X-linking: new clinical applications and potential future directions

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What is IROC ?

IROC

- Private institute in Zurich, Switzerland (www.iroc.ch)
  - Incorporated: 2003
  - Institute: Clinical and research & development setting
  - Partners: Theo Seiler, Farhad Hafezi, Michael Mrochen and Hans Peter Iseli

- Development of:
  - PRK in 1986
  - Wavefront-guided LASIK (1999)
  - Corneal collagen crosslinking (with Dresden, 1997)

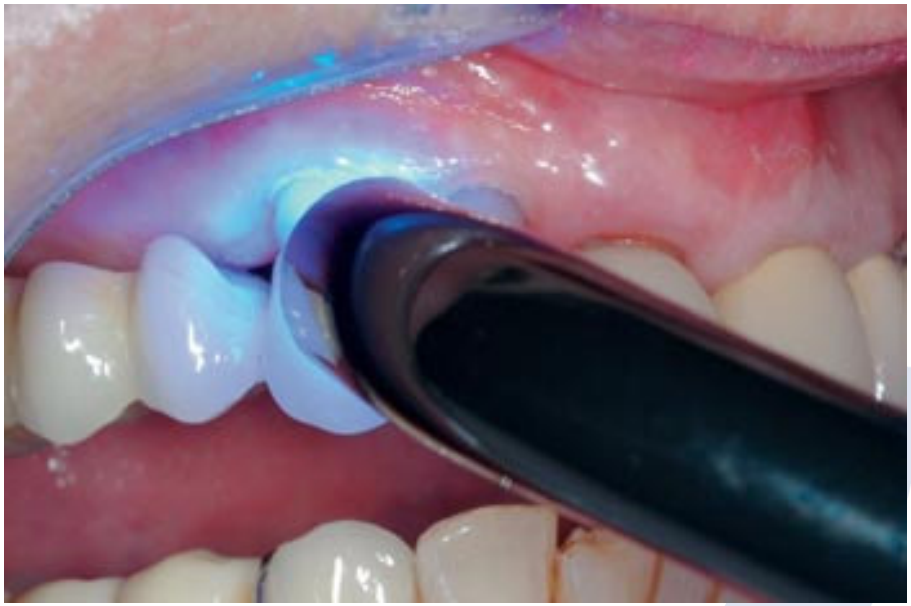
X-linking

- interesting details

X-linking history

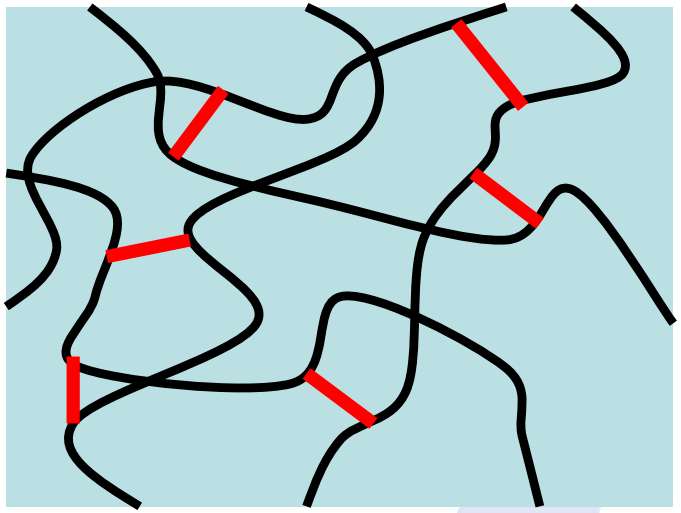
- 1970‘s: first use of polimerization compounds in dentistry

- Areas of application in medicine:
  - Dentistry
  - ENT surgery, cardiac surgery, orthopedic surgery



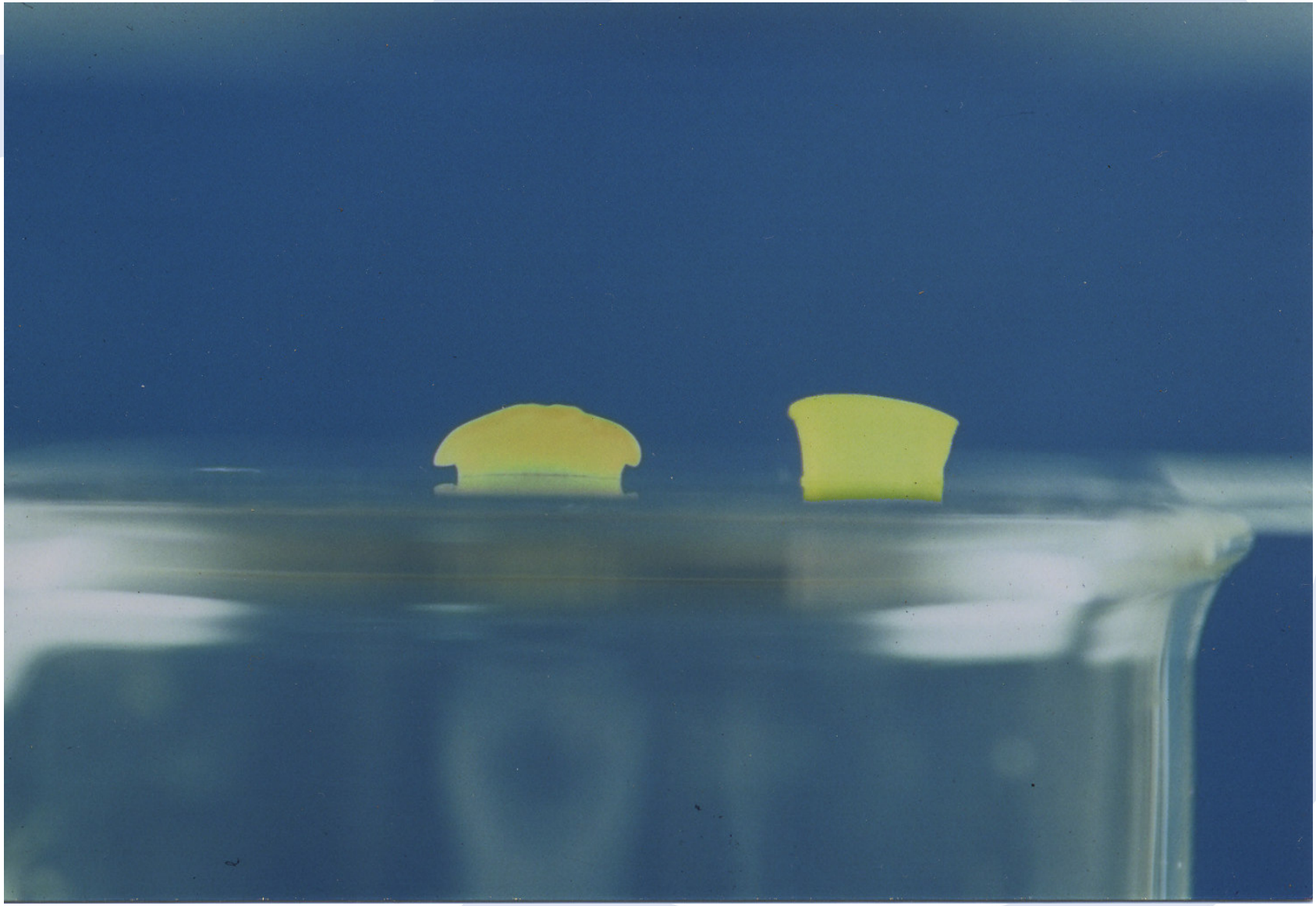
X-linking of collagen - principle

- Basic concept:
  - Increases the biomechanical and biochemical stability of tissues

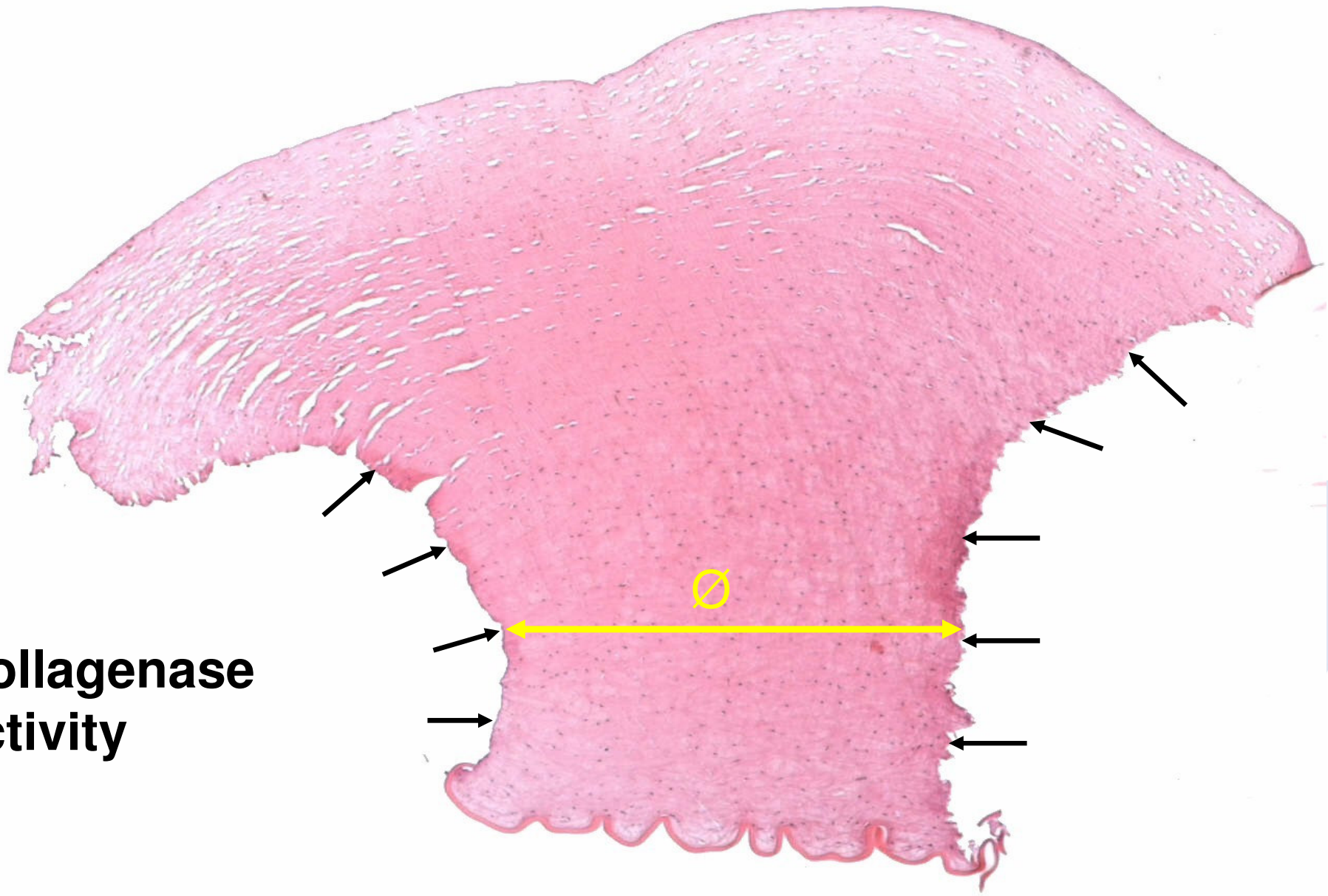


- Functional principle:
  - Biomechanically: Additional molecular bonds between collagen fibers
  - Biochemically: Increased resistance to enzymatic digestion. Changes in the tertiary structure of collagen. Steric hindrance

X-linking biochemical effect



X-linking biochemical effect



Collagenase activity

X-linking in the cornea

- Increase of X-links in the cornea:
  - Ageing (physiologically)
  - Diabetes
  - Smoking

