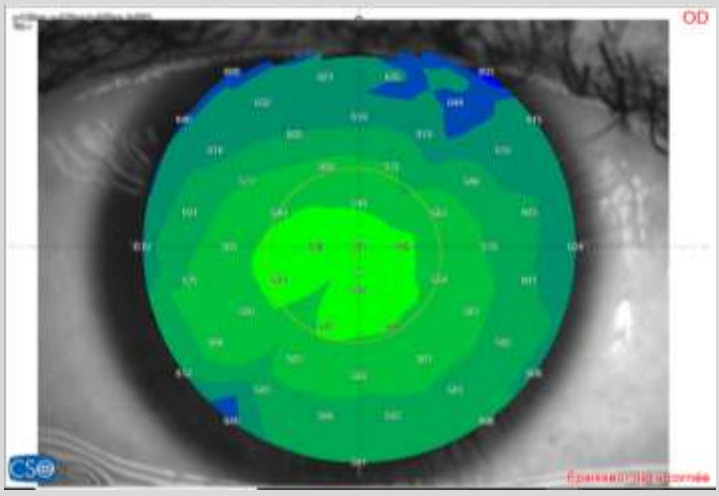


CORNEAL THICKNESS (more accuracy)

Analyse the shape

Symetry

Inferior displacement of the thinnest location

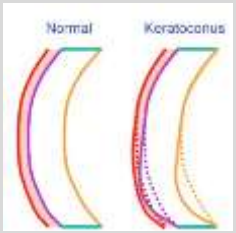


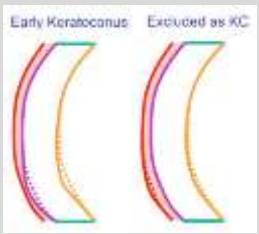
EPITHELIAL MAPPING +++

- Huge developement in Corneal Imaging
- Epithelium is **NOT homogenous**
- **Irregular stroma => irregular epithelium**

Epithelium hides stromal cone from the front surface

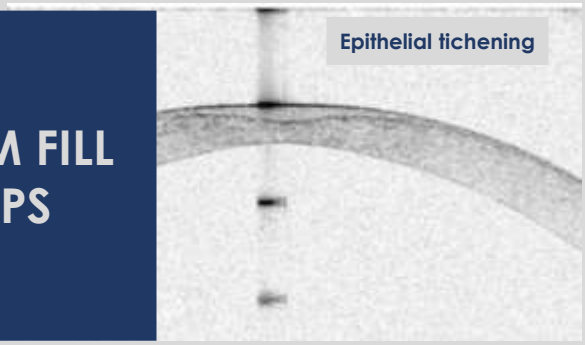
Theory of Early Keratoconus





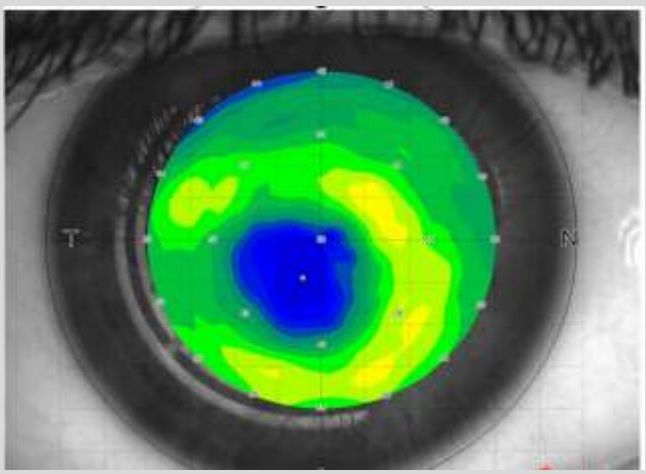
CORNEAL THICKNESS (more accuracy)

