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SCLERAL LENSES:

POSSIBILITIES AND LIMITATIONS ON PATHOLOGICAL OCULAR SURFACES

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- Msc. Bsc. Optometrist FAAO FSLS SBAO
  - Fellow of the Scleral Lens Education Society since 2019
- Specialized in scleral lens fitting since 2012
- Head of specialty lens clinic Linsencentrum GmbH, Switzerland
  - >80% specialty lenses
    - 60% scleral lenses
    - 20% RGP's on irregular cornea
    - 20% Myopia controll

Disclosures

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

Objectives

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- Knowing the gerneral indications for ScCL
- Learn a practical ScCL fitting approach for a variation of ocular conditions
- Understand the possibilities, limitations and contra indications in pathological conditions

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INDICATIONS FOR SCLERAL LENSES

General indications for ScCL

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- Show a high wearing comfort and excellent optical imaging properties
- Are particularly suitable for irregular astigmatism
- Are also used therapeutically to protect the cornea or for cosmetic correction
- Can be further used for normal eyes for everyday activities, sports, hobby...

SCL for pathological cornea changes

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Indications for scleral lenses compared to other lens modalities

- Visual rehabilitation of irregular astigmatism
- Expositions keratitis, severe dry eye conditions
- Optic-Cosmetic indications
  - Iris defects
  - Partial or full occlusion

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PART I
IRREGULAR ASTIGMATISM

Irregular corneal conditions

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- **Main purpose: Visual rehabilitation for irregular astigmatism**
  - Keratoconus, PMD, Keratoglobus
  - Secondary Ectasias
  - traumatic or infectious corneal scarring
  - Various pathological irregularities

«Remember the optics!»

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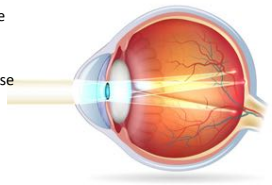
- Cornea is the first refractive surface (tearfilm)!
  - Responsible for roughly 2/3 of the total refraction of the eye
  - Every irregularity on the corneal surface in the optical axis will cause decresed vision



Bildquelle: Forest Eye Surgery

Optical indices

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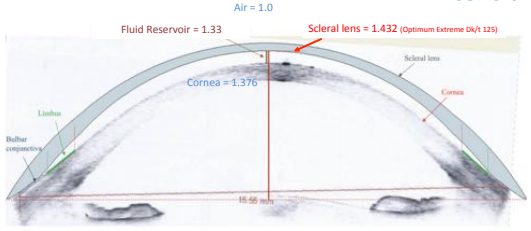

Abb: Clinical Guide for Scleral Lens Success Melissa Barnett, Daddi Fadel

«Remember the optics!»

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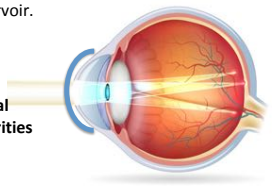
- Scleral lenses replace the first refractiv surface, vaults it and creates a new optical system with the fluid reservoir.
- → Eleminiation of most irregular astigmatism
- **All intra corneal, posterior corneal irregularities, scars, lens irregularities "cannot" be compensated!**



Bildquelle: Forest Eye Surgery

The «classic» case

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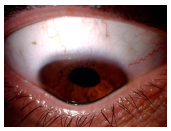

Keratoconus

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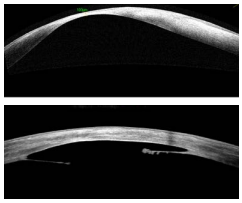
- ScCL's are well suited medium to high-grade Keratoconus including:
  - ICRS in Keratoconus
  - Post CXL
  - Post Hydrops
  - PMD
  - Keratoglobus



Keratoconus

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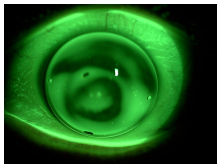
- ScCL's are alternative to RGP fitting
  - for unilateral fits
  - Comfort issues with RGP's
    - 3/9 Staining and irritation with RGP's
  - Apical erosions & scarring due to flat fitted RGP's
  - Extreme cones, steep base curves <5.50mm (limits of RGP's)
    - Lens movement almost impossible with parallel fits



Quant-specific KC lens
BCr_0: 5.40mm, x+50µm, Ø 10.60mm

Keratoconus

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- Often visual improvement compared to RGP's
  - VA often better and more stable due to «static seat» vs. unstable optics of corneal RGP lenses
- Beware with VA forecasts in mild Keratoconus
  - Low anterior corneal irregularities (Topography) with high «posterior float»
  - many times better VA with soft lenses
- «cerebral» Keratoconus
  - Neural adaptation: New scleral lens optics partly not tolerated

