

SynergEyes: The New Era in Hybrid Contact Lens Technology

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History of Hybrid Lenses

The 'Holy Grail' of contact lenses is a lens that provides the comfort of a hydrogel material, yet gives the precise, crisp vision of a rigid lens, whilst maintaining a good physiological response. In the early 1970's, Baldone pioneered the idea of placing a rigid lens over an underlying hydrogel lens (in a keratoconus case), with the idea that the soft lens would help cushion the effect of the rigid lens, improving comfort and stabilization, while the rigid lens provided the crisp, clear image.¹ This concept, known as 'piggybacking' had, and still has in many cases, clear benefits. However the rigmarole of inserting two lenses in each eye daily also has its drawbacks such as cost, time, and the obvious potential problem of hypoxia. The next phase in the idea of dual use of soft and hard materials was the evolution of the hybrid lens design, initially developed by Erikson and Neogi and acquired by Precision-Cosmet in 1977.¹ After years of development (and the joining of the Sola/Barnes-Hind group in 1986), the Food and Drug Administration (FDA) finally approved the fruits of their labour, which took the form of the Saturn II lens. The Saturn II, when correctly fitted, had the advantages of providing excellent centration and provided clear, stable vision to high astigmats and irregular corneas. However, it was not without its problems, including lens tearing with

handling and adherence, which often resulted in oedema. This led to a redesign and the introduction of the Softperm lens in 1989, which is now produced by Ciba Vision.

The design improvements in the Softperm lens meant that it was much more successful, and was regularly used in cases of keratoconus, irregular corneas and high astigmatism. However the lens still suffers from the problem of splitting at the soft/hard junction, and it's low Dk of 14 at the RGP centre and 5.5 at the skirt means it still has limited applications in modern practice.

In 2001 a California-based research company named SynergEyes recognised a niche in the market for a high Dk hybrid lens with a reliable soft/hard junction. The SynergEyes Hybrid Contact Lens received FDA approval and CE mark in 2005, and No.7 Contact Lens Laboratory now distributes these lenses in the UK.

Features of SynergEyes Lenses

SynergEyes contact lenses consist of a central RGP portion made from Paragon HDS material with a Dk of 100 and a soft skirt of 27% water non-ionic hydrogel material (HEMA). The two parts of the lenses are joined using a patented 'Hyperbond' junction, which is extremely strong and durable. The lens also has a special surface treatment called 'HydroEyes' to improve surface wettability.

The RGP portion is 8.4mm in

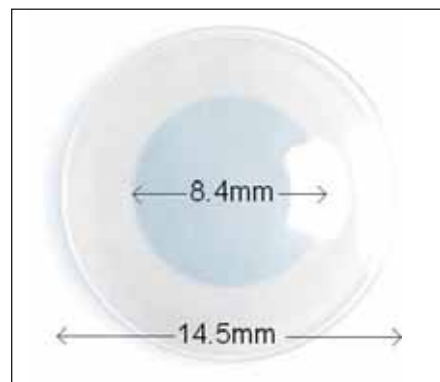


Figure 1: The SynergEyes lens design showing the size of the RGP portion relative to the total diameter

diameter and the total lens diameter including the soft skirt is 14.5mm, for all SynergEyes lens designs (Figure 1). There are currently 4 lens designs in the SynergEyes family: SynergEyes A, SynergEyes KC, SynergEyes PS and SynergEyes Multifocal.

SynergEyes A

The SynergEyes A (Advanced) lens is aimed primarily at the correction of standard ametropia, mild keratoconus and corneal scarring. It has a 7.8mm spherical optic zone, and is available in ten base curves, from 8.0mm to 7.1mm in 0.1mm steps. Each base curve has two possible skirt radii choices - a steep and a flat option (steep option is 1.0mm flatter than the RGP base curve, flat option is 1.3mm flatter than the RGP base curve).

SynergEyes KC

The SynergEyes KC lens has been designed principally for the correction of prolate corneas such as those found in keratoconus and post-surgical corneal ectasia. The RGP portion has an aspheric design (Figure 2) the back surface of which better matches the prolate corneal shape of these eyes. There are eight base curves offered in the KC design, from 7.1mm to 5.7mm in 0.2mm steps, though some 'extended range base curves' are available up to 5.3mm. Each base curve has three skirt choices for this design - a steep, medium and flat option that vary depending on the base curve.

