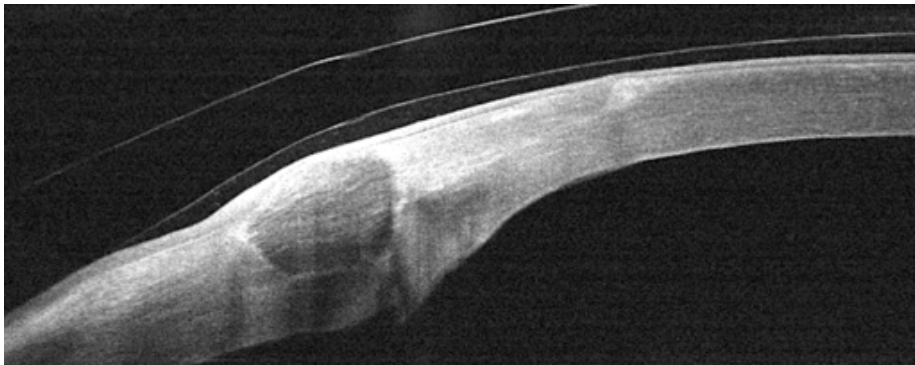


# **SCLERAL LENSES**

**POSSIBILITIES AND LIMITATIONS ON  
PATHOLOGICAL OCULAR SURFACES**



**Markus Ritzmann**

MSc. Optometry and Vision Science, FAAO, FSLS

# Markus Ritzmann

**linsen  
centrum**

- Manager of Optometry and Specialty Lens Clinic  
Linsencentrum GmbH
- @ RGP-lab Falco Linsen AG, Switzerland
- 85% of all fits are specialty lenses
  - 60% scleral lenses of these
  - 25% RGP's
  - 15% Ortho-K & Myopia Control

# Disclosures

- Employee and consultant of Falco Linsen AG, Switzerland
  - All cases were fitted with Falco scleral lenses at the specialty lens clinic Linsencentrum GmbH

# Equipment

## Need to have:

- Slitlamp with digital-photo, cobalt blue illumination and yellow filter
- Scleral lens Fitting Set

## Nice to have

- Topography
- OCT
- Eaglet Eye Surface Profiler or Pentacam with CSP-Tool

# **SCLERAL LENSES IN A PERFECT WORLD**

# Schematic scleral lens

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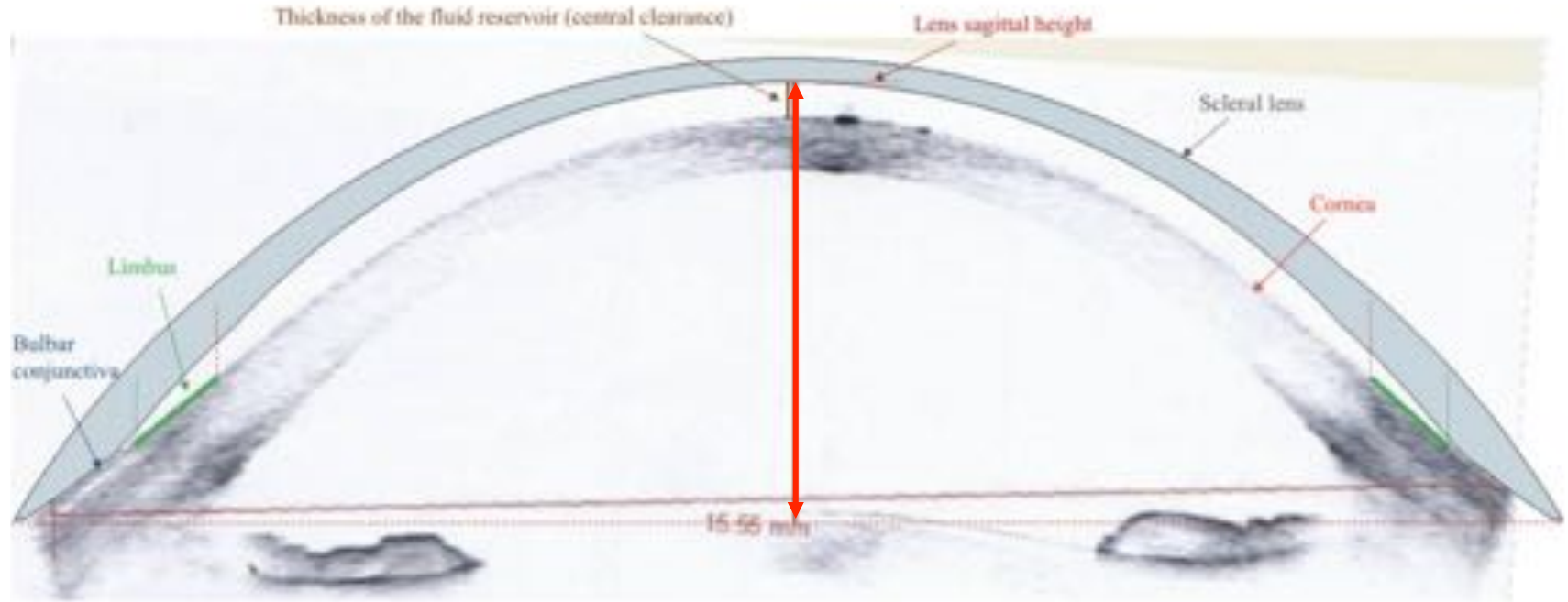


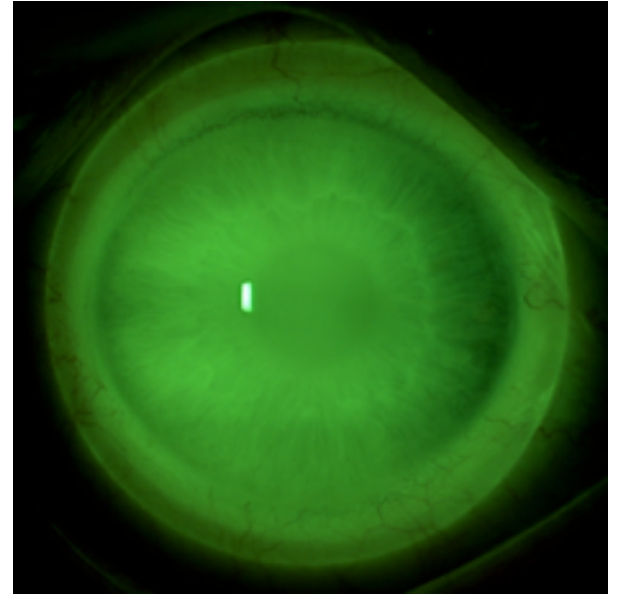
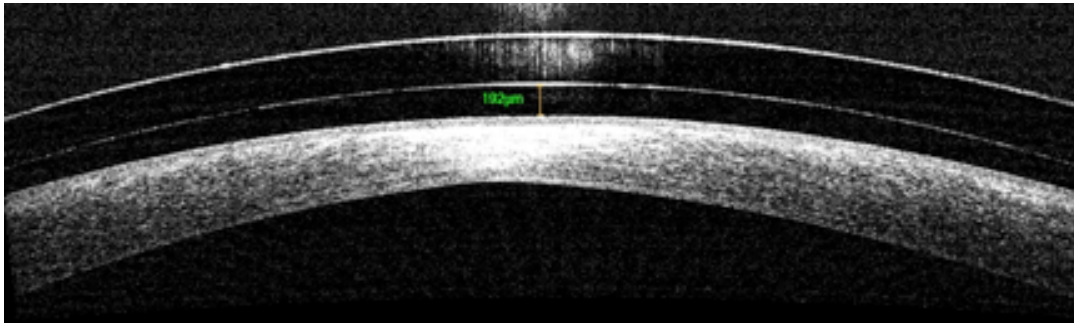
Abb: Clinical Guide for Scleral Lens Success Melissa Barnett, Daddi Fadel

# Fitting Guide

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## central:

- 150-250 $\mu$ m clearance
  - The larger the clearance
    - The less Oxygen to the Cornea
    - The worse VA usually gets



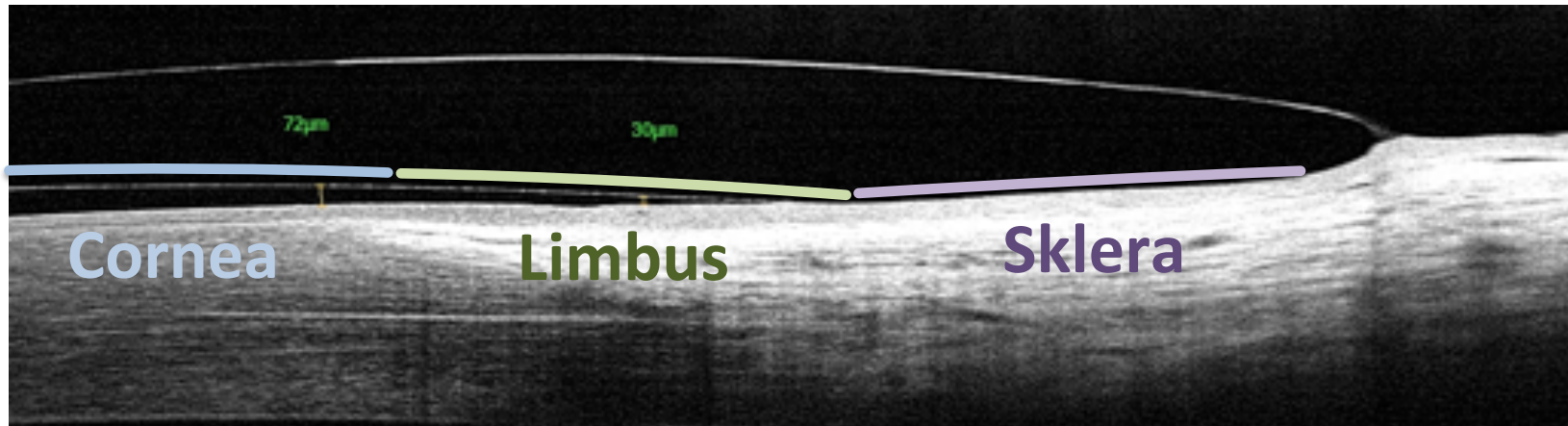
# Fitting Guide

## Limbal Zone:

- 10-40 $\mu$ m clearance, parallel to the limbus (no touch at the limbus)
- No conjunctival folds and edema

## Scleral Zone:

- Circumferential parallel rest on the Sclera
- NO Blanching, no Imprints
- torische Scleral zone where needed





# Scleral Lenses in a „Perfect World“

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- No "midday fogging" of tear reservoir
- Perfect surface wetting
- No staining of cornea and conjunctiva after removal
- No imprints on the cornea and conjunctiva
- No redness, no rebound after removal

Do we really live in  
a perfect world?!

# Scleral Lenses in a „Imperfect World“! **linsen centrum**

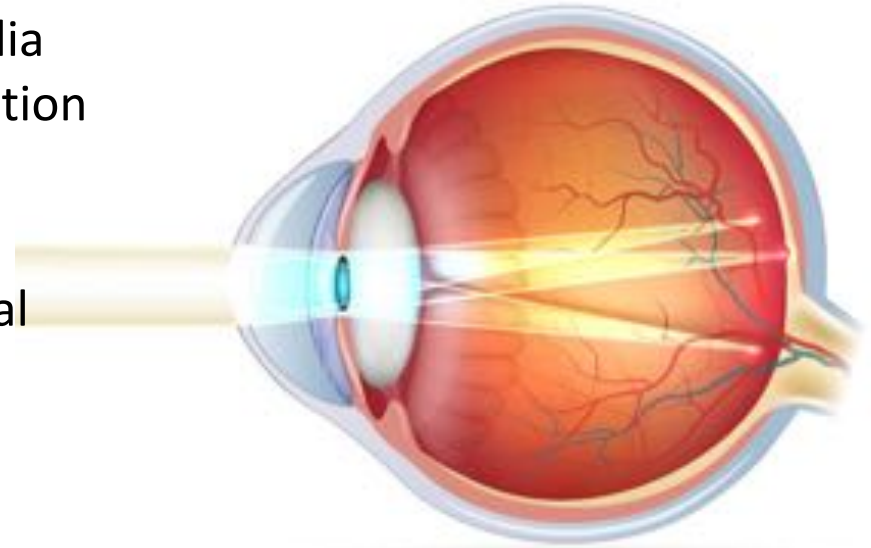
- The more complex the Cornea situation, the further away you usually get from the desired lens fit
  - Nevertheless the "ideal lens fit" has to be achieved
  - What compromises are tolerable?
    - No recipe available
    - Tight follow-up intervals

# **VISUAL REHABILITATION**

# «Remember the optics!»

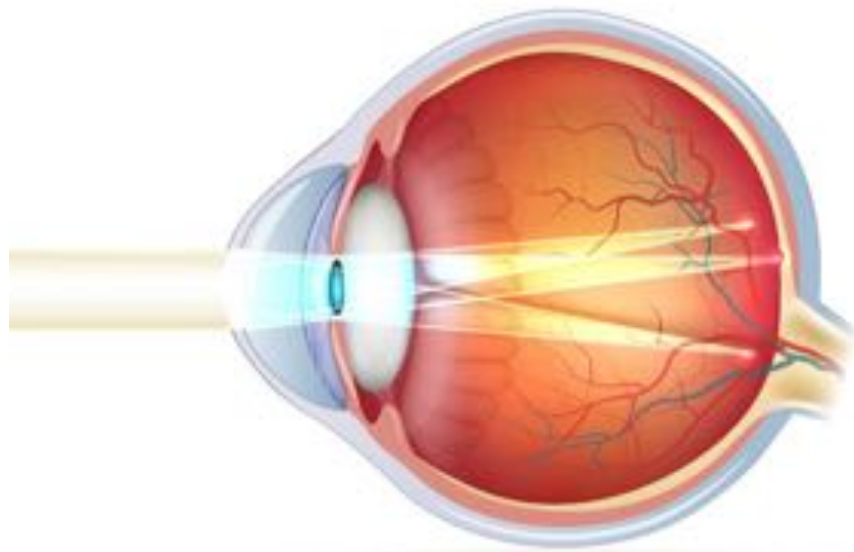
Cornea is the first refracting membrane on the eye

- Light refracts from oxygen to media  
→ ca. 66% of the total light refraction happens on the cornea (tearfilm)
- Every irregularity of the Cornea influences the quality of the retinal image



# «Remember the optics!»

**These irregularities only can  
be non-invasive corrected  
with scleral lenses or RGP  
lenses!**



# SCL for pathological cornea changes

## Indications for scleral lenses

- Visual rehabilitation of irregular astigmatism
  - Keratoconus, PMD
  - Keratoplasty
  - Post-Lasik with complications & radial keratotomy
  - Scars after trauma and infection
- Expositions keratitis, severe dry eye conditions
- Cosmetic indications
  - Iris defects
  - Partial or full occlusion

# SCL for pathological cornea changes

## Indications for scleral lenses

- Acceptance issues with RGP's comfort
- Normal eye with high refractive error
- High corneal astigmatism
- Sports
- Jobs with a dusty environment

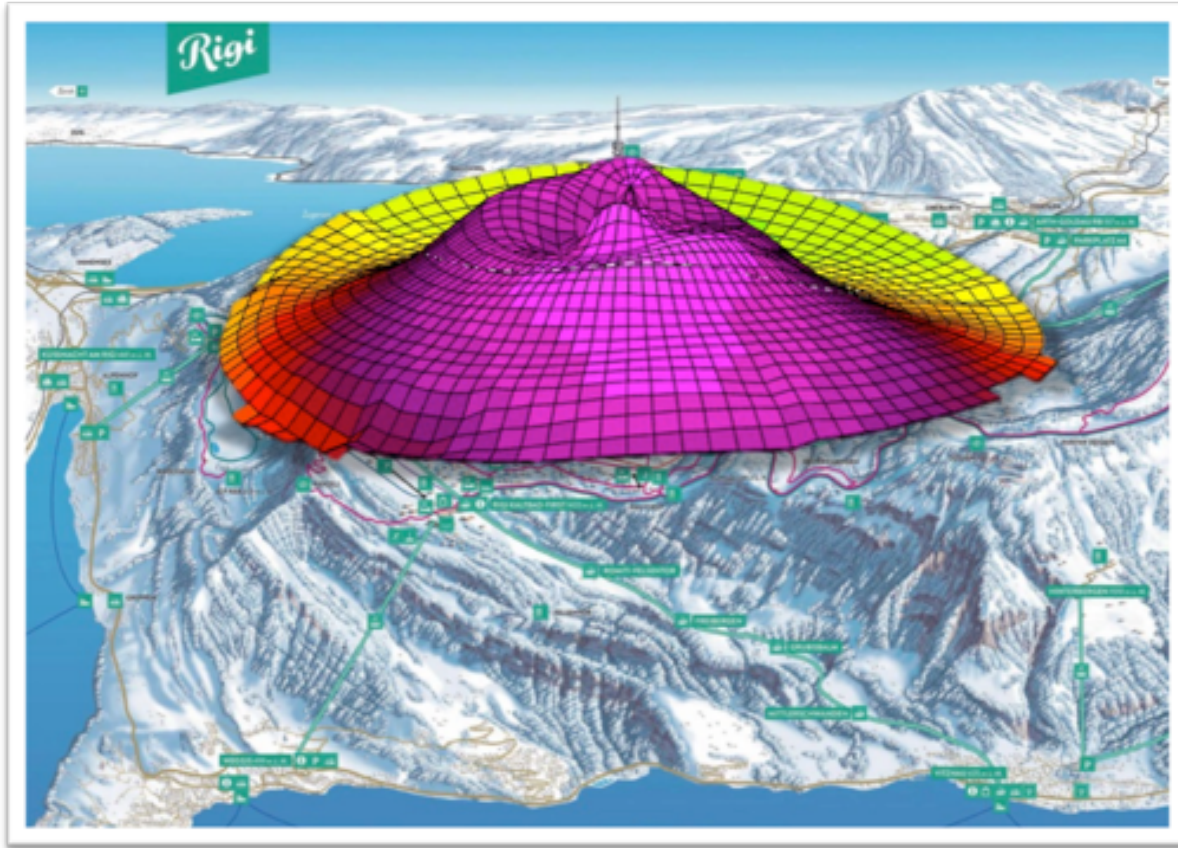
Irregular Astigmatism

# **SCLERAL LENSES IN PATHOLOGICAL CORNEA CHANGES PART I**



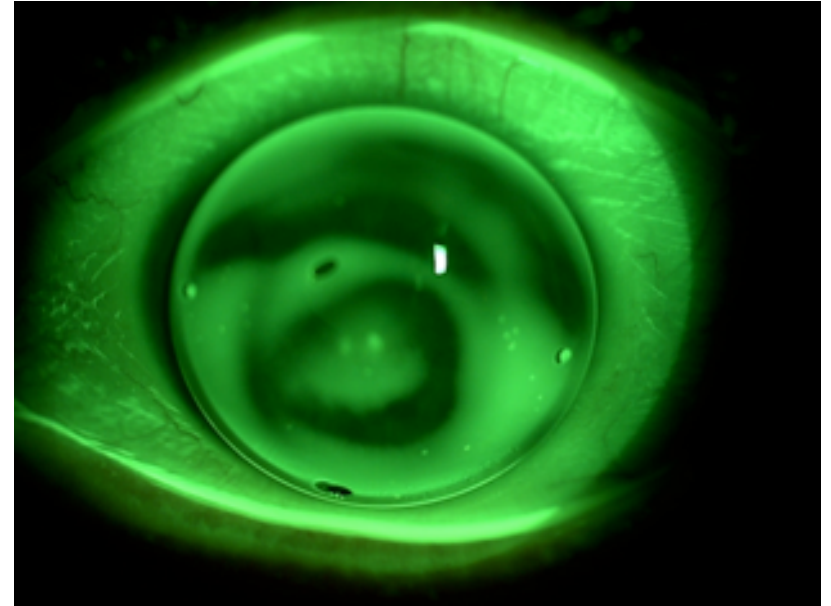
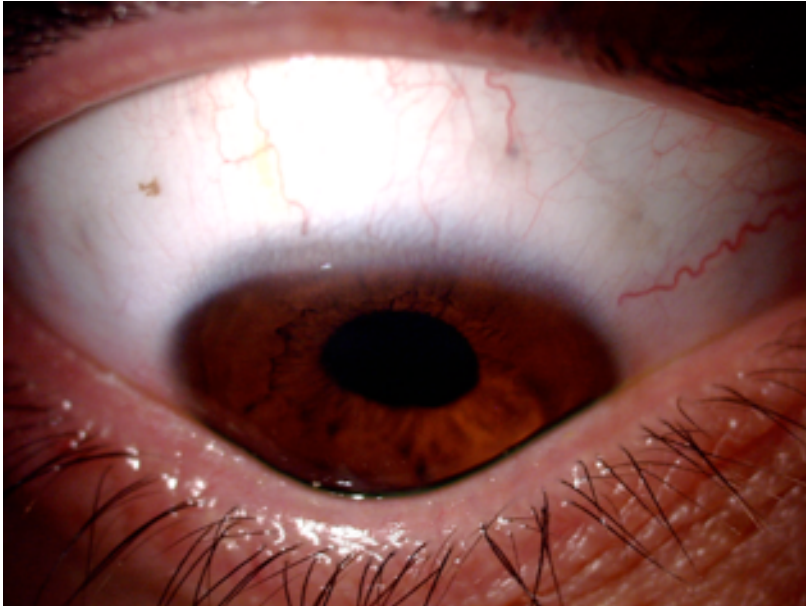
# The classic indication