Keratoconus

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

Case #1 Keratoconus

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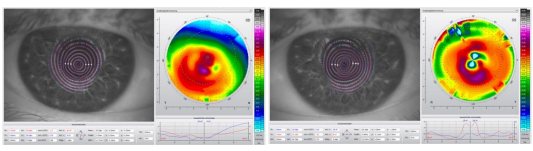
	$Vis_{cc\ CL\ old}$	Ref. (dpt)	$Vis_{cc\ glasses}$	K_{flat} (mm)	K_{steep} (mm)	
OD	0.5^{+3}	-8.25 -4.00 68°	0.2	5.96	5.72	Keratoconus
OS	0.3^{+2}	~-11.50	0.1	5.69	5.43 (manual capt.)	Keratoconus



Case #1 Keratoconus

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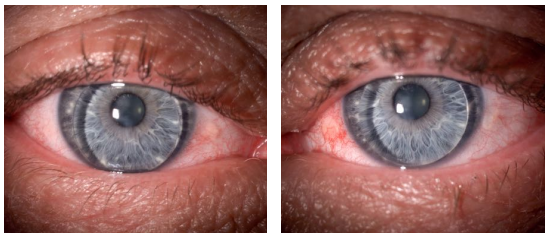

Case #1 Keratoconus

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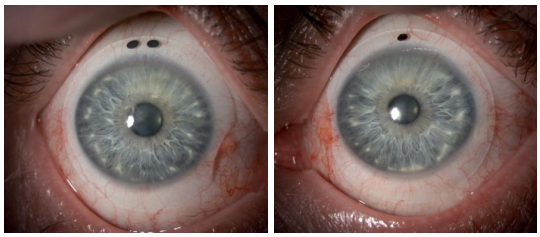

Case #1 Keratoconus

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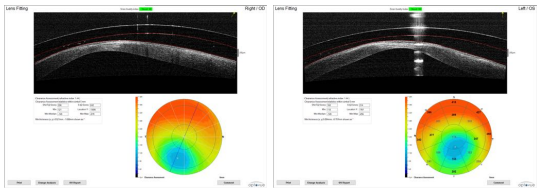

Case #1 Keratoconus

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- **Outcome**
  - Huge improvement in all day wearing comfort
  - Obvious reduction of conjunctival redness
  - 3/9 staining no longer occurred
  - Vis_{cc}: OD: 0.8pp (before 0.5^{+3}) OS: 0.6 (before 0.3^{+2})
- **Challenges:**
  - Piguecula notching necessary

Case #2 Unilateral Keratoconus with ICRS

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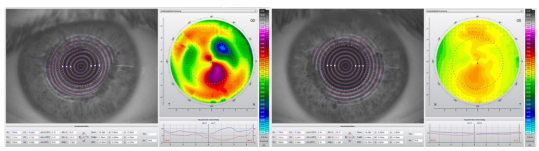
	Vis_{sc}	Ref. (dpt)	$Vis_{cc\ Brille}$	K_{flat} (mm)	K_{steep} (mm)	
OD	0.2p	+2.75 -4.50 46°	0.9p	7.89	7.17	KC with ICRS
OS	1.50	+0.25	1.50	7.79	7.59	normal



Case #2 Unilateral Keratoconus with ICRS

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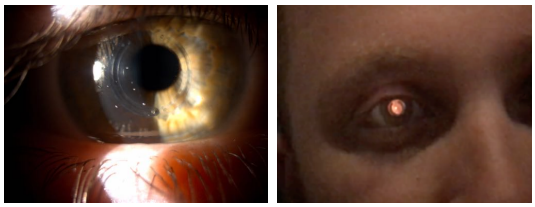

Case #2 Unilateral Keratoconus with ICRS

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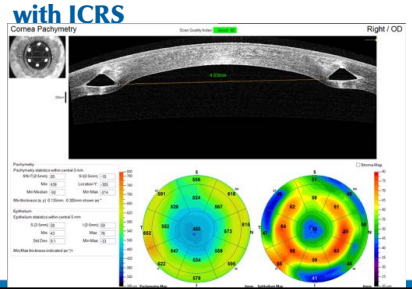

Case #2 Unilateral Keratoconus with ICRS

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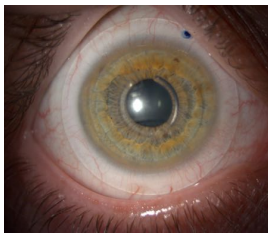

- **Outcome:**
  - Subj. good wearing comfort despite monocular lens fitting
  - VA increases from 0.2p to 1.2p
- **Challenges:**
  - Light-reflexes due to the ICRS remain at dawn to night time
  - ICRS usually present a difficult topography for fitting RGP's
  - scleral lenses usually simplify the fitting

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APENDIX KERATOCONE

Apical Clearence

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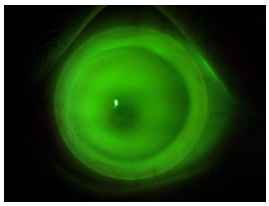
- Ensure clearance at the Apex after 2-3 weeks