	SynergEyes A	SynergEyes KC	SynergEyes PS
Diameter	14.5mm	14.5mm	14.5mm
Base Curve	7.1mm to 8.0mm in 0.1mm steps	5.7mm to 7.1mm in 0.2mm steps	7.6mm to 9.0mm in 0.2mm steps
Skirt Curve	1.0mm and 1.3mm steeper than BC	Steep, medium and flat	8.3mm and 8.6mm
Sphere Power	+8.00D to -8.00D in 0.25D steps +8.50D to +20.00D in 0.50D steps -8.50D to -20.00D in 0.50D steps	Plano to -20.00D in 0.50D steps	+2.00D to -6.00D in 0.25D steps

Table 1: Available parameters in the SynergEyes range

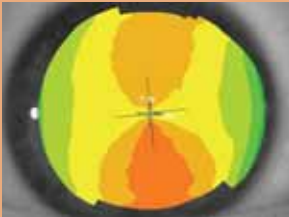
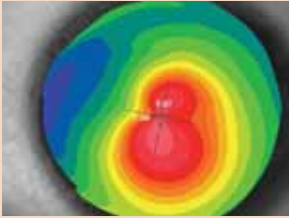
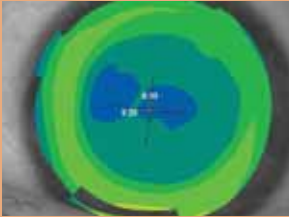
Design	Indications
<p>SynergEyes A</p> 	<ul style="list-style-type: none"> - Myopia, hypermetropia and regular astigmatism and patients who don't achieve good VA with soft lenses or who cannot tolerate RGP's - Mildly irregular or scarred corneas - Mild to moderate central cones
<p>SynergEyes KC</p> 	<ul style="list-style-type: none"> - Emerging to moderate peripheral cones - Emerging to severe central cones - Post-lasik induced ectasia - Pellucid marginal degeneration
<p>SynergEyes PS</p> 	<ul style="list-style-type: none"> - Post-refractive surgery/post-LASIK patients - Post-RK - Post-PRK - Pellucid marginal degeneration - Degenerative corneal conditions or corneal trauma - Post-penetrating keratoplasty and/or Intacs® for keratoconus

Table 2: Indications for the use of SynergEyes lenses

SynergEyes PS

The SynergEyes PS (post surgical) lens has been specifically designed for patients with oblate corneas resulting from refractive surgery, grafts, corneal trauma or degenerative conditions. It has a reverse geometry design to address the altered corneal shape resulting from refractive surgery. It has a 6.5mm optic zone, and there are eight base curves available, from 9.0mm to 7.6mm in 0.2mm steps. Each base curve has two associated skirt curve choices, a 8.6mm skirt and a 8.3mm skirt. There is a third parameter to consider in the PS range, which is the 'lift'. Each base curve has three 'lift' options, which is effectively the amount of reverse curve the lens has, with Lift 1 or 'L1' having the gentlest curve for mildly oblate corneas, and L3 having the most rapid steepening towards the edge, for more severe cases (Figure 3). The lift actually controls the amount of sag the RGP part of the lens has, and alters the sag between 50-60µm between each lift.

SynergEyes Multifocal

The SynergEyes MF lens is designed for

the correction of presbyopia and is based on the SynergEyes A design, incorporating a centre-near front surface addition. The near segment is very precise with no polishing or blending, and aims to give clear optics for both distance and near viewing using a simultaneous image principle. The base curves and skirt curves available are identical to the A-range, and the power range is +4.00DS to -8.00DS. Add powers are +1.25DS, +1.75DS and +2.25DS, with two segment diameter options of 1.9mm and 2.2mm.

