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CXL: Complications

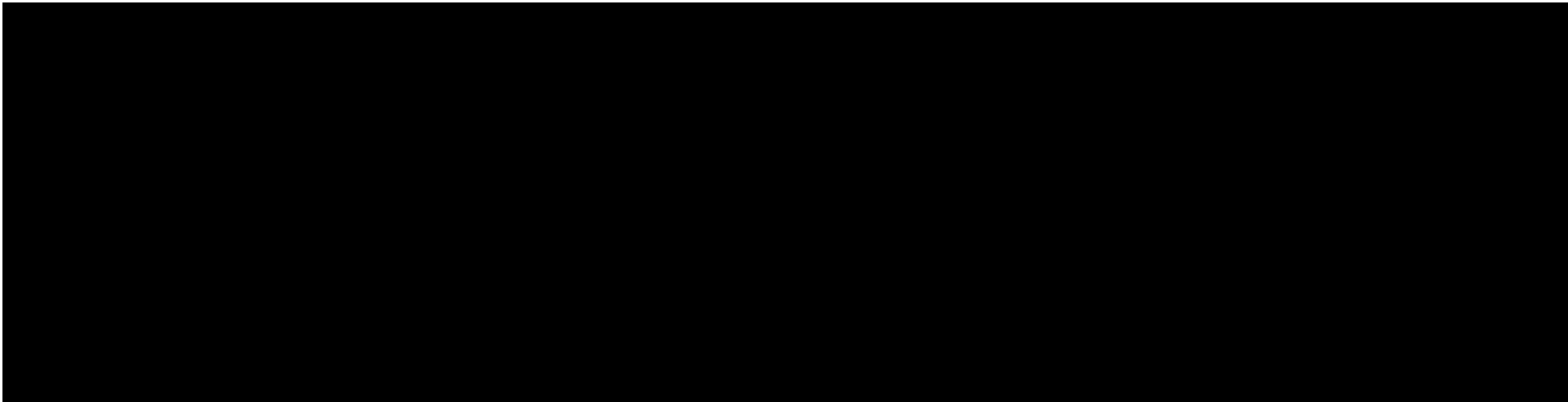


What we should avoid...
from perfect technology to
disaster



Before to speak about
complication...


Which are the results we
should expect?



Corneal Cross-Linking as a Treatment for Keratoconus

Four-Year Morphologic and Clinical Outcomes with Respect to Patient Age

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Change in BSCVA Safety %

Loss > 1

52% (9-17)

44% (18-29)

0% (30-39)

4% (>40)

Gained ≥ 1

20% (9-17)

25% (18-29)

31% (30-39)

24% (>40)

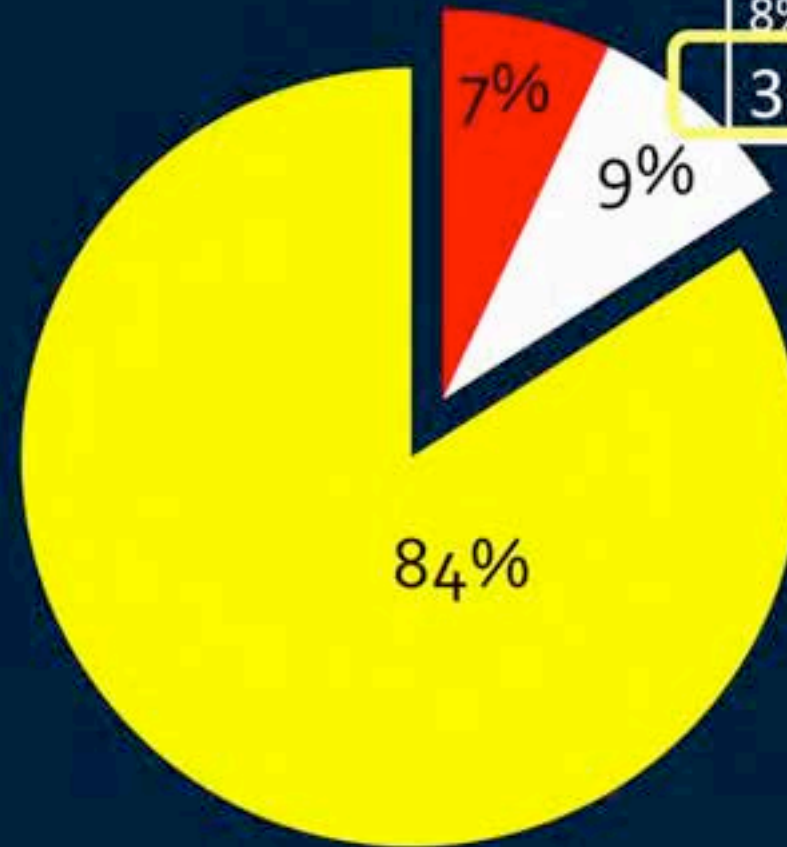
unchanged

35% (9-17)

22% (18-29)

8% (30-39)

35% (>40)



84%

7%

9%

24 mos post cxi

Pediatrici

18-29

30-39

>40

Sphere, Sph.Eq., Cyl overtime

- Sphere changes more than cyl
- Cyl reduce , but... has the coma reduces part of it is transformed in cyl
- The changes are taking years
- Patient report a constant improvement.
The opposite of pre-op

Pediatric population:

- CXL halted the progression of disease
- Significant improvement of BCVA
- Morphological results showed a significant improvement of selected parameters and stability for all other indexes.
- A more aggressive disease in the pediatric population probably resulted in the observed reduced refractive and morphological improvement of CXL.

Population 18-28 and 29-39 years

- Significant improvement of BCVA till 36 months of follow up
- Morphological results showed an improvement of topographic indices like Simk₁, Simk₂, SAI, OSI and DSI up to a maximum of 36 months of follow-up.
- Significant reductions in total, comatic and spherical aberrations up to 36 months of follow-up.
- 18- 39 years old ->best responder

Population >40 years

- CXL halted the progression of disease
- The limited improvement of CXL in this group is probably due to so-called "age-related crosslinks"

Changes by Curvature group

Curvature 45/50 D

- Better BCVA
- Better Curvature flattening
- Better Sph. Eq change
- Better Sph. change
- Better astigmatism

Outcomes by thinnest point value group....