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# Keratocone

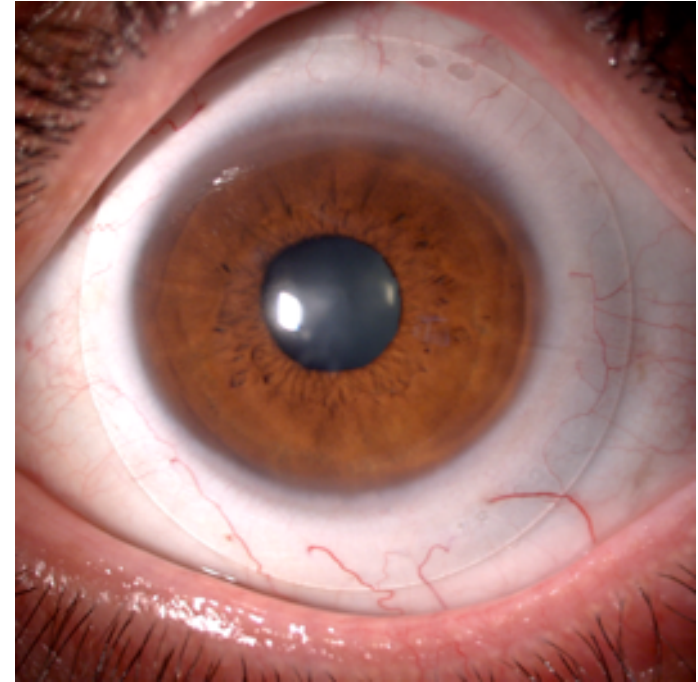
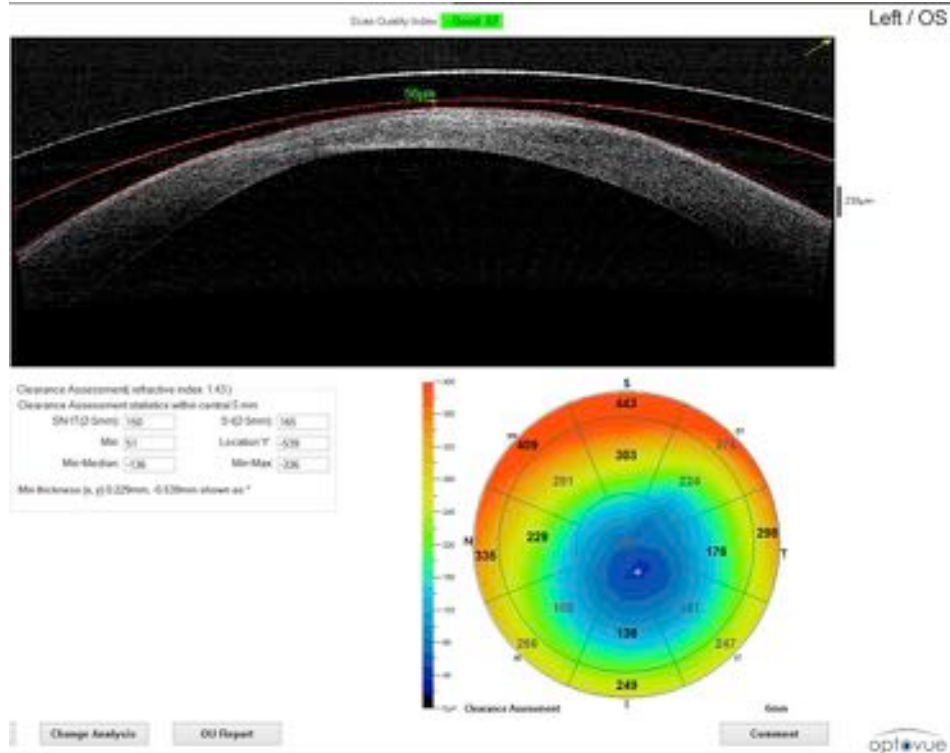
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centrum



Quadranten-spezifische Keratokonus Linse  
 $r_0$ : 5.40mm, x+50 $\mu$ m,  $\varnothing$  10.60mm

# Keratocone

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- Well suited medium to high-grade Keratoconus
  - Visus mostly better and especially more stable due to «static fit» vs. unstable optics of corneal RGP lenses
  - Beware with visus forecasts in mild Konus
    - Especially with high «posterior float» and relatively low anterior topography changes
    - In part better visus with soft lenses
- «cerebral» Keratoconus
  - Neural adaptation: New scleral lens optics partly not tolerated

- Post CXL lenses can be worn again 4-6 weeks
  - With Epi-ON even after 2-3 weeks post-surgery
- In progressive Keratocone (pre-operative):
  - Better monitoring and shorter CL-abstinence for measurements
  - Lenses do not need to be changed Post-CXL or only marginally, where corneal RGP lenses need to be adapted again and again

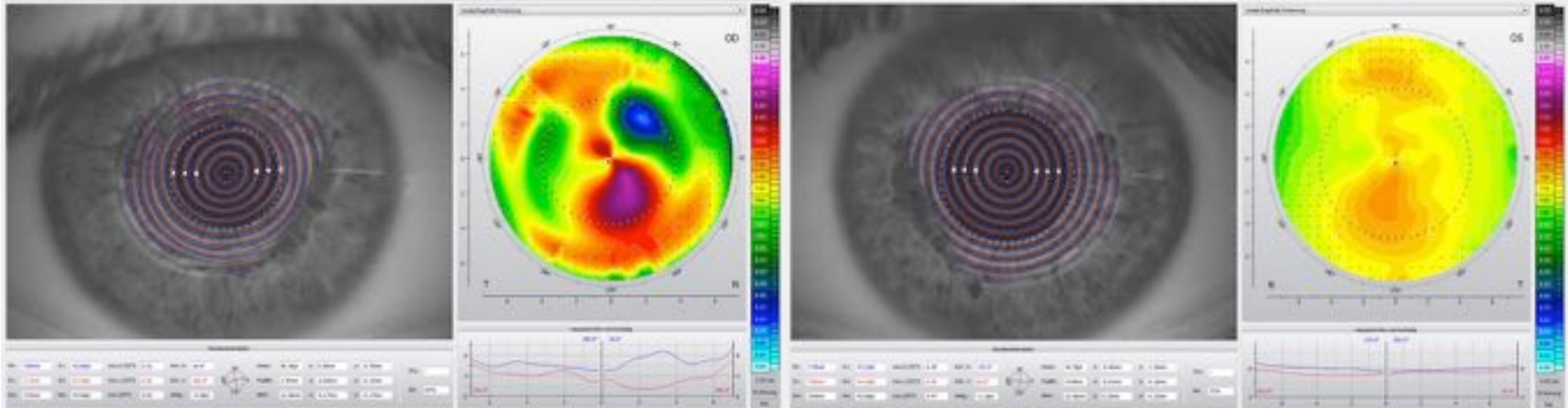
# **CASE # 2**

Unilateral Keratocone with ICRS (intra corneal ring segments)

# Case #2 Keratoconus

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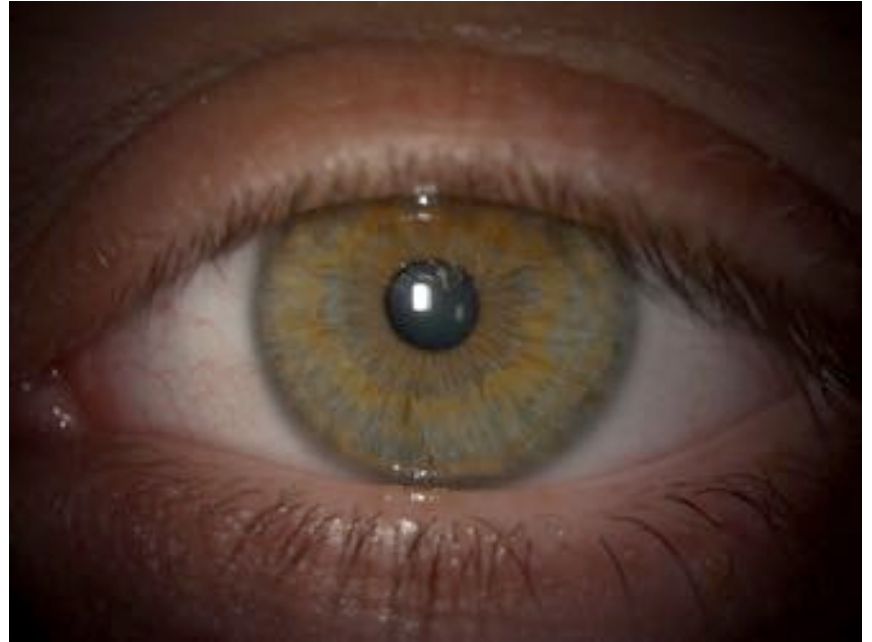
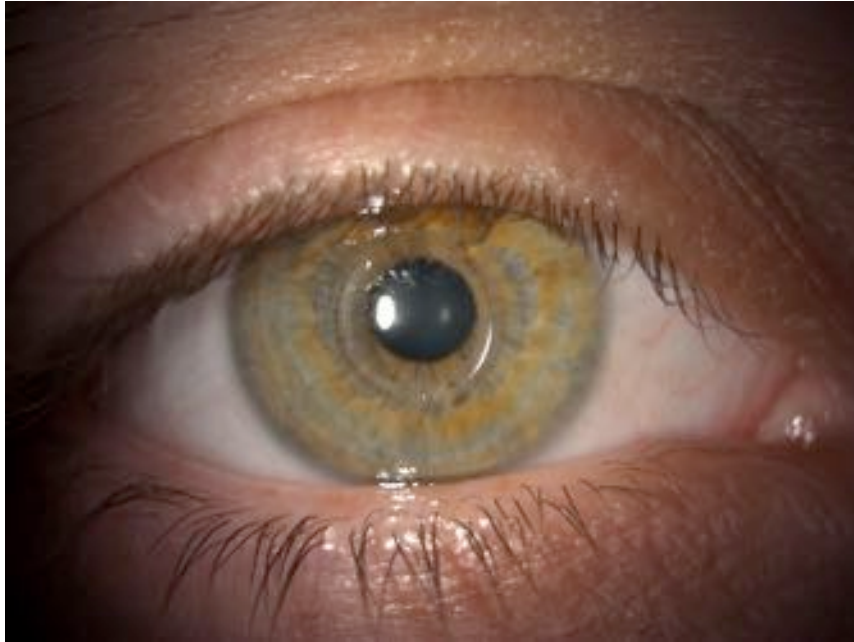
	Vis <sub>sc</sub>	Ref. (dpt)	Vis <sub>cc Brille</sub>	K <sub>flat</sub> (mm)	K <sub>steep</sub> (mm)	
OD	0.2p	+2.75 -4.50 46°	0.9p	7.89	7.17	KC with ICRS
OS	1.50	+0.25	1.50	7.79	7.59	normal





# Case #2 Keratoconus

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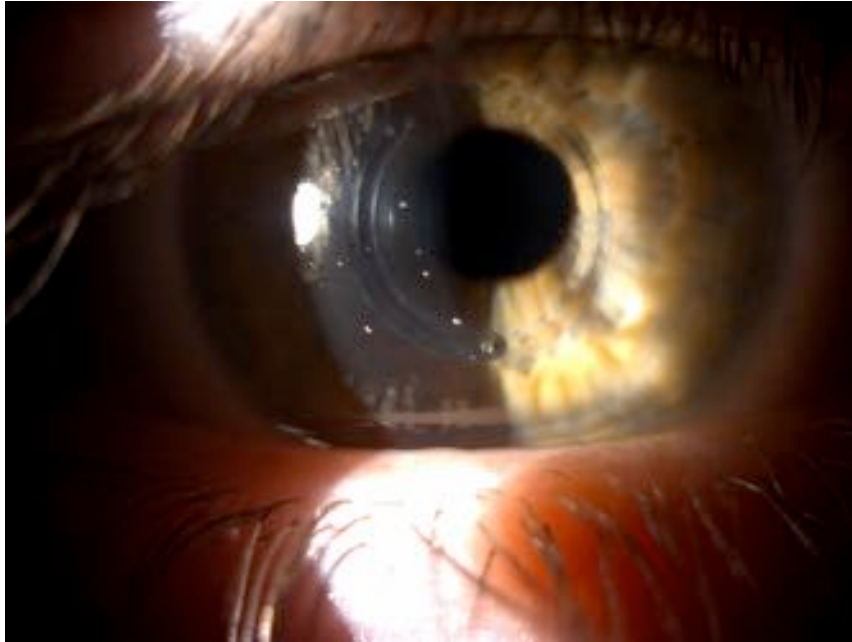






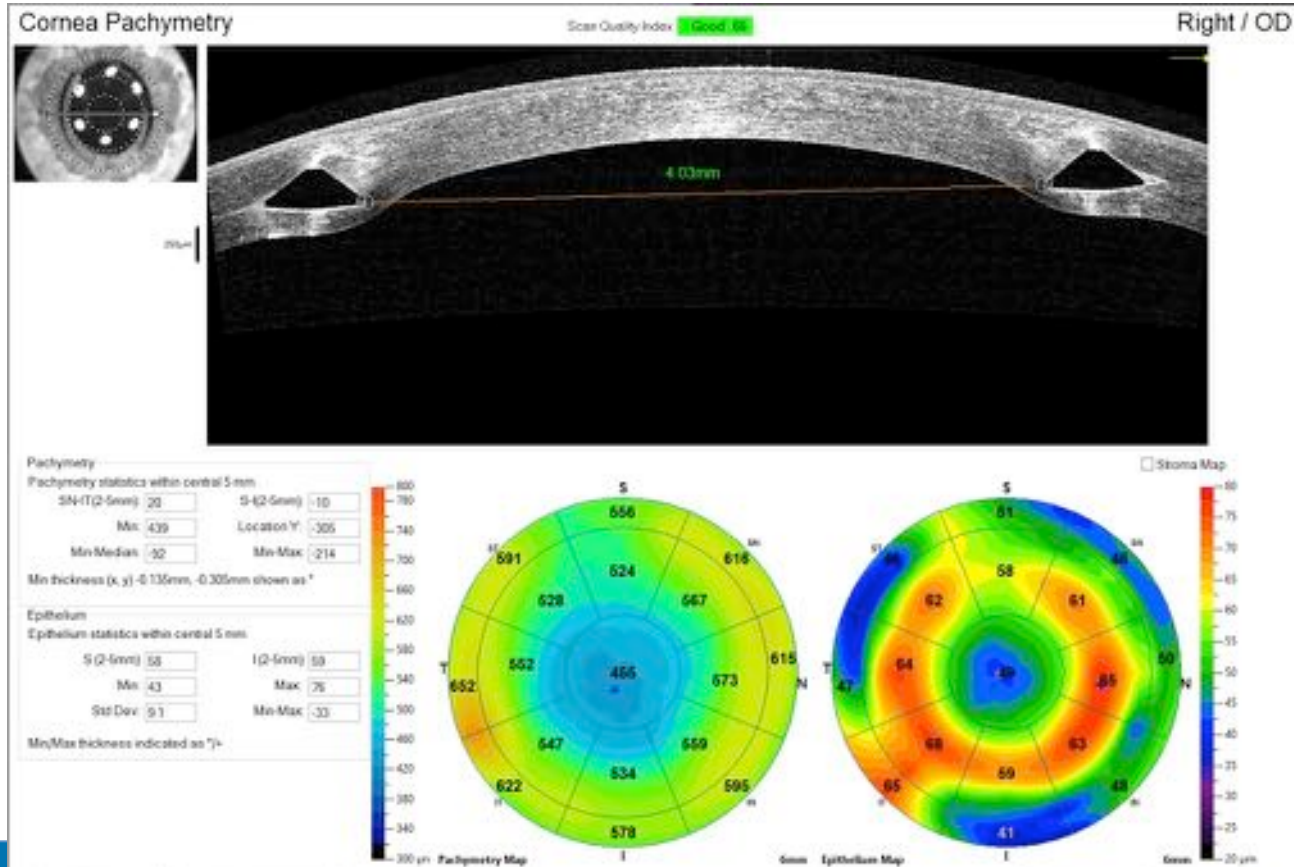
# Case #2 Keratoconus

**linsen  
centrum**



# Case #2 Keratoconus

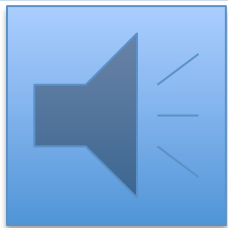
linsen  
centrum



## Case #2 Keratoconus

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centrum**





# Take Home Message

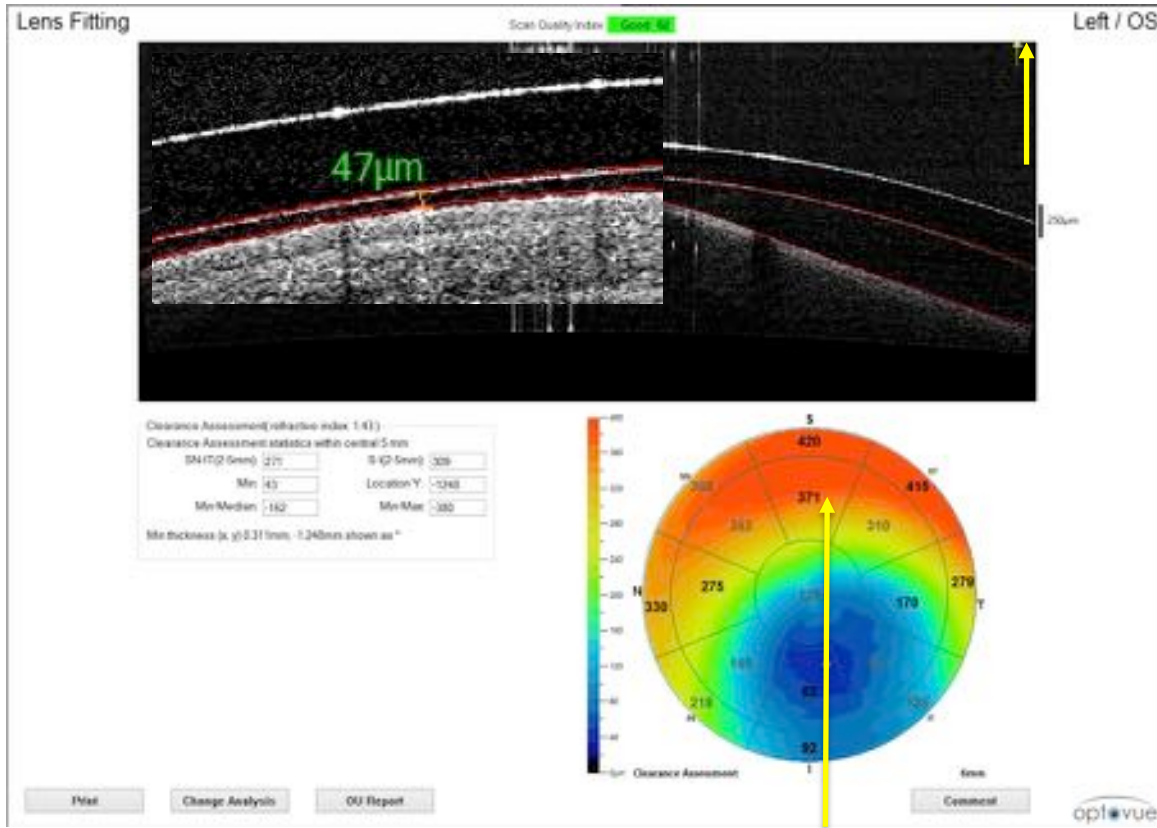
**linsen  
centrum**

- **Outcome:**
  - Subj. good wearing comfort despite monocular lens fitting
  - VA from 0.2p to 1.2p
- **Challenges:**
  - Reflexes of the ICRS remain at dawn to night time
  - Retinoscope shows in «all» lenses the quality of the vision and reveals media changes or the like.
  - ICRS Usually have a difficult topography for fitting RGP's
  - In my personal experience scleral lenses usually simplify the fitting

