1 Scleral Lenses 101
-the basics and beyond
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2 Overview
• Clinical Indications
• Advantages and Challenges
• Terminology
• Anterior eye anatomy
• Basic Design Features
• Instrumentation
• Fitting basics – lens selection, fitting, evaluation, follow-up
• Tips and Troubleshooting

3 Clinical Indications
• Vision Improvement
  – Correcting the irregular cornea
  • Corneal Ectasia
    – Primary – Keratoconus, Keratoglobus, Pellucid marginal degeneration (INTACS, CXL)
    – Secondary – post-refractive surgery, corneal trauma
  • Corneal Transplant
  • Corneal Degenerations
    – Normal Cornea
      • Presbyopia, moderate to high corneal astigmatism

4 Clinical Indications
• Ocular Surface Protection
  – Dry Eye
  – Incomplete lid closure
  – Sjögren’s Syndrome
  – Stevens-Johnson Syndrome
  – RCE / corneal abrasions
  – Graft host disease
  – Infiltrative keratitis

5 Persistent corneal epithelial defects
• Epithelium-off CXL (16 year old male)
– Constant epithelial defect for 2 months
  • Neomycin/dexamethasone, Zirgan, Oflaxacin, doxycycline, acyclovir, AT, BCL
– Applied a scleral contact (15.6 diameter)
  • Wore extended wear for 6 days
  • Cont Maxitrol and oflaxacin drops
– Lens removed after 6 days of wear
  • epithelial defect healed
  • overlying corneal haze

6. Corneal Abrasion

• Healing response attributed:
  – Oxygenation
  – Moisture
    • Constant tear film
  – Protection of the corneal epithelium
  • Minimal abrasion
    • Allows epithelium to migrate, adhere, and proliferate over the persistent epithelial defect.

7. Clinical Indications

• Cosmetic/Sports
  – Hand-painted scleral lenses
  – Ptosis
  – Water sports

• Lens failure in other designs

8. Advantages of Scleral GPs vs Corneal GP

• Centration
  – Fitting a “regular” part of the eye
• Lens Retention
  – Minimal chance of inferior standoff
• Comfort
  – Reduced lid interaction; no corneal interaction
• Vision
  – Masking severe corneal irregularity

9. Challenges associated with scleral lenses

• Handling
  – Difficult I and R (initially)
  – Apprehensive patients
• Fitting
– Subtle fit indications
– Increased chair time

• Physiology
  – Dk/L – Oxygen must diffuse over great distance
  – Long-term effects of scleral lens wear are unknown

10 □ Terminology
  • Classification
    • Corneo-scleral 12.9mm to 13.5mm
    • Semi-Scleral 13.6 mm to 14.9mm
    • Mini-Scleral 15.0mm to 18.00mm
    • Full-Scleral 18.1mm to 24+

11 □ Terminology

12 □ Anatomy and Shape of the Anterior Ocular Surface
  • Maximum scleral lens size
    for normal eye: 24mm
  • Scleral Shape Study

13 □ Anatomy and Shape of the Anterior Ocular Surface
  • Corneal Toricity does not typically extend to sclera
  • The ocular surface beyond the cornea is nonrotationally symmetrical
    – Asymmetrical
    – The entire nasal portion typically flatter compared to the rest

14 □ Anatomy and Shape of the Anterior Ocular Surface
  • Clinical Consequences
    – Temporal-Inferior decentration of scleral lenses
      • Inferior decentration
        – Weight/gravity
        – Eyelid pressure
      • Temporal
        – Flatter nasal elevation
    • Conjunctival Prolapse

15 □ Basic Design Features
  • Spherical Design
    • Concentric symmetrical (spherical) scleral lens
    • Non-toric back surface
  – Optic Zone
    • Centermost zone
• Optics/Lens power
  – Anterior surface
• Back surface
  – Ideally mimics corneal shape
• Completely vaults cornea

16 Basic Design Features
• Spherical Design
  • Concentric symmetrical (spherical) scleral lens
  • Non-toric back surface

  – Transition Zone
  • Mid-periphery or limbal zone
  • Creates the sagittal height
  • Can be reserve geometry
  • Completely vaults limbus

17 Basic Design Features
• Spherical Design
  • Concentric symmetrical (spherical) scleral lens
  • Non-toric back surface