Better outcome with respect of pre-op pachymetry:

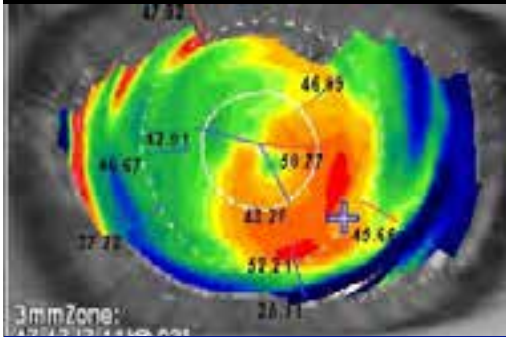
- BCVA gain → between 400/500
- Sph. Change → less than 400
- Cyl change → greater than 450
- Sph eq. change → inferior 400

Reduction of the area/power of the keratoconus overtime

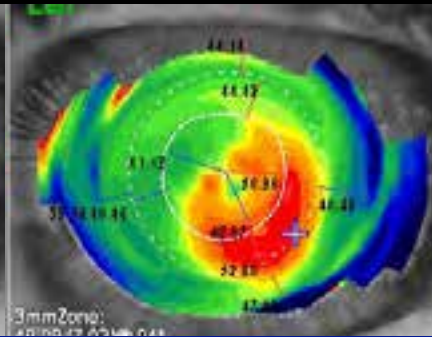
+3.65 D

-4.15 D

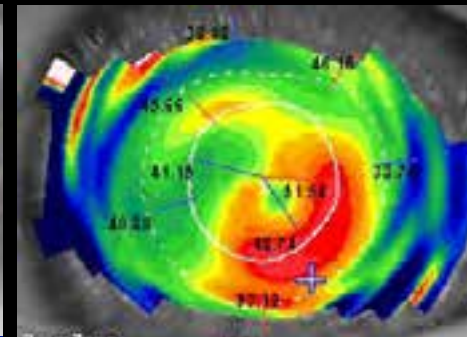
-6.18 D



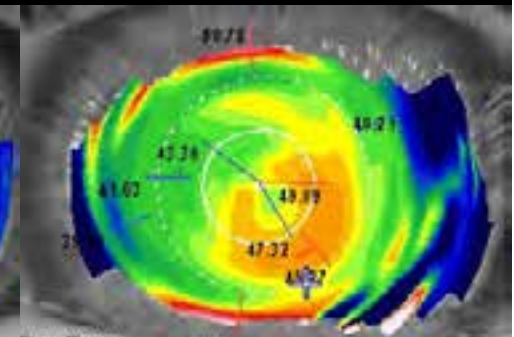
1° examination



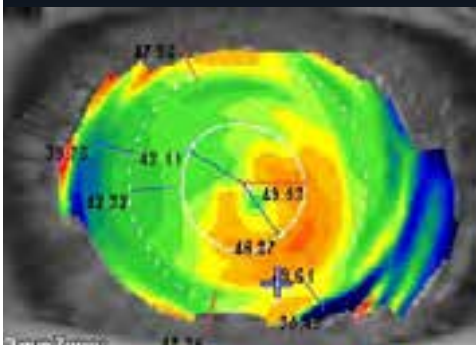
pre cxi



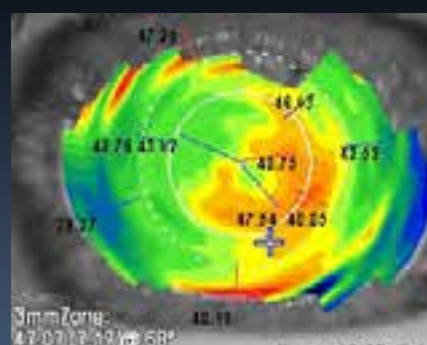
1 mos post-op



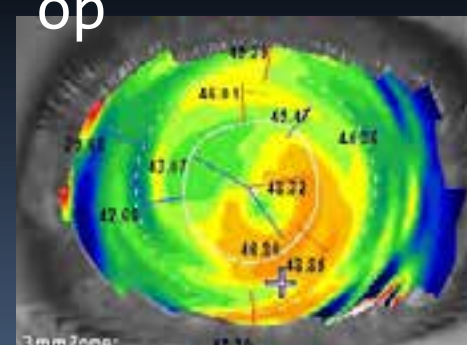
3 mos post



6 mos post
-5.17 D

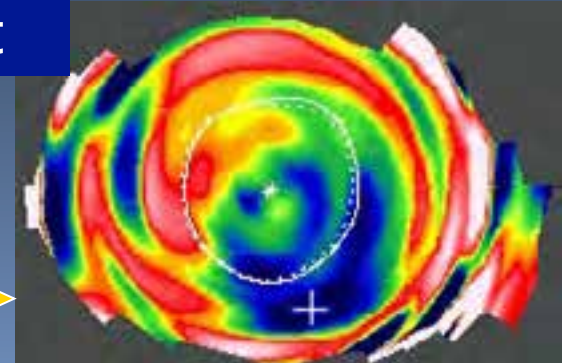


12 mos post
-6.08 D



24 mos post
-6.61 D

pt n° 138 Differential map from pre cxi to 24 mos post cxi



Are we looking at proper parameter in
the outcomes judgement of Cross
Linking (CXL)

NO!

Why?

- Cross linking aim to change the structure of corneal tissue
- Only tissue properties should be evaluated
- Refractive and aberrometric changes are desirable but are side effect of tissue changes
- Topography changes can be highly influenced by tears and epi-changes
- Many factors can change refraction

Which are the parameter to judge a CXL?

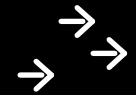
Primary:

- Depth of demarcation line at the OCT
- Biomechanical Improvement
- Scheimpflug or OCT based Tomography elevation changes
- Pachymetry changes
- Epithelial Changes

Demarcation line

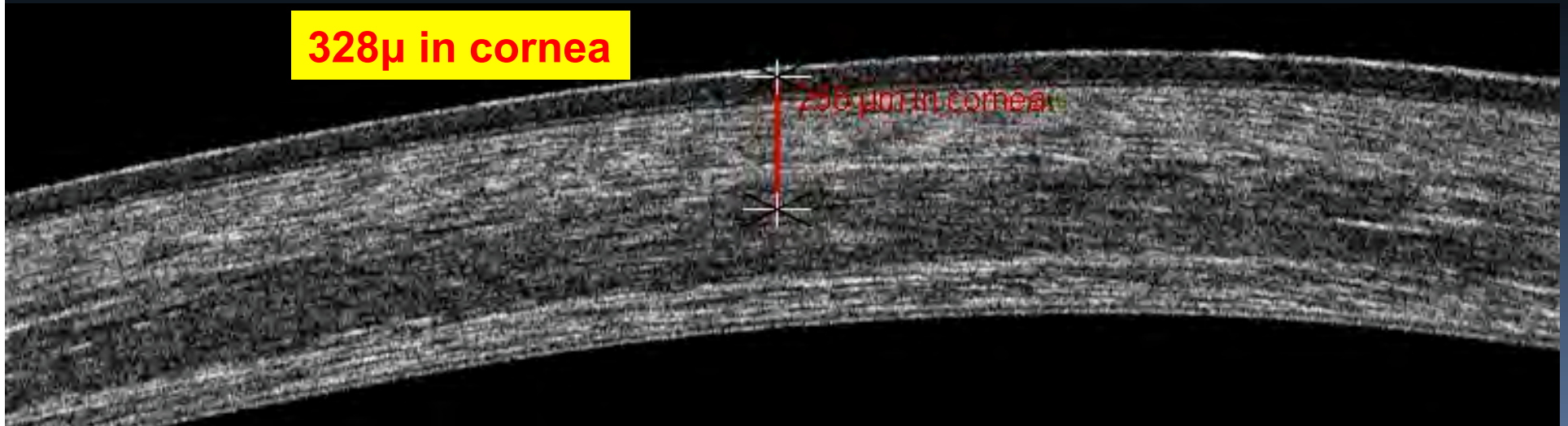
- The deeper the demarcation line at the AS-OCT the more tissue is involved
- The deeper the stronger the cornea
- Deeper → long term stability
- Deeper → more refractive changes

