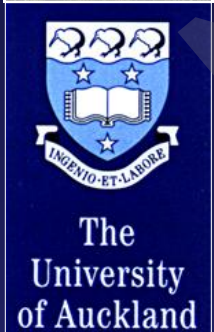




# Imaging the keratoconic cornea

Associate Professor Dipika Patel

Department of Ophthalmology  
University of Auckland, New Zealand

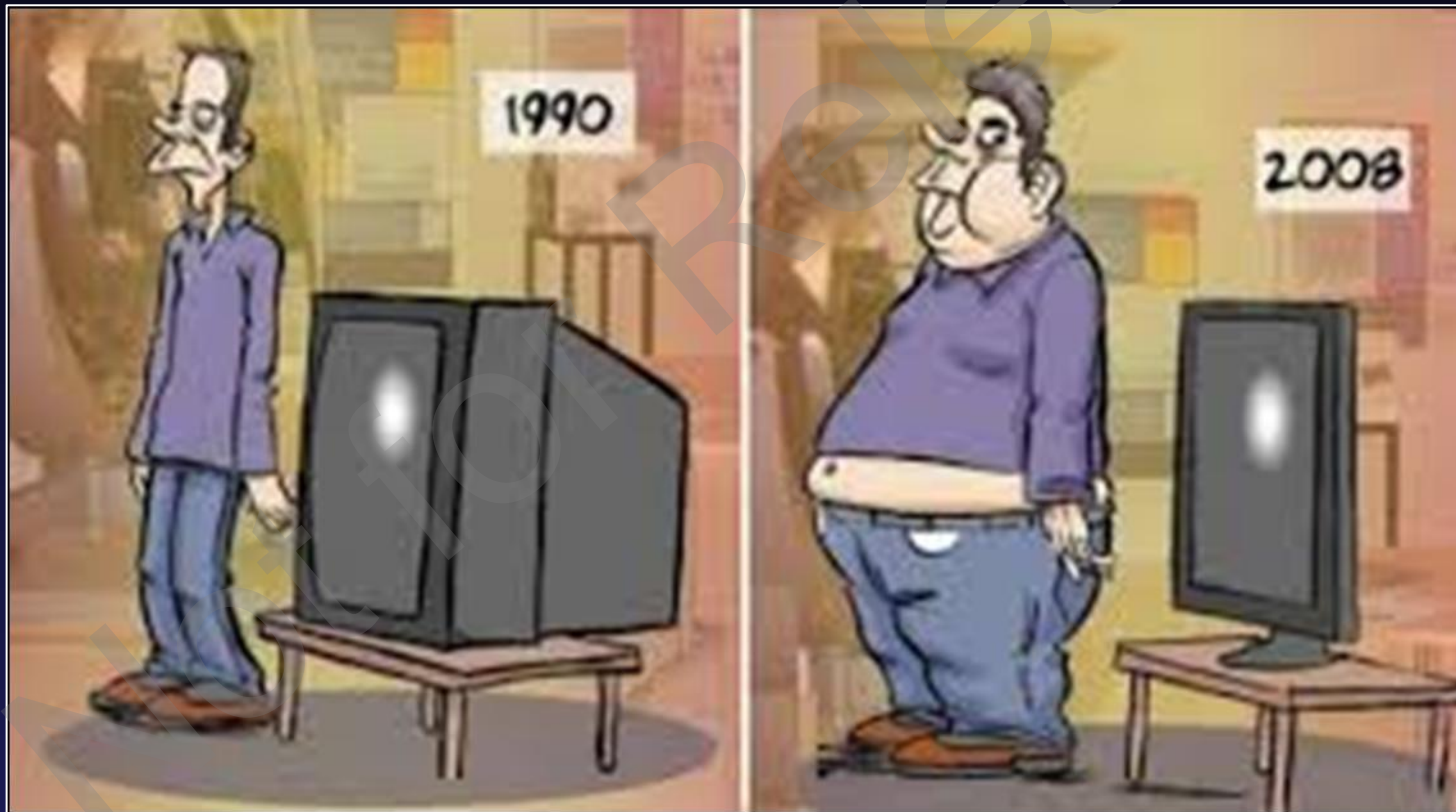


nz national eye centre

# New Zealand.....Land of cones?

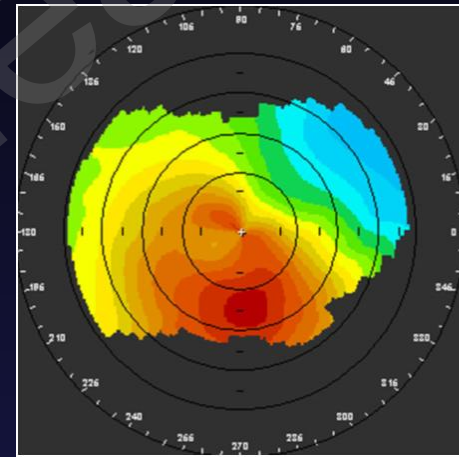


# Has technology helped?



# Corneal Tomography

- Diagnosis
- Screening
- Management
  - Determine progression
  - Eligibility for crosslinking
  - Monitor effects of crosslinking



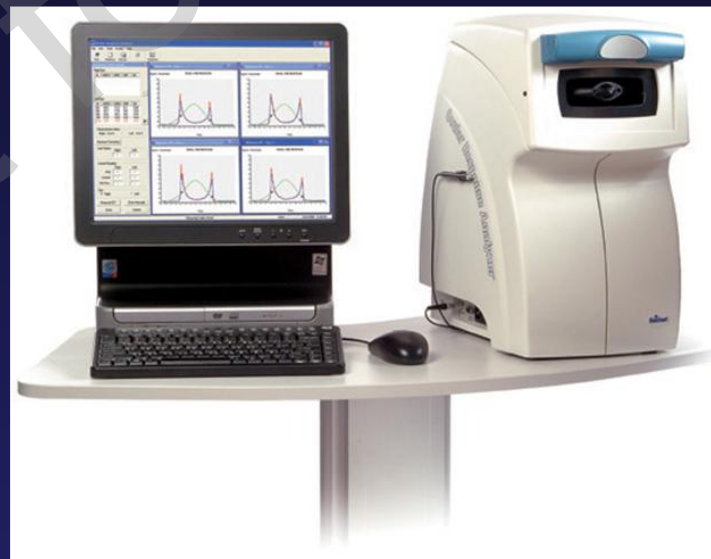
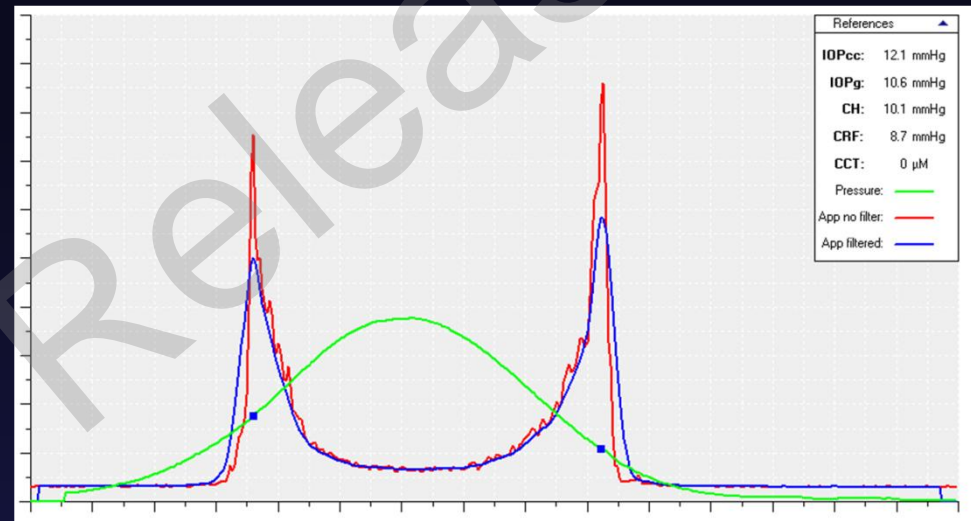
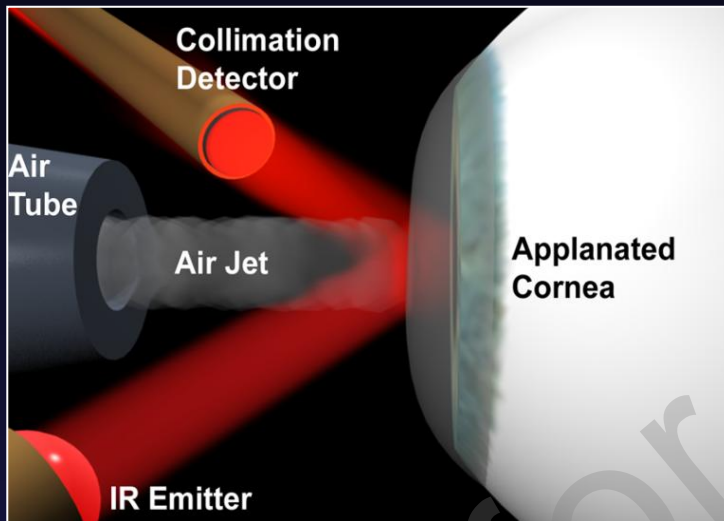
# Composite indices