- At the Apex as little as possible, as much as necessary
- In the second half of the day min 30-50 µm
- clearance <50 µm cannot be seen on Slit Lamp



Keratoconus

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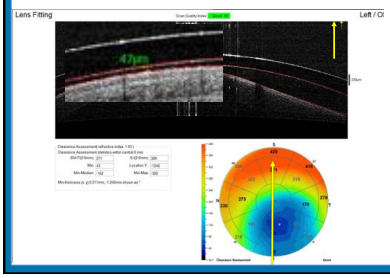

False KC-Progression

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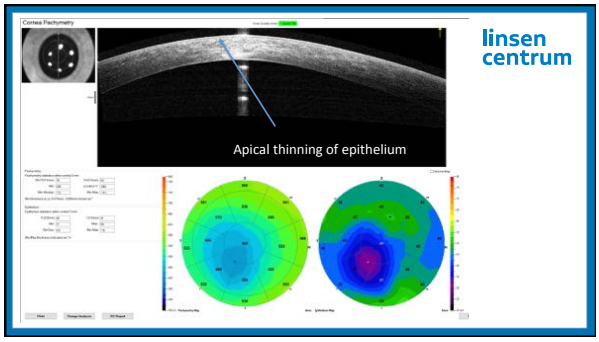
OCT vs. Topography vs. Scheimpflug

- Epithelial modulation before versus after scleral lens wear:
  - Epithelium is modulated by lid shear forces → Topographic surface regularization
  - Apparent progression (steeper K-values topographically) after scleral lens wear due to lack of lid shear forces
    → Epithelium thickens on Apex
  - Only if stroma is measured, "true progression" can be assessed in pachymetry



PMD

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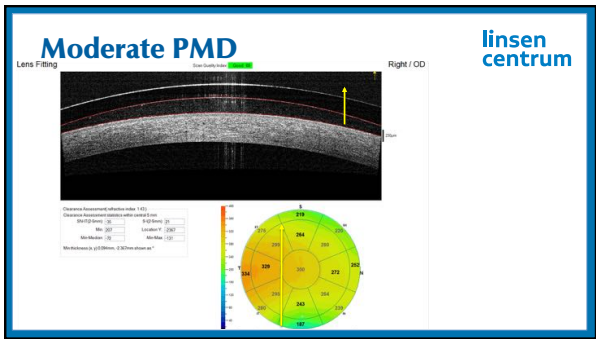
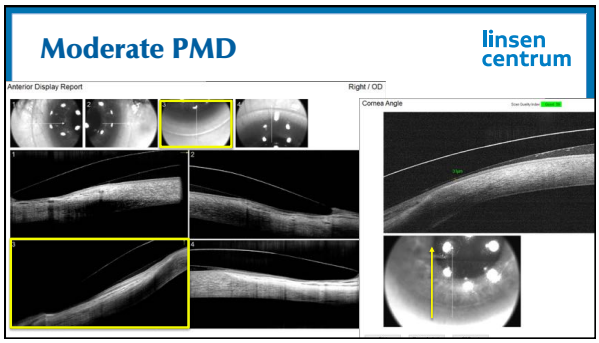
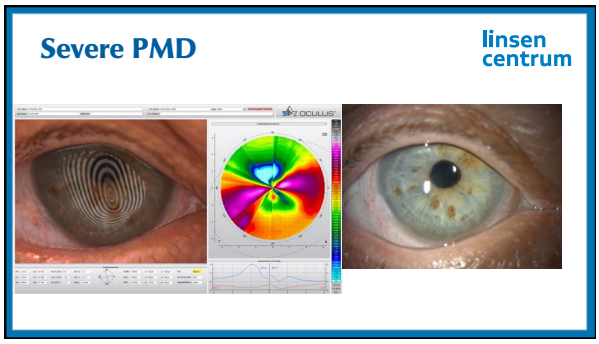
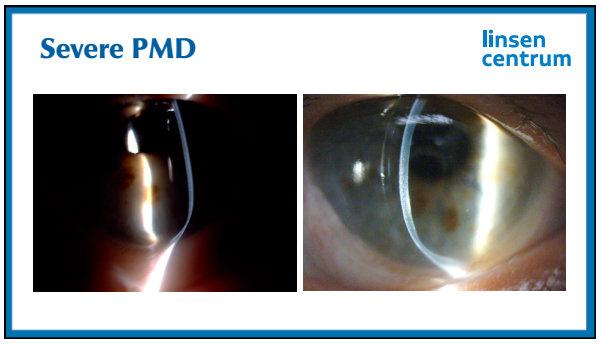
- Often compromise lens fitting depending on the nature of the PMD and its severity
  - Apex is extremely inferior in the limbal zone of the KL
    - Sometimes slight touch inferior at the Apex
    - OR slight conjuctival edema or conjunctival prolaps inferior
    - OR centrally too much clearence