# **APENDIX KERATOCONE**

# Keratoconus

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- Ensure clearance at the Apex after 2-3 weeks
- At the Apex as little as possible, as much as necessary
- In the second half of the day min 30-50 µm

- Often compromise lens fitting depending on the nature of the PMD
- Apex is extremely inferior in the limbal zone of the KL
  - Mostly light touch inferior at the Apex
  - OR light conjunctival edema or conjunctival prolaps inferior
  - OR centrally too much clearance



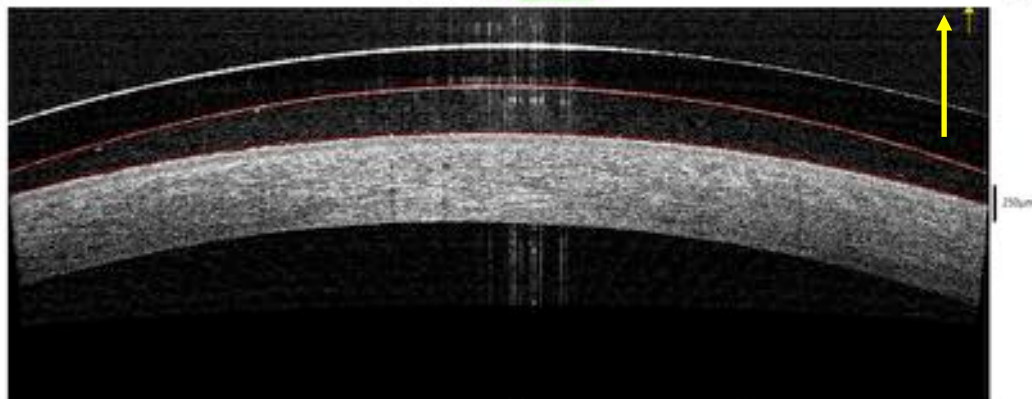
# PMD

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centrum

Lens Fitting

Scan Quality Index: Good (all)

Right / OD



Clearance Assessment (refractive index 1.43)

Clearance Assessment statistics within central 5 mm

SN (T(2-5mm)) -35

S (2-5mm) 23

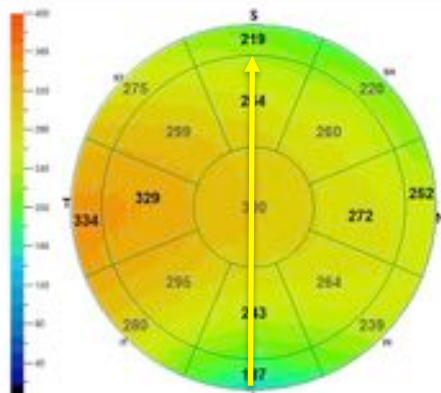
Min: -203

Location Y: -2367

Min-Median: -72

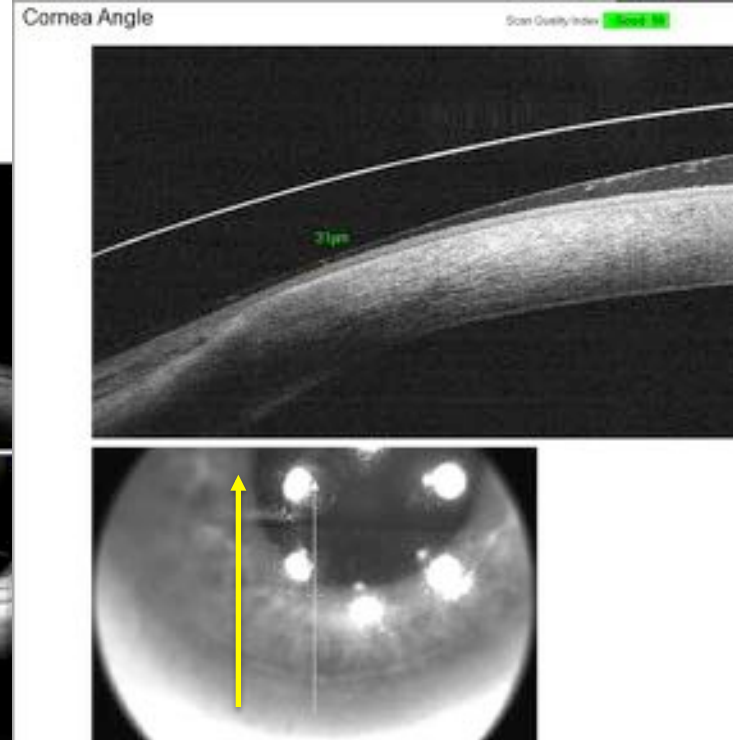
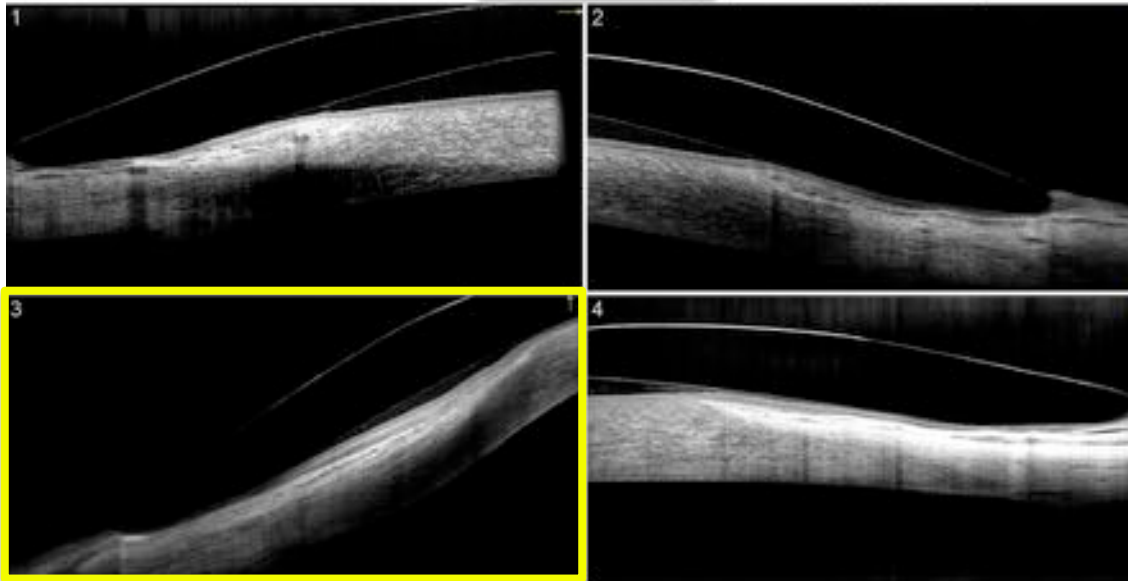
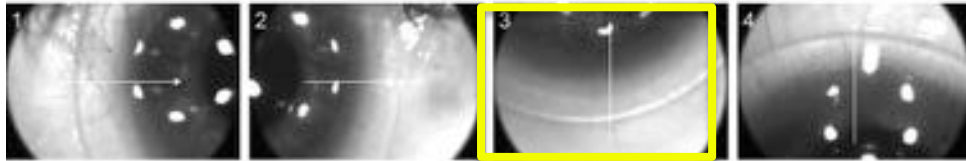
Min-Max: -131

Min thickness (x, y) 0.094mm, -2.367mm shown as °



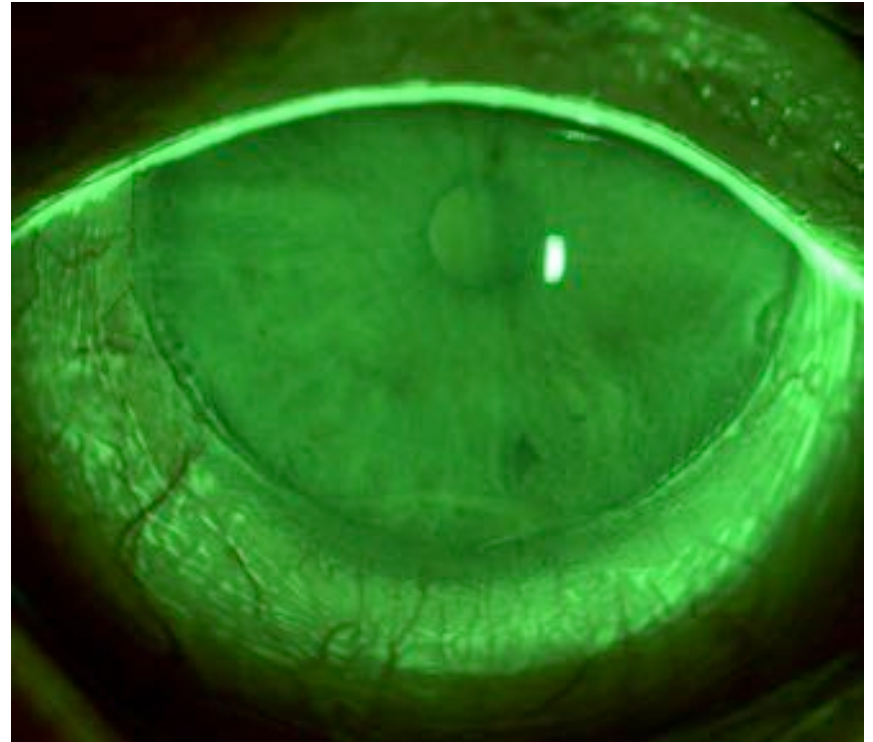
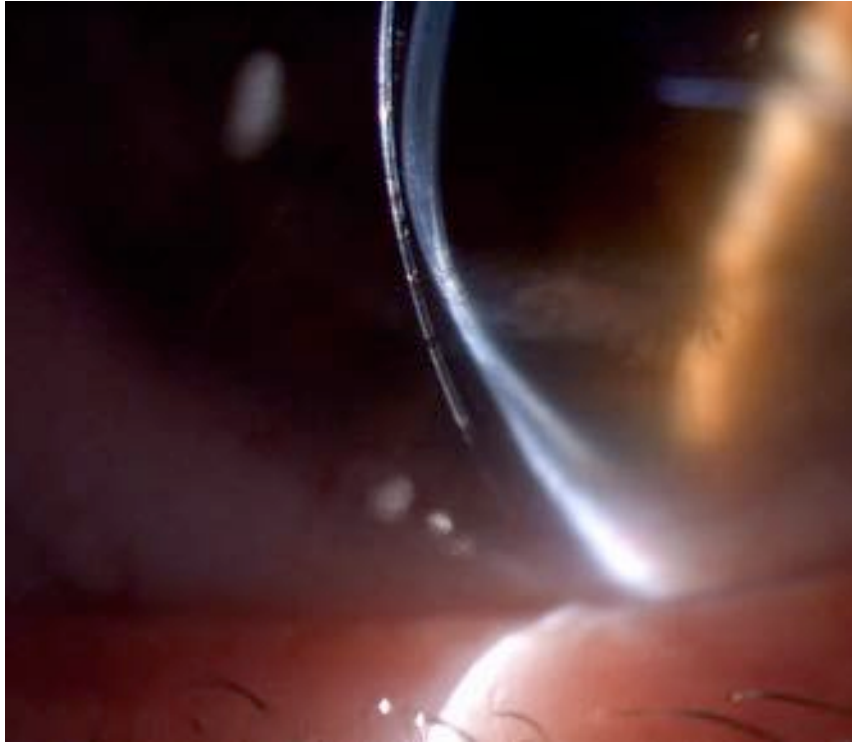
# PMD

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centrum



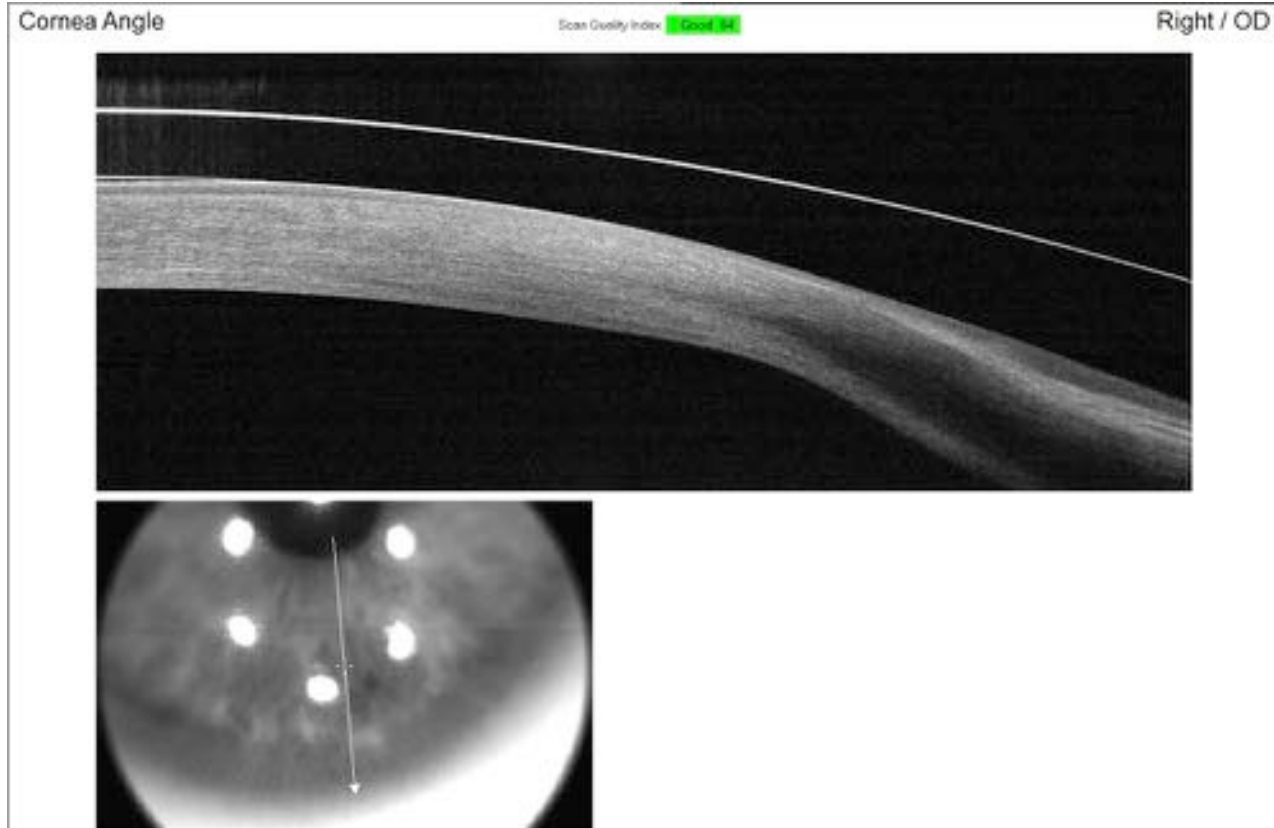
# PMD

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centrum



# PMD

linsen  
centrum



# **SCLERAL LENSES IN PATHOLOGICAL CORNEA CHANGES PART II**

Corneal conditions post surgery

# Irregular astigmatism Post-OP

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- Perforating keratoplasty
- Lamellar keratoplasty
- Graft restoration
- radial keratotomy
- Post-Lasik
- Photo Therapeutic keratectomy (PTK)

# Irregular astigmatism Post-OP

- Challenges
  - Keratoplasty extreme level differences, levels, graft decentration,...
    - Endothelial cell count can be a limitation for SCL fitting
  - Graft restoration
    - Unpredictable changes
  - Radial keratotomy & post-lasik
    - Normal peripheral corneal shape with extremely flat center and low sagittal heights
    - Difficult to achieve centrally optimal clearance

# Irregular astigmatism Post-OP

- This opens up the possibilities, variations, challenges and also limits
- Basically applicable for specialty lens fitting:
  - **“Scleral Lenses of a Perfect World applied in an Imperfect World with the least possible Compromises!”**
  - All customization skills contribute BUT not to get lost in it, but to strive for the best possible, tolerable and responsible lens fit
  - Follow up, follow up, follow up, ...