- KPI: Keratoconus Prediction Index
  - TMS videokeratoscope
  - Combination of 8 topographic indices
  - A value greater than 0.23 suggests keratoconus
- SCORE (Screening Corneal Objective Risk of Ectasia)
  - Orbscan IIz
  - Combination of 12 tomographic indices
  - Score of  $>0$  suggests keratoconus

# Composite indices

- KSI: Smolek/Klyce method
  - TMS, OPDscan
  - Input 10 topographic indices
  - Algorithm based on neural network
- Belin/Ambrósio Enhanced Ectasia Display
  - Pentacam
  - Input 9 parameters
  - Deviation from normal (D-value)

# Ocular response analyser



# Ocular response analyser

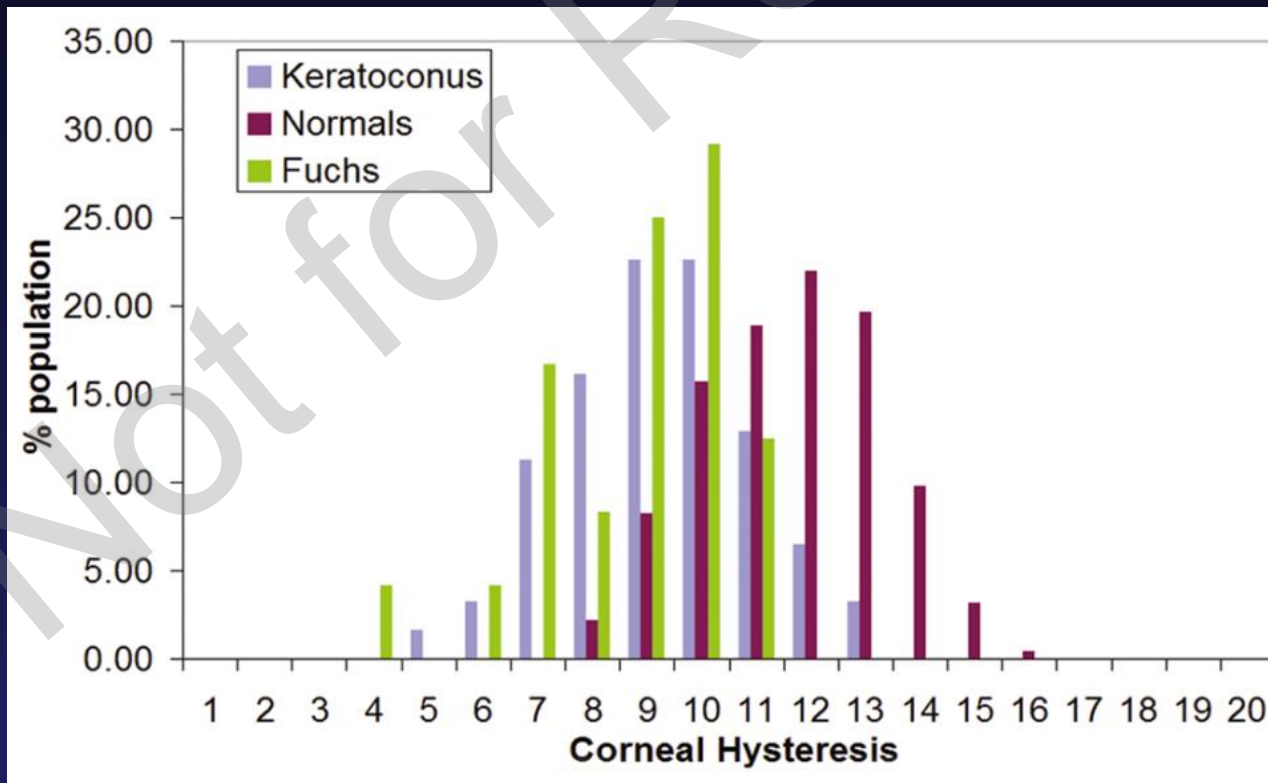
- Low CH and CRF
  - Normal CH  $10.7 \pm 2.0$  mmHg
  - Keratoconus CH  $9.6 \pm 2.2$  mmHg
- Not significantly altered by crosslinking





# Diagnostic value

- Normal CH  $10.7 \pm 2.0$  mmHg (range 6.1 – 17.6)
- Keratoconus CH  $9.6 \pm 2.2$  mmHg (range 4.7 – 16.7)



