Keratoconus Management
What do I expect in 2019?

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1. Classification of Keratoconus

Table 1: Amsler-Krumeich classification

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Stage I	Eccentric steepening Myopia/astigmatism < 5.00 D Mean K < 48.0 D
Stage II	Myopia/astigmatism > 5.00 D but < 8.00 D Mean K < 53.0 D Absence of scarring Minimal apical corneal thickness > 400 µm
Stage III	Myopia/astigmatism > 8.00 D but < 10.00 D Mean K > 53.0 D Absence of scarring Minimal apical corneal thickness < 400 µm but > 300 µm
Stage IV	Refraction not possible Mean K > 55.0 D Central corneal scarring Minimal apical corneal thickness < 300 µm

Amsler 1946

➢ **Central Keratometry**
➢ **Refraction**
➢ **Corneal thinning**
➢ **Corneal Scarring**

Failure to choose adequate calssification

Global Consensus on Keratoconus and Ectatic Diseases

José A. P. Gomes, MD, PhD,* Donald Tan, MD, PhD,† Christopher J. Rapuano, MD,‡
Michael W. Belin, MD,§ Renato Ambrósio, Jr, MD, PhD,¶ José L. Guell, MD,‖
François Malecaze, MD, PhD,** Kohji Nishida, MD,†† and Virender S. Sangwan, MD‡‡, the Group
of Panelists for the Global Delphi Panel of Keratoconus and Ectatic Diseases

Background: Despite extensive knowledge regarding the diagnosis and management of keratoconus and ectatic corneal diseases, many controversies still exist. For that reason, there is a need for current guidelines for the diagnosis and management of these conditions.

Purpose: This project aimed to reach consensus of ophthalmology experts from around the world regarding keratoconus and ectatic diseases, focusing on their definition, concepts, clinical management, and surgical treatments.

Methods: The Delphi method was followed with 3 questionnaire rounds and was complemented with a face-to-face meeting. Thirty-six panelists were involved and allocated to 1 of 3 panels: definition

and other ectatic diseases. It also provides an insight into the current worldwide treatment of these conditions.

Key Words: keratoconus, corneal ectasia, consensus, corneal cross-linking, corneal transplantation

(Cornea 2015;34:359–369)

Keratoconus and ectatic corneal diseases have been recognized for more than 150 years.[1,2] Over the last 2 decades, there has been a revolution in the knowledge related to the diagnosis and management of these conditions. In terms

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ABCD Grading System

Table 5: ABCD keratoconus classification

ABCD criteria	A ARC (3 mm zone)	B PRC (3 mm zone)	C Thinnest pach. µm	D BDVA	Scarring
Stage 0	>7.25 mm (<46.5 D)	>5.90 mm (<57.25 D)	>490 µm	≥ 20/20 (≥ 1.0)	–
Stage I	>7.05 mm (<48.0 D)	>5.70 mm (<59.25 D)	>450 µm	<20/20 (<1.0)	–, +, ++
Stage II	>6.35 mm (<53.0 D)	>5.15 mm (<65.5 D)	>400 µm	<20/40 (<0.5)	–, +, ++
Stage III	>6.15 mm (<55.0 D)	>4.95 mm (<68.5 D)	>300 µm	<20/100 (<0.2)	–, +, ++
Stage IV	<6.15 mm (>55.0 D)	<4.95 mm (>68.5 D)	≤ 300 µm	<20/400 (<0.05)	–, +, ++

Scarring – clear; no scarring (–); scarring, iris details visible (+); scarring, iris obscured (++); Diopters shown for anterior radius of curvature; anterior equivalent diopters shown for posterior radius of curvature

A New Tomographic Method of Staging/Classifying Keratoconus: The ABCD Grading System

¹Michael W Belin, ²Josh Duncan, ³Renato Ambrósio Jr, ⁴José AP Gomes

Alio-Shabayek Grading System

Based on the aberrometric data and the value of coma (2006)

ARTICLE

Keratoconus-integrated characterization considering anterior corneal aberrations, internal astigmatism, and corneal biomechanics

Jorge L. Alió, MD, PhD, David P. Piñero, PhD, Alicia Alesón, MSc, Miguel A. Teus, MD, PhD,
Rafael I. Barraquer, MD, PhD, Joaquim Murta, MD, PhD, Miguel J. Maldonado, MD, PhD,
Gracia Castro de Luna, MD, PhD, Ramón Gutiérrez, MD, PhD, César Villa, OD,
Antonio Uceda-Montanes, MD

What's the Value of a classification?