EPITHELIUM FILL THE GAPS

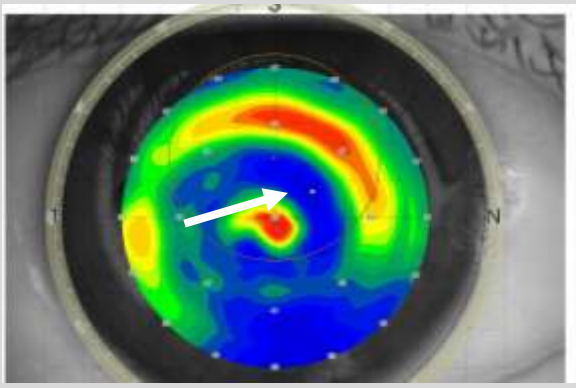


Abnormal epithelium

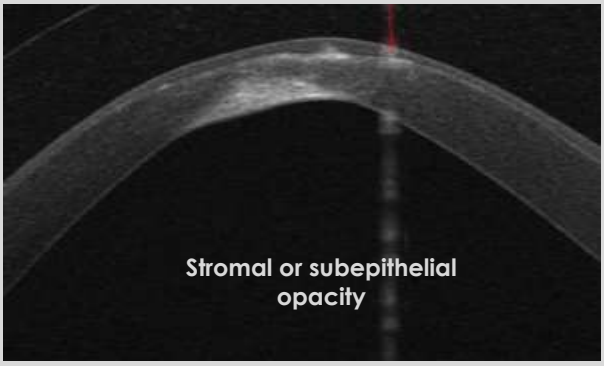
(Doughnut image)



