

**Therapeutic Contact Lenses  
Keratoconus & Beyond**

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1

*Michael DePaolis, OD, FFAO  
Financial Disclosure Statement*

- Associate Professor of Clinical Ophthalmology  
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- Optometric Editor, Primary Care Optometry News
- No disclosures

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2

*Therapeutic Contact Lenses – Keratoconus & Beyond*

*So, is there an underlying theme here ?*

*Like with all other clinical entities ... stuff happens ...*




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*Therapeutic Contact Lenses – Keratoconus & Beyond*

*Which corneal conundrums benefit from therapeutic contact lenses?*

- Keratoconus / Pellucid's Marginal Degeneration
- Refractive surgery: RK, PRK, and LASIK
- Keratoplasty (PTK, DALK, and PKP)
- Corneal Collagen Cross Linking (CCXL)
- Corneal Dystrophies, Trauma & Infections
- Significant OSD (Sjogrens, GVHD, LSCD)

*What is our rationale for prescribing contact lenses?*

- Perioperative Adjunct
- Visual Restoration

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*Therapeutic Contact Lenses – Keratoconus & Beyond*

*How has cornea structure and function been altered?*

- Epithelial, stromal, and endothelial involvement
- Ocular surface integrity
- Neurotrophic considerations

*What does the corneal topography look like?*



- 'Refractive' zone regularity & centration


*What refractive "demons" are we dealing with?*

- Higher order aberrations (Gemoules Eye & Con Lens 2005)

*Are there additional ocular co-morbidities to consider?*

- Glaucoma
- Graft vs Host
- HSV or HZV
- Sjogren's Syndrome

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*Therapeutic Contact Lenses – Keratoconus & Beyond*

**Increased popularity of scleral contact lenses due to ....**

- Improved fitting success
  - More O2 permeable materials & better designs
  - Better understanding of fitting relationship (AS-OCT, profilometry, impression technology)
- Expanded applications
  - Meridional elevation delta > 300u (Zheng GSL 2015)
- Challenges
  - Dynamic nature of fit
  - Average 112u settling over ~8 hrs (Kauffman OVS)
  - Mid-day fogging: CMC gtt in lens insertion (DeNaeyer CLS 2019)
  - Corneal Edema

*DK 120+, CT < 200u, VLT < 150u (Compan IOVS 2014)*

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Case study – GH 63 yom

Surgical history

- 8 incision RK OU / 8 incision enhancement OD
- Pilocarpine 0.5% OU prn
- Preoperative Rx
  - 1125 -050 x 175 / +175 = 20/30+
  - 950 -050 x 110 / +175 = 20/30+
- Biomicroscopy
  - Well healed 16 incision OD & 8 incision OS
  - No KCS or incision gaping OU

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7

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Case study – GH

Keratometry

OD 3325@150 & 3475@100  
OS 3525@100 & 3625@180

Refraction

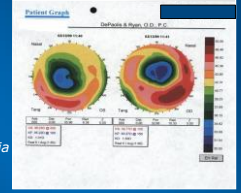
OD -275 -100 x 114 / +200 = 20/40-  
OS -300 -050 x 27 / +200 = 20/40-

Problem ?

Diurnal variations & monocular diplopia

Options:

- Additional surgery
- Contact Lenses



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8

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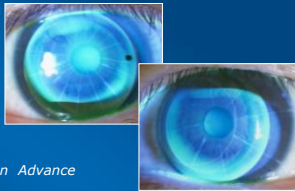
Case study – GH

Tx: BEO reverse geometry

OD 910 -700 98/80  
810(2nd)/1000(PC)  
OS 910 -550 98/80  
810 (2nd / PC)

- Optimal fit
- VA = 20/25 OU
- Wear time 12 hrs qd / Boston Advance

Problem ? Nuclear, cortical, and posterior subcapsular cataract



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9

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Case study – GH

Bilateral Cataract extraction with PC IOL

Challenges:

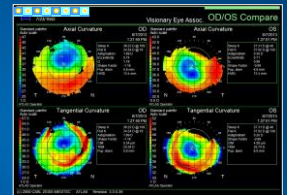
Previous RK  
Axial Length OD 29.3 OS 28.3

Post Op Refraction

OD +350 - 075 x 60 = 20/40  
OS +150 - 100 x 75 = 20/50

Problem ?