Standard Demarcation line in Epi off CXL



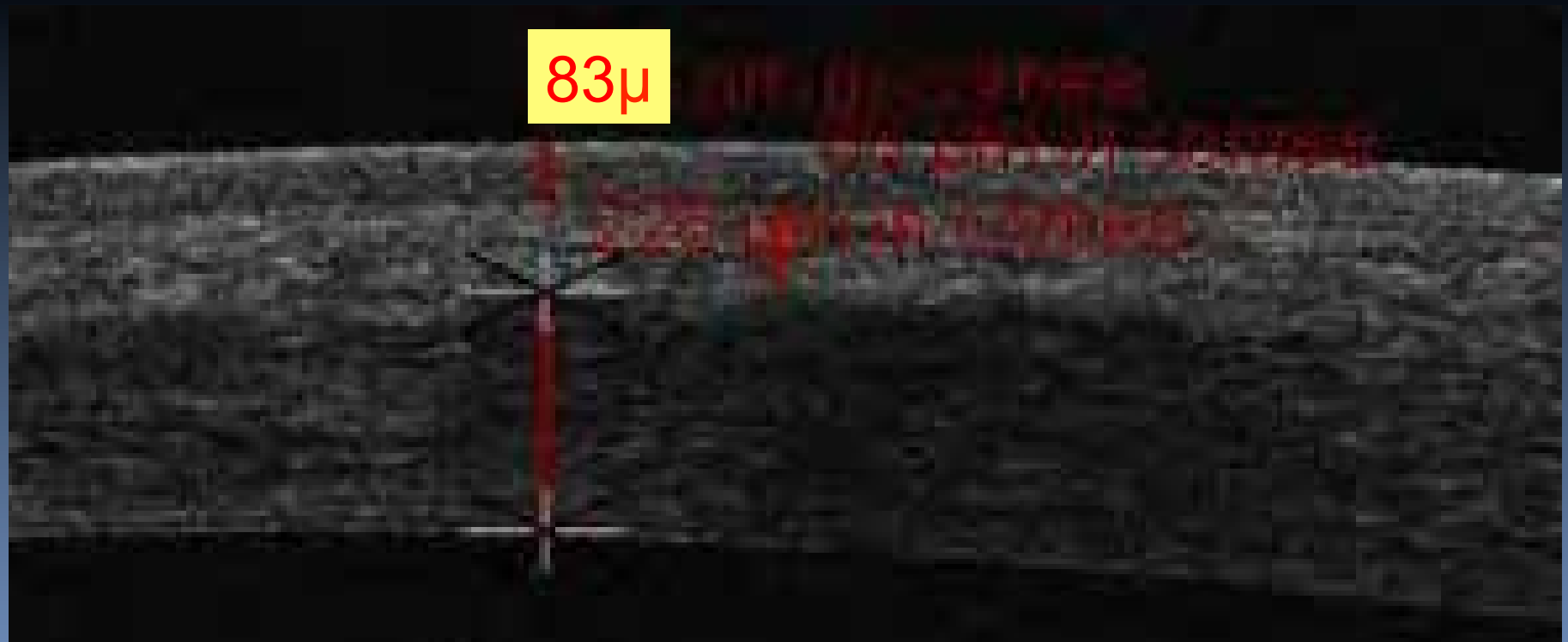
328 μ in cornea

295 μ m in cornea



CXL Epi on demarcation line variable depth
and less homogeneous

This is a complication!!



Postoperative Complications

Causes

1. Inappropriate patient selection
2. Surgical technique errors
 - Lack of sterility/antiseptis
 - Erroneous UV source calibration
 - Erroneous UV focusing
 - Inadequate impregnation
 - Inadequate irradiation
 - Inadequate corneal wetting
3. Inadequate follow up

Postoperative Complications

Immediate

- Corneal Burn
- Delay in re-epithelialization
- Infections and corneal melting
- Sterile Infiltrates

Immediate Postoperative Complications

- Erroneous UV calibration
- Inadequate UV focusing
 - Distance must be regularly verified
- Inadequate impregnation
 - Poor solution
 - Longer exposition to solution with secondary thinning

