Scleral Lens Complications: 2021 Update

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Objectives

- Review of scleral lens indications and fitting techniques
- Baseline testing and exam sequence
- Complications associated with scleral lenses
  - Fitting, application, & handling complications
  - Anatomical complications (conjunctival changes, staining)
  - Physiologic complications (IOP, edema)

The Scleral Lens

Indications for SL wear

- Irregular Astigmatism
  - Keratoconus
  - Pellucid Marginal Degeneration
  - Post-LASIK Ectasia
  - Post-Radial Keratotomy
  - Post-Penetrating Keratoplasty
  - Post-Infectious irregularities
  - Herpetic
  - Post-Scarring / Surgical
  - Penetrating injury scars
  - Suture irregularities

Sceral Lens Images

Indications for SL wear

- Ocular surface disease:
  - Graft versus Host disease
  - Sjogrens
  - Sarcoidosis
  - Rheumatoid Arthritis
  - Ocular surface exposure (post-surgical)
  - Neurotrophic Keratopathy
  - Neuropathic Ocular Pain
  - Limbal Stem Cell Deficiency
  - Ocular Cicatricial Pemphigoid
  - Familial Dysautonomia
  - Ocular Allergies
  - Steven's Johnsons syndrome
Diagnostic Fitting

Selecting a Diagnostic Lens

Are these eyes shallow or steep??

Scleral Lens Exam Sequence
- Visit 1: Baseline
- Visit 2: Dispense
- Follow-up: 1 week, 1 month, 6 months (year 1)
- 6mo - 1 year f/u on all pts

Baseline Exam
- Step 1: Evaluate disease state
  - Scarring
  - Neovascularization
  - Fibrosis

Baseline Exam
- Step 1: Evaluate disease state
  - Staining: Cornea & Conjunctiva
  - Eyelid health
  - Other: glaucoma? cataracts?

Baseline Data: Corneal Changes
- Corneal Pachymetry (global)
- OCT
- Pentacam
- Endothelial Cell Density
- Corneal Staining
- Neovascularization
- Corneal Scarring
- Watch out for...
  - Neo
  - Microsystic edema
  - Endothelial blebs, poly/pleo-morphisms
Baseline Data: Ocular health

- Visual acuity
- Intraocular pressure
- Conjunctival hyperemia
- Conjunctival “roadblocks”
- Retinal health

Scleral Shape: Beyond Torics

4 primary categories of shape
- Results suggest that the majority of eyes may benefit from custom back surface haptics beyond a toric design
- Measurement of the sclera allows for more efficient and accurate determination of lens design

Table 1: Scleral Surface Patterns Observed in 140 Scleral Lens Patients

<table>
<thead>
<tr>
<th>Group</th>
<th>Pattern Description</th>
<th>N (%)</th>
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<tbody>
<tr>
<td>1</td>
<td>Spherical</td>
<td>5 (5.7%)</td>
</tr>
<tr>
<td>2</td>
<td>Toric Regular</td>
<td>40 (28.6%)</td>
</tr>
<tr>
<td>3</td>
<td>Asymmetric High or Low Points</td>
<td>57 (40.7%)</td>
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<tr>
<td>4</td>
<td>Periodicity different from 180°</td>
<td>35 (25%)</td>
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</table>

Groups 3 and 4 have scleral shapes that are different from commonly designed spherical or toric haptic designs!
**OCT**

- (Optional) for SAG measurements when fitting
- Nice for monitoring hot spots of corneal ectasia (i.e. Kc apex, proud grafts)
- Corneal edema with SL

**Corneal Topography**

- Monitoring disease state
- Morphological changes with SL
- Corneal edema with SL

**Slit Lamp Evaluation of Lenses**

- White light
- Optic section
- 45 degree angle

**Evaluating the Limbus**

- Ectasia tear reservoir patterns
Landing Zone Assessment

The Landing Zone

Conjunctival/Scleral Bearing

Management:
- Flatten edge
- Customized designs (toric, quad specific)
- Increase diameter