- Diabetes and smoking are protective factors against keratoconus

New clinical applications

for X-linking

X-linking

in iatrogenic keratectasia

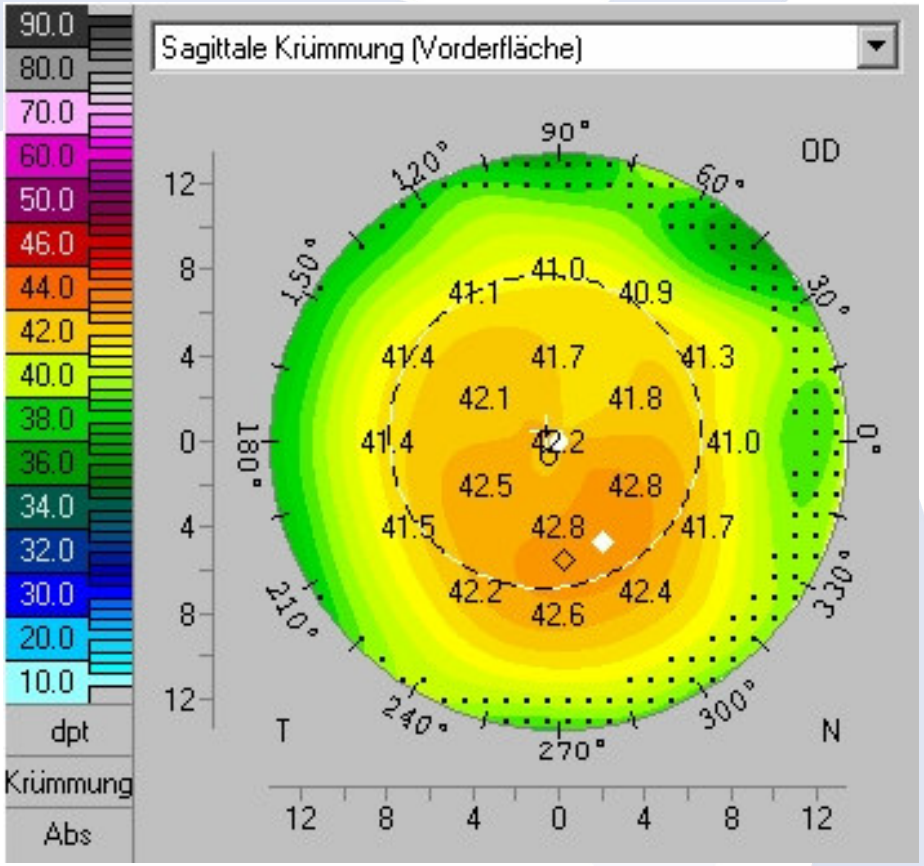
after LASIK surgery

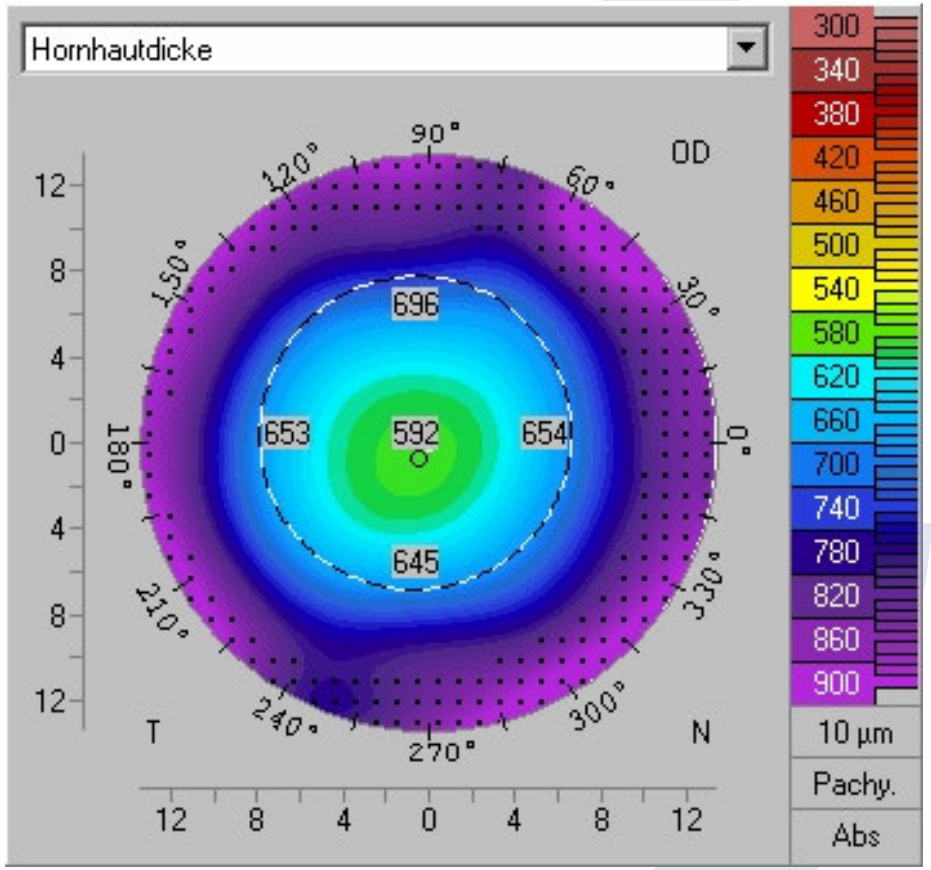
Iatrogenic keratectasia after LASIK

Risk factors

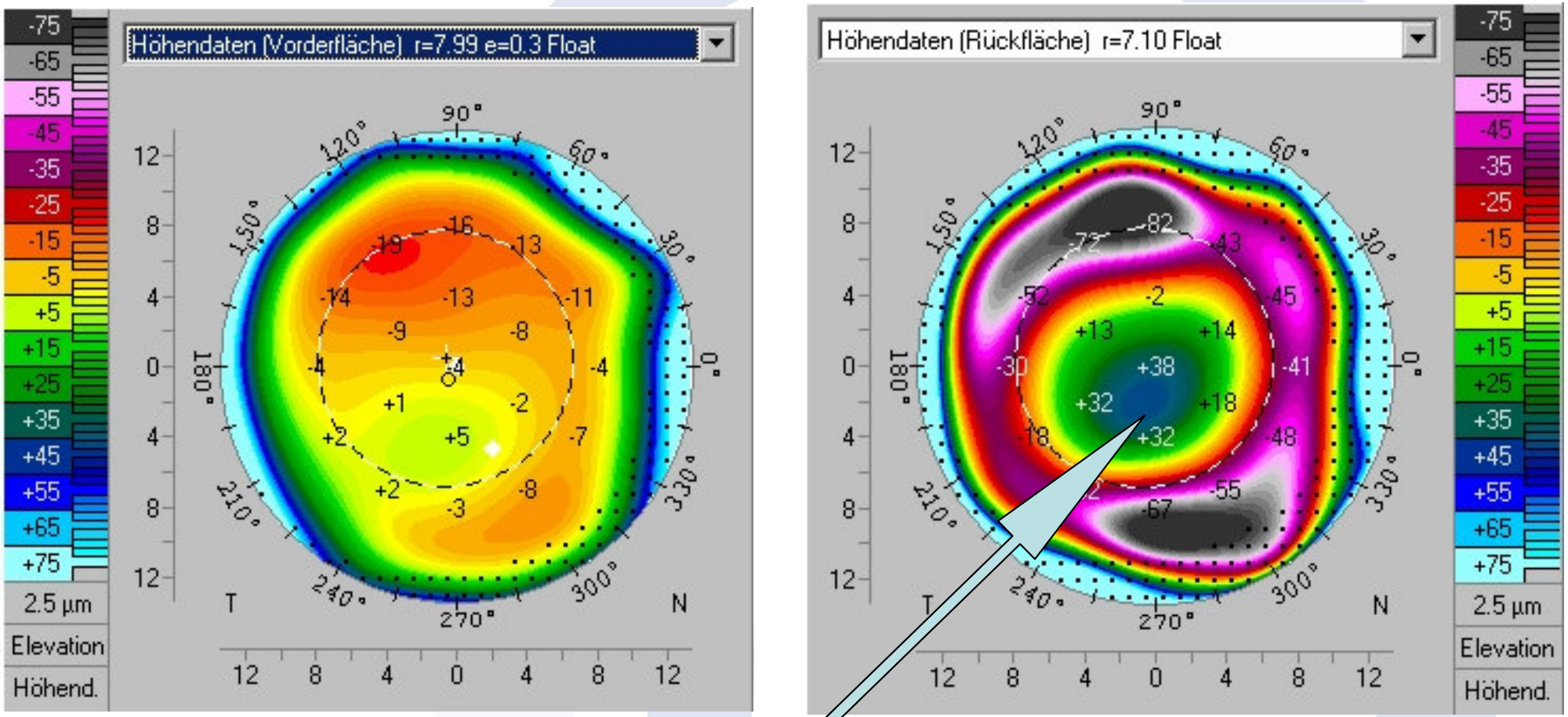
- Undiagnosed forme fruste keratectasia (88%)
- High corrections and thin residual stroma
- Pregnancy
- Age, gender (f:m = 9:1)

How do we recognize keratoconus preoperatively?





