

Advanced Fitting Guide



Keratoconus
Pellucid Marginal Corneal Degeneration
Corneal Ectasia
Corneal Graft
Irregular Cornea
Post Refractive Surgery
Astigmatism
Chronic Dry Eye
Sports

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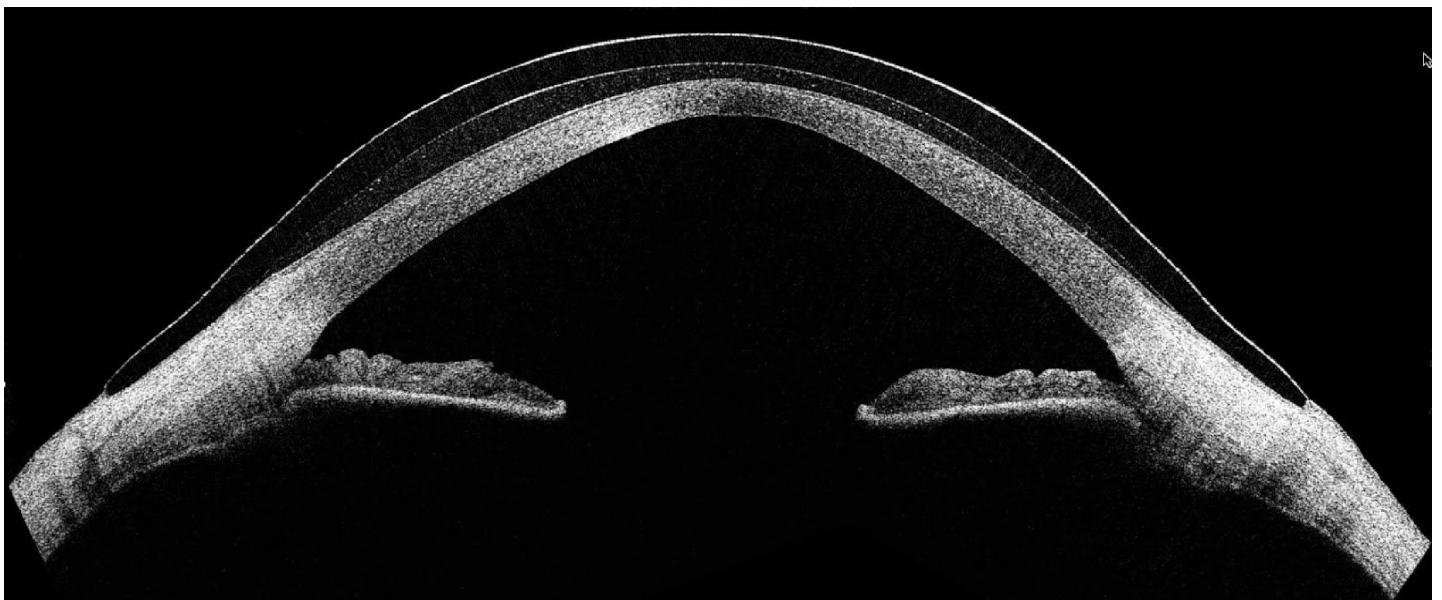
1. History and Development

The use of Scleral lenses for patients with irregular cornea such as Keratoconus has significantly increased in the last decade. This can be attributed to the introduction of high oxygen permeable materials, improved manufacturing technology, the development of lens designs, and easier fitting techniques.

In designing the EyeSpace Scleral lens range, extensive research was undertaken to ensure optimum fitting characteristics. Optical Coherence Tomography (OCT) imaging and Corneal Topography was used to measure and analyze the corneal, limbal and scleral shape, and to assess prototype Scleral contact lenses during development. Applying these high resolution, and micron precision technology's resulted in significant advances in the measurement of paralimbal scleral geometry, corneal/limbal/scleral toricity, lens thickness profiles, non-rotationally symmetric lens geometry's and scleral contact lens flexure.

A key focus in the development of the EyeSpace Scleral range was to create contact lens parameters that are easy to calculate, order and troubleshoot. Traditional nomenclature such as back optic zone radius (BOZR, in mm), diameter, and back vertex power (BVP, sphero-cylindrical notation, in D) have been maintained. Rather than describing a series of peripheral curves in zone diameter, radius of curvature, eccentricity or tangent angles, the EyeSpace Scleral lens is noted in sagittal height to control the depth, and therefore the apical clearance of the lens.

This, in turn, enables contact lens practitioners to quickly, and accurately design and order a Scleral contact lens that promotes excellent corneal health, stable vision, and all day comfort. The EyeSpace Scleral lens range is available in Boston XO and XO2 material to allow high oxygen permeability, excellent wettability and durability.



2. Anterior Eye Anatomy

To get the maximum potential from the EyeSpace Scleral lens range it is important for the contact lens practitioner to be familiar with the anterior ocular surface anatomy and cornea-limbal shape.

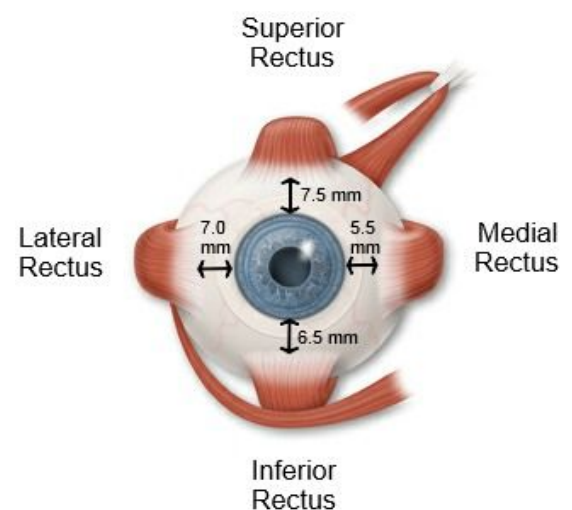
2.1 Corneal Diameter

The EyeSpace Scleral lens range is designed to completely vault the cornea and limbus. The bearing of the lens should be exclusive to the paralimbal sclera. Therefore it is important to know the corneal and limbal diameter. This is best measured clinically as the horizontal visible iris diameter (HVID). The HVID typically ranges between 10.00 mm and 13.00 mm. It should also be noted that the cornea is oval, and as a result the HVID is generally larger than the vertical visible iris diameter (VVID). The HVID directly affects the selection of the diameter in the EyeSpace Scleral lens range, and this will be discussed in more detail below.

2.2 Extraocular Muscles

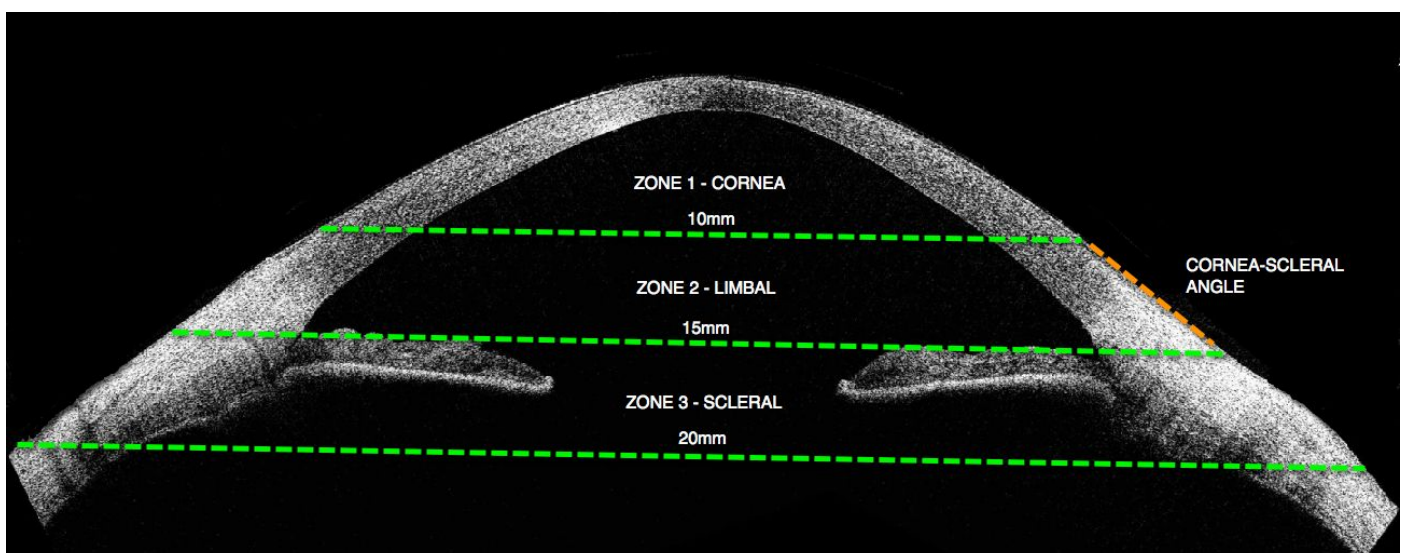
The rectus muscles insert in the sclera gradually further from the limbus beginning with the medial rectus at 5.50 mm (range 3.00 mm to 6.00 mm), inferior rectus 6.50 mm, lateral rectus 7.00 mm and superior rectus 7.50 mm. The line of insertion is called the spiral of tillaux.

Practically, this means that the nasal side of the post limbal area presents the physical limiting factor for fitting large scleral lenses at around 22.00 - 24.00 mm in lens diameter.



2.3 Cornea-Limbal and Scleral Shape

Due to advances in technology such as OCT, and the need to better understand the limbal and scleral shape to improve scleral contact lens fitting, Pacific University looked at the limbal-scleral angles using OCT analysis in the scleral shape study. They imaged and analysed the three anatomical zones, the cornea, limbus and sclera.



2.3.1 Corneal Zone

This area represents the cornea up to a chord length of 10.00 mm. This area can typically be analysed using standard topography methods and in normal corneas is a prolate shape. The cornea can be described using many mathematical methods such as axial curvature and power, tangential curvature and power, elevation, and eccentricity.

2.3.2 Limbal Zone

Initially it was thought that the limbal area and adjacent sclera had a curved shape. Recent research has indicated that this is not always the case and that this zone can be better described as a series of tangent lines in many eyes.

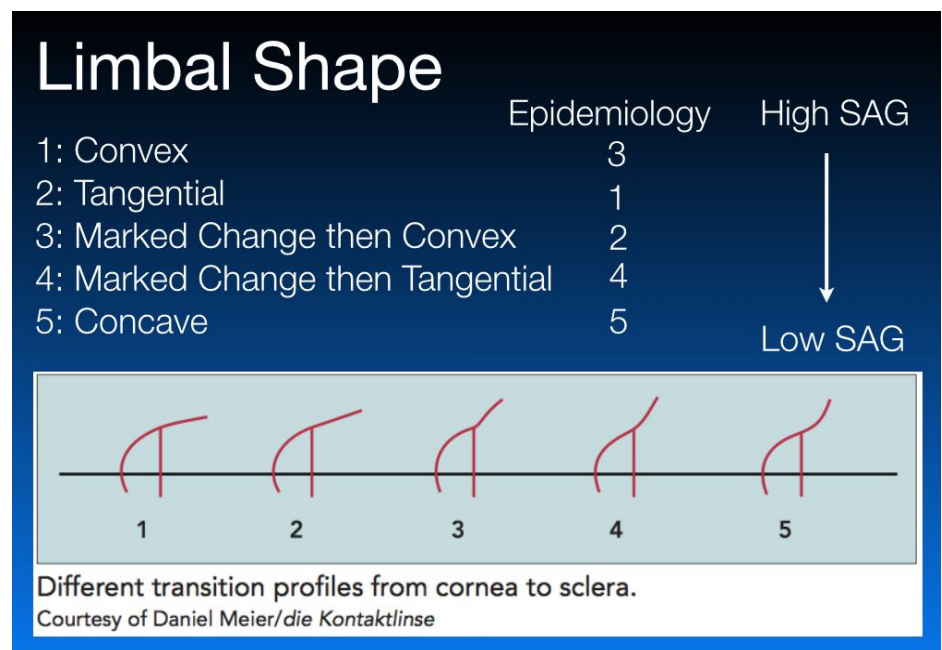
Meier described the limbal profile as having 5 different shape models:

- **Profile 1** - Corneal - Scleral shape is convex
- **Profile 2** - Sclera shape is tangential
- **Profile 3** - Marked transition between the cornea and sclera with the scleral shape convex
- **Profile 4** - Marked transition between the cornea and sclera with the scleral shape tangential
- **Profile 5** - Corneal shape convex and scleral shape concave

In comparison to the population it was evident that profile 2 is the most commonly observed corneal-scleral shape followed by Profile 3. The different shapes also result in different sagittal heights at the level of the sclera, with profile 1 having the greatest sagittal height, and profile 5 the least. See figure below.

The limbal zone can be defined as the cornea-scleral angle or limbal angle and is measured between the chord lengths of 10-15 mm. Research has shown that this area is not rotationally symmetric (or spherical) and that a low degree of variability exists between the limbal angles as measured on the 8 principal meridians of the eye.

The Scleral Shape Study concluded that the average difference is approximately 1.7 degrees or 108 microns with the nasal meridian being the flattest angle followed by the temporal, superior and inferior meridians in order of flattest to steepest.



2.3.3 Scleral Zone

The Scleral zone can also be defined as an angle and is measured between the chord lengths of 15-20 mm. The variability between the scleral angles increases significantly compared with the limbal angle. The average difference of the scleral angle in the 8 principal meridian is approximately 6.60 degrees or 400 microns.

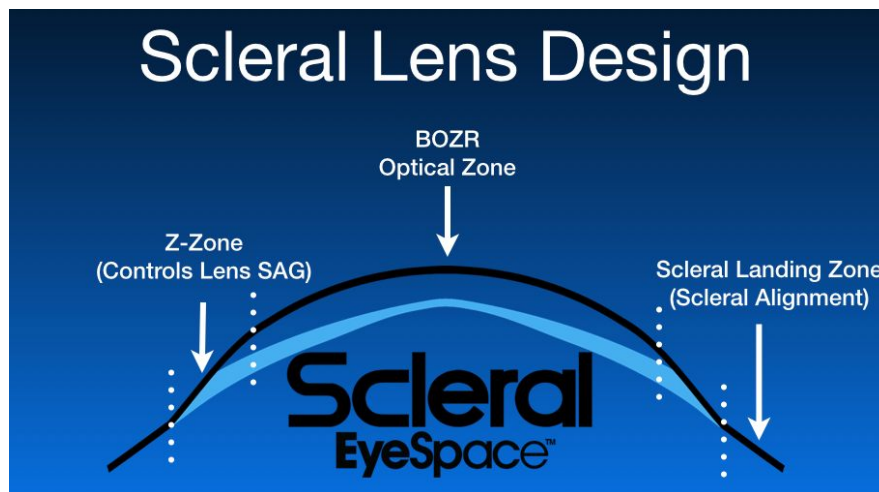
Taking these findings into account it is safe to assume that as the diameter of the scleral lens increases beyond the 15 mm chord length it will become increasingly necessary to fit a non rotationally symmetric

scleral lens.

3. Fitting Methodology

The EyeSpace Scleral contact lenses should not be fitted empirically. Before ordering a lens, in office trial fitting with the EyeSpace Scleral diagnostic lenses should be performed to confirm the optimum fitting parameters of the lens on the eye.

The EyeSpace Scleral contact lens has 3 individually controlled zones which can be adjusted to achieve the best possible fit and visual acuity.



To successfully fit the EyeSpace Scleral lenses it is necessary to calculate five parameters:

1. Lens diameter
2. SAG@15mm
3. Back Optic Zone Radius
4. Scleral Landing Zone
5. Back Vertex Power

When ordering the lenses the parameter notation should be:

Lens Type

BOZR / Diameter / SAG@15mm / SLZ / BVP / Lens Colour

Example:

EyeSpace Scleral

7.5 / 16.50 / 4500 / Flat / -2.00 / Clear

Building a Scleral Lens

- Step 1. RS or Toric
- Step 2. Diameter- 16.50 or 17.50 (HVID)
- Step 3. SLZ - Even landing 360 degrees
- Step 4. SAG@15mm - Aim for 150 to 200 μ m clearance
- Step 5. BOZR - Achieve an even PLTT
- Step 6. BVP

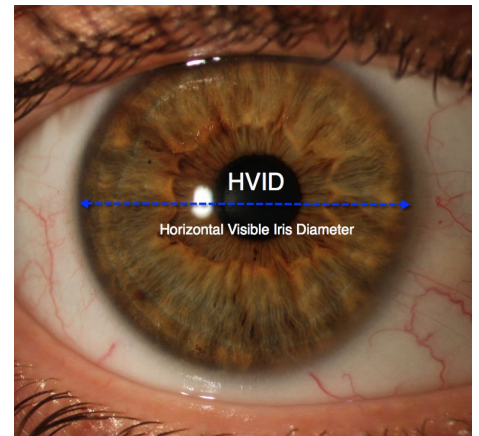
Specification

EyeSpace Scleral

8.0 / 16.50 / 4500 / Flat / -3.00

3.1 Lens Diameter

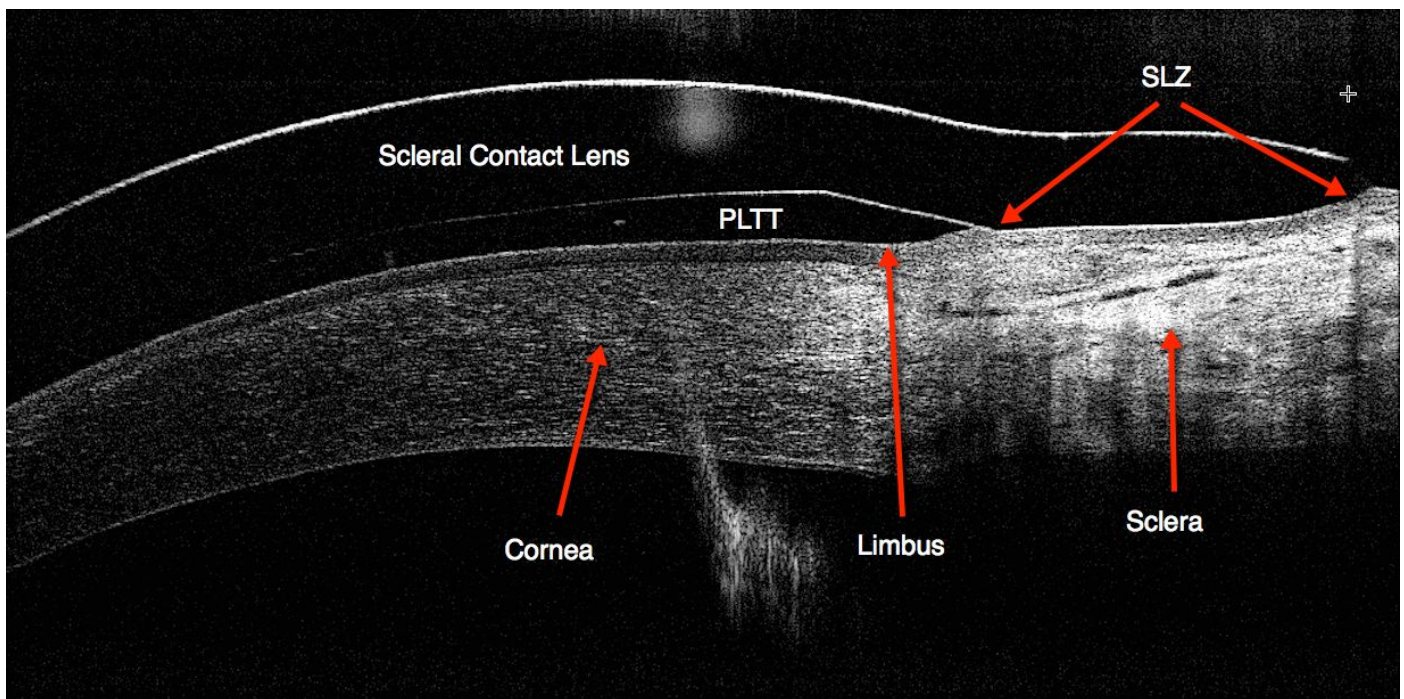
The EyeSpace Scleral contact lens should completely vault the cornea and limbus. In order to achieve complete clearance of the cornea and limbus the HVID must be taken into account. A larger cornea will require a larger diameter lens, otherwise the landing area of the lens will bear on the limbus. In the case of small cornea, the lens diameter does not need to be as large in order to achieve complete corneal and limbal clearance. The HVID can be measured using a handheld ruler, slit lamp graticule, or measuring tool in your corneal topographer.



The EyeSpace Scleral lens range is available in diameters 16.50 mm and 17.50 mm.

- If the HVID is **smaller** than **11.50 mm**, a **16.50 mm** lens diameter should be fitted.
- If the HVID is **equal to** or **larger** than **11.50 mm**, a **17.50 mm** lens diameter should be fitted.

If corneal but not limbal clearance is achieved then a larger lens is required. A larger diameter will provide limbal clearance as the start of the Scleral Landing Zone (SLZ) is further from the centre of the lens.



3.2 SAG@15mm

A successful scleral lens fit, is one where the lens vaults the cornea with 100-150 microns of clearance at the apex of the cornea. Although a fit where the clearance is greater than 150 microns, may provide good comfort and vision, the amount of oxygen that reaches the cornea is compromised by a thick layer of tears. A post lens tear thickness of greater than 150 microns will also cause the lens to fit tighter, with increase suction to the eye, and greater accumulation of debris (lipid, protein and mucus). The accumulation of debris may result in fogging or clouding of vision.