Excess Edge Lift

- Steepen edge (25-30um per "step")
- Usually need 3-5 steps for significant change
- Customized designs (toric, quad specific)
- Reduce diameter

Using NaFl for Landing Zone

Using Lissamine Green & NaFl
Over-Refraction

- Be careful not to over-minus
  - Max plus to max VA & duochrome test
- Sphero - cylinder
  - ~30% will need toric power
  - First lens: only Rx toric power if >0.75D
  - Stabilized with prism ballast (spherical haptic) or toric haptic zone
  - Tip: If Rx’ing toric power, put on a toric haptic trial lens

Presbyopia

- Front surface asphericity
  - Not a true multifocal design
  - Small change in the optics may be adequate enough to improve near vision in early presbyopes
  - Multifocal optics
    - A scleral lens with multifocal optics was rare 10 years ago, but now nearly every lab offers at least one option

Multifocal Scleral Lenses

- Scleral lenses do not translate on the eye
  - Minimal movement/rotation and are very stable
  - Simultaneous vision multifocal designs are necessary
  - Majority center-near designs, but some labs offer center-distance designs
  - Multifocal optics come with gradual increase in add
  - Some labs offer variable zone sizes based on patient’s pupil size
  - Multifocal optics are added to front surface of the lens

Setting Expectations

- Comfort
  - Consider dryness and tear layer stability.
- Patient selection
  - Dry eye disease and high/irregular astigmatism – poor candidates?
  - Should have less than +0.75D of residual astigmatism for the lenses to work as effectively as possible
  - Must set realistic expectations
    - not necessarily perfect at all distances

Residual Aberrations

“I can see it, but it’s not clear.”
WFG Scleral Lenses

- Exciting time to be fitting scleral lenses
- Technology has changed the way we fit scleral lenses
- Today, technology will improve patient’s vision

Images courtesy of Matt Kauffman

Scleral Lens Exam Sequence

- Visit 1: Baseline
- Visit 2: Dispense
- Follow-up: 1 week, 1 month, 6 months (year 1)
- 6mo - 1 year f/u on all pts

Scleral Lens Dispense

- Application and evaluation of lens fit
- SCOR - don’t go crazy! Patients often have minor visual complaints that will go away after adaptation...
- Patient training
  - Very short visit or very long visit
  - Dependent on patient proficiency with application and removal

Tip: Dispense anything that is mediocre or better!

Initial Follow-Up Exam: 1-3 weeks

1) Evaluation of lenses on eye
   - SCOR
   - Fit evaluation (OCT, imaging optional)
2) Removal of lenses
   - Cornea: check IOP, edema, staining, scarring
   - Conjunctiva: monitor impression rings, hyperemia, staining
3) F/U on patient education

Scleral Lens Complications

- Lens management complications
- Trouble with application, removal
- Lens deposits, non-wetting, solution sensitivities
- Fitting Complications
  - Corneal, limbal, conjunctival bearing or excess lift
  - Midday fogging, tear reservoir stagnation
- Corneal complications
  - Solution & fit-related epitheliopathies
  - Epithelial bogging
  - Corneal edema
- Limbal bearing, edema, infiltrates, neovascularization
- Conjunctival/scleral complications
  - Impression, compression, staining, edema, prolapse
Easy and Common Complications

- Lens deposits
- Use of Progent cleaner

Scleral Lens Application

- Establish a visible target for patients

Application Considerations

- Dexterity (Parkinsons/tremors)
- Eyelid apertures
- Visual Status

Removal

- Proper placement of plunger is key
- Wet the tip of the plunger for greater suction
- Slow and steady wins the race

Corneal Touch

- Increase SAG, steepen BC, or change limbal zone
Complicated Corneal Touch

Keratoconus apex

Transplant G/H interface

Excessive Apical Clearance

Problems:
- Blurry vision & visual distortion
- Lens discomfort
- Midday fogging (debris accumulation)
- Increased swelling

Corneal Staining

Causes:
- Lens touch (focal)
- Lens seal-off (diffuse)
- Disease state (remember to compare to baseline!)