Impregnation with riboflavin using the ring



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ISTITUTO CLINICO
HUMANITAS

Safety Measures

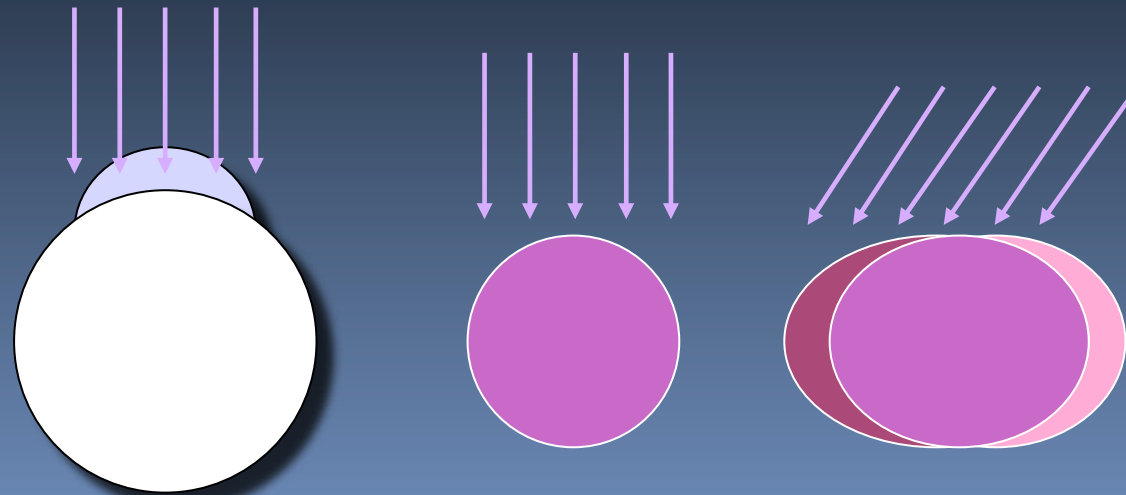
Complications due to technical errors

1. Incorrect focusing / irradiation
2. Inadequate impregnation
3. Insufficient hydration
4. Home-made solutions

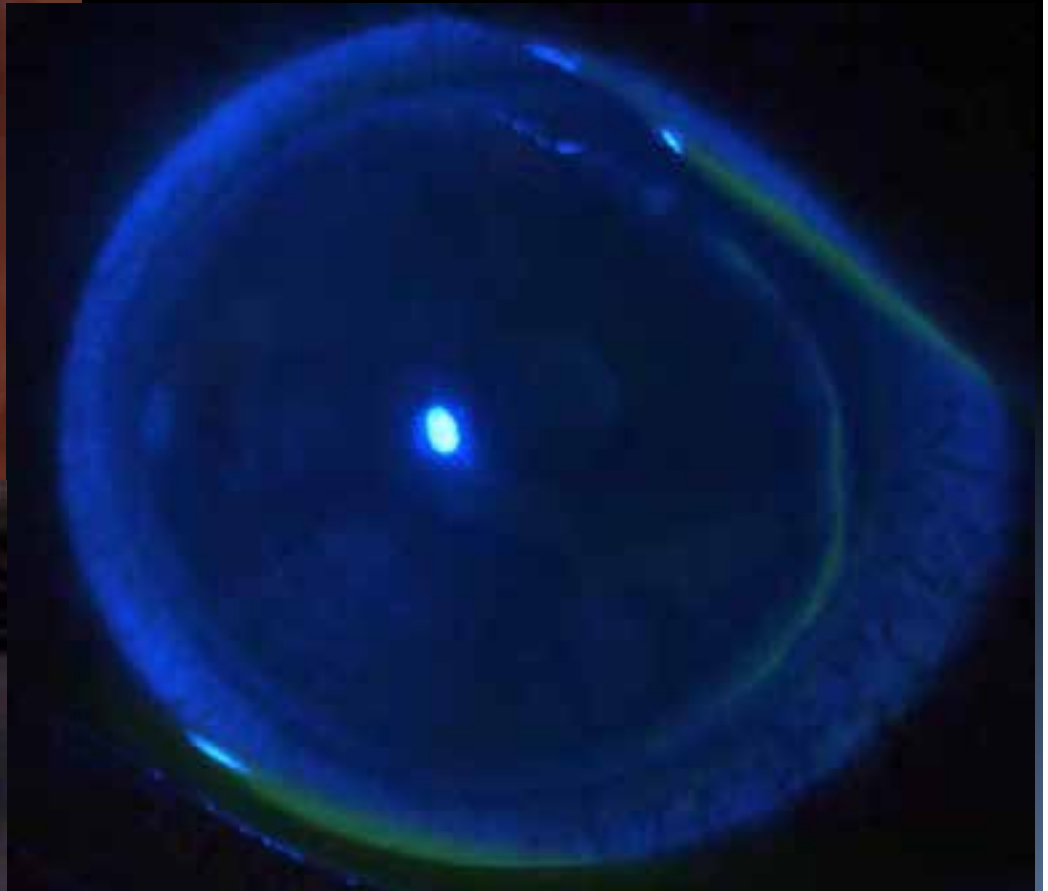
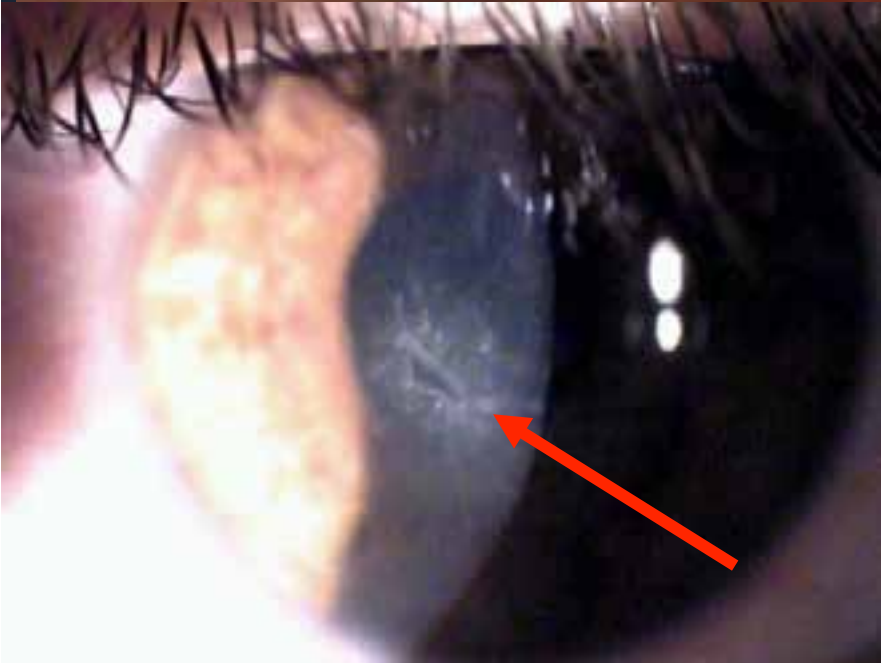
1. Incorrect Focusing

- Corneal Burns

- Erroneous UV calibration
- Inadequate UV focusing
 - Distance: verify regularly
 - UV rays: orthogonal to iris plane



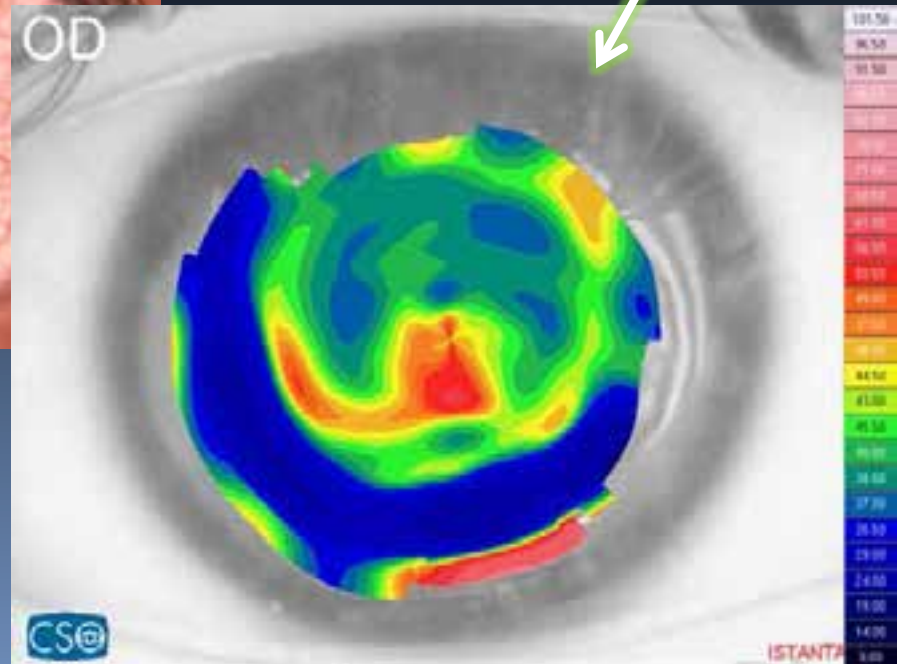
Delay in Reepithelialization
due to corneal burn