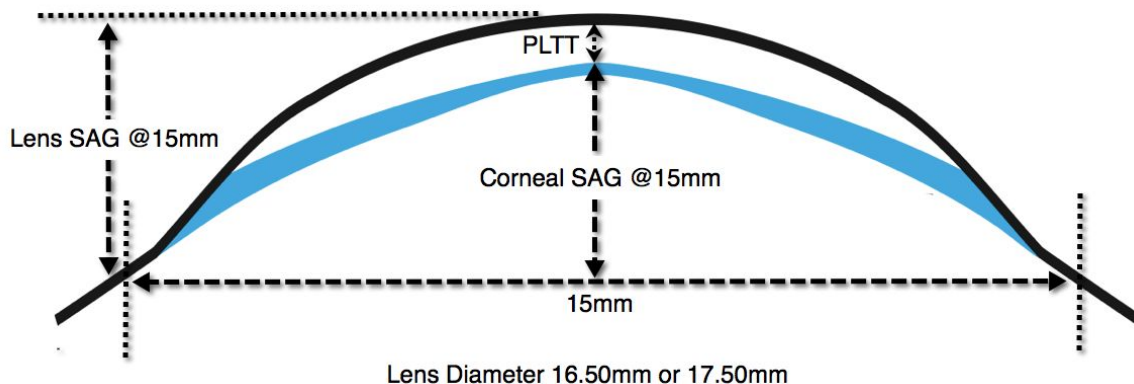
The EyeSpace Scleral lens uses the parameter SAG@15mm to control the depth of the lens, and the resulting corneal clearance. The SAG@15mm directly affects the Z-zone of the lens, which connects the BOZR to the Scleral Landing Zone (SLZ). The SAG@15mm is as the name suggests, the exact sagittal depth of the lens at the 15mm chord of the lens.

Changing the SAG@15mm value enables the contact lens fitter to easily increase and decrease the depth of the lens, and resulting corneal clearance. It also enables the contact lens fitter to adjust multiple parameters of the lens, like the Back Optic Zone Radius (BOZR), lens diameter and Scleral Landing Zone (SLZ), without having to take into account their effect on the total depth of the lens. If one or more of the BOZR, SLZ, or Diameter is changed, the Z-zone will independently be adjusted to account for the change in sagittal height of the BOZR, SLZ and Diameter to result in the desired SAG@15mm.

Note: Changing the Back Optic Zone Radius, lens diameter and Scleral Landing Zone does not influence the total sagittal height (depth) of the lens.

Various methods can be used to calculate the initial SAG@15mm value of the EyeSpace Scleral diagnostic lens:

- Smith Technique
- Topography SAG@10mm
- Trial fitting with a diagnostic trial lens set



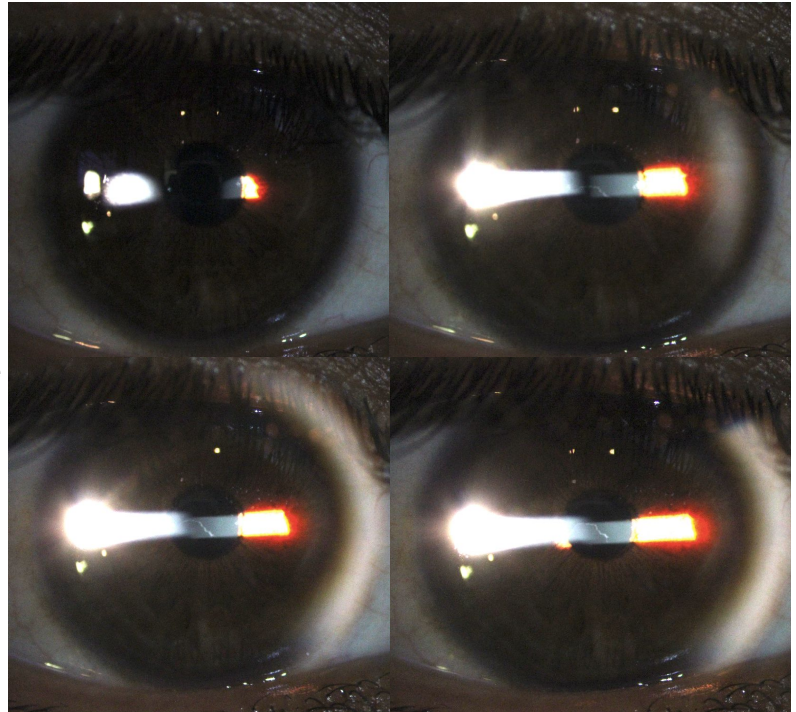
3.2.1 Smith Technique

The Smith Technique for estimating the depth of the anterior chamber was first published in 1979, and since then has been used as an efficient and accurate test that can be used in everyday clinical practice. The anterior chamber depth relates very closely to the sagittal height of the cornea at the 15 mm chord. Hence to calculate the SAG@15mm of the lens, you must determine the sum of the sag of the cornea at 15mm and the PLTT (150 microns). Although very practical, it is important to note that there are limitations to the Smith Technique, particularly between different slit lamp models.

1. Lock the illumination at 60 degrees on the temporal side. Keep the eye piece straight ahead.
2. Rotate the illumination to give a horizontal, small, thin, bright beam.
3. With the patient looking at the microscope, focus on the anterior surface of the lens. There should be two beams visible, one in focus at the anterior lens surface, and one out of focus on the temporal edge of the cornea.
4. Slowly increase the slit lamp length, keeping the focus on the anterior surface of the lens
5. Stop once the inside edges of both the focussed and unfocused beams meet.
6. Read the width of the beam off the illumination graticule.
7. Multiply this number by 1.4. This is the anterior chamber depth.
eg. Graticule reads 3.5. $3.5 \times 1.4 = 4.9$ mm or 4900 microns.

Note: For conditions such as Keratoconus or proud Corneal Grafts the measurement should be taken through the most anterior part of the cornea. In the case of Keratoconus this may be at the position of the cone, inferior to the centre of the eye. In the case of the aphakic eye you should focus on the pupillary ruff.

NOTE: Image 1 displays the infocus beam on the anterior lens capsule and pigmentary pupillary ruff, and the out of focus beam on the cornea. Image 2 shows the two beam slightly separated. Image 3 captures the scenario where the focussed and unfocused beams meet. At this stage record the graticule reading for calculation of the anterior chamber depth. Image 4 displays the point where the two beams overlap.



As scleral lenses should only land on the sclera and completely vault the cornea, add 150 microns (PLTT) to the AC depth as determined by the Smith technique, this value is then used to select the first trial lens from your scleral lens diagnostic kit. Should the value fall between two diagnostic lenses always choose the lens with the greater sagittal value.

3.2.2 Topography SAG@10mm

Current topographers can only measure the corneal sagittal height up to a chord length of 10.00 mm.

3.2.2.1 Medmont Weighted Ave Method

In the example below the “Analysis Details” feature on the Medmont software, shows the corneal sagittal height data (Weighted Ave) of an eye, measured over a chord length of 10.00 mm (Medmont SAG@10mm).

Analysis Details

Meridian (degrees): 7.2 Flat Steep

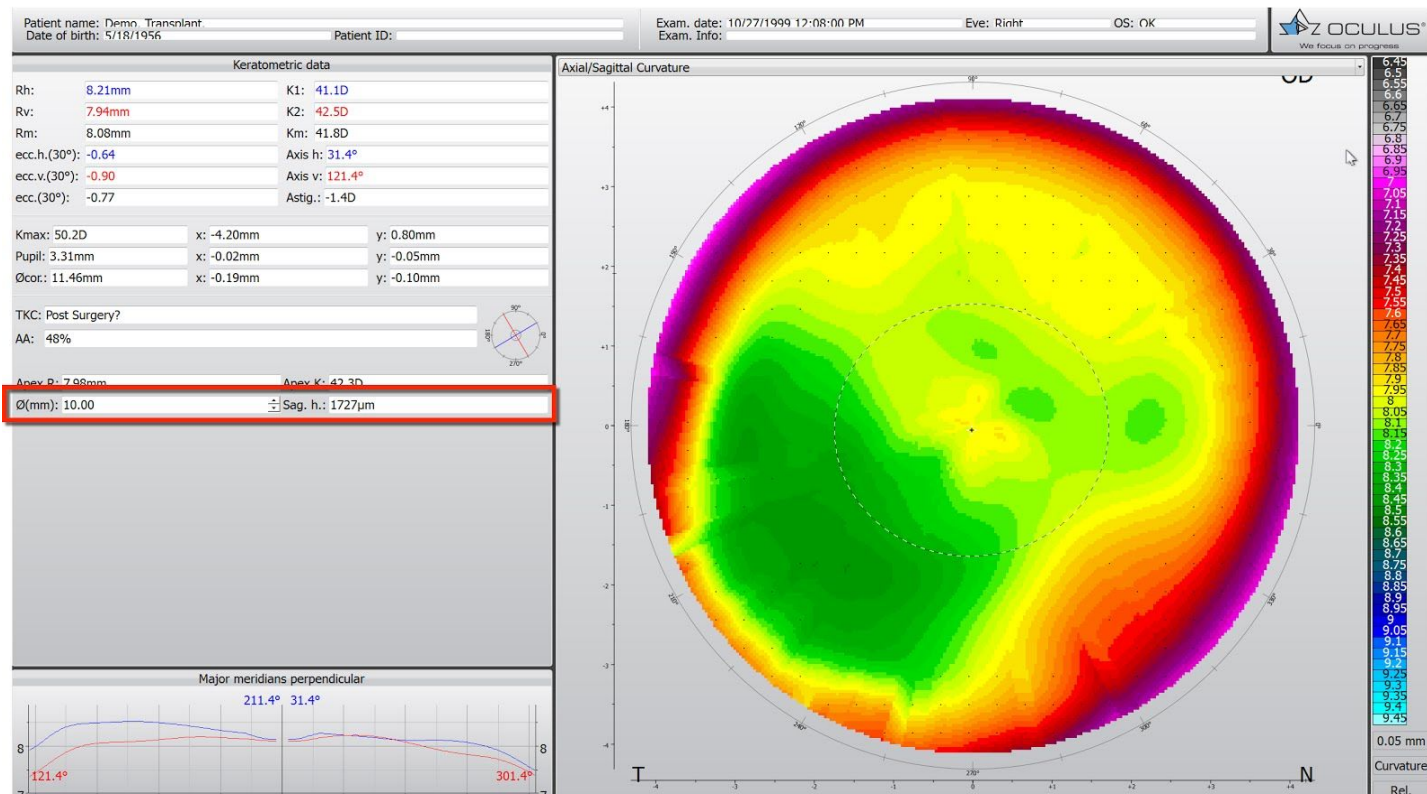
Chord (mm): 10.00

Exam	Apical Curv	Weighted Ave	e ² Values	e (Eccentricity)	Axial Curvature	Tangential Cu	Height	Surface Norm	Flat K	Flat Angle
4-Jun-2013 5:09:43 PM	7.550	1777.1	0.43	0.65	8.45	11.74	1730.47	36.3	43.73	7.2
μ (mean)	7.550	1777.1	0.43	0.65	8.45	11.74	1730.47	36.3	43.73	7.2
σ (standard deviation)	undefined	undefined	undefined	undefined	undefined	undefined	undefined	undefined	undefined	undefined

Export Print Print Preview OK

3.2.2.2 Oculus SAG@10mm

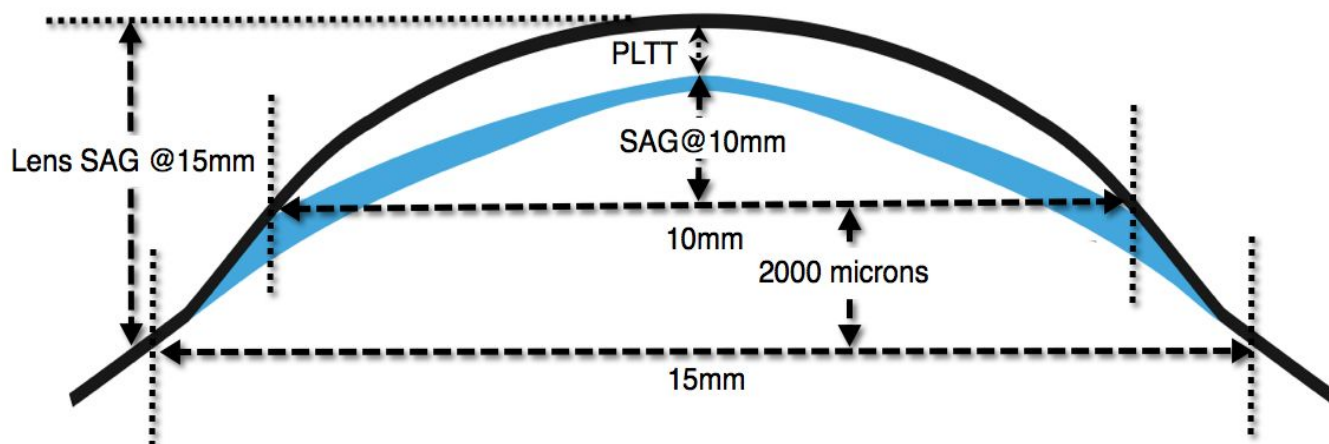
In the example below the “Display - 1 Large Color Map” feature on the Oculus software, shows the corneal sagittal height data of an eye, measured over a chord length of 10.00 mm (Oculus SAG@10).



3.2.2.1 Calculating SAG@15mm of Diagnostic lens

Studies by Pacific University found that the average corneal sagittal height difference between the chord lengths of 10.00 mm and 15.00 mm is approximately 2000 microns. They noted that most of the variance in sagittal height between individuals occurred in the central 10.00 mm.

This suggests that a simplified equation can be followed to calculate the sagittal height at a chord length of 15 mm for most eyes by simply adding 2000 microns to the sagittal height of the cornea at 10.00 mm as measured by the topographer.



To calculate the SAG@15mm of the initial EyeSpace Scleral diagnostic lens, simply add the SAG@15mm and the PLTT (150 microns).

For Example:

Topographer measure SAG@10mm as 1777.1 microns.

$$\begin{aligned}\text{SAG@15} &= 2000 + \text{SAG@10mm} + \text{PLTT} \\ \text{SAG@15} &= 2000 + \text{SAG@10mm} + 150 \\ &= 2000 + 1777.1 + 150 \\ &= 4077 \text{ microns}\end{aligned}$$

3.2.3 Using Corneal Condition Sagittal Height Table

Alternatively use the recommended starting diagnostic lens sag value based on corneal shape:

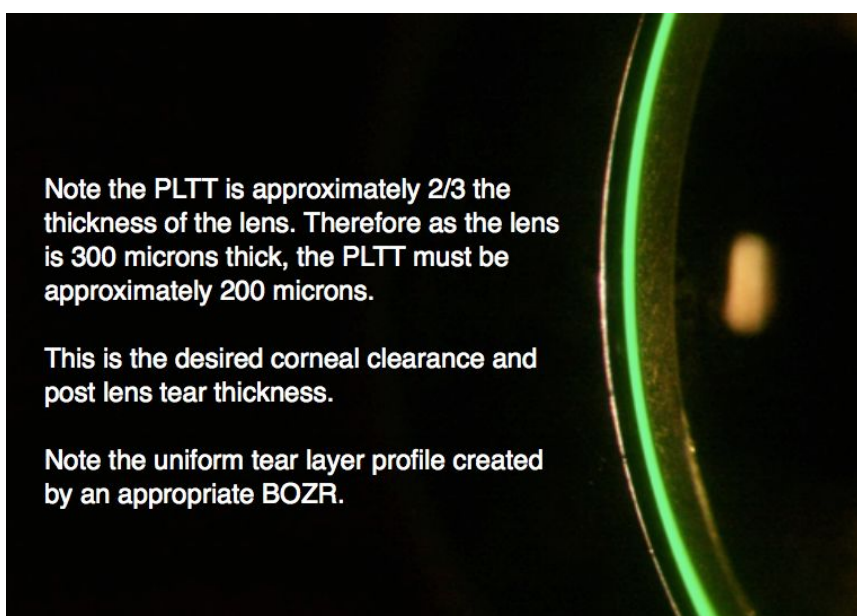
Normal shaped and refractive surgery	4000 microns
Keratoconus and Pellucid Marginal Degeneration	4300 microns
Corneal Transplants	4600 microns
Proud corneal Transplants and Keratoglobus	4900 microns

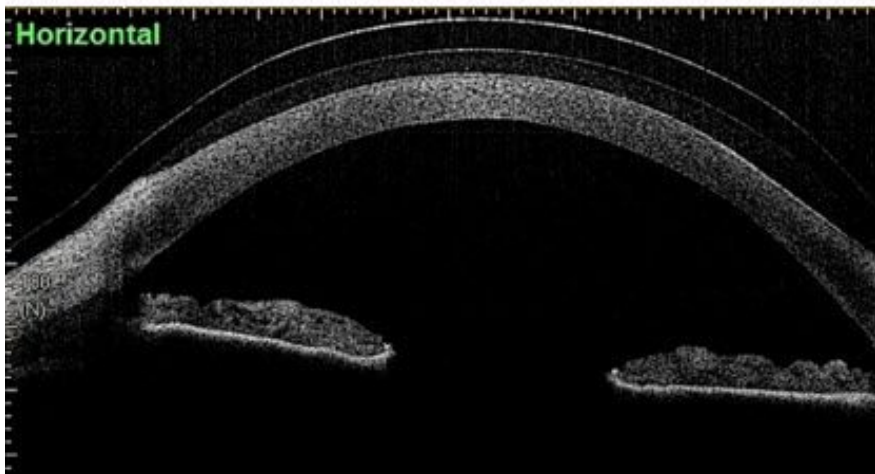
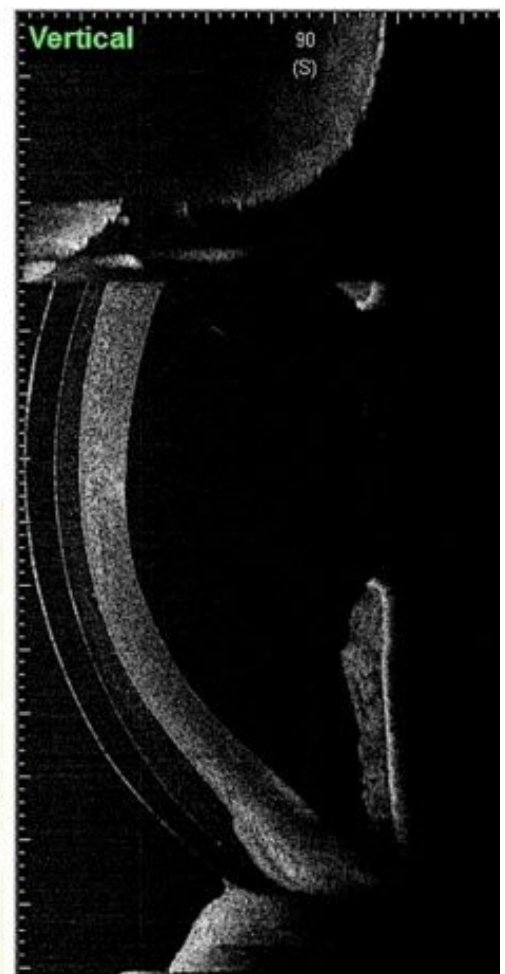
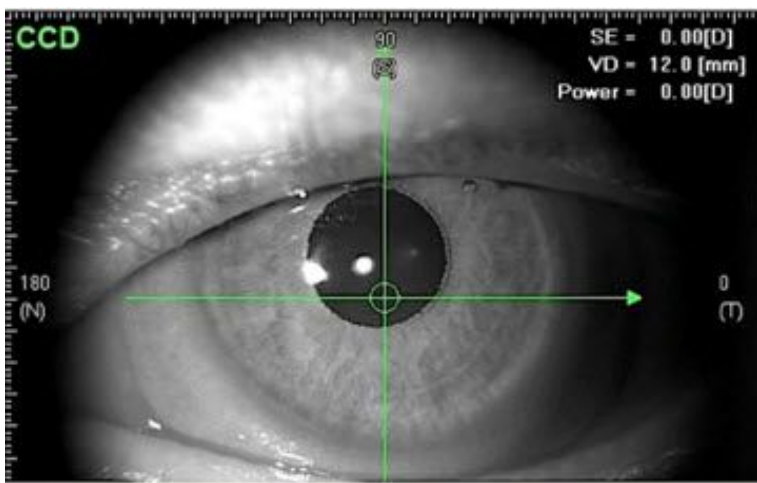
3.3 Back Optic Zone Radius

To achieve the best optical results, the BOZR should have a uniform clearance over the central 9.00 mm corneal zone.

To determine the best BOZR, insert a diagnostic lens from the EyeSpace Scleral fitting set into the eye with Fluorescein. Using slit lamp observation it is possible to judge if the BOZR provides a uniform clearance over the central 9.00 mm zone of the cornea.

OCT is very useful to observe the BOZR clearance in both the horizontal and vertical meridians of the central 9.00 mm cornea. See OCT image below, displaying a very even post lens tear thickness (PLTT) over the central 9.00 mm of the lens.