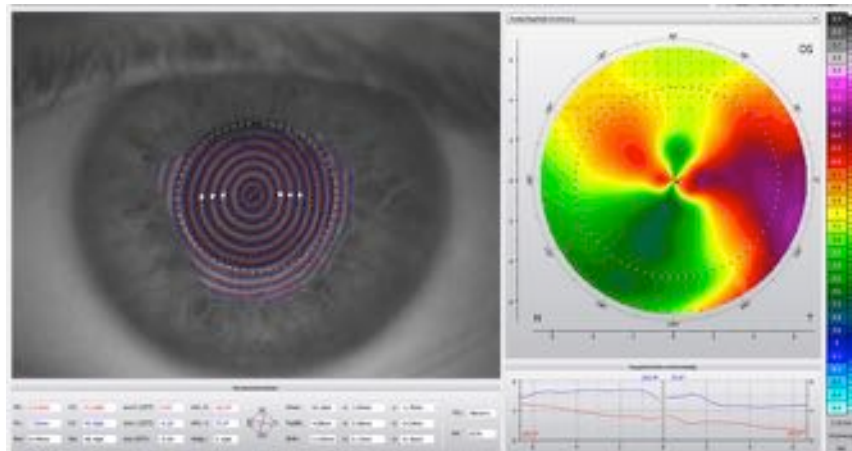
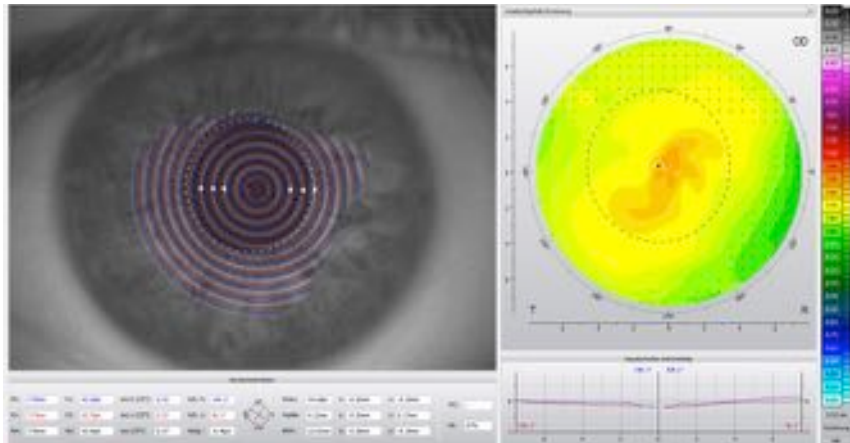
# **CASE # 3**

Post DALK keratoplasty

# Case #3 Keratoplasty

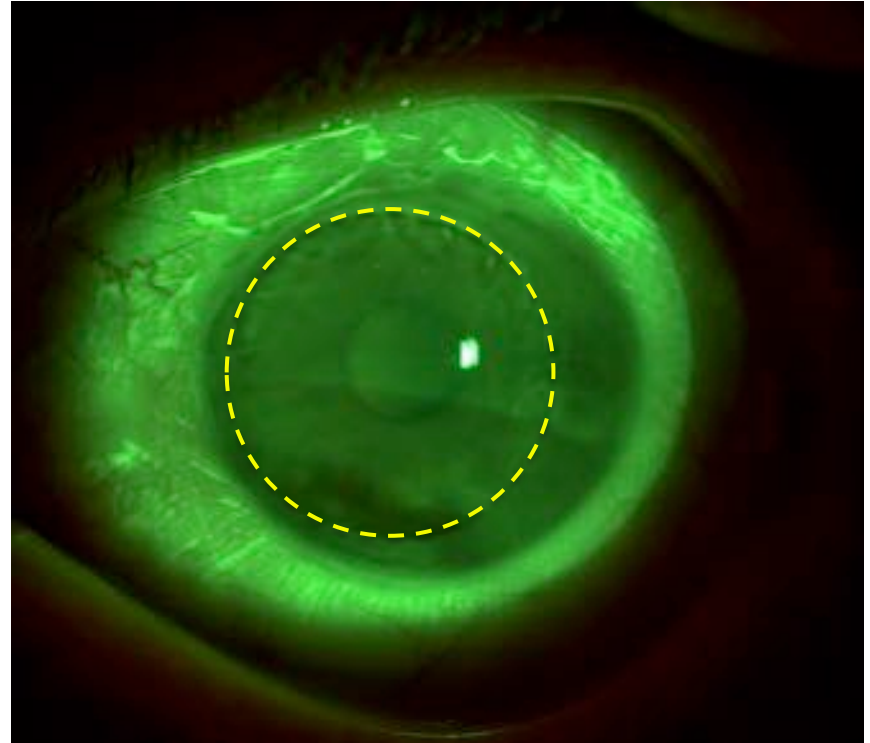
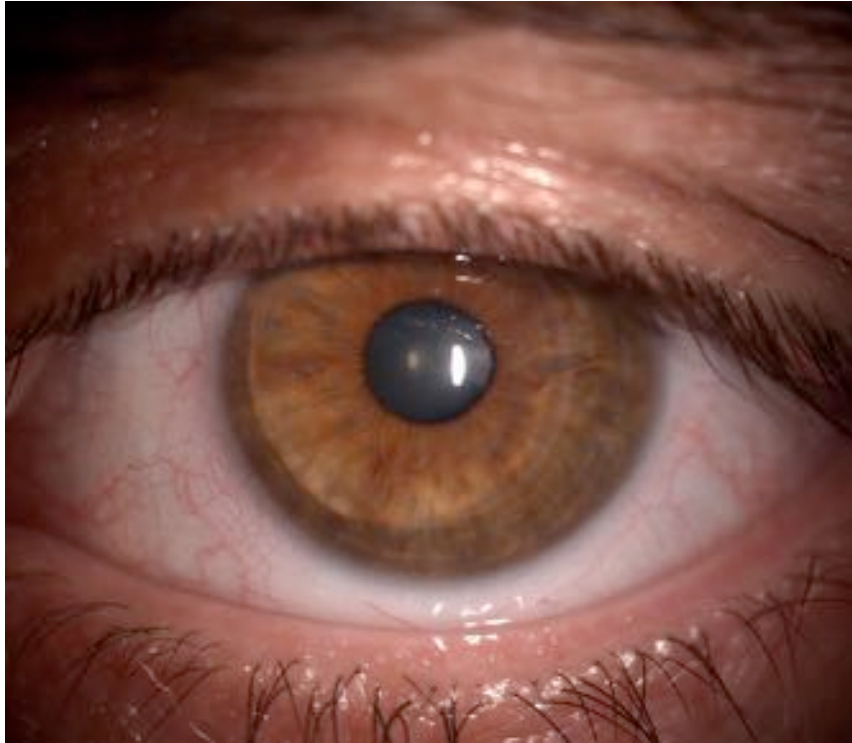
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centrum

	Vis <sub>sc</sub>	Ref. (dpt)	Vis <sub>cc Brille</sub>	K <sub>flat</sub> (mm)	K <sub>steep</sub> (mm)	
OD		-4.50 -0.50 110°	1.2	7.79	7.73	normal
OS	0.1	-4.50 -6.00 70°	0.5p	7.36	6.62	DALK



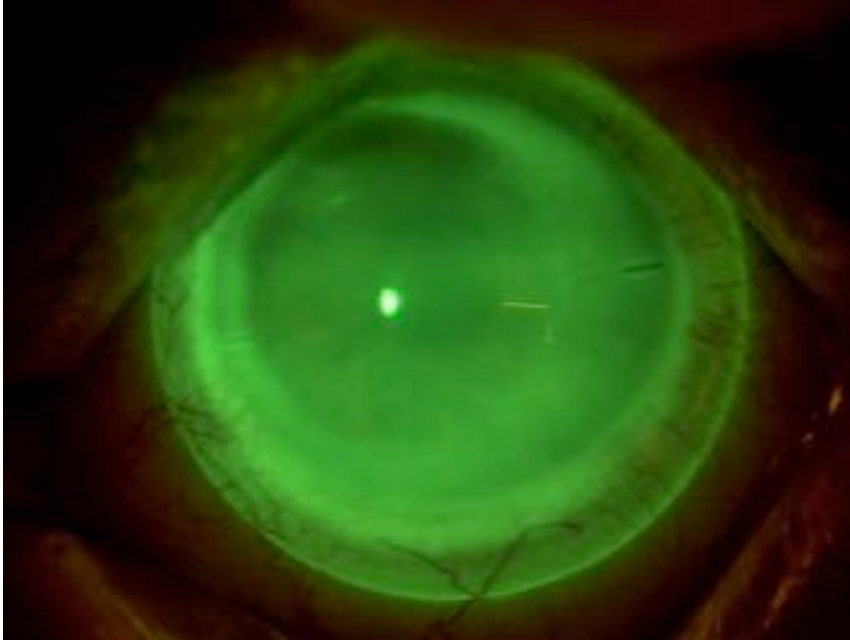
# Case #3 Keratoplasty

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centrum

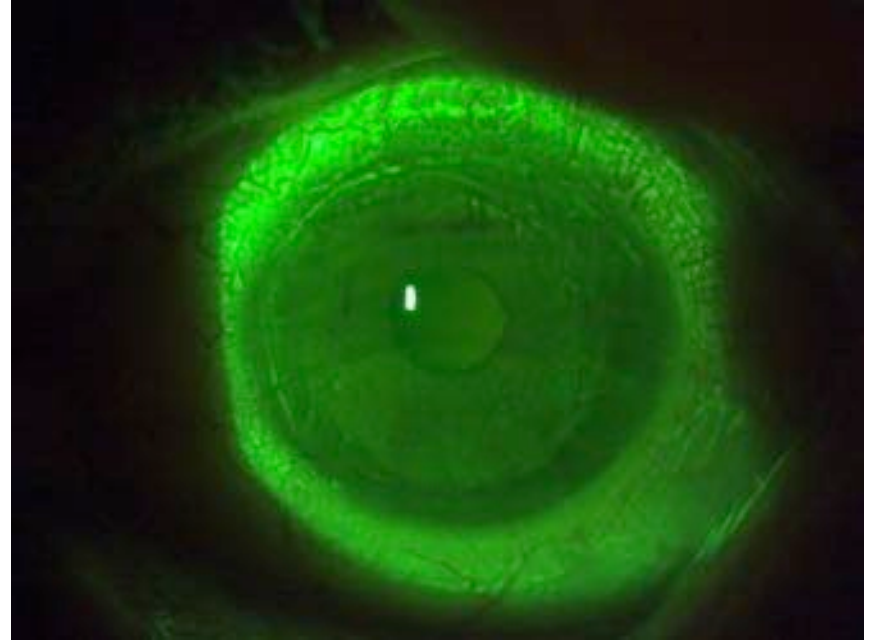


# Case #3 Keratoplasty

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centrum



Superior touch on the TP edge



Superior Fluo neg after 5h wearing time

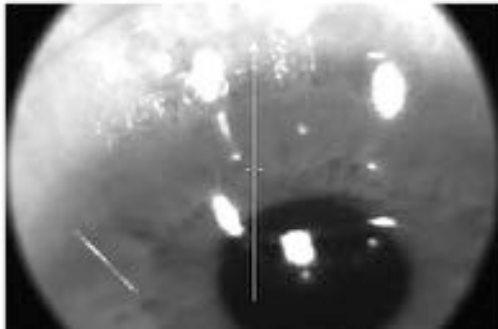
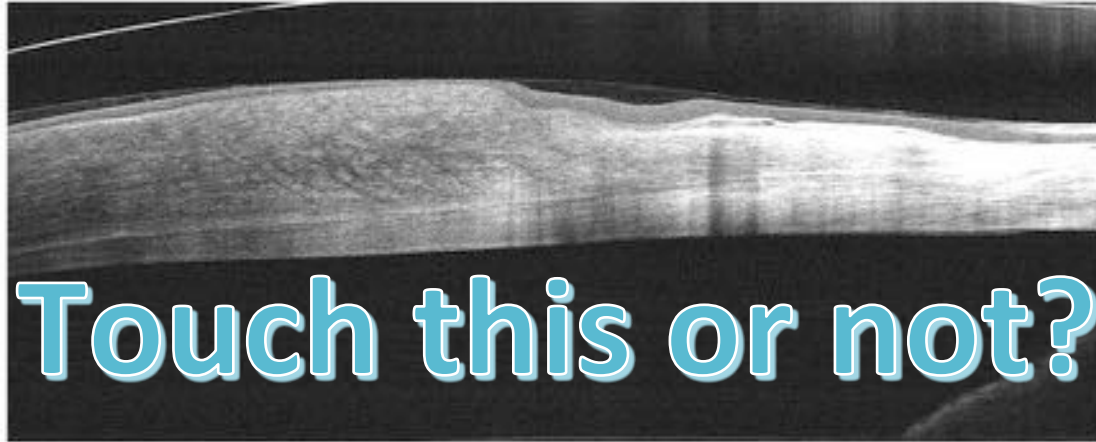
# Case #3 Keratoplasty

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Cornea Angle

Scan Quality Index Good 71

Left / OS



**“Can’t touch this?”**

**linsen  
centrum**



**“Yes we can!?”**

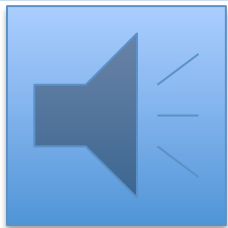
**linsen  
centrum**



# Can we or can't we touch??!?

This is a question that is in pathological cornea situations  
that keeps popping up ...





# Take Home Message

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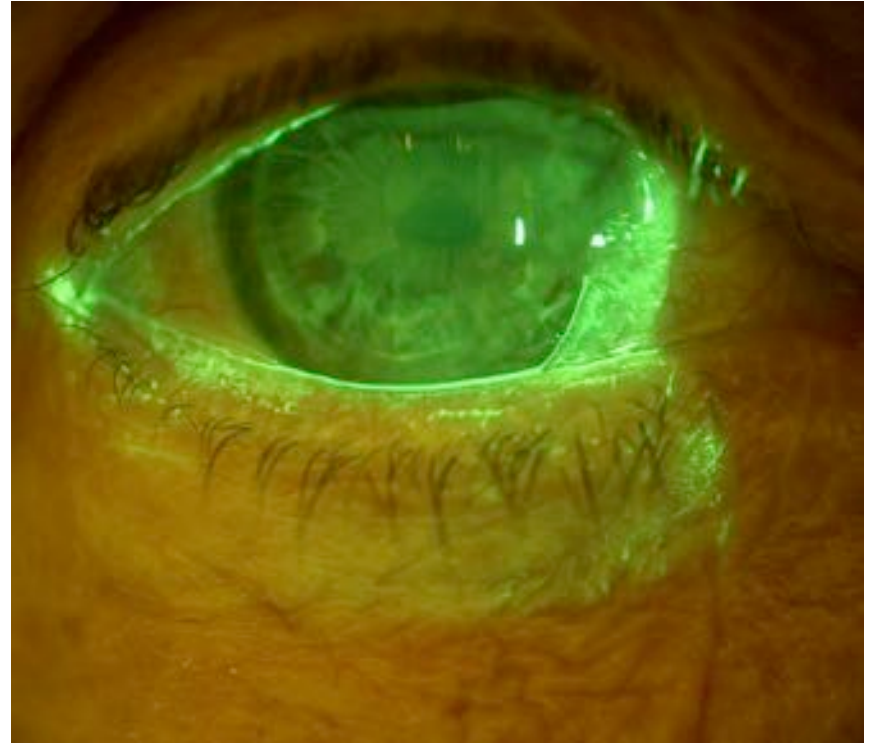
- **Outcome:**
  - VA @ far: OD: 1.0p (with MV dailies) OS: 0.9 (mit Bifo ScCL)
  - VA @ near: OD: 0.6 OS: 1.0
- **Challenge:**
- A decentered graft rarely allows acceptable centering of a corneal RGP lens
- **«Touch»**
  - Gentle touch in small areas is usually tolerable, but must be observed
  - Important: Avoid hard transitions
  - In some situations, a gentle touch is usually the better compromise than complete clearance e.g. PMD

# **CASE #4 KERATOPLASTY**

Partial graft restoration with suture and stiches

# Case #4 Keratoplasty restoration

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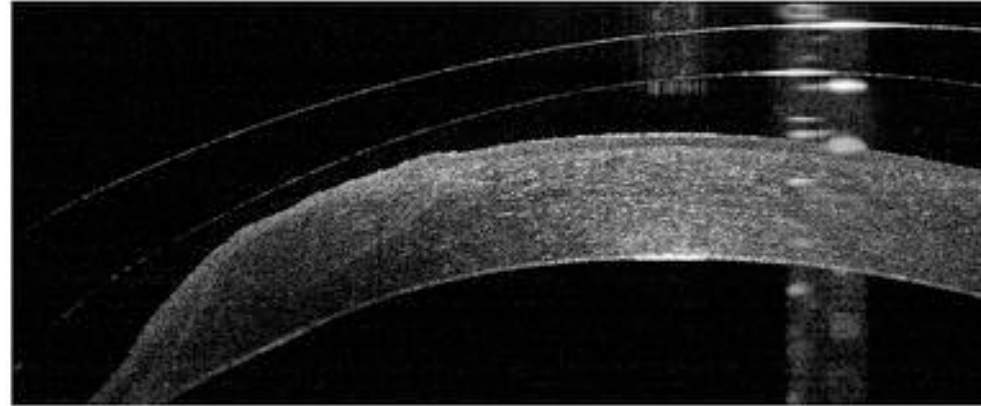
# Case #4 Keratoplasty restoration

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Lens Fitting

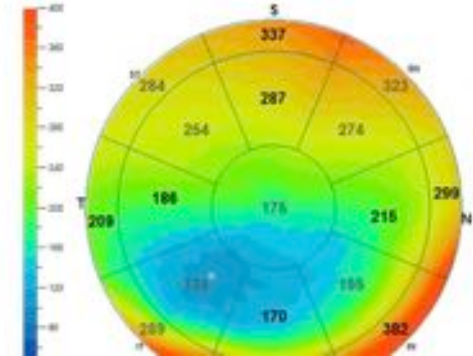
Scan Quality Index **Good 93**



Clearance Assessment (refractive index 1.43)

Clearance Assessment statistics within central 5 mm

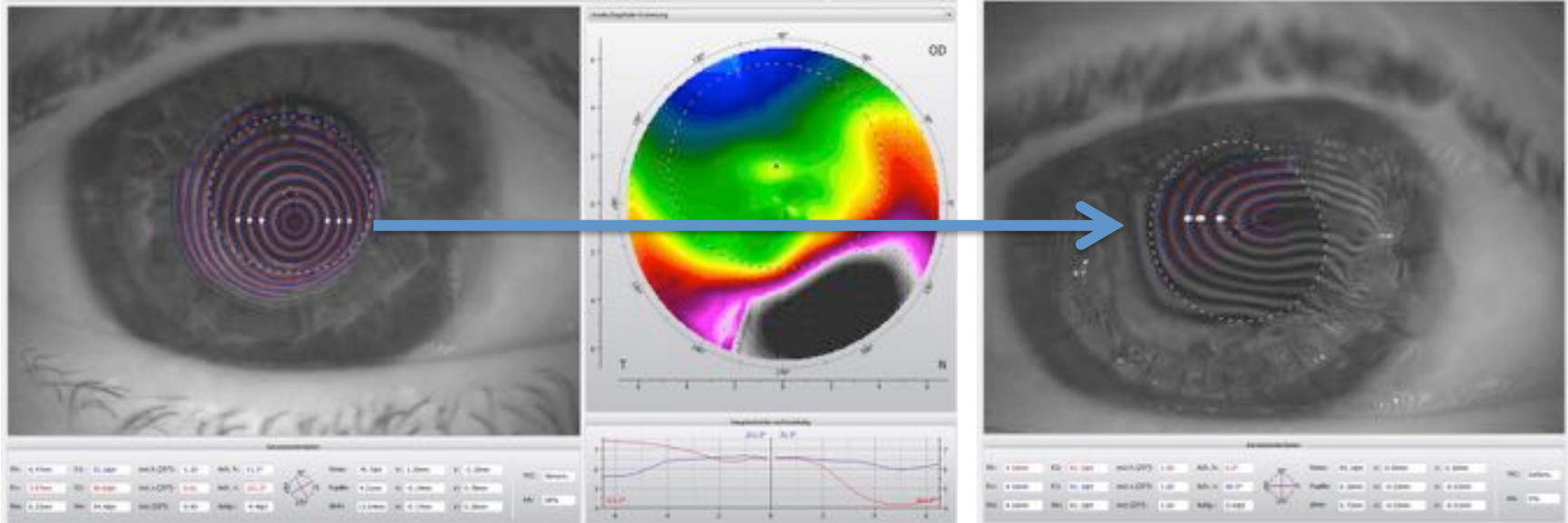
S-I (2-5mm)	140	S-42 (5mm)	117
Min	107	Location Y	1096
Min-Median	-100	Min-Max	-224
Min thickness (x, y) < 390mm, 1.096mm shown as *			