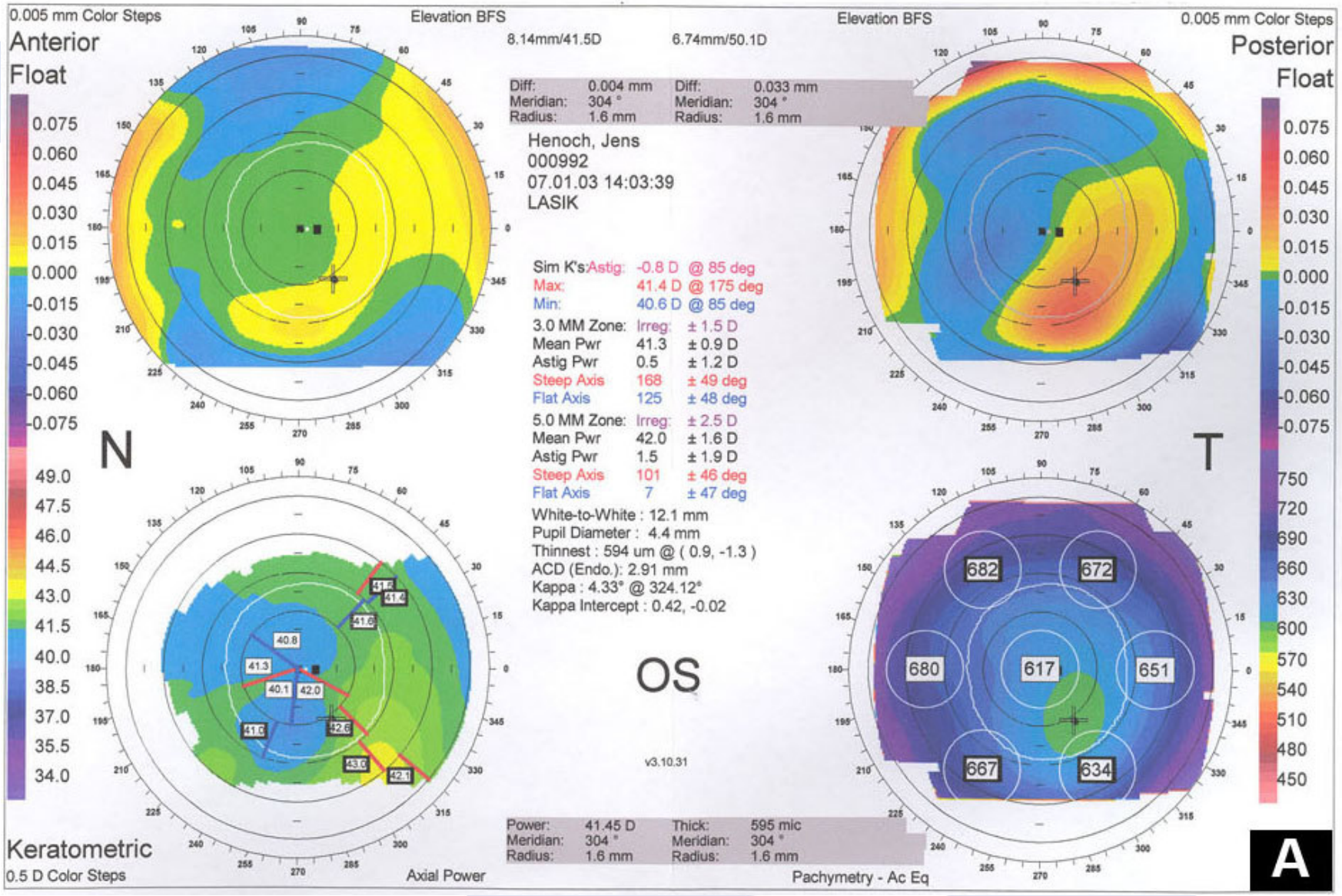
Iatrogenic keratectasia



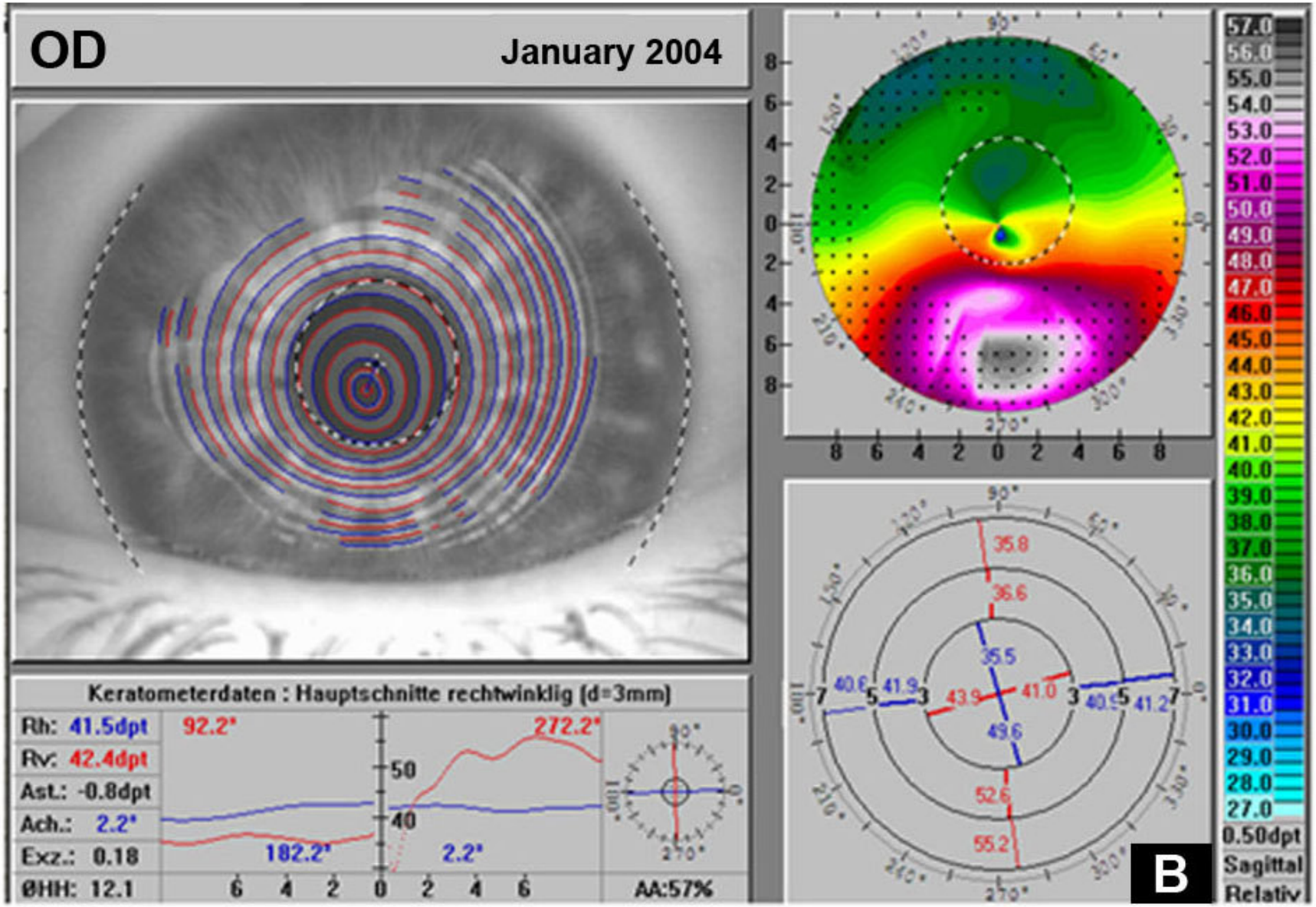
At the posterior surface

keratectasia is easier to recognize

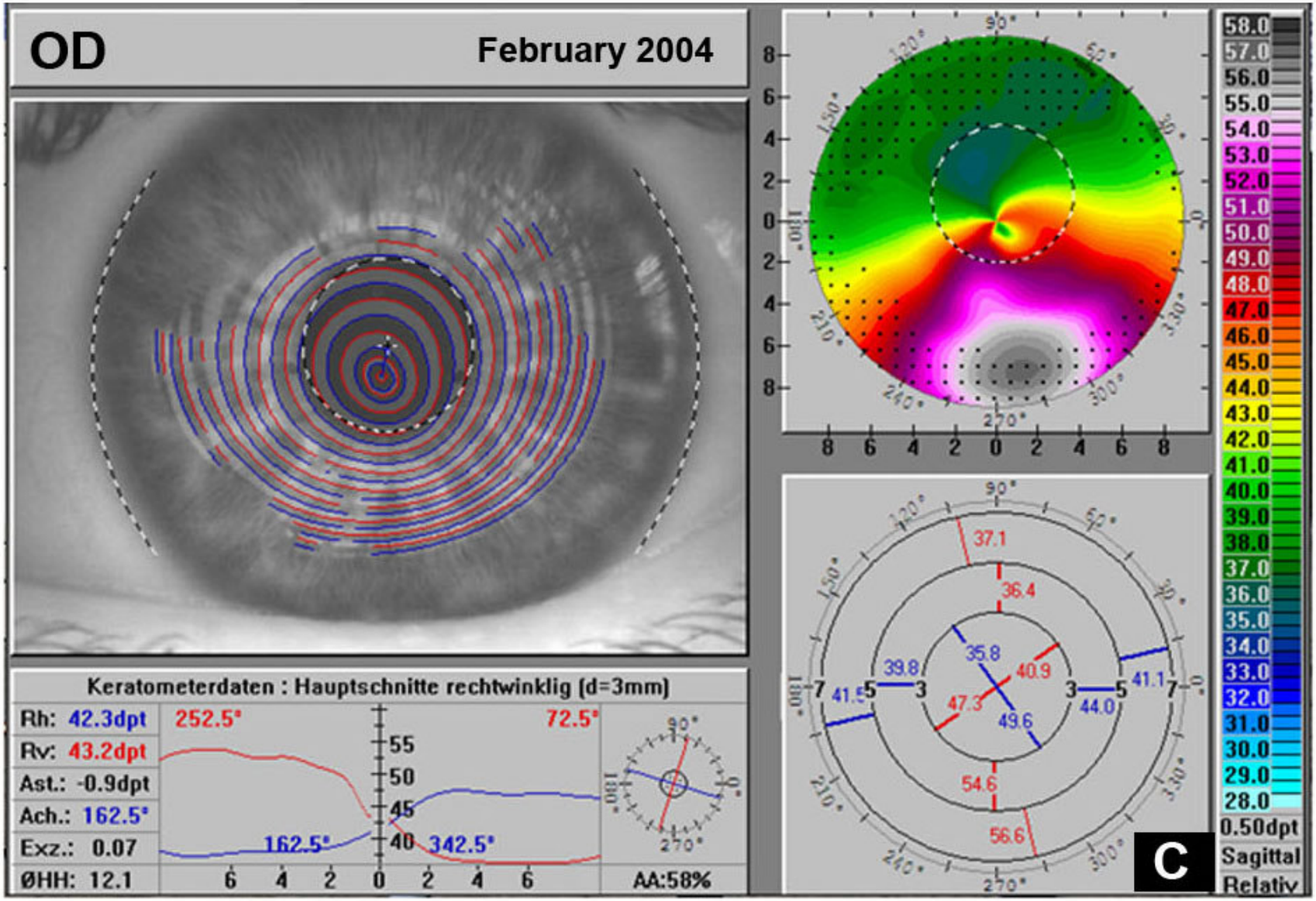
X-linking in Iatrogenic keratectasia - CASE 1