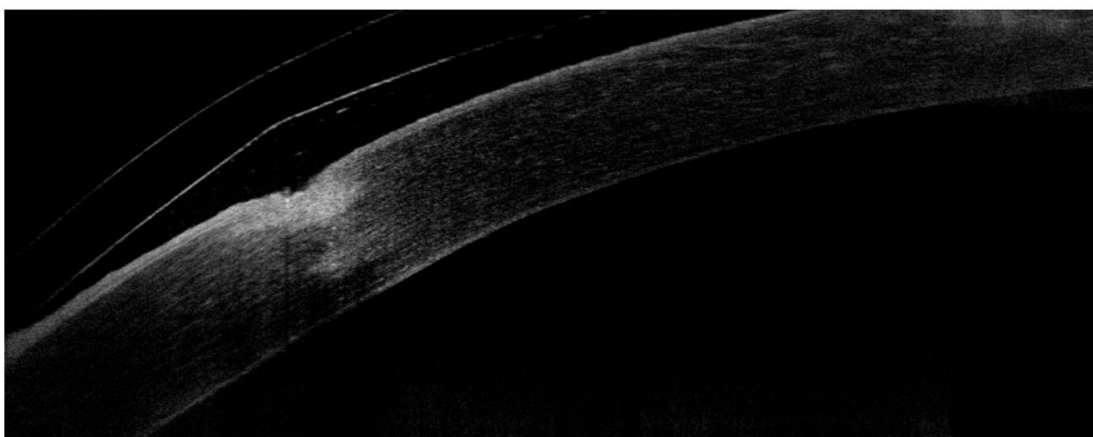


A BOZR fitted too steep will have more clearance over the centre cornea compared to 4.50 mm out from the centre, thus creating a convex or plus power post lens tear layer.

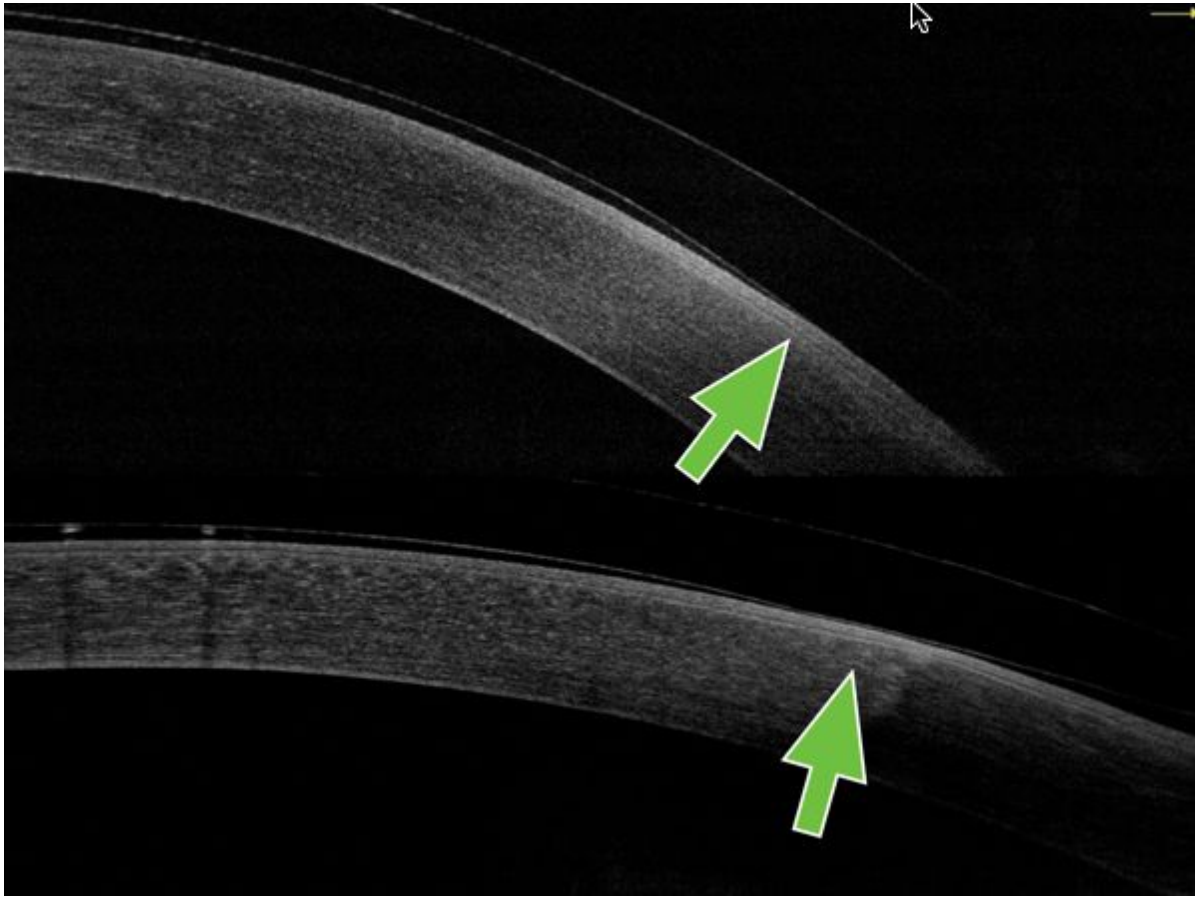


When observing the EyeSpace Scleral lens with a steep BOZR the central PLTT will appear to have adequate clearance but the peripheral BOZ portion, 4.50 mm out from the center, could potentially touch the cornea.

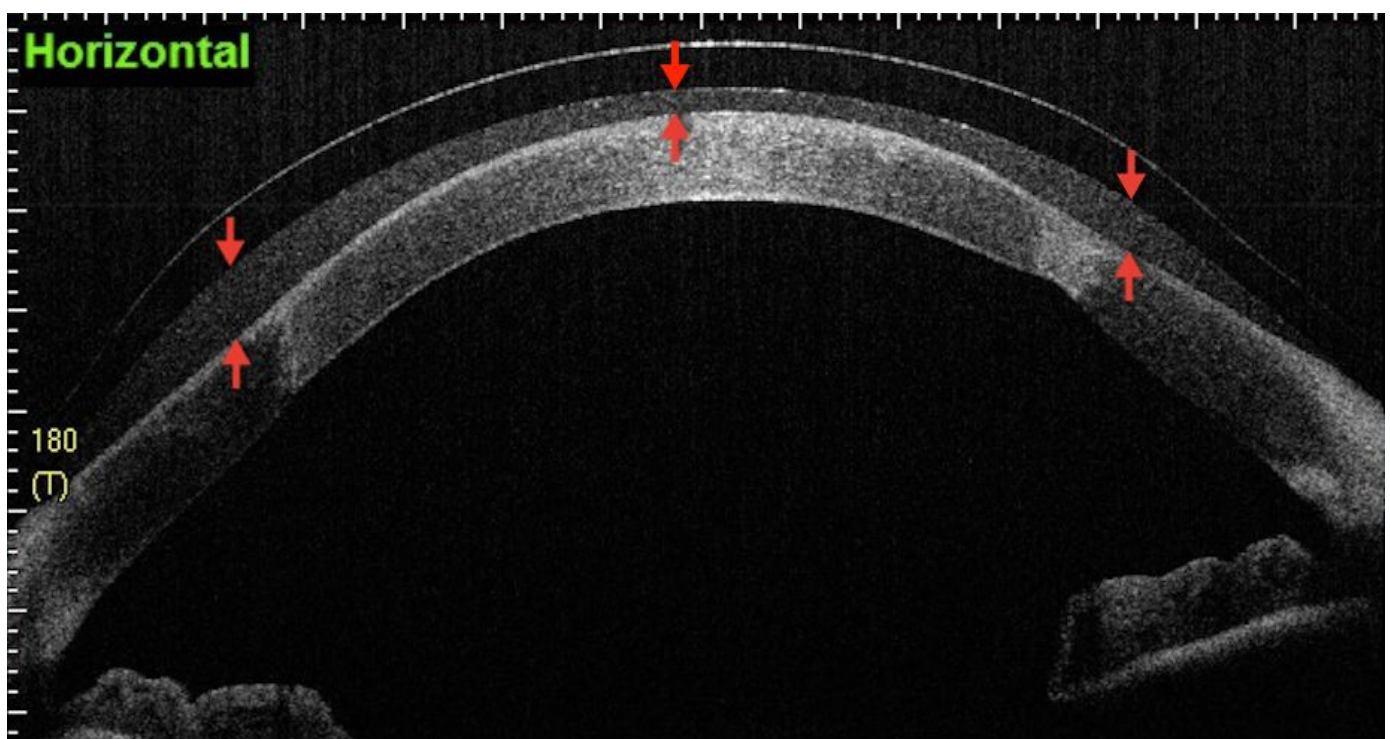
In the example below of a corneal graft, the BOZR shows good alignment over the mid peripheral cornea.



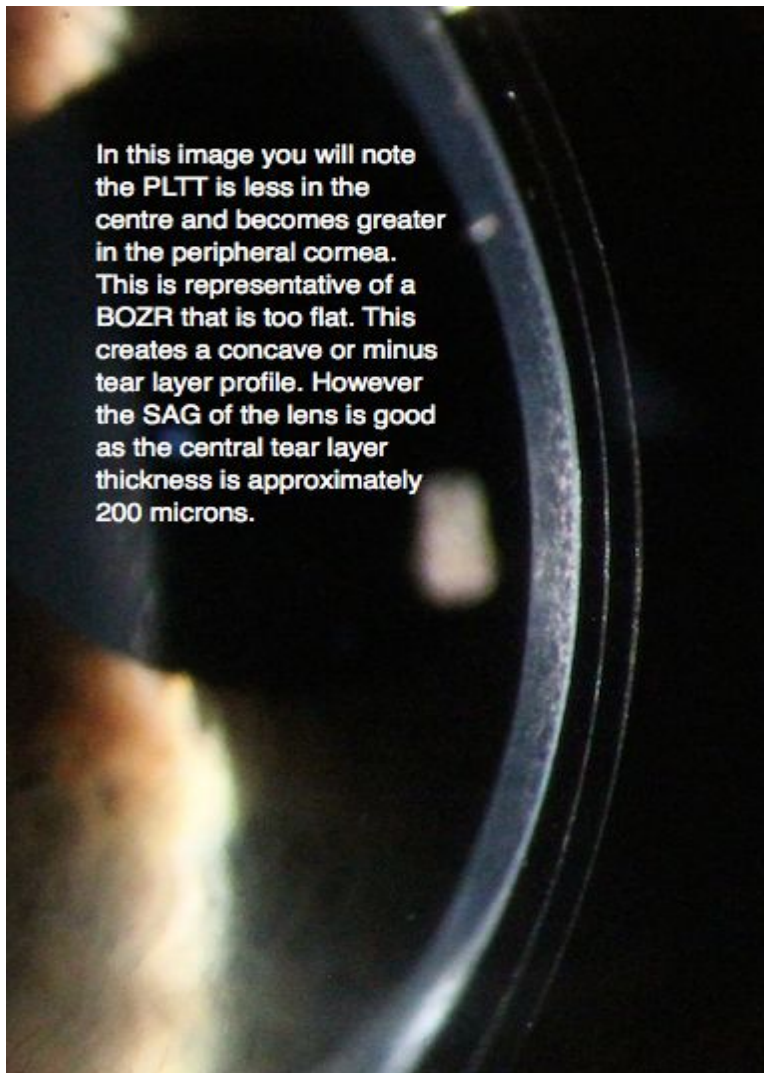
In the next example the BOZR is too steep relative to the corneal curvature causing the lens to touch the cornea in the mid peripheral zone. Flattening the BOZR will lift the BOZ edge away from the peripheral cornea without effecting the overall sag of the lens.



The reverse will be true for a BOZR that is too flat; the centre has less clearance than at 4.50 mm from centre, creating a concave or minus tear layer profile. See image below of a lens where the BOZR of the lens is significantly flatter than the cornea. Note the PLTT is much less in the centre than at the edge of the BOZR (4.50 mm from centre).



When there are large differences ($>6D$) in back-vertex power between the two eyes it can be worthwhile to deliberately adjust the BOZR to decrease these differences, providing the fit of the lens will not be compromised. Large differences in BVP can lead to vertical diplopia, as scleral lenses generally will decenter very slightly inferior temporally, leading to double vision or asthenopia. If one eye has a higher minus BVP then flattening the BOZR will reduce this. If one eye has a higher plus BVP then it follows that steepening the BOZR will reduce this. Adjusting the BOZR to keep the lens power closer to zero will also serve to keep the lens thickness at a minimum and increase oxygen transmission.



In this image you will note the PLTT is less in the centre and becomes greater in the peripheral cornea. This is representative of a BOZR that is too flat. This creates a concave or minus tear layer profile. However the SAG of the lens is good as the central tear layer thickness is approximately 200 microns.

Note: Changing the BOZR requires the lens BVP to be changed. Steepening the BOZR by 0.10 mm will increase the tear lens power by a +0.50D. To account for the change in tear power, caused by changing the BOZR, -0.50 must be added to the BVP of the lens. The reverse is also true, when flattening the BOZR by 0.10 mm, an extra 0.50D must be added to the scleral lens power to compensate for the induced negative tear power.

An easy way to remember this is the SAM/FAP rule.

- **Steep Add Minus**
- **Flat Add Plus**
- **For every 0.10 mm change in BOZR change 0.50D in lens power.**
- **Please be aware that the rule of thumb, 0.10 mm = 0.50D, only applies for small changes in BOZR, and is unreliable for steep BOZR changes.**

● **For example 7.80 to 8.00 = 0.20 mm change in BOZR = +1.00D added to lens power (FAP)**

3.4 Scleral Landing Zone (SLZ)

The Scleral Landing Zone or SLZ is sometimes referred to as the Haptic (from the Greek term *haptain*, to touch). As the lens completely vaults the cornea and limbus, a wide, even landing at SLZ is essential to provide all day comfort, reducing redness, achieving good centration and preserving corneal, conjunctival, and limbal health.

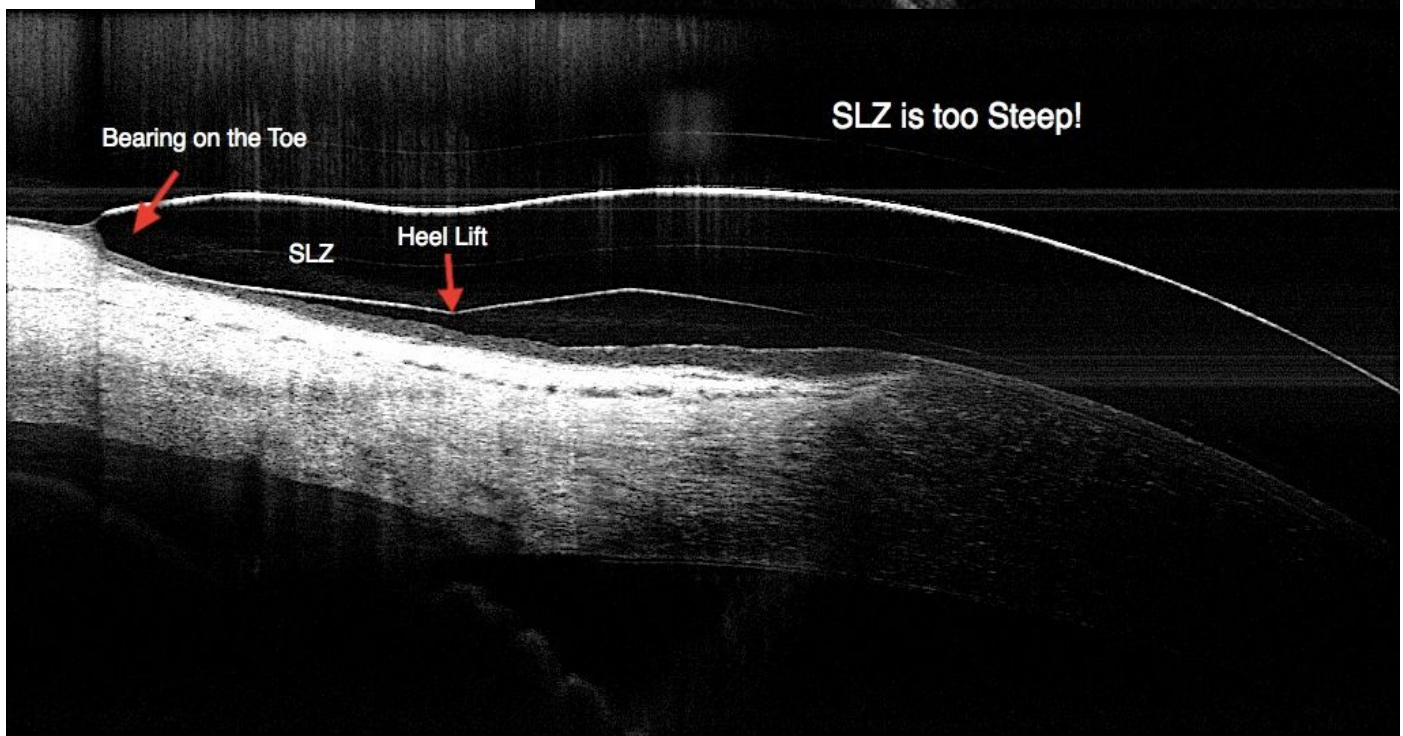
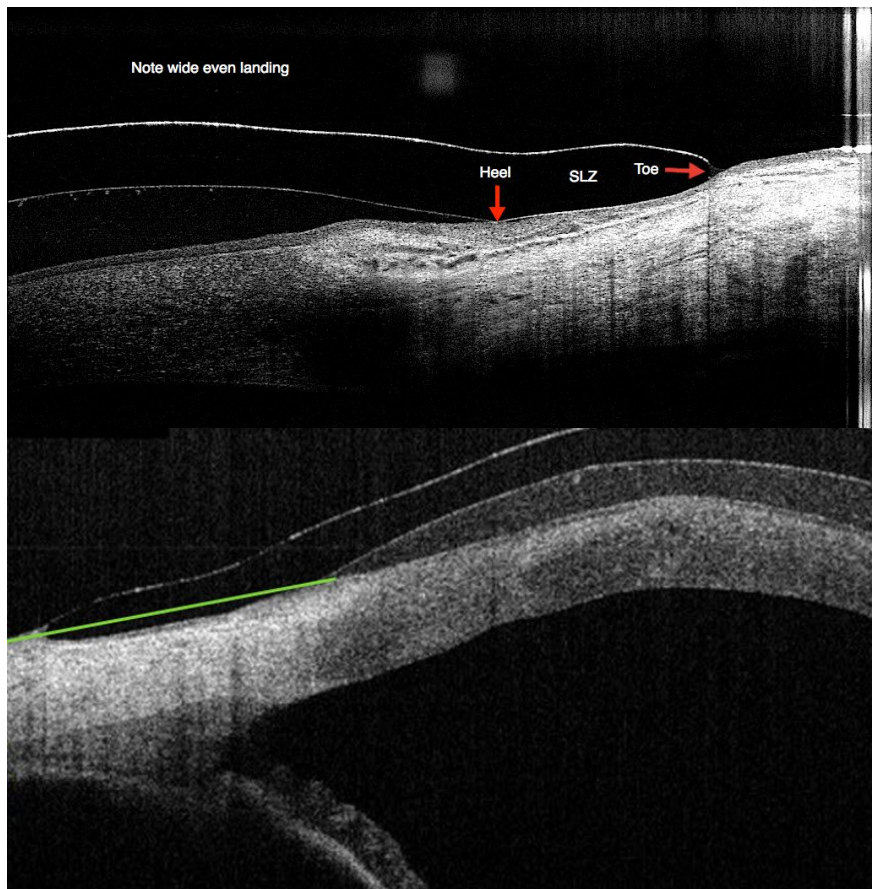
Assess the lens edge under the slit lamp as you would a soft lens. Check for fluting, tight lenses causing conjunctival blanching at the lens edge and ensure the lens lands evenly in all quadrants. The SLZ can be flattened or steepened, or even made toric or quadrant specific if it is too tight or loose in one particular direction.

The EyeSpace Scleral diagnostic lenses come in three different SLZ options namely Steep, Standard or Flat. When ordering a number of extra SLZ options are available including: Extra Increased Steep, Increased Steep, Steep, Standard, Flat, Increased Flat and Extra Increased Flat.

A useful analogy is to describe the SLZ as a foot, with the 'toe' as part of the SLZ nearest to the lens edge and the other end the 'heel'. As the conjunctiva overlying the sclera is relatively soft, the lens will depress into the conjunctiva. It is important that the lens lands evenly with a wide and even footprint.

