Correction of Presbyopia with GP Contact Lenses

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Table of Contents

contents

Introduction

About this book

Presbyopia can be safely and effectively corrected with gas permeable (GP) multifocal (bifocal) contact lenses, but statistics indicate that they remain the most underutilized contact lenses on the market. We believe that practitioners have been 'turned off' GP multifocals due to their experiences with older generations of these lenses, which tended to be difficult to fit, with poor visual results.

Fortunately, GP multifocals have come a long way, and practitioners who avoid fitting them are missing out on an important niche market. With this booklet, we hope to show you just how far GP multifocals have come and demonstrate the ease with which they can now be fit and managed.

The Centre for Contact Lens Research

Established in 1988, the Centre for Contact Lens Research at the School of Optometry, University of Waterloo in Canada focuses its research on the effects of contact lens wear on the eye. Made up of faculty, researchers and administrative and technical staff, clinical trials and basic research performed at the CCLR is for the most part the result of collaboration with a variety of contact lens and related companies. Many of our activities are also directed at supporting the development of optometric education for practitioners. Please visit http://cclr.uwaterloo.ca for more information about our work.

How to read this book

TERMINOLOGY

You may have recognized inconsistencies in the terminology used to describe the fitting of GP multifocal contact lenses. For example, 'translating', 'alternating' and 'segmented' contact lenses can all refer to the same lens design. The following is a list of terminology you will find throughout this booklet.

GP MULTIFOCAL LENS DESIGNS:

Alternating lens: An outdated term referring to a lens with distinct optical portions that rely on lens movement to position the distance and near optic zones in front of the pupil. In this booklet we refer to these as 'non-rotational' lenses.

Bifocal lens: Bifocal contact lenses correct presbyopia by incorporating two distinct power segments, one correcting the distance prescription and one correcting the near prescription. These contact lenses correct presbyopia by mimicking bifocal spectacles, with a distance segment at the top and a near segment below. In this booklet we refer to these as 'non-rotational' lenses.

Binocular over-refraction: This method of over: refracting has one eye fogged (blurred), using a +0.75D spherical lens, while optimizing the acuity of the contralateral eye with either the addition of plus or minus lenses.

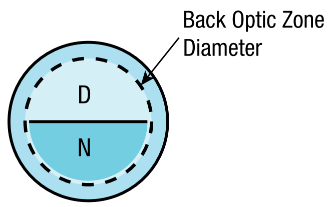
Elliptical shapes: The shape of the cornea varies from a sphere (shape factor of 0) as it has a curvature that flattens as you approach the periphery (relative to the center of the cornea). This is referred to as a prolate shape and resembles an ellipse (an egg standing on its end) with a shape factor between 0 and 1.0.

Fused segments: These are segments of higher refractive index material inserted into the body of the contact lens, to generate the near reading segment. This type of design is not currently available in GP materials.

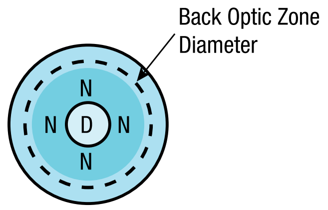
Hyperbolic shapes: When the cornea resembles a highly positive prolate shape, as in keratoconus (i.e. the cornea is very steep centrally and relatively very flat in the periphery) then the corneal shape factor may more closely resemble a hyperbola (shape factor ›1.0).

Multifocal lens: Correct presbyopia by incorporating an additional optical zone (or zones) correcting intermediate, distance and near vision.

Non-rotational lens design: Distance (D) and near (N) portions (usually segments) are directionally sensitive. The distance portion and near portions usually mimic the positions found within a pair of spectacles.



Rotational lens design: Concentric optical zones (or gradient optical powers) are co-axial with the geometric center of the contact lens.



Segment: The optical zone of the contact lens may have clearly defined (near and distance) optical portions, called 'segments.'

Simultaneous vision lens design: Positions both the distance and near portion of the optical zone in front of the pupil at the same time.

Varifocal lens: Multifocal lens incorporating optical zone powers that transition gradually from distance to near correction.

FITTING LENSES:

Diagnostic lens: Part of a diagnostic lens set (or specifically ordered from a lab) and used to determine or confirm lens performance and fit.

Mislocation: Undesirable movement (rotation) of a non-rotational multifocal GP lens.

Translation: The vertical movement of a (rotational or non-rotational) multifocal lens, positioning either the near or distance zone in front of the pupil.

ABBREVIATIONS:

BOZD: Back optic zone diameter

BOZR: Back optic zone radius (formerly known as base curve)

BVP: Back vertex power

HVID: Horizontal visible iris diameter

TBUT: Tear break: up time

TD: Total diameter (of the contact lens)

PA: Palpebral aperture

PS: Pupil size

Δ: Prism diopters

ASSUMPTIONS

We wrote this guide with a number of assumptions in mind:

1. Gas permeable multifocals are a good alternative to soft hydrogel multifocals.
2. Fitting GP multifocals is not as difficult as practitioners may think.
3. Every presbyopic patient should be given the opportunity to try multifocal contact lenses.
4. Taking a proactive approach is the best way to ensure that all presbyopic patients see multifocal contact lenses as an option.

These assumptions are fundamental to this booklet: We believe that GP multifocals are superior in many ways to their soft contact lens counterparts. We want you to feel comfortable giving GP multifocals a try. We don't want you to limit your patients' options by assuming they are not suitable for GP multifocals. And finally, we would like to encourage you to present all your patients with the full array of options for correcting presbyopia.

This booklet is meant to be a guide, not a text book. Reading it will: we hope: increase your confidence in fitting presbyopic patients with GP multifocals by clarifying design strategies and describing fitting techniques. Read it as a quick overview to refresh your memory or keep it on your office bookshelf as a quick reference when fitting GP multifocals. Either way, we hope you find it useful.

1 Opportunity knocks

in this chapter:

- Who are today's presbyopes? Meeting your patients' needs
- Today's GP lenses for presbyopia: getting better all the time

Who are today's presbyopes? Meeting your patients' needs

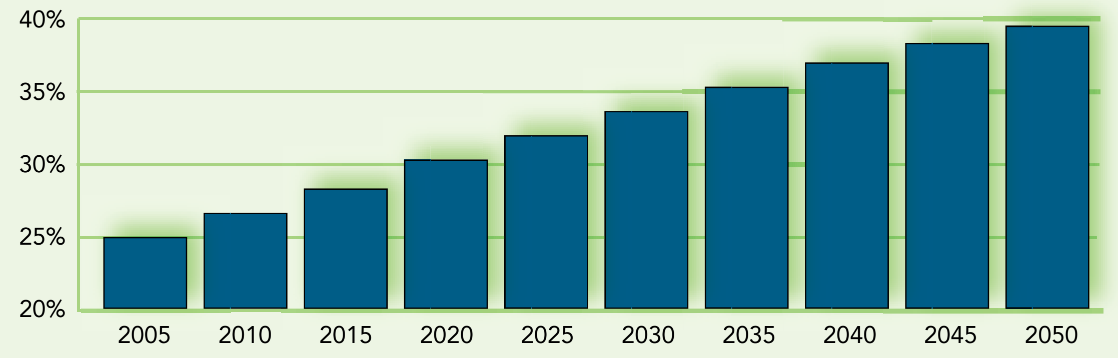
Today's presbyopes are not the same as the presbyopes in your parents' or grandparents' generation. Patients today are used to demanding that their practitioner satisfy their visual needs with the latest technology and advancements. You may find that your presbyopic patients are more reluctant to compromise their youthful appearance by wearing spectacles, for example, particularly if they have already been wearing contact lenses.

The increasing public awareness of advances in contact lens technology, and the resulting expectations: together with the growth of the aging population – has led the contact lens industry to invest time and effort in developing more modern lens designs in anticipation of a larger presbyopic contact lens market.

WORLDWIDE AGING TRENDS ›45 YRS

You have probably seen this demographic shift in your own practice. Consider the following questions as you decide how to accommodate current and future presbyopic patients in your practice:

POPULATION 45 YEARS AND OLDER



According to a 2001 report released by the United Nations, the world's aging population is growing at 2% every year worldwide.

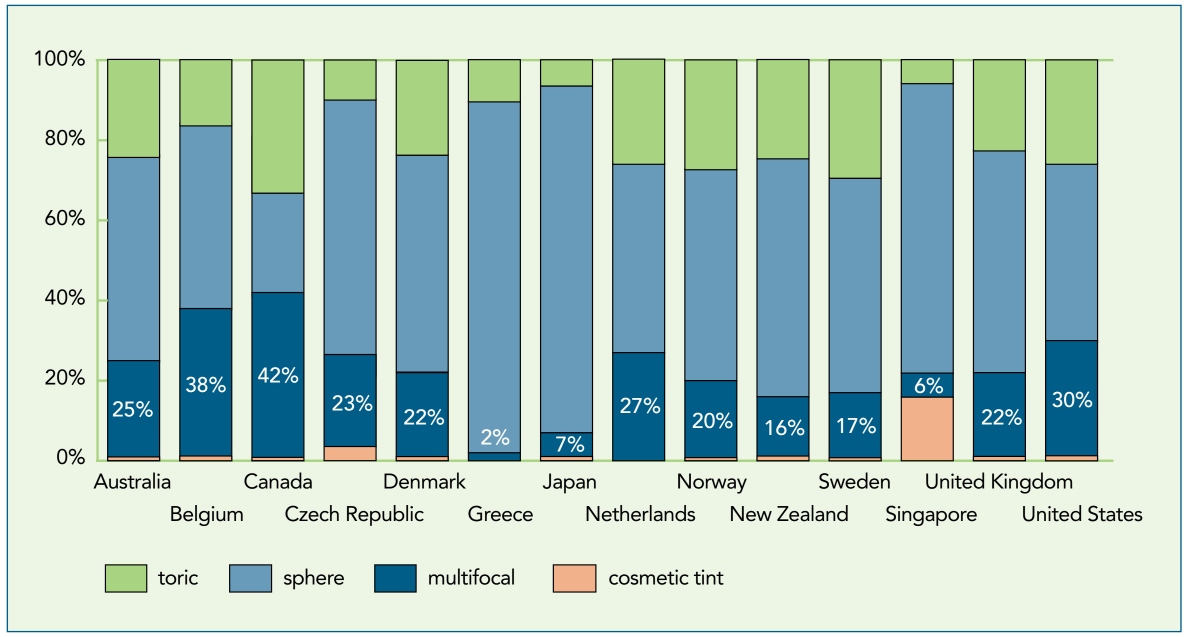
- How many presbyopic patients do you have?
- How many patients do you expect to become presbyopic in the near future?
- Are they already wearing contact lenses?
- Will they be content to wear multifocal spectacles or will they prefer to continue using spectacle-free correction?
- How will you attract new presbyopes and their families into your practice?

The market for multifocal contact lenses is expanding rapidly, and the GP lens market is ready to meet the demand for quality presbyopic vision correction. Approximately 50% of the developed world's population is presbyopic. If we assume an even distribution of lens fits throughout all age groups, 50% of contact lens fits should be to presbyopic patients. Though some of these patients may not be suitable for multifocals, the majority should be so we should expect half of presbyopes to wear multifocal contact lenses, or 25% of all fits. Instead, a recent international survey shows that 13% of contact lens fits are GPs, 77% of those fits are spherical, and only 6% are multifocals.

These data suggest that perhaps many practices are missing an opportunity to better serve their presbyopic population.

> "There's a progressive evolution of expectation with every generation. Our patients demand more of technology, so technology keeps improving. Bifocal spectacles were the only option available to our grandparents. Our parents were content with bifocal spectacles because the other options were not ideal. And today's technology has been able to develop contact lens multifocals to suit nearly every patient's needs. Once patients learn about the options available to them now, the demand for multifocal contact lenses will certainly increase."
>
> **CRAIG WOODS**
> Optometrist, Canada

PROPORTION OF GP LENS DESIGNS PRESCRIBED TO PRESBYOPIC PATIENTS



Today's presbyopic patients are…

- Health-conscious
- Financially secure
- Physically and socially active
- Computer-savvy
- Experienced contact lens wearers
- Interested in maintaining a youthful appearance

Today's GP lenses for presbyopia: getting better all the time

Radical changes in manufacturing processes and materials have made today's GP multifocals a very practical option. Computerized design and manufacturing processes incorporate three-dimensional lathing technology able to create custom-fit lenses with enhanced reproducibility and improved comfort and vision.

Multifocal GP designs offer custom parameters, facilitating even better vision.

Yesterday's GP multifocals:	Today's GP multifocals:
Associated with discomfort Thick lenses Poor wetting surfaces Lower oxygen transmissibility	Better comfort Reduced lens weight Better wetting surfaces High oxygen transmissibility
Fluctuating, inconsistent vision Poorer optics resulting in low contrast	Sharper acuity; more add powers Improved optics resulting in high contrast
Complicated fitting sessions Multiple pairs needed for fitting	Simple, step-by-step strategies Enhanced, custom design
Expensive lenses	Cost: effective fitting strategies

With increasing awareness of the relationship between hypoxic conditions and corneal health, the contact lens industry has put a great deal of energy into developing highly oxygen transmissible hydrogel contact lenses, but GP lenses have always been highly transmissible to oxygen. Many clinicians have concluded they should be considered the lens of first choice for this reason.

GP lenses also have a longer life expectancy, provide superior vision for those with corneal astigmatism, offer a reduced risk of microbial keratitis, and present less risk of toxic and allergic complications associated with lens care products.

Optical considerations are of foremost concern when fitting contact lenses for presbyopes. Multifocal lenses must "translate" (move with a change in gaze from distance to near or near to distance) in order for patients to see as clearly as possible, something that GP lenses do better than any soft presbyopic lenses.

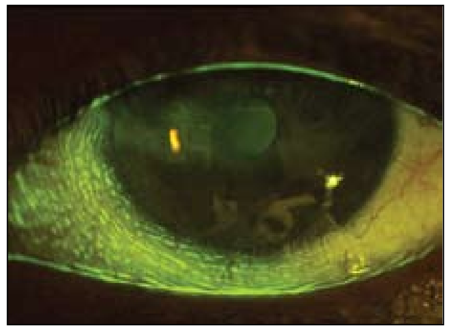
GP multifocals offer a number of advantages over hydrogel multifocal lenses, including:

- better optical designs matching a wider variety of visual needs
- clearest binocular distance and near vision
- lower risk of infection
- more suitable than monovision for patients with amblyopia
- lens translation and greater predictability
- easier removal of deposits
- longer-term comfort after initial adaptation
- smooth, wettable surfaces that do not dehydrate
- higher oxygen transmissibility
- longer lens life
- ease of handling

The Presbyopic Eye

The eye's needs shift as it ages, in response to a variety of physiological changes:

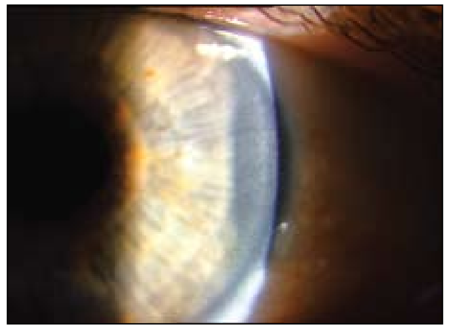
Smaller pupil



Smaller tear volume accompanied by increasing signs and symptoms of dryness or increased lens deposition

Loss of eyelid elasticity

Irregular lid margin contour



Loss of corneal transparency

Increased conjunctival redness

The presbyopic eye:

- needs more oxygen
- has less corneal sensitivity
- has increased positive spherical aberrations
- may see poorly in low light
- experiences increased light scatter (glare)
- has a small pupil size

take-home points:

- **The aging population is growing worldwide**
- **Today's presbyopes have active lifestyles and higher expectations when it comes to vision correction**
- **In addition to the benefits of improved technology, today's GP multifocal lenses offer a number of advantages over their soft lens counterparts**

2 Principles, designs and lens fitting: ensuring patient success

in this chapter:

How to approach the fitting of GP multifocals

Fitting GP multifocals can seem overwhelming, but do not let that deter you; you can learn how to fit GP multifocals with ease, particularly in light of the advances offered by today's GP multifocal technology. To fit GP multifocals successfully:

Get to know lens designs: GP multifocals fall under two main design principles: rotational and non-rotational. Make sure you understand how each design works and which physical characteristics they suit the best.