Herausforderung inferior  
TP-Kante

# Case #4 Keratoplasty restoration

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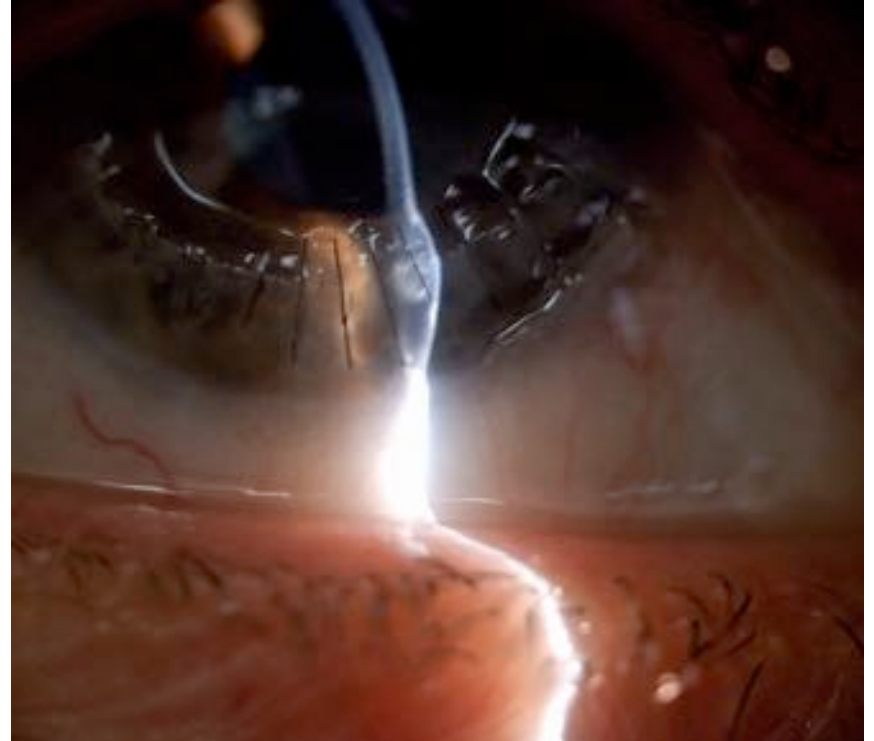


Pre-restoration

Post-restoration, Topography  
not measurable

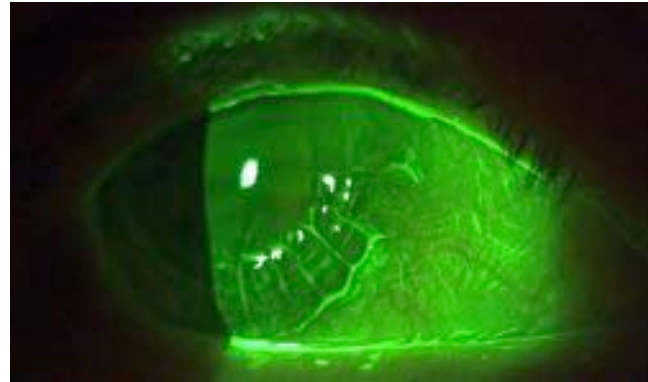
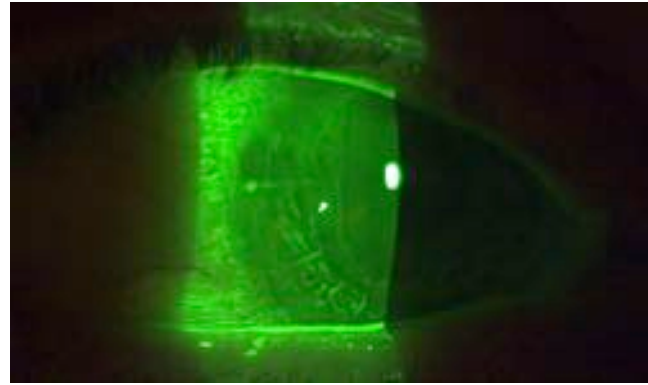
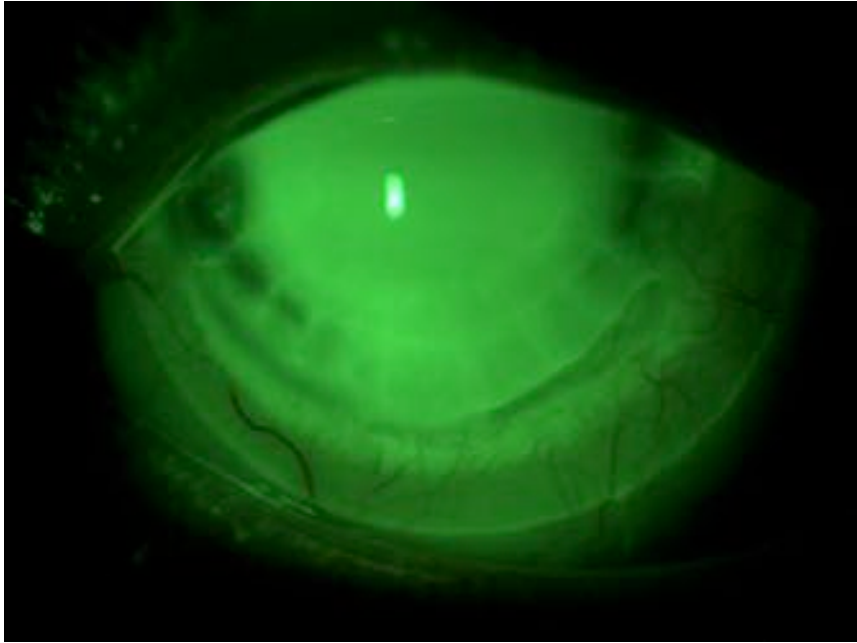
# Case #4 Keratoplasty restoration

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# Case #4 Keratoplasty restoration

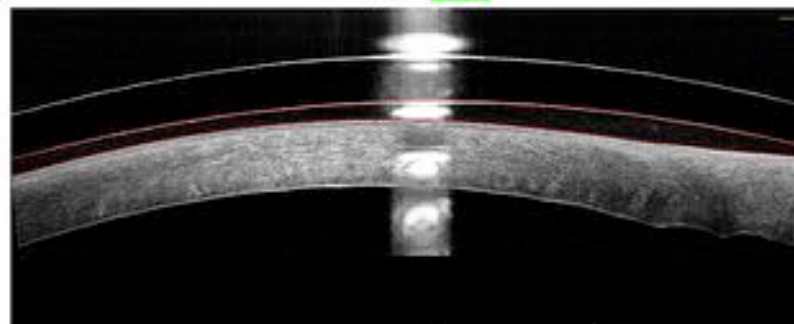
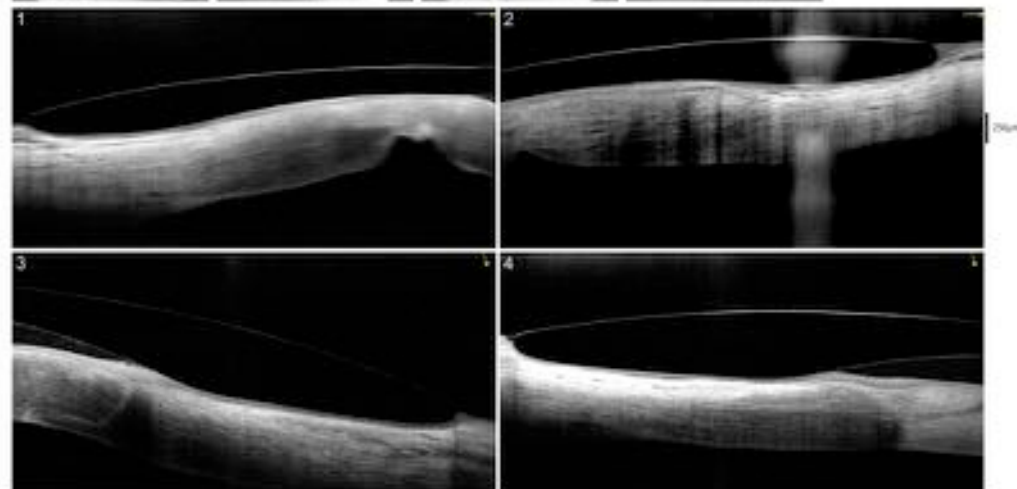
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Right / OD Lens Fitting

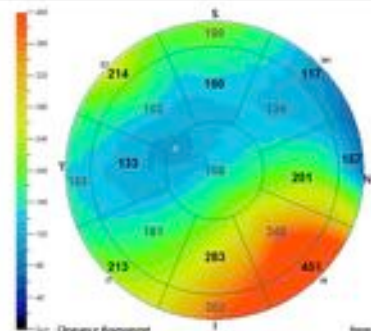
Score Quality Index **Good 75**

Clearance Assessment (reflexivity index 1.0)

Clearance Assessment: stable within control 5 mm

(24-72 Gms)	(-)	(-62-6mm)	133
Min	114	Location Y	429
Min-Median	36	Min-Max	540

Min thickness (x, y): 0.751 mm, 0.639mm shown as <sup>1</sup>



154

### Class Analysis

## References



1994]

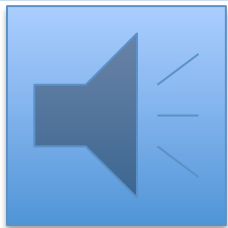
### Classroom Activities

### 4.2.3. Results

10

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# Take Home Message

**linsen  
centrum**

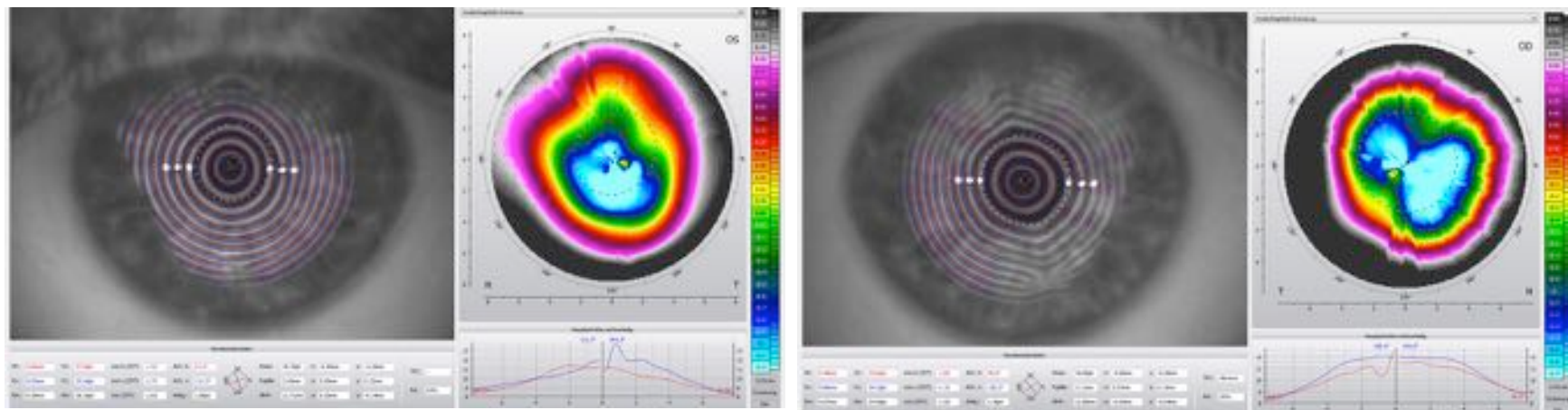
- Scleral lenses already can be fitted about 3-6 months after PKP
  - Also on top of initial sutures on the graft
  - After partial restoration even after 2-4 weeks post-surgery
  - Depending on the surgeon and technique the graft area can be very flat with swollen sutures (vulcano-like appearance)
    - In the case of high level differences, partial contact is usually not avoidable
  - Avoid conjunctival folds/ prolaps whenever possible (prone to neovascularization)

# **CASE #5 RADIAL KERATOTOMY**

# Case #5 Radial Keratotomy

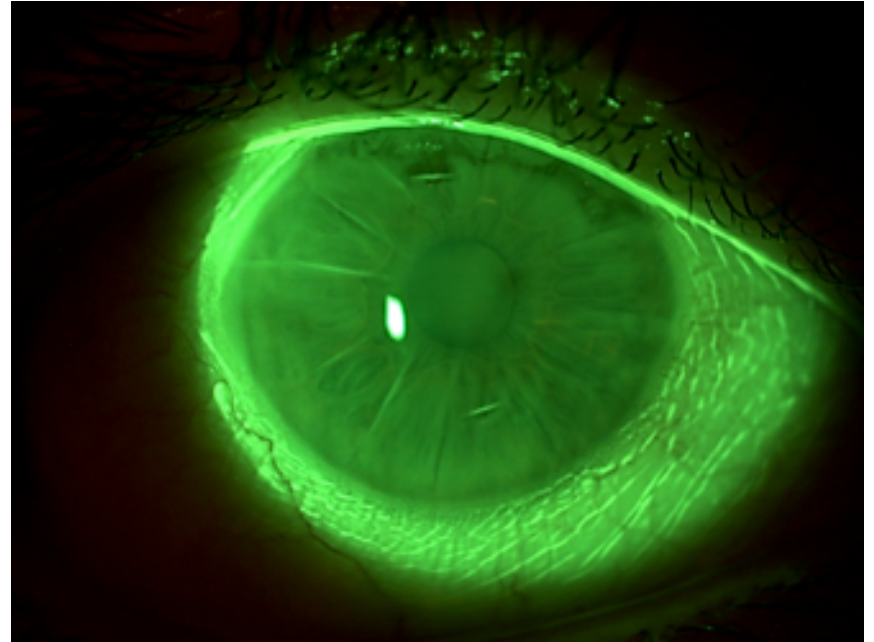
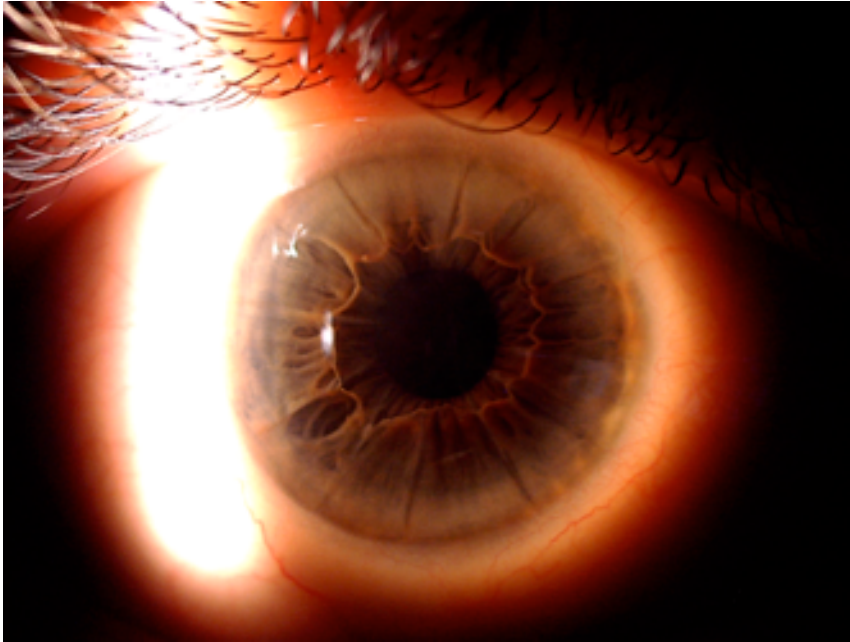
linsen  
centrum

	Ref. (dpt)	Vis <sub>cc Brille</sub>	K <sub>flat</sub> (mm)	K <sub>steep</sub> (mm)	
OD	+7.00 -2.00 141	1.0p	9.86	9.48	Rad. Keratotomy
OS	+7.00 -1.25 124	1.0p	9.52	9.06	Rad. Keratotomy



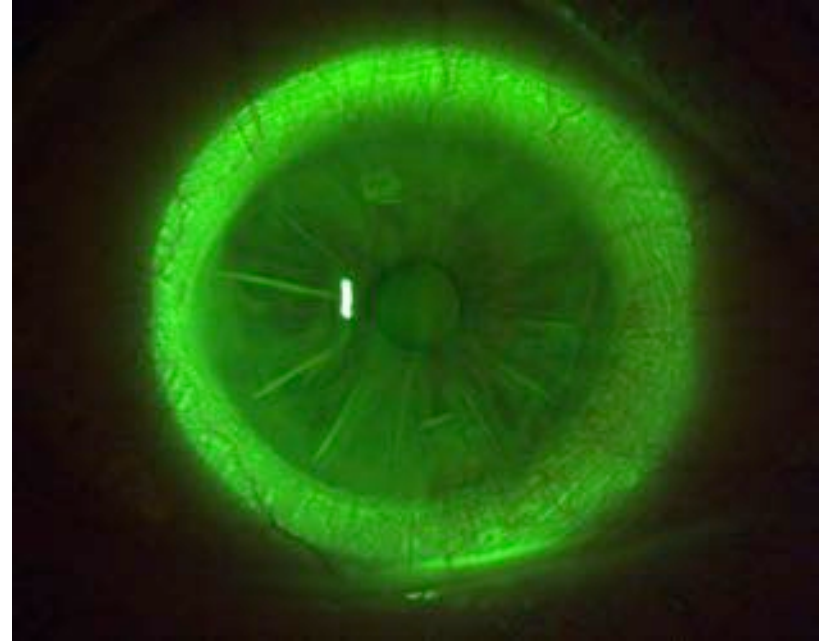
# Case #5 Radial Keratotomy

linsen  
centrum



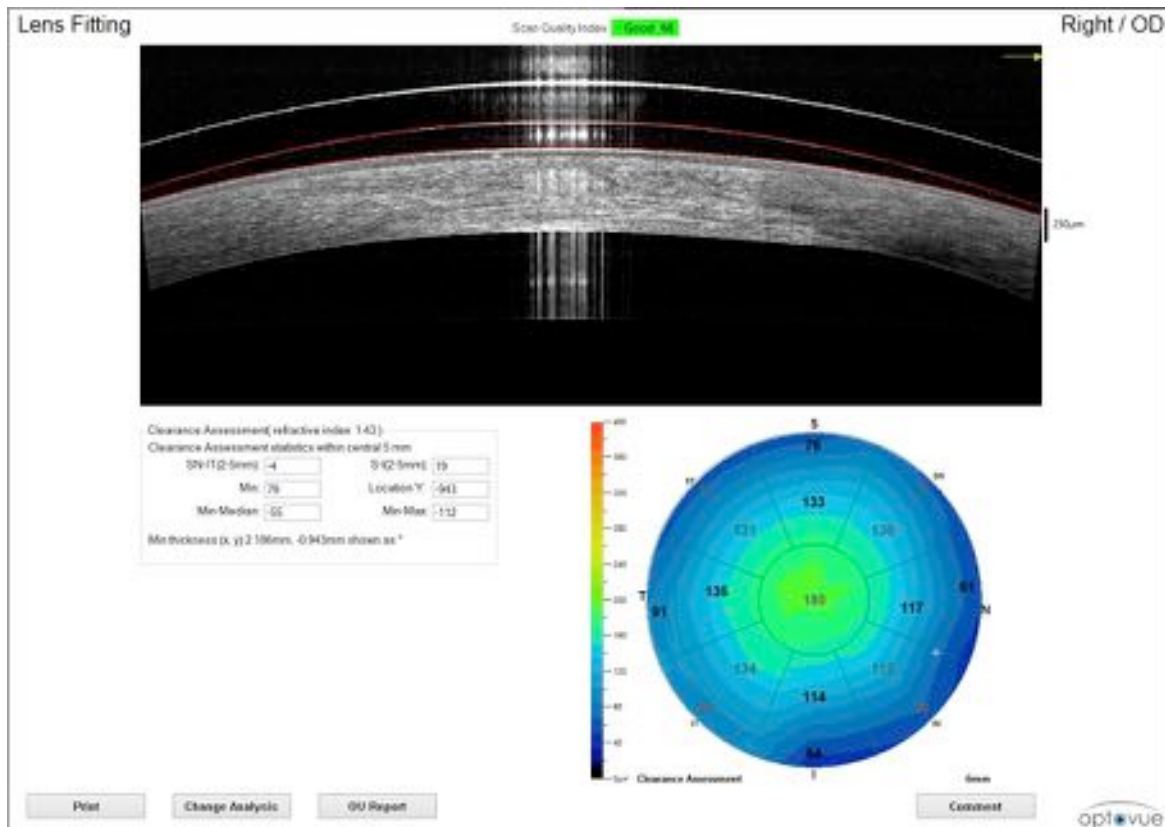
# Case #5 Radial Keratotomy

linsen  
centrum



# Case #5 Radial Keratotomy

linsen  
centrum





# Take Home Message

**linsen  
centrum**

- Extreme flat cornea situations are an indication for scleral lenses
  - Radial keratotomy due to very flat cornea radii and fluctuation during the day of in extreme cases +/-4dpt
  - Post-Lasik situations, etc.
- Often there are more complex scleral lenses geometries needed to avoid excessive clearance in the center
  - Major differences in radii central to periphery