Management:
- Determine cause
- Manage lens fit
- Increase clearance
- Loosen haptic
- Change application solution

The Tear Film Reservoir

Function of Tear Film:
- Lubrication
- Smooth refraction
- Microbial protection...
- Corneal nourishment and O2 delivery

Epithelial “Bogging”

- Potential etiologies:
  - Loss of glycocalyx layer
  - Epithelial edema
  - Osmotic imbalance

- Cause unknown, Patients asymptomatic
- Does not appear to be long-term effect

Corneal Epitheliopathy

Treatment:
- Change application solution
- Change fit to decrease vault
- Educate patients taking medicated drops
- Educate patients on proper use of solutions

Patient education is the key to SL success
Preservative Toxicity

Midday Fogging (MDF)

Current Thinking on MDF
- Sequestered lipids, proteins, cell fragments, make-up, mixture of all these components (variable)
- Can mostly be managed by lens fit and hygiene
- No apparent increase in inflammation
- Visual frustrating!
  - Necessitates removal and refreshing of solution 2-5+ times per day
  - Most often affects people with ocular surface disease (ie. MGD)

Causes of MDF
Main Culprits:
- Ocular Surface Disease
- Fit issues?
  - Excess apical clearance??
  - Excess limbal clearance??
  - Tight fit??

Reducing MDF
Primary Management Strategies:
- Reduce clearance
- Change landing zone
- Change solution...

Alternate solutions

Reducing MDF
- Eyelid health
- Treatment of allergies/dry eye
- Eyewash
- Waiting to apply lenses in AM
What about corneal edema?

Corneal Edema

Signs of Corneal Hypoxia

Corneal Hypoxia

Consequences of Hypoxia

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What about corneal edema?
Consequences of Hypoxia

Endothelial changes
- Bleb formation
- Polymegethism
- Changes in endothelial cell density
- Possible changes in endothelial function.

High Risk Patients

Transplant patients
Compromised endothelium

Endothelial changes
Bleb formation
Polymegethism
Changes in endothelial cell density
Possible changes in endothelial function.

Management of Edema with SL

- Diffusion through lens and tears
- Lens thickness (SAM/FAP)
- Lens Dk (lost ROI after 100?)
- Tear reservoir thickness
  (Fisher 2020)
- Application solution?

Dhalli et al 2020
Increase Dk: 100 to 200
CT: 350; FR: 325

Tear Exchange with SL

- Variable tear exchange rates
- Some patients do better with more exchange, some with less
- Clinically...
  - zero exchange (seal-off) can cause metabolic toxicity
  - excess exchange causes debris buildup and discomfort

Slow, moderate exchange is ideal for most patients

Assessing the Presenting Scleral Lenses

Prior to lens removal:
1) Add NaFl to several areas at the lens edge
2) Watch for NaFl in tear reservoir

Image courtesy of Dr. Karen Carrasquillo

Image courtesy of Dr. Karen Carrasquillo
Different Patterns of Tear Exchange

Limbal Bearing

Troubleshooting Limbal Touch
- Increase diameter
- Increase intermediate and/or mid-peripheral clearances
- Quadrant specific zones to improve centration

Conjunctival Prolapse

Causes:
- Asymmetric limbal clearance
Conjunctival Prolapse

Axial Power Map
Elevation Map
Low lying cornea

Management:
- Change (flatten) limbal zone
- Quadrant/toric specific changes to improve centration

The SL Landing Zone

Spherical Lens on an ATR Sclera

Bubbles due to haptic misalignment

Impression Rings
- Are they always bad? No
- Can we eliminate them? Not really
**Effect of Centration**

- Most lenses will decenter inferior and temporal
- Observe translation of lens on eye movement to make final decision

**Conjunctival Roadblocks**

- Pinguecula
- Pterygium
- Symblepharon
- Surgical interventions
  - Ahmed valve
  - Trabeculectomy
  - Scleral buckle

**Pingueculae, Pterygium, Blebs, Cysts**

- Scleral lens interaction may lead to...
  - Inflammation, discomfort, infection
- Goal:
  - Pterygium/pinguecula: avoid or vault over
  - Bleb: Avoid interaction

**Customized lens designs**

- Notches
- Without custom edge
- With custom edge
EyePrint™

- Transparent prosthetic scleral device designed to match the exact contours of the individual eye providing the best vision and comfort possible.
- Impression Process
  - Takes 2 minutes
  - 1 minute set up
  - 1 minute on the eye
  - Captures precise curvatures of the entire ocular surface
  - Impression material has 1-2 micron accuracy
  - No anesthetic necessary

EyePrint™

Gives more information than high tech computerized topographical scanners.