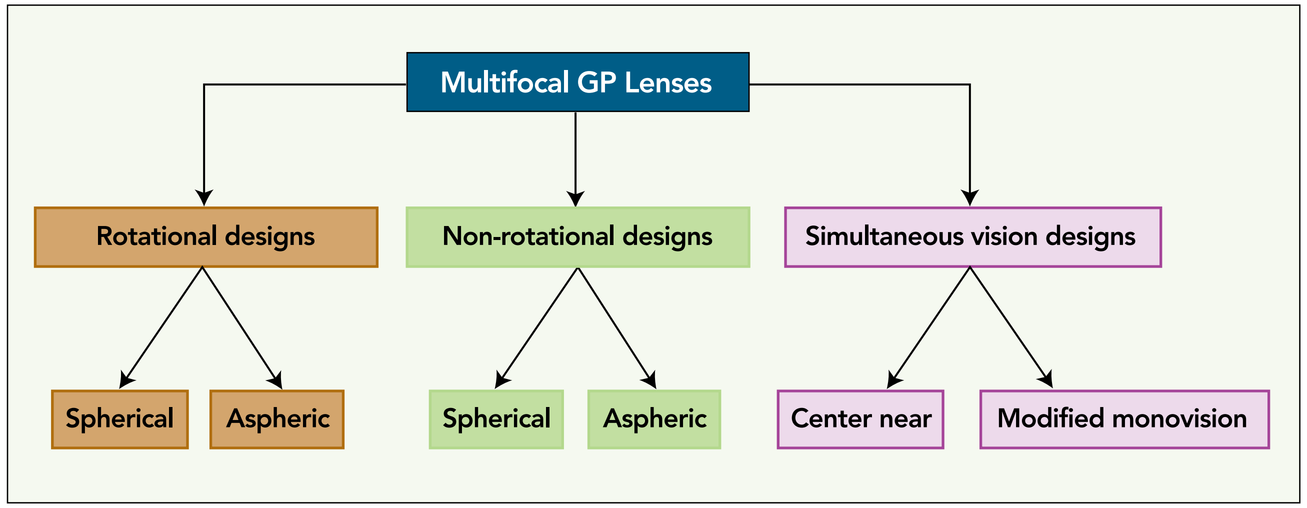
Build a relationship with your lab's consultant: He or she is your best resource when it comes to fitting designs offered by that particular lab.

Know your patient: Pay particular attention to pupil size, lid position and tonus, and visual requirements. Spend time talking to your patient about his or her visual needs.

Trust your professional judgment: Match the most appropriate lens design with your patient, modifying lens parameters to optimize performance.

Design principles

GP lenses for presbyopia fit into one of three categories: rotational, non-rotational and simultaneous designs.



> "Fitting GP multifocals can appear to be frustrating at first. But if you continue to fit the lenses, eventually things become easier and more intuitive. It is only by fitting GP multifocals that you can really learn how to fit GP multifocals."
>
> **JILL WOODS,**
> Optometrist, Canada

ROTATIONAL LENS DESIGNS

Rotational lenses are designed to keep the distance or near segments of the lens easily accessible, even when the lens rotates.

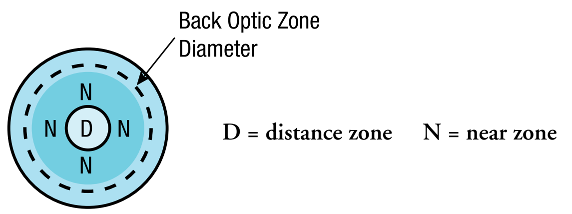


Figure 2: Spherical rotational design

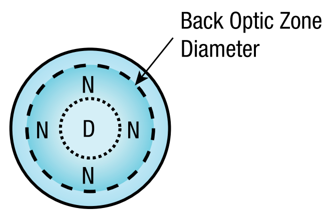


Figure 3: Aspheric rotational design

Concentric optical zones are either spherical (front or back surface) or aspheric (back surface, or on both surfaces). See figures 2 and 3 for illustrations of these designs. These allow the wearer to see distance through the center of the lens when their gaze is focused straight ahead (Figure 4a), and near vision through a surrounding annulus when their gaze shifts: usually downward: for reading (Figure 4b).

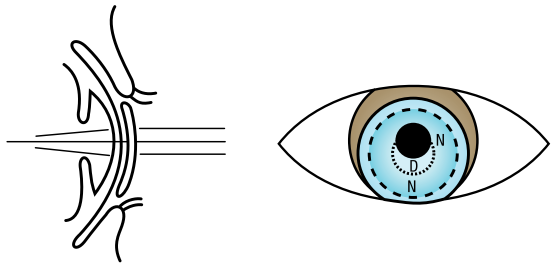


Figure 4a: Rotational design, looking straight ahead

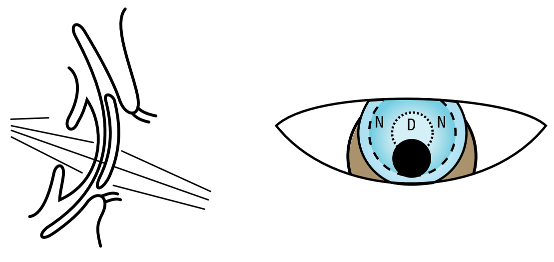


Figure 4b: Rotational design, looking downward

Rotational lenses do not require the incorporation of stabilization methods such as prism and truncation. Instead, these lenses can rotate under the influence of the blink yet still provide constant optic power for both distance and near vision tasks.

With front surface spherical designs there is normally a central distance zone surrounded by a transition zone, followed by a spherical near zone. The back surface of the lens is either a standard tricurve lens design or an aspheric design.

With back surface aspheric designs, the add power is limited in the amount that can be achieved on the back surface of the lens depending on the elliptical or hyperbolic shape that each manufacturer uses. Additional add power is achieved by changing the front surface of the lens by incorporating elliptical or spherical radii.

Example of range of parameters for spherical rotational lenses:

Lens diameter	BOZR (base curve)	BOZR (base curve)	BOZR (base curve)	Distance zone*
9.4 to 9.8mm	7.0 to 9.0mm	+20.00 to –20.00D	+1.00 to +2.50D	+1.00 to +2.50D

* the higher the add power, the smaller the distance zone

Example range of parameters for aspheric rotational lenses:

Lens diameter	BOZR (base curve)	Distance power	Add power	Distance zone*
9.4 to 9.8mm	7.0 to 9.0mm	+20.00 to –20.00D	+1.00 to +2.50D	+1.00 to +2.50D

* the smaller the distance zone, the higher the add power and the steeper the lens must be fit

NON-ROTATIONAL LENS DESIGNS

Non-rotational lenses, which resemble multifocal spectacles with a distance optic segment at the top and a near optic segment at the bottom, are designed to move vertically on the eye. See figures 5 to 9 for examples.

All non-rotational multifocal GP lenses are manufactured in the solid form as fused segmented designs are not currently available.

A trifocal design, where half of the add power is placed in the intermediate zone, can also be designed to move vertically on the eye.

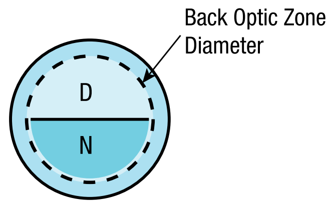


Figure 5: Straight top design, non-truncated

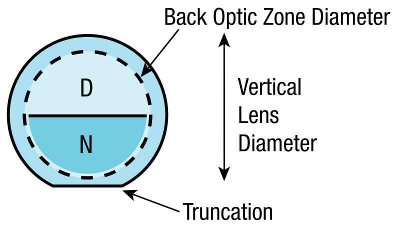


Figure 6: Straight top design, truncated

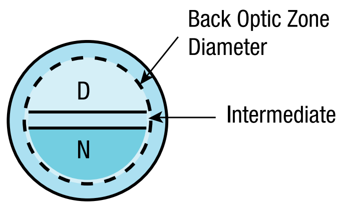


Figure 7: Trifocal design

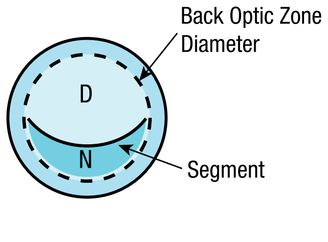


Figure 8: Crescent shape design, non-truncated

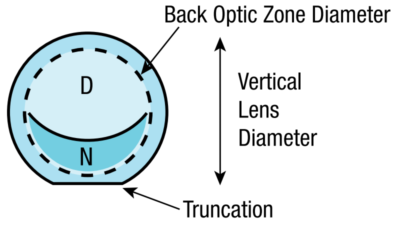


Figure 9: Crescent shape design, truncated

More accurately, non-rotational lenses are designed to allow the eye to move independently from the lens, positioning either a distance or near zone in front of the pupil depending on the direction of gaze: distance in front of the pupil with the primary (straight ahead) gaze (Figure 10a), and near in front of the pupil with the inferior (downward) gaze (Figure 10b).

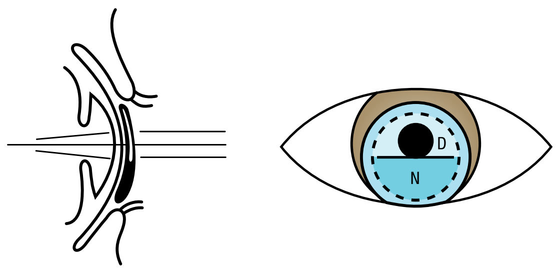


Figure 10a: Non-rotational, looking straight ahead

The natural resting point for these lenses places the distance zone in front of the pupil. As the wearer's gaze moves downward, the lower lid pushes the lens up (so that it 'translates'), aligning the pupil with the lower half of the lens containing the near power addition.

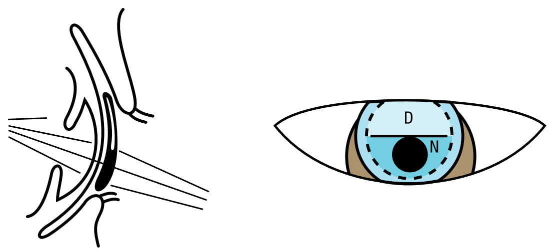


Figure 10b: Non-rotational, looking down

These designs mimic spectacles, allowing independent movement and aligning with the lower lid by incorporating a variety of stabilization techniques. Incorporating base down prism adds thickness to the lower portion of the lens, lowering the center of gravity of the lens so that it rests in a lower position on the eye. This lens profile also prevents lens rotation. Occasionally, use of base down prism alone is not sufficient to control lens rotation and position; truncating a design along the lower edge of the prism base emphasizes the effect of the base down prism by increasing the contact area between the lens edge and the lower lid.

Example range of parameters for non-rotational lenses:

Lens diameter	BOZR	Distance power	Add power	Stabilization prism	Stabilization height	Truncation
8.7 to 10.5mm	6.0 to 9.4mm	+20.00 to –20.00D	+0.75 to +4.50D	1 to 3Δ	1mm above to 2mm below the geometric center	omm 0.4 to 0.6mm

OTHER OPTIONS: SIMULTANEOUS DESIGNS

With simultaneous vision designs, both distance and near rays enter the pupil at the same time. The viewer's brain 'selects' distance or near depending on his or her visual needs.

Center-near: Centration is key, with center-near designs; the object is to provide both distance and near vision simultaneously, ensuring minimal lens movement (Figure 11). You need to achieve good centration while avoiding a fit that is too tight. Lens decentration results in vision-related symptoms, especially at night and while driving. This design is commonly used for soft lenses, but rarely for GP lenses.

Monovision: Monovision is considered simultaneous vision in that both distance and near images are presented to the wearer's brain at the same time: one eye (usually the dominant eye) is fully corrected for distance while the non-dominant eye is corrected for near. This form of correction is not considered to be truly multifocal in nature.

As with multifocal lenses, monovision requires a period of adaptation. Some patients may find vision with monovision difficult, but tolerable, because they have not been offered an alternative. As the reading addition increases, adaptation may become more difficult; patients who have unstable binocular vision may develop diplopia. Of course, those with amblyopia would not be suitable for monovision under any circumstances. Consider multifocals lenses as an option for correcting your patients' visual needs.

Modified monovision: If your patient is struggling to cope with multifocal lenses you could consider modified monovision, in which the dominant eye wears a distance-biased design (Figure 12) and the non-dominant eye wears a near-biased design. Modified monovision offers the advantages of monovision while also providing some multifocal function.

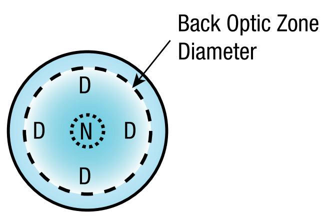


Figure 11: Center near aspheric, simultaneous design

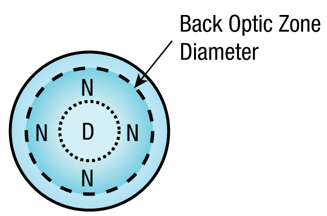


Figure 12: Center distance aspheric, simultaneous design

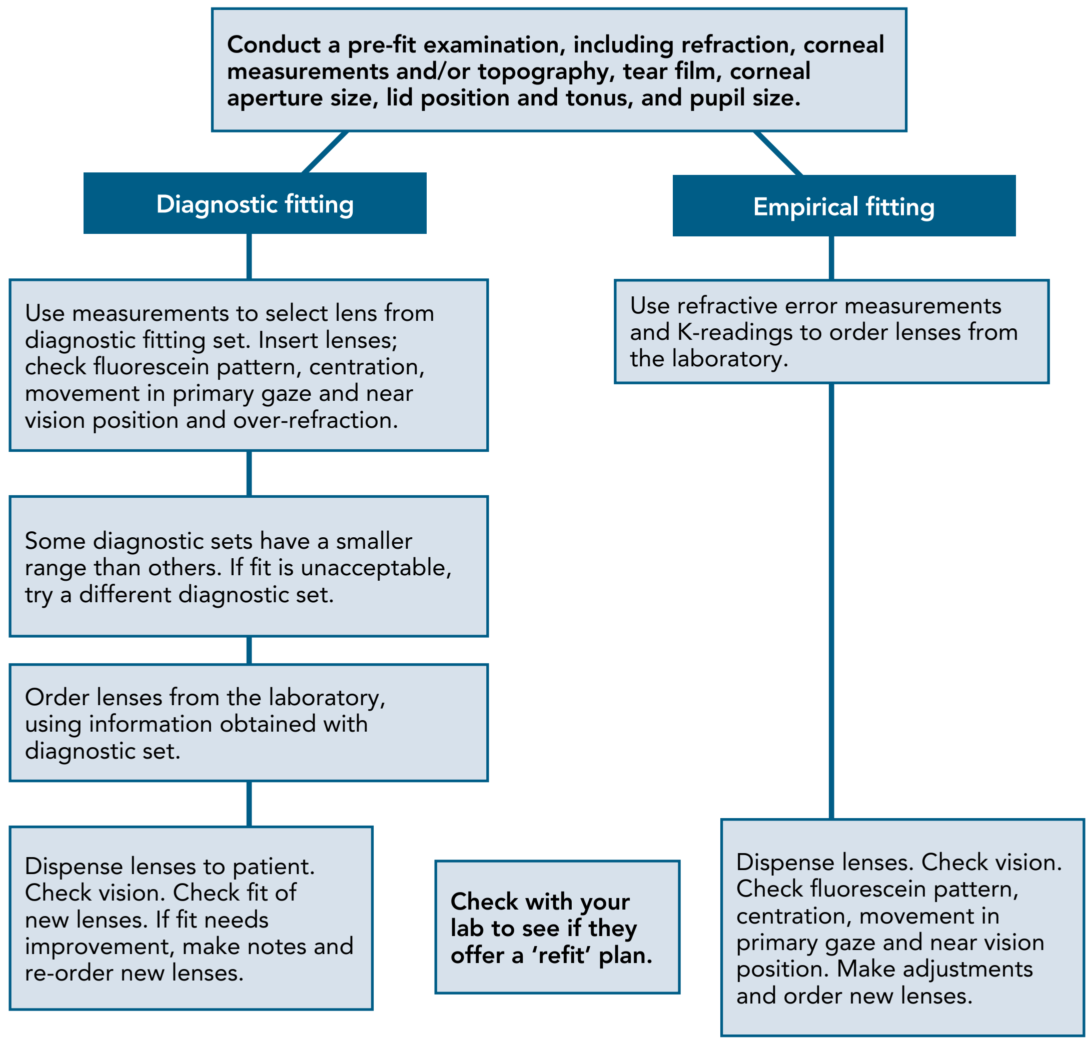
Consider the following combinations:

Modified monovision: examples of options

Dominant eye	Non-dominant eye
Rotational multifocal (center-distance)	Simultaneous multifocal (center-near)
Rotational multifocal (center-distance)	Near single vision lens
Distance single vision lens	Simultaneous multifocal (center-near)

Fitting GP multifocals: an overview

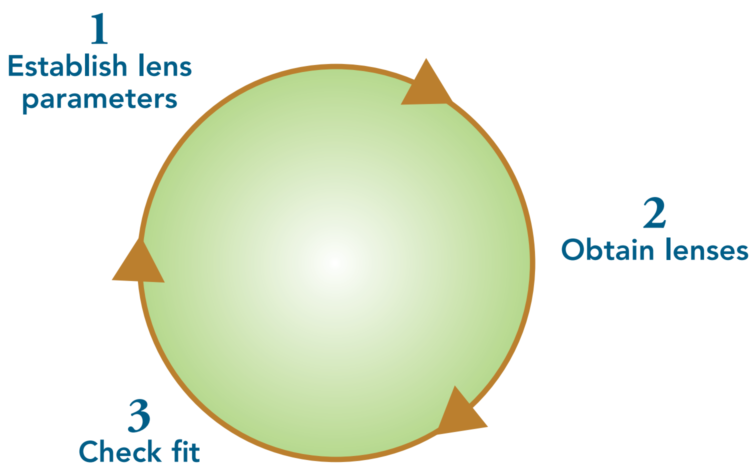
The fitting process involves a certain degree of decision-making and intuition, but the following basic roadmap provides an overview for practitioners not yet comfortable with fitting GP multifocals:



Regardless of whether you choose to follow the diagnostic route or the empirical route, when you try any lens on your patient's eye to evaluate its fit – that lens can be considered a 'diagnostic' lens. We will refer to it in this way when discussing the fitting process.

If your patient has already worn single-vision GP lenses, you may be one step ahead: it should not take long for them to adapt to GP multifocals. The patient will need instruction illustrating the ways in which multifocal lens wear is different from single vision lens wear.

Fitting GP multifocals is a somewhat cyclical process. Begin by examining the patient in order to determine initial lens parameters. Check whether the lenses fit. If they don't fit, alter the parameters. Check fit. Alter parameters. And so on.



You will need to decide whether to use diagnostic lenses or fit your patient empirically. Using a diagnostic lens may give you a head start in reaching an ideal fit. Diagnostic lens fitting is an excellent way to begin to educate the wearer on multifocal contact lens use. Be prepared to order more than one set of lenses before the fit is successful.

Take a thorough case history including:

- Previous contact lens wear
- Patient's visual expectations
- Attitude – are they apprehensive?
- Do they rely more on distance, intermediate or near vision?

Make sure you are in tune with your patient's outlook: Your approach should reflect your patient's perspective. Are they enthusiastic or wary about wearing contact lenses? Do they have realistic expectations about quality of vision and comfort with multifocals? You may need to reassure hesitant patients.

Note: Fitting GP lenses for the patient who has never worn them before

Share your thought process with your patient so that they understand your reasoning when you recommend that they try GP multifocals. Chances are, they will have heard that GP lenses take time to adapt to, so reassure them. People do wear GP lenses successfully all day, every day. Their design and material properties, which provide excellent vision and physiological health, do take some getting used to and may not be as comfortable as quickly as soft lenses.

Try using the following analogy with your patients, to highlight differences between soft and GP lenses during adaptation:

"When you buy a pair of slippers, they are instantly comfortable and do not require any adaptation. As they age, however, they become looser and make your feet hot and eventually you replace them because they are irritating. New dress shoes, on the other hand, are often uncomfortable initially. You know they fit, but your feet and shoes need to adapt to one another. Once the shoes have settled in, they are really comfortable; and the older they get, the better they feel. The same could be said of GP lenses."

Your patient's reaction to the diagnostic lens can hinder your efforts to optimize lens fit, particularly if they have never worn GP lenses before. They may be hyper: aware of the lens itself, or they may experience excess tearing – particularly if the lens fits poorly – until you succeed in optimizing the fit.

Fitting GP lenses need not be any more time: consuming than fitting a soft lens. Some practitioners consider using a topical anesthetic as part of the fitting process, but this is often not necessary. Anesthetics may reduce lens awareness, tearing and settling time, making it easier for you to assess lens fit and movement more quickly and easily.

Let your patient adapt to GP lenses once they have begun wearing the lenses that have been customized for them!

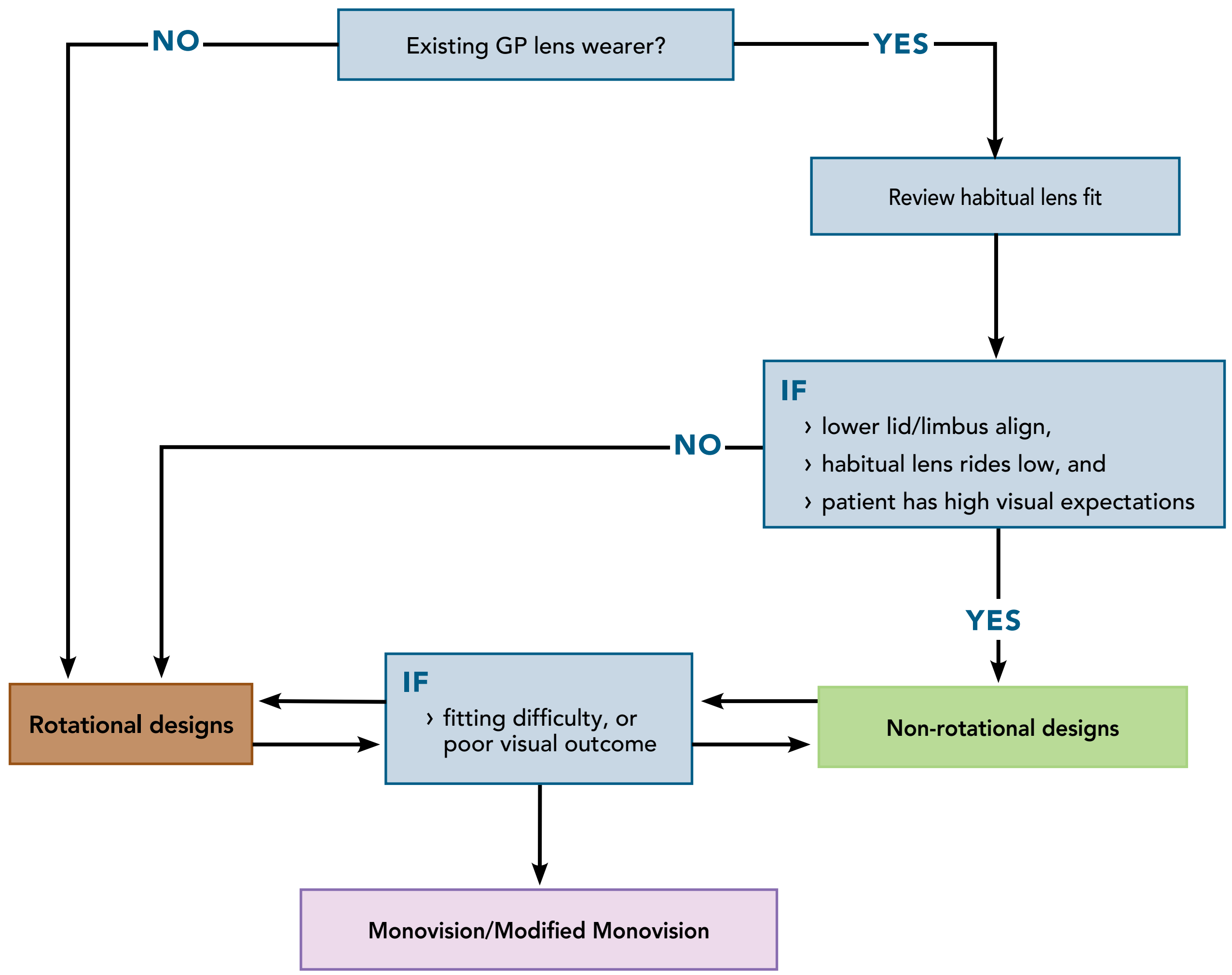
> "Soft lenses are most comfortable when first put on the eye and become less and less comfortable over time.
>
> GP lenses are least comfortable when first put on the eye, and become more and more comfortable with time."
>
> **STEPHEN BYRNES,**
> Optometrist, USA

Matching designs with patients

Regardless of whether you use a diagnostic set or fit the lenses empirically, you will refer to the same baseline measurements. Think of the process as a 'decision tree': step by step, you will make significant observations about your patient and the way the lenses fit on his or her eye. These observations will continually guide your decisions in selecting the best lens design. In particular, take into account your patient's lid tonus and pupil size. Both have significance for your choice of lens design.

» If your patient is an adapted GP lens wearer, select a design that matches the fit of his or her habitual lenses: if the habitual lenses ride high on the eye, select a rotational design with a high-riding fit requirement; if they ride consistently low, aligning with the lower lid, consider a non-rotational design.

DECISION TREE: MATCHING DESIGNS WITH PATIENTS

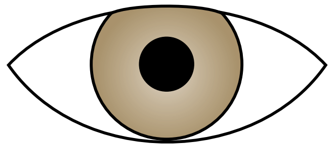


> "When it comes to discussing the type of multifocal lens that is most appropriate for a patient, always start with 'vision' as the first consideration. That is what they are here for—good vision at different distances.
>
> Secondary to assessing their visual needs are other considerations such as (initial) comfort, convenience, price, etc. Fitting multifocal GPs requires a different approach from fitting spherical contact lenses."
>
> **EEF VAN DER WORP,**
> Optometrist, Netherlands

ROTATIONAL LENS DESIGNS:

Although rotational designs still need to translate on the eye in order to support both distance and near vision, they do not need to move quite as much as non-rotational lenses due to their smaller central distance zones, so larger pupil sizes are acceptable. Your patient's lower lid can be flaccid, and does not need to be positioned at the lower limbus, because the lens does not need to translate as much – and therefore does not need to be nudged upward by the lower lid.

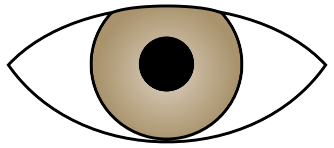
Figure 13a



Upper lid below limbus:
Facilitates lens positioning and controls centration (may be suited to a non-rotational design as well).

Palpebral aperture (PA) is up to 11.5mm

Figure 13b



Lower lid below limbus:
Lens translation would be difficult; lens may decenter inferiorly; PA is up to 12.0mm (see 'optimizing fit', page 47).

Best suited to concentric designs

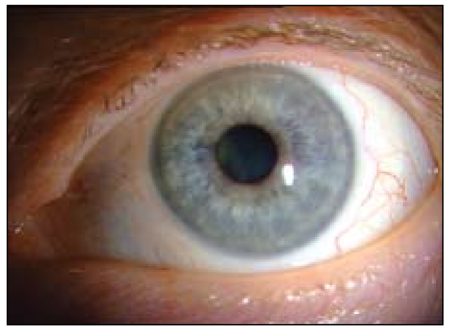
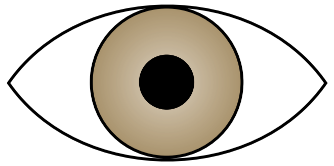


Figure 13c



Large palpebral aperture (PA):
encourages post blink blur due to excessive lens movement and provides little control of centration.

PA is over 12.5mm

Rotational designs are well-suited to:

- High myopes (these designs default to a high position)
- Hyperopes (these designs can be made thinner and lighter with lenticulation, aiding in centration)
- Steeper corneal geometries (particularly aspheric rotational designs)

NON-ROTATIONAL LENS DESIGNS:

Non-rotational lens designs must facilitate lens translation, positioning the distance segment in front of the pupil with the straight-ahead gaze and positioning the near segment in front of the pupil with down gaze.

Ideally, in the straight-ahead gaze the lower lid should allow the lens to position fairly low – but not so low that the lens crosses the inferior limbus. To facilitate this positioning, your patient's lower lid should be:

- at the lower limbus
- able to nudge the lens up, positioning the near optic in front of the pupil with the down gaze.

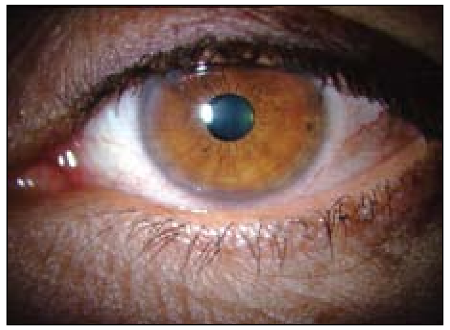
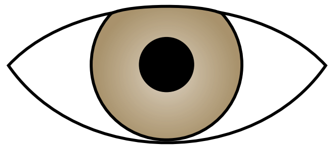
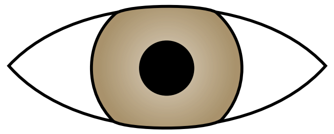


Figure 14a



Lower lid at limbus:
In this position, the lower lid is able to hold the lens in the correct position for distance vision, aiding in lens translation on downward gaze.

Figure 14b



Small PA:
Inter-palpebral fit may be difficult; the lens may ride high unless it has a smaller diameter.

PA = 9.0mm

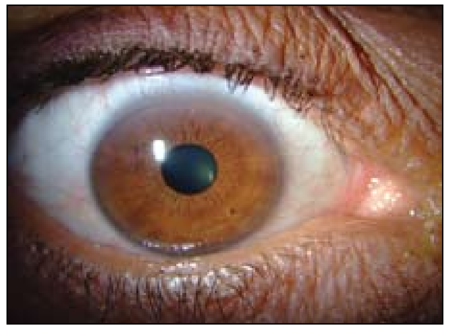
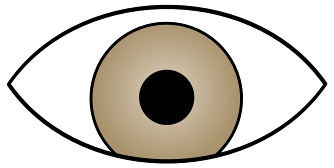


Figure 14c



Upper lid above limbus:
Inter-palpebral fit may be preferred; the upper lid is not likely to pull the lens high.