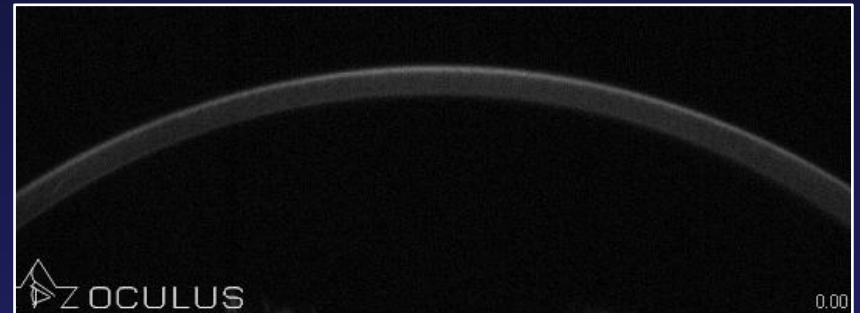
# The Corvis ST

## What is it?

- Air Tonometer
- Ultra high speed Scheimpflug camera

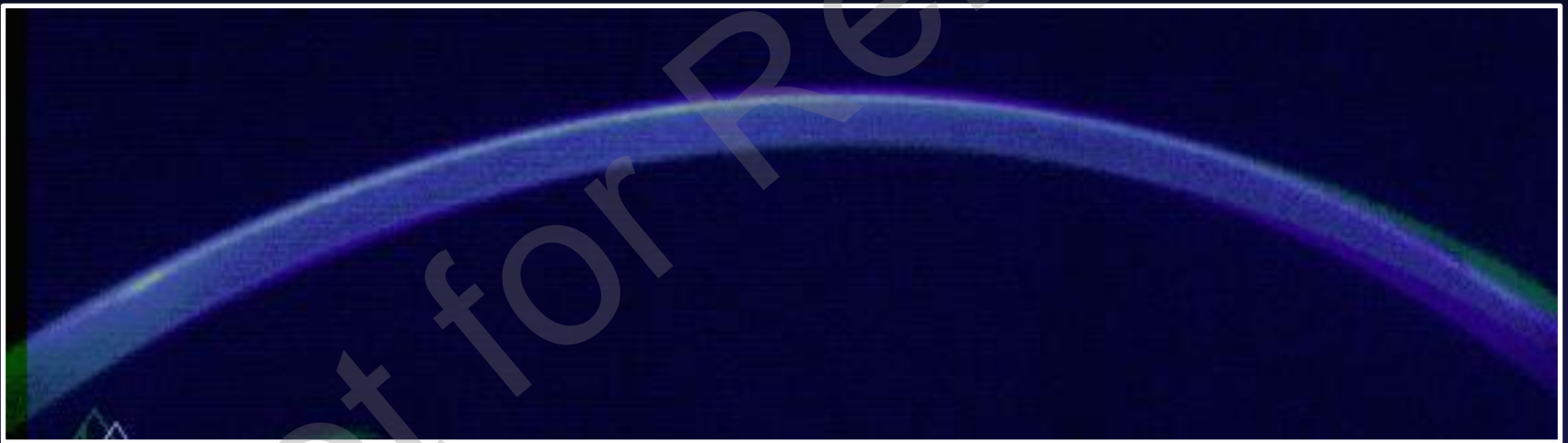
## How does it work?

- Air puff indents cornea
- Video 4333 frames/sec
- Calculates a range of output measurements



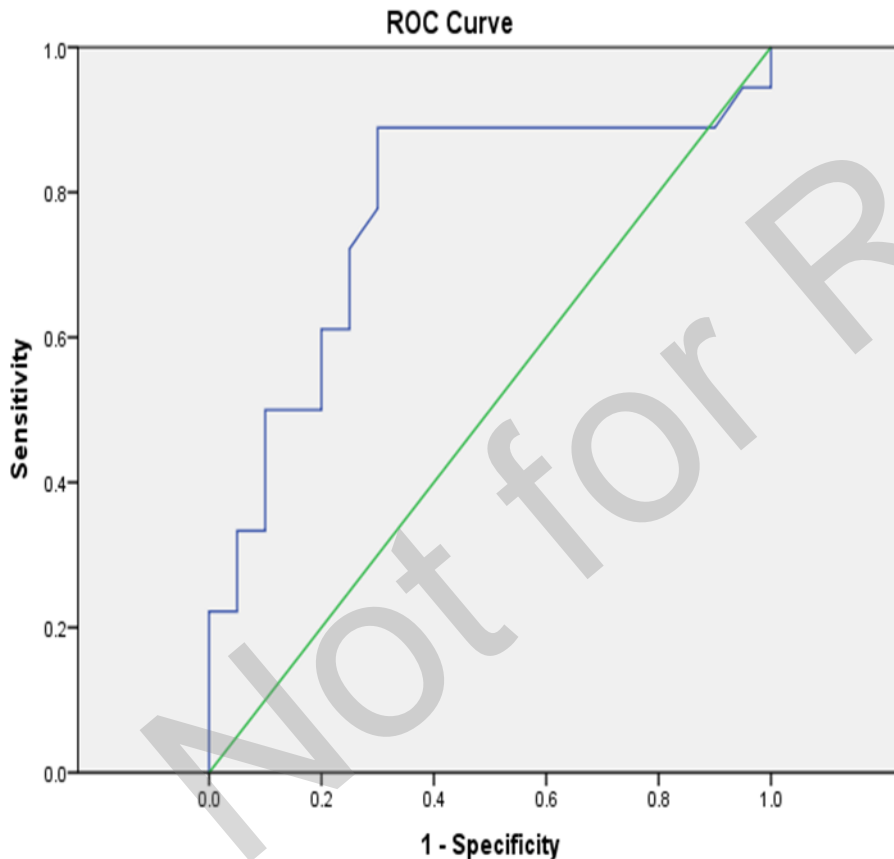
# Corneal biomechanical properties

## Keratoconus vs. Normal



	Normal	KC	p-value
Maximum corneal deformation (MCD)	0.81	1.19	0.003

# Diagnostic value



Corvis

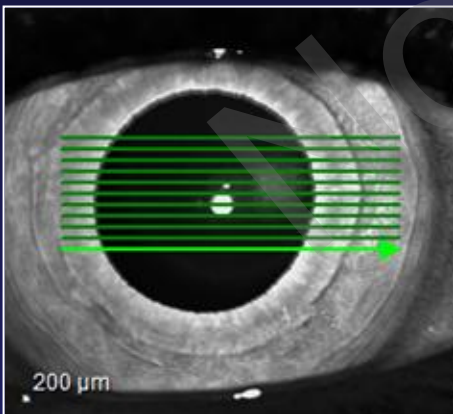
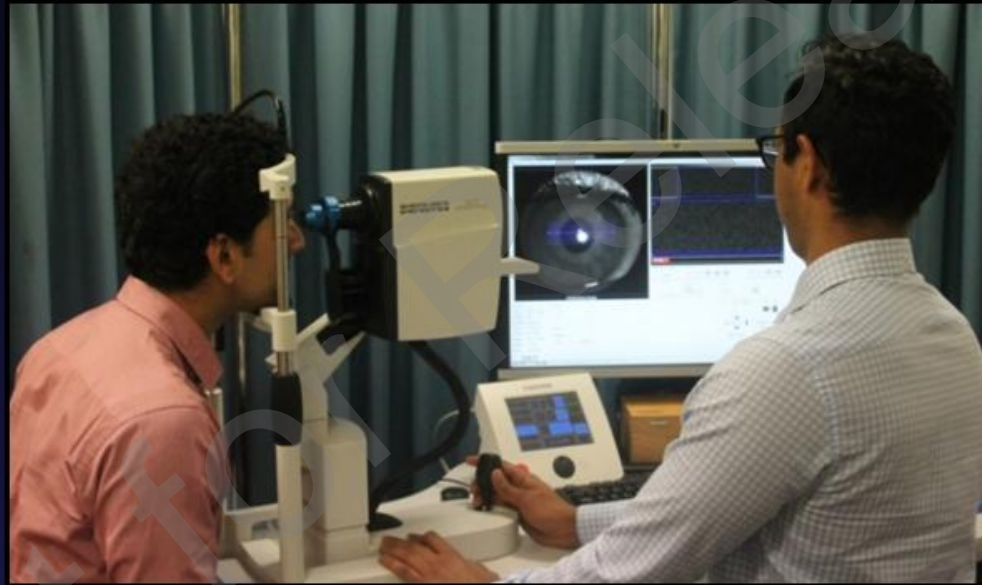
Deformation Amplitude