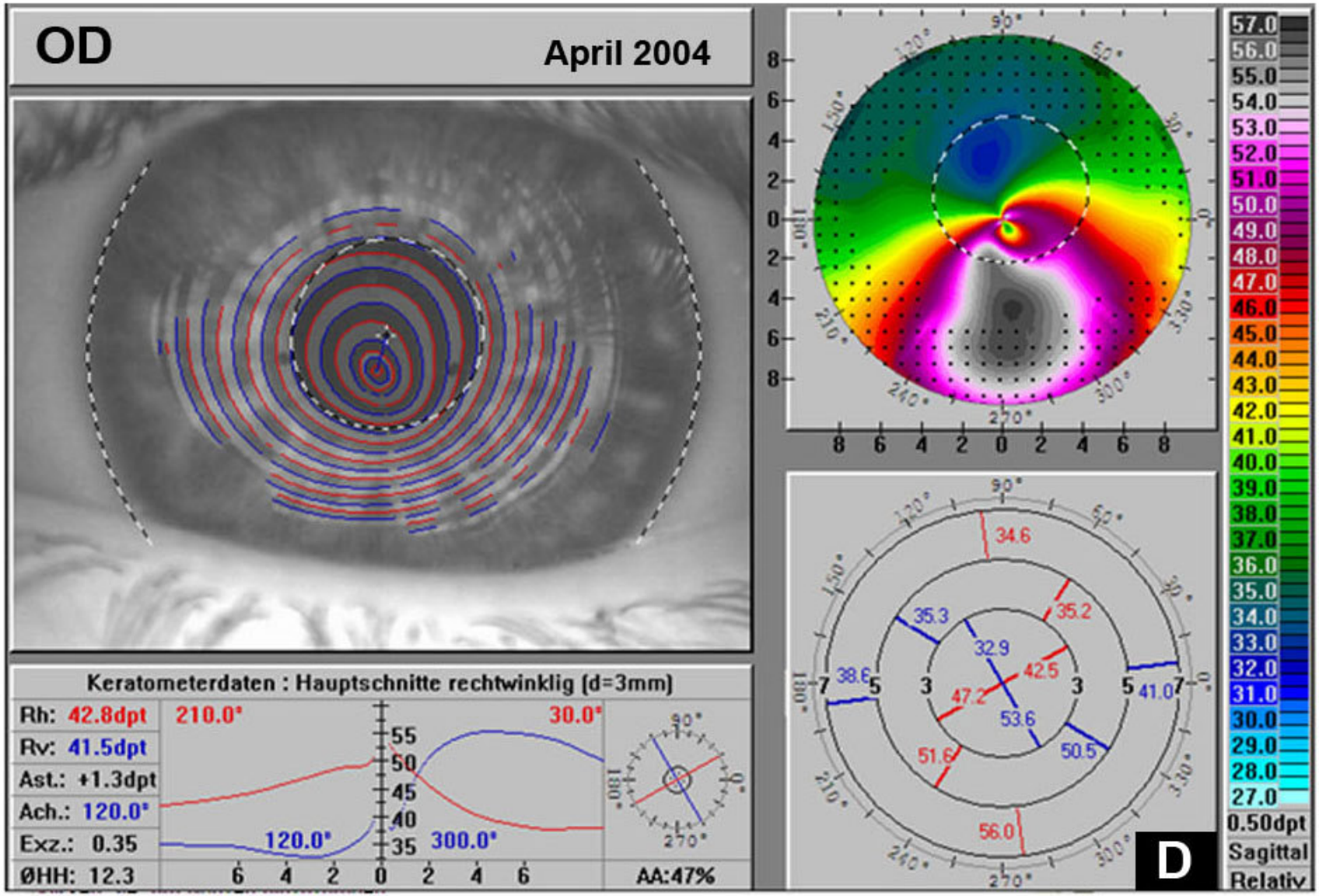
Iatrogenic keratectasia



Iatrogenic keratectasia



Iatrogenic keratectasia



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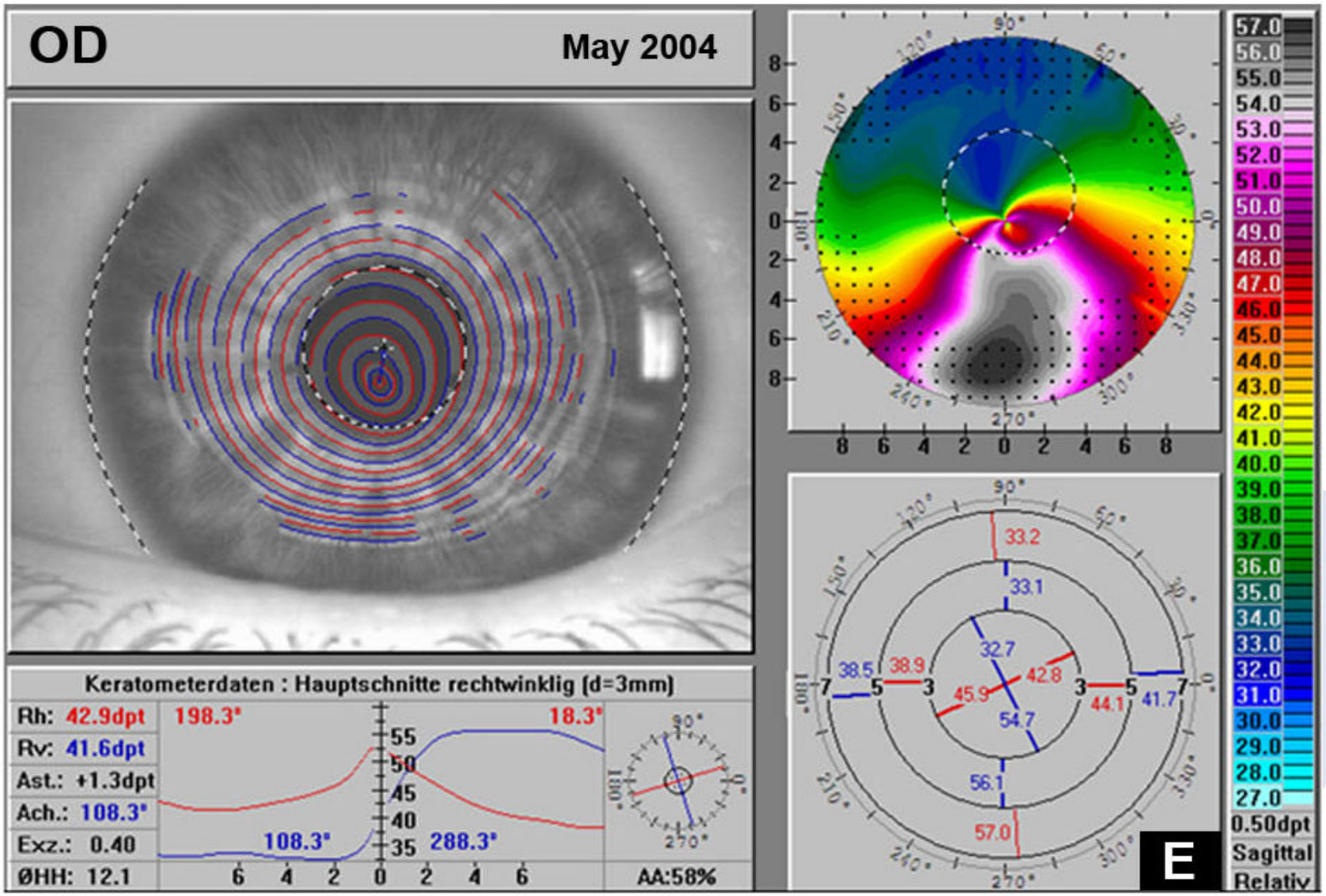

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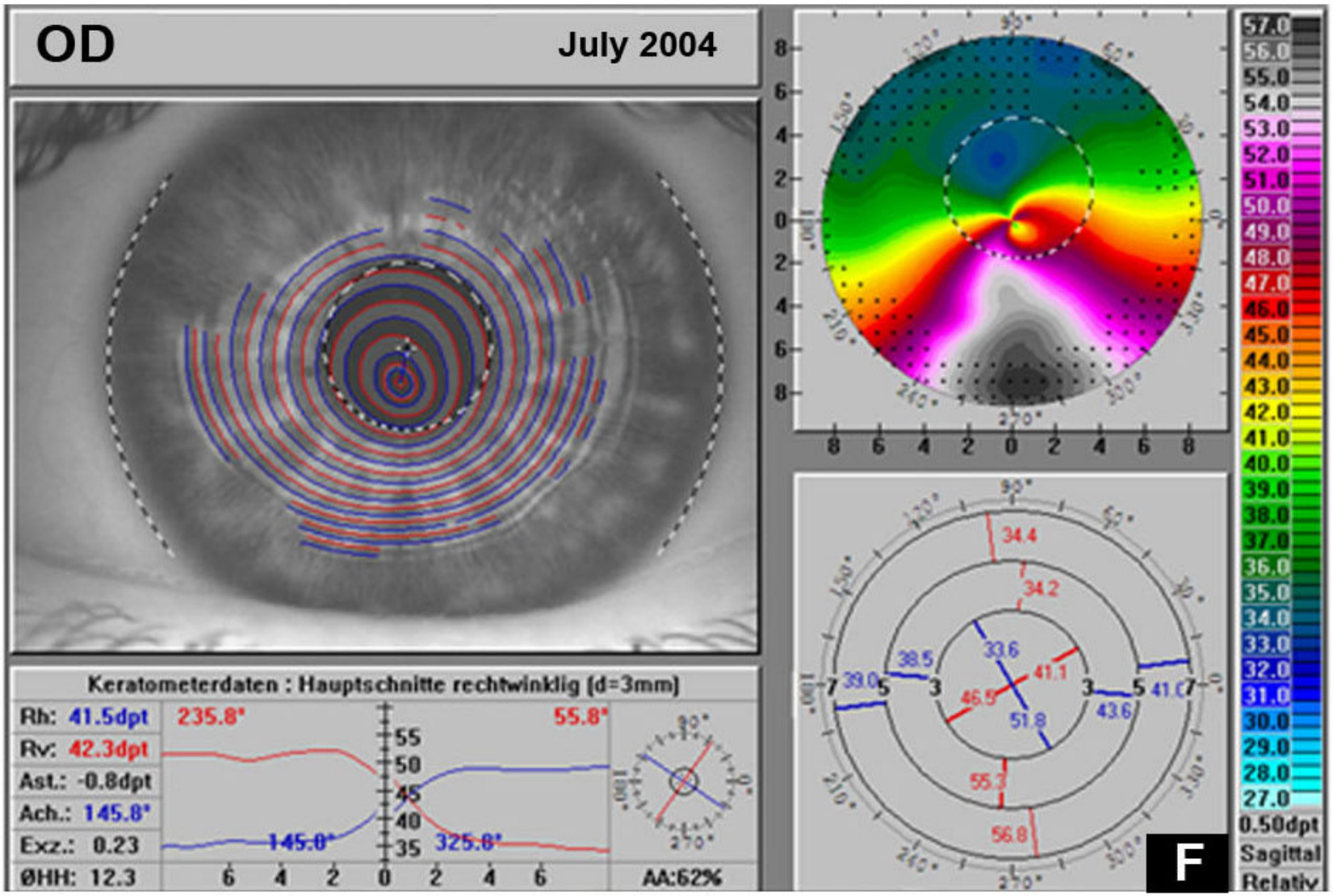
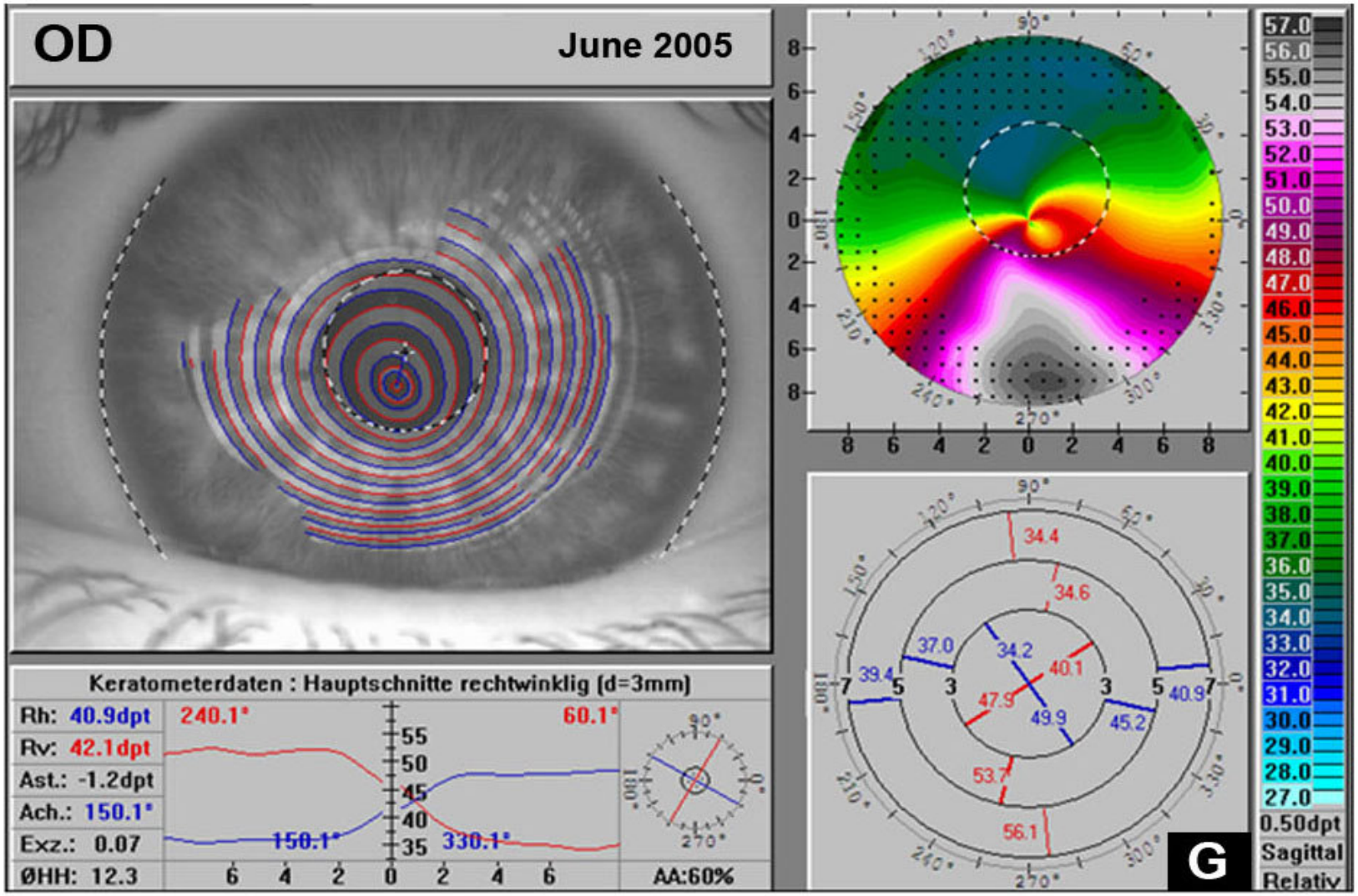
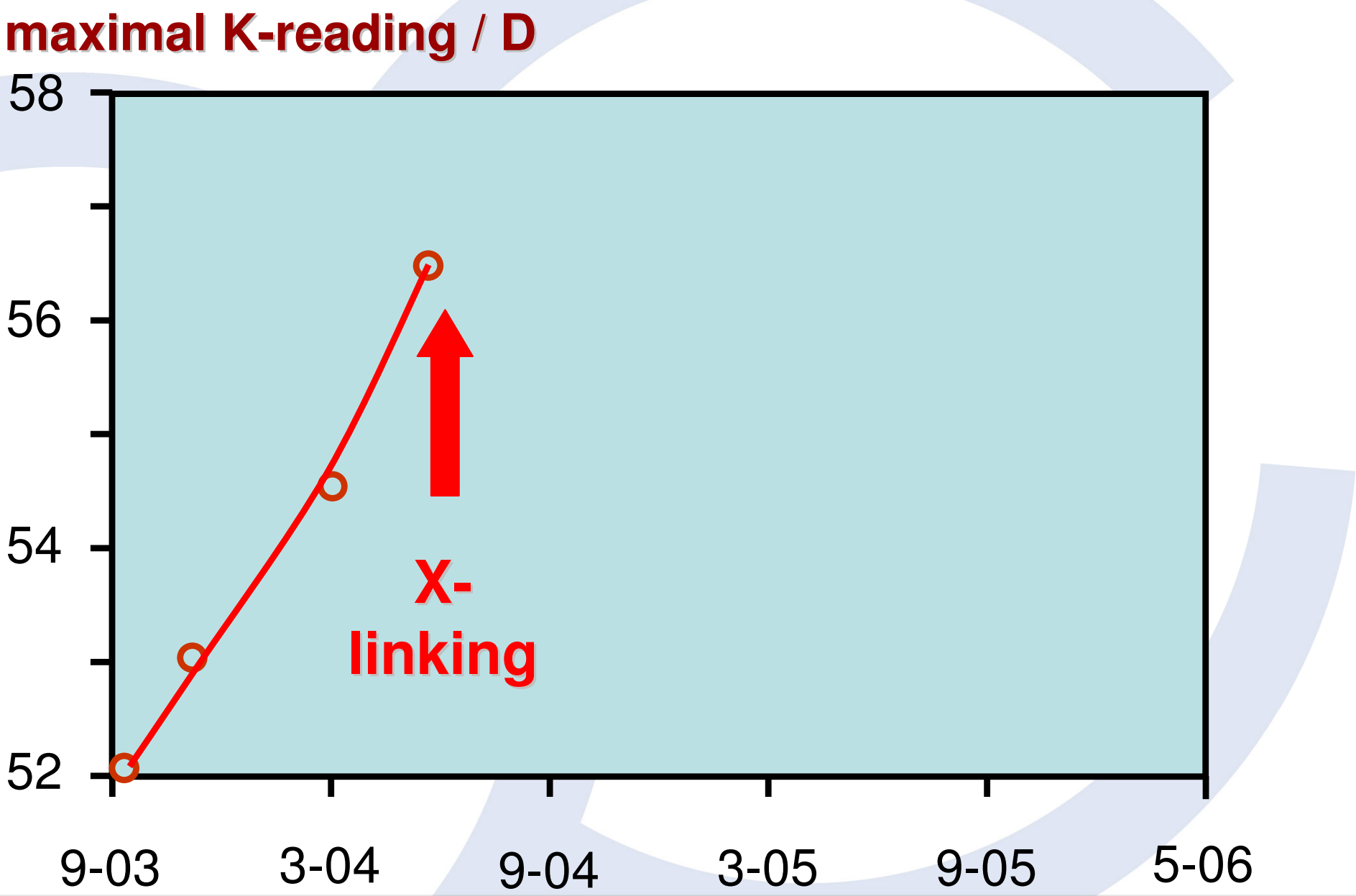