Corneal Burn: inadequate irradiation

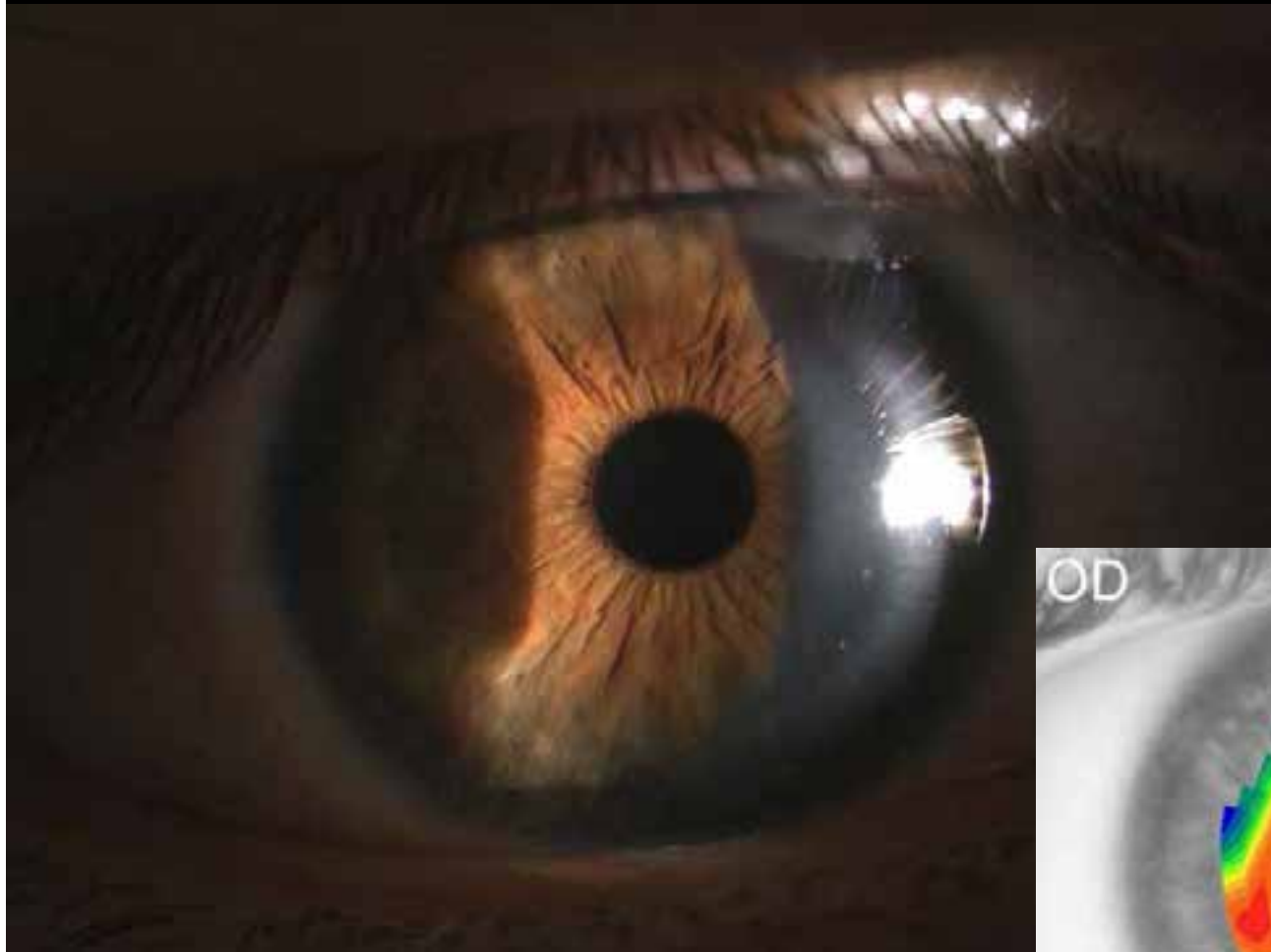


Marked flattening

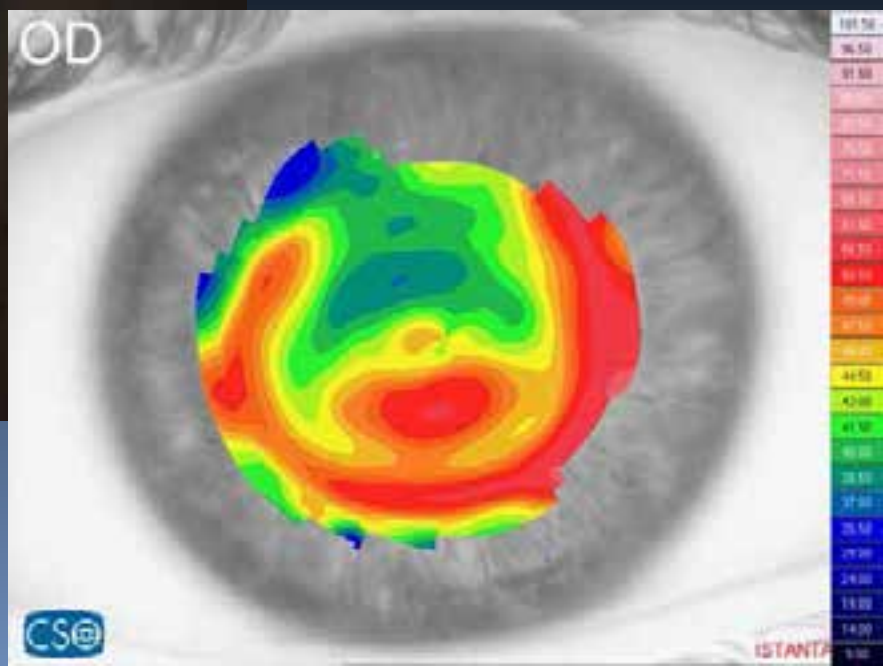


Day 5, RE

Corneal Burn: inadequate irradiation

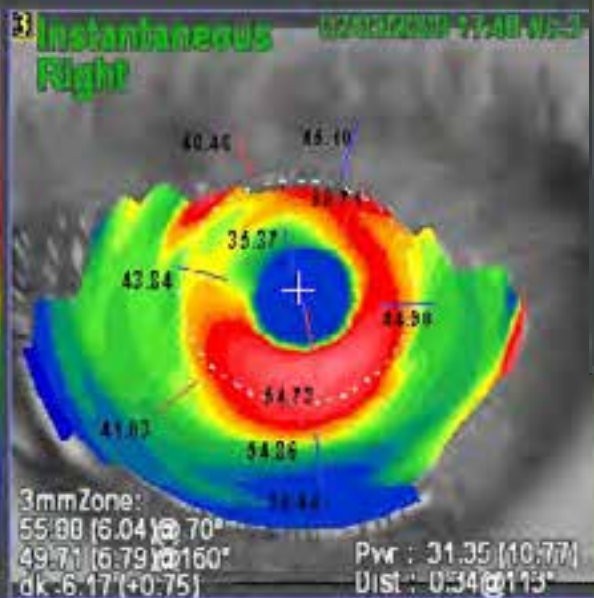
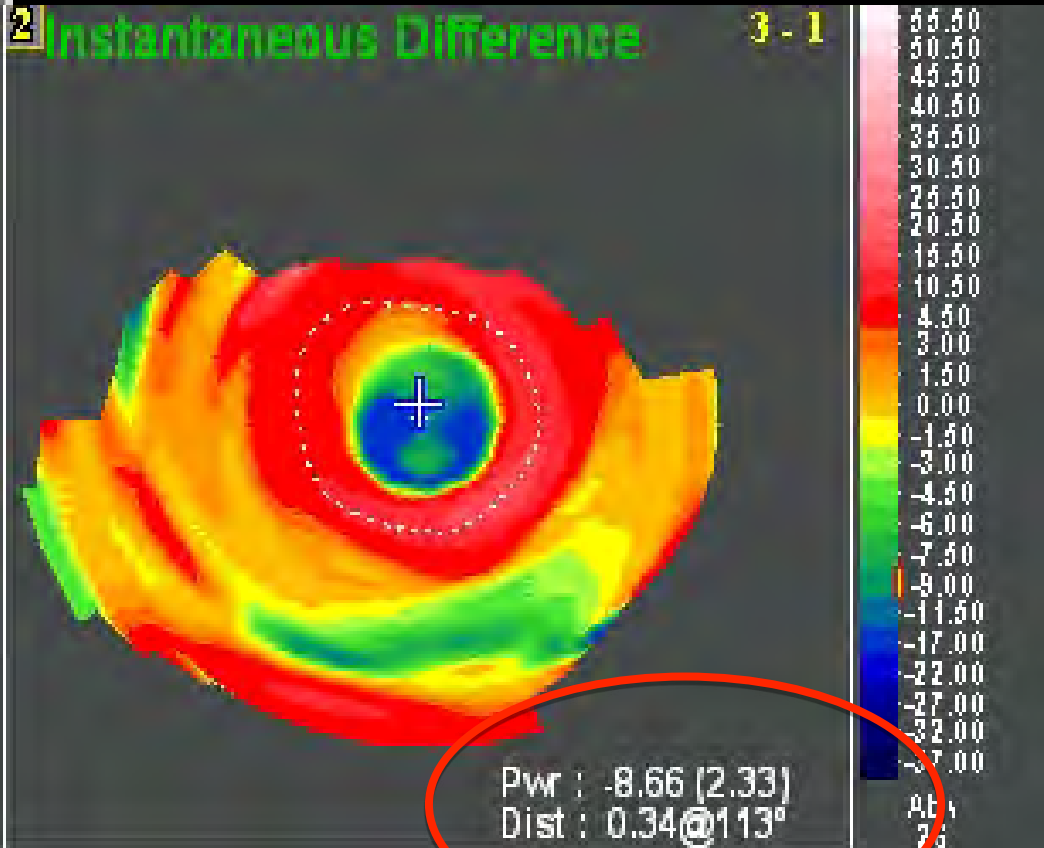
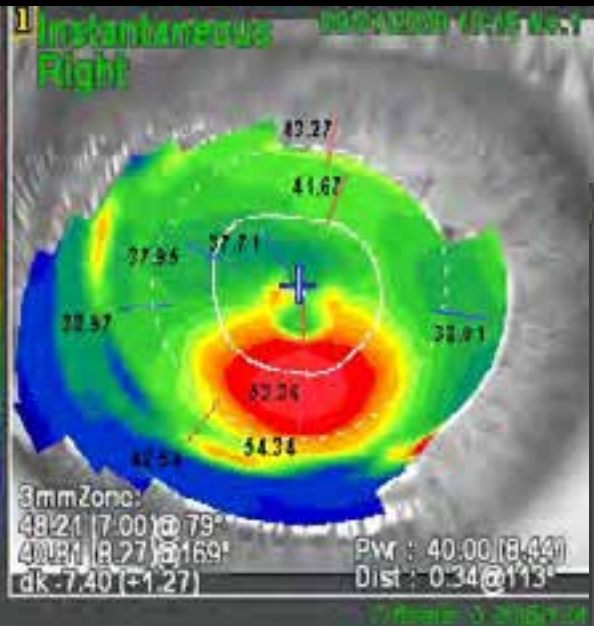


Day 30, RE



Excessive Flattening

PRE CXL OD BSCVA: 0.8 -1,25@94



POST CXL OD BSCVA: 0.6 +7,00 -1,00@90

6 mos: disappearance of flattening and hyp

Immediate Postoperative Complications

- Delay in reepithelialization
 - Selection criteria
 - Avoid excessively steep corneas
 - Corneal wetting
 - Contact lens
 - Aminoacids pre-load

Immediate Postoperative Complications

Provide adequate hygiene instructions!

• Infections

- CXL KILLS bacteria and fungi !
- Lack of sterility/antiseptis
 - OR-like procedure
- Home-made solutions
- Daily check until reepithelialization
- During epithelial healing cornea is vulnerable to infections

Immediate Postoperative Complications

- Acanthamoeba (melt, 5 days) *Rama P J Cataract Refract Surg, 2009*