➢ To assign a treatment plan for each stage.

➢ To Speak common language

➢To follow-up Regression/Progression

A hope to give a numeric value for KC!

SCORE Analyzer

The SCORE Analyzer uses a **Radar Map** system which helps to understand the SCORE result and shows the deviation of most significant indices from the average normal population.

Inferior-Superior steepening: > 1.5D

Central Pachy-
Thinnest pachy
Diffrence : >15µ

Thinnest pachymetry shift > 1.5 mm

SCORE Analyzer

The SCORE Analyzer uses a **Radar Map** system which helps to understand the SCORE result and shows the deviation of most significant indices from the average normal population.

Example Radar Map: "High similarity to "normal" cornea"	Example Radar Map: "Suspicious Cornea (e. g. FFKC)"	Example Radar Map: "High risk of Keratoconus"
SCORE: - 1.5	SCORE: + 1.0	SCORE: + 16.3
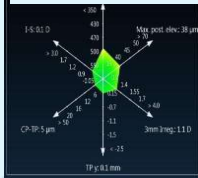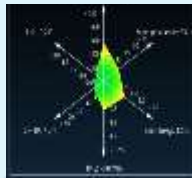
9
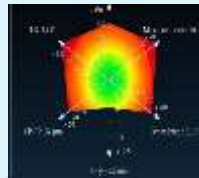
SCORE Analyzer
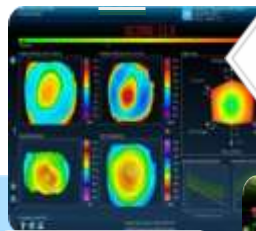
2007 (SCORE: +11.5):
- Max. Posterior elevation: 73 µm
- 3mm irregularity: 2.9 D
- TP: 444 µm @ 0.9 mm from apex
- Difference betw. CP and TP: 22 µm
- I-S index: 2.3 D

KC development was relatively slow

2009 (SCORE: +12.1):
- Max. Posterior elevation: 88 µm
- 3mm irregularity: 2.5 D
- TP: 404 µm @0.5 mm from apex
- Difference betw. CP and TP: 44 µm
- I-S index: 2.7 D
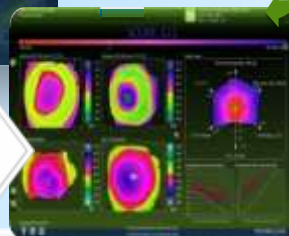
KC developed aggressively

2011 (SCORE: +16.3):
- Max Posterior elevation: 96 µm
- 3mm irregularity: 3.1 D
- TP: 427µm @0.6 mm from apex
- Difference betw. CP and TP: 32 µm
- I-S index: 3.7 D
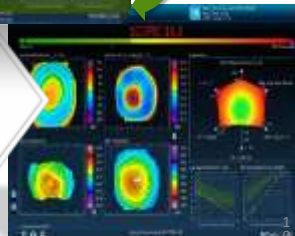
Can we give a common universal score to any KC ?
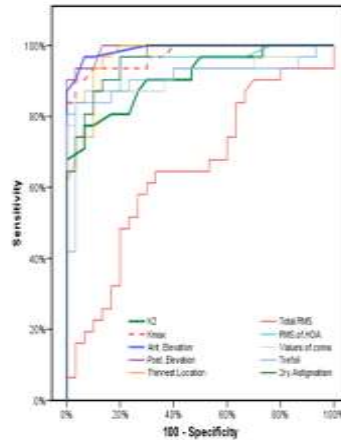
Data from my study cases using different Tomographic and Aberrometric data
(under publication)

