Scleral Lens Research Update

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Disclosures

- Dr. Walker (honoraria/research funding from Alcon, Bausch Health, CooperVision, AMO Optical)

Current areas of Scleral Lens Publications

1. Oxygen & corneal morphology
2. Conjunctival tissue changes
3. Intraocular pressure
4. Tear fluid studies (properties, exchange, composition)
5. Optics
6. Case reports and series

Oxygen and Corneal Morphology

- What changes will increase oxygen to the cornea in SL wear?
  - Decrease lens thickness
  - Increase lens Dk
  - Decrease fluid reservoir thickness
  - Fenestrate
  - Improve tear exchange (channel)
- What changes occur to the corneal morphology in SL wear?

The Conjunctiva

- Compression (radius of curvature & "SAG")
- Rebound rates and permanent changes to conjunctiva
- Goblet cells and epithelial cells
- Landing zone studies
• 26 Kc eyes
• Impression cytology of conjunctiva performed
• Goblet cell density & mucin cloud amplitude
• No changes observed

Compression occurs mostly in the conjunctiva/episclera (70%)
Superior quadrant showed greatest compression (mean ~50um), followed by temporal (~20um), inferior (~14um) and nasal (~13um)
Widening of limbal demarcation zone and flattening of radius

Looking for a review?
Conjunctival anatomy
Conjunctival elevations
Pingueculae and pterygia
Symblepharon
Filtration blebs
Trabeculotomy
Episcle and sclera anatomy
Scleral stroma
Biomechanics
Changes in age, glaucoma, myopia
Curvature and CSJ
SAG, curvature, morphology
Changes with scleral lens wear

Intraocular pressure
Does IOP increase during SL wear?
• Methods of IOP measurement
• Optic nerve head studies

Poll Question
How many practitioners track and measure IOP in SL wear?

Scleral Lens Wear and IOP
Huggert (1951)
• Elevation of IOP is 26/33 healthy patients, 25 min of glass SL wear
• Greater increase in glaucomatous (n=12) vs. healthy (n=20) eyes

Miller
• Patients with glaucoma: more rapid onset of corneal edema
• Estimated negative pressure of 5-18 mm Hg during scleral lens wear
Factors Affecting IOP

- Fluid intake
- Body orientation
- Head position
- Eye position
- Exercise
- Respiration
- Heart rate
- Diurnal variation
- Manipulation of lid/globe (i.e., measuring IOP)

Immediate Response

- Previous study shows that application of a scleral search coil may lead to change in IOP.
- IOP was assessed (ORA) in two recent studies; decrease in IOP was actually noted compared to same eye/different day controls.

- Reviewed existing literature, and concluded that no conclusions could be drawn.

CLAE 2019

- Graph showing change in IOP before and after lens wear.

OVS 2020

- Graph showing change in IOP with lens wear.
• Control day: BMO-MRW decreased by 4.65 ± 7.11 microns over 6 hours
• Study day: BMO-MRW decreased by 8.00 ± 5.88 microns over 6 hours
• Attempted to correlate to change in IOP during lens wear based upon animal study; high degree of variability
• Average corneal resistance was not related to change in BMO-MRW

What happens to the tears during SL wear?
• Tear exchange
• Midday fogging
• Tear properties

Poll Question
What do you think MDF is?
1. **Dabbah MA, Tse V, OVS**

   - **Outcomes:**
     - Corneal nerve measurement
     - Tear and fluid reservoir
     - Disease state of the eye
     - Inflammation/infection
     - Cellular/tissue health

2. **Graham et al.**

   - **Corneal nerve measured:**
     - 27 nerves worn dendritic cells were used for 30 subjects.