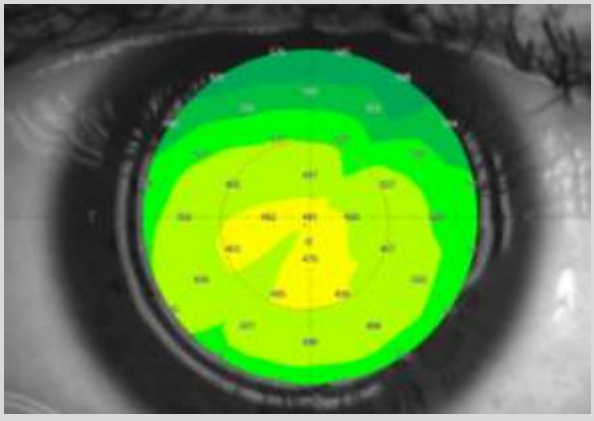
EPITHELIAL MAPPING



Epithelium thickenning in the peak of the cone in the center of the Doughnut

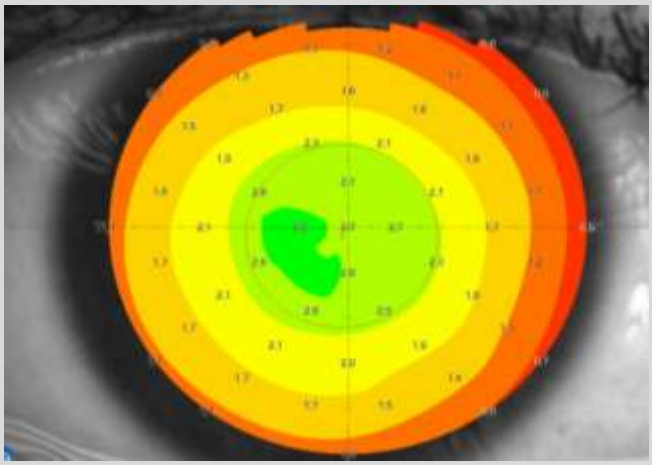


STROMA THICKNESS MAP

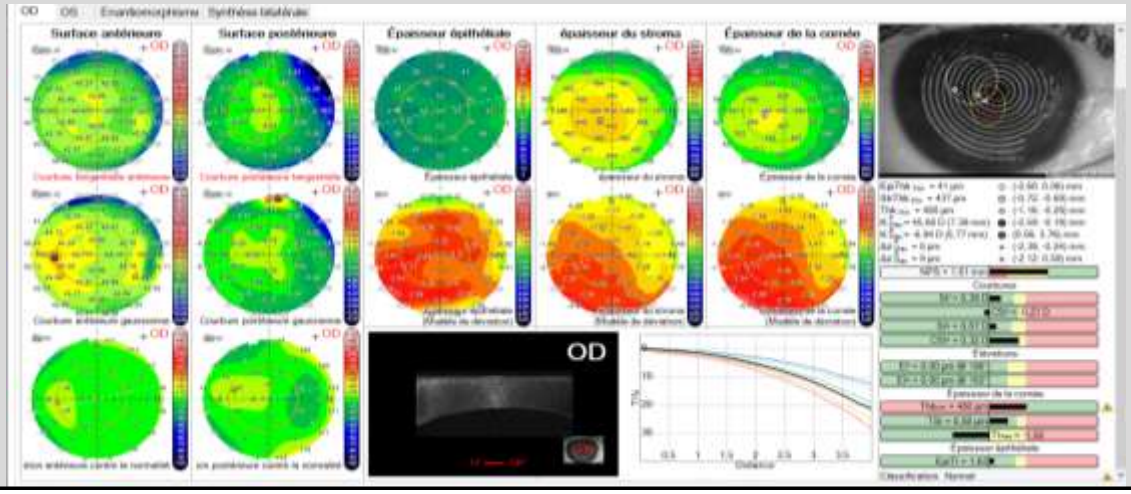


NOT INCLUDE EPITHELIUM
BETTER CONTRAST
REFLECTS REALITY OF THE STROMA

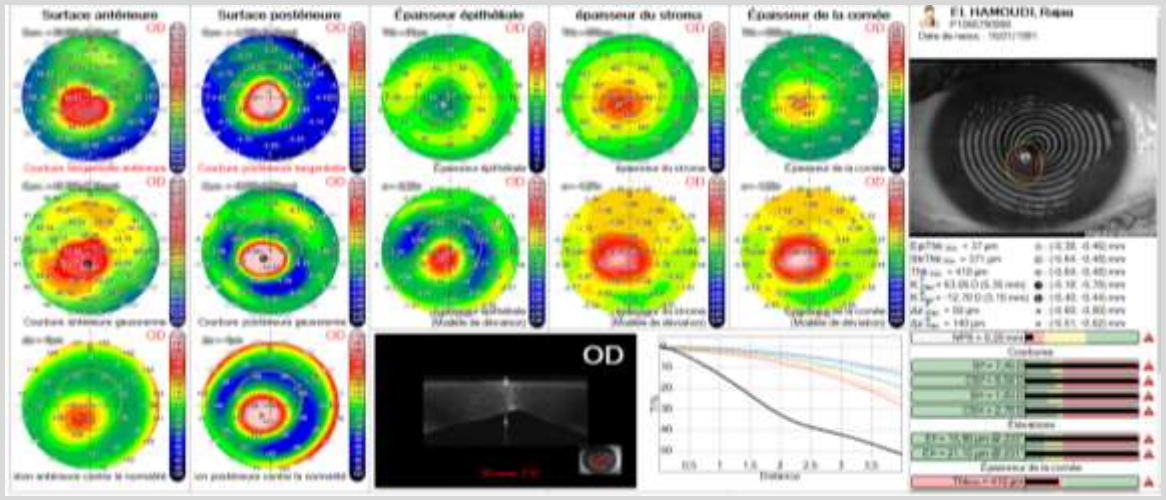
AC DEPT MAP



KERATOCONUS SUMMARY

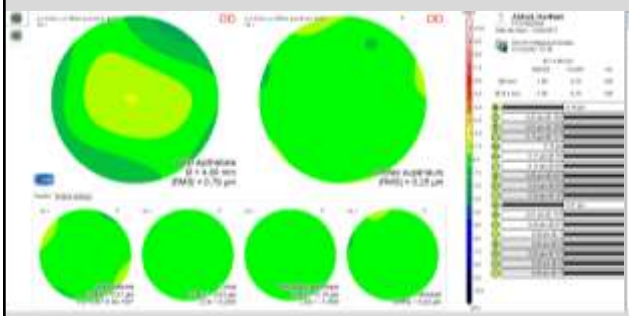


KERATOCONUS SUMMARY

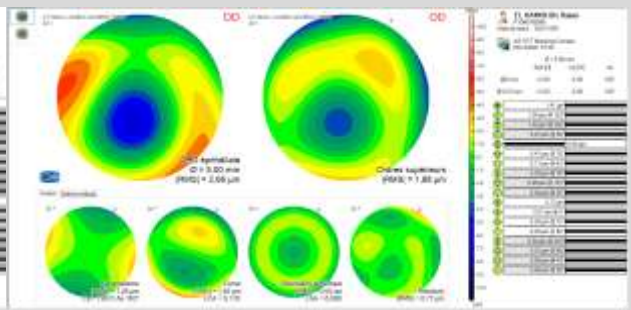


EPITHELIAL WAVEFRONT