  – Landing Zone
  • Area of the lens that rests on anterior ocular surface
  • Scleral zone or haptic
  • Alignment to provide even pressure distribution is key

18 Basic Design Features

19 Basic Design Features
• Toric Lens Designs
  – Front Surface Toric -
  • Anterior surface front toric optics to improve vision
  • Located on the front surface of the central optical zone
  • Indicated when residual cylinder over-refraction is found
  • Needs stabilization
    – Dynamic stabilization zones or prism ballast
    – LARS

20 Basic Design Features
• Toric Lens Designs
  – Back Toric Haptics
  • Landing zone is made toric to improve lens fit
• Does not interfere with central zone of scleral lens
• Better ocular health
  – Fewer areas of localized pressure
  – Decreased bubble formation
  – Longer wearing time and better patient comfort
• More frequently needed in larger diameter sclerals

21 Basic Design Features
• Toric Lens Designs
  – Bitoric both anterior optics and back toric haptics
  • Front surface toric optical power
  • Back surface toric periphery
  • No need for lens stabilization

23 Basic Design Features
• Multifocal Scleral lens design
  • Simultaneous Multifocal Lens Design
    • Aspheric or concentric
    • Center Near and Center Distance Designs
      – Can adjust near powers
      – Can adjust zone size
  • Not all scleral lens designs have a MF option

25 Basic Design Features
• Lens Material
  – High(est) Dk lens material; plasma or hydra-PEG
    • Considerably thicker when compared to corneal GP
    – 250 microns to 500 microns
    • Optimum Extreme, Menicon Z
  • Increasing Oxygen transmissibility
    – 1. high Dk material (Dk > 125)
    – 2. minimal tear clearance behind the lens (<200)
    – 3. Reduced center thickness of the lens (<.250)

26 Fitting Basics
• Hydra-PEG
  – Polyethylene glycol (PEG) – base polymer
    • Covalently bonded to the lens surface
    • Creates a wetting ocular surface, increases surface wettability, increases lubricity,
decreases protein and lipid deposits, improves TBUT.

27 Fitting Basics
• Completely vault the cornea and limbus while aligning to the bulbar conjunctiva

28 Fitting Basics

29 Fitting Basics
• 1. Diameter
• 2. Clearance
• 3. Landing Zone Fit
• 4. Lens Edge
• 5. Asymmetrical Back Surface Design
  • Some trial sets are toric back surface
• 6. Lens Power

30 Fitting Basics
• 1. Diameter
  – Choose a Fitting Set
  • Direct vs Indirect control
  – Laboratory warranty/exchange policy
  – Overall Diameter
  • Larger – more clearance needed, ectasias
  • Smaller – easier to handle, less clearance

31 Fitting Basics
• 1. Diameter
  – HVID
    • <12mm
      – Start with a 16.0 mm or smaller lens
    • >12mm
      – Start with a 16.0 mm or larger lens

  – Diameter of the optical zone and the transition zone chosen roughly 0.2mm larger than the corneal diameter

32 Fitting Basics
• 2. Clearance
  – Minimum of ~100 microns
  – Typically aim for 200-300 microns after settling
  – Maximum of 600 (if desired)
  –
  – Base Curve Determination
    • Select an initial base curve that is flatter than the flat k value
    • Use 14 mm chord OCT, measure sagittal depth
• Evaluate overall corneal chamber appearance
  – Diffuse beam, low mag, medium illumination
  – Observe centration, areas of bearing, tear lens appearance, look for bubbles

• Evaluate central clearance

• Change lens base curve/sagittal depth until desired central clearance is reached
  – Considerations:
    • All scleral lenses will settle over a period of hours
    • Expect ~ 90 to 150 microns settling
    • Aim for 150 to 300 microns after settling
    • Build-in settling time into fitting session ~30 min

• UMSL Study:
  – No significant settling after 4 hours of wear
  – Most settling within the 1st hour

  – Large Diameter Scleral settle ~90 microns, slower
  – Mini Scleral ~130 microns, faster

• Evaluate remaining corneal chamber
  – Optic Section
  – Sweep limbus to limbus noting tear lens thickness
  – Looking for tears in optic section beyond the limbus and should increase in thickness
toward the central cornea

** Adequate limbal clearance is critical for an acceptable fit and good tear exchange**

• Anterior Segment OCT

• Anterior Segment OCT
44 Anterior Seg OCT

• • • • • •

45 Fitting Basics

• 3/4. Landing Zone Fit/Edge
  – Bulbar conjunctival vessels
  – Look for blanching
    • Inappropriate scleral curve alignment
    • Typically indicates PC is too tight
    • Or new toric back surface haptics
  – Confirm no lens movement
  – Perform all peripheral lens evaluations in Primary Gaze.