PA = 12mm

Non-rotational designs are suited to:

- Smaller pupil sizes under normal illumination
- Moderate to tight lower lid tensions, with the lower lid above the lower limbus
- Patients who would benefit from larger optical zones
- Flatter corneal topographies
- Emmetropes, who may be unable to cope with the slight distance blur that an aspheric lens may provide
- Patients with residual astigmatism with front toric designs
- Those patients that require back or bitoric lenses
- Patients with a higher add requirement (>+3.00D)
- Hyperopes; this design may require less prism, when truncated, to maintain stability – resulting in a thinner lens design that also aids in centration and increases oxygen transmission
- Patients who regularly perform exacting, close deskwork

3 Fitting rotational lens designs

in this chapter:

Fitting rotational lens designs

Fitting rotational lens designs can be a very simple process, requiring variation in only minimal lens design parameters in order to achieve the best lens performance.

If your patient is a current GP lens wearer, the transition to a multifocal rotational lens design should be simple. Remember that these designs offer intermediate vision as well as distance and near vision.

If your patient is a current GP lens wearer, observe movement of the habitual lens: a multifocal design should fit the way their single vision lens fits.

If your patient has not worn GP lenses before, consider trying a single vision GP lens to observe how it fits.

Step 1: Examine your patient to determine lens parameters

Lens diameter: Horizontal visible iris diameter (HVID) or palpebral aperture (PA) size may be used to predict the lens diameter. It is better to begin by fitting a slightly larger lens diameter to improve comfort unless the PA is excessively narrow. The tables below indicate a starting point only and may vary by design.

Palpebral aperture	Diameter
<8mm	9.0–9.3mm
8–11mm	9.4–9.6mm
>11mm	9.7–10.0mm

Horizontal visible iris diameter (HVID)	Diameter
10–11mm	9.0–9.3mm
11.5–12.5mm	9.4–9.6mm
>12.5mm	9.7–10.0mm

Back optical zone radius (BOZR or base curve): Use corneal topography/keratometry (K) readings to choose the proper lens BOZR as per the manufacturer's instructions.

For front surface spherical rotational designs, the back surface is normally a tricurve design and the back optic zone radius is fit to achieve an alignment fitting relationship. This may be achieved by using the following table when the lens has a back optic zone diameter between 7.8mm and 8.2mm.

Corneal astigmatism	BOZR
Up to 1.00D	On flat K
1.25 to 2.00D	1/4 difference between K-readings + Flat K
>2.00D	Consider a toric design

For the back surface aspheric rotational designs, this measurement may be steeper than flat K by approximately 0.15mm to 0.80mm depending on the amount of add power needed (steeper for higher adds) and the shape of the aspheric curve used to induce the reading addition on the back surface of the lens. The degree to which the lens BOZR requires steepening will depend on each design's fitting guide.

Distance power: Calculate the distance power, compensating for the tear lens that was created by fitting the BOZR steeper than the flat K-readings. Remember: 0.25D for every 0.05mm change of BOZR.

Near power: Near power generation occurs on the front surface of spherical rotational lens designs: add powers ranging from +1.00 to +2.50 are usually feasible. Whereas, near power generation occurs on the back surface of aspheric rotational lens designs; generally up to +1.75D reading addition is feasible. If a patient needs a higher near power, additional reading addition is generated on the front surface of the lens. Contact your lab fitting consultant for design advice.

Step 2: Obtain lenses that match those parameters

Choose a diagnostic lens with measurements as close to your patient's BOZR, calculated power, near (reading) add and diameter as possible. Insert the lens and let it settle.

OR

If you prefer to fit the lenses empirically, order them from the laboratory. Remember, the lab will need:

- Spectacle refraction, including reading addition and vertex distance
- K-readings
- HVID

Remember: your lab's consultant is an important resource.

Step 3: Assessing lens fit

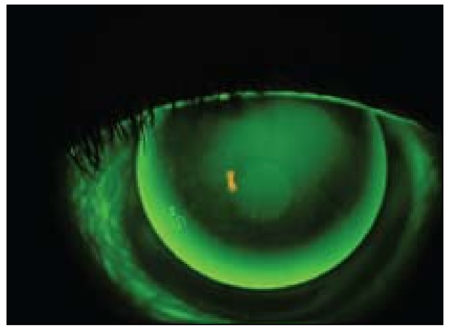


Figure 15: Ideal fit, rotational aspheric lens

Whether the lens is from a diagnostic lens set or sent by the lab, the following needs to be reviewed:

Lens centration and diameter: Ensure that the lens is positioned according to design requirements. Some designs work best with lid attachment, for example, which necessitates a larger diameter.

Lens movement with the blink: 1.0–2.0mm of lens movement is ideal. Larger lenses tend to move less, smaller lenses more.

Fluorescein pattern: For the spherical rotational lens, the lens should also be centered and an aligned fluorescein pattern should appear centrally with optimal edge clearance: 0.5mm in width (see Figure 26 on page 43). For the aspheric rotational lens, the lens should be centered or slightly high riding, with some central pooling and a wide band of peripheral edge clearance (see Figure 25 on page 43).

Accuracy of lens prescription: Using handheld lenses, determine whether the prescription is correct by performing a binocular over-refraction at distance and then at near, with the patient holding reading material that is of the same size as their current visual needs and under normal illumination.

The position of the diagnostic contact lens on the eye impacts its performance. To assess near vision, the lens should be positioned for near work, i.e., the person must be looking downward in their habitual reading position instead of an artificial head position as they would with a phoropter or a trial lens frame.

Step 4: Determine whether parameter and/or Rx changes are necessary.

Specific design changes are discussed later.

Case Study 1: Spherical rotational lenses

Patient M.P., aged 55, was recently fit with his second pair of progressive spectacles to help with reading. He was interested in contact lenses but wanted clear distance as well as near vision.

This case presented ideal conditions for fitting spherical rotational design lenses. Visual needs included driving, as well as computer work and reading books. History (ocular, personal and family) was negative. No medications.

Ocular findings:
HVID: 11.5mm, PA = 10mm, PS (pupil size in mesopic conditions) = 5.0mm
Tear Break Up Time (TBUT): 12 sec. (OU)

Lower eyelid slightly below the limbus. Lid tension strong. No unusual slit lamp findings. In this example the patient has the same K-readings and prescription in both eyes.

Keratometry:	Flat K:	Steep K:	Corneal Astigmatism:
	42.50D (7.94mm) @ 180	44.00D (7.67mm) @ 090	1.50 x 180

To convert millimeters (mm) to diopters (D), use the following formula:

$$\frac{337.5}{\text{mm or}} = \text{D or mm}$$

(See appendix B: Keratometer readings conversion chart)

Subjective refraction (VD = 12mm): –3.00/–1.50 x 003 6/6 or 20/20 Add = +2.00

This patient was fit using a diagnostic lens set:

1 We estimated lens parameters

a) **Total diameter (TD):** As the patient was not a habitual GP lens wearer, we based our TD calculations on HVID (since PA is not excessively small, in this case). HVID of 11.5mm = TD of 9.4 to 9.6mm. We used a 9.6mm diagnostic set with a back optic zone diameter of 8.2mm.

b) **BOZR:** For a Flat K = 42.50D (7.94mm) and corneal astigmatism = 1.50 x 180 refer to chart on Page 32.

Refer to TD and BOZR of habitual spherical GP lens, where possible. Our patient is a non-wearer.

BOZR = (1/4 corneal astigmatism (D) + Flat K (D))
That is, 1/4 (1.50) + (42.50) = 42.89D (≈ 43.00D or 7.85mm)
Calculated BOZR = 7.85mm

c) **Distance power (BVP) = ocular sphere + correction for the tear lens**
Step 1: Ocular refraction sphere:
–3.00D

Step 2: Tear lens: BOZR(D) – Flat K = Tear lens
43.00–42.50 = +0.50D (0.10mm)
Correct plus tear layer with a minus correction.

d) **Expected Final BVP**
BVP = Trial Lens Power + Correction for Tear lens
BVP = –3.00 + (–0.50) = –3.50D

2 **We selected the diagnostic lens most closely matching the estimated parameters**
BOZR: 7.85 TD: 9.60 BVP: –3.00 Add: +2.00

3 **We checked the fit of the diagnostic lens**
After the lenses had settled, the fit provided good centration and the following over-refraction:
–0.50D = 20/20 and N4, J1 @ 40cm
Distance and near acuities were checked monocularly and binocularly, under good lighting.

4 **Final lenses ordered**
Final prescription: BOZR: 7.85 TD: 9.60 BVP: –3.50 Add +2.00

Lenses were ordered in a high-Dk material to optimize physiological health. When the lenses were dispensed to the patient, fit and visual performance matched those found with the diagnostic lenses. **A two-week follow up visit showed excellent results.**

To fit these spherical lenses empirically:

Provide the lab with the following information:

- **HVID for the TD determination:** TD will be decided based on HVID by the lab.
- **K-readings for BOZR determination:** Lab will choose the BOZR based on flat K and the amount of corneal astigmatism present.
- **Spectacle Rx and VD for CL power:** From the sphere of the vertexed Rx that you send, the lab will adjust the sphere to correct for the tear layer created by the lens/cornea relationship.
- **Add power:** Lab will choose the lens design with add power matching your patient's needs.

Case Study 2: Aspheric rotational lenses

Patient G.S., aged 45, was recently fit with a pair of progressive spectacles to help with reading. When she used her GP contact lenses she found reading was not as clear as her new spectacles. She did not want a second pair of spectacles to wear over her contact lenses for reading.

This case presented ideal conditions for fitting aspheric rotational design lenses. The patient was an adapted lens wearer with a relatively low add and high motivation. Visual needs included computer work and reading books. History (ocular, personal and family) was negative, with no history of excessive dryness with contact lens wear. No medications.

Ocular findings:

HVID: 11.5mm, PA = 10mm, PS (pupil size in mesopic conditions) = 5.0mm
TBUT: 12 sec. (OU)

Lower eyelid slightly below the limbus. Lid tension strong. No unusual slit lamp findings. In this example the patient has the same K-readings and prescription in both eyes.

Keratometry:	Flat K:	Steep K:	Corneal Astigmatism:
	42.50D (7.94mm) @ 180	44.00D (7.67mm) @ 090	1.50 x 180

To convert millimeters (mm) to diopters (D), use the following formula:

$\frac{337.5}{\text{mm or}}$ = D or mm (See appendix B: Keratometer readings conversion chart)

Subjective refraction (VD = 12mm): –3.00/–1.50 x 003 6/6 or 20/20 Add = +1.50

This patient was fit using an aspheric rotational diagnostic lens set:

1 We estimated lens parameters

a) Total diameter (TD): As the patient was a habitual GP lens wearer, we based our TD on her current lenses, TD = 9.6mm. We used a 9.6mm diagnostic set.

b) BOZR: Flat K = 42.50D (7.94mm) and corneal astigmatism = 1.50 x 180

Step 1: Initial BOZR

Refer to TD and BOZR of current spherical GP lens, where possible.

Her current lenses have a BOZR of: 43.00D (or 7.85mm)

Step 2: Final compensated aspheric rotational multifocal BOZR: according to the manufacturer's instructions the lenses are fit 2.00D (0.35mm) steeper.
43.00 + 2.00D = 45.00D (7.50mm)

c) Distance power (BVP) = ocular sphere + correction for the tear lens

Step 1: Ocular refraction sphere:
–3.00D

Step 2: Tear lens: BOZR(D) : Flat K(D) = Tear lens
45.00–42.50 = +2.50D (0.50mm)
Correct plus tear layer with a minus correction.

Step 3: Final BVP: Trial Lens Power + Correction for Tear Layer = BVP
BVP = –3.00 + (–2.50) = –5.50D

2 We selected the diagnostic lens most closely matching the estimated parameters

BOZR: 7.50 TD: 9.60 BVP: –3.00 Add: +1.50

3 We checked the fit of the diagnostic lens

After the lenses had settled, the fit provided good centration, the expected fluorescein pattern, minimal movement and the following over-refraction:
–2.50D = 20/20 and N4, J1 @ 40cm

Distance and near acuities were checked monocularly and binocularly, under good lighting.

4 Final lenses ordered

Final prescription: BOZR: 7.50 TD: 9.60 BVP: –5.50 Add: +1.50

Lenses were ordered in a high: Dk material to optimize physiological health. When the lenses were dispensed to the patient, fit and visual performance matched those found with the diagnostic lenses. **A two-week follow-up visit showed excellent results.**

To fit these aspheric lenses empirically:

Provide the lab with the following information:

- **HVID for the TD determination:** TD will be same as current lens, since the patient is a lens wearer.
- **K-readings for BOZR determination:** Lab will choose the BOZR steeper than flat K depending on the required add and the amount of corneal astigmatism present.
- **Spectacle Rx and VD for CL power:** From the sphere of the vertexed Rx that you send the lab will adjust the sphere to correct for the tear layer created by the lens/cornea relationship.
- **Add power:** Lab will choose the lens design with add power matching your patient's needs.

EVALUATING THE FIT OF ROTATIONAL LENS DESIGNS

The following section addresses:

- Lens centration
- Lens movement
- Lens translation
- Fluorescein pattern
- Visual performance

Question 1: Is the lens centered?

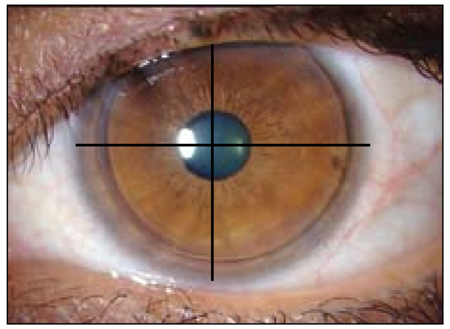


Figure 16:
Well-centered rotational lens

What should it look like?

The lens should be centered or slightly high: riding (Figure 16).

How do I check it?

Ask the patient to blink. Wait a second or two, to see where the lens settles.

Centration is relative to the center of the pupil. Imagine a cross-hair through the center of the pupil. Repeat the blink a few times to determine consistency of centration.

How can I fix it?

Centration can be optimized by altering the following parameters:

Lens diameter: A larger diameter will center the lens better. Compare figures 17a and 17b.

BOZR: A steeper lens will center better, but steepening a lens fit will reduce movement.

Figure 17a:
Smaller lens–decentered

Figure 17b:
Larger lens–centered

Lenticulation: A minus carrier will encourage the upper eyelid to pull the lens into a slightly superior or more centered position.

Axial edge lift: For spherical rotational lenses, adjust the axial edge clearance–if excessive or insufficient–by changing the edge lift (as you would normally do with any tricurve lens) once the central alignment pattern is achieved. However, with aspheric rotational lenses, increases in the add power reduces the optic zone diameter, which affects the fluorescein pattern and results in a looser fit with a higher edge clearance. The axial edge clearance can be controlled by steepening or flattening the BOZR.

Question 2: Is the lens moving well?

Rotational lenses need to move freely on the eye, as do all contact lenses. This movement promotes tear exchange behind the lens and is in part to facilitate translation from distance to near vision.

What should I look for?

With primary gaze, you should be able to see the lens move 1.0–1.5mm after each blink (less than average for a non: presbyopic GP).

How do I check it?

Using a slit lamp, set a narrow slit of light to a height of 2.0mm. Align it with the bottom edge of the lens, with the illumination and viewing system in line. Have the patient blink, and assess the amount of movement in relation to the line. The white bar represents the slit of light in figures 18a to 18c.