Normal



Keratoconus



IN KERATO REFRACTIVE SURGERY

Analyse of all these parameters (anterior / post surfaces / pachy / epith Mapping …)
+
Enantiomorphism
+
Corneal Wavefront
+
Clinical data +++

In Kerato refractive surgery

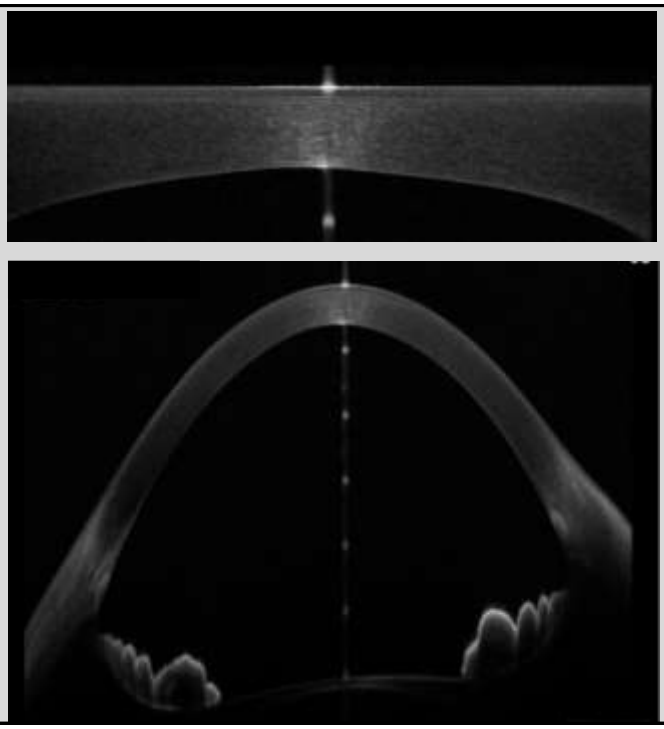
Major risks : Asymetry /Abnormal elevation/ Doughnut / Thin TL / keratoconus compatible …. = Contra indication

Minor risks : Small asymetry in axial with normal elevation and mapping, limit TL with all parameters ok …. = Surface ablation