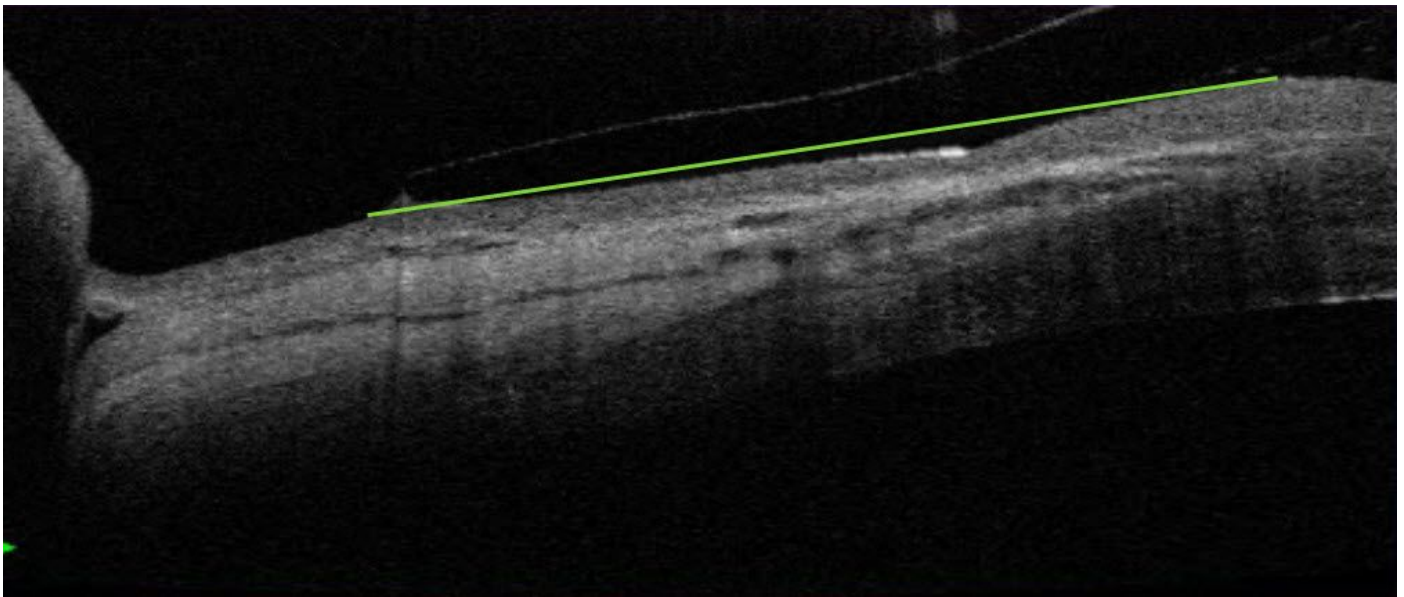
Note the angle of the SLZ and the sclera should be the same in the best fitting scleral lens.

When the SLZ is too steep the lens lands more on the 'toe', conjunctival blanching will be observed at the lens edge. This is typical of a tight or steep fitting SLZ. The OCT image below demonstrates a SLZ that is fitted too steep. Notice how the 'toe' digs into the sclera.



To correct a steep SLZ, simply select or order a lens with a flatter SLZ. Ordering a flatter SLZ will change the angle of landing by approximately 1 degree, lifting the 'toe' and bringing down the 'heel' to allow the SLZ 'foot' to distribute the downwards weight of the lens evenly over the scleral surface, thereby minimising the compressional footprint.

The alternative is when the lens lands more on the 'heel' of the lens, resulting in more of the bearing and scleral compression near the limbus. If this happens you may observe limbal vessel blanching and the limbus may appear blue, due to the diminished blood perfusion.



This is not an appropriate fit and a lens with a steeper SLZ should be selected to bring the 'toe' down and lift the 'heel' up.

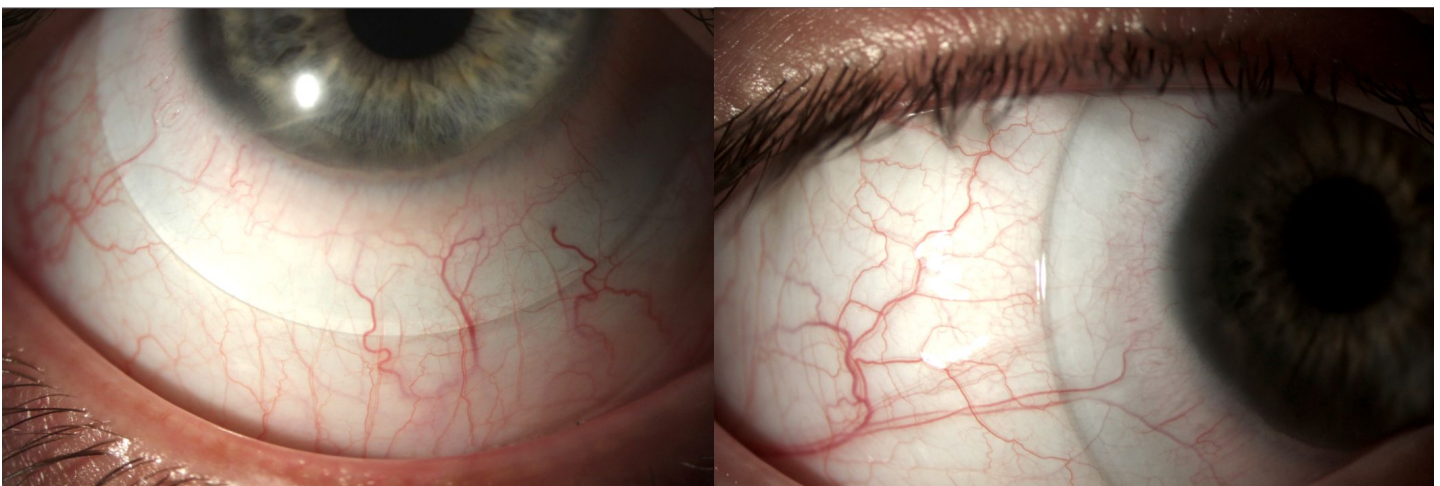
Note: Changing the SLZ angle does not change the sag of the lens.

3.4.1 Assessment of the SLZ using Biomicroscopy

When assessing the SLZ edge make sure to look in all quadrants and to pay attention to the lens edge for blood being pushed away or blanching by following blood vessels running under the lens edge.

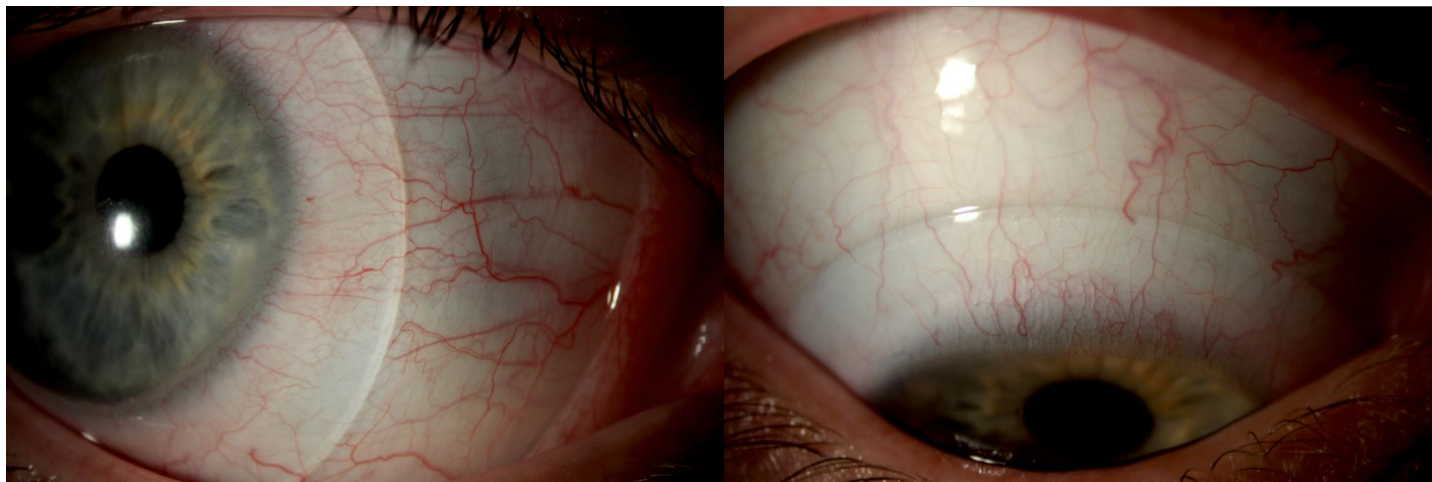
Ask the patient to look up and observe the inferior quadrant of the lens periphery for any signs of SLZ misalignment as shown in the picture below.

Next ask the patient to look nasally and observe the temporal quadrant of the lens edge for SLZ misalignment. Pay special attention to the inferior and superior temporal quadrants as some scleral shapes will present with oblique toricity.

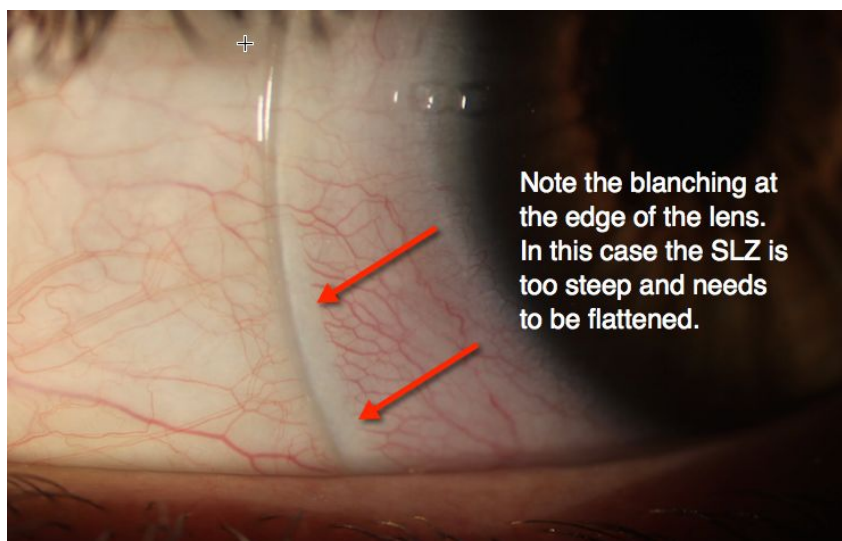


The nasal quadrant will typically show the SLZ with a slightly tighter fit (toe down) as anatomically the sclera is more flatter in the nasal meridian compared to the other meridians.

Finally instruct the patient to look down and observe the superior quadrant for any SLZ misalignment as shown in the picture below.



A good way to view blanching is to monitor the lens edge in all four main positions of gaze as described above. In each position watch the patient blink and look for blood being trapped and not flowing smoothly through the conjunctival vessels. Blanching caused by a lens pinching is not acceptable and will affect the long term comfort and success of the scleral fit. When blanching is observed the Scleral Landing Zone angle is incorrect and should be altered.

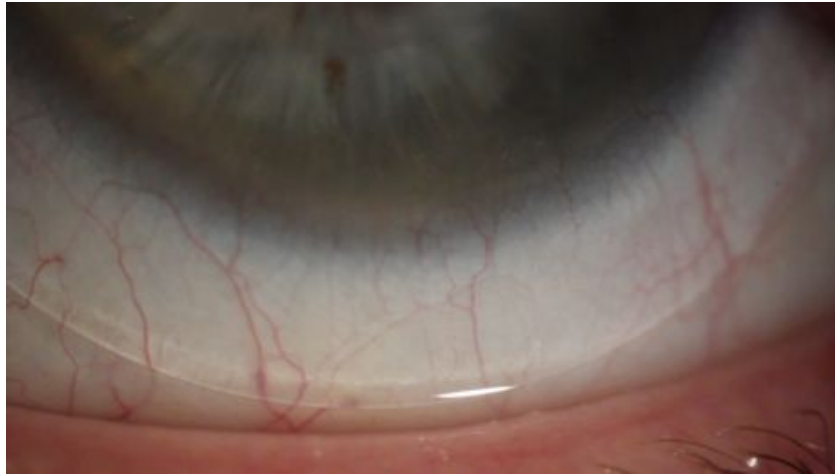


The fit of the SLZ can be judged and graded as follow:

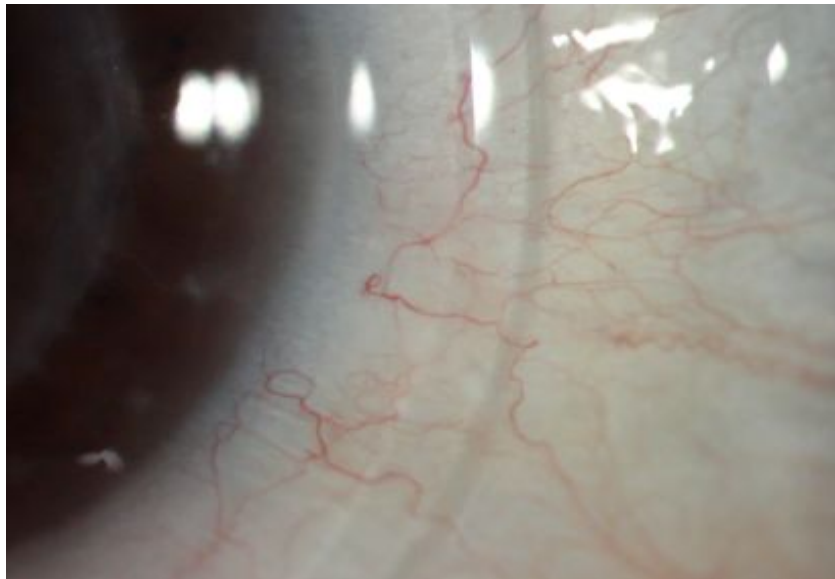
- Very flat - fluting, heavy blanching at limbus, and blue appearance of limbus



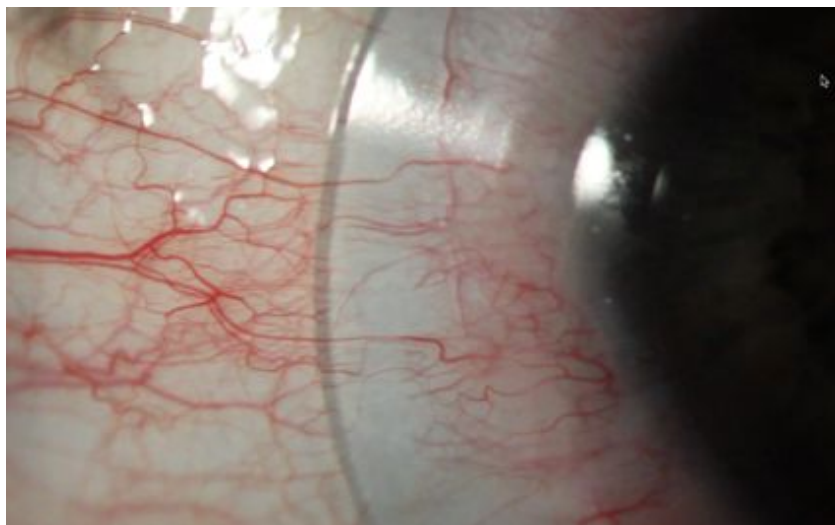
- Flat - light blanching at limbus. Note the slight blue hue at the limbus



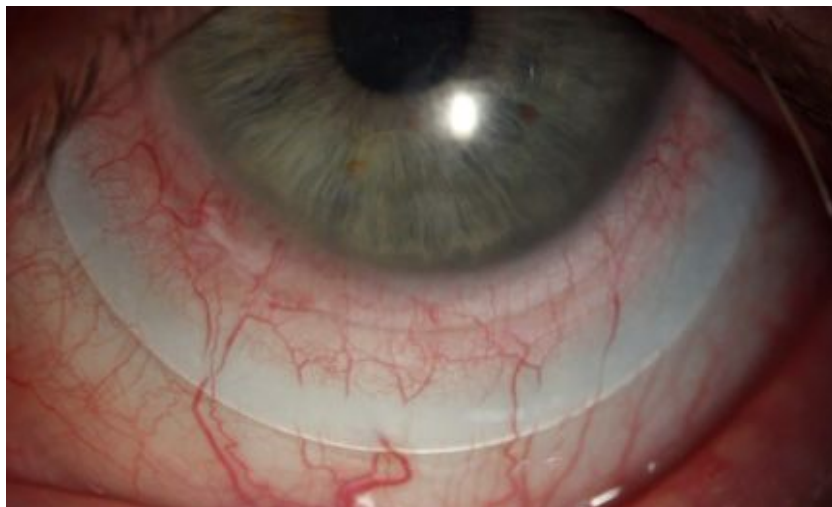
- Even landing on the sclera, no blanching at limbus or lens edge



- Tight - light blanching at lens edge



- Very tight - heavy blanching at lens edge and scleral indentation



Based on the above grading values the SLZ angle of the diagnostic lens should be changed, if necessary, to allow for even landing on the sclera.

- Very flat - steepen the SLZ by two steps
- Flat - steepen the SLZ by one step
- Even landing - SLZ is correct
- Tight - flatten the SLZ by one step
- Very tight - flatten the SLZ by two steps

The SLZ can then be ordered with the following values specified:

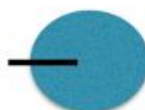
- Extra Increased Steep
- Increased Steep
- Steep
- Standard
- Flat
- Increased Flat
- Extra Increased Flat



The patient looks centrally.
Use the horizontal scan to measure the PLTT.
Use the vertical scan to ensure the lens doesn't touch the inferior-superior para-central cornea.



The patient looks to the right.
Use the horizontal scan to measure the left SLZ angle.



The patient looks to the left.
Use the horizontal scan to measure the right SLZ angle.



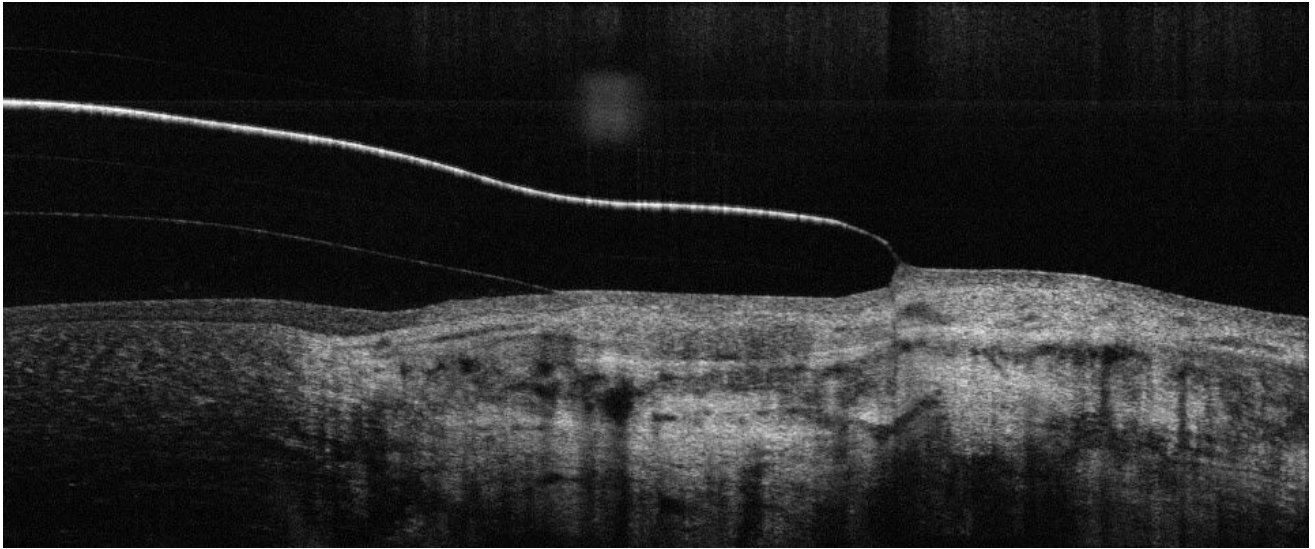
The patient looks down.
Use the vertical scan to measure the superior SLZ angle.



The patient looks up.
Use the vertical scan to measure the inferior SLZ angle.

3.4.2 Assessment of the SLZ using OCT

Using an OCT to assess the scleral fit on eye will greatly improve the accuracy of the fit, especially when determining the correct SLZ angles. It is best to use a line scan set at the longest length your OCT will allow (>6mm is best). To get the maximum benefit of the OCT scan use the following guideline:



Try and centre the scan so that the landing is in the middle of the OCT picture (below). This is so that you can see the sclera curvature and the limbal clearance simultaneously.

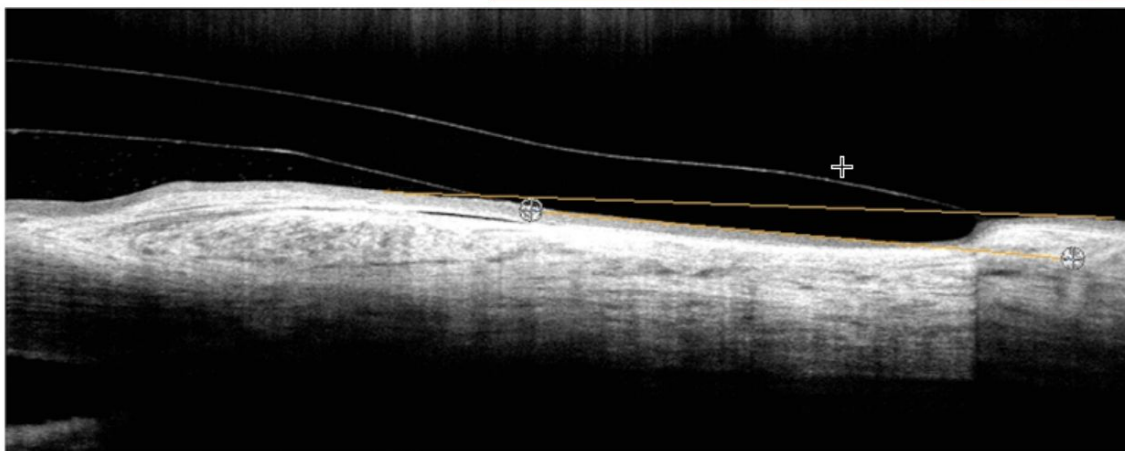
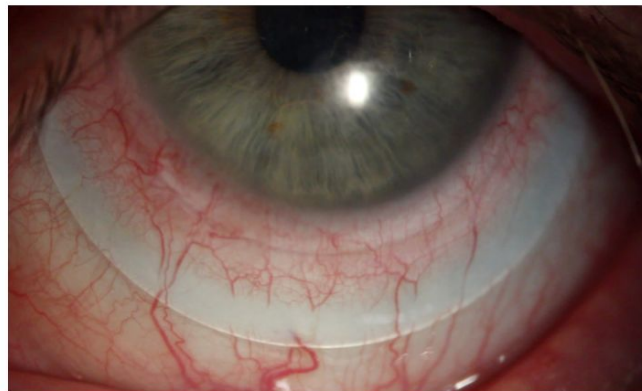
The SLZ scans can also be done at oblique angles if the flat and steep meridians of the lens are oblique.