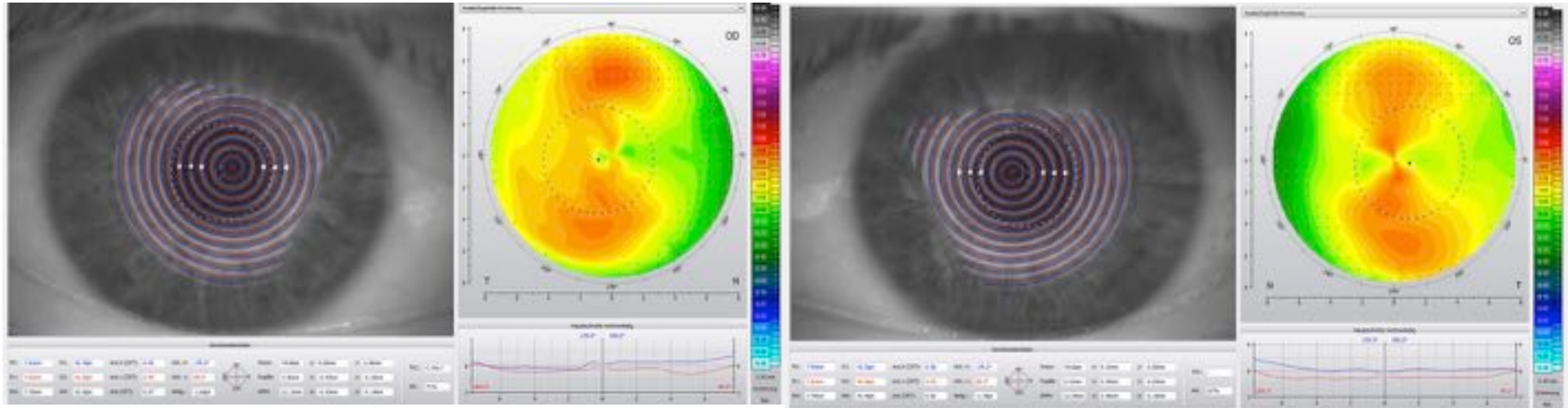
# **CASE #6 GRANULAR CORNEA DYSTROPHY (GCD I)**

Post Photo Pherapeutic Keratectomy (PTK)



# Case #6 Granular Cornea Dystrophy

linsen  
centrum

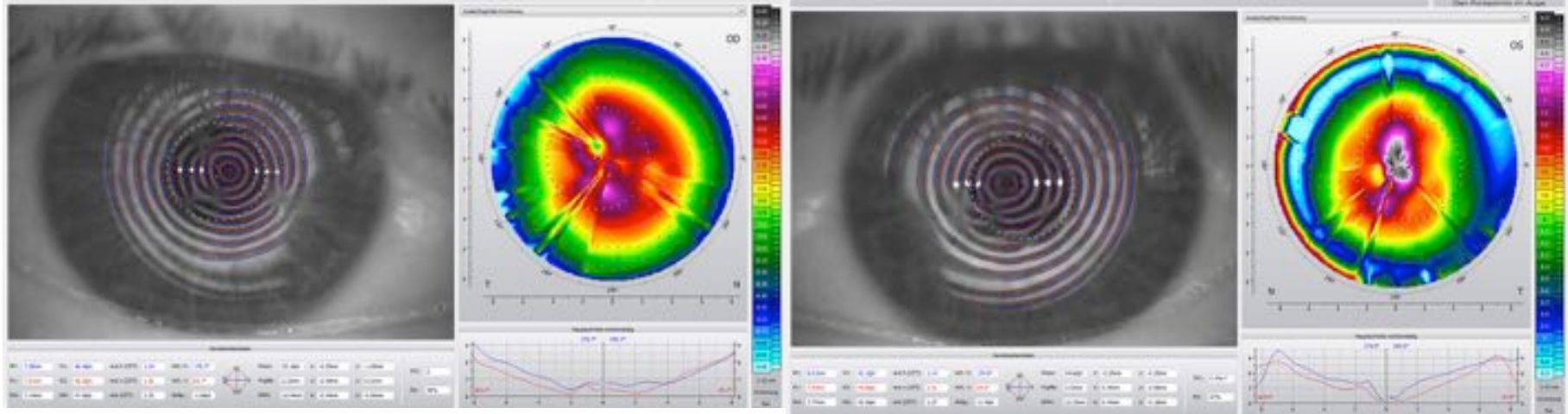


OD: Topo Pre-PTK

OS: Topo Pre-PTK

# Case #6 Granular Cornea Dystrophy

linsen  
centrum

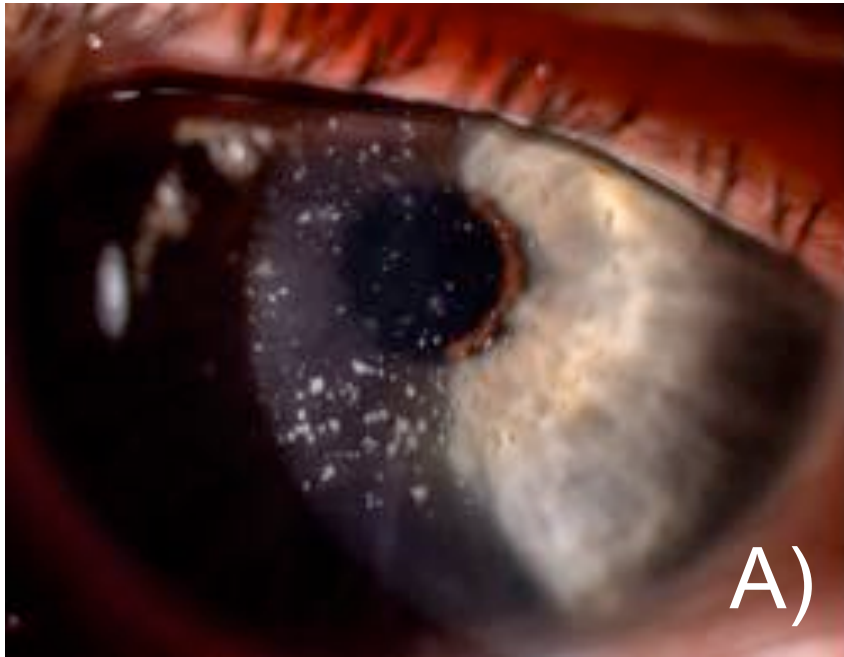


OD: Topo 2 Mon Post-PTK

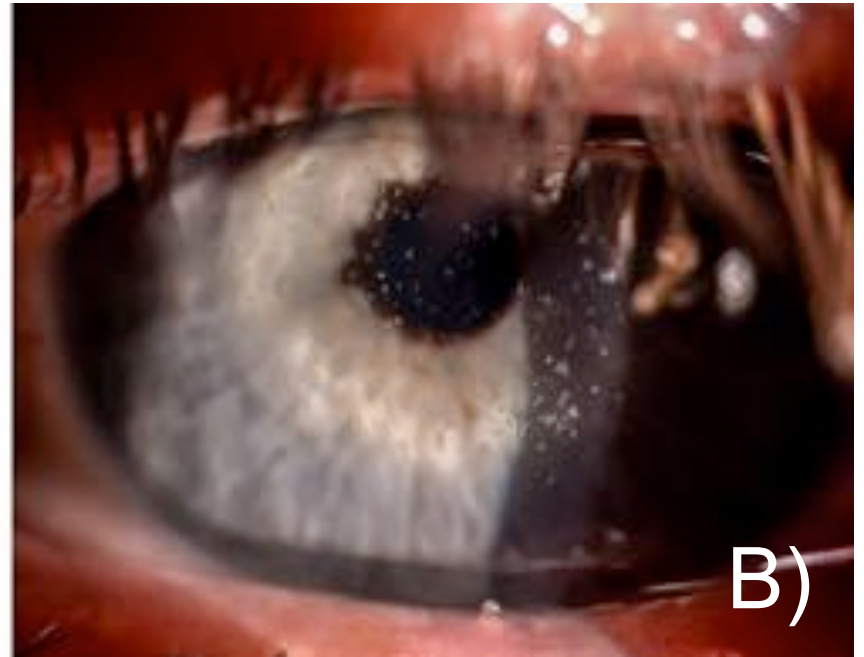
OS: Topo 2 Mon Post-PTK

# Case #6 Granular Cornea Dystrophy

linsen  
centrum



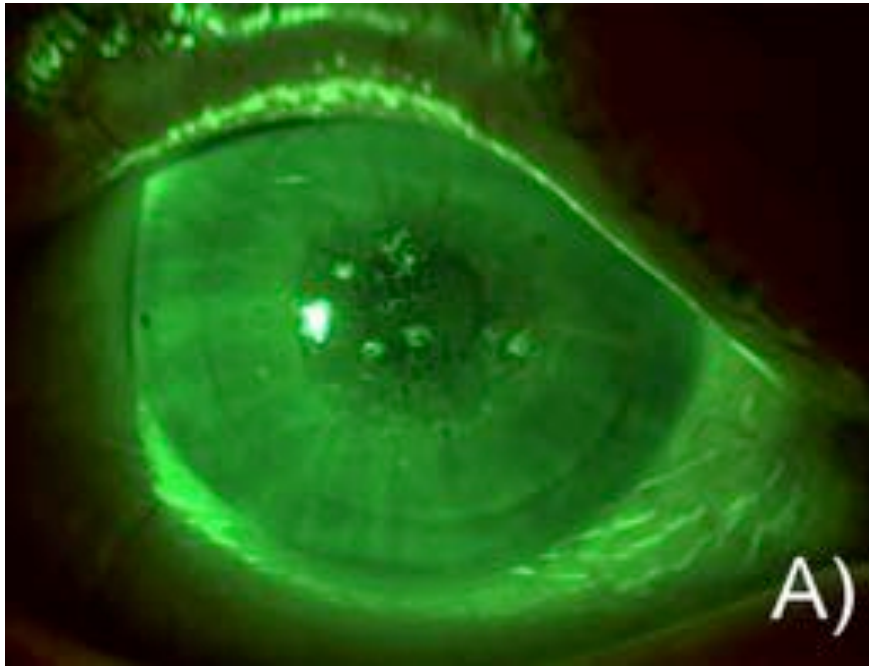
A) OD Post-PTK



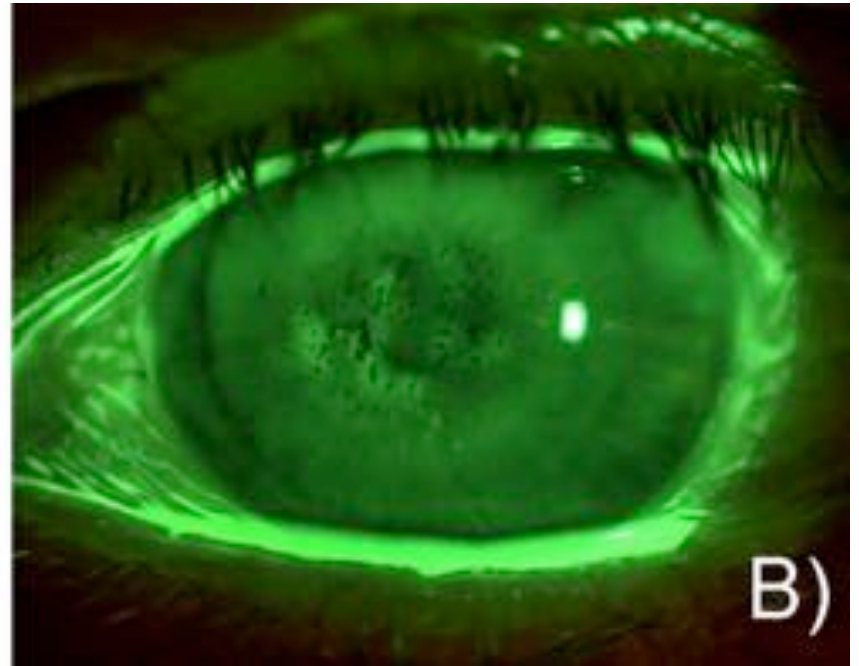
B) OS Post-PTK

# Case #6 Granular Cornea Dystrophy

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centrum



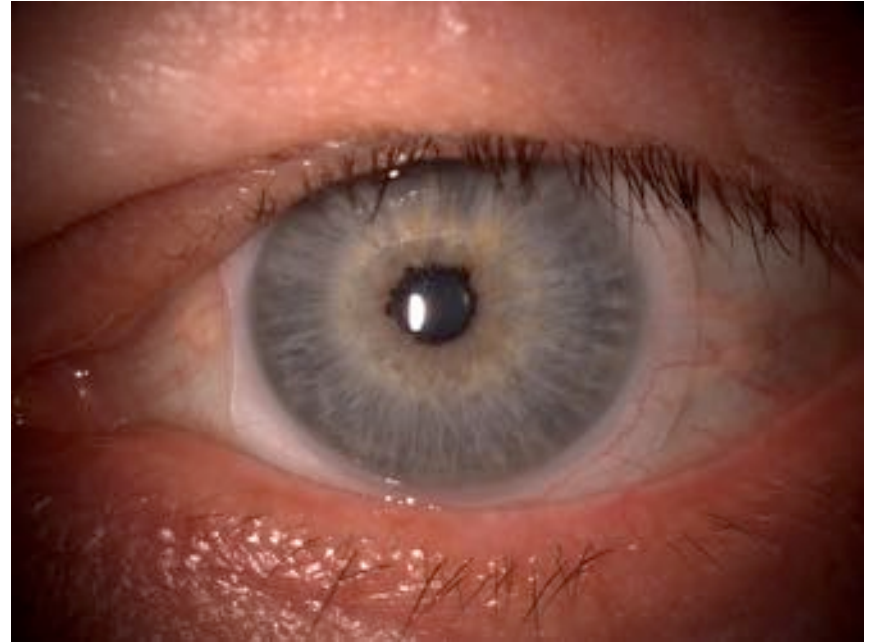
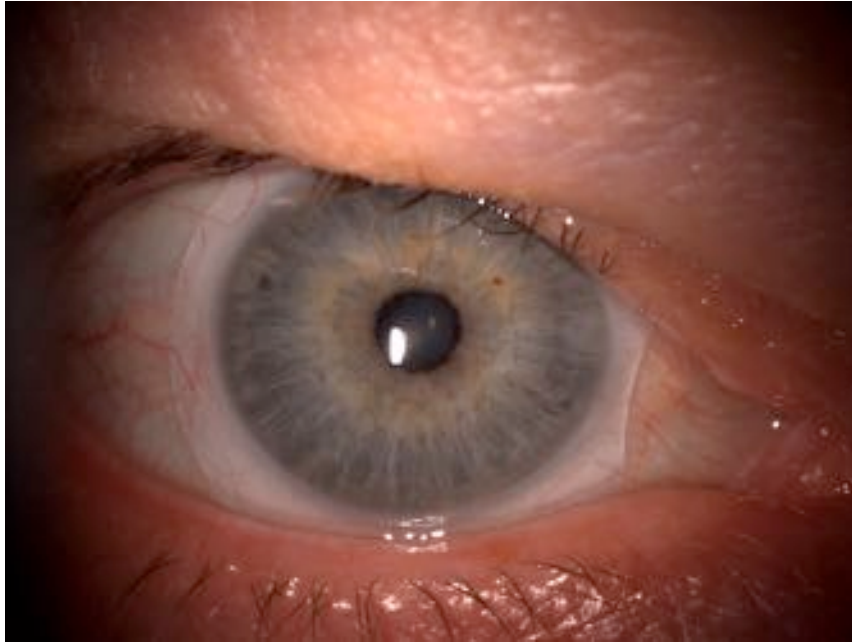
A) OD Post-PTK



B) OS Post-PTK

# Case #6 Granular Cornea Dystrophy

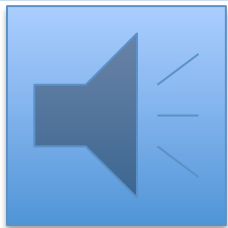
linsen  
centrum



# Case #6 Granular Cornea Dystrophy

- Outcome:
  - Visus: OD: 1.2p OS: 1.0
  - Massive improvement of vision and quality of life
  - High contrast, no double images and shadows, hardly glare at dusk
  - Reading glasses over CL's





# Take Home Message

**linsen  
centrum**

- Unusual indication?
  - Irregular cornea surface can be corrected with tear reservoir RGP Lenses
- Recurrence of GCD 1: YES! PTK Repeatedly possible? YES!
  - «same» lenses can be reused after 2nd PKT with small refraction changes

# **SCLERAL LENSES IN PATHOLOGICAL CORNEA CHANGES PART III**

Other pathological indications for scleral lenses



# Further indications for scleral lenses

- Expositions keratitis
- Severe dry eye conditions
- Cosmetic / Prosthetic scleral lens fit
  - Congenital cosmetic changes
  - Acquired traumatic changes

# **CASE #7 LAGOPHTHALMUS**

# Case #7 Lagophthalmus



- Facialis paresis (7th cranial nerve)
- severe exposure keratitis, conjunctive injection and mild chemosis
- Subj. Severe dry eye sensation, discomfort and pain, redness
- Fit of protective scleral lens

# Case #7 Lagophthalmus



- **Challenges:**
  - Poor wetting due to only manual lid closure, ointments, gels,...
  - Despite tangible Science Hydra PEG coating

# Case #7 Lagophthalmus

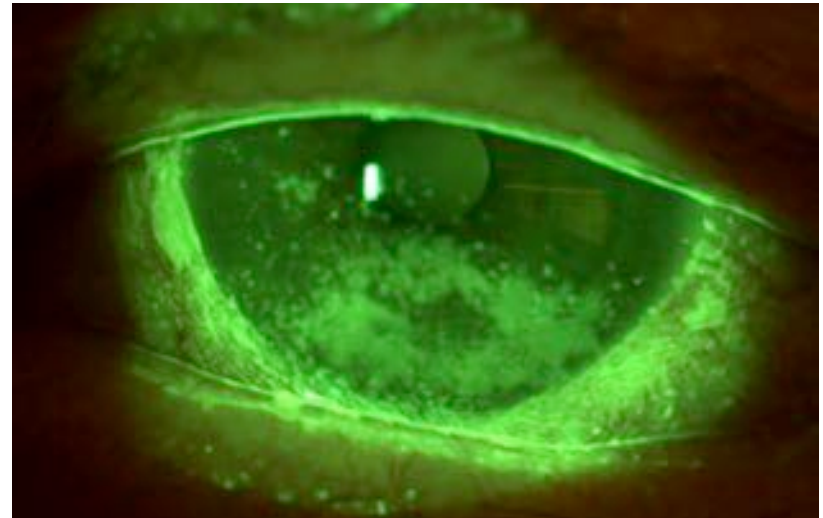
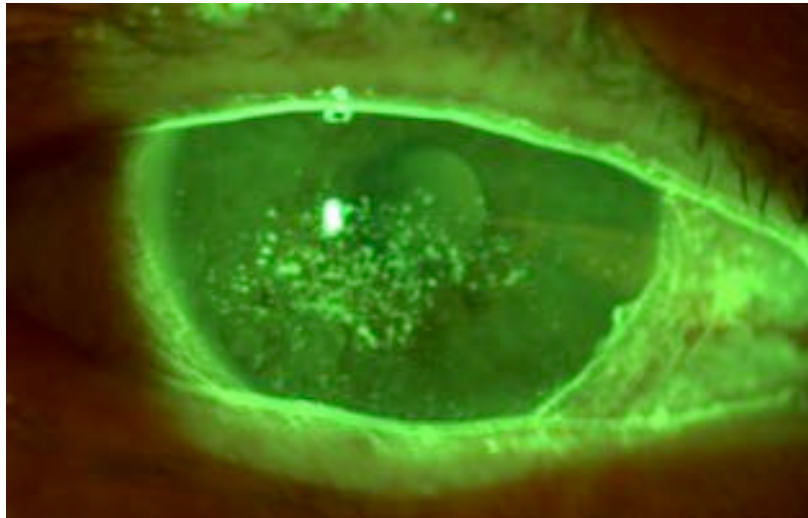
- Outcome:
  - with scleral lens was a massive improvement in subjective & objective symptoms
  - In the morning the eye shows most redness, despite eyepatch / wet chamber with Lacryvisc
  - The longer the lens is in the eye during the day, the better the eye feels, redness is lowest in the evening with the lens