Take Home Message

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ScCL in Keratoconus

- Mild KC: Consider other options
  - (always consider glasses, to reduce ScCL wearing time)
- Use your "inexpensive aberrometer": **Retinoscopy is a must!**
  - You see what the patient can see
- PMD: fitting of ScCL often with compromises
- ICRS: usually good indication for ScCL's
- Mind apical clearance
  - After lens settling
  - Follow-up: before removing ScCL's (SL or OCT if available)

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PART II
POST-OP CORNEAL CONDITIONS

Irregular astigmatism Post-OP

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- Perforating keratoplasty (pKP)
- Anterior lamellar keratoplasty (DALK)
- Graft restoration
- Radial keratotomy (RK)
- Post-Lasik
- Photo Therapeutic keratectomy (PTK)

Irregular astigmatism Post-OP

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

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KERATOPLASTY

pKP «Graft in niveau»

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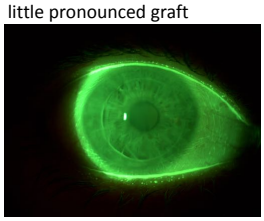
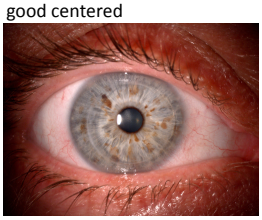
little pronounced graft



good centered



pKP «prominent graft»

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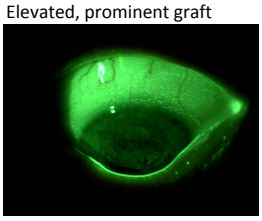
Elevated, prominent graft



Often more prominent inferior

pKP «extreme protruding graft»

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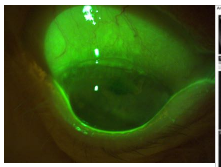
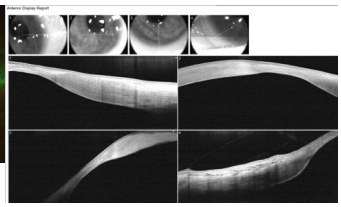
Severe elevation



wound dehiszenz in aging grafts



Revers Geometry for pKP

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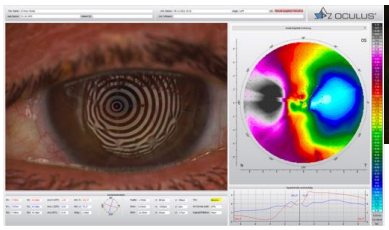

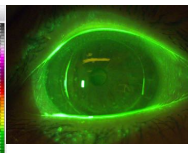

Horizontal incisions for astimatism reduction post pKP

Revers Geometry for pKP

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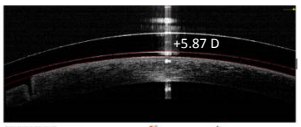

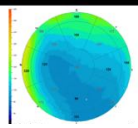

- High oxygen supply
  - High Dk material
  - Low CT of the Lens
    - Difficult to achieve in «plus» powers
  - Revers-geometry to avoid excessive central clearance

Revers Geometry for pKP

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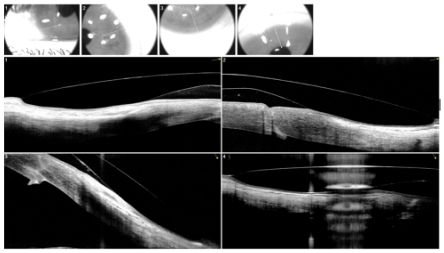

Fitting post-pKP with suture threads

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Improve visual performance with ScCL's due to high irregular astigmatism post-OP

- Caution
  - Wait for the surgeons OK to fit ScCL
  - From 2-6 months depends on:
    - visual demand contra lateral eye
    - Surgery and healing progress/ complication
    - Visual outcome of the graft

Fitting post-pKP with suture threads

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- Challenges
  - High oxygen demand (= minimal clearance)
  - BUT: Difficult topography profiles
    - Often very flat "crater-like" central zone
    - Steep Limbal transition zone → Suture Edema
  - Don't touch the wound suture

Fitting post pKP with suture threads

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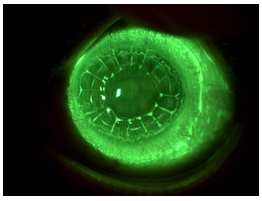
Swollen wound edges

Fitting post pKP with suture threads

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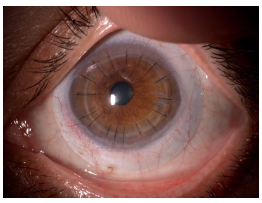
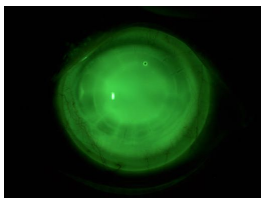