Still have diurnal fluctuations and suboptimal VA with spectacle Rx



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10

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Case study – GH

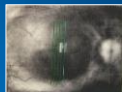
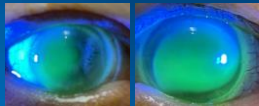
Zenlens Oblate (Boston XO2)

OD = 20/40  
OS = 20/50

- Wear Time 12+ hrs qd
- ClearCare qhs. PF Saline qam.
- Pilocarpine 1% prn.

Co-morbidities

- Strabismus (LSR recession)
- Myopic macular degeneration
- Preservision AREDS2



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11

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Case Study – GH additional considerations ...

- Would CCXL be of benefit?
  - Elbaz, etal Cornea 2014
    - N = 9 RK eyes CCXL restored stability
    - May wane over time

Piggyback IOL (IO aberrometry)?

- Curado, etal J Ref Surg 2019
  - N = 52 RK eyes using ORA
  - No better than Barrett True K

What about HOA correcting scleral lenses?

- Kumar, etal Con Lens Ant Eye 2029
  - Rose K2 XL scleral lenses in KCN, ICRS, RK, and PKP
  - HOA-RMS reduced 1.1u across all groups

Is a small aperture IOL the answer?

- Franco, etal J Ophth Vis Res 2022
  - N = 9 eyes with IR & HOA's implanted with IC-8 IOL
  - Improved quality of vision and QOL without peripheral VF constrictions



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12

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Clinical case – JV 44 YOF

Ocular history

- Previous EWSCLOU
- Bilateral acanthamoeba keratitis

Systemic history

- Borderline hypercholesterolemia. Hypovitaminosis D.

Chief complaint

- Blurred Vision with spectacles OU.
- Failed soft, GPCL, piggyback, and hybrid lenses
- Ocular medications:
  - Systane Hydration PF prn. Lumify prn.

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13

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Clinical case – JV

Visual acuity cc

- OD 20/40+
- OS 20/400

Biomicroscopy

- Mild LG conjunctival staining & tbut < 5 sec
- Corneal leukoma and NV OS > OD
- Symmetrical corneal sensation

Pachymetry

- OD 545 u & OS 553 u



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14

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Clinical case – JV

Refraction

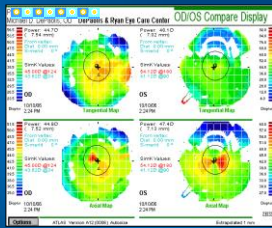
- OD -6.25-0.75x45 = 20/20
- OS -4.50-5.50x91 = 20/50

Topography

- Irregular astigmatism OU

Keratometry

- OD 43.62 x 45.00
- OS 41.12 x 54.12



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15

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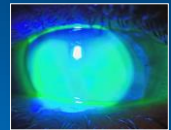
Clinical case – JV

Contact Lenses

- OD Zenlens RC FT (Boston XO2) = 20/20
- OS Zenlens RC (Boston XO2) = 20/20
- Good centration, adequate mvmt, ~100u vault OU.
- ClearCare qhs & PF saline qam.
- No water exposure!

Dry Eye Tx

- Adequate hydration, dietary omega 3's, vitamin D, & thermal mask daily
- Systane Hydration PF prn and HylolNight ung qhs



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16

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Case Study - JV additional considerations ...

- Seal, etal Eye 2003: Occur in 1:30,000 wearing years. 88% soft & 12% GPCL
- Joslin, etal AJO 2006 & 2007: 40 AK cases in Chicago 2003-2005. 6.67x increased RR & increased risk showering, reusing solution, and not rubbing
- Johnston, etal J Clin Microbiol 2009: 11 solutions ... only peroxide cysticidal
- Tu, etal Cornea 2008: Diagnosis before ring infiltrate for improved visual outcome
- Dart, etal AJO 2009: Diamadines and biguanides best treatment combination
- Said, etal Oph 2014: CCXL valuable adjunct in eradication of AK
- Naranino, etal AJO 2019: RB-PDT valuable adjunct in eradicating AK
- Naranjo, etal AAO 2019: Impavido (miltefosine) FDA orphan approval for AK
- Liu, etal Acta Oph 2020: meta-analysis links hypovitaminosis D with dry eye

