BRING YOUR SCLERAL LENS FITTING TO THE NEXT LEVEL

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Disclosures

Langis
- Honorarium and research grants
  - Alcon
  - Bausch & Lomb
  - Cooper
  - Allergan
  - Johnson & Johnson
  - Blanchard Labs
  - Genzyme
  - Shire
  - Santen

Jason
- Consultant to Bausch and Lomb SVP
- Honorarium:
  - Oculus
  - Allergan

Scleral Lens Zones

- Geometry of the lens can be broken down into three zones
  - The optical zone
    - Base curve / minimal influence of the overall fit
  - The transition zone
    - Compares and equilibrates other parameters
  - The landing/haptic zone
    - A set of 3-5 peripheral curves aiming to vault over the limbus and to land softly and evenly on the conjunctiva

http://forkliftspareparts.co.uk/assets/scleral-contact-lenses
How Do Sclerals Work?

- Corneal clearance - No corneal bearing in optic zone
- Limbal clearance / alignment in transition zone
- Tear reservoir between lens and eye
- Scleral landing – gentle alignment
  - Scleral shape important
- Final lens fit depends on:
  - Corneal elevation
  - Sagittal depth of the eye at points of scleral landing

Advanced Scleral Lens Fitting

- Evaluating fit at follow up
- Evaluating landing zone
- Dealing with astigmatism in the over refraction
- Fitting with oxygen permeability in mind
- Fitting for optimal limbal clearance

Lens Evaluation at Follow Up
Evaluating the Landing Zone for Toricity

- Utilization of toric landing curves is easy with most scleral designs
- Improves fit, comfort and makes the lens more stable and less likely to accumulate debris
- How do we determine if this is helpful or needed?

Scleral Topography
IF YOU DO NOT HAVE SCLERAL TOPOGRAPHY…

Shadowing from the Lens Edge

- Easy way to assess the edges for excessive lift
- Position slit beam across lens and view the far lens edge

Direct illumination tells you if you have blanching or compression – a tight fit.
Indirectly evaluating the lens edge allows you to see edge lift easier – a loose or flat fit.

Shadowing of Lens Edge

Shadowing of Lens Edge
Possible Consequences of Using a Toric Haptic

- Loss of central vault if you are flattening a meridian that is currently too tight
- Make sure to compensate if your current vault is marginal at all
- Bubble formation at application if not inserted close to the proper axis
- Altering the positioning of a front toric if the toric haptic is added later

How Much Toricity Should I Add?

- If you are doing a lot of sclerals, it is a good idea to consider having some toric diagnostic lenses
- Consultation can help
- If unsure, some will be better than nothing, you can always reorder
- Typically most people tend to underestimate the amount needed, so don’t skimp on the toricity

How Much Toricity Should I Add?

- Communicate to lab your findings
- With experience and familiarity with a design you will learn how to estimate how much is needed
- If you can measure it, communicate that to your lab
- Don’t be afraid to add toricity!

Managing residual astigmatism

• When a scleral lens fit looks good, but visual acuity is reduced, a spherocylindrical over refraction should be obtained
• If correcting astigmatism improves vision, the reason for the astigmatism should be determined
• Lens Flexure vs. Internal Astigmatism
• To differentiate, over topography is useful

Flexure

RX: +7.00 -4.00 x 180
Topo demonstrates 1.75 D residual cylinder

Resolving Flexure

• If flexure is present:
  • May try to increase lens thickness to resist flexing
  • Also consider toric landing zones if demonstrate that there is edge lift in the steep meridian
Resolving Flexure

- If the flexure appears to correlate to the shape of the eye:
  - Consider fitting a toric landing zone
  - If after fitting a toric landing zone, there is still residual astigmatism, then a front toric can be added to resolve the remaining cylinder

Residual Astigmatism without flexure

- If there is no scleral toricity to stabilize the lens design, then the stability must be added to the front surface
- These lenses can be fitted assuming no rotation unless observed in clinical setting
- Con: Adds thickness and bulk to the lens
Residual Astigmatism without flexure

- In many cases, there is enough scleral toricity to use toric landing curves to stabilize the lens rotationally

- Need to compensate for lens rotation if there is any (actual or anticipated)

- LARS rule applies

- Lens marking is typically on flat meridian

Ocular Health: How much oxygen is REALLY getting to the cornea?
Contact Lenses and DK/t:

- Holden and Mertz
  - DK of 18 necessary to avoid corneal edema for daily wear
- Harvitt and Bonanno
  - DK of 24 necessary to avoid corneal edema for extended wear
- Papas
  - DK of 24 necessary to avoid anoxia
- Morgan and Elston
  - DK levels need to be approximately 20 and 33 for the central and peripheral portions of a soft lens, respectively, in order to avoid edema with daily wear.