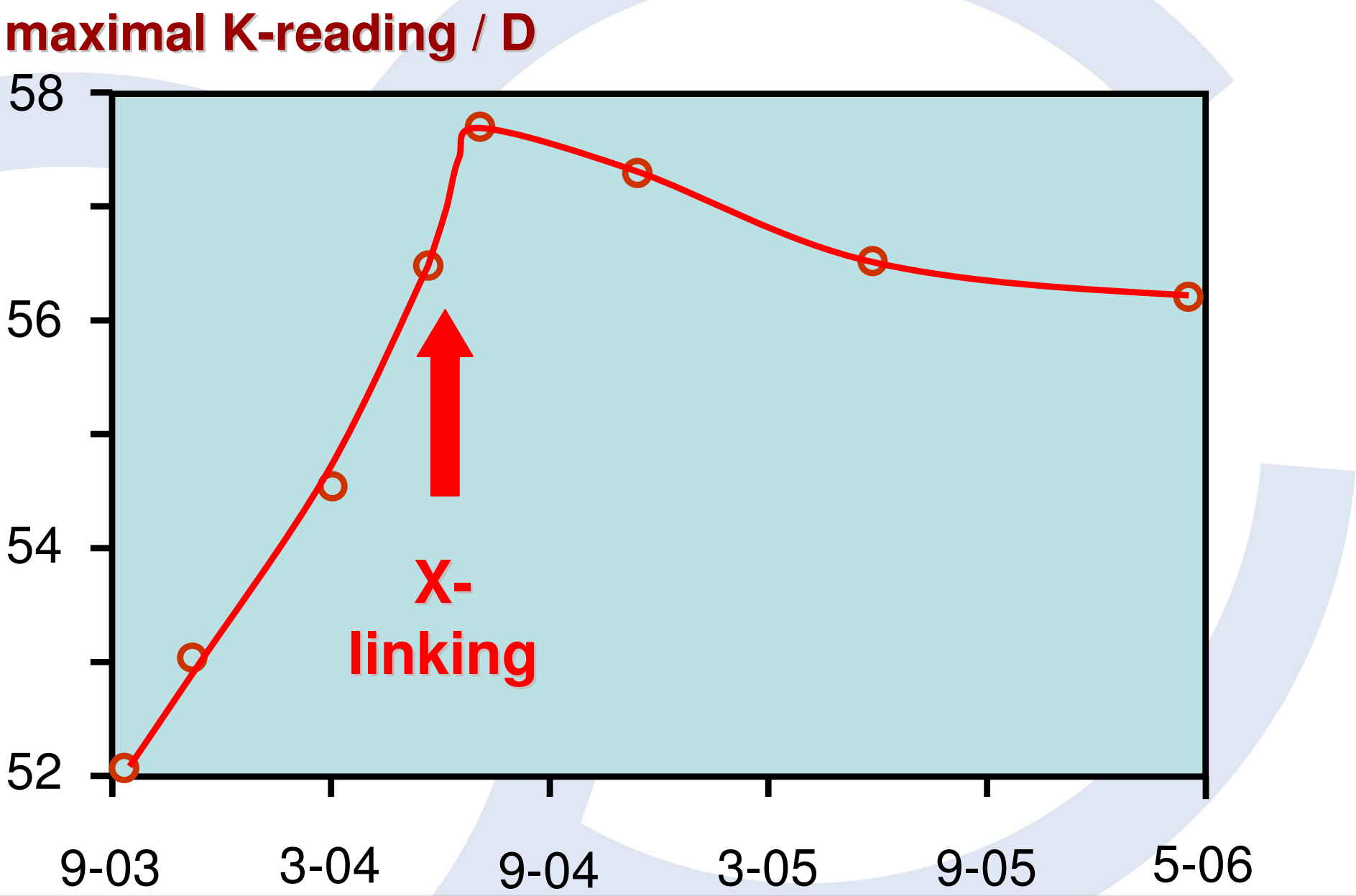
Iatrogenic keratectasia



X-linking in Iatrogenic keratectasia - CASE 1



X-linking in Iatrogenic keratectasia - CASE 1

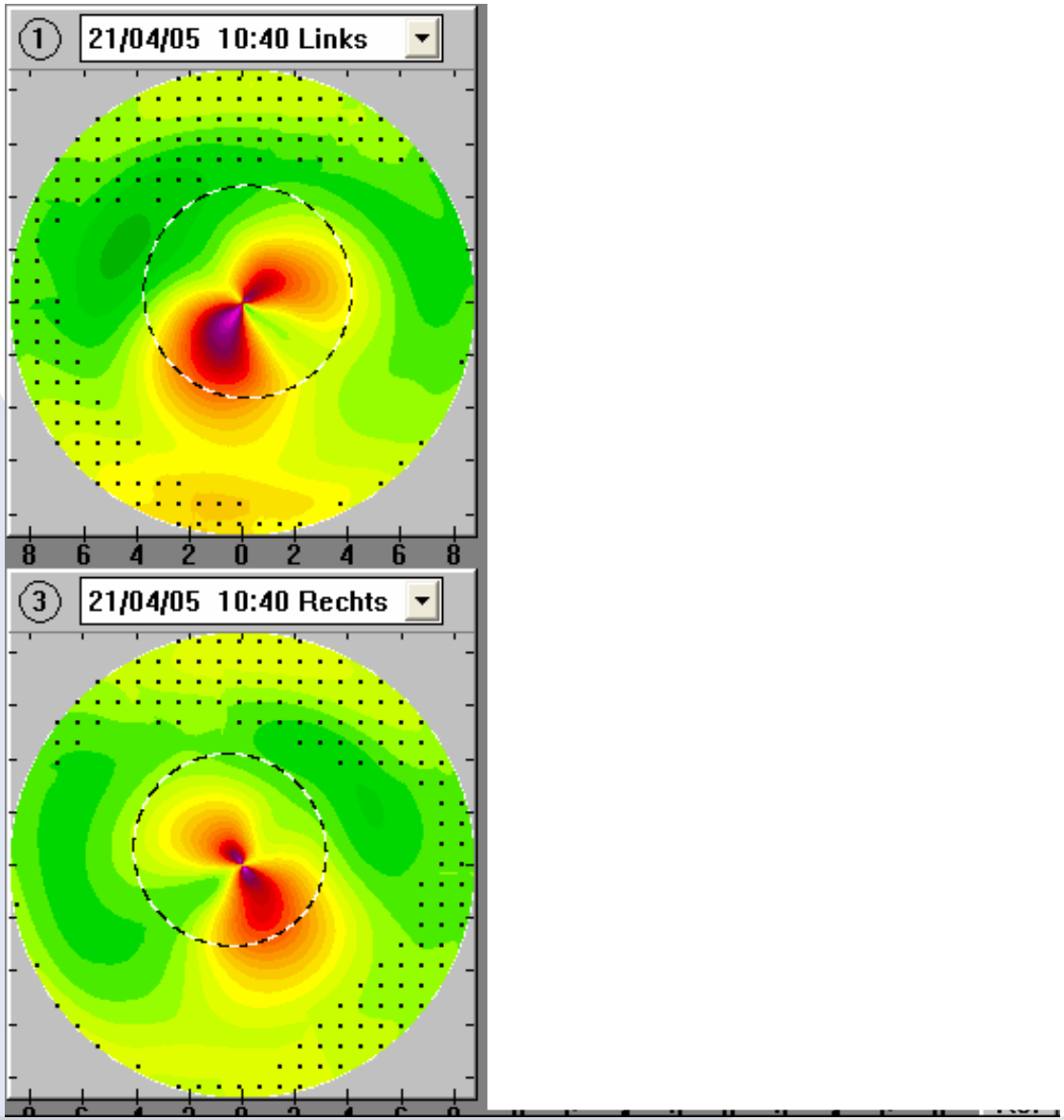


X-linking in Iatrogenic keratectasia - CASE 2

LASIK for -4.0 D

Preop pachymetry 500µm, no signs of FFKC

Bilateral iatrog. keratectasia starting 12 months after surgery



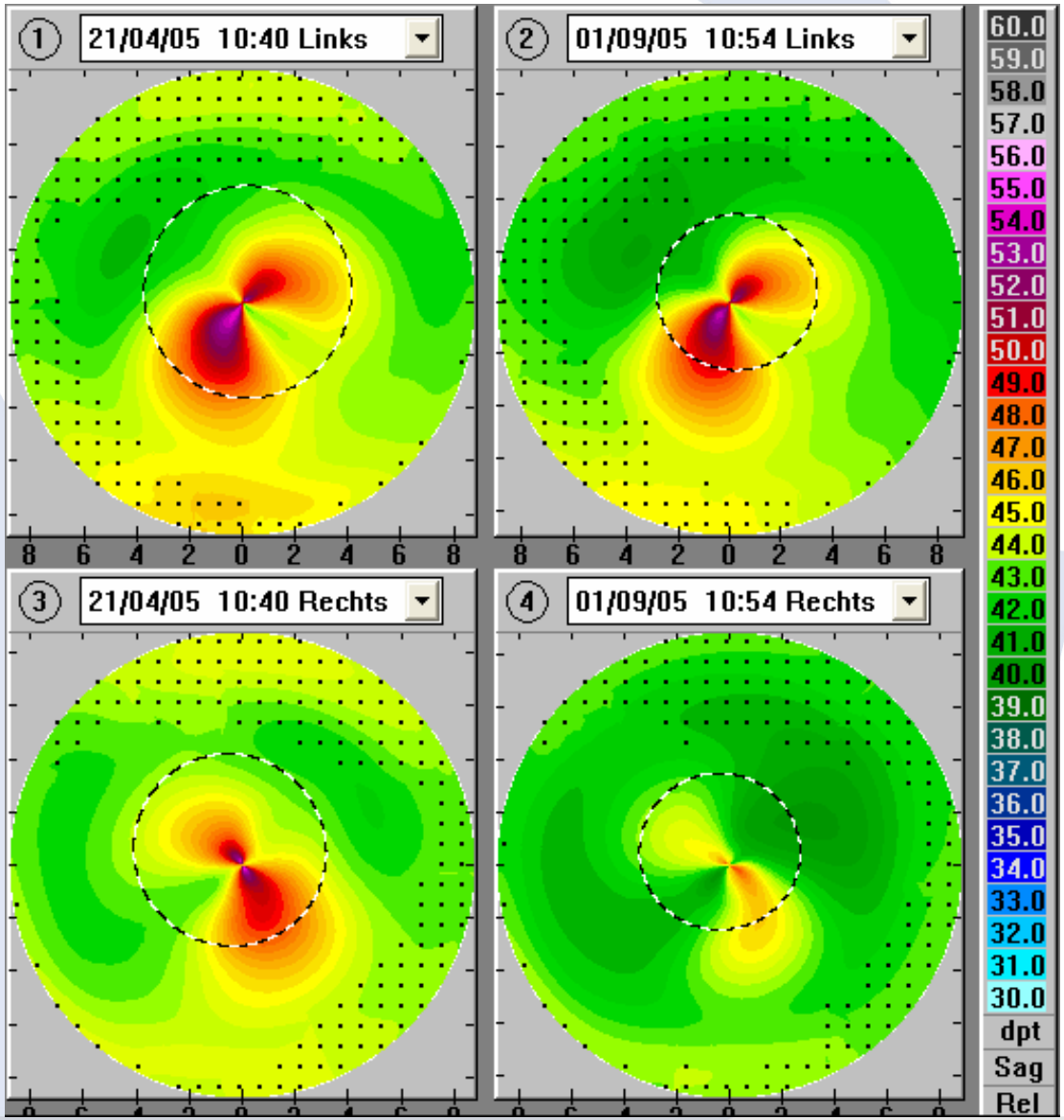
X-linking in Iatrogenic keratectasia - CASE 2