No risks : LASIK / SMILE / PRK , depends on clinical data

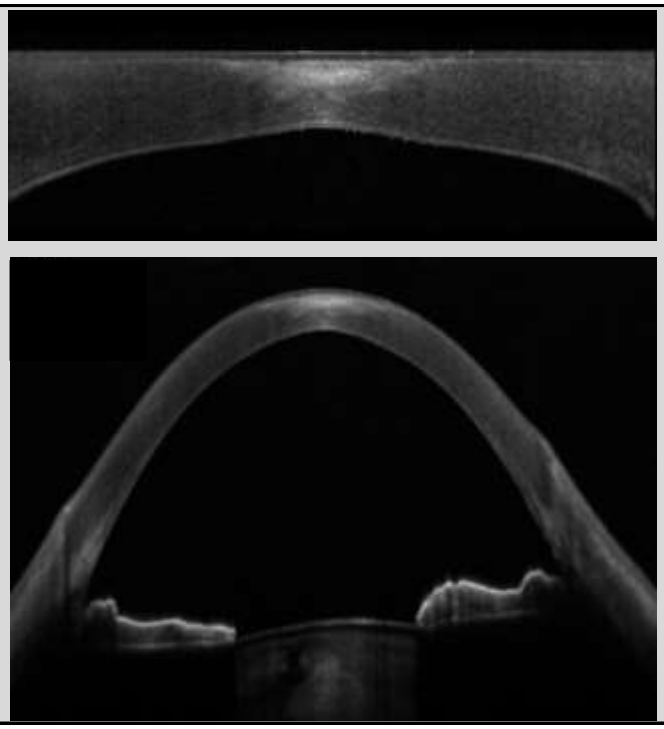
HIGH DEFINITION OCT SCANS

Normal

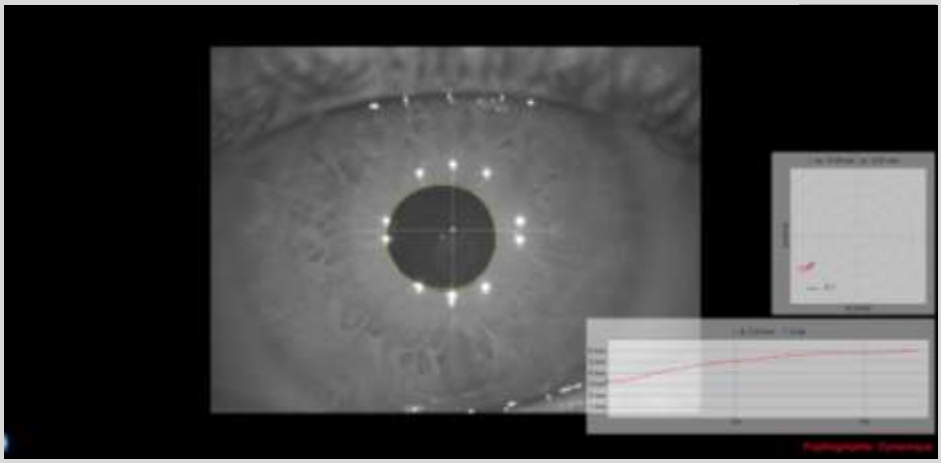


HIGH DEFINITION OCT SCANS

Stromal subepithelial opacity



Pupillometry



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Accuracy of the indices of MS-39 anterior segment optical coherence tomography in the diagnosis of keratoconic corneas

Original research article

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Table 3. The indices of the MS 39 anterior segment optical coherence tomography that showed the highest accuracy (AUROC values, cut-off values, sensitivity, specificity, and optimal criterion with its sensitivity and specificity.

Index	AUC	SE	95%CI	Cut-Off Value	Sensitivity (95%CI)	Specificity (95%CI)	Optimal Criterion	Sensitivity	Specificity
RMS Front[a] at 6 mm circle	0.996	0.00212	0.985 to 1.000	>1.69	97.67	97.98	>2.06	93.02	99.60
RMS/A[a] Front at 6 mm circle	0.996	0.00212	0.985 to 1.000	>0.06	97.67	97.98	>0.07	93.02	99.60
KVf[b]	0.996	0.00187	0.985 to 1.000	>7.98	98.26	97.98	>15	84.88	100
BCV[a]	0.994	0.00514	0.981 to 0.999	>0.45	97.67	98.39	>0.66	94.77	100
Elevation of front surface at TL	0.993	0.00300	0.979 to 0.998	[illegible]	96.49	97.18	[illegible]	68.42	100
Elevation of back surface at TL	0.993	0.00380	0.979 to 0.998	>13	95.32	99.19	>16	92.40	100
BCVf[a]	0.993	0.00511	0.979 to 0.999	>0.79	96.51	99.60	>0.91	94.19	100
RMS Front at 8 mm circle	0.988	0.00531	0.973 to 0.996	>4.5	94.19	99.60	>4.6	94.19	99.60
RMS/A Front at 8 mm circle	0.988	0.00531	0.973 to 0.996	>0.09	94.19	99.60	>0.09	94.19	99.60
BCVb[a]	0.988	0.00592	0.972 to 0.996	>0.46	95.93	98.39	>0.75	91.28	100
RMS Back[a] at 6 mm circle	0.983	0.00771	0.966 to 0.993	>3.2	96.51	99.19	>4.49	95.35	100
RMS/A Back at 6 mm circle	0.983	0.00771	0.966 to 0.993	>0.11	96.51	99.19	>0.16	95.35	100
KVb[a]	0.983	0.00725	0.965 to	>14	95.93	98.79	>19.6	93.60	100