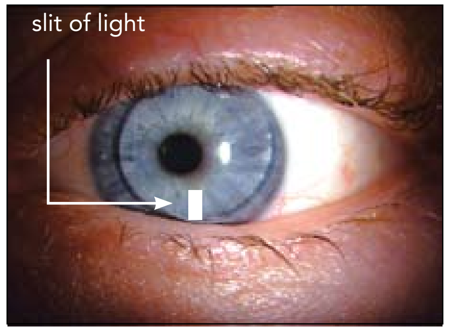


Figure 18a:
Before blink set the 2mm slit of light at the lower lens edge

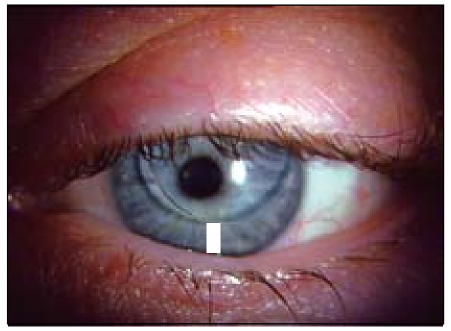


Figure 18b:
Immediately after blink, before lens settles in normal position, compare the amount of lens movement to the known height of the slit of light

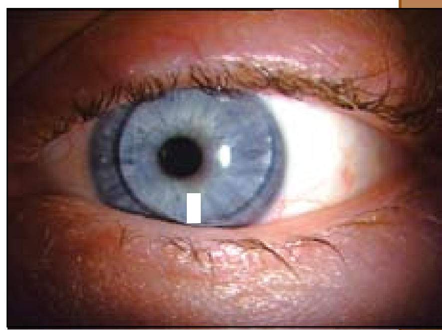


Figure 18c:
After lens settles

How can I fix it?

Instill fluorescein and assess movement and fluorescein pattern:

- If movement is insufficient, lens may be too steep > flatten BOZR or reduce TD
- If movement is excessive, lens may be too flat > steepen BOZR or increase TD

Question 3: Does the lens translate with downward gaze?

Rotational lenses must translate (move vertically) slightly when the wearer shifts between straight-ahead and downward gaze.

What should I look for?

The lens should translate upward by 1–2mm w hen the patient shifts from straight-ahead to down gaze.

How do I check it?

It is difficult to view the contact lens when your patient is looking down.

Hold the upper lid up as the patient looks down. If the lens has adequate room for translation, it should cross the upper limbus. Use your direct ophthalmoscope or retinoscope to illuminate the lens to see if the lower edge of the lens has been pushed up by the lower lid, i.e., translates, so that the patient is viewing through the near zone. (Figure 19a)

Alternatively, place a small (2.5 x 1.5mm) rectangular mirror between your patient's cheek and lower eyelid. Tilt the mirror while he or she is looking down until the mirror reflects the eye and lens (Figure 19b).

Figure 19a: View of lens in downward gaze with upper lid held up

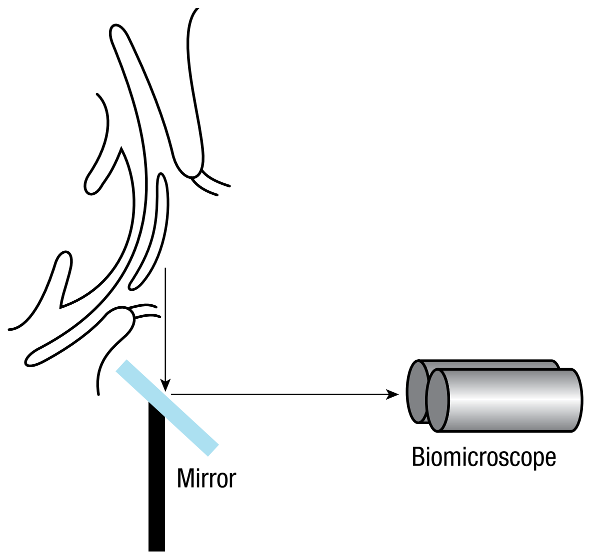


Figure 19b:
Set-up to view lens in downward gaze

What should it look like?

The proper lens portion should be in front of the pupil, as can be seen in Figures 20 and 21.

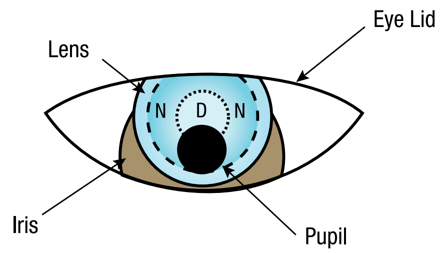


Figure 20: Aspheric rotational design – lens translates up on down gaze

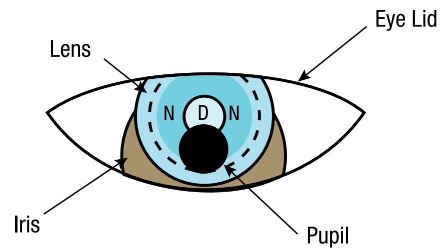


Figure 21: Spherical rotational design – lens translates up on down gaze

How can I fix it?

With spherical and aspheric rotational lenses, if the lens slips under the lower lid, it is either too steep or does not have sufficient edge clearance (Figures 22 and 23). Review the fit. If it appears steep, consider flattening the BOZR.

With spherical rotational lenses only, if the central fit is optimal and the lens is positioning low, increase edge clearance by:

- Flattening the secondary/peripheral radii
- Increasing the axial edge lift by increasing the secondary/peripheral width/diameter
- Reducing the BOZD (adjust BOZR to maintain the equivalent fit)

Similarly, if the lens rides too high, preventing translation, it is either too flat or has too much edge clearance. Review the fit. If it appears flat, consider steepening the BOZR.

With spherical rotational lenses only, if the central fit is optimal and the lens is positioning high, reduce the edge clearance by:

- Steepening the secondary/peripheral radii
- Reducing the axial edge lift by decreasing the secondary/peripheral width/diameter
- Increasing the BOZD (adjust the BOZR to keep the equivalent fit)

For spherical rotational designs:

If you increase the BOZD by 0.3mm you must also flatten the BOZR by 0.05mm (or steepen it by the same amount, if you decrease the BOZD), in order to maintain the equivalent fit (i.e., to maintain the initial sagittal height of the lens).

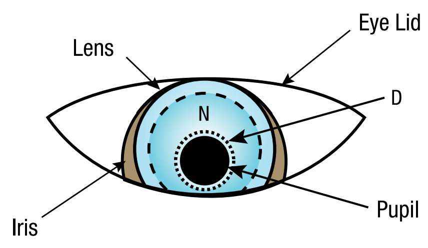


Figure 22: Aspheric lens does not translate up in down gaze, lipping under lid

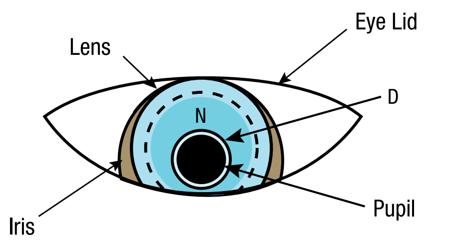


Figure 23: Spherical lens does not translate up in down gaze, slipping under lid

Poor reading position on downward gaze–lower edge of lens slipping under the lower lid

Question 4: What does the fluorescein pattern look like?

Fluorescein pattern is indicative of the BOZR-cornea relationship, which determines lens position, translation, movement and comfort as well as segment position.

What should I look for?

For aspheric rotational designs, look for a steep fluorescein pattern centrally, with slight mid-peripheral bearing and peripheral clearance 0.5–0.7mm wide (see Figure 25). For spherical rotational designs, look for an aligned central fluorescein pattern (see Figure 26).

How do I check it?

Instill fluorescein. Use a slit lamp with cobalt blue filter to view the lens fit using a wide slit beam and a yellow filter, such as a Wratten filter #12, to enhance the fluorescence of the image seen. View the static fluorescein pattern in the lens' natural resting position. Additionally, keep the lens mobile by having the patient blink (dynamic fluorescein pattern) and nudging the lens into a centered position with the lower lid (static fluorescein pattern).

Figure 24:
Boston™ slit lamp filter

Placing a yellow filter, such as a Wratten filter #12, in front of the observation system of the slit lamp will allow you to see much greater detail in the fluorescein pattern. These filters are available from your manufacturing laboratory.

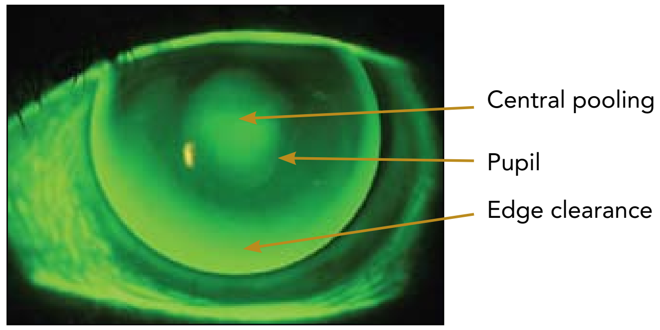


Figure 25:
Aspheric rotational design– ideal pattern

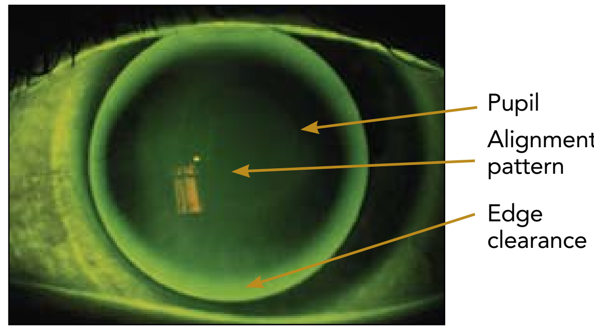


Figure 26:
Spherical rotational design– ideal pattern

How do I fix it?

The aspheric designs require clearance in the optical zone. If the lens fit appears to be generating central corneal touch, the fit needs to be steepened (Figure 27).

- Decrease the BOZR
- Increase the BOZD if possible

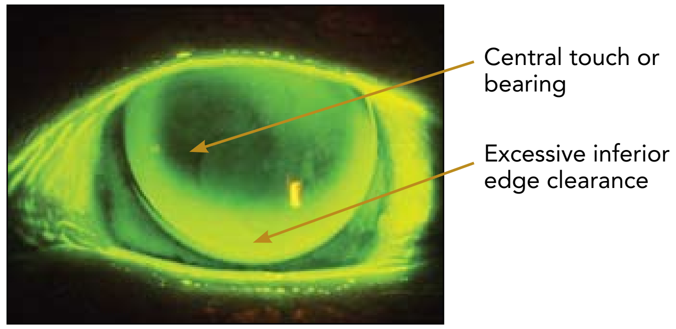


Figure 27:
Aspheric rotational design– too flat

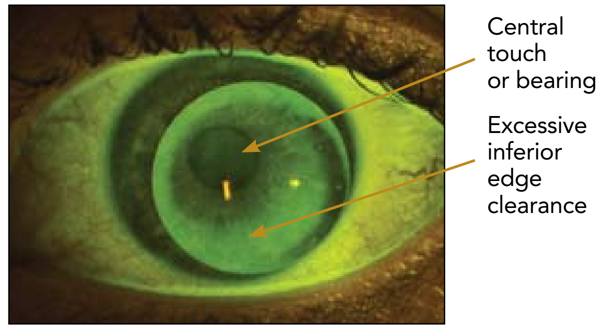


Figure 28:
Spherical rotational design–too flat

The spherical lens designs require an alignment of the fluorescein pattern to insure centration and minimal movement. If the lens fit appears to be generating central corneal touch, the fit needs to be steepened (Figure 28).

- Decrease the BOZR
- Increase the BOZD

Once the central fit is optimal, ensure that there is sufficient edge clearance to allow lens translation (see page 41 to review edge clearance).

Steepening BOZR will improve centration and reduce lens movement. Flattening the fit will increase translation, but aspheric rotational designs require a stable tear film to provide the optical powers to create the multifocal effect. Over-flattening can minimize the optical performance of this lens design.

Question 5: How good is the patient's vision?

If the distance and near prescriptions are correct and your patient is still having trouble seeing, there is likely a problem with one of the other fitting factors.

Remember that these designs offer intermediate vision within the transition zone from the distance to the near prescription, as well as distance and near vision!

What should I look for?

The over-refraction should be minimal, with minimal cylinder correction for both distance and near.

How do I check it?

Perform the binocular over-refraction with hand: held diagnostic lenses in free space at both distances or use flippers with +/–0.50D lenses. Remember, a + 1.00D lens should blur to 20/40 (6/12).

Remember to note the over-refraction and acuities for distance and near.

How do I fix it?

If the over-refraction is significantly different, incorporate the new findings into the lens prescription.

If visual acuity is still poor and no over: correction improves it, check lens fit and ensure that the lenses are not positioned incorrectly on the eye as seen in figures 29 and 30 where the lenses are too steep. Figures 31 and 32 are too flat and decentered.

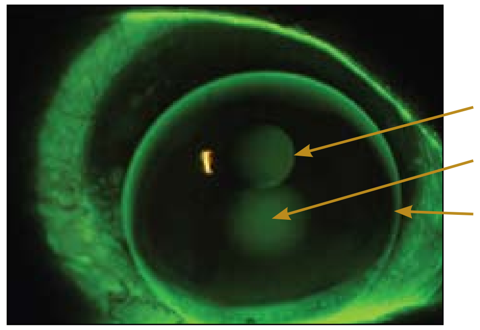


Figure 29: Aspheric rotational design, too steep

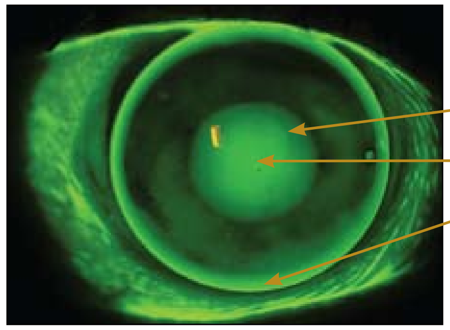


Figure 30: Spherical rotational design,too steep

Lens positions too low. On down gaze the lower edge of the lens slips under the lower lid thus near vision will be poor. Improve lens translation and centration to improve the near vision rather than simply increasing the add. The same would apply for the spherical rotational lens design.

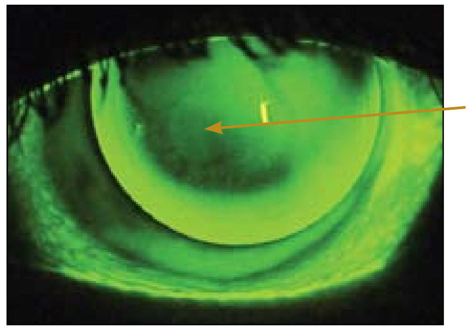


Figure 31: Aspheric rotational design, too flat

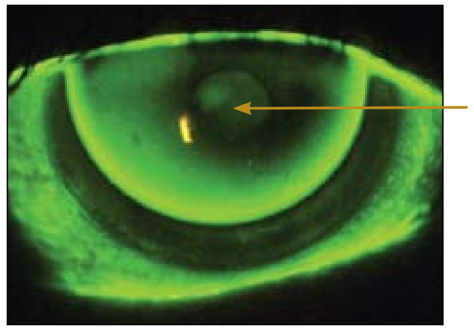


Figure 32: Spherical rotational design, too flat

Lens is superiorly decentered. On straight-ahead gaze patient is looking through the intermediate portion of the lens, causing blurry distance vision and a minus over-refraction. If more minus is prescribed, the distance vision will improve but the near vision will be compromised. Address the excessive superior lens decentration rather than over-minusing the patient. This also applies to the spherical rotational design.

- For spherical rotational lens designs, any increase in the reading addition results in a smaller distance portion and a larger intermediate and near portion of the lens. But, since this occurs on the front surface of the lens, no change in lens fit results.
- Correct any lens decentration by improving the base curve/cornea relationship or by changing the lens and optic zone diameter.