LASIK for -4.0 D

Preop pachymetry 500µm, no signs of FFKC

Bilateral iatrog. keratectasia starting 12 months after surgery

6 mo after X-linking

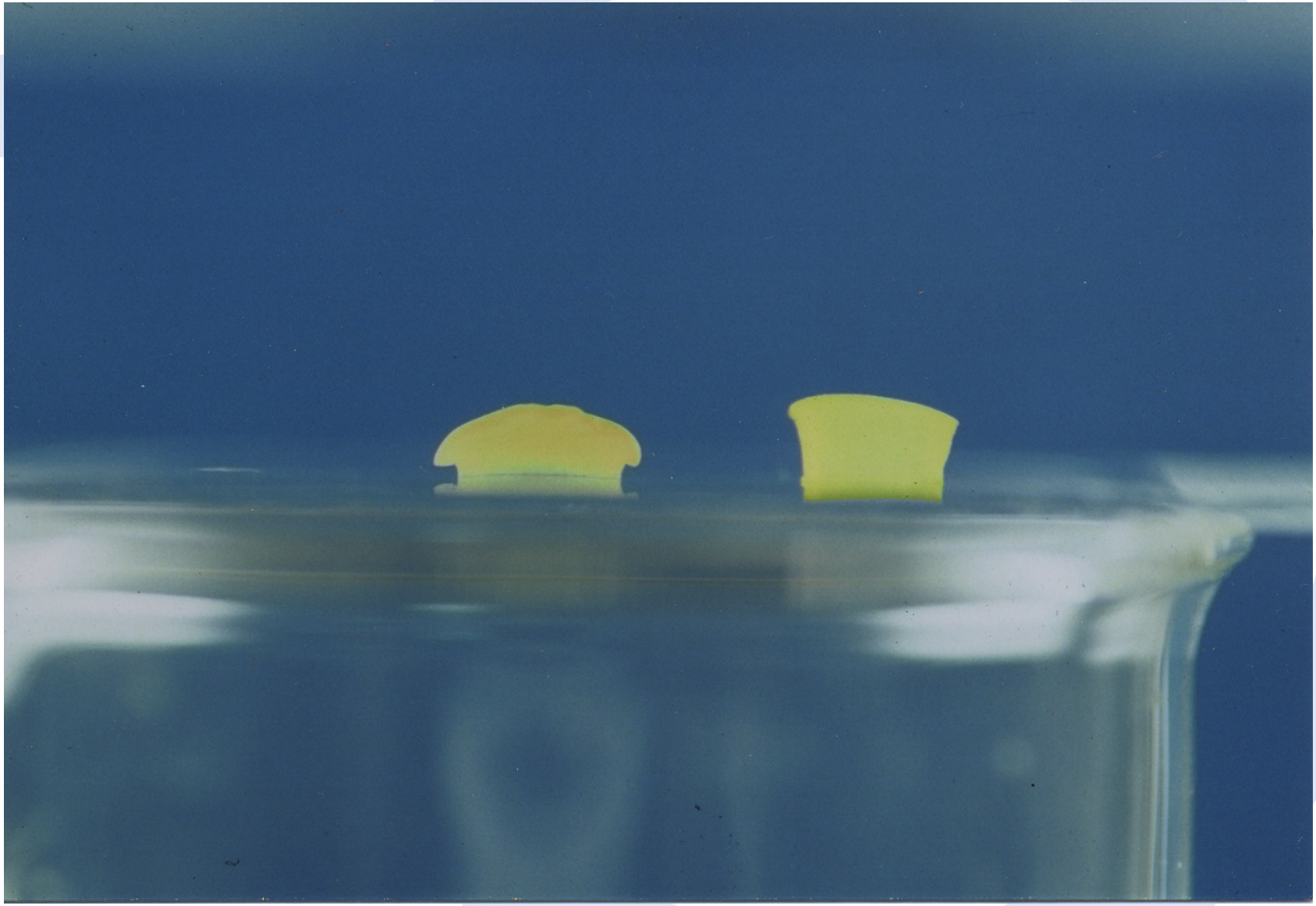


Conclusions

- In cases of iatrogenic keratectasia after LASIK X-linking is effective. The keratectasia can significantly reverse (n= 13).
- X-linking might be of particular interest for the management of complications after refractive laser surgery.

X-linking in corneal melting processes

X-linking biochemical effect



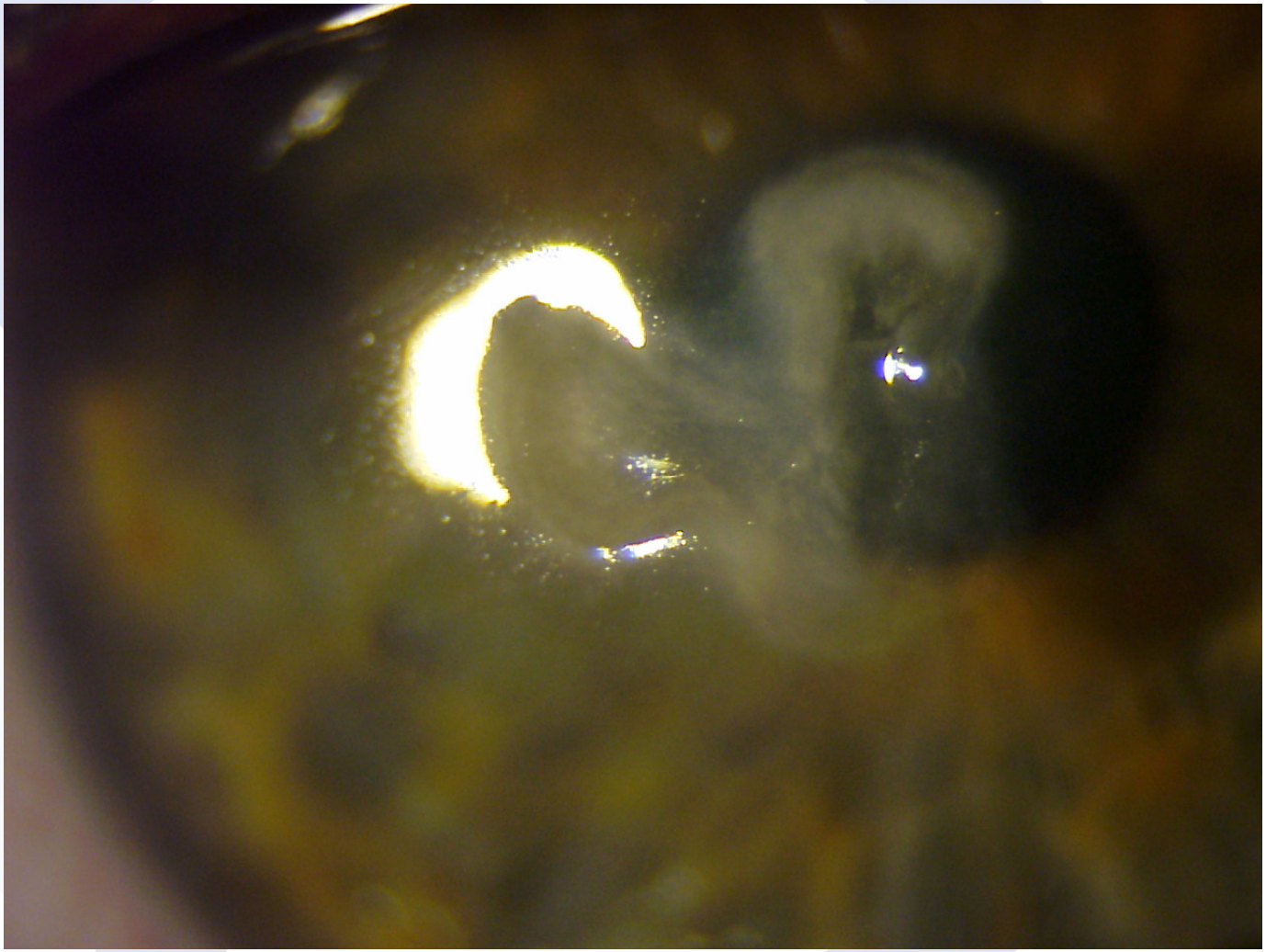
Acute corneal melting

5 months after LASIK with DLK+4

Interface floating twice, antibiogram negative

Maximal antibiotic, antifungal, and steroid therapy

EDTA-therapy ineffective



X-linking in acute corneal melting

5 days after X-linking

standard antibiotic-steroid therapy

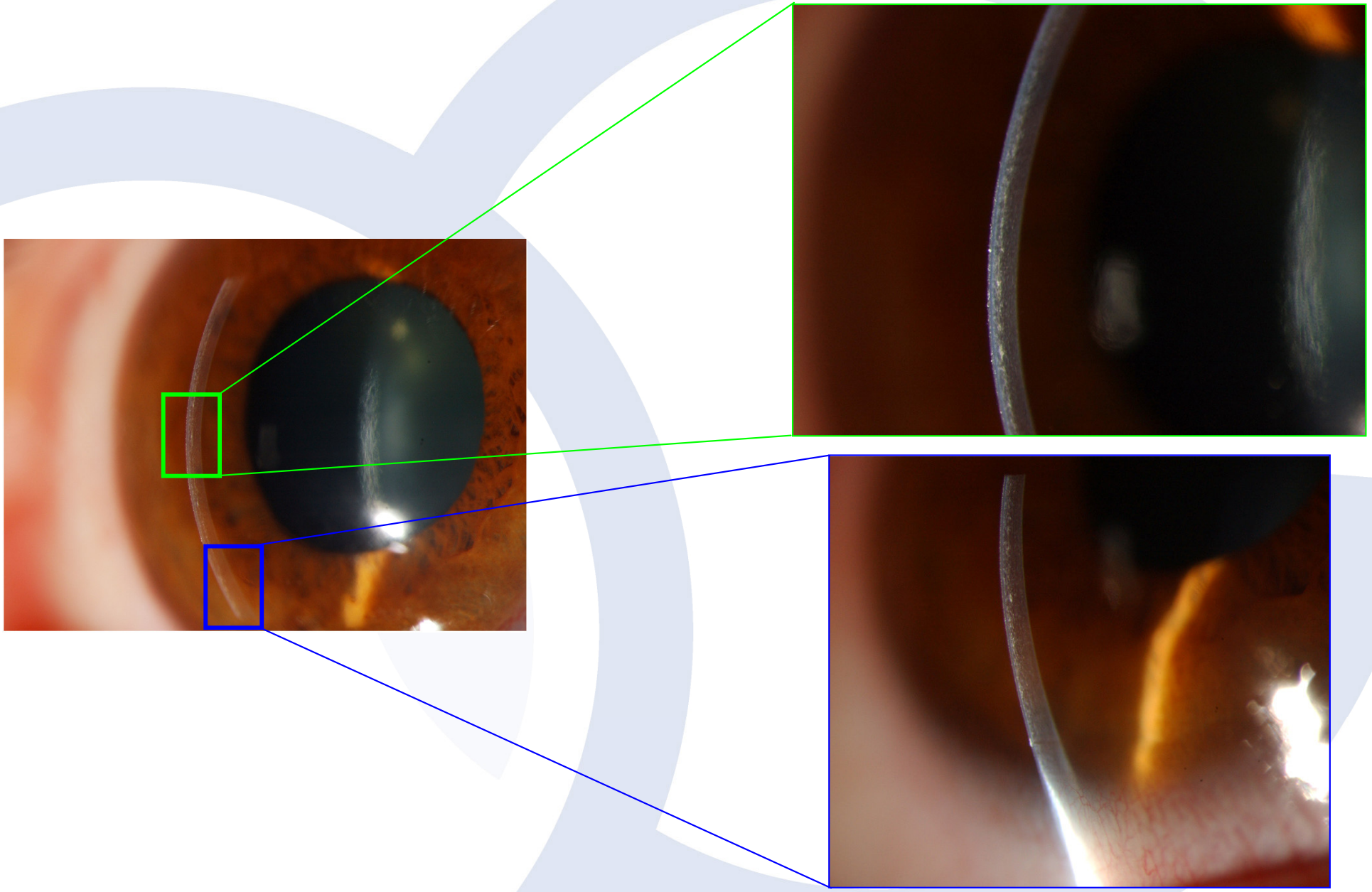
3 months later deep lamellar keratoplasty

Stromal demarcation line

Corneal demarcation line after X-linking

- X-linking in 16 cases of progressive keratoconus
- Stromal demarcation line was identified in slit lamp examination
- Use a thin slit and high illumination levels.
- The line becomes visible as early as at 2 weeks after treatment and disappears at approximately 6 months after the procedure.