Fitting post re-pKP with suture threads

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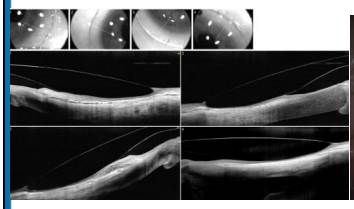
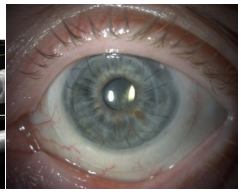
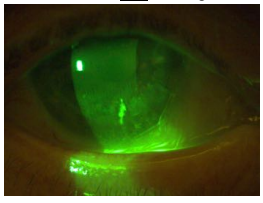



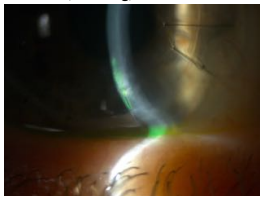
Loose Threads!

linsen centrum

More FB-sensation **after** removing ScCL!



Filament, staining, thread is movable



Take Home Message

linsen centrum

- Different Keratoplasty topographic profiles and SAG's require advanced ScCL geometries
- Re-Grafts are lager in diameter (revers-geometry)
- Graft-Fitting with suture threads
  - Don't touch sutures
  - Instill topical drops (steroid,…) 15-30 before inserting ScCL's
  - Follow-up closely and check for loose threads

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REFRACTIV SURGERY

Refractive Surgery

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- Visual demand & complications post refractive surgery
  - Post LASIK,…
  - Radial Keratotomy RK
- Topography:
  - Flat BC, relatively steep periphery
  - RGP's often do not centre due to the flat radii
- After ScCL wear more pronounced flap edges or radial incisions
  - Guess: Missing Lid shear forces for surface regulation
  - influences of insertion fluid to the surface bogging („bath-tub syndrome")

Post LASIK with complication

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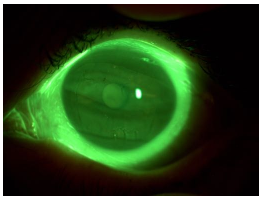
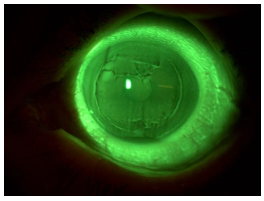
Pre ScCL wear



Post ScCL wear



RK with visual demand

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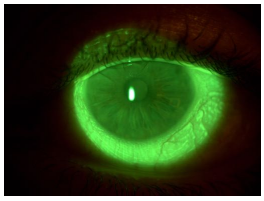
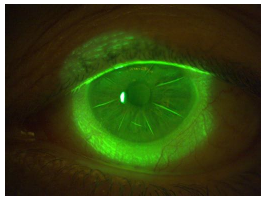
Pre ScCL wear



Post ScCL wear



Radial Keratotomy

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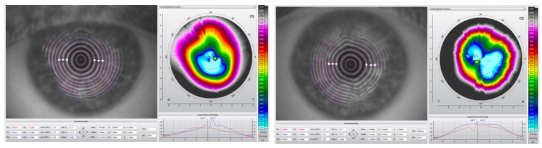
	Ref. (dpt)	Vis cc Brille	K_{flat} (mm)	K_{steep} (mm)	
OD	+7.00 -2.00 141	1.0p	9.86	9.48	Rad. Keratotomy
OS	+7.00 -1.25 124	1.0p	9.52	9.06	Rad. Keratotomy



Radial Keratotomy

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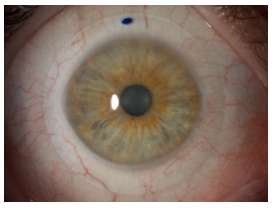

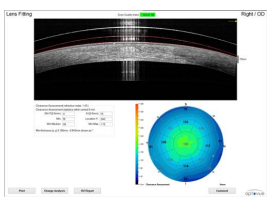

Take Home Message

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 plus powers required (lens thickness increased)

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CORNEAL SCARRING & IRREGULARITIES

Corneal irregularities

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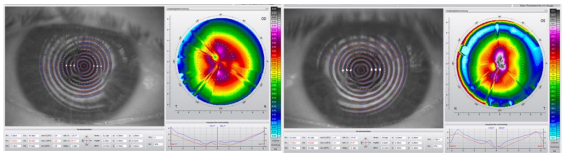
- Various pathological conditions
- Scarring
  - Infectious
  - traumata