Index	Sensitivity (95% CI)	specificity (95% CI)	Overall Test Accuracy (p value)
Posterior Elevation (µm)	90.32 (74.2-98.0)	100.00 (88.1-100.00)	95.08 (p=0.0040*)
Anterior Elevation (µm)	96.77 (83.3-99.9)	93.33 (77.9-99.2)	95.08 (p=0.0040*)
Kmax (D)	90.32 (74.2-98.0)	96.67 (82.38-99.9)	93.44 (p=0.0061*)
Thinnest location (µm)	93.55 (78.6-99.2)	90.00 (73.5-97.9)	91.80 (p=0.0075*)
RMS of HOA (µm)	80.65 (62.5-92.5)	100 (88.4-100.0)	90.16 (p=0.0112*)
Values of coma (µm)	83.87 (66.3-94.5)	96.67 (82.8-99.9)	90.16 (p=0.0112*)
Trefoil (µm)	83.87 (66.3-94.5)	96.67 (82.8-99.9)	90.16 (p=0.0112*)
Secondary Astigmatism (µm)	87.10 (70.2-96.4)	90.00 (73.5-97.9)	88.52 (p=0.0164*)
K2 (D)	77.42 (58.9-90.4)	93.33 (77.9-99.2)	85.25 (p=0.0283*)

2. Epi off Vs. Epi on CXL ..... Can we do better??

➤ **No doubt that Epi off has superior results.**

➤ **But, we have some concerns about Epithelium removal**

Delayed Epithelial Healing

A step towards converting Epi-off to Epi-on!

A New Matrix Therapy Agent for Faster Corneal Healing and Less Ocular Discomfort Following Epi-off Accelerated Corneal Cross-linking in Progressive Keratoconus

Etude *Gumus et al. (2017)* [4]

- **A J2 le RGTA® est significativement plus efficace sur la cicatrisation de l'atteinte cornéenne**

Groupe contrôle :
0.17 ± 0.46 mm²
(0-12 mm²)

Groupe RGTA® :
0.23 ± 0.58 mm²
(0 - 2.25 mm²)
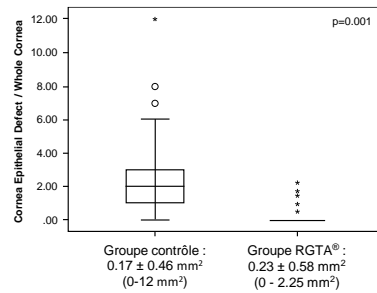
- **A J2 le RGTA® permet de guérir significativement plus de patients (P < 0,001)**

Groupe contrôle (n=30) :
13,3% des patients guéris

Groupe Cacicol® (n=30) :
83,3% des patients guéris

2 patients groupe témoin à J2

2 Patients RGTA® à J2
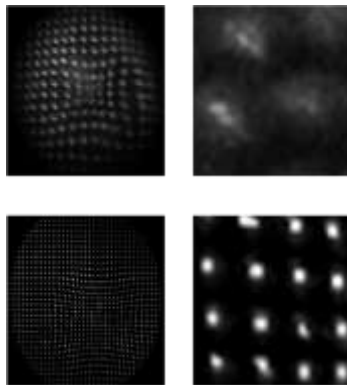
We can get rid of Epi-off CXL nightmares!

- With the RGTA you can get the results of the Epi-off CXL with the comfort of the Epi-on CXL.

(The best of the 2 worlds)

3. **PRK for keratoconic eyes …..When and How?**

Outcomes of Simultaneous and Sequential Cross-linking With Excimer Laser Surface Ablation in Keratoconus

JRS
October 2018

The extreme irregularity of the pupil entrance is the main reason for visual degradation

Can we precisely ablate them????

Yes…! If we can read them!

New Generation of High-Resolution Aberrometers

Dr. Mohamed Shafik
Horus Vision Correction Center (HVCC)
Alexandria, Egypt

Athens Protocol

My Protocol

" Simultaneous

Topo-guided
PRK"

" Sequential to
CXL +
Wavefront-
guided PRK"

I do CXL 1st and I wait for at least one year → **Wavefront-guided PRK with MMC**

CLINICAL SCIENCE

Wave Front–Guided Photorefractive Keratectomy Using a High-Resolution Aberrometer After Corneal Collagen Cross-Linking in Keratoconus

CORNEA 2016

4. Corneal Tissue Augmentation Procedures... A Promising Modality.

KC is mainly a thinning disease
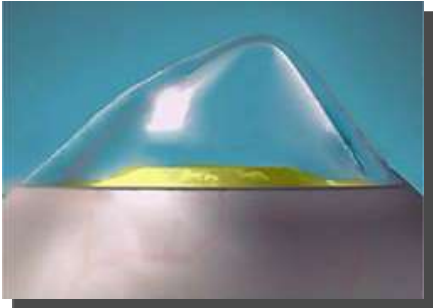
R. Ambrósio Jr
2013

Rio de Janeiro
Corneal Tomography
and
Biomechanics Study
Group

Brazilian
Study Group
of Artificial
Intelligence
and Corneal
Analysis

BrAIn

→ Biomechanical Failure with progressive thinning and protrusion of the cornea, leading to irregular corneal geometry which causes progressive astigmatism with HOA (irregular astigmatism) and possibly myopia

Courtsy: Renato Ambrosio, MD

Tissue Augmentation by Lenticule transplantation: A solution???