What About IOP?

- Aqueous Humor Outflow

How do we measure IOP in SL wear?

- Goldmann
- www.youtube.com
- www.isda.org
- iCare
- Tono-Pen
- NCT
- Portable NCT
- Pneumotonometry

OCT and IOP

- Bruch’s Membrane Opening (BMO): termination of Bruch’s membrane at the optic nerve head
- Minimum Rim Width (MRW): shortest distance from the BMO to the inner limiting lamina (also termed BMO-MRW)

- Thinning of the MRW indicates increase IOP
Managing the Disease State

- Keratoconus
  - Inflammation, atopy, eye rubbing
- Post-transplant
  - Transplant rejection, endothelial loss
- Ocular Surface Disease
  - Risk of infection

Fitting a SL Post-CXL

- Recommended for all progressive ectasias
- Increasing insurance coverage
- Avg ~$2,000 per eye

Post CXL SL Considerations

- Recommend 6-8 weeks post-procedure
- Monitor and document haze (usually present)
- Patients often on steroids
- Can they still wear a SL?

Post-CXL Haze

- Haze is inflammatory cells in anterior stroma
- Usually go away within 1 year
- Rarely affect vision
- Based on what we know... it's okay to fit SL while haze is still present
**Australian MK Incidence Study**

Incidence per 10,000

*Hydrogel lens materials only (silicone hydrogels not included)*

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 19.3
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**Infection with scleral lenses**

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Indication(s)</th>
<th>Infectious Organism(s)</th>
<th>Outcome</th>
<th>Taking steroids? (y/n)</th>
<th>Taking antibiotics? (y/n)</th>
<th>Comments</th>
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<tr>
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<td>Not cultured</td>
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<td>Unknown</td>
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</tr>
<tr>
<td>Farhat &amp; Sutphin (2014)</td>
<td>GVHD</td>
<td>Acanthamoeba</td>
<td>DALK performed</td>
<td>Y</td>
<td>Y</td>
<td>Authors report poor compliance</td>
</tr>
<tr>
<td>Zimmerman &amp; Marks (2014)</td>
<td>Neurotrophic keratitis HSK</td>
<td>Unable to determine on culture</td>
<td>Resolved with antibiotic treatment</td>
<td>N</td>
<td>Y</td>
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<td>Mycobacterium abscessus</td>
<td>Failed graft</td>
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<td>Y</td>
<td>Known epi defect at time of infection</td>
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<td>PED post-PK</td>
<td>Alpha-hamolytic streptococcus, Staphylococcus epidermidis (x2)</td>
<td>Failed graft</td>
<td>X</td>
<td>X</td>
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<td>MRSA</td>
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**Major Risk Factors:**
- Ocular surface disease
- Steroid use

**Concluding remarks**
- Scleral lenses have revolutionized specialty contact lens management.
- Like all specialty lens management, it is a balancing act of risks and benefits.
- Important to understand the positive impact...while being aware of potential limitations.
- Use cautious optimism when fitting SL patients!

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**Scleral Lens Education Society**

[www.sclerallens.org](http://www.sclerallens.org)

Become a Member or Fellow Today

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**Thank you!**

mkwalker@central.uh.edu
Fitting Technique:

**Fluoroscein**

**Apical Bearing**

**Limbal Clearance Zone**

**Too much**

**Appropriate Limbal Clearance**

**Inadequate Limbal Clearance**

**Epithelial breakdown**

**Punctate Staining**

**Corneal Erosion**

**Scleral Landing Zone**

**Subepithelial fibrosis related to graft ectasia**

**Well-aligned Scleral Landing**