Granular Corneal Dystrophy (GCD I)

linsen centrum

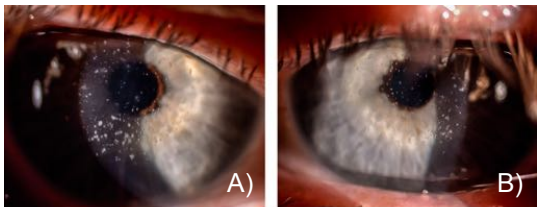


OD: Topo 2 Mon Post-PTK

OS: Topo 2 Mon Post-PTK

Granular Corneal Dystrophy (GCD I)

linsen centrum

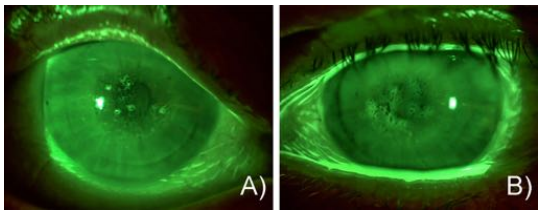


A) OD Post-PTK

B) OS Post-PTK

Granular Corneal Dystrophy (GCD I)

linsen centrum

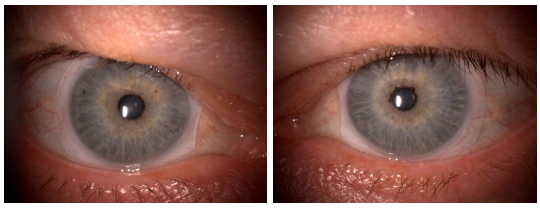


A) OD Post-PTK

B) OS Post-PTK

Granular Corneal Dystrophy (GCD I)

linsen centrum



Granular Corneal Dystrophy (GCD I)

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- Outcome:
  - Visus: OD: 1.2p OS: 1.0
  - Massive improvement of vision and quality of life ☺
  - Pt. Has not seen as good for decades ☺
  - High contrast, no double images and shadows, hardly glare at dusk ☺
- Challenges:
  - Pinguecula had to be relieved OU with notches nasally

Corneal scar

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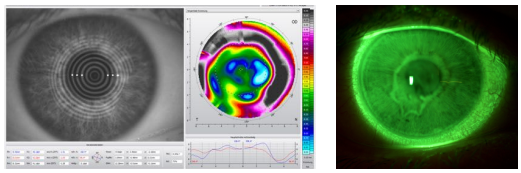
Monocular fit after infectious corneal central scar



Corneal scar

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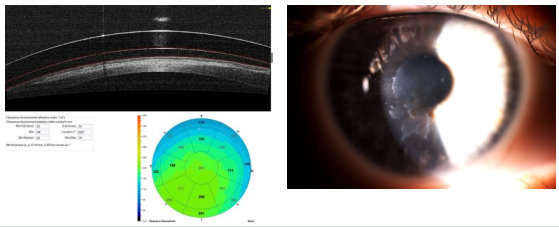

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PART IV
THERAPEUTIC INDICATIONS

ScCL therapeutic indications

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- Severe DED
  - GVHD, Sjögren, Steven Jonson
- Exposition keratitis
- Neurotrophic keratopathy
- Cosmetic / Prosthetic scleral lens fit
  - Congenital cosmetic changes
  - aquired traumatic changes

Lagophthalmus

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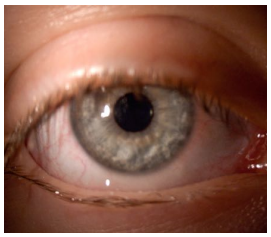

- Facialis paresis (CN 7)
- severe exposure keratitis, conjunctival injection and mild chemosis
- Subj. severe dry eye sensation, discomfort and pain, redness
- Fit of protective scleral lens

Lagophthalmus

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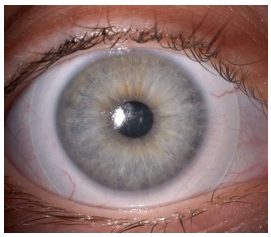

Outcome:

- massive improvement in subjective & objective symptoms
- despite eyepatch / wet chamber@ night Pt. Has red eye mornings
- EoD: redness is lowest in the evening with the lens

Challenges:

- Poor wetting due to only manual lid closure, ointments, gels,...

GVHD (Graft-Versus-Host Disease)

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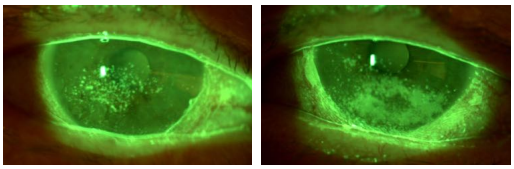
Autoimmune response after bone marrow transplantations :
Reduced lacrimation Keratoconjunctivitis Sicca
Dry sensation, pain, discomfort, photophobia



GVHD

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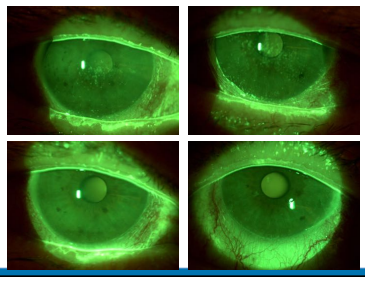

After 1 Month

ScCL's 3-4 hrs/day

Symptoms subj. strongly improved

After 3 months

ScCL's 4-6 hrs./day

Symptoms further improved, Pt. can no longer imagine how she had endured this before!