Corneal demarcation line after X-linking



Conclusions

- Direct clinical sign to detect the effect of X-linking in the cornea

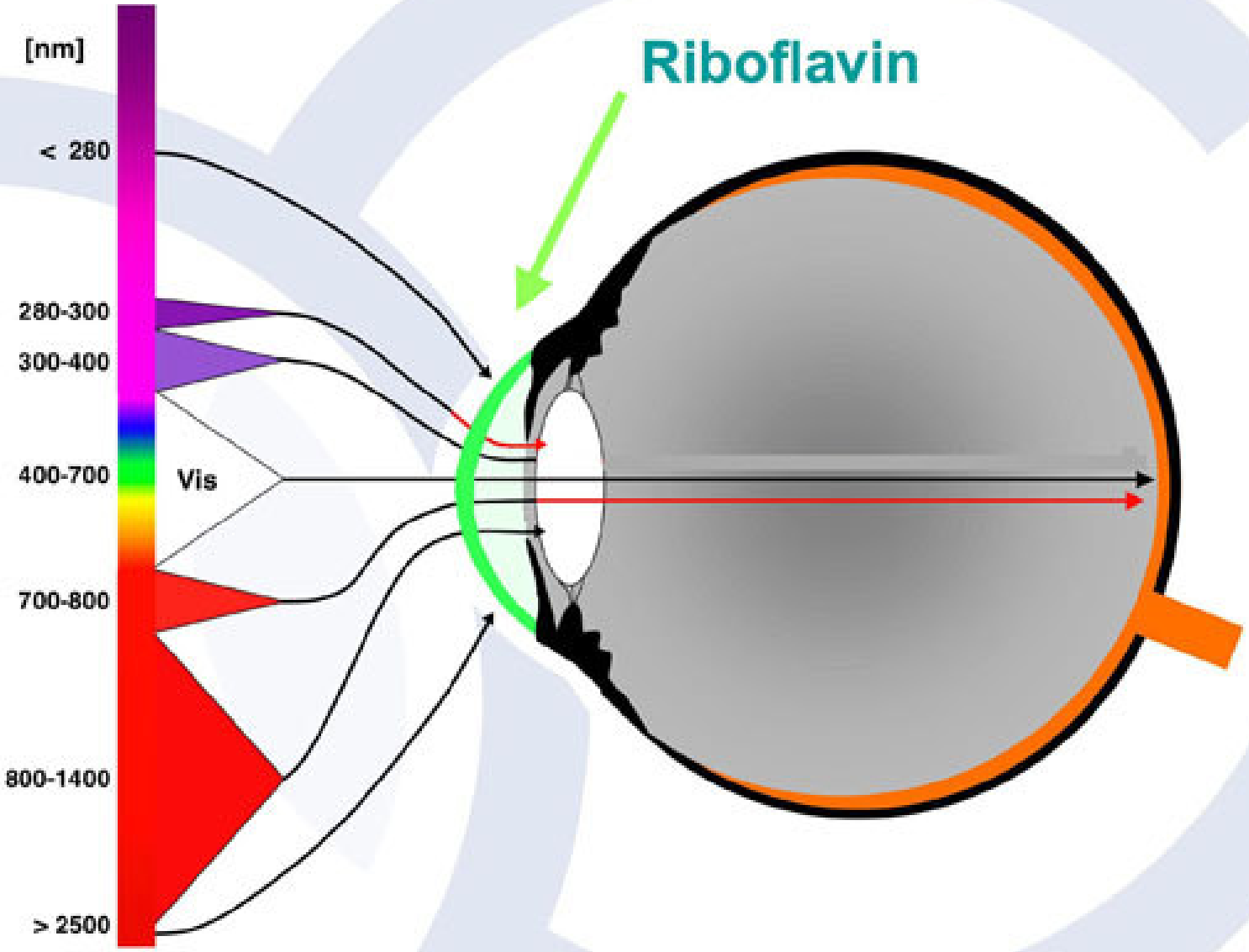
- Simple and effective clinical tool to easily monitor the effective depth of X-linking treatment.