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17

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Clinical Case – EB 79 yom

Ocular history

- Fuch's combined corneal dystrophy OU
- Penetrating keratoplasty (PKP) OD 1998 and OS 2000
- Cataract with PCIOL OU 2011
- PTK OS 2012
- HSV corneal ulcer OS 2012
- POAG – dorzolamide/timolol OU bid and brimonidine OU bid

Biomicroscopy

- Grade 2 meibomian gland dysfunction (MGD) OU
- Grade 1 conjunctivochalasis with tear prism < 1/2 mm
- PKP clear & compact OD / PKP trace epithelial & stromal edema OS
- TBUT 4-6 seconds OU

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18

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Clinical Case - EB

Refraction

OD Plano - 2.25 x 150 = 20/40+  
OS +2.00 - 5.00 x 117 = 20/60.

Keratometry

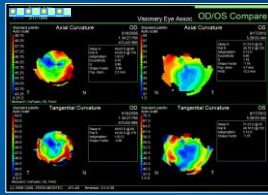
OD 45.00 @ 178 / 46.63 @ 88  
OS 46.10 @ 125 / 51.25 @ 35

Tonometry:

OD 17 mm Hg OS 17 mm Hg

Pachymetry:

OD 612u and OS 561u.



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19

Therapeutic Contact Lenses – Keratoconus & Beyond

Clinical Case - EB

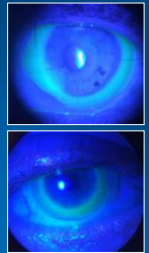
Contact Lens Data

OD Zenlens Oblate (Boston XO2) = 20/20  
OS Zenlens Prolate FT (Boston XO2) = 20/30

Boston Daily Cleaner & ClearCare qhs

PF saline rinse & insertion qam

Refresh Relieva PF insertion & prn



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20

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Case study – EB

Dry Eye treatment

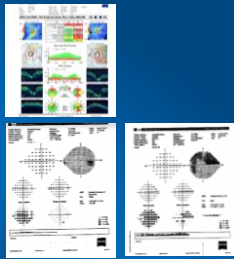
- Hot compress & lid hygiene qd
- Refresh Relieva PF prn
- Dietary omega 3's

POAG treatment

- Dorzolamide / Timolol OU bid
- Brimonidine OU bid

Corneal treatment

- Loteprednol OU qhs



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21

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Case Study – EB additional considerations ....

Are Scleral lenses indicated in this case? LaPorta, et al AJO 2016

- 41 eyes with moderate to severe dry eye refractory to standard tx
- improved BCVA, osmolarity, DE symptoms, and QOL scores

Does glaucoma impact graft survival? Stewart, et al AJO 2011

- UK registry 6255 grafts and 1994 grafts with glaucoma
- 3 yr survival: 86% w/o and 72% w glaucoma
- surgical mgt and endothelial dysfunction increase risk of failure

Do scleral lenses influence IOP? Shahnazi, et al Eye Con Lens 2019

- 46 eyes wearing scleral lenses for OSD
- mean decrease in IOP of 0.89mm

Michaud, et al Ophth & Physio Optics 2024

- Bruch's membrane opening – minimum rim width (BMO-MRW)
- BMO-MRW significantly thinner in KCN pts 6 hr of scleral lens wear

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22

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Case Study – EB additional considerations ....

Should we avoid a prostaglandin given history of HSV keratitis?

- He, et al Int Ophth 2023  
Canadian province registry of 20,000 glaucoma patients  
684 cases of HSV or HZV reactivation over 10 yr review  
No increased risk of reactivation with any of 4 glaucoma drug classes (PG's, BB, AA's, or CAI's) while adjusting for age / sex
- Dvived, et al Oc Im & In 2023  
case of bilateral HSV endothelitis in patient on prostaglandin  
confirmed HSV with PCR confirmation of AC tap  
responded to cyclo, pred, acyclovir  
no recurrence with dorzolamide-timolol

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23

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Clinical Case - JM 48 yom

Ocular history

- Dx PTSD, fibromyalgia, and OSA 2015
- Dx Pellucid's marginal degeneration 2016
- Corneal Collagen Cross-linking 2018
- Meds: Seroquel, Buspar, Cymbalta. C-Pap qhs.
- Halos & glare at night. Unable to drive.