Conjunctival Blanching

Using OCT imaging software draw a line connecting the conjunctival tissue that is unaffected by the scleral lens' landing zone. Draw another line that follows the SLZ angle. If these two lines run parallel the SLZ is at the correct angle.

If, like in the example below, the distance between the two lines increase towards the 'toe' part of the SLZ this would indicate that the SLZ is too steep and will manifest as conjunctival blanching.

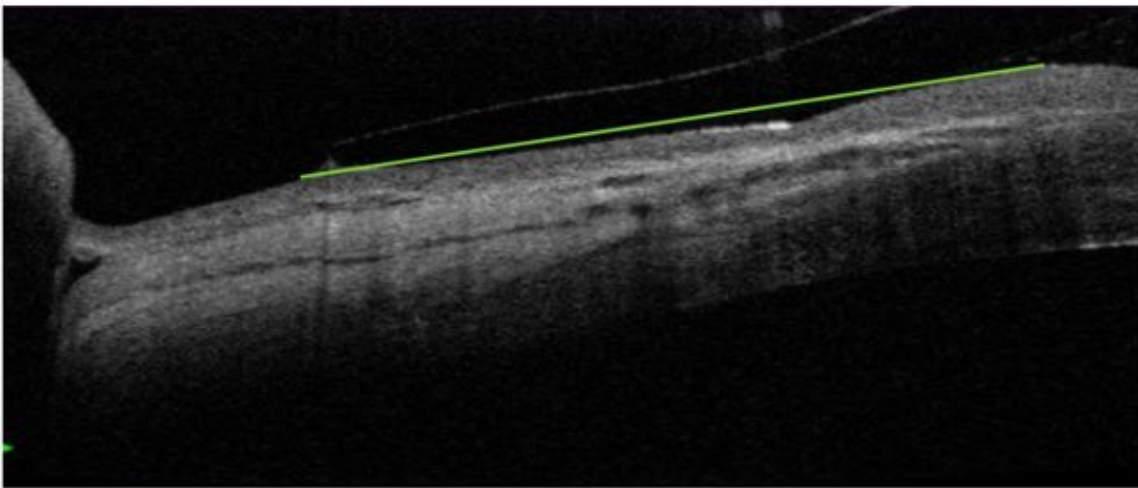
- SLZ too steep
- "Toe fit"
- Fit flatter SLZ



Limbal Blanching

If the distance between the two lines is greatest at the 'heel' of the SLZ this will indicate that the SLZ is too flat and will manifest as limbal blanching. See example below.

- SLZ too flat
- "Heel fit"
- Fit steeper SLZ



3.5 Lens Power

Once satisfied that the best fitting trial lens is on the eye wait for at least 30 mins before performing a refraction over the lens. The lens power can then be calculated following the same rules as any RGP contact lens. EyeSpace can be used to quickly and very accurately calculate the power, or "rules of thumb" like in the example below can be used.

Step 1.

Determine the difference in trial lens back optic zone radius and the desired BOZR.

For every 0.10 mm in base curve change add or subtract 0.50D to the diagnostic lens power using the steeper add minus/flatter add plus (SAM/FAP) rule.

As an example:

Diagnostic lens BOZR: 7.80 mm

Required BOZR: 8.00 mm

Difference between the two values is 0.20 mm which equals 1.00D. The required BOZR is flatter than the diagnostic lens so the FAP rule is used (Flatter Add Plus). In the final lens order +1.00D must be added (+) to the diagnostic lens power to compensate for the changed BOZR.

Note: The SAM/FAP rule is only an approximation and the approximation breaks down for large changes in BOZR and changes at steeper dioptric values.

Step 2.

Do an over-refraction. Correct the over-refraction value for vertex distance.

Step 3.

Add the vertexed-corrected over refraction value to the trial lens power as calculated in step 1 to get the final lens power. If there is significant cylinder in the over-refraction look for flex in the lens and consider a toric scleral lens (see section 4 - Toric Scleral Lenses)

As an example:

Trial Lens BOZR: 7.80 mm with BVP of -3.00D

Required BOZR: 8.00 mm

Over refraction: -6.50DS

Step 1

$7.80 \Rightarrow 8.00 = 0.20 \text{ mm} = 1.00\text{Ds FAP}$

$\text{BVP} = -3.00 + 1.00 = -2.00\text{DS}$

Step 2

Over refraction $-6.50 \Rightarrow$ vertex for 12 mm = -6.00DS

Step 3

Final BVP = Step 1 + Step 2

$= -2.00 + (-6.00)$

$= -8.00\text{DS}$

4. Trial Fitting

The initial diagnostic lens is NOT selected by matching the BOZR with the corneal keratometry readings as is the case with most RGP trial lens sets. Instead the HVID, and SAG@15mm value, is required to select the initial trial lens.

4.1 Step 1. HVID

The HVID dictates the diameter of the diagnostic trial lens that should be selected. The trial set is made of 26 lenses, lenses 1-13 are 16.50 mm in diameter and lenses 14-26 are 17.50 mm in diameter (see table below). If the HVID is less than 11.5 mm, a 16.50 mm diameter should be used. Alternatively if the HVID is 11.50 mm or greater, a 17.50 mm diameter is appropriate.

4.2 Step 2. SAG@15mm

Once the lens diameter has been determined, the next step is to select the diagnostic lens with the closest SAG@15mm to that determined from one of the above mentioned methods, eg. Smith Technique, Corneal Topography, or corneal condition.

Tip: If the initial starting SAG@15 value lies between two of the diagnostic lenses, choose the lens with the greater sag value.

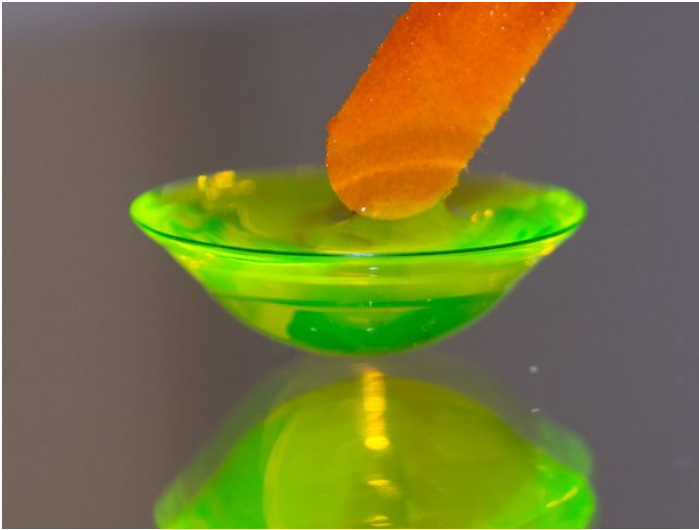
Note: If the SAG@15 is greater than 5100 microns, use only the 17.50 mm diagnostic trial lens.

EyeSpace Scleral Diagnostic Trial Set

#	SAG@15mm	BOZR	SLZ	Power	Diameter	Colour
Lens 1	3900	8.2	Standard	plano	16.5	Blue
Lens 2	4000	8.1	Steep	-0.5	16.5	Blue
Lens 3	4100	8	Flat	-1	16.5	Blue
Lens 4	4200	7.9	Standard	-1.5	16.5	Blue
Lens 5	4300	7.8	Steep	-2	16.5	Blue
Lens 6	4400	7.7	Flat	-2.5	16.5	Blue
Lens 7	4500	7.6	Standard	-3	16.5	Blue
Lens 8	4600	7.5	Steep	-3.5	16.5	Blue
Lens 9	4700	7.4	Flat	-4	16.5	Blue
Lens 10	4800	7.3	Standard	-4.5	16.5	Blue
Lens 11	4900	7.2	Steep	-5	16.5	Blue
Lens 12	5000	7.1	Flat	-5.5	16.5	Blue
Lens 13	5100	7	Standard	-6	16.5	Blue
Lens 14	3900	8.2	Standard	plano	17.5	Clear
Lens 15	4000	8.1	Steep	-0.5	17.5	Clear
Lens 16	4100	8	Flat	-1	17.5	Clear
Lens 17	4200	7.9	Standard	-1.5	17.5	Clear
Lens 18	4400	7.8	Steep	-2	17.5	Clear
Lens 19	4600	7.7	Flat	-2.5	17.5	Clear
Lens 20	4800	7.6	Standard	-3	17.5	Clear
Lens 21	5000	7.5	Steep	-3.5	17.5	Clear
Lens 22	5200	7.4	Flat	-4	17.5	Clear
Lens 23	5400	7.3	Standard	-4.5	17.5	Clear
Lens 24	5600	7.2	Steep	-5	17.5	Clear
Lens 25	5800	7.1	Flat	-5.5	17.5	Clear
Lens 26	6000	7	Standard	-6	17.5	Clear

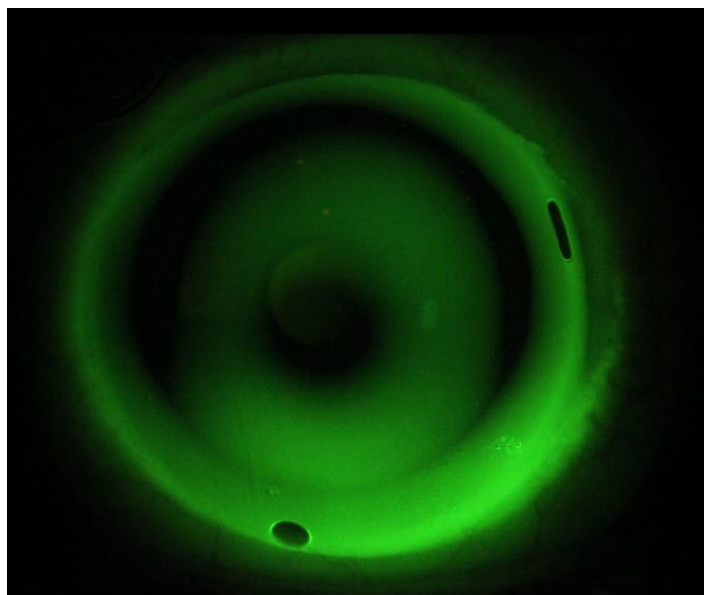
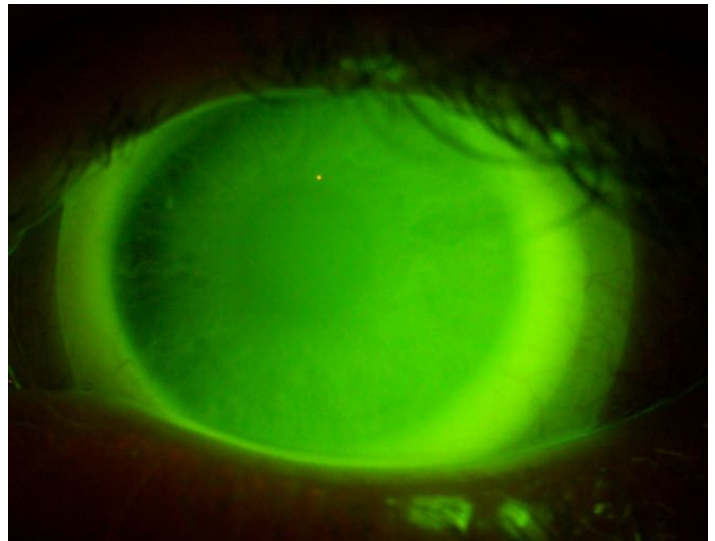
4.3 Step 3. Lens Insertion

Clean and rinse the lens thoroughly, then fill the lens with non-preserved saline or a non-preserved lubricant. Ensure only a saline solution that contains no preservatives or pharmaceutical agents is used, as this solution remains captured between the cornea and the back of the lens for the duration of the lens wear.



Dip a fluorescein strip into the back of the lens full of saline. Once the contact lens is in place, this will allow you to assess the tear film layer under white and cobalt blue light. The lens must be inserted in a face down position, with the back of the lens full of non-preserved saline. Ensure that there are no air bubbles trapped under the lens following insertion. Topical local anaesthetic may be used prior to insertion for neophyte scleral or contact lens wearers, and if a lens cannot be inserted without bubbles using non preserved saline, a gel may be used instead.

Once the lens has settled, assess the fluorescein pattern through a microscope using a diffuse cobalt blue light, wratten yellow filter with low magnification. The aim is to achieve complete corneal and limbal clearance, which will appear as a nice even glow of NaFI over the entire surface of the cornea.

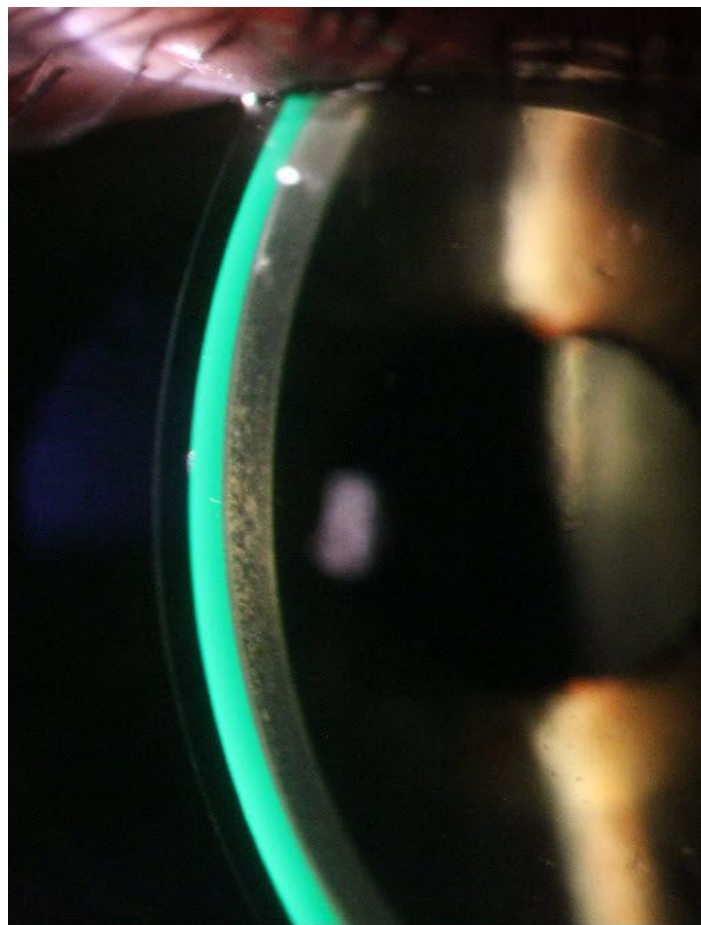


If any touch to the cornea is visible (see example below), remove the lens and select a diagnostic lens with at least 200 microns more SAG@15mm. Scleral contact lens should not touch the cornea or limbus. Be aware that with settling time the initial PLTT may decrease by up to 100 microns. Therefore it is important to let the diagnostic lens settle for a minimum of 30 mins.

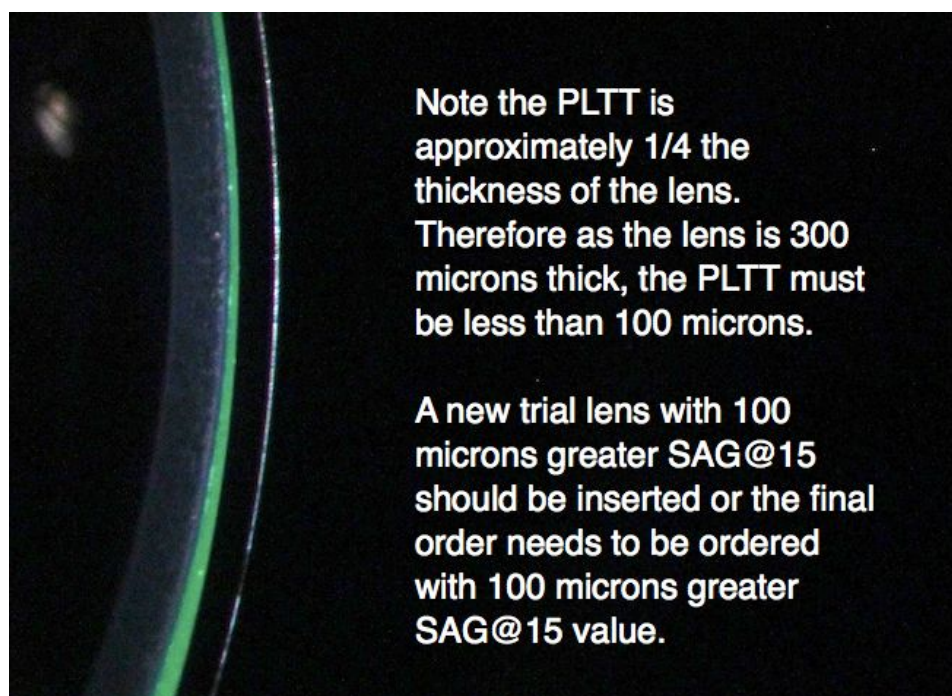
Next examine the cross section of the lens on the eye and observe the Post Lens Tear Thickness (PLTT) over the entire cornea using the white light of the slit lamp. This is done by setting up your slit lamp with the illumination (thin bright beam) positioned directly in front of the eye, and the microscope viewing from the temporal or nasal side.

Shortly after insertion you are aiming to achieve a central PLTT of around 200-300 microns. The approximate thickness of the post lens tear layer can be assessed by comparing the thickness of the lens (300 microns) to the thickness of the post lens tear layer. If the PLTT is greater than 300 microns, remove the lens and select a trial lens with a smaller SAG@15 value. Alternatively if there is corneal touch, select a trial lens with at least 300 microns greater SAG@15 value.

After settling for 30 mins, the PLTT should be around 100 - 200 microns (Or $\frac{1}{3}$ to $\frac{2}{3}$ the thickness of the lens) and at any aftercare should never be less than 100 microns.



It is normal for a scleral lens to settle on the compressible conjunctival tissue over time and show a lower central clearance after a period in the the eye when compared to immediately after insertion. This amount of 'sinking' is variable amongst patients with studies suggesting a range from 100 microns to 180 microns. Make sure you factor this into your calculations of sagittal height if you have not allowed the recommended 30 minutes for settling. You do not want a lens with what you thought was an ideal central clearance of 150 μm actually resting on the apex of the cornea after it has settled.



Note the PLTT is approximately 1/4 the thickness of the lens. Therefore as the lens is 300 microns thick, the PLTT must be less than 100 microns.

A new trial lens with 100 microns greater SAG@15 should be inserted or the final order needs to be ordered with 100 microns greater SAG@15 value.

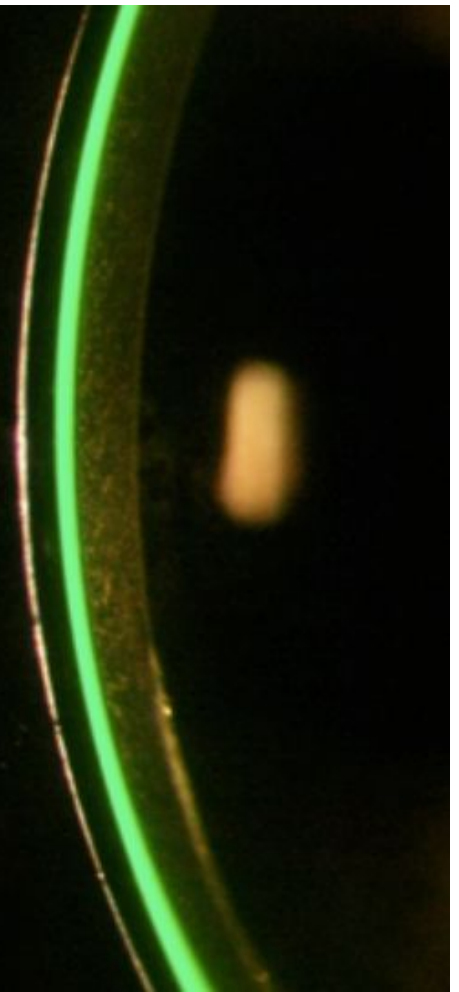
Using an Anterior OCT is an easy way to measure apical clearance. However, without an OCT, the Post Lens Tear Thickness can be estimated using a slit lamp by comparing the thickness of the lens (300 microns) to the observed cross section image of the PLTT. See example images below.

Note: Be aware research has shown that estimation of clearance under the slit-lamp tends to underestimate by approximately 50 microns when compared to the OCT measured value.