X-linking

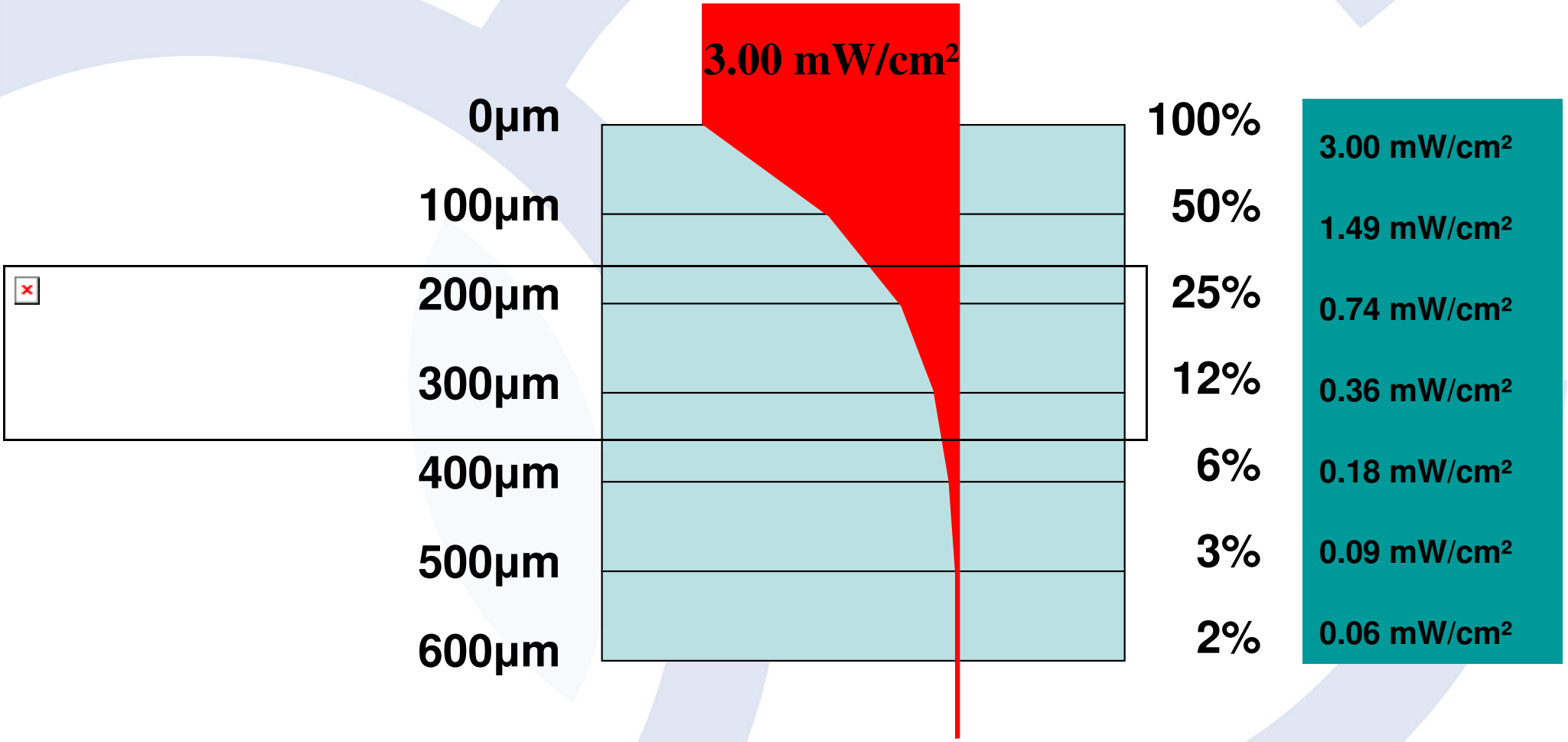
in thin corneas

Absorption and transmission of the human eye

Riboflavin shielding



Riboflavin shielding

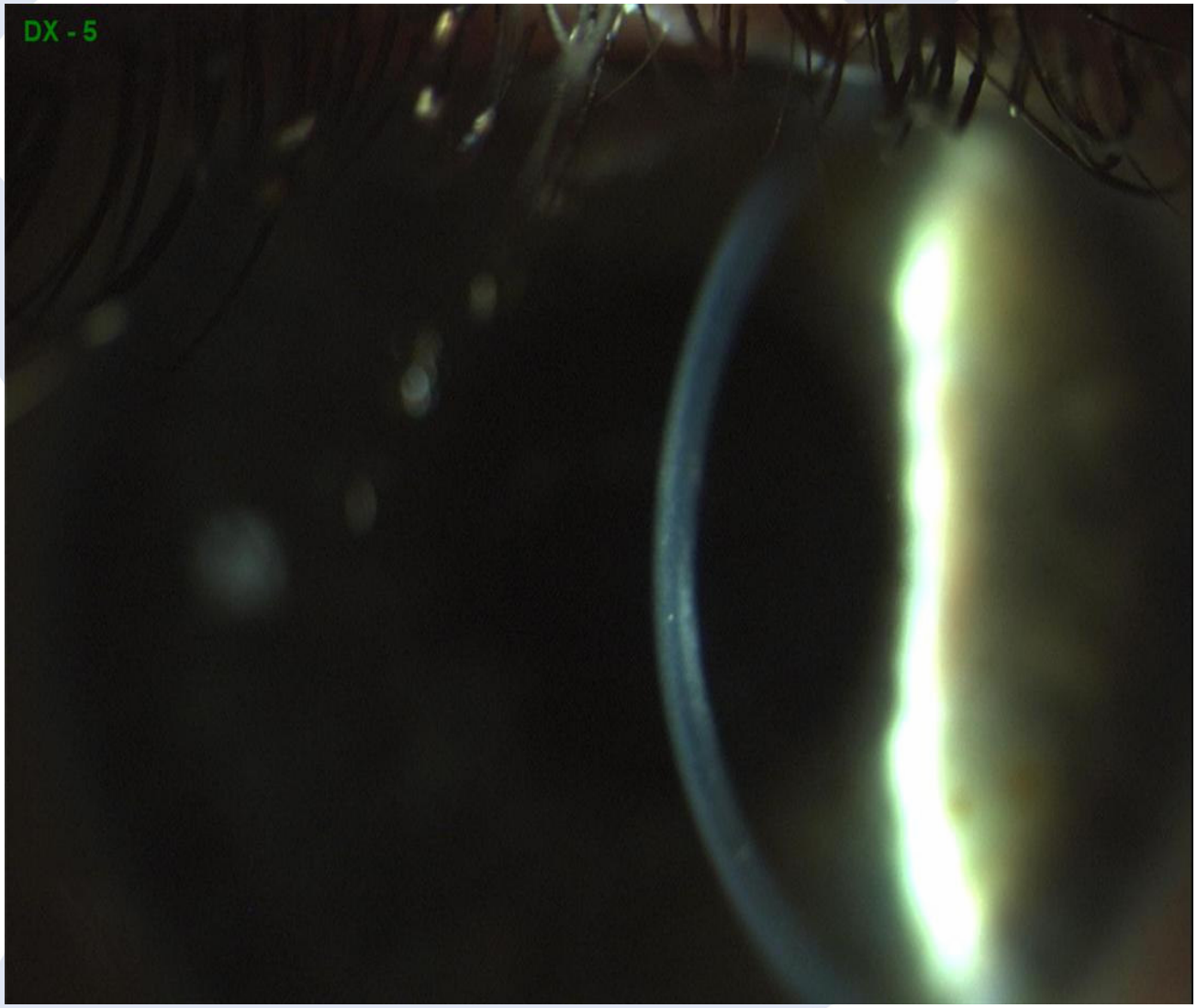


Beware of too thin corneas

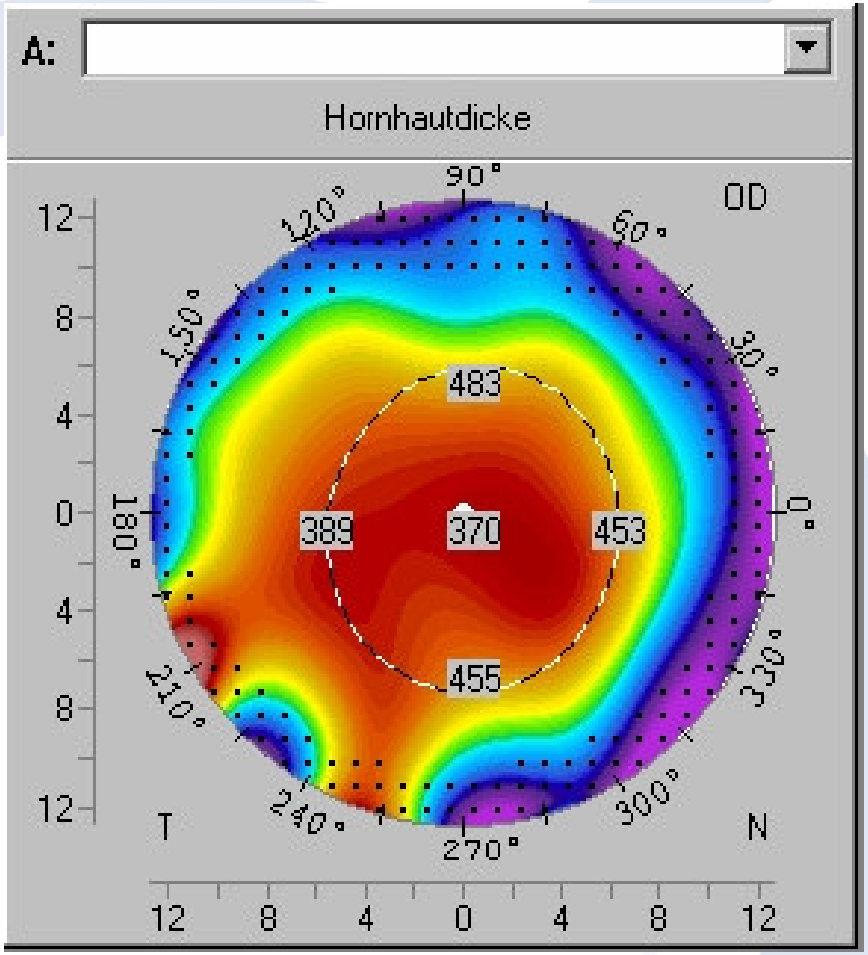
First complication !

endothelial reaction

Pachymetry pre-X 372µm

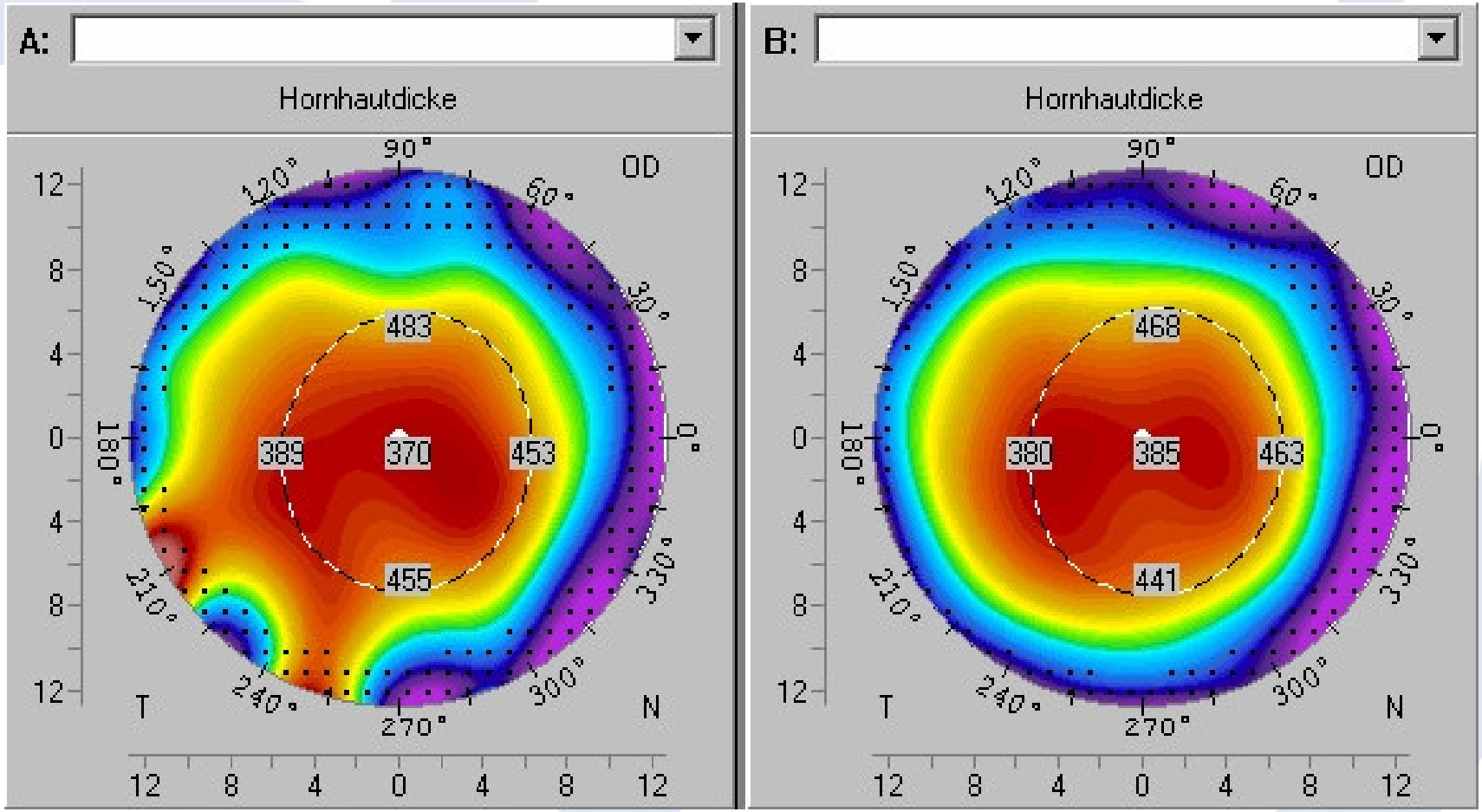


Low residual thickness

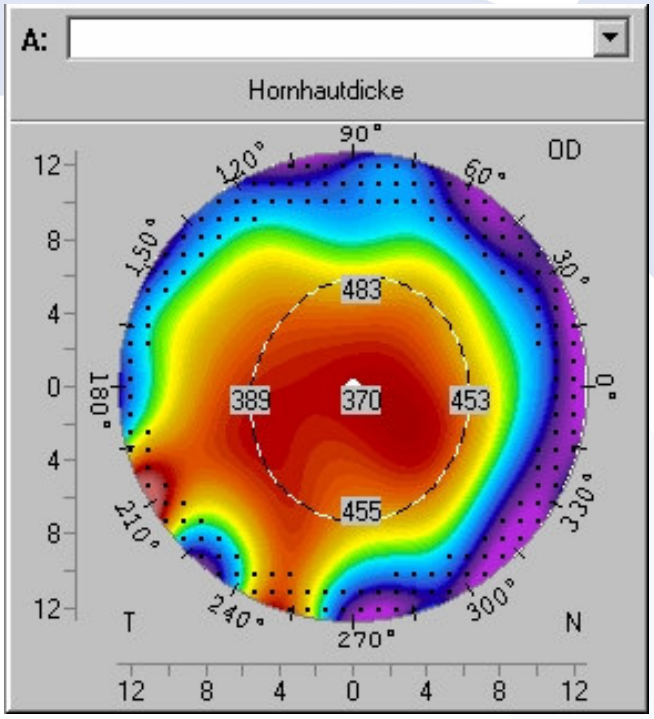


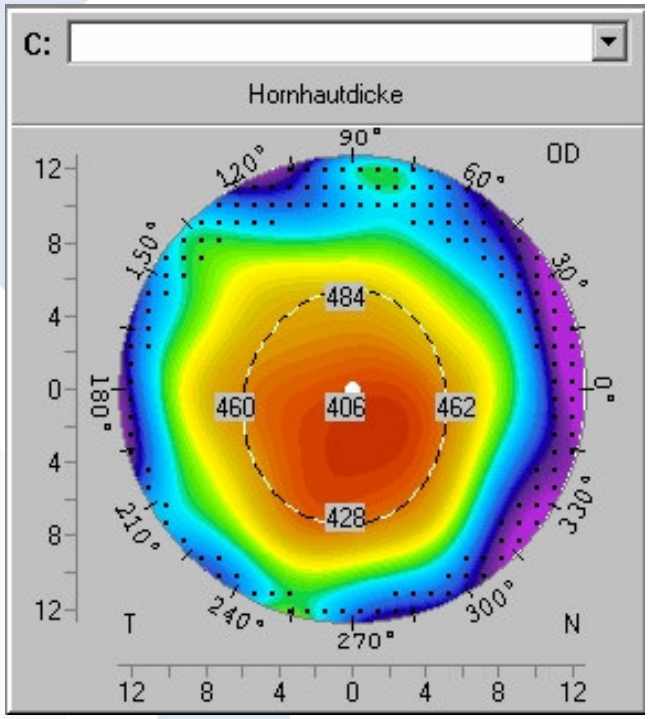
- **X-linking or not ?**

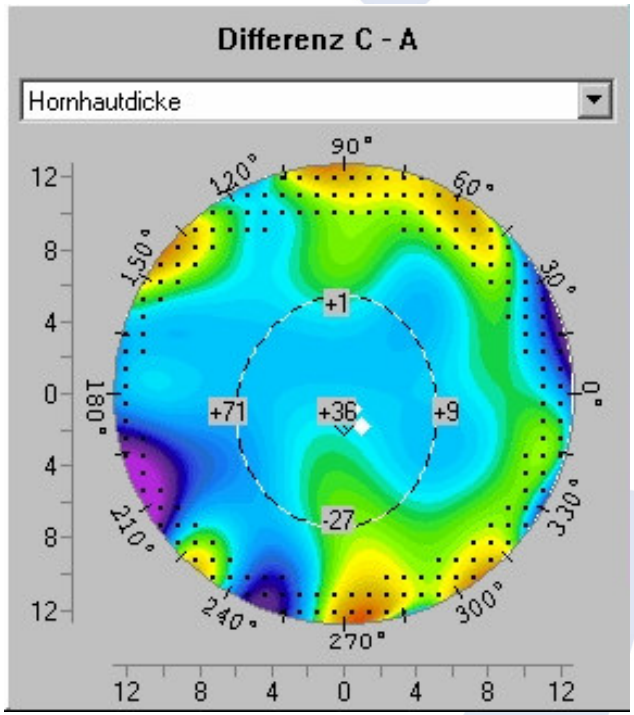
Riboflavin application - change in corneal thickness



Enforce swelling using ddH_2O







before after difference

Conclusions

Pearl 1

- Iatrogenic keratectasia after LASIK as well as corneal melting processes can be treated by X-linking.

Pearl 2

- A stromal demarcation line can be identified at 2 weeks after X-linking.

Pearl 3

- Preoperative stromal swelling enables treatment of thin corneas.

Potential future applications

X-linking in KC and subsequent topo-guided PRK

- Goal is to further homogenize the cornea for better CL fitting
- Wait at least 36 months
- Weakened biomechanics ?

X-linking prior to keratoplasty in KC and PMCD

- Keratoconus and PMCD might affect the donor cornea several years after grafting

- Treat the recipients cornea by X-linking prior to grafting

X-linking and orthokeratology

- Changing the corneal shape and X-linking
- First cases treated by T. Seiler and S. El Hage in September 2006
- Results are ambiguous (6 eyes)

X-linking the sclera

- X-linking as a means to arrest progressive myopia ?

Thank you for your attention