Courtesy: Prof. Shah & Gebauer Medical
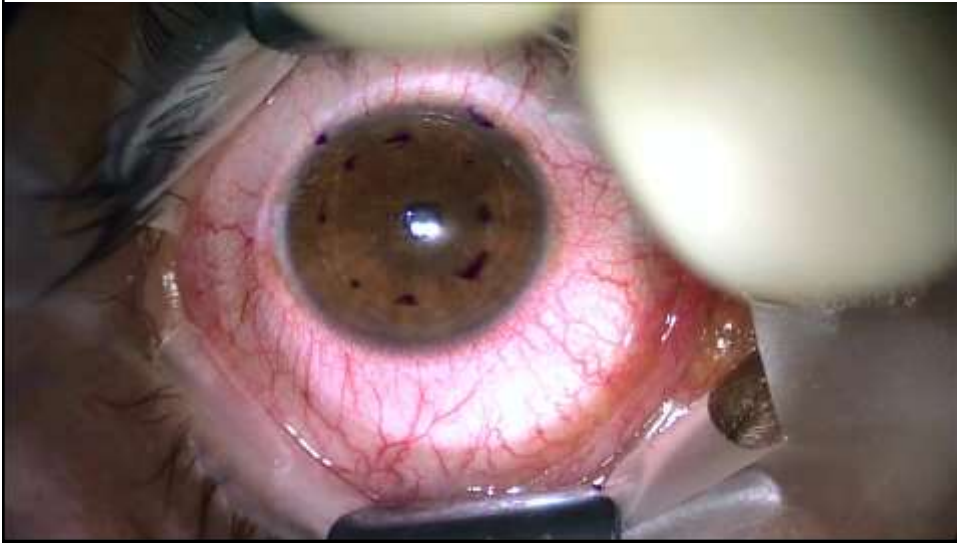
Bowman Layer Transplantation
A New Innovative Hope
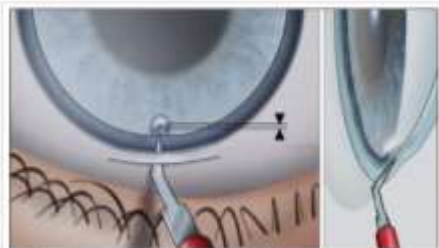
https://www.healio.com/ophthalmology/cornea-external-disease/news/print/ocular-surgery-news/%7Be788621c-aa9f-45f9-9a5b-6538d4177d42%7D/bowman-layer-transplantation-another-option-for-advanced-keratoconus

5. **Understanding Pathogenesis of the Keratconus!**

Inflammatory Molecules in the Tears of
Patients with K...

Isabel Lema, MD, PhD, *Juan A. Durán...*

Purpose: To determine levels of a
tears of patients with keratoconus.
  Design: A prospective, case-conte
  Participants: Twenty-eight patients
Oftalmoloxía, Santiago de Compostela,
normal control subjects (1 eye each) w...
  Methods: Patients with keratocon...
taken to monitor the degree of ectasis. ...
  Main Outcome Measures: The c...
necrosis factor α [TNF-α], cell adhesion
molecule 1), and matrix metalloproteinas...
  Results: Patients with keratoconus
[1.0–4.1] pg/ml in control subjects [P<
subjects [P<0.080±]), and MMP-9 (66.5
of the increase was found to be associ...
  Conclusions: Interleukin-6, TNF-α,
indicating that the pathogenesis of kerat...
112:654–659 © 2005 by the American ...

CLINICAL AND EXPERIMENTAL
OPTOMETRY

RESEARCH PAPER

Effects of eye rubbing on the levels of protease, protease activity and
cytokines in tears: relevance in keratoconus

Can we discover a Biomarker for KC??

• With CXL, we now in a historic era that we are
able to treat the disease!

• With a Biomarker we can predict the KC /
Post-Refractive Surgery Ectasia and we can
Prevent the disease!

Thank You