RMS Back at 8 mm circle	0.981	0.00753	0.962 to 0.991	>8	94.77	95.56	>12.5	84.88	100
RMS/A Back at 8 mm circle	0.981	0.00753	0.962 to 0.991	>0.16	94.77	95.56	>0.25	84.88	100
K apex front*	0.978	0.00608	0.959 to 0.990	>47.4	93.60	93.15	>51	76.74	100
SIf*	0.978	0.00957	0.959 to 0.990	>1.19	94.19	99.19	>1.37	91.28	100
K apex back*	0.976	0.00793	0.957 to 0.989	>57	95.35	93.95	>66	77.33	100
RMS HOA*	0.976	0.00719	0.956 to 0.988	>0.73	94.19	94.33	>4.91	5.81	100
Vertical coma	0.971	0.0110	0.950 to 0.985	>0.37	95.35	95.97	>0.55	88.95	100
SIb*	0.968	0.0122	0.946 to 0.982	>0.25	93.02	100.00	>0.25	93.02	100
Convergence Radius*	0.965	0.00982	0.943 to 0.981	≤0.74	93.60	91.53	≤0.49	54.65	99.60
TL*	0.94	0.0121	0.913 to 0.961	<467	79.07	97.58	<432	46.51	100
Posterior K2*	0.938	0.0137	0.910 to 0.959	>56.6	86.63	95.56	>59.6	69.19	

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circle					
Temporal quadrant epithelial thickness at 3–6 mm circle	48.973 ± 4.68 (48.269 to 49.677)	50.925 ± 3.68 (50.465 to 51.385)	<0.0001	0.655	≤48
Superior quadrant epithelial thickness at 3–6 mm circle	52.972 ± 5.26 (52.180 to 53.764)	49.779 ± 3.70 (49.316 to 50.241)	<0.0001	0.670	>53
Inferior quadrant epithelial thickness at 3–6 mm circle	49.408 ± 4.77 (48.690 to 50.126)	52.39 ± 3.71 (51.926 to 52.854)	<0.0001	0.711	≤50
Minimum epithelial thickness at 3–6 mm ring	41.72 ± 4.35 (41.066 to 42.374)	45.598 ± 3.74 (45.130 to 46.066)	<0.0001	0.765	≤42
Maximum epithelial thickness at 3–6 mm	59.731 ± 6.46 (58.759 to 60.703)	56.009 ± 4.19 (55.485 to 56.533)	<0.0001	0.674	>59
Minimum epithelial thickness of inferior quadrant at 3–6 mm	43.65 ± 4.60 (42.958 to 44.341)	49.196 ± 3.82 (48.718 to 49.674)	<0.0001	0.830	≤47
Maximum epithelial thickness of inferior quadrant at 3–6 mm	55.154 ± 5.50 (54.326 to 55.981)	55.213 ± 3.97 (54.717 to 55.710)	0.8971	0.531	≤54
Inferior - Superior epithelial thickness a 3–6 mm circle	−3.564 ± 5.85 (−4.445 to −2.683)	2.611 ± 2.04 (2.357 to 2.866)	<0.0001	0.871	≤−0.6
Maximum - Minimum epithelial thickness o inferior quadrant at	11.504 ± 5.08 (10.739 to 12.268)	6.017 ± 1.89 (5.781 to 6.254)	<0.0001	0.875	>7

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CONCLUSION

The study evaluated many available indices, including some that were not assessed in previous studies, and presented both normative values and cut-off values for many parameters. The MS-39 AS-OCT combines the benefits of Placido disc topography and high-resolution OCT-based tomography.

The study found that the MS-39 AS-OCT device is accurate in diagnosing keratoconus at early stages before the development of corneal scars and advanced keratoconic conditions.

THANK YOU