Area under the curve

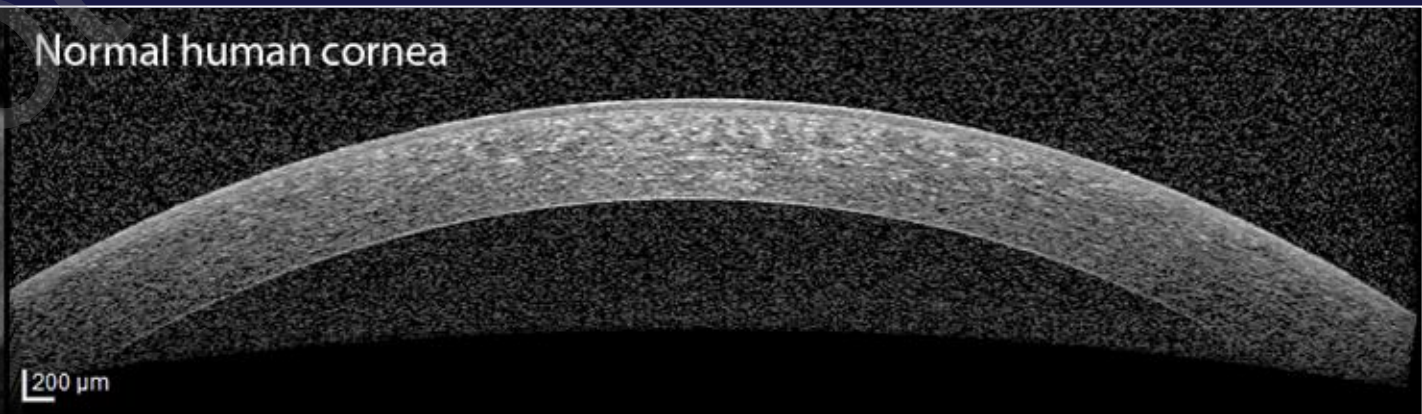
$0.77 \pm 0.08$

But no ideal cut-off value

# Optical coherence tomography

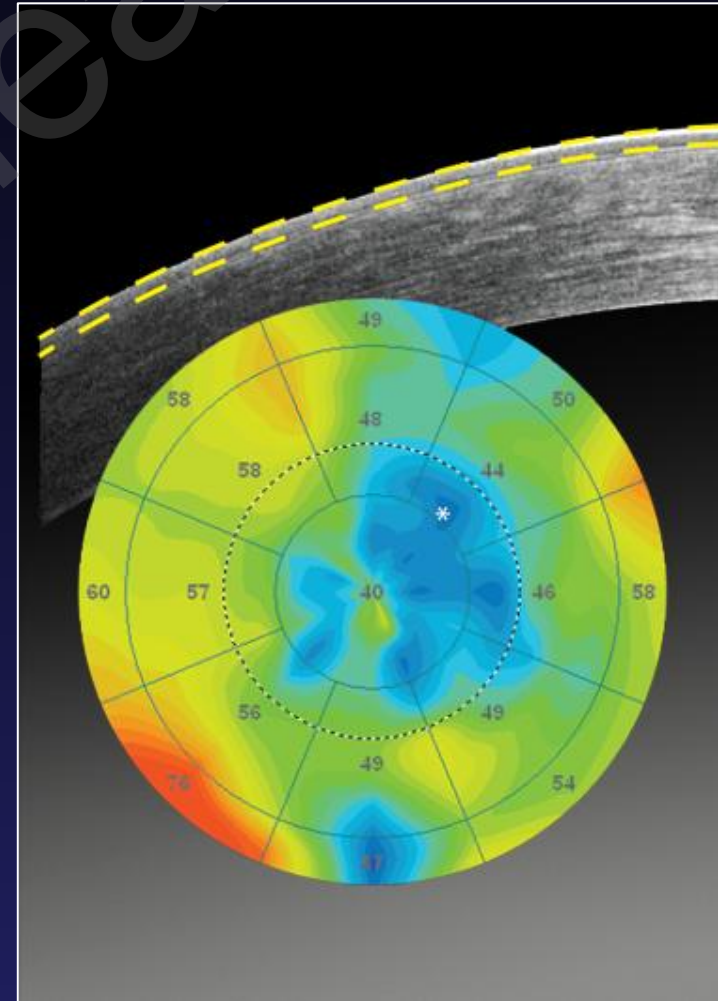


Normal human cornea

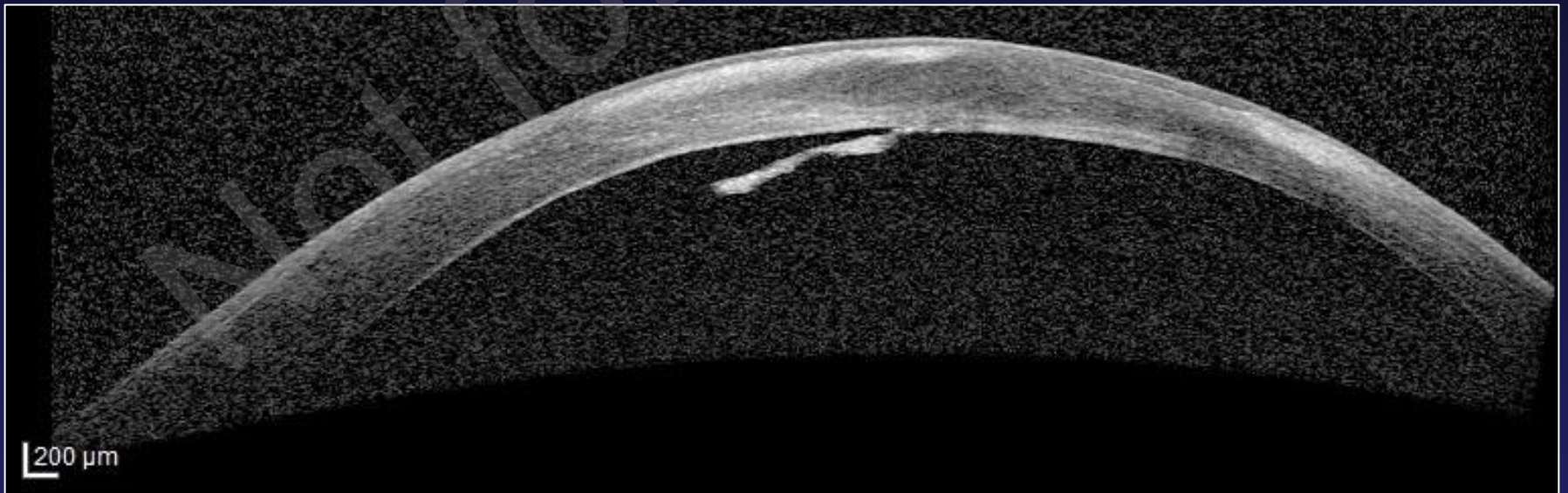


# Epithelial thickness mapping

- RTVue, Optovue
- 6mm diameter map
- Apical epithelial thinning
- Pattern standard deviation