A theoretical approach

- Considering available materials
  - DK of 100 to 170
- Various lens thicknesses
  - 250-500 um
- Post-lens tear thickness
  - 100-400 um

Conclusion

- To avoid anoxia, a scleral lens should be fitted with
  - 200 um of clearance
  - 250 um of lens thickness
  - Using Highest DK material (150)
A theoretical model validated

- Jaynes et al; Weissman et al:
  - Calculations to determine the ideal fit to prevent corneal hypoxia effect
  - Larger diameter lens higher risk than smaller lens

In conclusion, our results show agreement with Michael et al. [18] suggesting that clinicians would be prudent to prescribe scleral GP lenses manufactured from what we consider currently to be the highest acceptable DK materials and to fit without excessive cornealcentration, in their efforts to provide GP scleral lenses that minimize potential corneal hypoxia while promoting the other optical and physiological benefits of these devices.

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**Average Scleral Lenses**

- **Traditional CT**
  - 0.3mm thick (300 microns) to 0.6mm thick (600 microns)
  - Range greatly based on Rx
  - Average CT = 0.45mm

- **Traditional Vaults**
  - Multiple fitting sets and lenses reviewed
  - Low vault = 100 microns
  - High vault = 600 microns
  - Average = 300

- **Traditional Material**
  - Lagun Tyro 97 = Dk 97
  - Boston XO = Dk 100
  - Contacta Optimum Extra = Dk 100
  - Average Dk = 100

- **Traditional Haptics**
  - No tear exchange, no tear mixing after settling

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**Modeling Corneal Oxygen with Scleral Gas Permeable Lens Wear**

- **Authors:** Gupa et al., Kudla et al., Timothy B. Edrington, Barry A. Weissman

**ABSTRACT**

The main goal of this current work is to use an updated calculation paradigm, and updated boundary conditions, to provide theoretical guidelines to assist the clinician choose the right gas permeable (GP) contact lens wearing patient, and prevent corneal hypoxia.

**Methods:** Our model uses a steady-state corneal oxygen consumption described through several equations that describe the corneal oxygen tensions within the corneal tissue overlaid on the corneal surface of the GP contact lens wearing eye. To describe the oxygen tension and gas partial pressures, we used steady-state pressure, corneal endothelial oxygen tension, and the corneal oxygen consumption.

**Results:** The model of current corneal oxygen concentrations produces levels of corneal hypoxia and oxygen that were not observed in other models. Under these conditions, the oxygen tension is 100 microns (300 microns), similar to the oxygen tension of gas permeable contact lenses.

**Conclusions:** Our study suggests that clinicians would be prudent to prescribe gas permeable contact lenses rather than the current use of soft contact lenses.
Average Dk/t for Average Scleral Lens Systems

- Dk/t Estimations of Average ScCL (central cornea):
  - Dk/t = 1/(Thickness of Lens/Dk of Lens Material) + (Thickness of Post Lens Tear Layer/Dk of Tear)
  - Dk/t = 1/(450 microns/100 Dk) + (300 microns/80 Dk)
  - Dk/t = 12.1

Dk/t values were used only on a normal cornea
Diseased/functionally compromised cornea

Edema is reported

In Vivo Study

- AIM: To evaluate relative pO2 at the corneal surface under scleral rigid gas permeable lenses of different clearances.
Equivalent Oxygen Percentage (EOP)

- Hill developed the concept of EOP in the sixties to estimate partial pressure in oxygen (pO2) at the corneal surface under contact lenses.
- Basic:
  - Oxygen consumption increased
    - Immediately after contact lens wear, or exposure to gases containing decreasing tensions in oxygen
    - In proportion to the level of hypoxia
- Electrode application on the cornea: exponential decay of oxygen
- Possible to interpolate %pO2 beneath scleral lenses (after a 5-minute wear) with linear function between k (pO2) of calibrating gases.