Protective Role of Scleral Lenses

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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

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OPTICAL- PROSTHETIC SCLERAL LENSES

Partial occluding scleral lenses

Optical-prosthetic ScCL

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- Visual rehabilitation combined with artificial iris aperture
  - Refractive errors
  - Corneal irregularities
    - Injuries or infectious
  - Congenital iris defects
  - Iris traumata
  - Surgery complications with iris defects

Optical-, Prosthetic, therapeutic ScCL after multiple injuries

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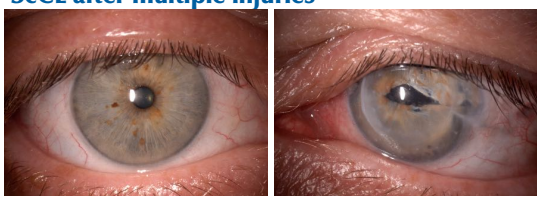

Truckdriver with 3 traumatic injuries on 3 different occasions on the left eye, KP, Re-PKP, IOL, Iris reconstruction

Optical-, Prosthetic, therapeutic ScCL after multiple injuries

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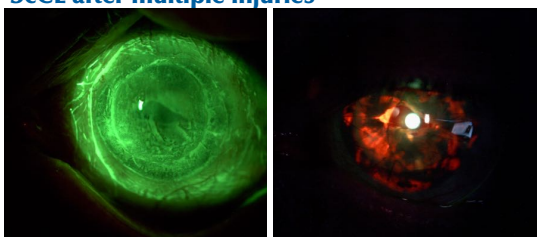

Optical-, Prosthetic, therapeutic ScCL after multiple injuries

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Vis_{sc}: <0.05 Vis_{cc} ScCL without iris print: 0.2p
Vis_{cc} ScCL with Print: 0.5p

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COSMETIC/ PROSTHETIC SCLERAL LENSES

Partial or full occluding scleral lenses

Prosthetic Scleral Lens

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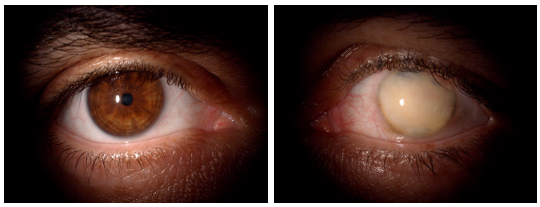

OD: Small caliber gun protectile injury with age 12 yrs., now 50yrs., Exo position

Prosthetic Scleral Lens

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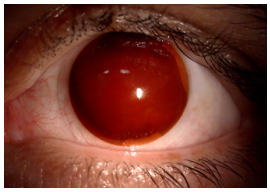
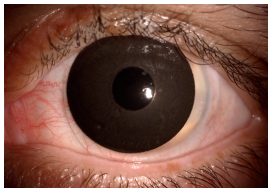


OS: Old soft lens with brown tint
in adduction (right gaze, comfort issues



New full occlusion print SCL, max. decentration, for ortho appearance
Huge comfort improvement vs. Softlens

Prosthetic Scleral Lens

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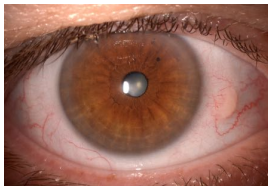
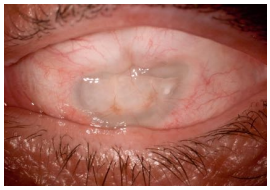


OD: normal eye



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

Case #11 Prosthetic Scleral Lens

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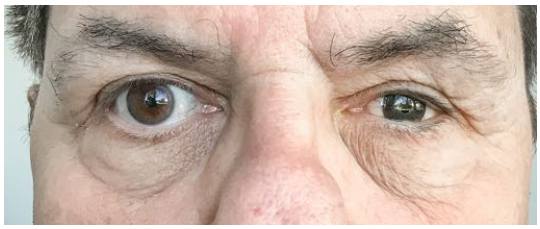

linsen centrum

SCLERAL LENS LIMITATIONS AND CONTRA-INDICATIONS

Filtering bleb

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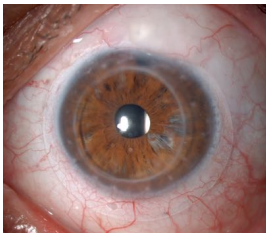
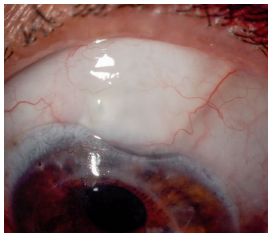
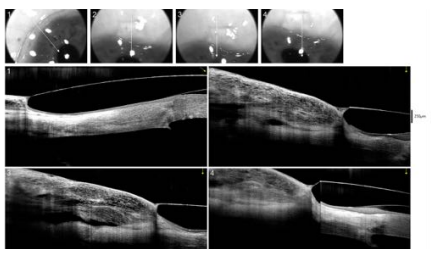