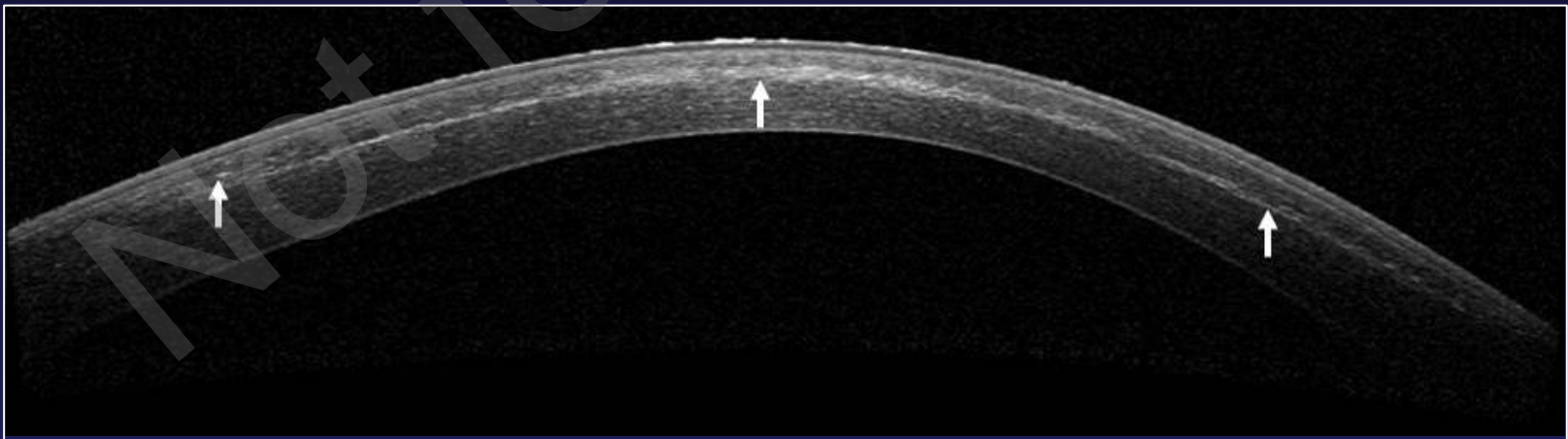


# Acute corneal hydrops



# CXL demarcation line

- Represents transition zone between cross-linked and untreated corneal stroma?
- A true indicator of CXL efficacy?
- Depth: Standard > Accelerated > Transepithelial

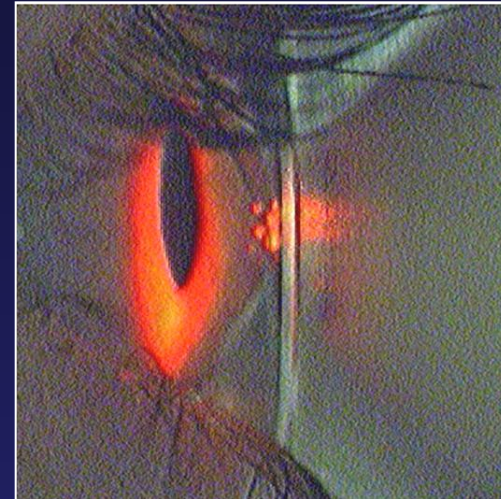




# *In vivo* confocal microscopy



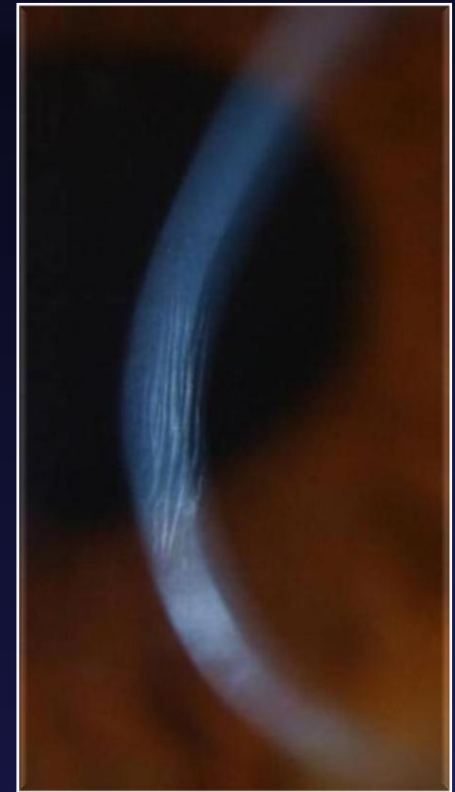
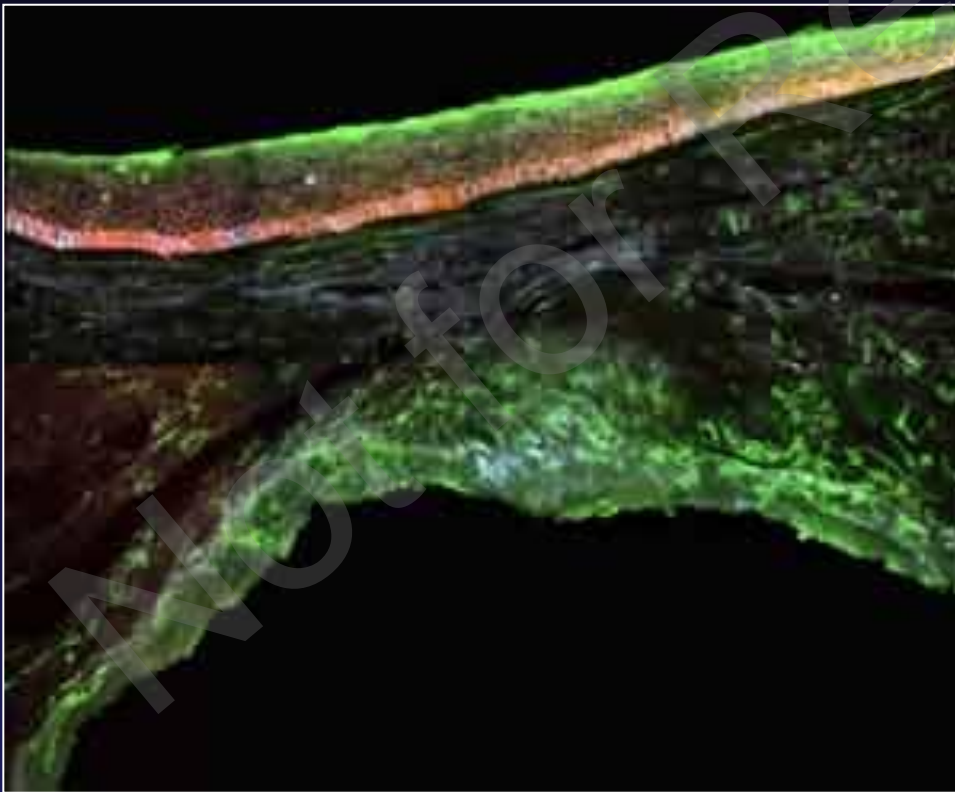
Confoscan