**Conclusions.** As shown in vivo for the first time, an 18-mm scleral lens fitted with a 400-μm clearance reduces the oxygen tension in the cornea by 30% compared to a similar lens fitted with a 200-μm clearance after 5 minutes of wear. (Cepura, 1985: 226-300-40)

|        | SL 200   | SL 400   | P  
|--------|----------|----------|------
| Average clearance (μm) (μm) | 236 ± 17  | 434 ± 38  | <0.05
| Average lens thickness (μm) (μm) | 251 ± 28  | 385 ± 35  | <0.05
| Estimated DK (μm²/cm²) (μm²/cm²) | 14.3 ± 6.4 | 12.6 ± 9.7 | >0.05
| Predicted pO2 (%)** | 9.2 ± 0.35 | 8.3 ± 0.28 | >0.05
| Measured pO2 (%) (SEM) | 9.07 ± 0.86 | 6.19 ± 0.87 | <0.05

1. As for reference: minimal level of pO2 to avoid hypoxia: 9.9%

**Corneal edema can occur**
Hyposic Consequences

- Experimental models prove that the cornea is swelling by up to 3% during scleral lens wear
  - Case reports showing corneal edema relates to corneas with compromised endothelial layer
- Some authors compare this to physiological edema present upon awakening
- Elements to consider
  - 3% edema is measured centrally
  - At the limbal level, clearance is reduced, allowing normal oxygen delivery
  - Physiological edema goes away within 1h after exposure to air
  - Induced central corneal edema under scleral lens wear is lasting during all wearing hours
- No known effects on the long term
  - Raise concerns on the risk/benefit ratio

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

Hyposia

- Mini-sclerals can be fitted with lower clearance and reduced lens thickness
  - Minimizes hypoxia
- Oxygen transmission and tear exchange are important considerations for post-graft patients or those with compromised endothelium (low cell count)
Conclusion

- Higher clearance in scleral lenses is associated with chronic edematous response from the central cornea
- This raises the importance of evaluating the risk/benefit ratio before fitting patients, especially if the cornea is compromised
- There are options to alleviate hypoxia
  - To fit lenses with reduced thickness
  - To limit fluid layer thickness (clearance) wherever possible
  - To modulate scleral lens wear based on individual corneal characteristics

Most likely achieved with smaller diameter lenses

What about the limbus?

- Consensus: Scleral lenses should clear the limbus
  - How much clearance is optimal? Lower clearance (no touch)
    - No evidence of mechanical impact on the stem cells
    - No evidence of neovascularization, pannus, or other adverse events
    - Healthier: delivers more oxygen to stem cells
    - Associated with less debris (fogging) in the reservoir
    - Do not tolerate compression ring or limbal staining

Limbal Clearance

This study used a 14.3 mm lens - no longer used

They did not take into account corneal diameter

Short-term issues - not related to significant clinical negative outcome

Contact Len and Anterior Eye

Corneal epithelial bullae after short-term wear of small-diameter scleral lenses

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**Limbal Clearance**

- **Optimal:** 40-60 um
  - < 30 um: NaFl is difficult to see under blue light
  - Rotate illumination – avoid shadowing effect

- **Higher clearance**
  - Associated with more fluid reservoir debris
  - Limit oxygenation over stem cells

- **Lower clearance**
  - No evidence of mechanical impact on the stem cells
  - Do not tolerate compression ring severe staining

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**Limbal Clearance**

<table>
<thead>
<tr>
<th>Limited clearance</th>
<th>50-100 clearance</th>
<th>Optimal</th>
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<tbody>
<tr>
<td>Excessive</td>
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**Troubleshooting Limbal Clearance**

- If a compression ring or significant staining
  - Modify the limbal curves
  - Steepen the base curve
  - Increase lens diameter

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Photo: L. Michaud OD

Photo: Andrea Lasby OD

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