Filtering bleb

linsen centrum



Caution with Filtering blebs

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

Buphthalmus

linsen centrum

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

Endothelial cell function

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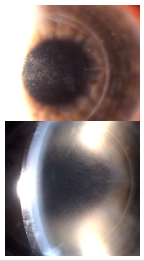
Low endothelial cell counts with aging grafts:
< 800 c/mm² may cause edema

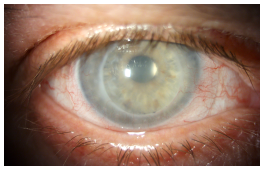
- Occasionally possible with very low cell count
  - Perform a «Stress-Test» with ScCL
- Insert scleral lenses after overnight edema is fully resolved, in the case of critical endothelial cell count
  - let patient check for Halo's
  - if patient has marked overnight edema, indicates low success for ScCL's



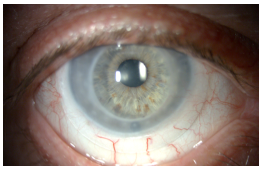
Graft decompensation

linsen centrum

Graft decompensation with scleral lens



Post DSAEK: same lens geometry but refractive change +2 D



DSAEK

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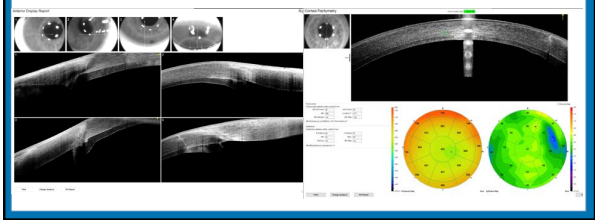
ScCL refit 6 weeks post DASEK



Endothelial «Stress-Test»

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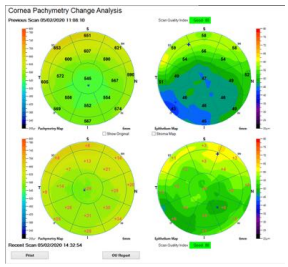
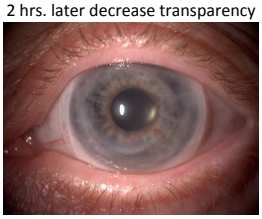


2 hrs. later decrease transparency



Re-perforation Keratoplasty

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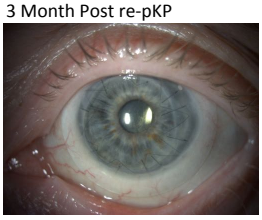
3 Month Post re-pKP



- Patient ☺ has not seen as good for several decades as after the re-pPK with ScCL
  →Contra lateral re-transplant will follow

Interface fluid Syndrome IFS

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- Condition after LASIK, Fuchs dystrophy, DSAEK.
- IFS after scleral lens wear with DK/t 200 & minimal postlens reservoir of 30-40 microns.

Figure 1 Interface fluid on slit lamp examination Figure 2 Interface fluid collection on anterior segment OCT

DOI: 10.1055/a-1068-8896 Klinische Monatsblätter für Augenheilkunde 2020; 237(04): 406 - 407

Extreme and old Corneal-Grafts

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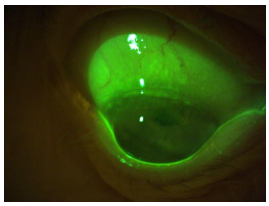

- With extreme grafts
  - High SAG's required
  - suction forces ↑
  - Air bubbles ↑
  - Conjunctival prolapse ↑

Extreme and old Cornral-Grafts

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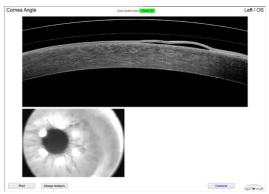

- Sometimes sup-epithelial fluid can occur

What's the solution?

→ Back to the roots:

- Smaller diamter
- Corneal bearing
- ventilation

Corneo-Scleral fit with ventilation

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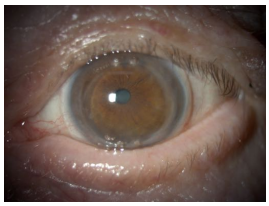

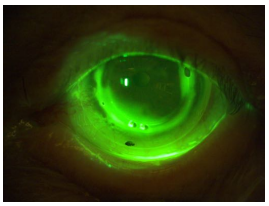

Take Home Message

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- Scleral lenses can be applied in many pathological corneal changes and can increase QoL substancially!
- 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, ...

Clincal pearls

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- Check Pachymetry (KC progression, graft edema,…)
- Use your retinoskopy skills as «vision analyzer»
- In low KC consider other options i.e. soft disposable lenses
  - Always measure refraction and consider glasses, to reduce daily ScCL wearing time
- Instruct patients in correct drug application with ScCL's
- **Be careful but with a good grain of boldness!**

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Restore Vision & Improve QoL

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THANK YOU…

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