SynergEyes Parameters Available

The parameters of SynergEyes lenses that are available are shown in Table 1. SynergEyes should be fitted using a diagnostic fitting set (Figure 4), as empirical fitting does not always give predictable results. A tolerance test using the diagnostic lenses is also recommended prior to ordering. SynergEyes A diagnostics comprise 20 lenses (every base curve in both flat and steep skirt options) and each lens is -3.00DS in power. SynergEyes KC

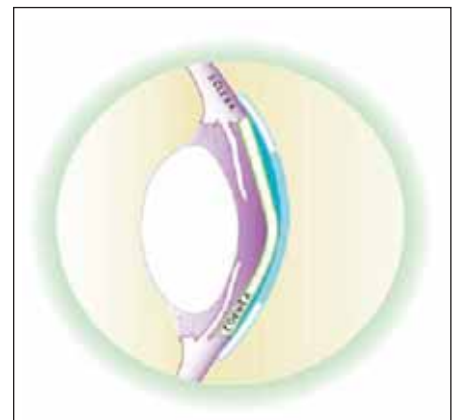


Figure 2: Aspheric design of the RGP portion of the SynergEyes KC lens

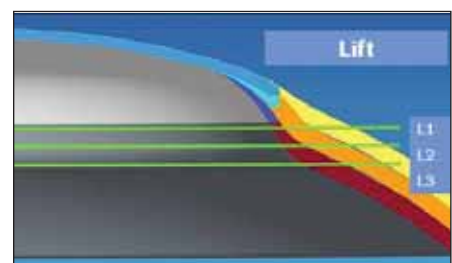


Figure 3: Lift options in the SynergEyes PS design

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Patient's Age (Years)	Dominant Eye Add (DS)	Non-Dominant Eye Add (DS)
<50	+1.25	+1.25
50-57	+1.75	+1.75
<57	+1.75	+2.25

Table 3: Suggested reading additions for SynergEyes Multifocals

diagnostics comprise 24 lenses (every base curve, each with all three skirt options provided) with powers ranging from -4.00DS to -14.00DS depending on the base curve. SynergEyes PS diagnostics comprise 24 lenses (every base curve, each with all three lifts, skirt curve 8.6mm) and all lenses are Plano powered. Each lens is laser marked on the skirt, so that diagnostic lenses can be easily identified.

Indications for the use of SynergEyes contact lenses are highlighted in Table 2. No lens will work on every type of cornea, and the same is true for SynergEyes, which may not be suitable for the following patient types: globus cones, very advanced decentred cones, corneas in which the lens is effectively unable to vault over the cone without generating a large persistent air bubble, advanced pellucid marginal degeneration, and keratoconus patients who are prone to getting neovascularisation, particularly if a corneal graft is anticipated in the future. SynergEyes might also not be your first lens of choice for a patient who is not particularly dextrous as both insertion and removal can be fiddly at first.

Handling of SynergEyes Lenses

Handling SynergEyes is slightly different compared to other lens types, and it can be a cause for failed fitting if not done properly. To insert, the lens should be filled to the brim with saline plus one drop of Fluoresoft® high molecular weight fluorescein. The

patient must lean forward with their head down, and the lens should be placed on the cornea, coming up from underneath, thus trapping the saline under the lens to avoid air bubbles. Allow the lens to settle for around 30 seconds before assessing the fit. To remove the lens, pinch the soft skirt at the 6 o'clock position with DRY fingers, with the patient looking up. As soon as the lens puckers it should come out.

Fitting of SynergEyes Lenses

Healthy corneas for the correction of ametropia, astigmatism and presbyopia

Although SynergEyes suggest that you can fit a healthy cornea empirically, the authors recommend that you always use a fitting set to achieve an optimal fit. Potential patients for SynergEyes might be astigmats who have never achieved adequate visual acuity (VA) with soft torics, cannot tolerate RGP's, RGP wearers who want improved comfort but won't compromise on VA, or dissatisfied soft lens wearers.

The primary fitting principle for SynergEyes lenses is that the soft skirt should be in alignment with the eye, and the RGP portion should entirely VAULT the central cornea (without the presence of an air bubble).

1. Select a trial lens that has a base curve of 0.3mm steeper than the flattest k-reading.

2. The ideal fit will have:

- Apical clearance over the central cornea (optimum fit has little or no touch in rigid zone of lens – total



Figure 4: The SynergEyes diagnostic set

corneal clearance – see Figure 5)

- Clearance free of bubbles over flattest corneal zone
 - Alignment under soft skirt
 - Soft skirt free of scleral impingement or fluting
 - Lens free to move on push-up test
3. When you have achieved a good fit, let the lens settle for at least 10 minutes before performing a final over-refraction and ordering the lens.