  • Ideal alignment when vessels course unobstructed under the scleral curves

46 Fitting Basics

47 Fitting Basics

48 Fitting Basics

• Anterior Segment OCT

49 Fitting Basics

• 5. Asymmetrical Back Surface Design
  – Allows for more equal pressure distribution
  – Can help center a inferiorly decentered lens
  – Flat and steep meridian
    • Can adjust either independently
    • Flat meridian is typically marked
    • Will lock into place

50 Fitting Basics

• 6. Lens Power/Over-Refraction
  – Expect close to spherical OR
  – If OR yields significant cylinder check - flexure
    • Do over-keratometry or over-topography

  – Residual Cylinder
• Front surface toric
• Usually has a great visual outcome

51 Fitting Basics
• Design and Order
  – Often lens modifications will need to be made from the best trial lens fit
  – Lab Consultants are helpful
    • Some warranties require consultation when re-ordering

52 Fitting Basics
Scleral Lens Handling
• Insertion
  – Prepare Lens
    • Large DMV
    • Clean lens, rinse
  – Fill with non-preserved sol
    • 0.9% NaCl inhalation sol
    • Off label: Addipak, Modudose
    • Lacripure, ScleralFil (buffered)
    • Refresh Optive single vials
    • Celluvisc

53 Is buffered better??

54 Fitting Basics
Scleral Lens Handling

55 Fitting Basics
Lens Insertion
• Place paper towels on patient’s lap
• Have patient tuck chin to chest and look straight down
• Have patient hold lower lid
• Clinician hold upper lid
• Insert lens straight onto cornea

56 Fitting Basics
Scleral Lens Handling

57 Fitting Basics
Lens Application

58 Fitting Basics
Scleral Lens Handling
• Removal
  – Loosen Lens – gently nudge lens
– Medium DMV
  • placed on inferior portion of lens
  – Hold both lids

59 □ Fitting Basics
  Lens Removal

60 □ Fitting Basics
  Scleral Lens Handling

61 □ Fitting Basics
  Scleral Lens Handling
  • Educate patient about proper lens orientation upon insertion
    – Dots at 6 o'clock

62 □ Parameter Considerations
  • Common Parameter Changes:
    – Sagittal Height
    – Overall diameter (OAD)
    – Optic Zone Diameter (OZD)
    – Base Curve (BC)
    – PC width
    – PC radius of curvature
    – Center Thickness

63 □ Parameter Considerations
  • Common Parameter Changes:
    – Sagittal Height
      • Adjustment to the transition zone
      • Allows clinician to increase or decrease central lens clearance without adjusting base
curve or peripheral lens curves
      • Indicate to lab the amount of clearance you want to gain or lose

64 □ Patient GH
  – Fit in 2013
  – OD: 7.50 / -7.00 / 14.5 20/50
  – OS: 7.5 / -7.50 / 14.5 20/40
  – SLE: central touch in both eyes
    • Increase diameter; increase sagittal height; steepen lens

65 □ Patient GH
  • New Scleral Lens
    • OD: 7.5 / 14.8 / -7.50 -1.25 x 013  20/30
      – 1.5 steep limbal zone
    • OS: 7.18 / 14.8 / -8.25 -0.75 x 162  20/40+
Parameter Considerations

- 1 step flat limbal zone; 1 step flat scleral zone

66 Parameter Considerations
- Common Parameter Changes:
  - Overall diameter (OAD) / Optic Zone Diameter (OZD)
    - Can increase or decrease
    - More likely to increase
  - If you need additional central clearance
    - Can increase OZD which will increase OAD
  - If you need more clearance at limbus
    - Can increase OZD which will increase OAD

67 Parameter Considerations
- OZD changes: often done to improve fit
  - OZD increase without BC compensation

68 Parameter Considerations
- Increase OZD with BC compensation

69 Parameter Considerations
- Common Parameter Changes:
  - Base Curve (BC)
    - Typically adjusted during initial fit
    - Flatter base curve to address peripheral lens tightness or excessive central clearance
    - Steeper base curve to increase central clearance or loose periphery
  - If you need to adjust the central clearance, but you are happy with peripheral alignment
    - Adjust sagittal height NOT base curve