3. **Truong et al.**

   - **IL-8 (ng/mL):**
     - Baseline: 1.8 ± 1.89
     - 8 hours: 2.1 ± 2.34
     - 4 days: 2.0 ± 2.2

4. **Wang et al.**

   - **Greater MMP-7, 9, and 10 in the Basal and Fluid Reservoir Tears:**
     - Interleukins 4 and 8 in the Basal and Fluid Reservoir Tears

5. **CLAE 2020**

   - **Conclusions of current tear component studies:**
     - Fluid reservoir composition is different from ocular surface tears (increased inflammatory mediators & cells) with unknown physiology effect (may be beneficial in maintaining homeostasis in presence of K)

6. **OVS 2020**

   - **Corneal Health during Three Months of Scleral Lens Wear**

     - **Results (after 1 and 3 months of SL wear):**
       - Mean post-lens tear thickness: 22.0um

   - **No change in corneal permeability measurements**

   - **Mean post-lens tear thickness:**
     - 22.0um

   - **No change in corneal permeability measurements**

   - **Tears with SL wear:**
     - Superior to dry and saline wet conditions

   - **Microscopy**
     - Confocal: Corneal nerve fibers in inferiorly, centrally, and anterior corneal stroma
     - Inflammatory/infection
     - Structure and Function
• 22 habitual scleral lens wearers reporting MDF, 20 with 6:1
• 2 visits: day 1 and 5-9 days of using test solution
• Nutrit, Contamac
• Biomicroscopy and OCT to measure MDF
• Subjective Sx:
  • ODB:
  • Current symptoms survey (VAS scale)
  • Burning/stinging
  • Grittiness of FBS
  • Dryness
  • Blurry or fluctuating vision
  • Overall ocular pain or discomfort

<table>
<thead>
<tr>
<th>TABLE 5: SYSTEMATIC DATA FROM 25% MTRACTION</th>
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<tbody>
<tr>
<td>Sodium chloride</td>
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<tr>
<td>Calcium chloride</td>
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<td>Potassium chloride</td>
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<td>Magnesium chloride</td>
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<td>Sulfuric acid</td>
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<tr>
<td>Distilled water</td>
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<td>Change in flow (mg/cm²)</td>
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• Results:
  • Significant improvement in subjective symptoms
  • No change in MDF
  • No change in ocular surface health

• Conclusion:
  • Safe to use and may improve subjective satisfaction with SL

SCOPE survey study
• 292 respondents (4 practitioners)
• 248 responded to MDF question
• Practitioners were asked to report MDF in patients, and characteristics were compared
• Demographics (age, sex, race/ethnicity)
• Lens fitter experience
• Practice modality

Factors associated with patient-reported midday fogging in established scleral lens wearers

Quantifying the optical and physical consequences of daily cleaning on conventional and WFG-guided scleral lenses

Design Group
- 12 scleral lenses
  - 4 Design “A”, 4 Design “B”, 4 Design “C”
  - 1 control in each group, 3 test lenses
  - Cleaned a total of 378x over 27 days
  - simulating 1 year of cleaning
  - Cleaning with Unique pH and Optimum

Quantifying the optical and physical consequences of daily cleaning on conventional and WFG-guided scleral lenses

Results:
- No change in optical aberrations or base curves of conventional or WFG scleral lenses
- Okay to clean lenses as customary and not change the optics

Figure 6: Standard deviation (SD) of higher order wavefront error <0.05%. Results from 50% cleaning on conventional scleral lenses (mean ± SD).
SCOPE study group
- 422 patients surveyed
  - 75 corneal GP wearers
  - 76 scleral lens wearers
- Queried subjects regarding:
  - visual satisfaction
  - comfort
  - burden of care
  - Expenses
  - Frequency of lens-related issues

Results

Optics

What advancements have been made optically with SL?
- Front surface torics
- Aspheric optics
- Wavefront-guided
- Multifocal

Poll Question

Do you think that multifocal scleral lenses work?

Case reports and series

What have these reports taught us about SL wear?
- Case series
- Case reports
The post-graft cornea

- N = 10 eyes, 9 participants
- Mean age 31 ± 9 years, 5 F: 4 M
- ~4 years post-graft
- Lens details:
  - Keracare, Dk 100, LT 250 µm
  - Initial clearance 250-300 µm
- Scleral lens challenge:
  - Duration of lens wear = average 6 hours (range 4-8)
  - Pentacam data averaged over central 6 mm

- Edema averaged across the central 6 mm = 2.71 ± 3.14%
- Regional variations:
  - Inferior cornea – more edema further from the corneal centre

Interested in learning more or participating in research?