SynergEyes Multifocal fitting process

The fitting procedure for SynergEyes Multifocal lenses is identical to that of standard spherical lenses. However, to optimise near vision, establish which is the dominant eye, and use the 1.9mm segment for this eye and the larger 2.2mm segment for the non-dominant eye. Alternatively, if your patient has a greater demand for distance vision, you can use the 1.9mm segment for both eyes. Equally if there is a greater need for good near vision, use the 2.2mm segment bilaterally. The selection of the addition should be loosely based on Table 3. The adds are very effective and usually that which is 0.50D less than the usual spectacle add will suffice.

It is recommended that the Multifocal fitting set be used when fitting these lenses to establish their potential for the patient, before ordering. This fitting set will only be supplied to practitioners once they are experienced with single vision lenses.

Note: Slight ghosting or reports of “3D” vision upon dispensing are typical effects of a simultaneous vision system. After an adaptive period (typically 1-2 weeks), this effect will usually resolve. Patients unable to adapt after two weeks may not be ideal candidates for

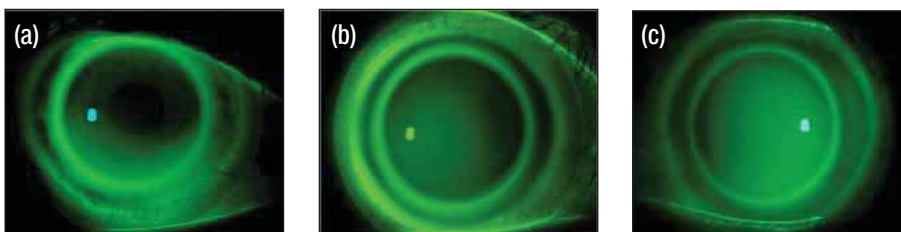


Figure 5: (a) Flat fitting SynergEyes A lens, (b) Marginally flat fitting SynergEyes A lens, and (c) Optimal fitting SynergEyes A lens

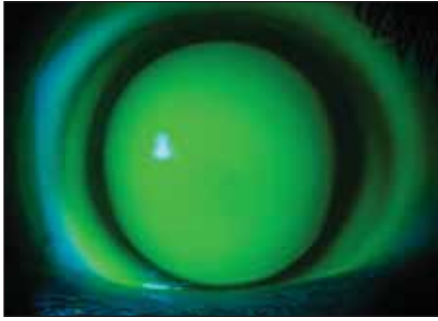


Figure 6: Optimal fitting of a SynergEyes KC lens showing total clearance of the cone with no bubbles

simultaneous vision.

Fitting SynergEyes for Keratoconus and Prolate Corneas

When fitting SynergEyes for a keratoconic eye, you can use either the SynergEyes A or KC ranges, depending on the severity and location of the cone. In general, for an emerging central cone with average K-reading of 7.35mm or flatter, start with SynergEyes A. For a more moderate to severe cone, central or otherwise, you will probably require the KC range.

The fitting process is as follows:

1. Use corneal topography to locate the steepest part of the cone, or in the absence of a topographer, note the steepest K reading.
2. Select a diagnostic lens closest to the steepest K reading, rounding down to the next steepest lens if necessary. For example, if the steepest K is 6.40mm, select the 6.30mm lens.
3. The recommendation from SynergEyes is to initially select the medium skirt curve. However, around 80% of the time the steeper skirt curve will be the best final fit. This is because the steeper skirt radius adds sagittal depth and will help lift the RGP/soft junction off the cornea so that landing occurs at the soft skirt. So you may want to go straight to the steepest skirt and then go flatter if necessary. You can always go flatter if you observe impingement at the sclera.
4. Insert the lens and let it settle for 30



Figure 7: SynergEyes KC lens with a central bubble

seconds, and then assess using slit lamp and a Wrattan filter. (The RGP material has a UV blocker so a Burton lamp may not work).

5. The ideal fit will demonstrate:

- Apical clearance over the central cornea with little / no touch in the RGP portion of the lens (Figure 6).
 - Corneal clearance free from air bubbles.
 - Light touch at the 9mm chord, which should occur at the SOFT part of the lens, not at the RGP/soft junction.
 - Alignment under the soft skirt, free from scleral impingement or fluting.
 - Potentially very little movement on blink, but free to move on push up test.
6. If the initial assessment looks good, let the lens settle for a further 10 minutes or so, as it may settle on and become flatter looking. Once you are happy with the fit, perform an over-refraction and order the lens.