- Staph epi *Perez-Santonia JJ J Cataract Refract Surg, 2009*
- Staph epi non-infective *Angunawela RI J Cataract Refract Surg, 2009*
- Escherichia Coli (3 days) *POLLhammer M J Cataract Refract Surg, 2009*
- Herpes simplex (5 days) *Kymionis GC J Cataract Refract Surg, 2007*
- LASIK, ectasia and CXL: diffused anterior lamellar keratitis
 - Corneal melt *Kymionis GC J Cataract Refract Surg, 2007*
 - Staph epi non infective
 - Diclofenac-induced *Angunawela RI J Cataract Refract Surg, 2009*
Gokhale NS Cornea, 2009
- Sterile Infiltrates *Koller T J Cataract Refract Surg, 2009*

Early/Late Postoperative Complications

- **Early** – First Three months
 - Stromal deep opacity (NOT haze !)
 - Night time glare and haloes
 - Variable improvement of UCVA during the first months
- **Late** – After Three months
 - Stromal opacity
 - Endothelial damage

Early/Late Postoperative Complications

Stromal opacity

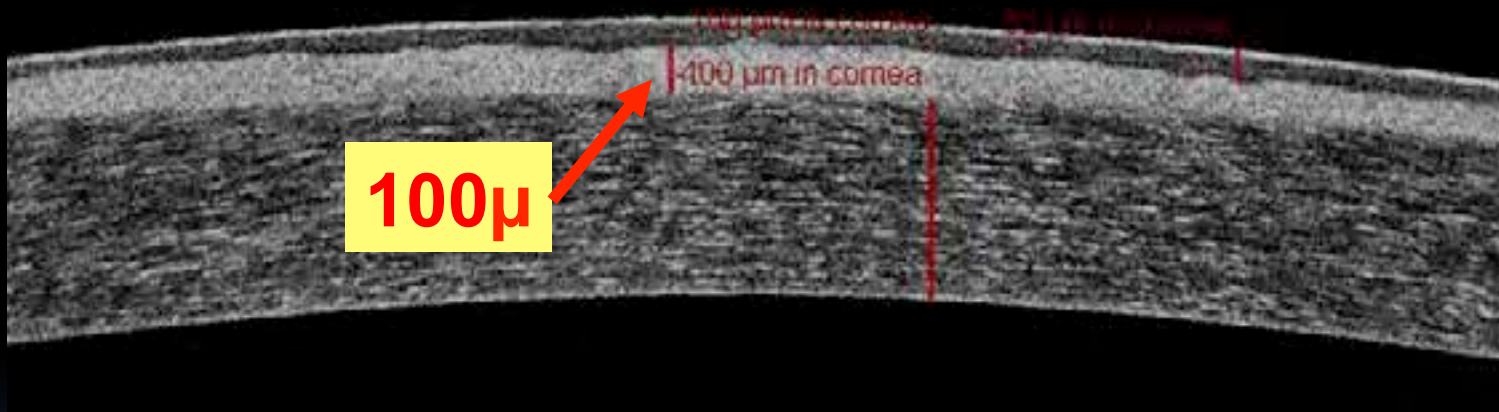
- 1+ Haze (Hanna scale) (12.7%)
 - Intraoperative corneal dehydration
- Inadequate corneal protection
 - Inadequate impregnation
 - Home-made solutions