- For aspheric rotational designs, any increase in reading addition results in a change in lens fit due to a decrease in the distance optic zone of the lens. The smaller optic zone causes a looser fitting lens thus steepening the base curve will be necessary to compensate. In larger pupils, the reduced distance optical zone can impact distance vision; however, reading addition usually increases with age, while pupil size decreases.
- Lens decentration results in visual symptoms, particularly at night and while driving.
- To increase the effect of the reading portion, decrease the distance optical zone.

Suggested starting points for front surface spherical rotational lens parameters:

Lens parameter	Starting point	Clinically significant change
BOZR	On flat K or steeper than flattest K-reading depending on the amount of corneal astigmatism	0.05mm
BOZD	Starting point is influenced by lens diameter, use average amount to allow for pupil dilation (7.8 to 8.4mm)	0.10mm
Lens diameter	Usually between 9.2–10.4mm	0.30mm

Suggested starting points for back surface aspheric rotational lens parameters:

Lens parameter	Starting point	Clinically significant change
BOZR	Steeper than flattest K-reading from 0.75D to 4.00D (0.15 to 0.8mm), depending on the lens design used	0.05mm
BOZD	Starting point is influenced by design. Increasing this diameter reduces the effectiveness of the near addition of the lens	0.30mm
Lens diameter	Usually between 9–10mm	0.30mm

Changes in parameters and impact on fit:

Lens parameter	EFFECT ON FIT Increase	Decrease
BOZR	Flattens the fit Increases lens movement Increases lens decentration Decreases lens translation	Steepens the fit Decreases lens movement Improves lens centration Increases lens translation
BOZD	Steepens the fit Decreases lens movement Improves lens centration Decreases translation	Flattens the fit Increases lens movement Increases lens decentration Increases translation
Lens diameter	Decreases movement Improves centration	Increases movement Increases decentration
Axial edge lift	Increases edge clearance Aids lens translation	Decreases edge clearance Decreases translation

OPTIMIZING THE FIT OF ROTATIONAL LENS DESIGNS

Suggested starting points for front surface spherical rotational lens parameters:

Patient concern	Diagnosis	Solutions
"I have to hold reading material in an awkward position."	Reading segment does not translate to a high enough position. Reading area is too narrow (a recognized limitation of rotational lenses).	Flatten BOZR, increase edge clearance or reduce BOZD. Increase area of near zone size. Refit with non-rotational lens design OR single vision lenses plus reading glasses.
"I have poor distance vision."	Lens is not centered Insufficient apical clearance or too flat for aspheric designs. Central touch with spherical lens designs.	Fit of lens is most likely flat, so steepen BOZR or increase BOZD or consider a larger lens.
"My distance vision gets worse at night."	Enlarged pupil size in low light positions near vision zone in front of the pupil competing with distance zone, distorting vision.	Increase central distance zone diameter.
"I have poor vision with my spectacles after removing my lenses."	The lens fit may be inducing corneal moulding, which results in spectacle blur.	The fit of the lens may be too steep, so flatten the BOZR.

4 Fitting non-rotational lens designs

in this chapter:

- Fitting non-rotational lens designs
- Case studies

Fitting non-rotational lens designs

Fitting non-rotational lenses can be more complex than fitting rotational lenses, as more parameters can be varied to optimize the fit and visual performance.

Step 1: Determine lens parameters

Your pre-fit examination should gather measurements for:

Lens diameter: The HVID or palpebral aperture (PA) size may be used to predict the lens diameter. When given the choice, have a preference toward a slightly larger lens diameter to improve comfort unless the PA is excessively narrow.

Example

Palpebral aperture	Diameter
<8mm	9.0–9.3mm
8–11mm	9.4–9.6mm
>11mm	9.7–10.0mm

Horizontal visible iris diameter	Diameter
10–11mm	9.0–9.3mm
11.5–12.5mm	9.4–9.6mm
>12.5mm	9.7–10.0mm

BOZR: The BOZR should facilitate an aligned fit; if the cornea is spherical, start with a BOZR that is equal to the flattest central K-reading. Remember to steepen the BOZR with increase in corneal astigmatism:

Example

Corneal astigmatism	BOZR*
Up to 1.00D	On flat K
1.25 to 2.00D	1/4 difference between K-readings + Flat K
>2.00D	Consider a toric design

* **Note:** This is a guide for average (7.8 to 8.2mm) BOZDs; if the design you are using has a smaller BOZD, steepen the BOZR by 0.25D or 0.05mm; if it is larger, flatten the BOZR by 0.25D or 0.05mm.

» Corneal shape is another feature that may affect lens decentration. Correct a decentered corneal apex by using a larger lens design.

Figure 33: Measuring lens segment height using a graticule

Segment height: Measure the distance from the lower lens edge or lower lid (where lens should be positioned in primary gaze) to the bottom of the pupil margin. Alternatively, segment height should be 1mm below the geometric center of the lens.

Prism stabilization: For a minus prescription, start with a prism of 1Δ; for a plus prescription, start with a prism of $1\frac{1}{2}\Delta$ if truncation is not present.

Prism axis: If there is significant lid: lens interaction, start with the prism axis along 90°. If you see nasal rotation of 5° to 10°, offset the prism axis clockwise in the right eye and counter: clockwise in the left eye, that is, to 95° or 100°. Be aware that some designs may automatically incorporate an offset in the prism axis. Ask your consultant for the specifics of the lens design you are using.

If the position of the inferior prism marking is rotated to your (i.e., the practitioner's) left, add the same degree of rotation to the prism axis. If it has rotated to the right, subtract the same degree of rotation from the prism axis. This is the LARS principle (Figure 34).

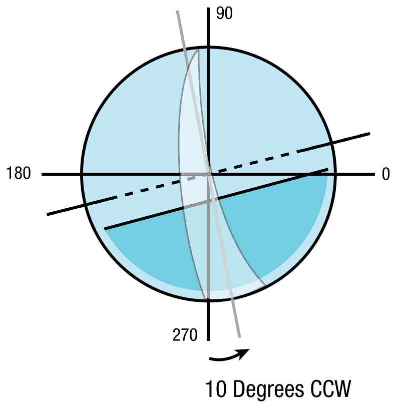


Figure 34: Left rotation–add. Right rotation–subtract

Distance power: With a diagnostic lens, determine distance power by performing a binocular over-refraction; otherwise, calculate distance power by considering both the ocular spherical power and the tear layer created by the lens-to-cornea relationship.

Near power: With the distance over-refraction in place, perform an over-refraction to optimize the near vision, remembering to add the additional power to the reading addition. Also, ensure that the patient's head is tilted slightly downward with eyes set at a down gaze, to ensure that the lens translates upward: the head should not be bent forward with eyes looking straight ahead. Have the patient hold reading material at a comfortable distance, with normal room illumination.

Truncation: If the lens does not translate, truncation may be necessary to stop the bottom lid from sliding over the inferior portion of the lens (Figures 35 and 36).

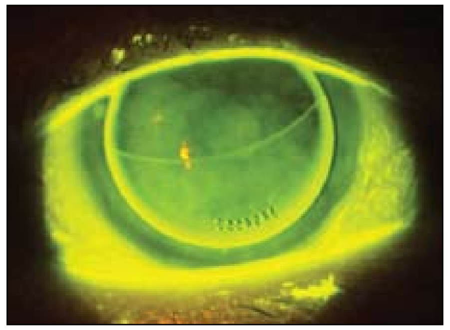


Figure 35: Non-rotational design–non-truncated

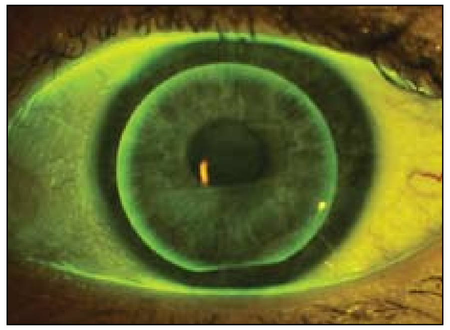


Figure 36: Non-rotational design–truncated

Remember: your lab's consultant is an important resource.

Step 2: Order the lenses

Refer to the parameters of the lenses that provided the best fit and vision during the diagnostic fitting. Minimally, the lab needs:

- BOZR
- BOZD (may be a stock parameter)
- TD
- BVP
- Add power
- Segment height
- Prism amount and axis

If you have chosen to order lenses without using a diagnostic set (i.e., empirical fitting), the lab needs:

- Spectacle prescription (vertex distance, when needed)
- Keratometry results
- HVID and palpebral aperture size
- Pupil height from lower lid in primary gaze (lab: dependent)

Step 3: How well does the lens fit? Assessing the ordered lens

Check:

- **Lens centration and diameter:** Ensure that the lens is well centered or slightly low
- **Lens movement with the blink:** 1 to 2mm of lens movement
- **Lens translation on down gaze:** 2mm of lens translation to enable the near segment of the lens to translate over the pupil
- **Lens rotation:** Usually 5–10° and usually nasal for both distance and near gaze
- **Near segment location:** The top of the near segment should be positioned at or just above the lower pupil margin
- **Fluorescein pattern:** An aligned fluorescein pattern is indicative of lens centration, lens translation and movement
- **Distance/near vision:** Optimal distance and near acuities at comfortable working distances

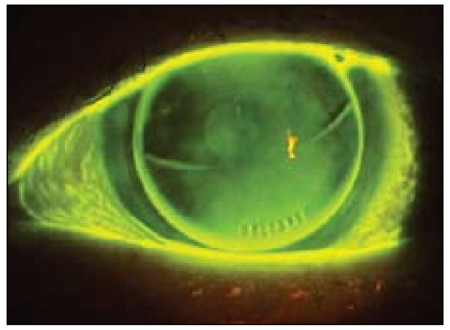


Figure 37: Ideal fit: non-rotational lens

» Test vision with reading material that is similar in size to your patient's habitual visual needs, and under illumination that is normal for them.

Step 4: Making changes

After assessing the ordered lens you may need to make some parameter changes. These changes may be obvious or you may decide to allow a longer settling period. Send your patient away for a week before reassessing the lenses; you may find that fewer changes are needed once the patient has had a chance to adapt to them.

» Most manufacturers offer reasonable refund and exchange policies. Although, making parameter changes too hastily can increase your lens cost.

Case Study: Non-rotational lenses

Patient B.G. aged 59, was a non: lens wearer trying GP lenses for the first time. He had a high reading addition. He presented with difficulty reading close work. His daily activities included exacting close work tasks, including reviewing fine print in charts and spreadsheets.

This case provided an ideal opportunity to consider non-rotational lenses. The patient had high motivation, and his history (ocular, personal and family) was not significant. There was no history of excessive dryness with contact lens wear, and he was not taking any medications.

Ocular findings:

HVID = 11.5mm, PA = 9.5mm, PS (under mesopic conditions) = 3.5mm
TBUT: 10 sec. (OU)

Lower eyelid was positioned at or slightly above the limbus in the primary position of gaze. Lid tension was average. There were no unusual slit lamp findings. In this example the patient has the same K-readings and prescription in both eyes.

Keratometry:	Flat K:	Steep K:	Corneal Astigmatism:
	42.50D (7.94mm) @ 180	44.00D (7.67mm) @ 090	1.50 x 180

» **To convert millimeters (mm) to diopters (D), use the following formula:**

$\frac{337.5}{\text{mm or}}$ = D or mm (See appendix B: Keratometer readings conversion chart)

Subjective Refraction (VD = 12mm): –3.50/–1.50 x 003 Add = +2.50

To fit this patient using a diagnostic lens set, we:

1 Predicted lens parameters

TD: 9.4 to 9.6mm (calculated based on HVID). We used a trial set with a TD of 9.4mm.

» Save time by basing TD on habitual lens measurements, if possible

BOZR: Based on fitting rules for TD 9.4mm and BOZD of 8.0mm:
Flat K = 42.50D (7.94mm) and corneal astigmatism = 1.50 x 180
BOZR (for TD = 9.4, BOZD = 8.0) was: (1/4 corneal astigmatism + Flat K (D))
that is: 1/4 (1.50) + (42.50) = 42.88D (≈ 43.00D or 7.85mm)

Remember: If you adjust the BOZD/TD…to maintain equivalent fit you should adjust the BOZR by 0.05mm to compensate for a 0.3 to 0.5 change in BOZD; i.e., as BOZD decreases, BOZR needs to steepen.

Segment height: Starting point was 1.0mm below the geometric center of the lens, as indicated by the diagnostic fitting lens set.

Segment height = 1/2 (TD) –1.0mm

thus 1/2 (9.4) –1.0mm = 3.7mm

If the segment is difficult to see, try using a cobalt blue filter with the slit lamp, under low illumination.

Once the lens was on the eye and settled centrally (a slightly lower position would also be acceptable) we assessed segment height in normal room lighting and away from the slit lamp. *The segment should ideally be positioned along the lower edge of a mid: sized pupil. Ask your lab consultant the degree to which segment height can be adjusted.*

Diagnostic fitting sets come with a variety of specifications.
Don't forget: your lab consultant is your best source of information and guidance.

Prism: The diagnostic lens we selected for this patient had a prism of 1.25Δ. The fitting set that we used provided only the lowest amount of prism (1.25Δ for a minus lens and 1.75Δ for a plus lens). We knew that the lab could add additional prism if needed.

Prism axis: The diagnostic lens we selected had a prism axis along 90° (i.e., assumed no lens rotation).

Remember LARS: If the lens settles in a slightly rotated position on the eye, adjust the axis according to the direction of rotation. For a 15^0 counter clockwise position, if lens is nasally or temporally rotated, ask the lab to adjust the prism axis by the amount you have measured, i.e., to 75^0 .

Truncation: Our diagnostic fitting set had no truncation, and it was not necessary to order lenses with truncation.

Consider truncation if the lower edge of the lens slips under the lower eyelid, obscuring the segment on down gaze (view this with the aid of a diagnostic mirror). Truncating the lens allows the lower eyelid to push it up over the pupil on down gaze. Truncation is usually 0.3 to 0.4mm less than TD.

Lens power

Step 1: Ocular refraction sphere: –3.50D
Step 2: Tear lens (BOZR – flat K): 43.00–42.50 = + 0.50D (0.10mm)
Step 3: Final lens power (ocular sphere + correction for the tear lens):
BVP = –3.50D + (–0.50D) = –4.00D

Compensate for the plus tear layer power by adding a minus correction.

The diagnostic lens we selected had the following parameters:

BOZR: 7.85 TD: 9.40 BVP: –3.00 Add: +1.50
prism 1.25Δ axis along 90°
segment height = 3.7mm

We expected to find:

–1.00D over-refraction for distance and an extra +1.00D for near

If the actual results had been significantly different, we would have had to review the fit.

As it was, the fit of the left eye appeared slightly flat, so we selected a different lens:

BOZR: 7.80 TD: 9.40 BVP: –3.00D Add: +1.50
prism 1.25Δ axis along 90°
segment height = 3.7mm
Over-refraction: –1.25D (distance) and an extra +1.00D for near

Remember to assess acuities at distance (ensuring the segment does not slightly double the image) and at near (ensuring that the lens translates adequately) and using good room lighting.

Order trial lenses based on lens parameters predicted during the diagnostic fitting. Remember to optimize physiological performance: request a high-Dk lens material.

Finally, we ordered lenses with the following measurements:

BOZR: 7.80 TD: 9.40 BVP: –4.25 Addition: +2.50
Prism 1.25Δ axis along 90°
Segment height = 3.7mm

We ordered the lenses in a high-Dk material to optimize physiological health. Fit and visual performance matched the diagnostic lenses. After two weeks of wear, our patient reported excellent vision but was more aware of the lens. This sensation had decreased over the two-week period. At a further follow-up one month later, results were excellent and the patient was asymptomatic.