This is meant to be a guide to selecting the best 'first try' lens, and will not necessarily hold true for all cones and for all eyes. Small, steep cones in particular may require a flatter than expected lens, as although the apex may be very steep, if the cone is small then the sag will be low. For the same reason, large cones will often need a steeper base curve to provide greater sag to totally vault the apex.

TROUBLESHOOTING 1

1. Bubble under the lens - if the bubble (Figure 7) is central and greater than around 1-2mm in diameter, the first thing to do is to remove the lens and reinsert it, whilst ensuring as much saline is preserved under the lens as possible. If the bubble persists, resolve by **FLATTENING** the base curve. A bubble less than 2mm diameter should dissipate with time, or may be eliminated by asking the patient to look down, while you gently pull the lens upwards with your finger - the bubble will often slip out the bottom of the lens.
2. Central touch - if you observe central touch in the RGP portion of the lens (Figure 8), resolve by **STEEPENING** the base curve. If the central touch is significant, you may want to steepen the base curve by more than 0.2mm - try two or even three lenses steeper. Although this might seem like a huge jump, on the eye these seemingly large changes are much less dramatic.
3. Peripheral touch - if you observe touch towards the periphery of the RGP portion of the lens (Figure 9), due to the



Figure 8: SynergEyes KC lens with central apical touch

aspheric design it is actually more productive to steepen the skirt curve radius, as this will add sagittal depth and lift the lens off the cornea. If this makes little or no difference or you are already on the steepest skirt, then try steepening the base curve. If you try both these measures and there is still significant peripheral touch, SynergEyes may not be suitable for this patient.

4. Heavy bearing at junction - if you observe heavy bearing at the RGP/soft junction, which appears as a dark ring at the visible junction between the materials (Figure 10), this tends to cause a 'tight' feeling for the patient, who will often complain that it feels like the lens is 'squeezing' the eye. If this problem is left uncorrected, it will result in an uncomfortable lens that is very difficult to remove, and will often leave a ring of staining on the cornea, like a 'coffee cup stain'. Instinct tells you to flatten the fit, however this will reduce the overall sag and make the problem worse. Counter-intuitively, you actually need to **STEEPEN** the skirt curve, which will effectively increase the sag and lift the junction off the eye, helping it land at the skirt.

You can see that most problem solving with SynergEyes involves making either the base curve or the skirt curve steeper, in order to increase sagittal depth. This often goes against intuition and it does take a few fits to get your head around!

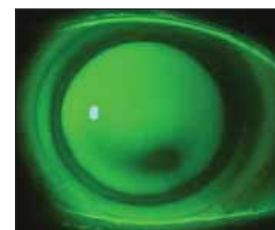


Figure 9: SynergEyes KC lens with peripheral touch

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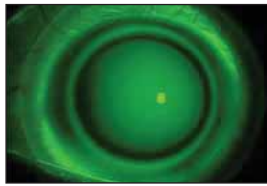


Figure 10: SynergEyes KC lens showing heavy bearing at the soft/RGP junction

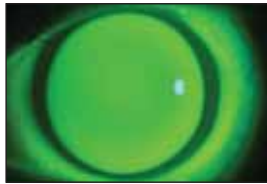


Figure 11: Optimal fitting of a SynergEyes PS lens

Fitting SynergEyes for Post-Lasik and Oblate Corneas

The majority of patients who will benefit from SynergEyes PS lenses will be unhappy post-refractive surgery patients (post-LASIK/LASEK or PRK) and post-graft patients. The main differences between fitting these lenses compared to the rest of the range are that the lens has a reverse geometry design and that there is the third parameter of 'lift' to consider. This design is NOT suitable for keratoconus or post-laser induced ectasia - the SynergEyes A or KC ranges should be used for these corneas.