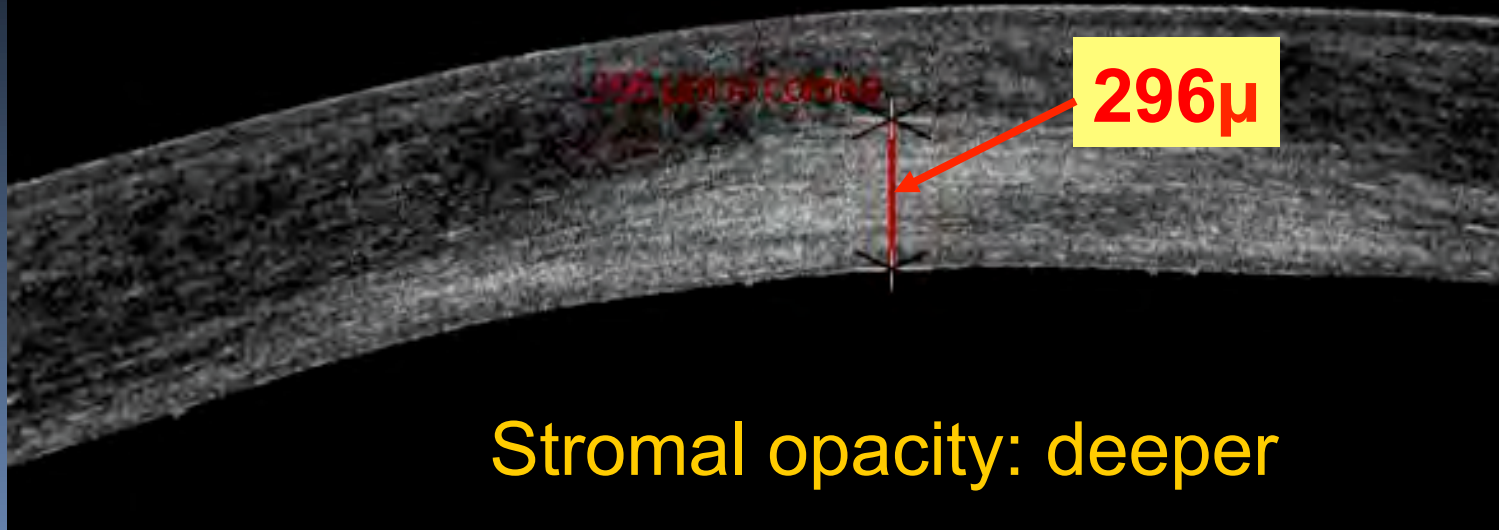
stromal opacity

Post PRK

Haze: more superficial

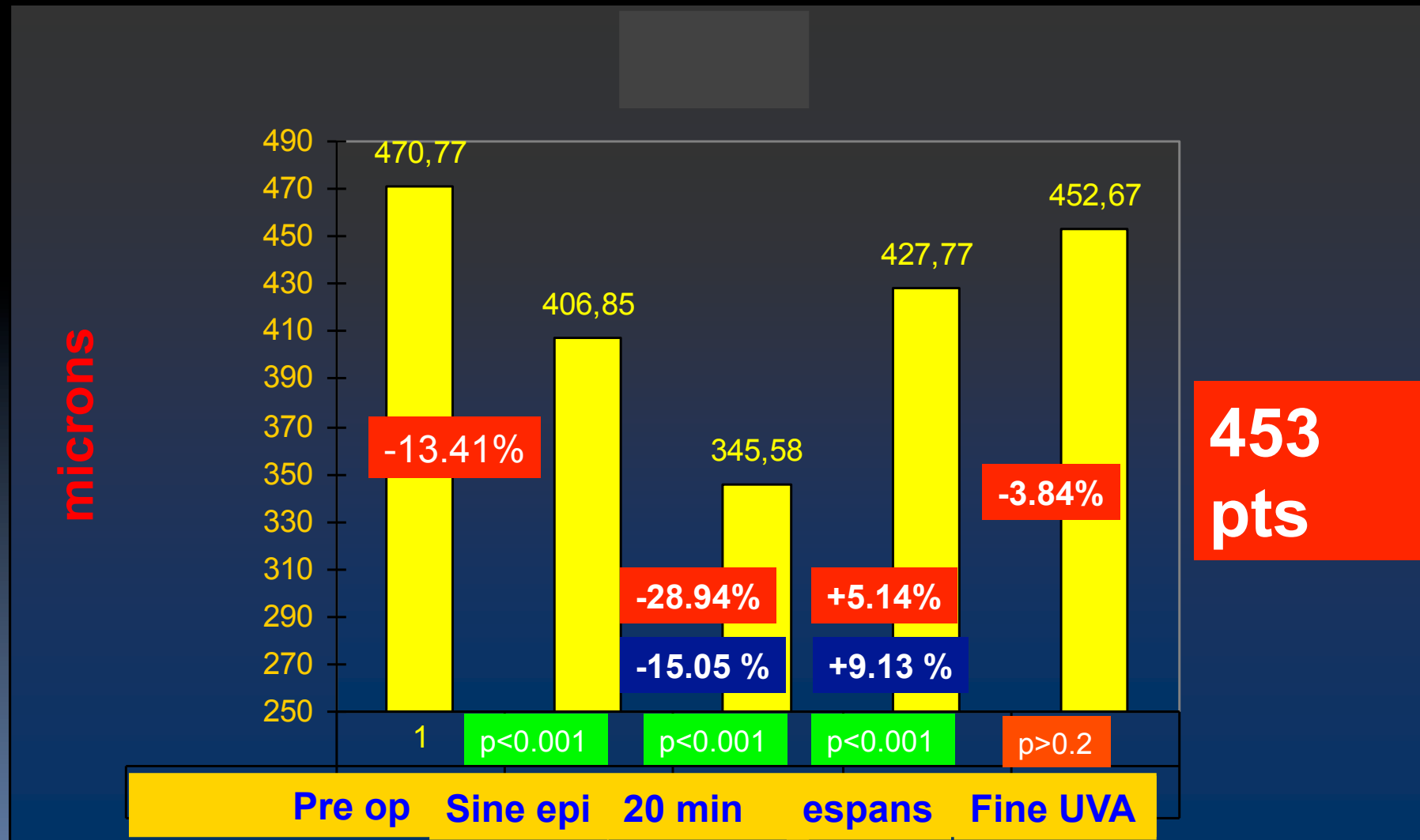


Post CXL

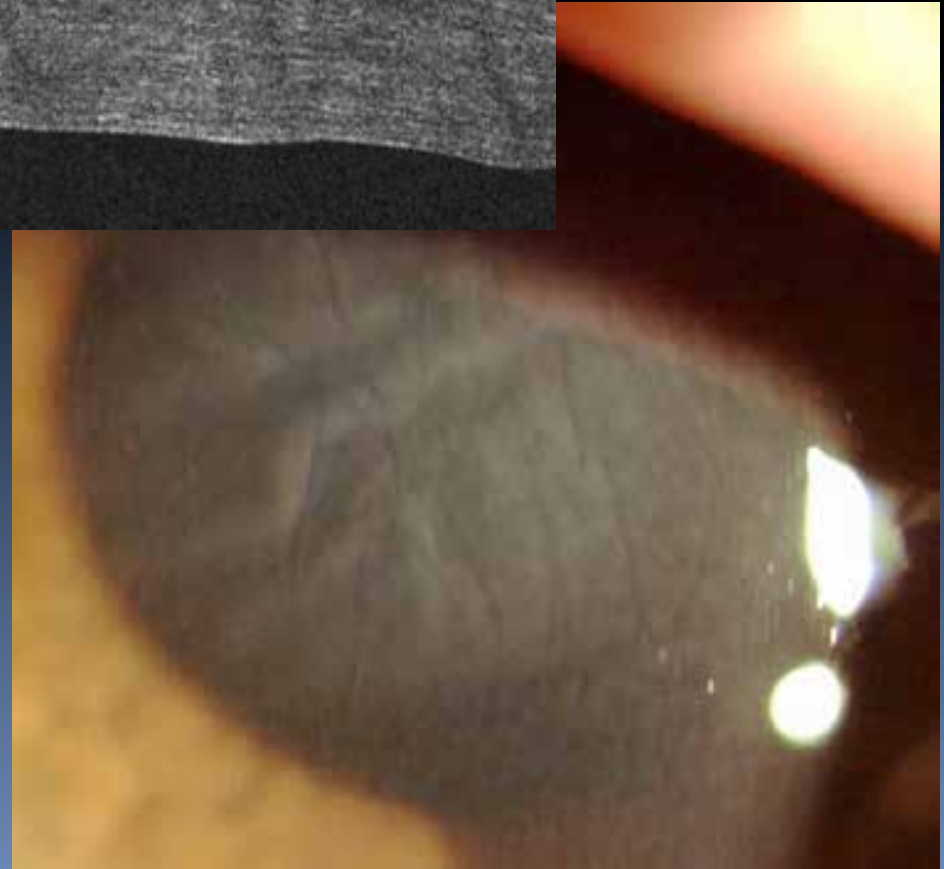
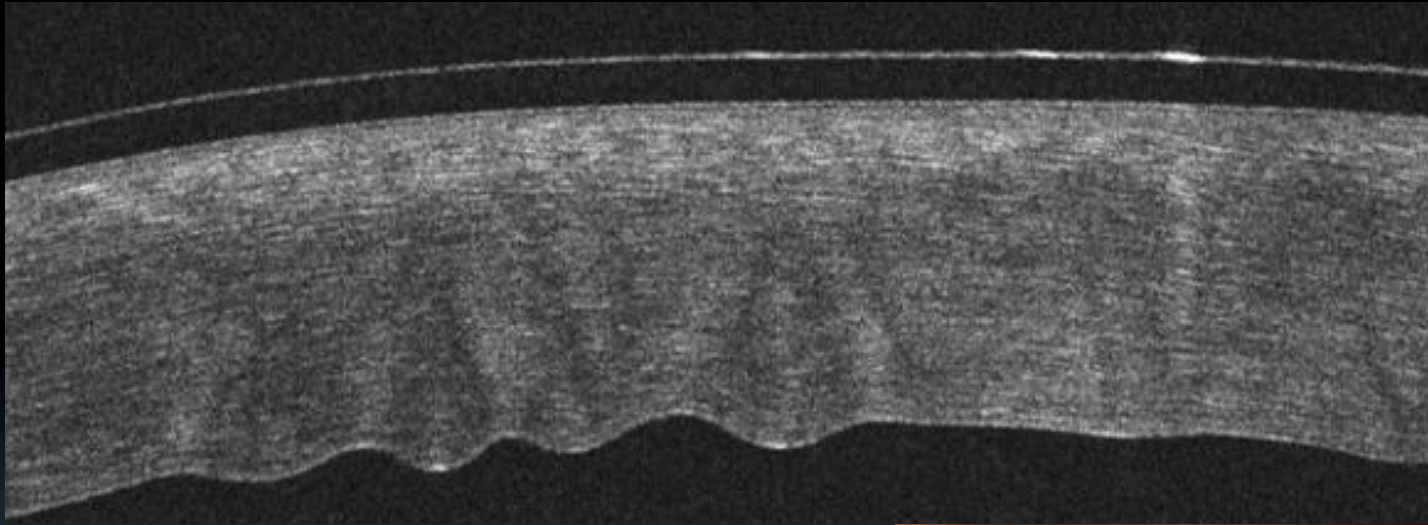


Stromal opacity: deeper

1. Intraoperative Pachimetry



Opacity and Corneal Edema post CXL



How to avoid post-op opacities

- The corneal stroma, by dextran, is reduced in pachymetry
- If U.V. is applied when the pachymetry is less than 340 post op haze should be expected
- Always check intra-op pachymetry
- If < than 340 micron expand with hypotonic solutions

Early/Late Postoperative Complication : **Stromal Opacity**

- extending to 60% of stromal depth (300µm)
- regression after one month with topical steroids regimen
 - relative resistance to steroids
 - higher tendency with more **advanced** keratoconus
 - frequently fade or disappears within a year

Vinciguerra et al. Ophthalmology 2009; Mar

Vinciguerra et al. Arch Ophthalmol 2009; Oct

Vinciguerra et al. J Refract Surg 2009; Sep

Hafezi, Vinciguerra, Br J Ophthalmol accepted, 2010

Hermann et al. Ophthalmologe 2008;105

Raiskup et al. J Cataract Refract Surg 2009; 25

Mazzotta et al. Clin Experiment Ophthalmol 2007; 35