# GVHD

## **After bone marrow transplant:**

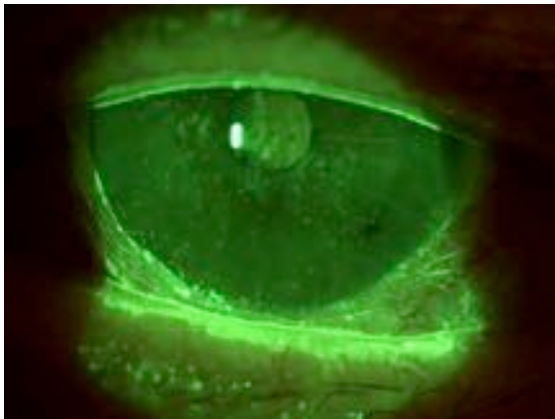
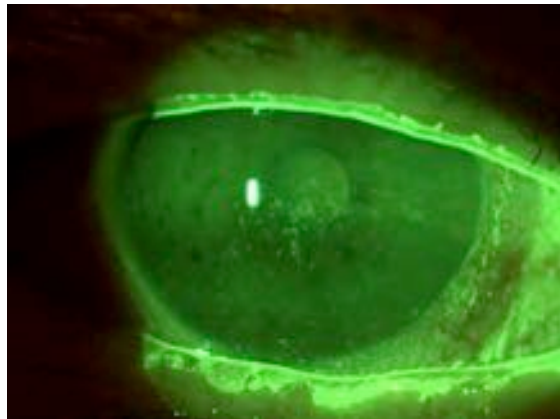
Systemic rejection resulting in reduced tear production

Moderate to severe dry eye symptoms, pain, photophobia



# GVHD

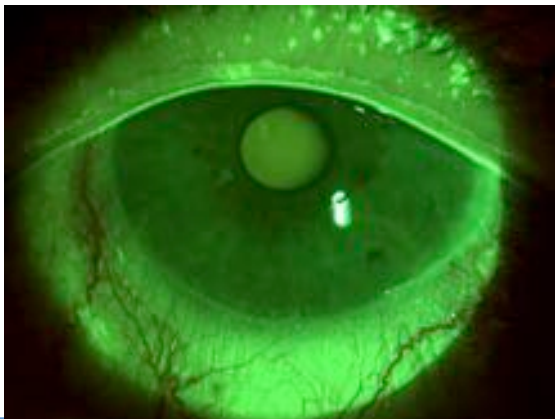
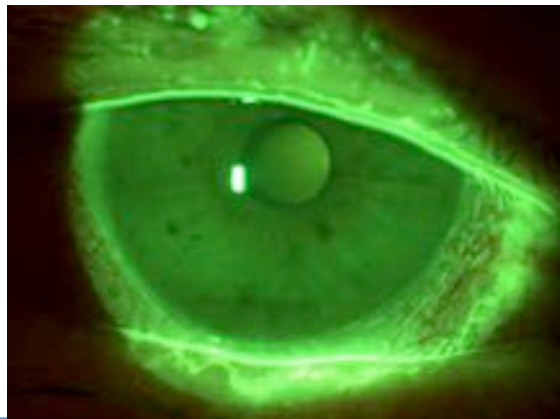
**linsen  
centrum**



## **1 months with ScCL**

Wearing time 3-4 hrs. / day

Symptomes better

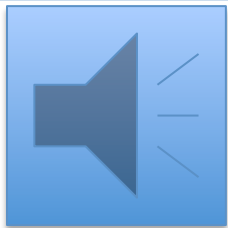


## **3 months with ScCL**

Wearing time 4-6 hrs./day

massive improvement of  
pain, photophobia

Almost not imaginable, how  
she could live without the  
lenses



# Take Home Message

**linsen  
centrum**

- Various pathological expositions keratitis can be supplied with scleral lenses and greatly improved
- Try different insertion fluid and post-wetting cocktail for the best combination
  - Autologous serum
- Large-scale corneal erosions can heal faster with scleral lenses than only with surface wetting (literature)
- **„Patient AND Doctor education“** 😊



# Protective Role of Scleral Lenses

linsen  
centrum

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6. Rosenthal, P., Cotter, J.M., Baum, J., 2000. Treatment of persistent corneal epithelial defect with extended wear of a fluid-ventilated gas-permeable scleral contact lens. *Am. J. Ophthalmol.* 130, 33–41.
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11. Weber, S.L.P., de Souza, R.B., Gomes, J.Á.P., Hofling-Lima, A.L., 2016. The Use of the Esclera Scleral Contact Lens in the Treatment of Moderate to Severe Dry Eye Disease. *Am. J. Ophthalmol.* 163, 167-173.e1. <https://doi.org/10.1016/j.ajo.2015.11.034>
12. Weyns, M., Koppen, C., Tassignon, M.-J., 2013. Scleral contact lenses as an alternative to tarsorrhaphy for the long-term management of combined exposure and neurotrophic keratopathy. *Cornea* 32, 359–361. <https://doi.org/10.1097/ICO.0b013e31825fed01>
13. Zaki, V., 2017. A non-surgical approach to the management of exposure keratitis due to facial palsy by using mini-scleral lenses: *Medicine* 96, e6020. <https://doi.org/10.1097/MD.0000000000006020>

# **COSMETIC/ PROSTHETIC SCLERAL LENSES**

Partial or full occluding scleral lenses

# **CASE #8 PRIMARY HYPERPLASTIC VITREOUS**

# Case #8 primary Hyperplastic Vitreous

linsen  
centrum



# Case #8 primary Hyperplastic Vitreous

**linsen  
centrum**



15 yr. Girl without cosmetic CL



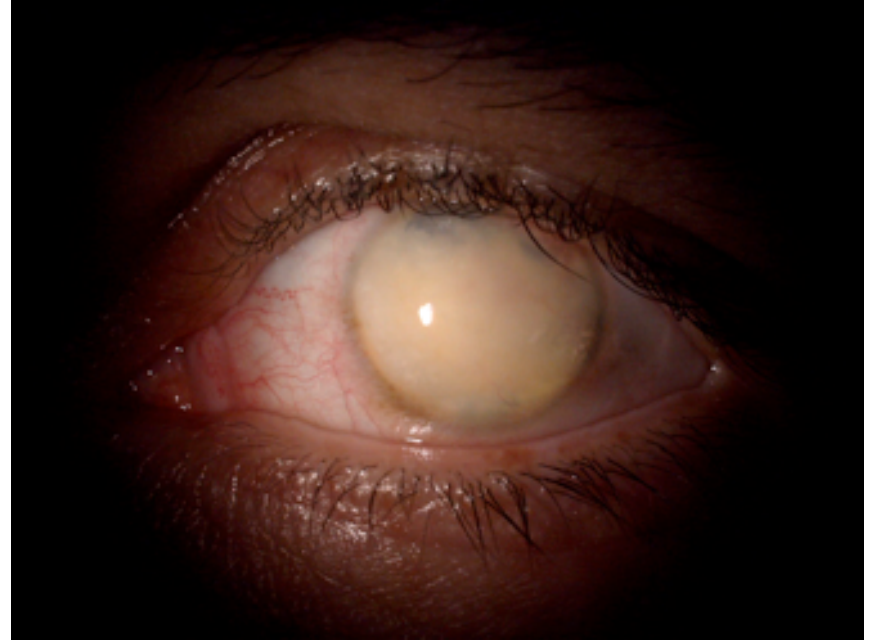
With cosmetic scleral lens:  
Black pupil 4.5mm on back surface

(minor ET by convergence on photo)

# **POST TRAUMATIC INDICATIONS**

# Case #9 Prosthetic Scleral Lens

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centrum

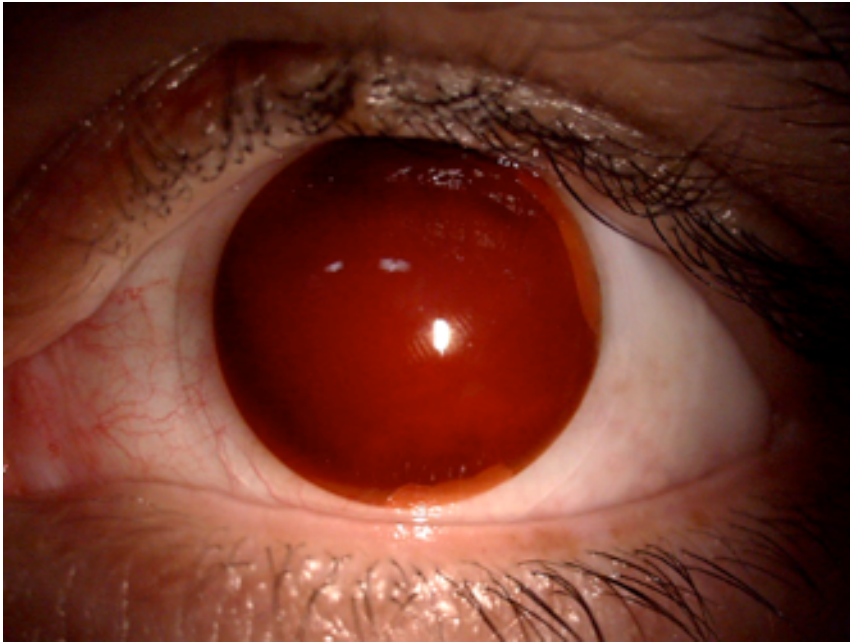


OD: Small caliber gun projectile injury with age 12 yrs., now 50yrs., Exo position

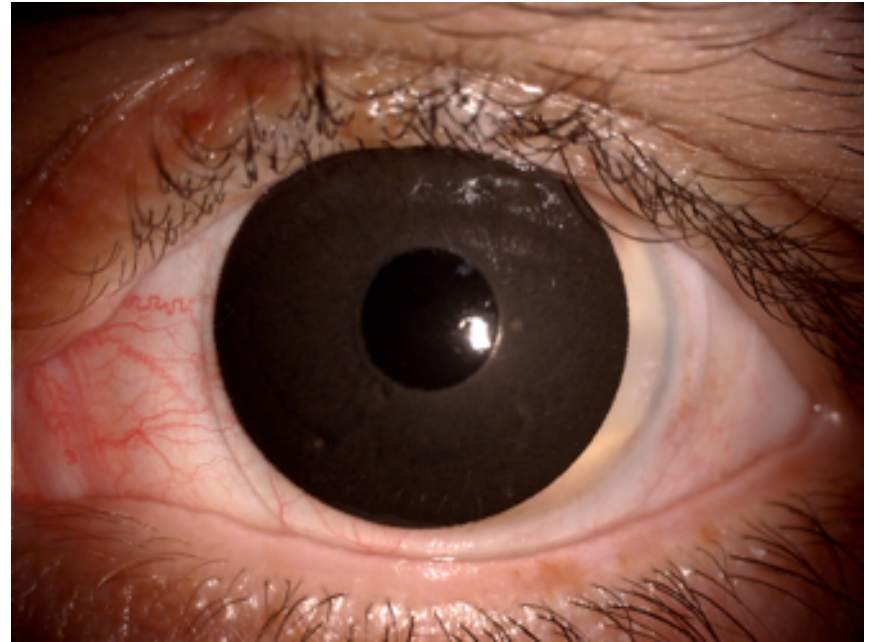


# Case #9 Prosthetic Scleral Lens

linsen  
centrum



OS: Old soft lens with brown tint  
in adduction (right gaze)

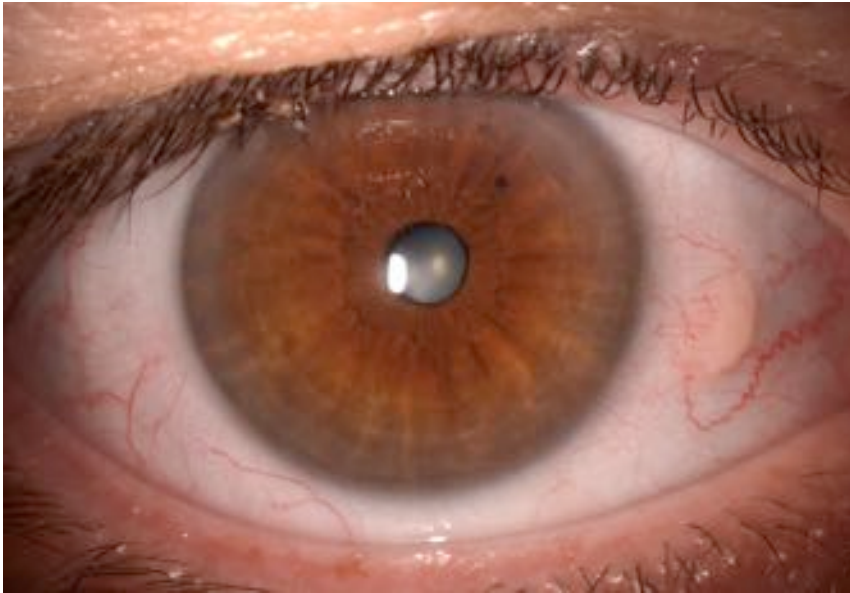


OS: full occlusion Irisprint on SCL, maximum  
Decentered, for as much Ortho appearance  
as possible



# Case #10 Prosthetic Scleral Lens

linsen  
centrum



OD: normal eye



OS: medium gun projectile injury, shrinking of the bulbus/cornea over the years.

# Case #10 Prosthetic Scleral Lens

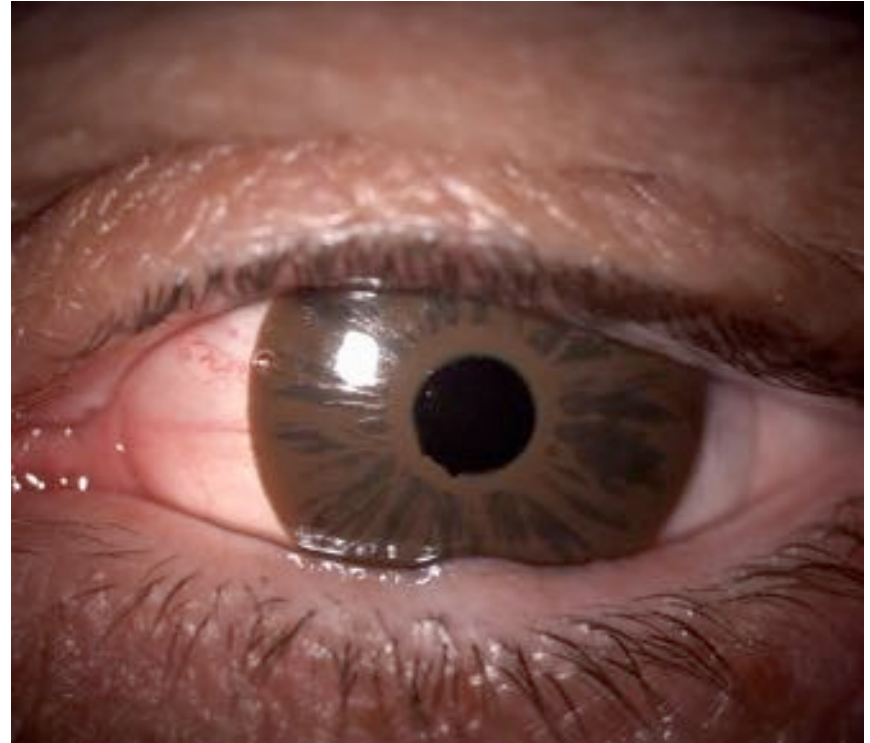
linsen  
centrum



- extreme decentered print
- extreme Scleral Toricity
  - ca. 1.5mm = 1500 $\mu$ m  
(height difference flat-steep)