The fitting process is as follows:

1. Determine the mean K reading of the central 6mm of the cornea.
2. Select a diagnostic lens closest to the average K reading, rounding down to the next steepest lens if necessary. For example, if the average K is 8.90mm, select the 8.80mm lens.
3. Select 'Lift 2' initially for all new fits.
4. Insert the lens as described, although you will find you don't need to fill the bowl right up for the PS lenses - 2 or 3 drops of saline and one drop of FluoreSoft is usually enough.
5. Let the lens settle for 30 seconds, then observe the fit using a slit lamp with Wrattan filter.
6. The ideal fit will demonstrate (Figure 11):

- Apical clearance over the central

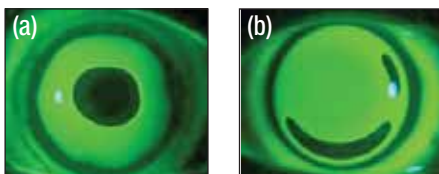


Figure 12: (a) SynergEyes PS lens with a central air bubble, and (b) SynergEyes PS lens with peripheral arc-shaped bubbles

cornea with little / no touch in the RGP portion of the lens.

- Corneal clearance free from air bubbles.
 - Light touch at the 9mm chord, which should occur at the SOFT part of the lens, not at the RGP/soft junction.
 - Alignment under the soft skirt, free from scleral impingement or fluting.
 - Potentially very little movement on blink, but free to move on push up test
 - Any touch in the RGP portion of the lens will inevitably produce staining.
7. If the initial assessment looks good, let the lens settle for a further 10 minutes as it may settle on and become flatter. Once you are happy with the fit, perform an over-refraction and order the lens (remembering that diagnostic PS lenses are plano powered).

TROUBLESHOOTING 2

1. Air bubbles - if bubbles are present, identify the shape and location. If they are round and centrally located (Figure 12a), flatten the base curve. If they are arc shaped and situated towards the skirt junction (Figure 12b), or if seen both peripherally and centrally, decrease the lift from L2 to L1.
2. Touch - if excessive touch is observed, note the location of the touch. If the area of touch is central (Figure 13a), steepen the base curve. If the area of touch is more peripheral (Figure 13b), with central pooling, increase the lift from L2 to L3.
3. Soft Skirt Fluting - if you see fluting of the skirt part of the lens (Figure 14), order the steeper 8.3mm skirt curve.
4. Additional Tips - more highly oblate corneas, (i.e. those with the greatest difference between the central K's and the peripheral corneal curvature), are more likely to need the steeper Lift (L3). Mildly oblate corneas will most likely benefit from the flatter Lift (L1), or may even be fit with the SynergEyes A lens design. However, for your first few fits the authors suggest you always start with L2 and alter if necessary.

Conclusions

SynergEyes is not a lens to be fitted by the practitioner who says "I've been fitting Softperm for years - I reckon it's pretty much the same". SynergEyes lenses require a totally new approach and attempts to 'wing it' will cause unnecessary suffering for the patient and financial hardship for the practitioner. On average, the

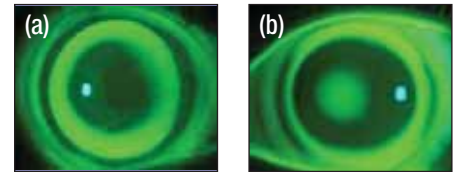


Figure 13: (a) SynergEyes PS lens with excessive central touch, and (b) SynergEyes PS lens with excessive peripheral touch

SynergEyes RGP portion will tend to be 0.50mm steeper than the equivalent Softperm, whilst the soft skirt has a completely different function.

An easy mistake to make is to fit SynergEyes too flat. This causes the lenses to abrade the epithelium resulting in severe discomfort to the patient. They also tend to adhere, making them very difficult to remove. If the guidelines presented in this article are followed, practitioners can expect around an 80% success rate on your most difficult and challenging patients. However, you don't have to save SynergEyes for the most difficult patients - they work just as well on patients whose refractive errors demand an RGP but who want the ease and comfort of a soft lens. Because SynergEyes centre so well, they are also ideal for patients who like a near centre add multifocal but need a correction for low astigmatism too. (Note: You can only be supplied with SynergEyes Multifocal once you have mastered single vision.)

About the Author

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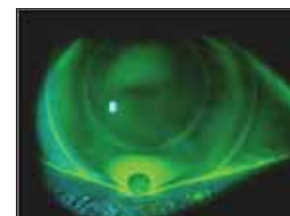
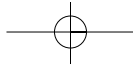


Figure 14: Fluting of the soft skirt in a SynergEyes lens



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