Note the PLTT is approximately $\frac{2}{3}$ the thickness of the lens. Therefore as the lens is 300 microns thick, the PLTT must be approximately 200 microns.

This is the desired corneal clearance and post lens tear thickness.

Note the uniform tear layer profile created by an appropriate BOZR.



Note the PLTT is approximately 1.5 times the thickness of the lens. Therefore as the lens is 300 microns thick, the PLTT must be approximately 450 microns.

A new trial lens with 200 microns less SAG@15 should be inserted and assessed.

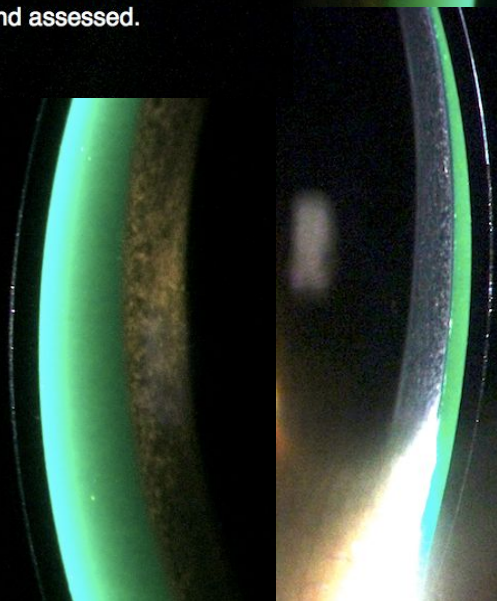
Note the PLTT is approximately 2 times the thickness of the lens. Therefore as the lens is 300 microns thick, the PLTT must be approximately 600 microns.

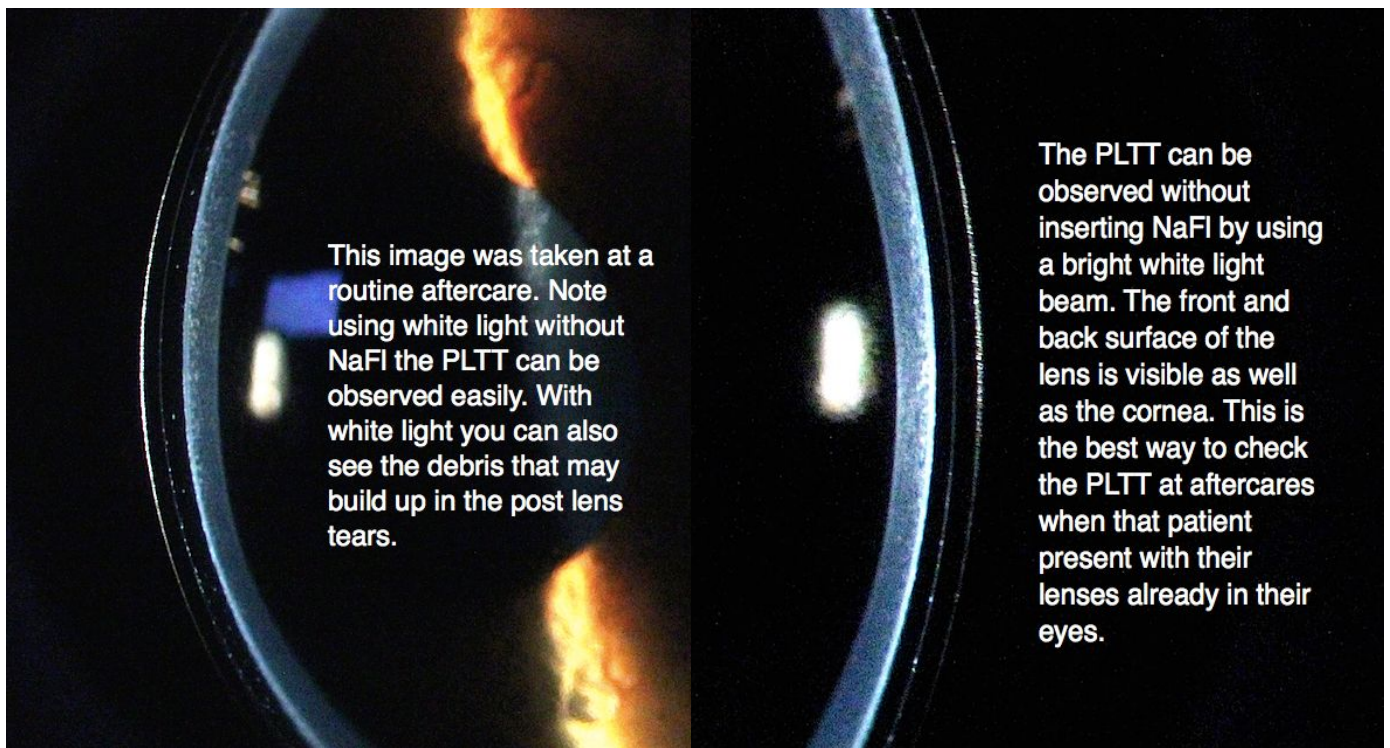
A new trial lens with 400 microns less SAG@15 should be inserted and assessed.

Note the PLTT is approximately 3 times the thickness of the lens. Therefore as the lens is 300 microns thick, the PLTT must be approximately 900 microns.

A new trial lens with 700 microns less SAG@15 should be inserted and assessed.

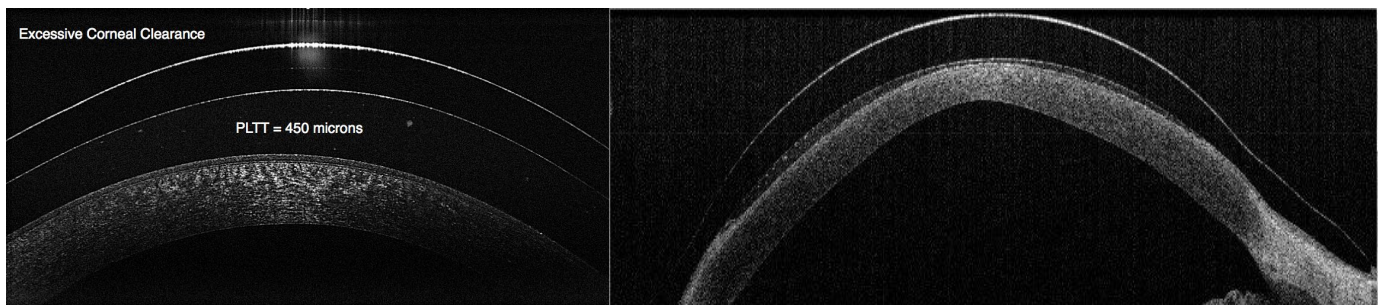
The PLTT over the limbus can also be easily viewed by having the patient look up, down, left, and right. Note in this image the lens easily vaults the limbus.



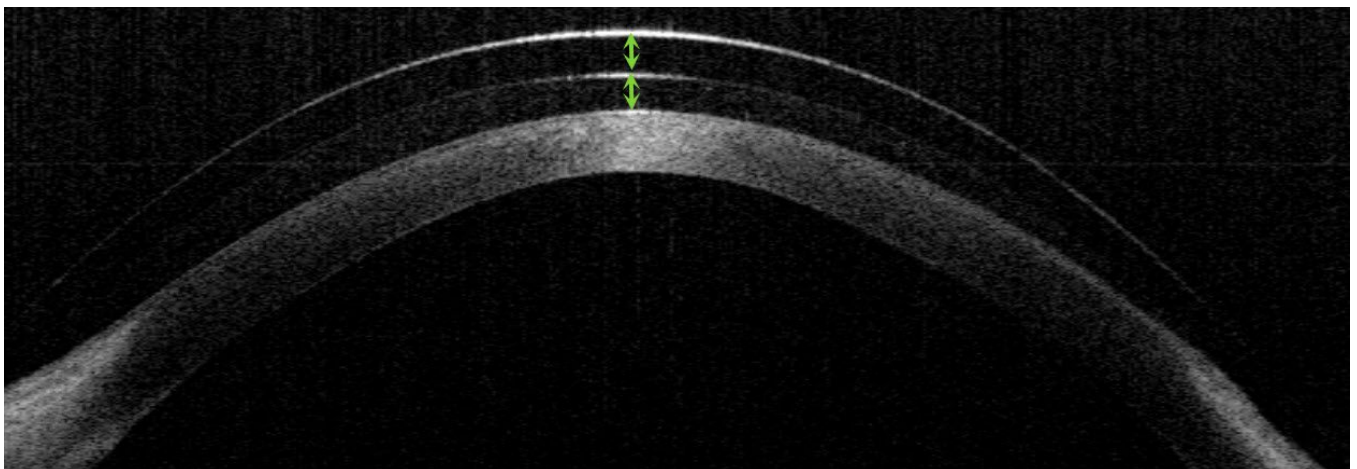


Using OCT imagery, the PLTT can be quantitatively measured and provides a very accurate and user friendly method of assessing the correct lens sagittal height. See examples below.

Most OCT analysis software should have the ability to measure a distance from point to point making the evaluation of clearance very accurate. In comparison the OCT image below shows a scleral lens with insufficient sagittal height.



The OCT image below shows a scleral lens with the ideal amount of apical clearance over the cornea. The Post Lens Tear Thickness is approximately $\frac{2}{3}$ the thickness of the lens, indicating a central corneal clearance of 200 microns.



5. Toric Scleral Lenses

Cylindrical over refraction is commonly seen with larger diameter scleral lenses and is often not a result of internal or residual astigmatism, rather it can be caused by lens flexure on eye. Nearly 1 in 4 patients end up with flexure on eye causing 0.75 to 1.50DC on eye.

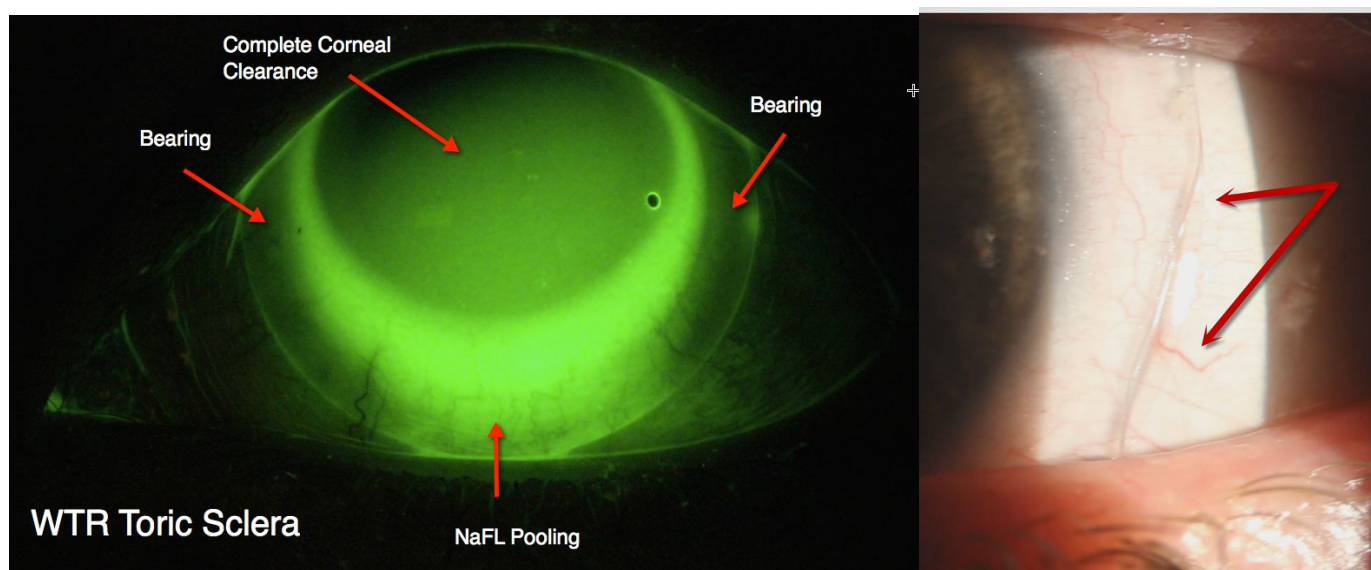
The lens flexure is due to the scleral shape being non rotationally symmetric. Just like corneal toricity, the sclera can exhibit steep and flat meridians. Although the lens fit may appear good on the eye the toricity of the sclera will be masked by the depression of the lens into the sclera in the flat meridian and lens flex in the steeper meridian.

The lens will flex due to an imbalance in the downwards compression of the landing zones on the toric sclera. The EyeSpace Scleral lens range uses High Dk lens material to maximise the amount of oxygen reaching the cornea, however High Dk lens materials do tend to flex more than the lower Dk materials.

If a resulting overrefraction has a significant cylindrical component, you must determine if the astigmatism is a result of internal astigmatism or astigmatism induced by lens flexure. To differentiate between internal astigmatism or astigmatism from lens flexure, perform keratometry or corneal topography with the lens on the eye. If keratometry or corneal topography with the lens on eye does not reveal any significant toricity, the cylindrical component can be attributed to internal astigmatism. If the keratometry or corneal topography with the lens on eye does revealed toricity of similar magnitude and direction to the cylindrical component in the overrefraction, this is attributed to the flex of the lens, and can be solved by making the back surface of the lens toric to eliminate the flexure of the lens on eye. This will be discussed further in the sections below.

Lenses that have been flexing on the eye for many years may result in lens warpage. A lens that flexes will only do so with the lens *in situ*, whereas warpage is more permanent. To differentiate between lens flex and warpage, the lens should be checked off the eye with a vertometer and radiuscope to ensure the lens measures to the original BVP and BOZR. Lens warpage on an originally spherical scleral lens may result in a BVP with some astigmatism present or a BOZR with a significant difference of radii of curvature between orthogonal meridians. Of course a lens that is merely flexing on an eye will be spherical in these measurements.

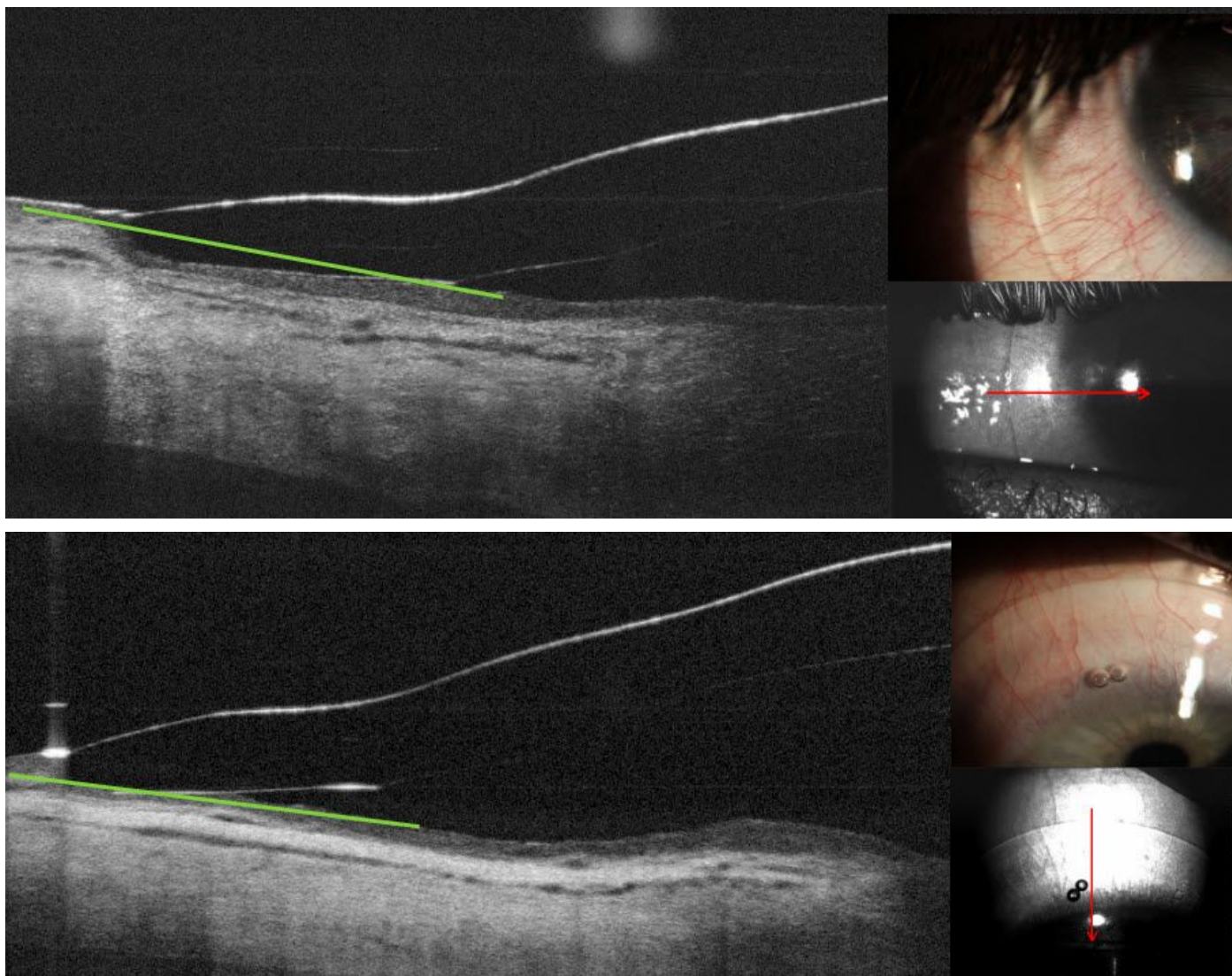
In more pronounced cases where the scleral toricity is greater than 300 microns, the scleral toricity can clinically be observed by noting compression or impingement at the SLZ in the flat meridian and excessive edge lift or fluting in the steep meridian.



5.1 Determine the Toric SLZ

The first step when designing a non-rotationally symmetrical scleral lens is to determine the correct SLZ for each meridian. Checking whether the lens is tight or flat on the conjunctiva in a particular meridian is very helpful to assess this. Please see section “3.4 SLZ” for more information.

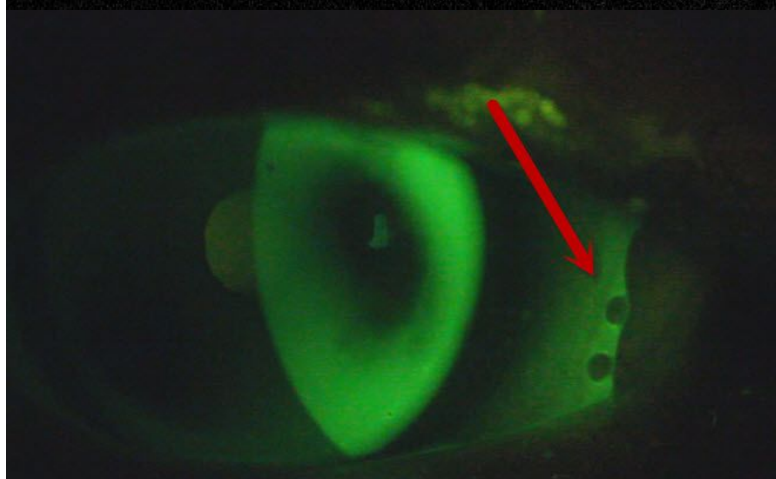
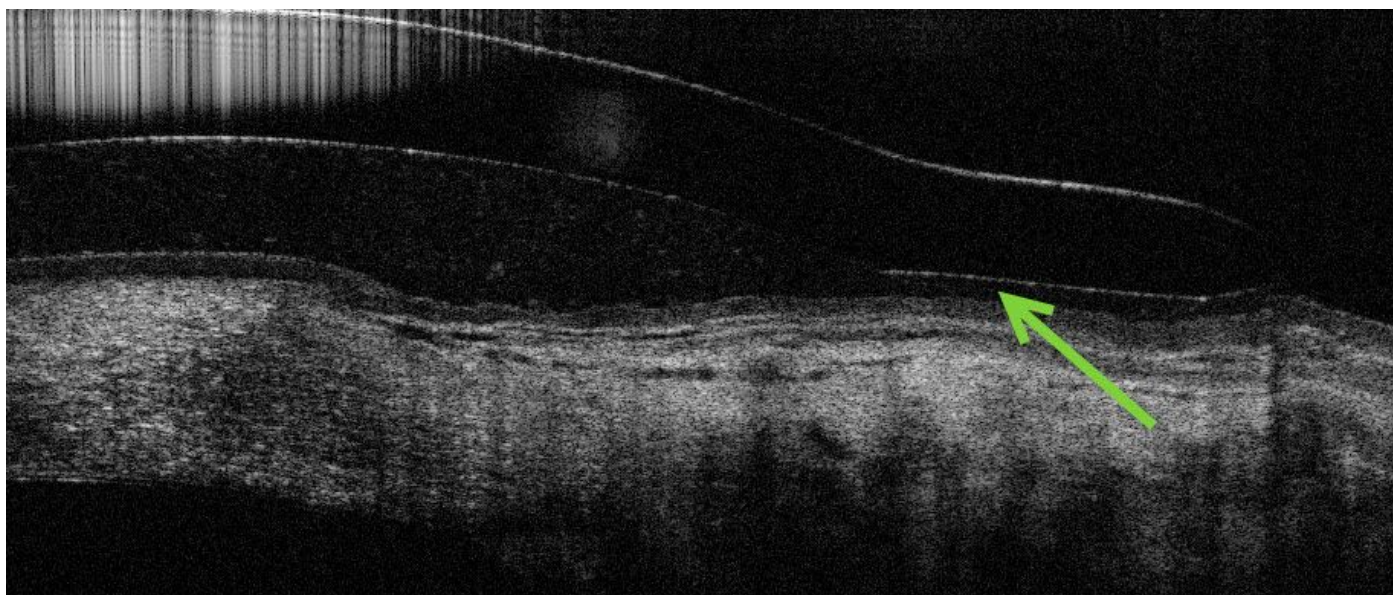
The following two images show a lens that is 1 step too tight in the temporal meridian and 2 steps too tight in the vertical meridian. These meridians should be flattened appropriately in the next lens order.



