Optimizing ocular health in scleral lens fitting: adopt the minimalist approach

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Disclosure Statement:
OXYGEN DIFFUSION THROUGH SCLERAL LENSES

Dr. Langis Michaud O.D M.Sc. FAAO (Dipl) FBCLA FSLF FEAOO
Contact Lenses and DK/t

- Holden and Mertz
  - Dk/t of 24 – DW
  - Dk/t of 87 – EW

- Harvitt and Bonanno
  - Dk/t of 35 – DW
  - Dk/t of 125 – EW

- Morgan and Efron
  - DK/t of 20 – DW – central cornea
  - DK/t of 33 – DW – peripheral cornea

How much oxygen is REALLY getting to the cornea?
Average Scleral Lenses

• Traditional CT
  – .3mm thick (300 microns) to .6mm thick (600 microns)
    • Ranges greatly based on Rx
    • Industry concern of flexure under .3mm
    • **Average CT = .45mm**

• Traditional Vaults
  – Multiple fitting sets and lectures reviewed
    • Low vault = 100 microns
    • High vault = 600 microns
    • **Average = 300**

• Traditional Material
  – Lagado Tyro 97 = Dk 97
  – Boston XO = Dk 100
  – Contamac Optimum Extra = Dk 100
    • **Average Dk of 100**

• Traditional Haptics
  – No tear exchange, no tear mixing after settling
Average Dk/t for Average Scleral Lens Systems

- Dk/t Estimations of Average ScCL (central cornea):
  - \( Dk/t = \frac{1}{[(\text{Thickness of Lens/Dk of Lens Material}) + (\text{Thickness of Post Lens Tear Layer/Dk of Tears})]} \)
  
  - \( Dk/t = \frac{1}{[(450 \text{ microns/100 Dk}) + (300 \text{ microns/80 Dk})]} \)
  - \( Dk/t = 12.1 \)

- Dk/t this low: what’s the effect on normal cornea? Fragile corneas?
Corneal Edema Can Occur
Edema is reported.
Predicting estimates of oxygen transmissibility for scleral lenses
Langis Michaud *, Erf van der Worp, Daniel Brazeau, Richard Warde, Claude J. Giasson
École d’optométrie, Université de Montréal, Québec, Canada

In conclusion, our results (in agreement with Michaud et al. [18]) suggest that clinicians would be prudent to prescribe scleral GP lenses manufactured from what we consider currently to be the highest reasonable Dk materials and to fit without excessive corneal clearance, in their efforts to provide GP scleral lenses that minimize potential anterior segment hypoxia while providing the other optical and physiological benefits of these devices.

Predicting scleral GP lens entrapped tear layer oxygen tensions
Jared M. Jaynes *, Timothy B. Edrington, Barry A. Weissman
Southern California College of Optometry at Marshall B. Ketchum University, 2575 Yorba Linda Blvd, Fullerton, CA 92831, United States

Modeling Corneal Oxygen with Scleral Gas Permeable Lens Wear
Vicente Canga *, Marcel Aguilera-Arau *, Timothy B. Edrington, and Barry A. Weissman

Conclusions. Our study suggests that clinicians would be prudent to prescribe scleral GP lenses manufactured from higher oxygen permeability materials and especially to fit without excessive corneal clearance.
(Optom Vis Sci 2016;93:00-00)
In Vivo Study

- **AIM**: To evaluate relative pO₂ at the corneal surface under scleral rigid gas permeable lenses of different clearances.

<table>
<thead>
<tr>
<th></th>
<th>SL 200</th>
<th>SL 400</th>
<th>p</th>
</tr>
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<tbody>
<tr>
<td>Average clearance (um) (SD)</td>
<td>240.0 ± 34.9</td>
<td>434.9 ± 33.3</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Average lens thickness (um) (SD)</td>
<td>315.1 ± 0.7</td>
<td>309.5 ± 1.3</td>
<td>&gt; 0.05</td>
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<tr>
<td>Estimated DK/t (x 10⁹) (cm/sec/ml O₂/ml X mmHg)</td>
<td>16.9</td>
<td>12.0</td>
<td>N/A</td>
</tr>
<tr>
<td>Predicted pO₂ (%) **</td>
<td>7.79</td>
<td>5.97</td>
<td>N/A</td>
</tr>
<tr>
<td>Measured pO₂ (%) (SEM)</td>
<td>9.07 ± 0.86</td>
<td>6.19 ± 0.87</td>
<td>&lt; 0.05</td>
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A NEW FINDING: BLEBS !!!

18 mm lens
BXO2
320 um thick
200 /400 clearance
Results

<table>
<thead>
<tr>
<th>Clearance</th>
<th>Participants with &gt; 1 bleb</th>
<th>Number of blebs (min/max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>9</td>
<td>1-5</td>
</tr>
<tr>
<td>400</td>
<td>12</td>
<td>1-12</td>
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SRB en fonction du temps

Lentille
p = 0.04

Temps
p = 0.002
Model revisited

- Current large diameter lens wear is associated with 2-3% edema
  - Not comparable to physiological edema
- Affects primarily central cornea
  - Reduced clearance over other areas of the cornea
  - No hypoxic stress over the limbus: no neovascularization seen
  - Could be transient: if clearance is reduced < 200 um over lens wear
- Clinical impacts?
  - Unknown on the long term
  - Other mechanisms can be in play…
  - Raise the question about risk/benefit for normal cornea patients
Conclusion

• EDEMA occurs

• To avoid anoxia, a scleral lens should be fitted with
  – 200 um of clearance
  – 250 um of lens thickness
  – Using Highest DK material (150)
MINIMALIST PHILOSOPHY TO IMPROVE CORNEAL OXYGENATION