BiOMICROSCOPY

- Grade 2+ MGD OU. Floppy eyelid OU.
- Grade 1 conjunctival chalasis with scant tear prism
- Pellucid's marginal degeneration clear s/p CCXL OU
- TBUT 6-8 seconds OU

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24

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Clinical Case - JM

Examination:

- Normal pupils, motilities, and CFVFs OU.
- IOP's: 10 OD and 14 OS.
- DFE: healthy NRR, vessels, macula, pos pole and peripheral retina

Refraction:

- OD Pre-CCXL -1.50-3.50x35 = 20/60 Post-CCXL +0.25-3.50x58 = 20/60
- OS Pre-CCXL -0.25-2.50x125 = 20/50 Post-CCXL +075-2.50x129 = 20/40

Simulated Keratometry:

- OD 45.82 x 48.79
- OS 44.63 x 47.14

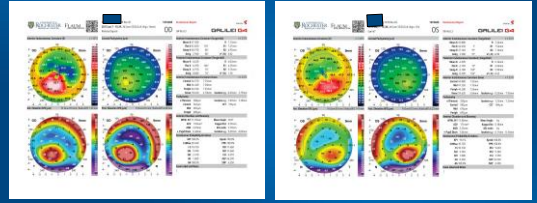
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25

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Clinical Case - JM



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26

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Clinical Case - JM

Contact Lens Rx: Zenlens Prolate Front Toric (Boston XO2) OU

- OD 20/25
- OS 20/25
- ClearCare qhs, Lacrasure PF Saline & Refresh Plus PF qam
- Pataday Once Daily OU prn
- Pilocarpine 1% OU bid prn

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27

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Clinical Case - JM additional considerations ....

- Keratoconus vs PMD  
PMD is rarer, starts later, but is progressive thru life. Tuminanapelli, et al J Cat Ref Surg 2013  
PMD narrow band of thinning 4-8 o'clock. Balin, et al AJO 2011  
PMD higher densitometry Koc, et al Eye (London) 2018
- Does stress play a role?  
Hair cortisol concentrations Lenk, et al JRS 2017  
Progressive KCN > stable KCN = controls  
Improved psychological distress & QOL s/p CCXL KCN Cingu, et al Eye Con Len 2015
- Contact Lenses & HOA correction  
GPCL reduced HOA-RMS 66% Gemoules & Morris Eye Con Len 2007  
Rose K2 XL reduced HOA-RMS 1.1u Kumar, et al Con Len Ant Eye 2019  
Scleral lenses improve CS, BCVA, and HOA profile in PMD Dutta, et al Ind J Oph 2024

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28

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Case study - CH 61 yof

Ocular history

- Soft contact lens wear 1985-1990. Saw dust in OS 2010.
- referred for 'corneal degeneration' OU.
- Dry eye with limited benefit from OTC AT's.
- C/O blurred vision, variable vision, & ocular irritation

Systemic history

- Hyperlipidemia. Pre-diabetes.
- Meds: Atorvastatin. NKDA.
- Family history: non-contributory

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29

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Case study - CH

- VA Rx OD 20/40+ & OS 20/150
- PERRLA (4mm) EOM full & smooth CF full to FC OU

Biomicroscopy

- moderate MGD with evaporative DE OU
- 6 clock hour limbal conjunctivalization OU
- scattered Salzmann's nodules OU
- grade 1 NS OU

Tonometry: OD 17 OS 18

Ophthalmoscopy

- Healthy posterior pole OU

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30

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Case study – CH

Topography

- Irregular astigmatism OU

OD

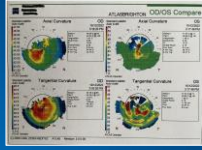
OS

Refraction

OD -1.00-3.25x133 = 20/40  
OS -0.50-5.25x134 = 20/50-

Biomicroscopy

- superior LSCD
- Salzmann's nodules



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31

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Case study - CH

Zenlens Prolate FT (Boston XO2)

OD 20/20

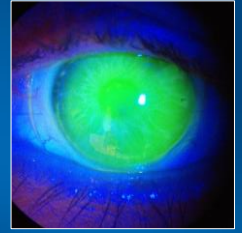
OS 20/25-

- Well tolerated with optimal fit
- ClearCare qhs. PF saline qam.