5.2 Determine the sagittal height for toric scleral lenses

Once you have decided the correct SLZ angle for each meridian it is necessary to determine the difference in sagittal height required between the two principal meridians.

For example, a lens may only settle/compress along the horizontal in WTR scleral toricity by 150 microns and then only just touch in the vertical meridian. Hence you have 150 microns of scleral toricity, with more sag in the vertical meridian. After taking into account a little flexure on eye, you could have up to 200 to 250 microns of sagittal toricity (difference in sag at the 15 mm chord). An OCT can show this concept as seen in the image below where the inferior edge of a rotationally symmetrical lens is barely landing on the conjunctiva due to insufficient sag.

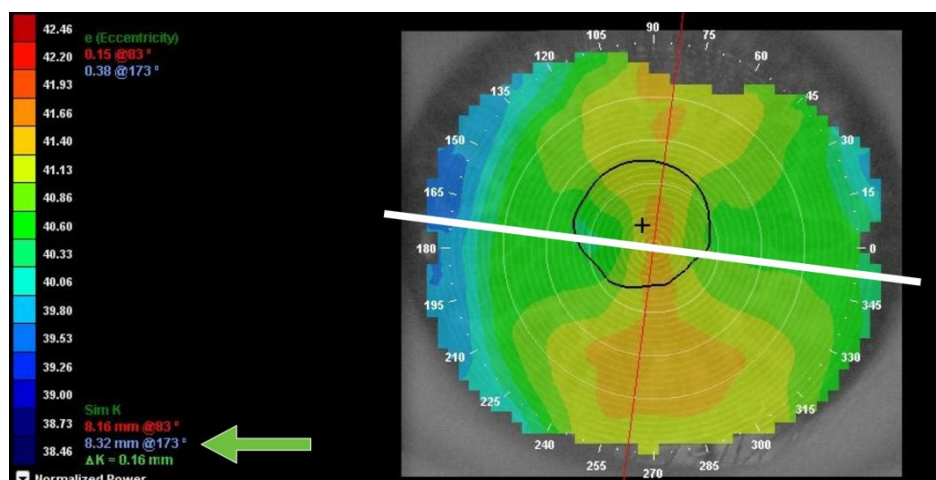


As with corneal toricity, scleral toricity typically exhibits a with-the-rule pattern. Without a topographer sometimes the only way to identify scleral toricity is to observe the pattern of tear exchange with fluorescein. To identify the steep meridian, look for lens fluting or fluid exchange 90 degrees from the flat meridian.

5.2.1 Corneal Topography and lens flexure

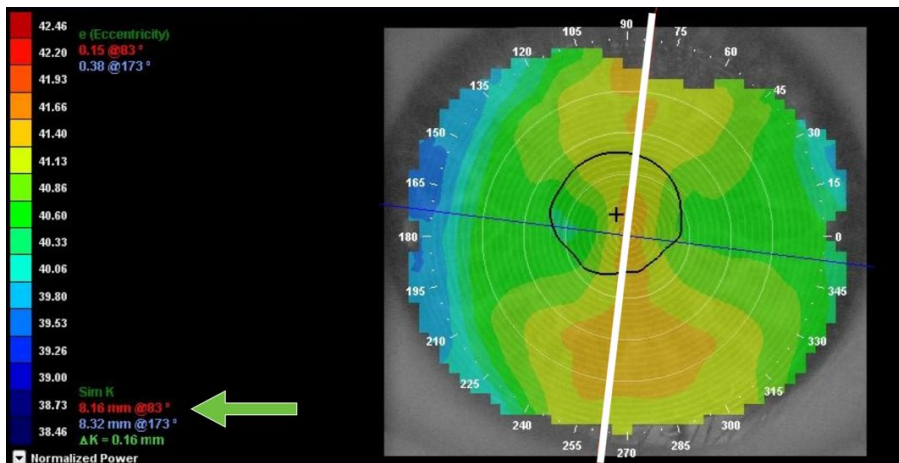
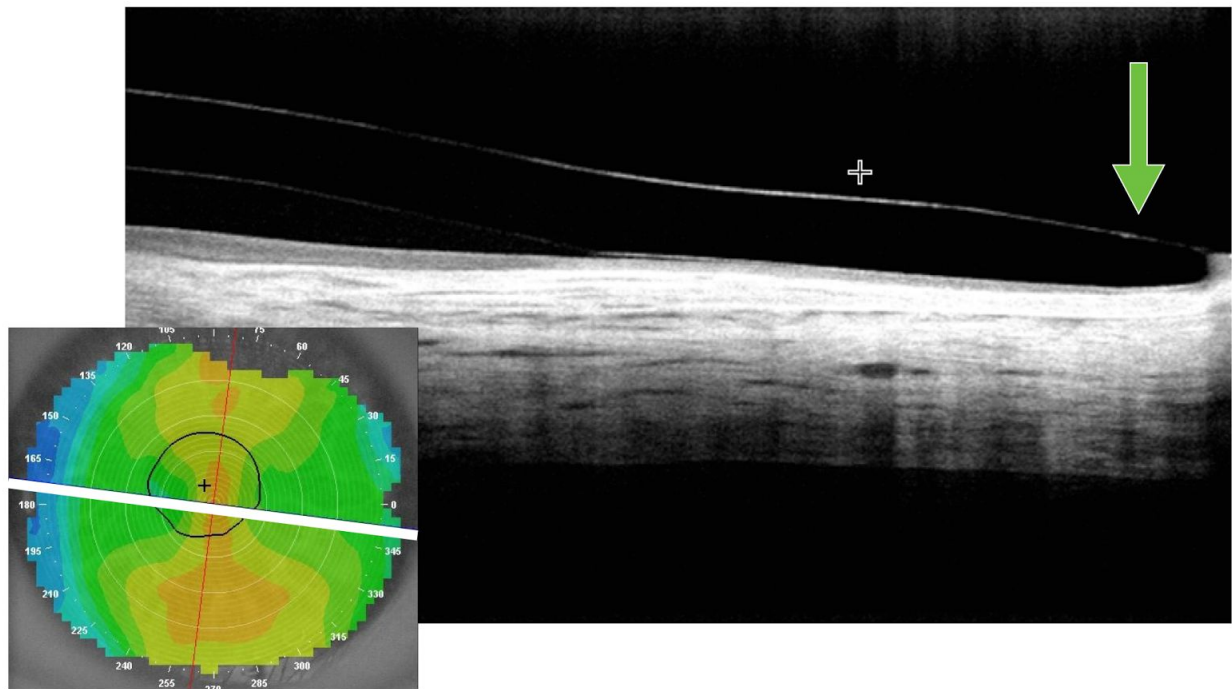
Using corneal topography over the lens is the best way to assess lens flexure. In order to determine the amount of lens flexure, allow the trial lens settle on the eye for 30 minutes and perform a topography of the front surface of the lens on eye. Any torsional pressure placed on the lens will cause lens flexure and will represent as an astigmatic pattern on the topography.

Important: Ensure that the corneal topographer measures the centre portion of the scleral lens.
Measuring the lens off-centre can result in an erroneous cylinder measurement.



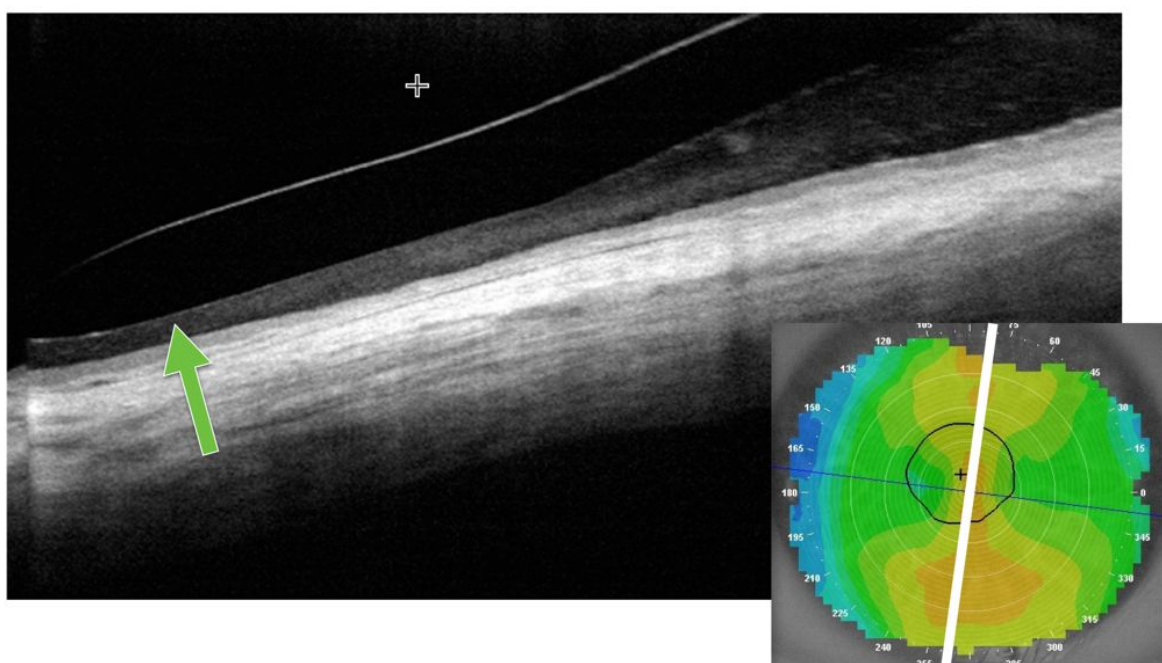
Note how much cylinder there is and at what axis it is occurring. The flat meridian represents the area where the lens is bearing down the most on the sclera (see topography left).

Below the OCT scan of the flat meridian shows that the SLZ is bearing the lens weight and the conjunctival tissue is compressed under the SLZ.



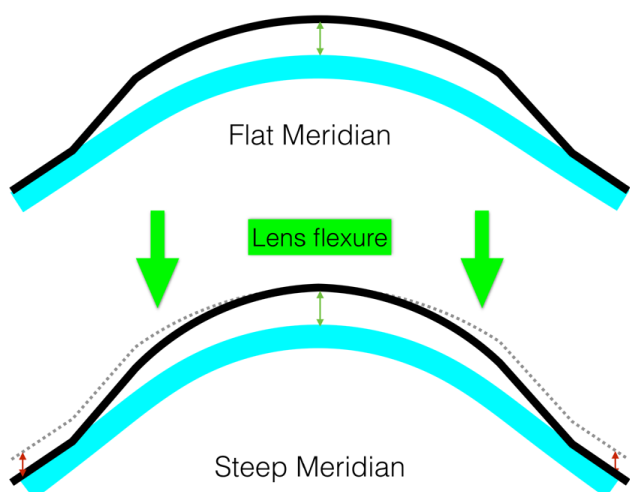
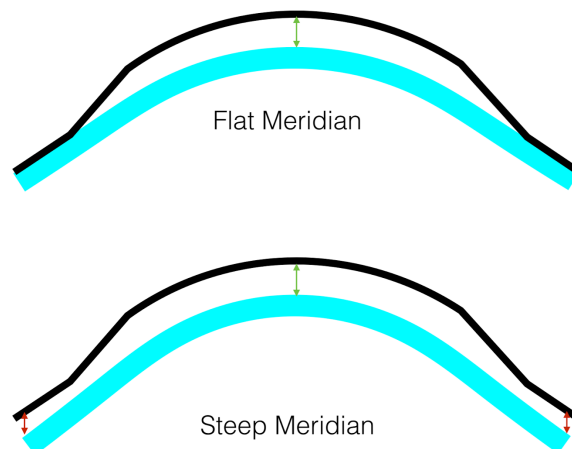
The steep meridian indicates the area of the lens where the least amount of bearing is occurring on the sclera and the lens is effectively flexing 'down' towards the cornea.

Below the OCT scan of the steep meridian displays how the SLZ is not landing on the conjunctiva. Fluid and lid forces flex the lens towards the sclera with time.



Like in corneal GP lenses, a rotationally symmetrical scleral lens on a toric sclera will not bear evenly in all meridians due to the difference in sagittal height between the meridians. The sagittal height in the flat meridian is less than the steep meridian, causing the lens to bear entirely on the flat meridian, and a layer of tears equal to the difference in the sagittal height between the two meridians to sit between the landing area of the steep meridian and the lens (see image right).

This unequal distribution of lens bearing will cause more down pressure on the conjunctiva and sclera in the flat meridian, resulting in the lens depressing into the soft conjunctival tissue. However in the steep meridian where there is no lens bearing, the lens will flex towards the surface as a result of lid, and tear film forces (see image below).



The flex results in increased steepening of the BOZR in the steep meridian, inducing a more positive tear power in that meridian only, as well as a toric front optic zone. This flexure will introduce astigmatism into the overall system.

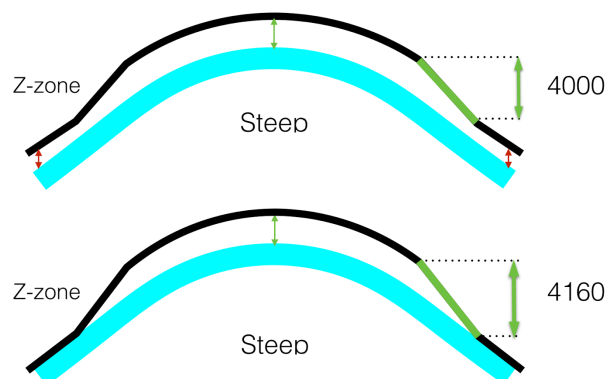
The resulting astigmatism will be of similar magnitude and direction to the resulting toric front surface of the lens created by the lens flexure. This can be easily measured by taking keratometry or corneal topography with the lens *in situ*.

meridians. With the EyeSpace scleral lens this can be easily achieved by specifying independent SAG@15mm values for the flat and steep meridians.

Note: With EyeSpace Scleral lenses the z-zone controls the sagittal height of the lens. Increasing the sag of the steep meridian effectively means increasing the sag of the steep z-zone.

If the trial or fitted lens has the desired central clearance, however there is flexure present, the difference in sagittal height should be added to the steep meridian. Once the landing of the lens is evenly distributed the lens will cease to flex, thereby eliminating any refractive astigmatism induced by lens flexure.

To calculate the required SAG@15mm each meridian to ensure even landing of the lens, the keratometry or Sim K reading with the lens on eye must be measured. As the trial lenses are spherical in BOZR and power, any measured toricity on the front surface is a result of lens flexure. Note the

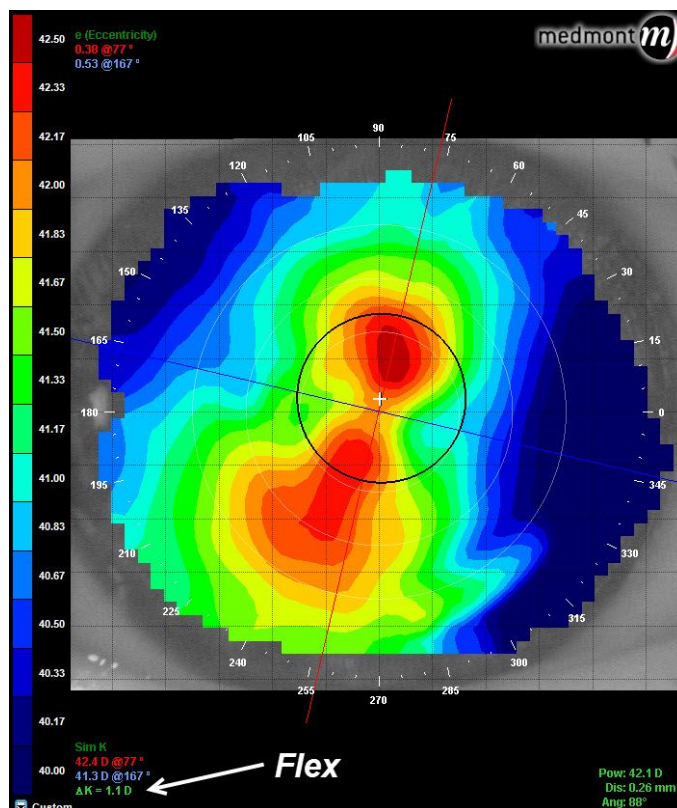


amount of toricity present in the Sim-Ks in dioptres (ΔK). When viewing the topography of the front surface of the lens *in situ*, it can be helpful to manually adjust the range of the scale to show the flexure on the lens most effectively.

The below topography displays the Axial Power map for the front surface of the lens *in situ*. Note the scale has been adjusted to a narrow range, and the flex measures 1.1D.

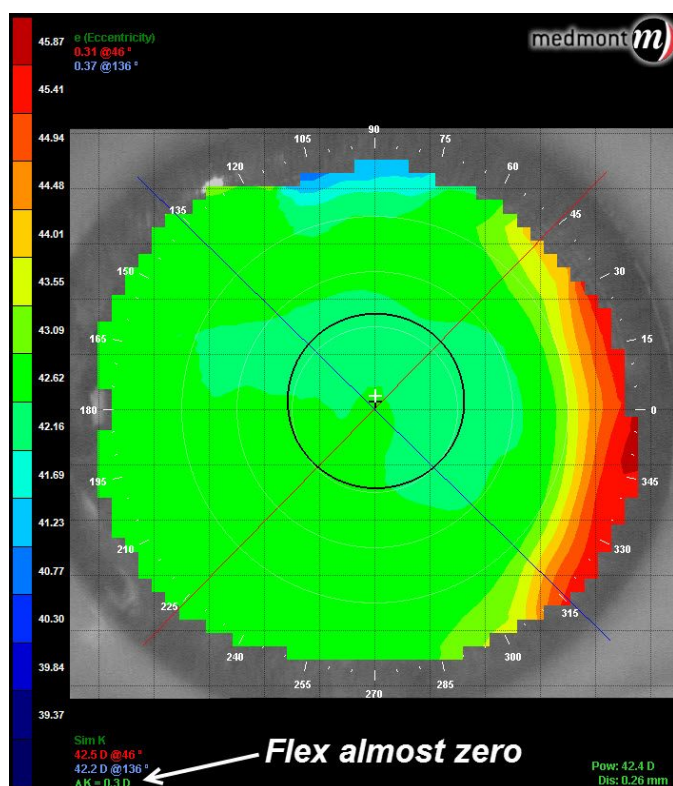
Use the following guideline to specify the difference in the SAG@15mm value

ΔK (D)	$\Delta \text{SAG@15mm}$
0.75D	150 microns
1.00D	200 microns
1.25D	250 microns
1.50D	300 microns
1.75D	350 microns
2.00D	400 microns



In the example above we would need 200 microns sag difference between the meridians to eliminate the flex.

Note: As with fitting soft toric contact lenses, making the lens toric and therefore more complex should only be done when the resulting flexure or induced astigmatism is clinically significant.



The topography to the left is of a lens *in situ* with very little, and clinically insignificant (ΔK 0.3D) lens flexure.

Note: Studies show scleral toricity increases peripherally from the limbus, therefore the larger the lens, the greater the need for a toric lens. It is also typical to see higher degrees of scleral toricity in eyes with corneal astigmatism and corneal ectasia like Keratoconus than in normal spherical cornea.

5.2.2 Examples

5.2.2.1 Back and front surface rotationally symmetrical (RS) lenses.

Example: 7.0 / 16.50 / 3400 / Flat / -3.00

In this scenario if a RS lens is fitted to a toric sclera the lens will flex to mimic the toricity at the scleral landing area. The flex of the lens can be easily observed and measured by taking a topography of the front surface of the lens on eye.

Note: We recommend as standard of care to routinely do topographies over scleral lenses on eye. The over topography provides valuable information about lens flexing, enabling accurately designed and fitted lenses with toric peripheral curves to best fit the toric limbal and scleral shape.

The refraction over the lens (ROL) will generally have a cylinder that closely matches the amount of flex in dioptres, and the direction. The ROL axis will generally be the same or close (± 20 degrees) to the flat axis of the lens flex as measured by the topographer.

In order to troubleshoot, and redesign the lens, two key measurement must be taken.

1. Topography of the front surface of the lens on eye, recording ΔK in D, and the axis of the flat meridian.
2. The ROL in spherocylindrical format.

This information allows us to accurately design and fit a toric periphery to the scleral lens, dictating the amount of toricity needed ($\Delta \text{SAG@15mm}$), and also the probable location of where the flat meridian of the lens will stabilize.

The lens will generally stabilise with the flat meridian of the toric periphery (two engraving lines) at the same position of the flat meridian of the lens flex as was seen with the previous fitted RS lens. When the lens on eye no longer flexes, due to a well fitting toric periphery, in most cases the ROL that rendered a cylindrical component will no longer be present.