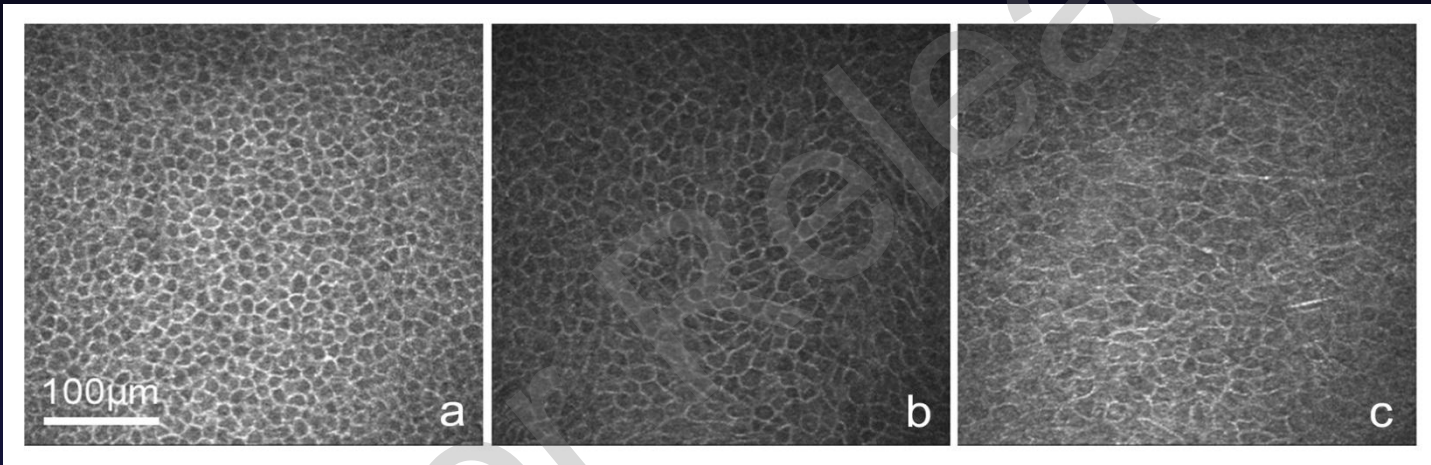
HRT  
corneal  
module

# In vivo confocal microscopy

- Understanding the disease process



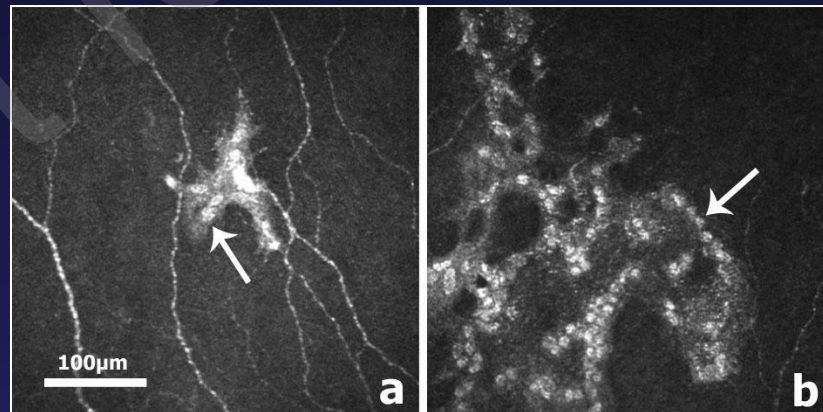
# Basal Epithelium/Bowmans layer



Normal

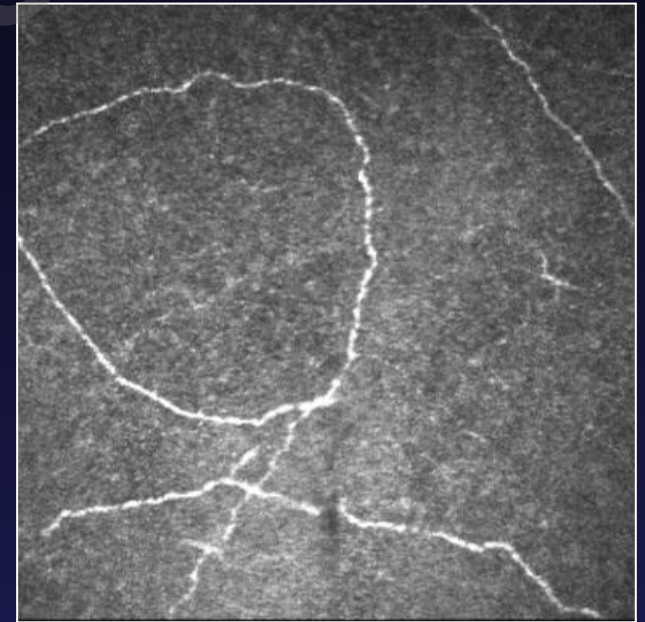
KC no CL

KC and RGP

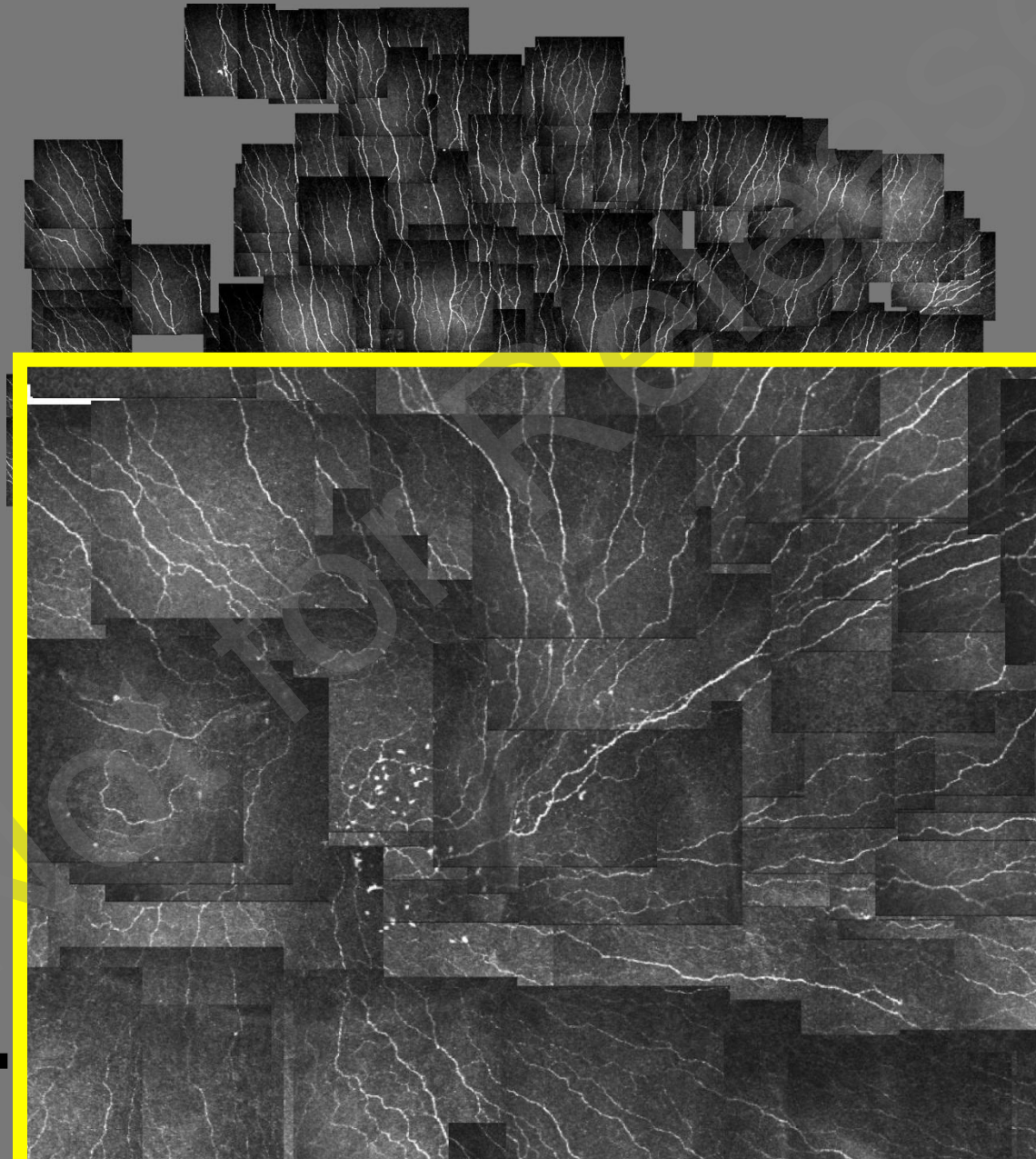