Ancillary considerations

- hydration, omega 3's, & vitamin C
- thermal mask daily
- Systane Hydration PF prn
- HylolNight ung qhs

Loteprednol pulse dose for flares



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32

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Case Study – CH additional considerations ....

Do scleral lenses make sense in LSCD?

Kim, etal. Eye & Cont Lens

- N = 31 eyes fit with PROSE for LCSD
- Improved BCVA (20/150 -> 20/60) and epithelial defect score
- Ocular surface instability (OIS) no change

Is vitamin C beneficial?

Gujal, etal. Ind J Ophth 2020

- Rabbit model to study wound healing
- 10% vitamin C beneficial (= acetylcysteine & vitamin E)

Stojanovic, etal. J Ref Surg 2003

- N = 515 eyes undergoing PRK w or w/o oral Vitamin C
- Less perioperative and late presenting haze in Vitamin C group

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33

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Case study – SS 50 yom

Ocular history

- LASIK OU 8 years prior
- Progressive ectasia OU
- C/O blurred vision, variable vision, & ocular irritation
- Prior wear of KeraSoft failed due to blurred vision

Systemic history

- Migraines. Hyperlipidemia. Pre-diabetes
- Meds: Atorvastatin. NKDA.
- Family history: non-contributory

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34

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Case study – SS

- VA Rx OD 20/80 & OS 20/50
- PERRLA (4mm) EOM full & smooth CF full to FC OU

Biomicroscopy

- Well healed LASIK OU
- Inferior corneal thinning OU
- Epithelial pigment deposition OU

Tonometry: OD 17 OS 18

Ophthalmoscopy

- Healthy posterior pole OU

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35

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Case study – SS

Topography

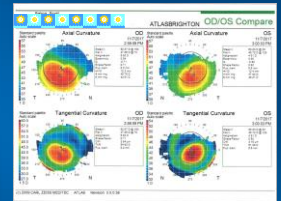
- Ectasia OU
- OD 47.05 x 52.87
- OS 45.72 x 50.23

Refraction

OD +1.00-8.00x75 = 20/80-  
OS -2.00-3.50x125 = 20/40-

Biomicroscopy

- no significant ocular surface disease



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36

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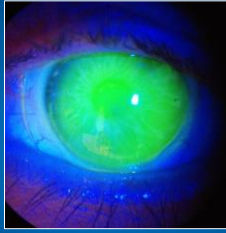
Case study - SS

Zenlens Prolate (Boston XO2)  
OD 20/25+  
OS 20/20-

- Well tolerated with optimal fit
- ClearCare qhs. PF saline qam.

Ancillary considerations

- Saline rinse & fill mid-day
  - Carboxymethylcellulose gtt
  - avoid excessive vault
- Goggles at work



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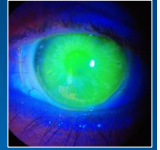
37

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Case study - SS

Not all therapeutic contact lenses end so well ...

- 2021 – DM with neuropathy
- 2021 – Corneal Collagen Cross-linking OD
- 2022 – Diffuse Lamellar Keratitis (DLK) OS
- 2023 – Limbal Stem Cell Deficiency (LSCD) OU
- 2024 – Polymicrobial Corneal Ulcer OD
- 2025 – Scleral Lens BCVA OD 20/40 & OS 20/20



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38

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Case Study – SS additional considerations ....

**Is corneal collagen cross-linking an option?**

- Greenstein & Hersh Trans Vis Sci Tech 2021
- US FDA multicenter trials
- Flatter K's, improved BCVA, & improved stability

**What about ICRS?**

- Poulsen & Kang Curr Opin Ophth 2015
- Improve corneal stability & Rx, but not aberrations
- Enhanced by CCXL

**Is mid-day fogging the 'demon in the closet?'**

- Fogt, et al Optom & Vis Sci 2020
- NutriFill saline = less mid-day fogging and improved OSDI scores
- Postnikoff, et al Invest Ophth & Vis Sci 2019
- increased vault and increased PMN's => mid-day fogging

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39

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Thank you for attending!

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40