5.2.2.2 Troubleshooting a toric periphery scleral lens with a spherical OZ

**Example: 7.0 / 16.50 / 3400 / Flat -3.00
3650 / Steep**

In this scenario where the front and back OZ is spherical, and the peripheral curves are toric, the lens may still flex if the peripheral curves have too little or too much toricity.

In order to troubleshoot, and redesign the lens, three key measurement must be taken.

1. The axis of the flat meridian of the back surface peripheral toric curves. All toric lenses are manufactured with engravings at 3 key locations. The flat meridian of the peripheral curves is indicated by line or dash engravings on the front surface of the lens (the alphabetical serial code will be located on the steep meridian).
2. Topography of the front surface of the lens on eye, recording ΔK in D, and the axis of the flat meridian.
3. The ROL in spherocylindrical format.

If a topography with the lens on eye shows significant toricity/flex (ΔK more than 0.75DC), there are possible two scenarios:

1. The lens needs **more** toricity.

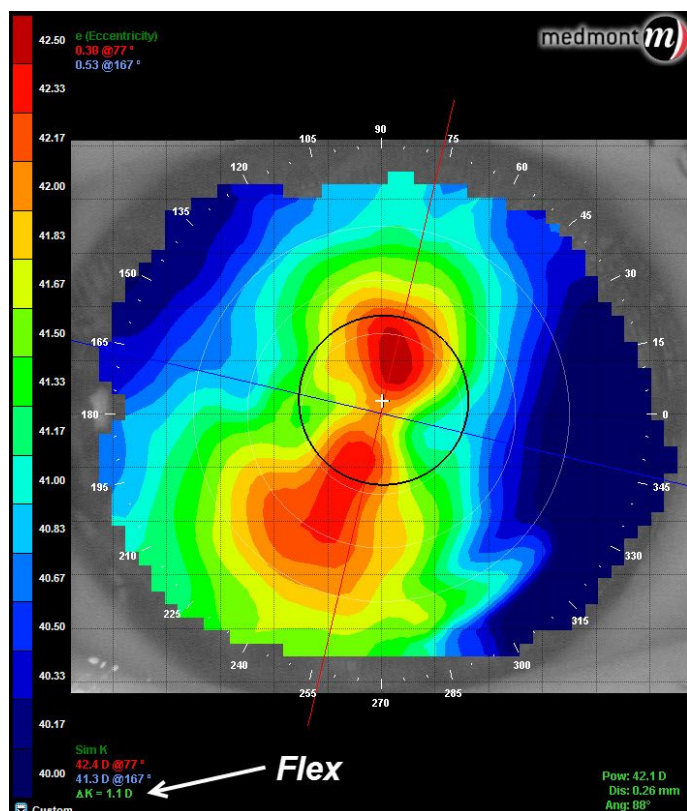
In this case the flat meridian of the back surface peripheral curves (0 and 180 dash marks) will be the same or close to (± 20 degrees) the flat axis of the topography of the lens on eye. More toricity needs

to be added to the peripheral curves, with the amount proportional to ΔK in diopters (see table above).

2. The lens needs **less** toricity.

In this case the flat meridian of the back surface peripheral curves (0 and 180 dash marks) will be 90 degrees or close to 90 (+/- 20 degrees) away from the flat axis of the topography of the lens on eye. This lens has too much toricity, with the amount proportional to the ΔK in diopters.

5.3 Lens Power



If the cylindrical component of the refraction over the lens (ROL) is similar in magnitude (within 0.75DC) and direction (+/-20 degrees) to that of the measured topographical flexure with the lens *in situ*, it can be assumed that by ordering a lens with appropriate $\Delta \text{SAG}@15\text{mm}$ to eliminate lens flexure, the resulting lens will not longer have a cylindrical component. Therefore the lens power should be order with a spherical BVP.

For example: we have a spherical lens with power -1.00DS and topography with the lens *in situ* measures ΔK 1.1DCx167. The over-refraction is -0.50/-1.00x165. This makes sense as the cylindrical component of the over-refraction matches the dioptric flex on the front surface of the lens. We would order a lens with 200 μm $\Delta \text{SAG}@15\text{mm}$ (to correct the flex) and a power of -2.00DS (Add the ROL best sphere to the lens power).

5.3.1 Toric Front Optic Zones

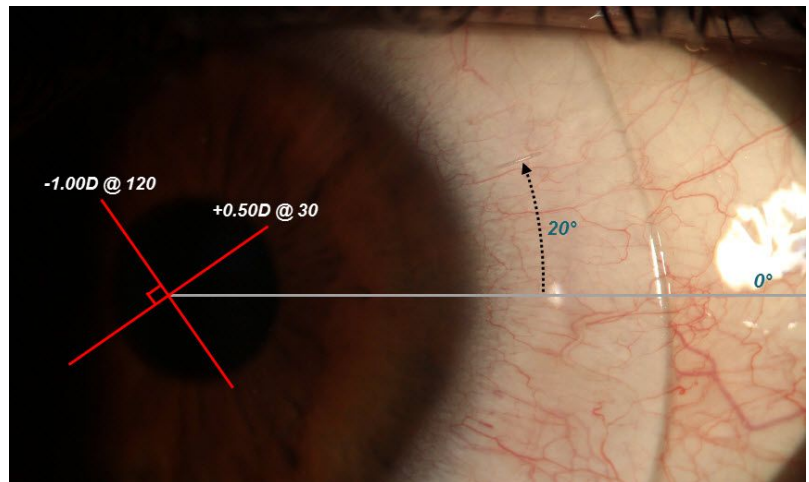
Even in an excellent fitting lens with no lens flexure you may still find astigmatism in the refraction over the lens. This can be due to lenticular astigmatism or unusual corneal (anterior or posterior) curvatures in ectatic eyes. If a lens has a difference in $\text{SAG}@15\text{mm}$ and locates in a stable position then this astigmatic over-refraction can be incorporated on the front surface of the lens to improve vision.

As the lab receiving your order will not have information about where your lens locates (in terms of rotation) the convention is to order the power **relative to the flat meridian** of the lens. Therefore to order you must note the axis of the laser engravings (dashes '-') that denote the flat meridian of the back surface, and the axis of the refraction over the lens. The ordered axis is relative to the flat meridian of the back surface of the lens.

In some situations this residual astigmatism will be orthogonal to the flat or steep meridians, meaning that the axis of the cylindrical power will be 180 or 90 depending on its direction. For example a lens with power -2.00, locates on eye with no flexure measurable on topography, with the laser engravings (dashes '-') along 170 degrees, and the ROL measures -0.25/-1.25x170. As the axis of lens location and ROL is the same, the lens should be order with power -2.25/-1.25x180.

The following example describes how to order the lens when the power is not along the principal meridians (see image below):

Example 1: We have a lens of power -2.00DS with 250 μm of $\Delta\text{SAG}@15$ that rotates and is stable with the 0/180 dashes at **20** degrees, and the 3 letter engraving at 110 degrees. Topography shows no suggestion of lens flexure and all the meridians show even touch in the SLZ. However ROL is +0.50D/-1.50Dx**30**. Therefore the order power -1.50/-1.50x**10** for our next lens. This is because we know the 20 degree rotation of the lens will bring the minus meridian to where it needs to be at 120 degrees.



It is worth noting that front surface toricity can only be ordered when there is sufficient toricity of the peripheral SLZ to stabilize the lens rotationally. It will not work effectively with no SAG@15mm difference between the principal meridians.

It is also worthwhile to ensure the cylinder correction improves a patient's vision significantly before ordering, as troubleshooting a lens with cylinder lathed into the front surface can be more problematic than with a spherical front surface.

5.4 Key Points on Toricity in Scleral Lenses

- From trial fitting with a rotationally symmetric lens it is possible to establish the parameters for a toric back periphery scleral lens using topography of the lens surface in situ.
- Never order a lens with a cylindrical BVP until, a lens with toric back periphery has been fitting and established that the lens is 1) Rotating to a stable position 2) Is not flexing on the eye 3) A significant amount of residual astigmatism **that improves the vision** is found in the ROL.
- Once a lens is ordered with cylindrical BVP (a toric front surface), topography with the lens in situ will tell you about the power ground into the front surface only, you will lose all information about lens flexure (this is why it is so important to have zero flex before trying a cylindrical BVP/front surface toric). This is useful to verify the axis of the front surface toricity.
- There is no point ordering a cylindrical BVP/front surface toric on a lens that is rotationally symmetric on the back surface, as the lens will not be rotationally stable. Prism ballast is not currently used in scleral lenses due to poor stabilisation.
- Be aware most significant residual astigmatism is due to lens flexure. If residual astigmatism is still present on a lens that is rotationally symmetrical and is not flexing according to topography over the lens then you could either 1) Create some sag difference in the back surface periphery of ~100 μm to see if the lens will rotate to a position and remain stable. This will enable front surface toricity to be built into the lens at a certain axis. or 2) Consider spectacles over the lens to correct any residual prescription.
- It is very rare to require a toric back optic zone in scleral lenses. Rotational stability is controlled by sagittal differences between the two back surface meridians.
- It is useful to keep in mind that a rotationally symmetric lens on a toric sclera/cornea will often be unstable and not sit well in the eye. Refitting with a toric scleral lens should improve stability, centration and comfort.

6. Ordering Scleral Lenses

To order your scleral lens you need to specify the following

1. Type of scleral lens eg. EyeSpace Scleral, EyeSpace Scleral Toric, EyeSpace Scleral Quad,
2. Lens diameter (16.50 mm or 17.50 mm)
3. SAG@15mm of the one, two or four meridians
4. Back Optic Zone Radius (BOZR)
5. Scleral Landing Zone (SLZ)
6. Lens Power (if front surface cylinder is required then write in minus cyl form relative to the flat meridian)
7. Lens colour
 - a. 16.50 mm: default is clear for right and ice blue for left.
 - b. 17.50 mm: lenses are only available in clear.

6.1 Parameter Notation

Rotationally symmetric Lens

Lens Type

BOZR / Diameter / SAG@15mm / SLZ / BVP / Lens Colour

As an example:

EyeSpace Scleral

7.7 / 16.50 / 4500 / Flat / -2.00 / Blue

Non Rotationally Symmetric Lens

Lens Type

BOZR / Diameter / SAG@15mm (Flat meridian) / SLZ (Flat) / BVP / Lens Colour
/ SAG@15mm (Steep meridian) / SLZ (Steep) /

As an example:

EyeSpace Scleral Toric

8.2 / 17.50 / 4500 / Flat / -5.00 / Clear
/ 4700 / Std

7. Scleral Lens Delivery and Aftercare

Once the lenses have arrived it is recommended to verify the BVP, BOZR and engravings are correct for the lens you ordered.

7.1 Delivery

To deliver the lens we recommend inserting the lens into the patient's eye and allowing it to settle for 30mins before assessing vision, flexure, central clearance and peripheral fit. As with any other rigid lens delivery if there are changes to the parameters that you think will improve the vision, comfort or long-term fit of the lens then incorporate these into the next order.

7.2 Insertion

Here are the steps to insert a scleral lens that we recommend giving to your patients:

To avoid confusion, make a habit of inserting the same lens – generally the right lens – first. Minimise the risk of lens loss by plugging the sink or using a paper towel over the drainage opening.

- Place the contact lens between the middle and forefinger (two finger method) , with the thumb also (tripod method – see picture), or on a contact lens plunger (see image below). Fill the lens with sterile non preserved saline (eg Lens Plus). This stops bubbles being trapped between the lens and your eye, which disrupts vision. If you see or feel a bubble trapped behind the lens promptly remove it and reinsert correctly.
- While looking down at a horizontal mirror, place your left middle finger on the top lid and pull it open.
- Using another finger on the right hand open the bottom lid. Pull the lids apart and place the contact lens upwards onto to the cornea at the front of your eye.
- Blink gently. The lens should be centred on the eye.



- Rinse your case out with hot water, wipe with a tissue and leave to dry upside down on a clean paper towel.

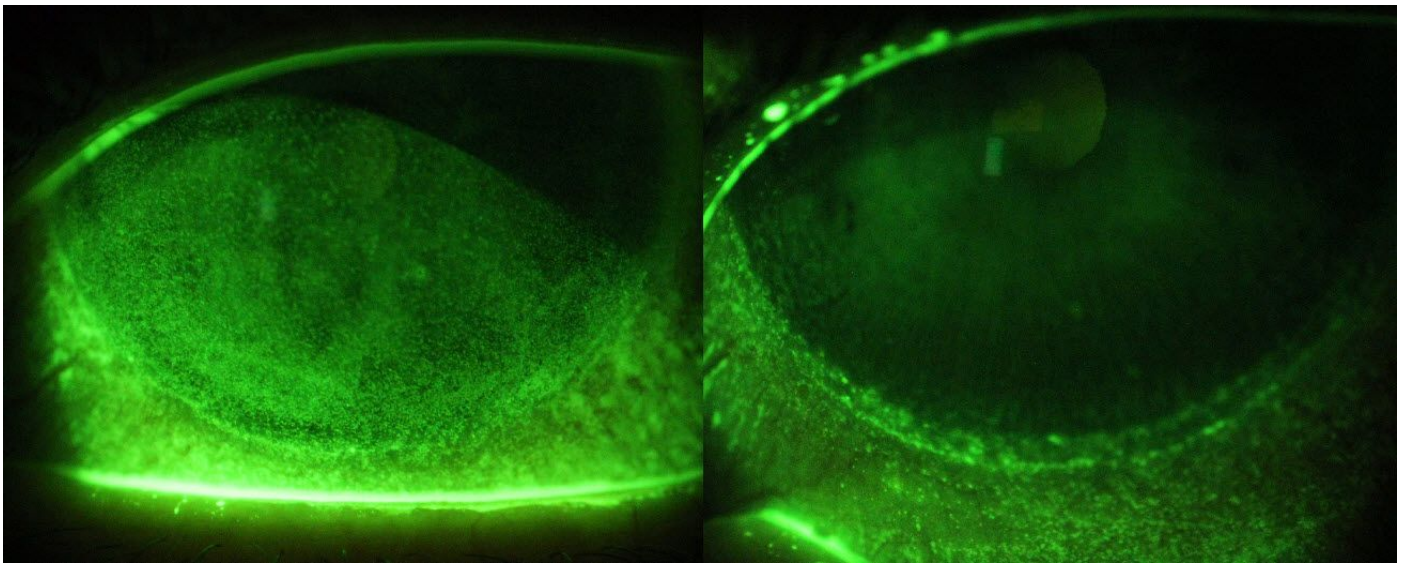
Note: Scleral lens must be inserted in a face down position, with the lens full on saline.

You may experience some discomfort if the lens is not in place correctly on the eye or if a foreign body, such as an eyelash or make-up pigment, is trapped underneath the lens. If this is the case, remove the lens and reinsert.

It can be helpful when the optometrist is inserting a lens into a patient's eye to get the patient to help you hold the bottom lid, and stand up rather than sitting in a chair. Patients with narrow palpebral apertures may have difficulty inserting the lens in one step and may need to insert under the top lid first, then pull the lower lid down and over the lens. In this instance using a thicker non-preserved insertion solution such as Polygel rather than saline will prevent bubbles being trapped.

7.3 Insertion Solution

Some patients will exhibit redness and diffuse epithelial irritation during aftercares if they are reacting to the ingredients in the solution, such as preservative and buffers in bottled saline. These patients may benefit from non-preserved artificial tears such as Theratears, Optive, Xailin Fresh SDU or Systane Ultra UD, or individual vials of non-preserved saline, in the lens bowl instead. The image below shows a patient wearing EyeSpace Toric scleral lenses that were switched from saline to Theratears for insertion due to diffuse corneal staining. After 2 weeks the cornea looked much healthier and the patient reported better comfort.



7.4 Removal

Here are the steps to remove a scleral lens that we recommend giving to your patients:

- First ensure you break the seal of your scleral lens. To do this, press firmly with your bottom lid on the white of the eye, just below the edge of your lens, then push upwards. This should create a bubble under your lens and allow it to move on your eye, making removal easier. After a longer amount of wear time the seal will be harder to break.
- While looking in the mirror in front of you, open your bottom lids as you did with insertion. Attach your suction tool to the bottom third of the lens, it helps if the tool is wet so that it sucks on well.
- Pull the lens up and out, tilting it out of the eye. If there is resistance to removal then try and re-break the seal correctly.



Alternatively if you do not have a suction tool you can try and remove the lenses manually.

- Look down over a horizontal mirror or towel to begin.
- Using your middle fingers as you did with insertion, open the lids wider than the lens diameter (about 16.00 mm).
- Apply pressure to the lid margins (as close to the lashes as you can – you do not want to show any of the red inside surface of your lids), pushing in and together to move your lids under the lens and lever it out of the eye. It can be helpful to try this on the bottom edge first then the top edge.

A good patient resource for teaching the insertion technique can be found at

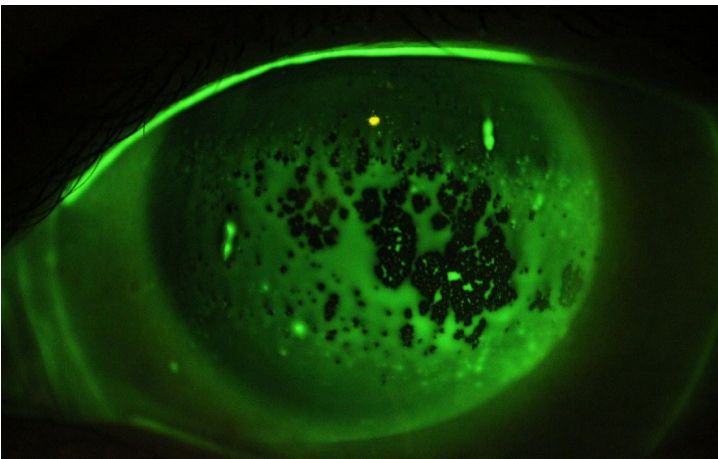
www.innovativeeyecare.com.au.

7.5 Cleaning

Lenses should be cleaned daily on both surfaces with a hard lens solution such as Menicare plus, Boston or Total Care. To improve lens wetting (a common reason for a decrease in vision throughout the day, best viewed after instillation of NaFI at the aftercares) a surfactant cleaner like Optimum Lobob can be very useful in conjunction. A protein removal cleaner such as Progent is best used every two weeks to keep the lenses as clean as possible. If you prefer, hydrogen peroxide such as AOSep, Oxysept or Clear Care can be used for daily disinfection instead.

If patients continue to experience poor wetting during the day then a cotton tip soaked in cleaning solution can be used to polish the anterior lens surface when it is still in eye can give some improvement in vision without removing the lens.

The image below shows a patient with a poorly wetting scleral lens that benefited from using Lobob cleaner.



7.6 Aftercares

It is common for neophyte eyes to experience a mild reaction to the scleral lens during the first few weeks, causing haze in the vision with extended wear due to debris building up in the post-lens tear film. This can be improved by decreasing the sag of the lens so there is a decreased thickness of tears for material to accumulate in, as well as a reduction in negative tear film pressure on the lens.

Topical antihistamine/mast-cell stabilizer drops such as Zaditen, Relestat or Patanol can also be useful, especially in atopic keratoconus.

Some patients will still find they need to remove the lens during the day to replenish the saline behind the lens. This management strategy is encourage to all patients if the process is not too inconvenient, as a chronically stagnant tear film can lead to ocular surface issues and irritation over time.

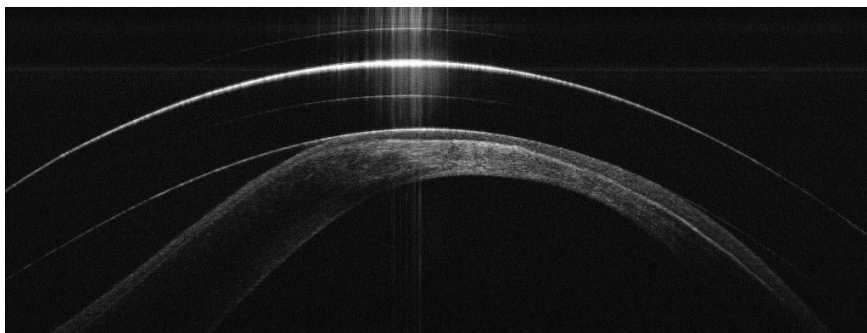
Although most patients will do fine with saline, some patients find benefit in switching from saline to non-preserved artificial tears in the lens bowl as they found it not necessary to re-insert the lenses as frequently. The cost of these drops can be a factor however.

The image to the right shows a highly atopic patient with pellucid marginal corneal degeneration demonstrating marked mucous accumulation behind his lens. This decreased after switching from saline to non-preserved artificial tears as the insertion solution and he could get away with reinserting the lens only once a day rather than upwards of 3-4 times.



Successful scleral lens wearers should be reviewed every 6 months. The lens fit, vision and health of the eye should be assessed. Ensure the lens is clean and not warped with the help of a radiuscope.

At these visits ensure the lens is still offering adequate clearance and is not touching anywhere across the cornea. This image below shows the scleral lens of a progressive keratoconic who had delayed his follow-up for several years until his eyes started hurting!



8. Conclusion

Modern scleral lenses have simplified the process of fitting irregular corneas as well as other indications such as high ametropia, dry eye, and sports. Taking care to properly fit and monitor your patients will ensure happy and healthy patients who will be wearing their scleral lenses for years to come.

Should you have any questions or require troubleshoot advice please contact your local supplier.

9. Contributors

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