# Case #10 Prosthetic Scleral Lens

linsen  
centrum



# Case #10 Prosthetic Scleral Lens

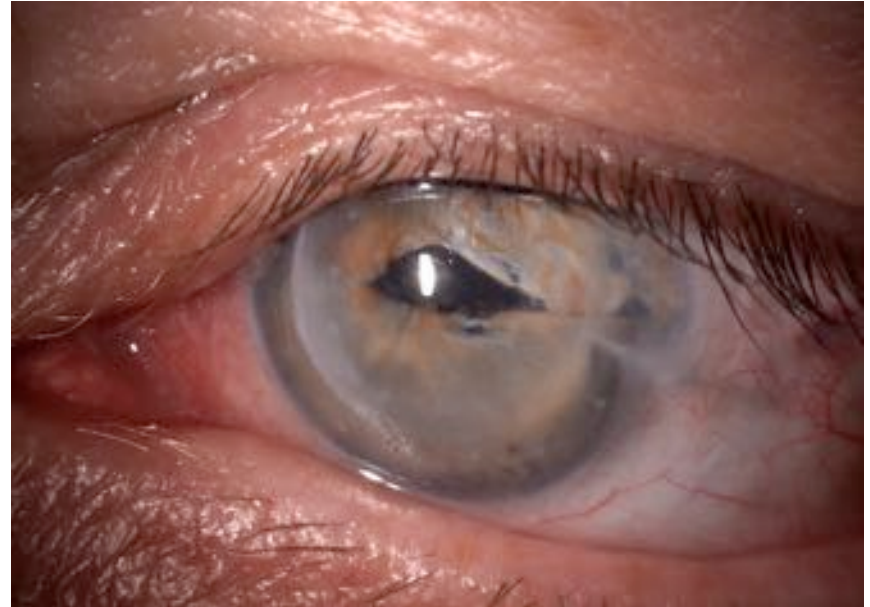
**linsen  
centrum**





# Case #11 Prosthetic Scleral Lens multiple traumata

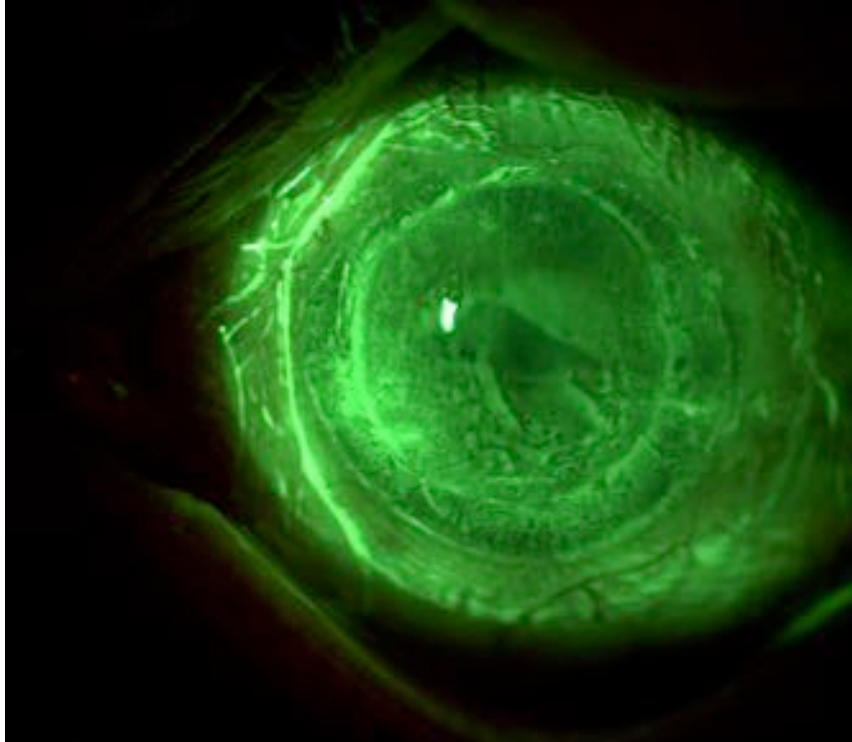
**linsen  
centrum**



3 Injuries on 3 different occasions on the left eye, KP, Re-PKP, IOL, Iris reconstruction

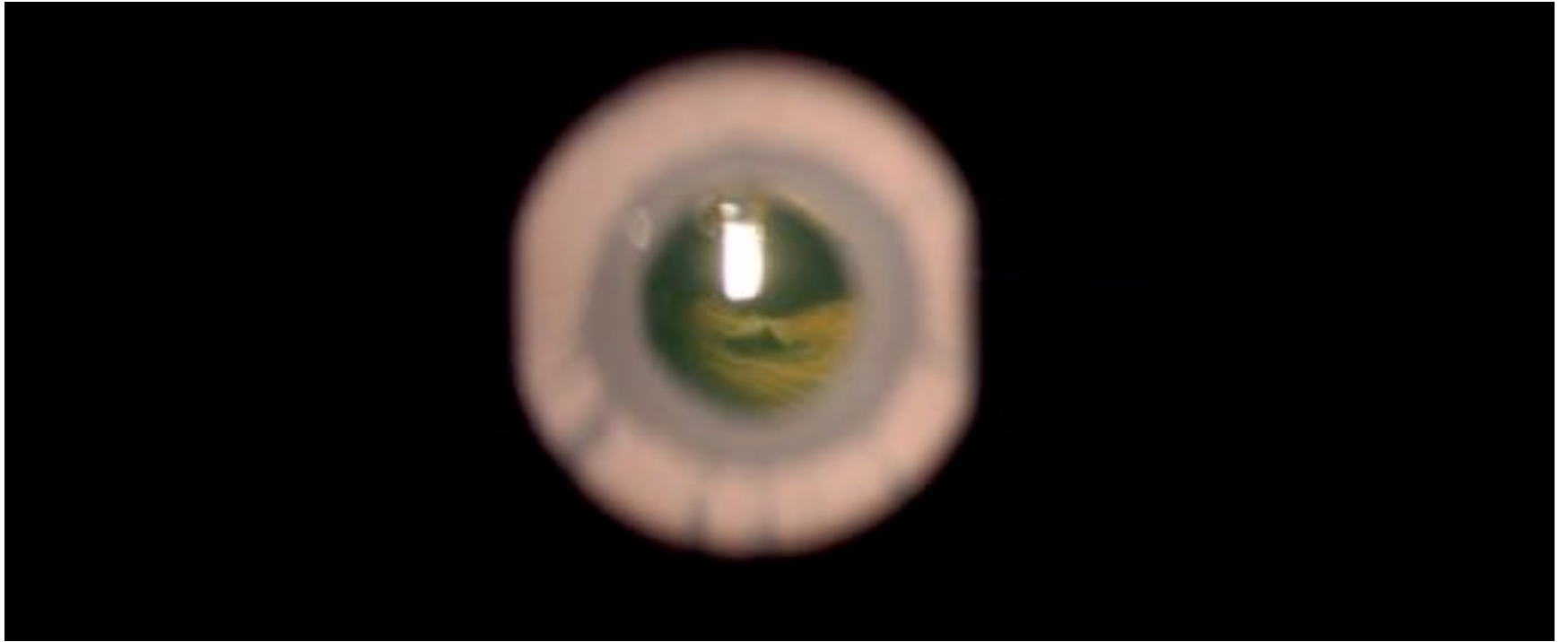
# Case #11 Prosthetic Scleral Lens multiple traumata

linsen  
centrum



# Case #11 Prosthetic Scleral Lens multiple traumata

linsen  
centrum



# Case #11 Prosthetic Scleral Lens multiple traumata

**linsen  
centrum**





# Case #11 Prosthetic Scleral Lens

## multiple traumata

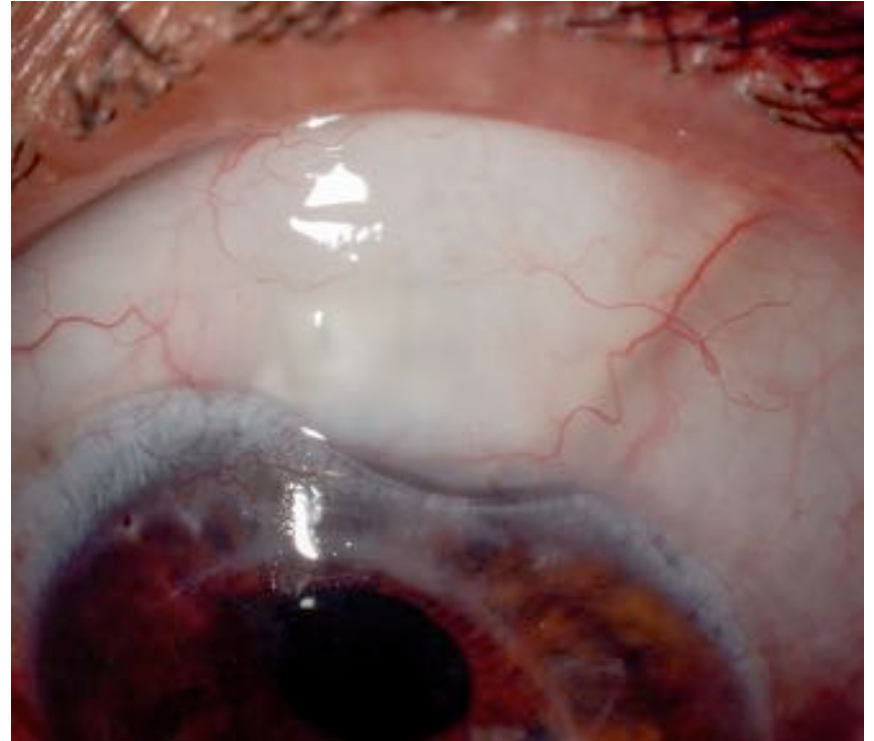
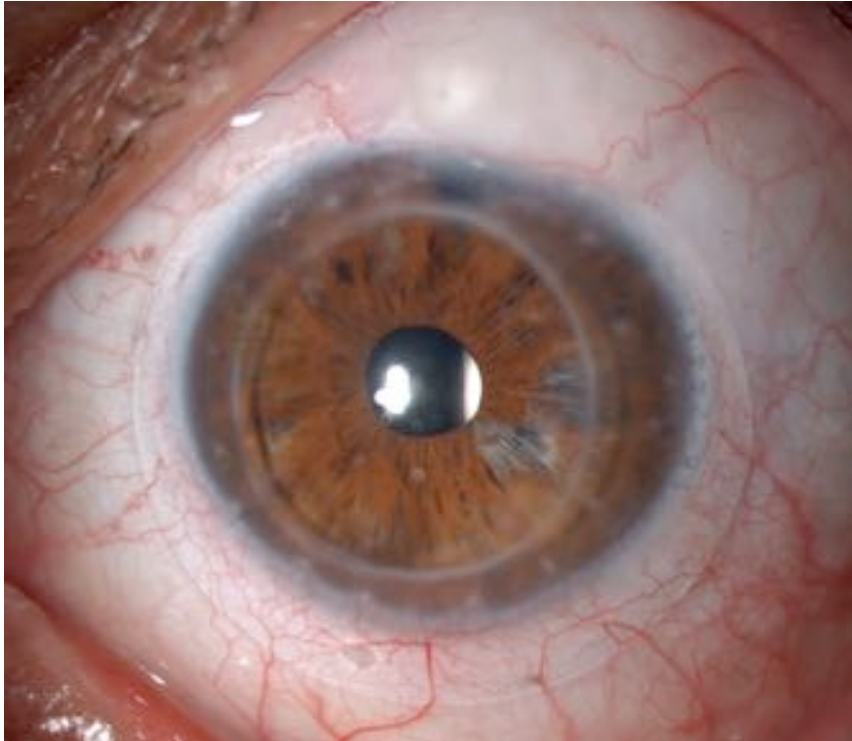
linsen  
centrum

- $Vis_{sc}$ : <0.05
- $Vis_{cc}$  Skleral o Print: 0.2p
- $Vis_{cc}$  m. Print: 0.5p
- Challenges:
  - Scarring Cornea and Sclera
  - Centering the print to subj. visual axis

# **LIMITS AND CONTRAINDICATION OF SCLERAL LENSES**

# Filtering bleb

linsen  
centrum



# Filtering bleb

- Notching possible to avoid blockage of aqueous outflow
- Watch IOP!!!
- Instruct for glaucoma drug application befor and after scleral lens wearing
  - Apply drugs at least 15min prior to lens insertion

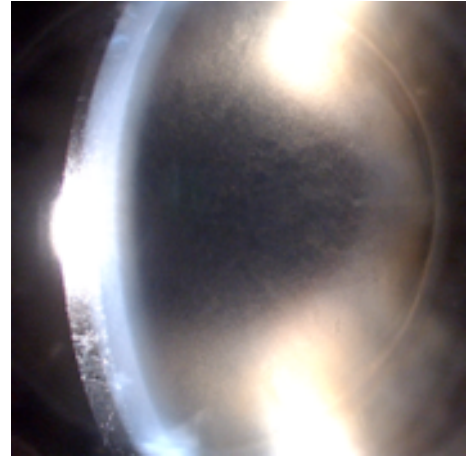
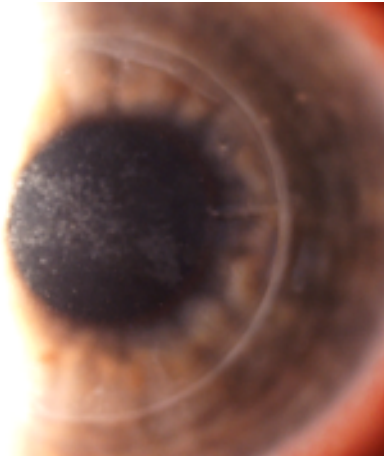
# Buphthalmus

- Cornea diameter 16.8mm
- Extremely low IOP
- Unstable sclera and cornea
- Movie:  
scleral lens with diameter  
16.0mm



# Endothelial decompensation

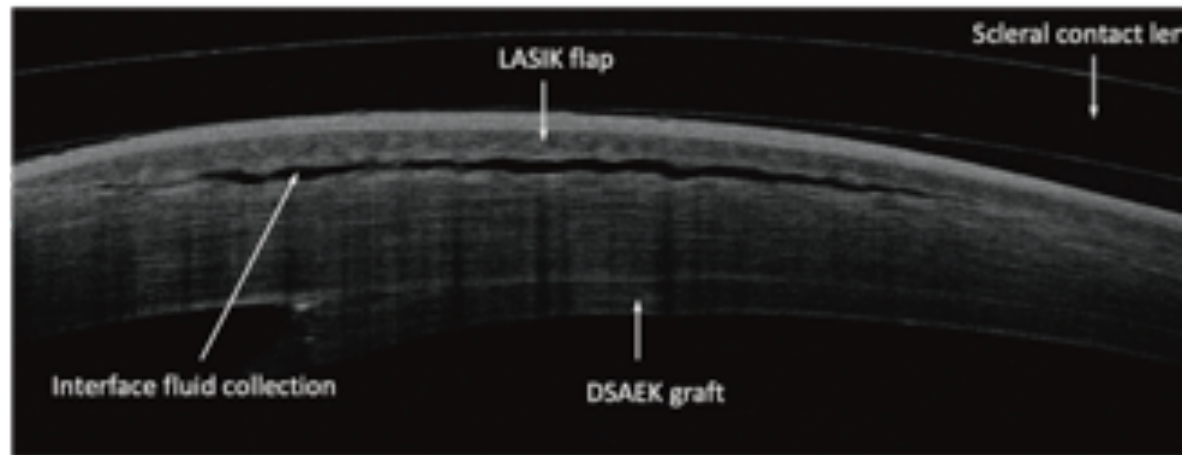
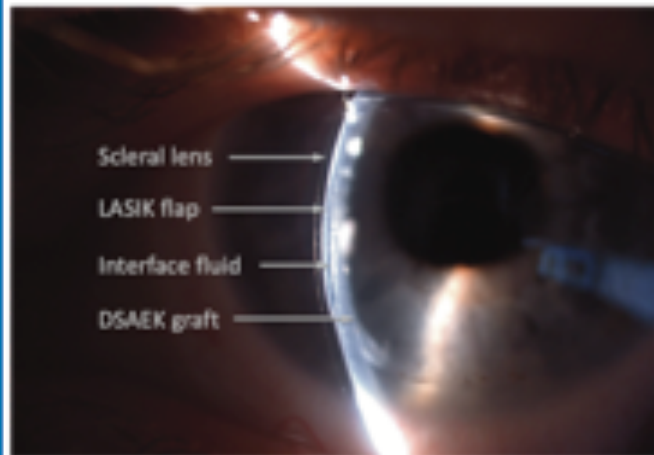
- Endothel cell count  $<800 \text{ z/mm}^2$  is usually the limit for modern Scleral lenses
- Dekompensation
  - Alte pKP, DSAEK & DMEK
  - Endothel Dystrophien,...



# INTERFACE FLUID SYNDROME INDUCED BY SCLERAL CONTACT LENS

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Low endothelial cell count after pKP

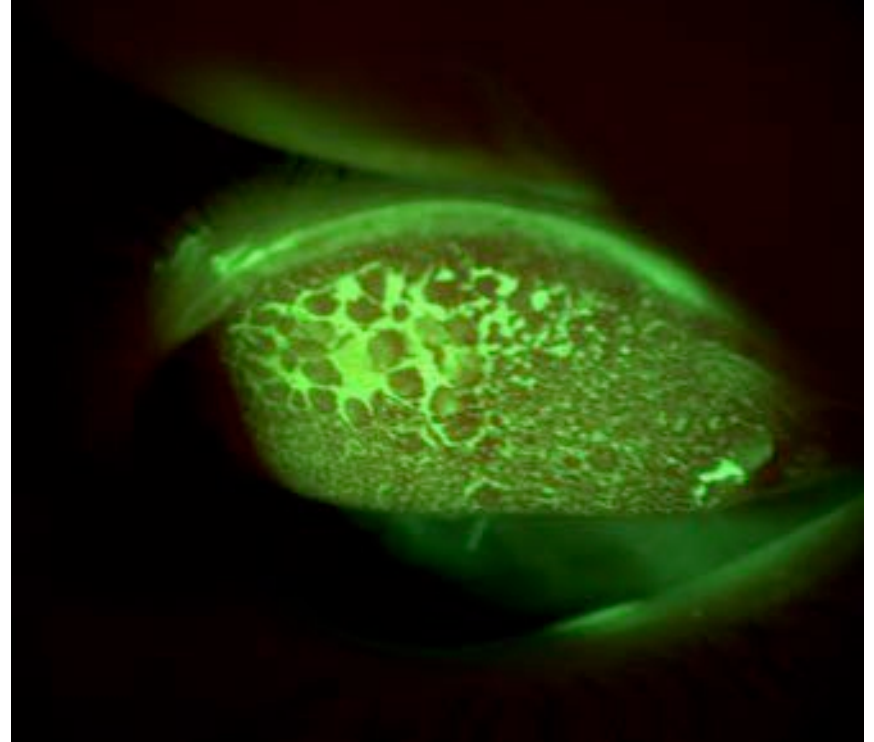
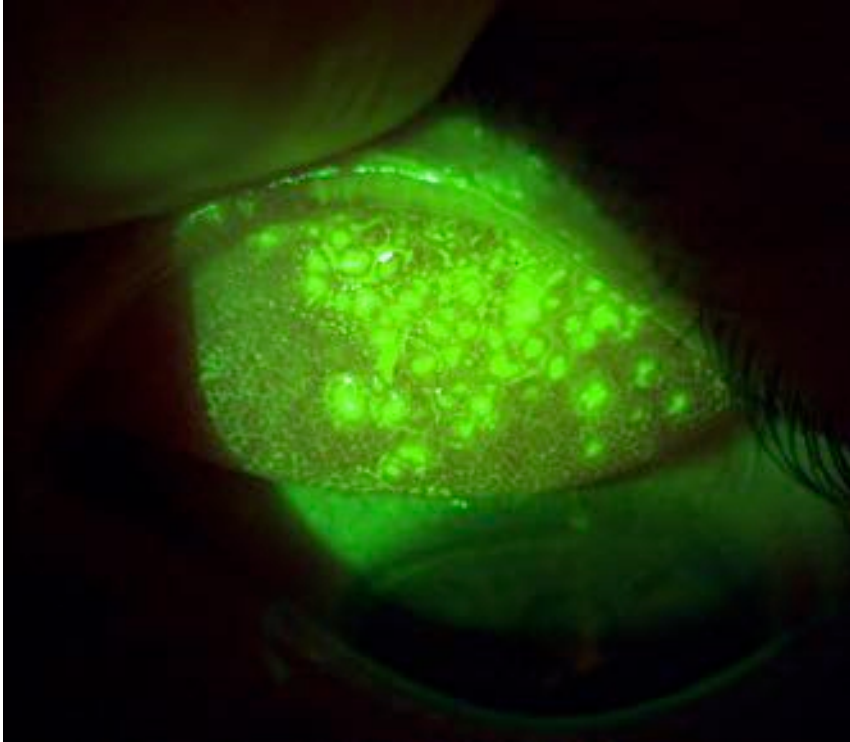
- $< 800-1000$  c/mm<sup>2</sup> may cause edema
  - Occasionally also possible with very low cell count
  - Insert scleral lenses after overnight edema is fully resolved, in the case of critical endothelial cell count
  - While wearing and especially after removing the lenses let patient check for Halo's

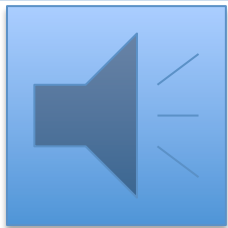


- Follicles can be caused by scleral lenses superior tarsal
- Cumulative ' denatured ' fatty acids on CL surface
  - Alcohol cleaner or combined sensitivity alcohol cleaner
- Chronic fluo-positive → coating scleral lens
  - Tangible™ Hydra-PEG
  - Better wetting & friction properties of the surface
  - Lower tendency for deposits
  - In most cases, an improvement in follicles
- Some cases have to be supported with steroid therapy

# Follikel

# linsen centrum





# Take Home Message

**linsen  
centrum**

- Scleral lenses can be applied in many pathological changes in cornea and can increase QoL substantially
- Apply creativity to your fitting experience of normal scleral lenses and strive for the best possible, tolerable and responsible lens fit
- Follow up, follow up, follow up, ...

**“Scleral Lenses of a Perfect World  
applied in an Imperfect World with  
the least possible Compromises!”**

# **Restore Vision & Improve QoL**

Markus Ritzmann

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