70 Parameter Considerations
- Common Parameter Changes:
  - PC width / PC radius of curvature
    - Make wider or smaller
    - Steeper or flatter
    - Toric Haptics
  - Center Thickness
    - Can increase or decrease
      - Considerations: flexure and edema

71 Parameter Considerations
- Scleral Curve Changes

72 Tips for Fitting
- 1. Go flatter than flat K value for initial lens selection
• 2. Use Fluorescein for initial lens selection
  – Use BLUE Light – GET THE BIG PICTURE
  – Use WHITE Light – to evaluate everything else

• 3. Analyze Superior and Inferior lens edges in Primary Gaze
• 4. Try not to make parameter changes at dispensing
• 5. Toric Haptics – spin lens and watch for quick return

73 □ **Tips for Follow-up**
  • 1. Ask patient: “How do you take care of your lenses”
  • 2. Follow-up should be at least 2 hours after lens insertion
  • 3. Paint the front of the lens to look for fluid exchange
  • 4. Remove lens and evaluate cornea

74 □ **Troubleshooting**
  • Problem: Decreased vision after insertion
    – Often caused by mucin build-up in tear lens
    – Begins ~30min to 4 hrs after insertion

  • Possible Solutions
    – Reinsert lens with fresh solution/ use solution mixture
    – Rx lid hygiene
    – Rinse eye prior to insertion
    – Refit with decreased central clearance/better peripheral alignment
    – Change lens material or Lens coating – Hydra-PEG

75 □ **Troubleshooting**
  • Decreased Vision after Insertion

76 □ **Troubleshooting**
  • Conjunctival Prolapse

77 □ **Troubleshooting**
  **Conjunctival Prolapse**
  – Caused by negative pressure under the lens
    – More prominent in patients with loose conjunctival tissue or elderly patients
  • Check for neovascularization
  • Solution
1. Fit an asymmetrical back surface scleral lens to help alleviate the problem
2. Decrease limbal clearance

### Troubleshooting

#### Conjunctival Prolapse
- Prolapse with tight PC
  - Flatten the PC

#### Troubleshooting

#### Conjunctival Prolapse
- Prolapse with peripheral alignment
  - Decrease the limbal clearance
  - 2 ways:
    - Flatten the BC
    - Decrease the reverse curve

#### Troubleshooting
- Problem: Diffuse Corneal Staining on follow-up
  - Due to fill media, care systems, AT’s or meds
  - Can be difficult to isolate cause
  - Can be more significant if tear exchange is low
  - Possible solutions:
    - Switch Care systems
    - Rx 0.9%NaCl inhalation solution
    - Completely rinse MPS off lens
    - Confirm compliance with prescribed care

#### A severe case of stain
- 27 yo patient with Keratoconus OU
  - Wearing scleral lens OU – 2014
  - Hx of Corneal Crosslinking OU (’09)
  - Presents 7/2017
    - Cc: blurred vision OS> OD
    - using clear care to clean lenses
    - sometimes sleeps in lenses
    - uses Boston Advance to fill lenses prior to insertion

#### A severe case of stain
- 27 yo patient with Keratoconus OU
• VA 20/30 OD 20/125 OS
• SLE: Punctate staining OU, mild corneal edema OS
• 150 microns clearance OU
• Adequate limbal clearance
• No peripheral blanching or impingement
• Plan: educated patient about proper lens care; RTC 1 week fitting

83 Troubleshooting
• Problem: Poor surface wetting
  – MGD can contribute / cause problem
  – Multipurpose Solution (MPS) may cause problems
  – Lens Material
  –
• Possible Solutions:
  – Evaluate lid margins/ tear film
  – Prescribe lid hygiene if necessary
  – Change MPS / Lens material
  – Lens Coating – hydra-PEG

84 Troubleshooting
• Problem: Poor surface wetting (old lens)
  – Lens Coating break-down
  – Lens Material break-down
  –
• Possible Solutions:
  – Order new lenses (with HydraPEG)
  – Clean with laboratory cleaner
  – Prescribe Progent