CONTENT TO COME
CASE REPORT

Jason Jedlicka, OD, FAAO, FSLS
Indiana University School of Optometry
DM

- 60 yo female presents by referral from local OD/MD group for scleral lens fitting
- History of HZO OD with Neurotrophic Keratopathy for 6 months
- CC: “Blurry vision and dry feeling eye”
- Using gel drops / ointments / humidifiers
- Taking Gabapentin for Post herpetic neuralgia
DM – Initial Presentation

• VA OD with glasses = 20/200, PH = 20/100
DM – Lens Fitting

- Fitted with Scleral Lens OD
  - Used topography and HVID of OS as a guide for fitting due to poor ocular surface OD

- 7.8 BC / 17.0 mm / -1.00 / Boston XO2 / SAG 4800
- Initial Vault 300 microns after 30 minutes of settling
- Ordered with CT of .35
- VA = 20/80
DM @ Dispensing

• Dispensed 1 week later for daily wear
  – Non Preserved saline to fill
  – Clear Care for storage and disinfection
  – Up to all waking hours to cover ocular surface.

• Follow up 1 week
DM @ 1 week F/U

• CC: “Everything was great for the first 4 days, improved VA, good comfort, then the last 3 days the VA has gotten increasingly blurry”

• VA OD = 20/800
• Assessment: Corneal Edema with Bullous Keratopathy

• Plan:
  – 1% Pred Forte QID
  – Muro 5% ointment QID (vision is already blurry)
  – D/C initial scleral lens, return 1 week for dispensing of new lens

• Reorder scleral lens
  – Decrease diameter to 15.4 mm
  – Fit with less central clearance (200 microns at 30 minutes of settling)
  – Decrease CT to .30
  – Boston XO2
DM – 2nd lens dispensing

• 1 week following prior visit
• Corneal edema nearly resolved
  – Cut the 1% PF to BID
  – Cut the 5% Muro ointment to qHS
• Dispense new lens
• Limit wearing time to 6 hours a day until follow up
  – call if vision starts to get blurry like last time
DM – follow up with new lens

- 1 week follow-up with second lens
- VA with CL 20/50
- Comfort good
- Epithelium looking much better
- Edema resolved
- Now apparent for the first time (due to the epithelium and edema looking better) is the significantly reduced endothelial cell count likely from the HZO
• 3 months later

• VA without lens 20/40

• VA with lens 20/20-1

• Wears 6-10 hours a day and uses Muro ointment qHS

She has successfully maintained for the last 2 year now – through a flare up of HZO – with no visible edema
Minimalist Scleral Lens Fitting

- Subtle excesses in clearance or lens thickness can make a difference in the cornea’s ability to stay clear.
- Watch wearing time – balance the benefit to the ocular surface with the ability of the endothelium to keep the cornea clear.
- Check the endothelium – in particularly in infectious processes.
OBLATE DESIGN

- **Concept:** When the base-diameter measures lead to optimal limbal clearance and scleral edge landing but with excessive central clearance (300 microns and more), there is necessity to use a reverse geometry design on the oblate shape cornea.
POST LASIK-PRK-RK patients-TOPO
POST PENETRATING KERATOPLASTY
PELLUCID MARGINAL DEGENERATION
MID PERIPHERAL CURVES are important
OBLATE DESIGNS 70-110-150 μm
PROLATE VS OBLATE CENTRAL CLEARANCE

- 70 um
- 110 um
- 150 um
Power compensation

• The central clearance reduction is achieved by flattening the central base curve.

• This generates more minus power + compensation needed

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<tr>
<th>CCR Value</th>
<th>Power Compensation</th>
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<tr>
<td>70</td>
<td>+2.00</td>
</tr>
<tr>
<td>110</td>
<td>+4.00</td>
</tr>
<tr>
<td>150</td>
<td>+6.00</td>
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In this case

- Trial lens selected .2mm flatter than the mid periphery (manufacturers recommendation)
  - 7.80 -2.00D 15.0mm from the regular set
    - over refraction is -2.00D.
  - Fit is good, vault the entire cornea
    - central clearance : 375 um
    - need to lower by 150 um (= +6D)
    - 7.80 diam 15.0 -4.00D lens becomes
      Final RX 7.80/R150 diam 15.0 +2.00
New clinical applications

- To lower minus power of scleral lenses
  - Prolate Corneas
  - Keratoconus
  - Irregular corneas

- To reduce induced lens HOA and spherical aberrations of the eye

- To improve presbyopic correction
  - Reduced minification
  - Effective more add power

- All of this at the same time !!!
Magnification

• Formula

\[
G_a = \frac{1}{1 - \frac{e}{n} \left( F_{f'} - \frac{1 - n}{r^2} \right)} \times \frac{1}{1 + \frac{e}{n} F_{f'} - \frac{e}{n(1 - n/r^2)}}
\]

\[
1 - \frac{e}{n} \left( F_{f'} - \frac{1 - n}{r^2} \right)
\]

1 - 0.003F_{f'}

Where \( G_a \) represents the image size, \( e \) the lens thickness, \( n \) lens index of refraction, \( F_{f'} \): front vertex power and 0.003 the entrance pupil size (in m)

• With Oblate 150um, image size is increased by 1.75%
  – This improves near vision for presbyopic patients
  – and at all distance for higher myopes
Benefits

- Better visual acuity
- Thinner design for high minus power lenses
- O2 transmission
- Normal corneas
CONCLUSION

“Thinking outside of the box is difficult for some people. Keep trying.”
CONCLUSION
You don’t have to shoot a mosquito with a bazooka

Use the lens with the lowest risk
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