Early/Late Postoperative Complications

- Night time glare and halos
 - Change in refraction
 - Will subside after few weeks
- Variable improvement of UCVA

Early/Late Postoperative Complications

- Endothelial damage
 - To be expected with corneal thickness of less than 400 μ m
 - Inadequate impregnation
- Lens damage
 - Three-year objective follow-up with Pentacam software
 - No lens damage or induction of opacity
- Retinal damage
 - One-year follow-up ON head with OCT
 - No ON damage

Wollensak G Ophthalmic Res, 2003

Vinciguerra P, J of Cat and Ref Surgery

Vinciguerra P, personal data

When everything was properly done but..

- The pts still progress and V.A. does not improve overtime as expected...
- What we should look for?

Eye rubbing



Conclusions 1°

- Complication rate: 2.9% at one year
- Expressed as visual loss of 2 Snellen lines of BSCVA
- Failure factor:
 - K above 58.00 D
- Risk factors:
 - Age older than 35
 - Preop BSCVA better than 20/25

*Koller T J Cataract Refract Surg 2009; Aug
Vinciguerra et al. Ophthalmology 2009; Mar
Vinciguerra et al. Arch Ophthalmol 2009; Oct*

Conclusions 2°

- Cross-Linking is a generally **very safe** procedure
- Beware of technical errors !

Thank you. Arrivederci



2005