85 Troubleshooting
• Problem: Corneal edema at follow-up
  – Can arise after weeks / months => f/u is important!
  – More common in post PK corneas
  – Higher risk in corneas with low endothelial cell count
  – Consider Dk/L as Dk is likely not the issue

• Possible Solutions:
  – Prevention: do endothelial cell count before fitting (1000 +?)
  – Scrutinize grafts at every visit!
  – Educate graft patients on symptoms of rejection: pain, light sensitivity, redness, blurred vision
87 Troubleshooting

- Keratoconus and Fuchs! Oh My!
- 64 year Female with Keratoconus
  - Presents with blurry vision in scleral lenses and irritation OU
    - Lenses are uncomfortable and dry
    - Redness OU
  - Interested in Eyeprint PRO
    - 20/40- OD 20/30- OS HVID 12mm
    - OD: +0.75 -4.00 x 175 20/40- OS: +1.50 -3.50 x 180 20/30-
    - Pinguecula Temporal and Nasal OU

- P

88 Case TS: KCN and Fuchs

- Initial FITTING
- **HVID 12mm; Pinguecula T/N OU**
  - 8.4 base curve 4.6 sagittal height 17.0 diameter
  - OR: +3.75 -0.75 x 180 20/25-- +4.00 -0.75 x 180 20/30
  - Options to Troubleshoot Pinguecula:
    - Microvault
    - Toric PC

89 Case TS: KCN and Fuchs

90 Case TS: KCN and Fuchs

- Keratoconus and Fuchs! Oh My!
  - At one year follow-up

91 Case TS: KCN and Fuchs

- Toric Haptics/Peripheral Curves
  - Steepen the Vertical meridian to relieve pressure in the horizontal
  - Flatten the horizontal meridian
  - Always evaluate the location of the flat meridian markings
  -
• MicroVault
  – Confirm lens design can incorporate microvaults
  – Measure location and size

92 Troubleshooting
• Problem: Discomfort immediately after insertion
  – Ask patient where discomfort is located
  – Poor peripheral fit – too flat
  – Base curve too flat- central bearing or touch
  – Mucus adhered to back surface of lens
  –
• Possible solutions:
  – Adjust peripheral systems for proper alignment
  – Select steeper base curve
  – Clean inside of bowl daily; prescribe Progent (Menicon) to remove mucus

93 Troubleshooting
• Problem: Discomfort after several hours of wear
  – Follow-up patient questions
  –
  – Does your eye become red while wearing the lens?
  – Does your eye become red after lens removal?
  – Where is the irritation located?
  – Do you notice any changes in your vision?
  – What solution(s) are you using for lens application?

94 Troubleshooting
• Problem: Discomfort after several hours of wear
  – Poor peripheral fit (too steep)
  – Lens is too small to support its weight
  – Corneal chamber too small
  –
• Possible solutions:
  – Adjust peripheral systems for proper alignment
  – Increase surface area of scleral curves
  – Increase OAD or corneal chamber size if appropriate

95 Troubleshooting
• Problem: Lens hurts upon removal with subsequent difficulty wearing it the next day
  – Poor peripheral fit – scleral compression
  • Causing rebound hyperemia and inflammation
  –
• Possible solutions:
  – Changing Diameter
  – Changing peripheral curves

96 Troubleshooting

• Problem: Bubbles under the lens
• Too much sagittal height/Too flat peripheral curves
  – Improper insertion
  – Fenestration hole

• Possible Solutions:
  – Fill bowl completely with solution prior to insertion
  – Remove fenestration hole
  – Central bubble: Adjust lens parameters to decrease sagittal height
  – Peripheral bubbles: steepen peripheral curves or increase lens diameter

97 Patient AB

• History: KCN OU; crosslinking OU
• Lens history: soft toric lenses

98 Patient AB

• Examination findings
  – MR:
    • OD +0.75 -3.50 x 060 20/70+
    • OS -0.25 -0.75 x 142 20/100+
  – Lens options
    • Specialty Corneal lens
      – Patient attempted to wear and could not adapt
    • Intralimbal design
      – Patient attempted to wear and could not adapt
    • Scleral Lens

99 Patient AB

100 Patient AB

101 Final Thoughts

• Consider mini-scleral / scleral for appropriate patients
  – Select one lab, one design
• First couple fits are the most challenging
• Scleral lenses are not going away
• Consultants are a great resource
• Huge practice building opportunity