# Sub-basal nerves & sensation in keratoconus

- Reduced nerve density
- Reduced corneal sensation
- Abnormal nerve morphology



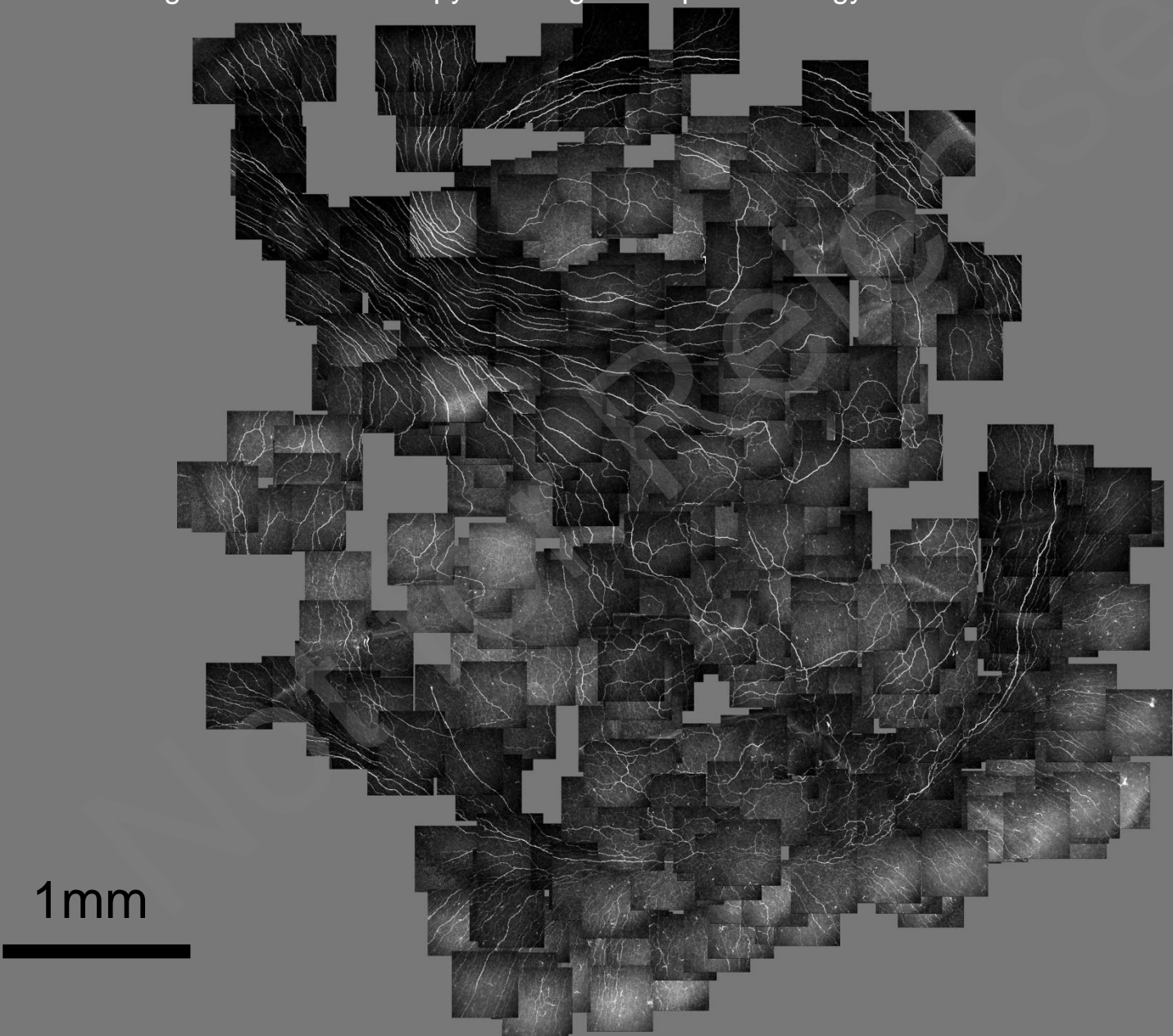
Patel DV, McGhee CNJ. Mapping of the normal human corneal sub-basal nerve plexus by *in vivo* laser scanning confocal microscopy. Investigative Ophthalmology & Visual Science 2005;46;4485-4488