For empirical fitting, provide your lab the following information:

- **HVID for the TD determination:** TD will be same as current lens if patient is a lens wearer, otherwise lab will decide on HVID
- **K-readings for BOZR determination:** Lab will choose the BOZR usually steeper than flat K depending on the amount of corneal astigmatism present to provide an alignment fitting relationship.
- **Segment height:** The lab will provide a lens with the standard segment height (1.0mm below the geometric center of the lens); it can be adjusted at a later date.
- **Prism power:** The lab will send you a lens with the amount of prism used on average for the lens power you have ordered.
- **Prism axis:** The lab will set the axis along 90° (i.e., assuming 0° lens rotation to start) or the lab may preset the prism axis to be offset 10° nasally for the right and left eye (80° and 100° respectively).
- **Spectacle Rx and VD for contact lens power:** From the sphere of the vertexed Rx that you send the lab will adjust the sphere to correct for the tear layer created by the lens: cornea relationship.
- **Add power:** Lab will choose the lens design with add power matching your patient's needs.

EVALUATING THE FIT OF NON-ROTATIONAL LENS DESIGNS

The following section addresses:

- Lens centration
- Lens movement
- Lens translation
- Fluorescein pattern

With non-rotational lenses, the goal is a fit similar to a mobile-fitting single vision lens: the lens should move but not decenter.

You have already decided on the initial lens parameters and obtained a first set of lenses (either from your diagnostic set or the laboratory). How can you tell if they fit properly?

Question 1: Is the lens centered?

Centration is critical with non-rotational lenses in order for the segment to be properly positioned on straight ahead and downward gaze.

What should I look for?

Is the lens centered relative to the center of the pupil?

What should it look like?

The lens should be centered or slightly low-riding (Figure 38a).

How do I check it?

Ask the patient to blink a few times. Wait a second or two, to see where the lens settles.

Centration is relative to the pupil, so imagine a cross through the center of the pupil.
Note the decentered lens in Figure 38b.

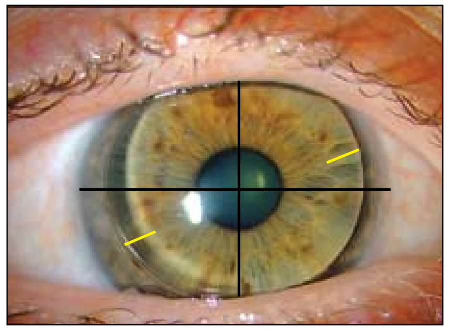


Figure 38a:
Non-rotational design – centered

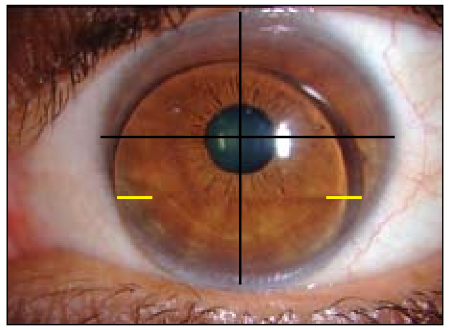


Figure 38b:
Non-rotational design – decentered

How can I fix it?
Centration can be altered by changing the following parameters:

Lens diameter: A larger diameter may center better.

BOZR: Too flat or too steep may cause decentration. Check the fit with fluorescein and target an aligned fitting pattern.

Prism: If lens is positioned superiorly, increase prism; if lens is positioned inferiorly, decrease prism, provided that the BOZR is neither too steep nor too flat.

Question 2: Is the lens moving well?

Non-rotational lenses – as all contact lenses – need to move comfortably on the eye with the blink to promote tear exchange.

What should I look for?
With the straight-ahead gaze, you should be able to see the lens move 1–2mm after each blink.

How do I check it?
Using a slit lamp, align a slit of light 2mm in height with the bottom edge of the lens. Have the patient blink, and assess the amount to which the lens moves in relation to the line. The white bar represents the slit of light in Figures 39a to 39c.

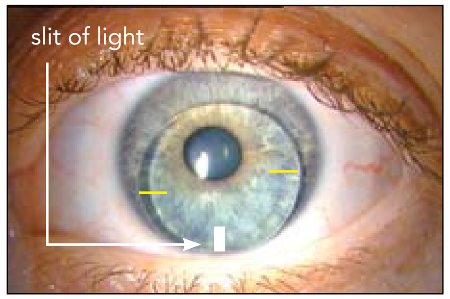


Figure 39a
Before blink, set the 2mm slit of light at the lower lens edge

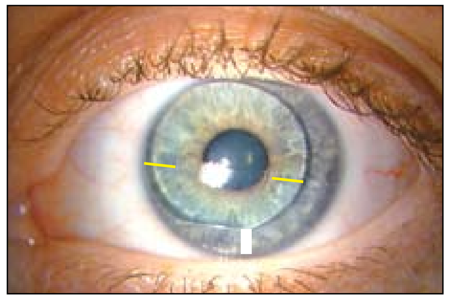


Figure 39b
Immediately after blink, assess the lens movement relative to the slit of light

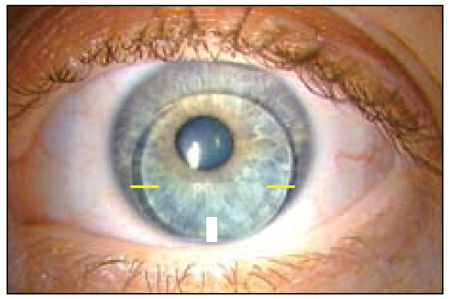


Figure 39c
After lens settles

How can I fix it?
Instill fluorescein. If movement is insufficient, the lens may be too steep; if movement is excessive, the lens is probably too flat.

Question 3: Does the lens translate with downward gaze?

Non-rotational lenses must translate (move) upward when the wearer shifts from the straight-ahead to the downward gaze for reading.

What should I look for?
The lower eyelid should translate the lens upward by 1.0 to 2.0mm when the patient shifts from straight-ahead to down gaze.

How do I check it?
It is difficult to view the contact lens when your patient is looking down.

Hold the upper lid up as the patient looks down. If the lens has adequate room for translation, it should cross the upper limbus. Use your direct ophthalmoscope or retinoscope to illuminate the lens to see if the lower edge of the lens has been pushed up by the lower lid, i.e., translates so that the patient is viewing through the near zone.

Alternatively, place a small (2.5 x 1.5cm) rectangular mirror between your patient's cheek and lower eyelid. Tilt the mirror while he or she is looking down until the mirror reflects the eye.

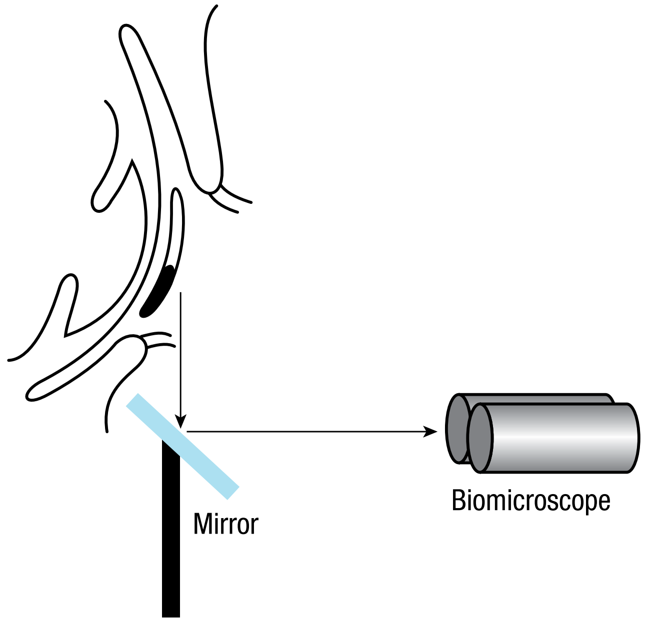


Figure 40: Set-up to view lens in downgaze

What should it look like?

The reading (lower) segment should be in front of the pupil (Figure 41). Nasal rotation is usually expected on downgaze.

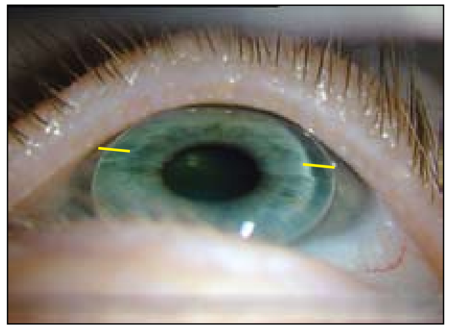


Figure 41:
Non-rotational design–good reading position in downgaze, segment over the pupil

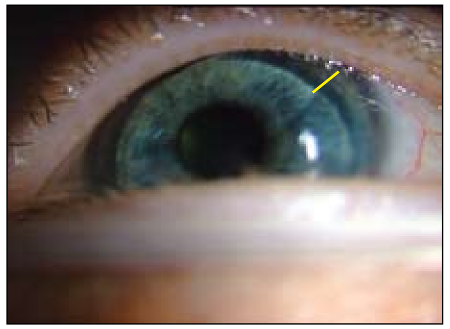


Figure 42:
Non-rotational design–poor reading position in downgaze, segment not over the pupil. Lens has slipped under the lower lid margin.

Note: These images were captured using the mirror set up described in Figure 40.

How can I fix it?

If the lens slips under the lower lid (Figure 42), consider having it truncated to provide the lower lid with leverage to push the lens upward on down gaze.

Consider whether the lens is too steep; if it is, flatten the BOZR, reduce the BOZD or reduce the TD to improve translation.

If the lens rides too high, preventing translation, consider increasing base down prism only if the lens is aligned when held in a centered position while viewing with fluorescein in the eye.

Question 4: What does the fluorescein pattern look like?

The fluorescein pattern is indicative of the BOZR: cornea relationship, which can affect lens comfort, lens position, segment position, lens translation and lens movement.

What should I look for?

Look for an aligned fit – similar to the fit of a single vision spherical GP lens.

How do I check it?

Instill fluorescein. Use a slit lamp with cobalt blue filter to view the lens fit using a wide slit beam and a yellow filter, such as Wratten filter #12, to enhance the fluorescence of the image seen. View the static fluorescein pattern in the lens' natural resting position. Additionally, keep the lens mobile by having the patient blink (dynamic fluorescein pattern) and nudging the lens into a centered position with the lower lid (static fluorescein pattern).

Figure 43: Boston™ slit lamp filter

Placing a yellow filter, such as a Wratten filter #12, in front of the observation system of the slit lamp will allow you to see much greater detail in the fluorescein pattern. These filters are available from your manufacturing laboratory.

Figure 44:
Non-rotational design–steep fit

Figure 45:
Non-rotational design–alignment fit

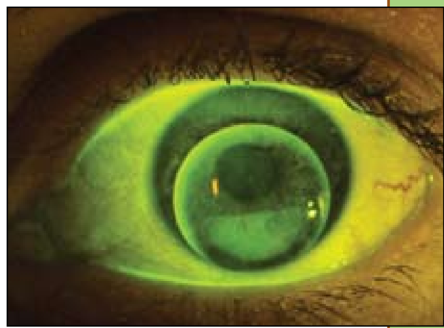


Figure 46:
Non-rotational design–flat fit

How do I fix it?

If there is central pooling, flatten the BOZR or decrease the BOZD.
If there is central touch, steepen the BOZR or increase the BOZD.

Question 5: How good is the patient's vision?

If the distance and reading prescriptions are correct and your patient is still having trouble seeing, there is likely a problem with one of the other fitting factors.

What should I look for?

Check the lens over-refraction for both distance and near first. If vision is still poor (distance, near or both), it is likely being affected by lens fit. Figures 47a and 47b show a good reading position on downgaze.

How do I check it?

Perform the binocular over-refraction with hand: held diagnostic lenses in free space at both distances, or use flippers with + or –0.50D lenses. Remember, a +1.00D lens should blur to 20/40 (6/12).

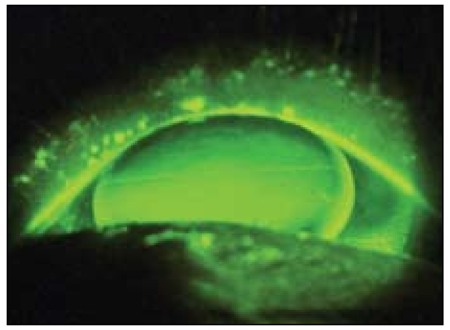


Figure 47a:
Non-rotational design – good reading position

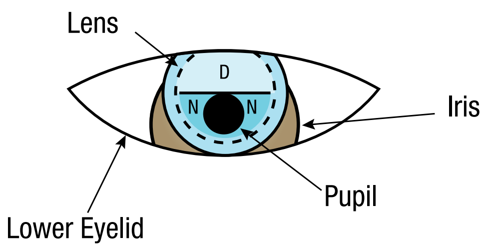


Figure 47b:
Non-rotational design – good reading position

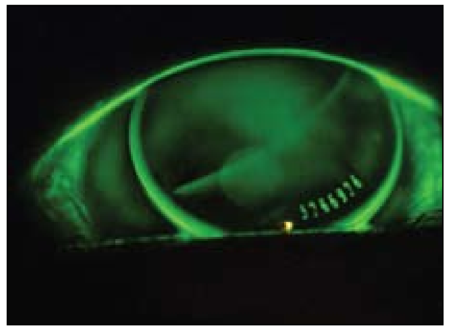


Figure 48a:
Non-rotational design – poor reading position on downward gaze

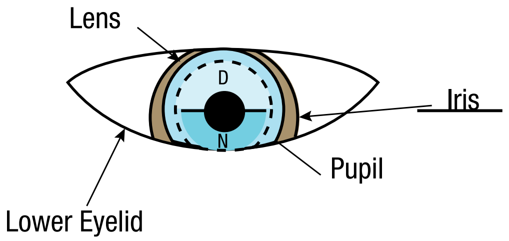


Figure 48b:
Non-rotational design – poor reading position

Remember to note the over-refraction and acuities for both distance and near.

How do I fix it?

If there is a significant over-refraction it should be incorporated into the lens prescription.
If not, optimize lens fit and translation. Note the poor lens translation in figures 48a and 48b.
If the fit is already optimal and there is insufficient translation, consider a different design.

Question 6: Does the lens rotate excessively?

Non-rotational lenses should not rotate excessively in the straight ahead position, some minimal nasal rotation may occur.

What should I look for?

There should be minimal to no nasal rotation in the straight ahead position (Figure 49). Nasal rotation is acceptable when reading. The segment should return to its reading position fairly quickly after the blink.

How do I check it?

Using a slit lamp, focus a thin slit of light on the lens through the center of the pupil, aligning the observation and illumination systems. Use the slit lamp scale to rotate the beam of light either nasally or temporally depending on the rotation of the lens segment. Using the scale on the slit lamp, determine the degree of rotation.

Figure 49:
Non-rotational design – no rotation

Figure 50:
Non-rotational design – too much nasal rotation (15°)

How can I fix it?

The factors that affect excessive lens rotation are:

- upper lid/lens interaction
- lower lid alignment
- orientation of corneal astigmatism

Assuming the fit of the lens has been optimized with regard to BOZR and TD, the lens needs to be re-ordered with the prism axis offset by the degree of rotation and in the direction of the rotation following LARS. In the above example (Figure 50), to counter the rotation the prism axis would be re-ordered at axis along 75°.

Question 7: Is the segment at the correct position?

What should I look for?

In the straight-ahead gaze, the segment should be positioned at or just above the lower pupil margin (Figure 51).