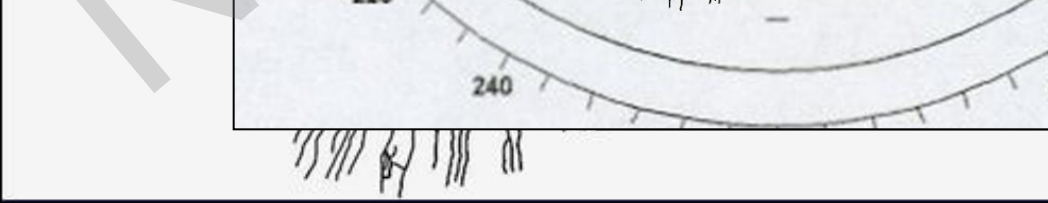
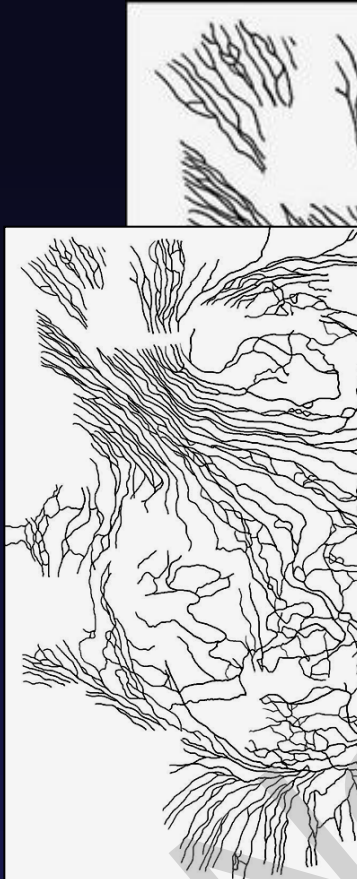
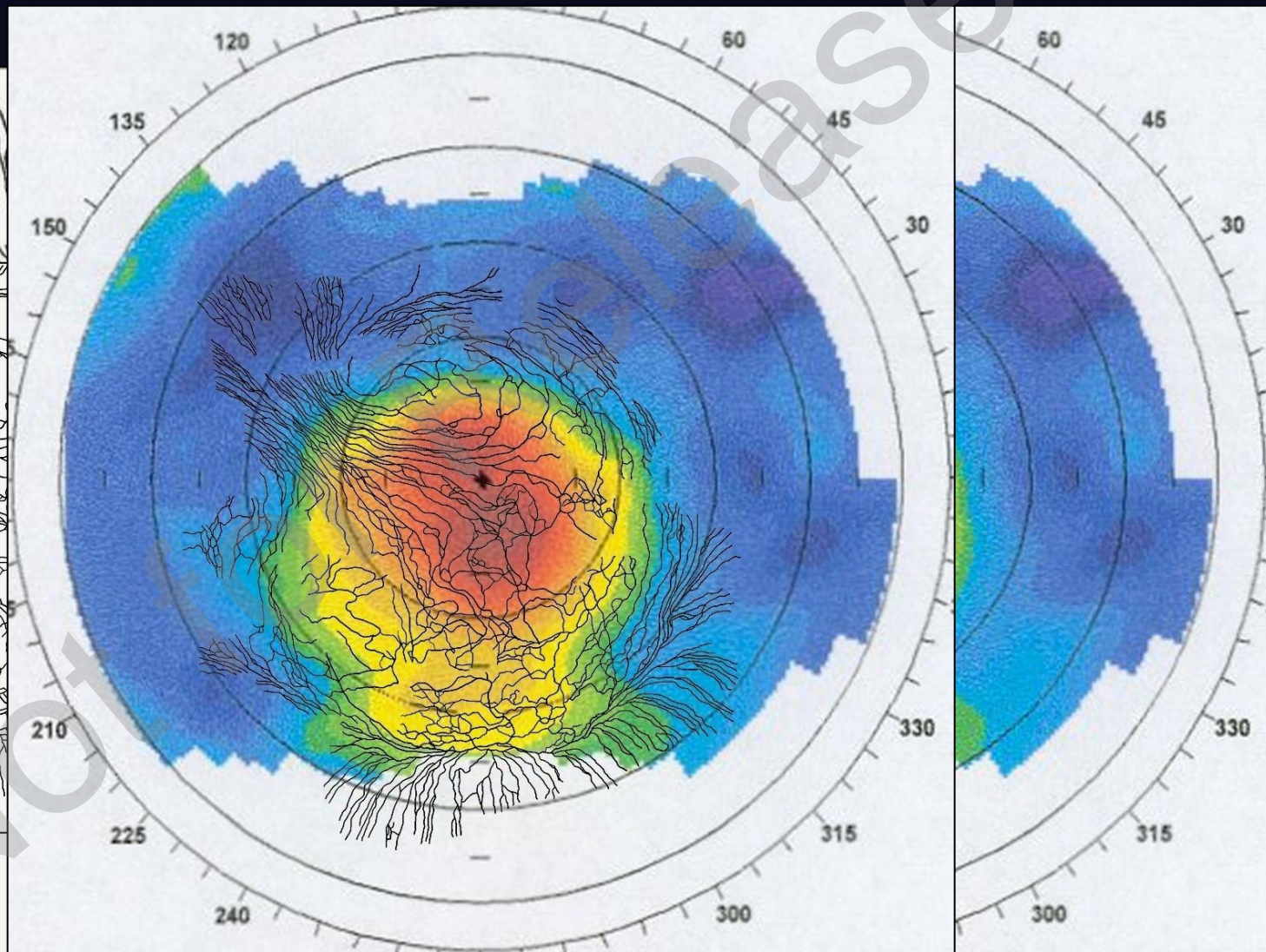


1mm



Patel DV, McGhee CNJ. Mapping the corneal sub-basal nerve plexus in keratoconus by *in vivo* laser scanning confocal microscopy. Investigative Ophthalmology & Visual Science 2005;46:4485-4488





# Keratocyte density

- Control > Keratoconus > Keratoconus + CL
- Keratoconus with contact lens - significant reduction anterior & posterior density
- Keratoconus without CL - significant reduction only in anterior density

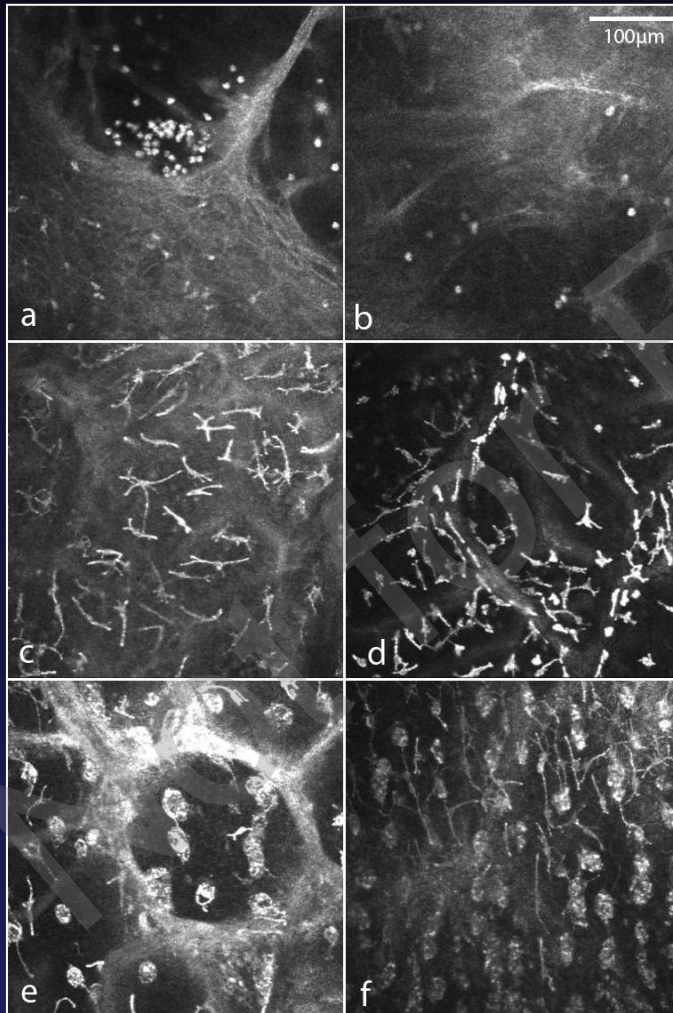
Erie JC, Patel SV, McLaren JW, Nau CB, Hodge DO, Bourne WM. Keratocyte density in keratoconus. A confocal microscopy study. *Am J Ophthalmol.* 2002 Nov;134(5):689-95.

Ku JY, Niederer RL, Patel DV, Sherwin T, McGhee CN. Laser scanning in vivo confocal analysis of keratocyte density in keratoconus. *Ophthalmology.* **2008**;115(5):845-50





# Acute corneal hydrops



- Round cells at presentation in 4 cases
- Disappeared in 2-4 weeks in 2 cases
- Elongated branching cells at 6-12 weeks
- Large round speckled cells at 3 months

# Conclusions

- Multiple imaging modalities
- Roles in diagnosis, screening and management
- Understanding pathophysiology
- Diagnosis of early keratoconus remains challenging

# Thank you

## Acknowledgements

Prof Charles McGhee



Akilesh Gokul



Jennifer Fan-Gaskin



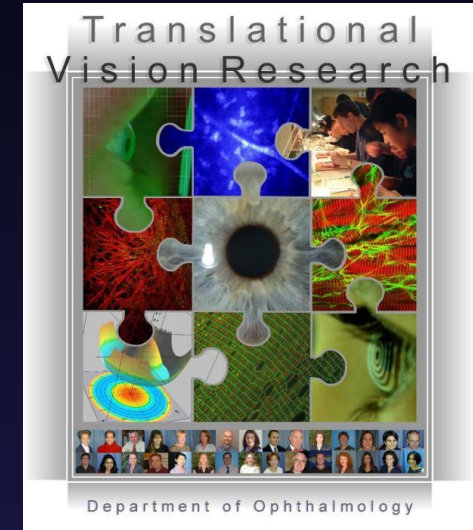
Hans Vellara



Noor Ali



David Lockington



Health Research Council of New Zealand