How do I check it?

Using the slit lamp, assess the position of the segment relative to the lower pupil margin while the patient blinks in the straight ahead position.

The lens should be centered on the eye; if it is not (Figure 52), adjust parameters to improve centration and assess the segment position. The segment height can be measured with a reticule on the slit lamp

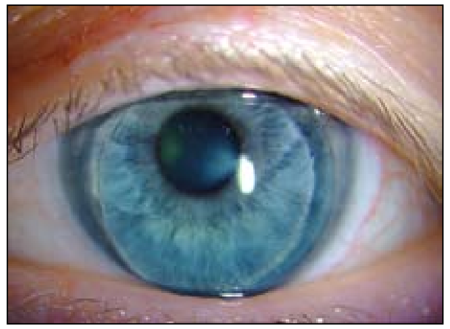


Figure 51:
Non-rotational design – good segment position

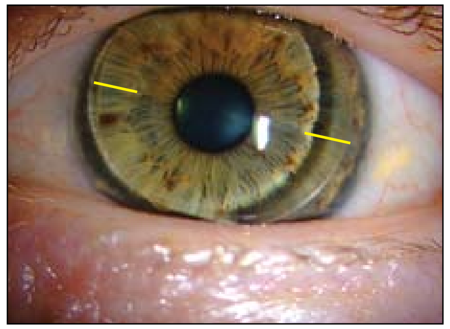


Figure 52:
Non-rotational design – poor segment position. Segment bisects the pupil (too high)

How can I fix it?

If the lens is centered, and:

- the segment is too high – decrease segment height
- OR if the lens is truncated – increase truncation

If the lens is centered, and:

- the segment is too low – increase segment height
- OR if the lens is truncated – decrease truncation

If the lens does not center perfectly vertically on the eye, and:

- the lens segment is too high – increase prism
- the lens segment is too low – decrease prism

If the lens is decentered laterally, and:

- sits nasally as in figure 53, the fit may be steep
- sits temporally, then the lens may be flat
- is aligned but the segment is rotated – rotate the prism base in the same direction as the lens rotation

Each of these strategies requires a new lens.

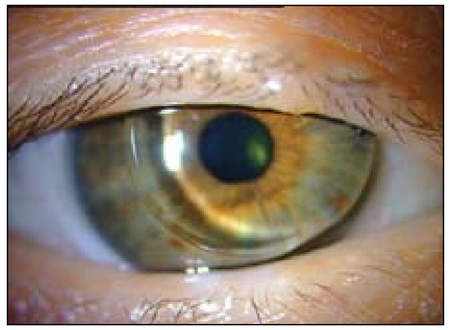


Figure 53:
Non-rotational design – nasal lens positioning. Example of lateral (nasal) decentration

Prism controls segment position (Δ amount) and orientation (Δ axis) in primary gaze.

Truncation controls segment position and translation in downward gaze.

Suggested starting points for lens parameters: non-rotational lenses

Lens parameter	Starting point	Clinically significant change
BOZR	On flattest K-reading or 1/4 of the difference steeper in Ks if astigmatism 1.25 to 2.00D	0.05mm
BOZD	Larger than pupil diameter, usually 7–8mm	0.30mm
Lens diameter	Usually 9–10mm	0.30mm
Prism power	Start with 1.25	0.50D
Truncation	Start without truncation; if needed, start with 0.4mm	0.20mm

Changes in parameters and impact on fit: non-rotational lenses

Lens parameter	Starting point	Clinically significant change
BOZR	Flattens the fit Increases lens movement Increases lens decentration	Steepens the fit Decreases lens movement Improves lens centration
BOZD	Steepens the fit Decreases lens movement Improves lens centration	Flattens the fit Increases lens movement Increases lens decentration
Lens diameter	Decreases movement Improves centration	Increases movement Increases decentration
Prism power	Lowers lens position Decreases lens rotation	Raises lens position Increases lens rotation
Truncation	Decreases near segment height Increases influence of lower lid, decreasing rotation	Increases near segment height Decreases influence of lower lid, increasing rotation

OPTIMIZING THE FIT OF NON-ROTATIONAL LENS DESIGNS

Patient concern	Diagnosis	Solutions
"I have to hold my head up too high to read near."	Segment position likely too low and/or too small and needs to be raised.	If translation is adequate, increase segment height. If translation is poor, consider increasing prism or truncating lens (remember to increase segment height to compensate for truncation).
"These lenses are not as comfortable as my previous lenses."	Non-rotational lenses are thicker and the base down prism increases edge thickness inferiorly, increasing lower lid sensitivity.	Counsel patients that they may adapt to the lenses over time. Re-order lens in thinner design (but thismay introduce translation problems). Refit with a rotational multifocal.
"My distance vision is poor at times, especially after I blink."	Lenses ride high post-blink; near segment interferes with distance vision.	Increase the return time after each blink by increasing base down prism.
"My near vision is poor at times."	Lenses are rotating excessively on down gaze; near segment does not position properly over the pupil.	Improve lens stabilization by aligning prism axis equivalent to the degree of rotation or by adding truncation.

5 Other options

CENTER: NEAR DESIGNS

These lens designs have a very small near reading optic in the center of a distance optical zone (Figure 54 on page 68). Both distance and near optics are usually spherical and positioned in front of the pupil simultaneously. These are most often used with soft lenses.

With center-near designs, centration and minimal lens movement are key to achieving a good lens fit. The object is to provide both distance and near vision simultaneously. You need to achieve good centration while avoiding a too-tight fit. Lens decentration results in vision-related symptoms, especially at night and while driving.

The ideal fit for a center near design can be achieved by increasing the lens diameter, steepening the optical zone (steepen BOZR or increase BOZD) or by reducing the axial edge lift.

Step 1: Examine your patient to determine lens parameters

Example

Lens diameter: As with a single vision GP lens, choose a lens diameter based on palpebral aperture size and corneal diameter to optimize lens centration.

Horizontal visible iris diameter (HVID) or palpebral aperture (PA) size: May be used to predict lens diameter. It is better to fit a slightly larger lens diameter to improve comfort unless the PA is excessively narrow.

Example

Palpebral aperture	Diameter
<8mm	9.4–9.6mm
8–11mm	9.7–10.0mm
>11mm	10.1–10.5mm

HVID	Diameter
10–11mm	9.4–9.6mm
11.5–12.5mm	9.7–10.0mm
>12.5mm	10.1–10.5mm

BOZR: The BOZR should be steeper than what you would select for a single vision lens, to facilitate a well: centered fit with minimal movement based on a BOZD between 7.8 and 8.2mm.

Corneal astigmatism	BOZR
Up to 1.00D	0.10mm steeper than flat
1.25D to 2.00D	0.10mm steeper than 1/4 of the difference between K-readings (steeper than flat K-reading)
>2.00D	Consider a toric design

Distance power: Over-refract the diagnostic lens. Otherwise, calculate the distance power of the lens considering the vertexed spherical power and the tear layer created by the lens-cornea interaction. Remember, the center of the lens is for near vision, so minimal minus should be offered during the binocular over-refraction.

0

Near power: Determine near power while compensating for your patient's distance Rx, in a natural reading position; that is, with the patient holding reading material at a comfortable distance and under normal room illumination. If you have over-minused for the distance, near vision will be poor.

Step 2: Obtain lenses that fit those parameters

Choose the diagnostic lens most closely matching BOZR, power, reading addition and diameter. Insert the diagnostic lens and let it settle.

OR

Order the lenses from the laboratory (empirical fitting).

Step 3: Check how well the lenses suit your patient

Lens centration and diameter: Ensure that the lens is centered, with good corneal coverage.

Lens movement with the blink: Less movement is necessary (approximately 1mm).

Fluorescein pattern: The lens should be centered, with central alignment or a slightly steep pattern, ensuring adequate edge clearance.

Distance/near vision: Determine the final prescription based on the final diagnostic lens over-refraction, performed in free space with the patient holding reading material of the same size as their current visual need and under normal illumination.

You should now be able to order lenses from the laboratory.

Review the vision and fit. If suitable, the lenses should be dispensed with a patient review after one to two weeks of wear.

Ensure that your patient is aware that simultaneous lenses may cause visual compromise. You will likely need to encourage and support the patient throughout the adaptation period. Even after adapting to these lenses, your patient may find that they require additional spectacles for certain tasks (e.g., reading the newspaper or driving long distances).

The assessment of these fitting factors is discussed further below:

Step 4: Follow-up visit

Expect the patient to report an improvement in lens performance over the initial wearing period. Significant parameter changes can be made if necessary.

Vision: Adding extra minus to improve distance vision performance may affect near vision. Conversely, adding more plus to improve near vision will affect distance vision. The key is to find a balance that can satisfy distance and near vision needs.

Fit: If the lens moves too much, consider increasing TD or steepening BOZR.

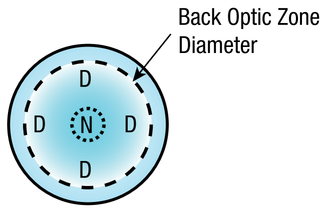


Figure 54:
Aspheric rotational design, simultaneous CN

Suggested starting points for lens parameters: non-rotational lenses

Lens parameter	Starting point	Clinically significant change
BOZR	Steeper than flattest K-reading 0.10mm	0.05mm
BOZD	Larger than pupil diameter, usually 7–8mm	0.30mm
Center near/ distance zone	2.0 to 2.5mm	Defer to lab
Lens diameter	Usually 9.80mm	0.30mm

Changes in parameters and impact on fit: simultaneous design

Lens parameter	Starting point	Clinically significant change
BOZR	Flattens the fit Increases lens movement Increases lens decentration	Steepens the fit Decreases lens movement Improves lens centration
BOZD	Steepens the fit Decreases lens movement Improves lens centration	Flattens the fit Increases lens movement Increases lens decentration
Lens diameter	Decreases movement Improves centration	Increases movement Increases decentration

Optimizing the fit: center-near designs

Patient concern	Diagnosis	Solutions
"My vision is poor (distance and/or near)."	Demonstrating inability to suppress defocused image.	Refit with rotational multifocals. Try modified monovision. Refit with singe vision lenses and over reading spectacles.
"My near vision gets worse at night."	Enlarged pupil size in low light positions near vision zone in front of the pupil with distance zone, distorting vision.	Consider increasing near segment zone size.

MODIFIED MONOVISION

If your patient is struggling with multifocal lenses, consider modified monovision. With monovision, the dominant eye wears a distance-biased design (Figures 55) while the non-dominant eye wears a near-biased design. Modified monovision offers the advantages of monovision while providing a degree of multifocal function (Figures 55 and 56).

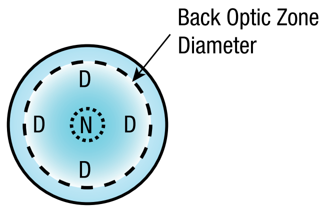


Figure 55: Aspheric rotational design – simultaneous CN

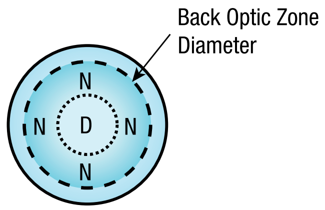


Figure 56: Aspheric rotational design: – simultaneous CD

As with multifocal lenses, monovision requires a period of adaptation. Some patients may find monovision difficult but tolerable as they have not been offered an alternative. As reading addition increases, adaptation may become more difficult; patients with unstable binocular vision may develop diplopia. Of course those with amblyopia are not suitable for monovision under any circumstances.

Combinations worth considering are listed below:

MODIFIED MONOVISION

Dominant eye	Non-dominant eye
Rotational multifocal (center distance)	Simultaneous multifocal (center near)
Rotational multifocal (center distance)	Near single vision lens
Distance single vision lens	Simultaneous multifocal (center near)
Rotational multifocal (center near-small)	Rotational multifocal (center near-large)
Rotational multifocal (center distance-small)	Rotational multifocal (center distance-large

Optimizing fit: monovision lenses

Patient complaint	Diagnosis	Options
"My eyes are 'fighting' each other."	Binocular imbalance due to inability to suppress contralateral eye. May be due to intolerance related to increasing reading addition OR patient may have difficulty adapting to monovision.	Compensatory spectacles. Refit with rotational contact lenses. Refit with single vision distance contact lenses supplemented with reading spectacles.
"My computer screen is not very clear."	Monovision does not provide intermediate vision correction.	Refit with rotational multifocals. Supplementary corrective spectacles worn over top of the existing contact lenses.

take-home points:

- **Fitting GP multifocals may take time to learn, but their advantages make the learning curve worthwhile.**
- **Using a diagnostic set can make the fitting process run more smoothly, but the decision is ultimately up to you.**

6 Next steps

in this chapter:

- Getting started: make decisions
- Preparing to fit GP multifocals
- Structuring your practice to make the most of multifocal GP fitting
- Educating, supporting and communicating with your patients

Regardless of how easy it is to fit GP multifocal lenses, not all practitioners take the time to learn how to fit them. Remember: a learning curve exists any time a new modality is introduced into a practice; the more you fit these lenses, the easier and more profitable they will become. In other words, "Success begets success."

"I dare to disagree with people who say that fitting multifocal lenses is difficult, because it is not. Finding the right lens for the right patient is the hard part of the fitting procedure, not the lens fit itself."

EEF VAN DER WORP,
Optometrist, Netherlands

Getting started: make decisions

WHICH LAB?

Find out what your options are: which laboratories do you have access to? Contact each lab and decide which one suits your needs – and the needs of your practice: best. Ask the lab consultant:

- which lens designs and materials are offered;
- how the lab can customize its lens designs;
- about timelines for lens production and shipping;
- about costs;
- whether the lab has a warranty (for refitting patients);
- what can they do to support your practice in promoting multifocal lenses.

It may be useful to find a lab that offers both rotational and non-rotational lens designs – or a couple of labs that you feel equally comfortable using – so that both options are available to your patients.

It is important that you feel comfortable working with your lab consultant.

WHICH PATIENTS?

Think of all your presbyopic patients as potential multifocal GP wearers. Your preliminary examination will provide you with an opportunity to ensure that their ocular health is suitable for contact lens wear.

WHICH FEE SCHEDULE?

What is the most effective and efficient way to make GP multifocals available to your patients?

Fitting fee + materials: Your patient receives a bill itemizing cost by fitting and materials. Patient knows the break-down of your rate up front, facilitating informed decision-making.

All-in-one fee: Your patient receives one bill for both fitting and materials. An advantage of this approach is that it allows the practitioner to incorporate a profit margin, while a disadvantage is that your patient may be overwhelmed by the up front cost.

Scheduled Payments Program: Your patient receives one bill for both fitting and materials, but it is divided over a monthly, quarterly or semi-annually basis. This payment plan reduces the pressure of a full up-front payment plan.

"Multifocals are now, and will be forever, the future for presbyopes… In my opinion, it is best to try them first in every case!"

BRIAN TOMPKINS,
Optometrist,
United Kingdom

Fitting fee + free trial: You charge for fitting the lenses, but there is no charge for the first pair of lenses until the 30: day trial period is over. The patient pays for the final lenses prescribed only.

Appointment by appointment: Charge patients for each appointment as needed. This approach may be more financially manageable for some patients. A disadvantage of this approach is that your patient may decide not to return for follow-up visits.

It is important to decide on a strategy ahead of time for the sake of consistency. Bear in mind that your choice of fee schedule will depend on your local professional regulations. Keep in mind that any GP multifocal fitting will include an extended schedule of visits (see below).

Go to the GPLI website and look up their "Presbyopia Tools" with a fee calculator for some insight into choosing a fee schedule (www.gpli.info)

EMPIRICAL OR DIAGNOSTIC FITTING?

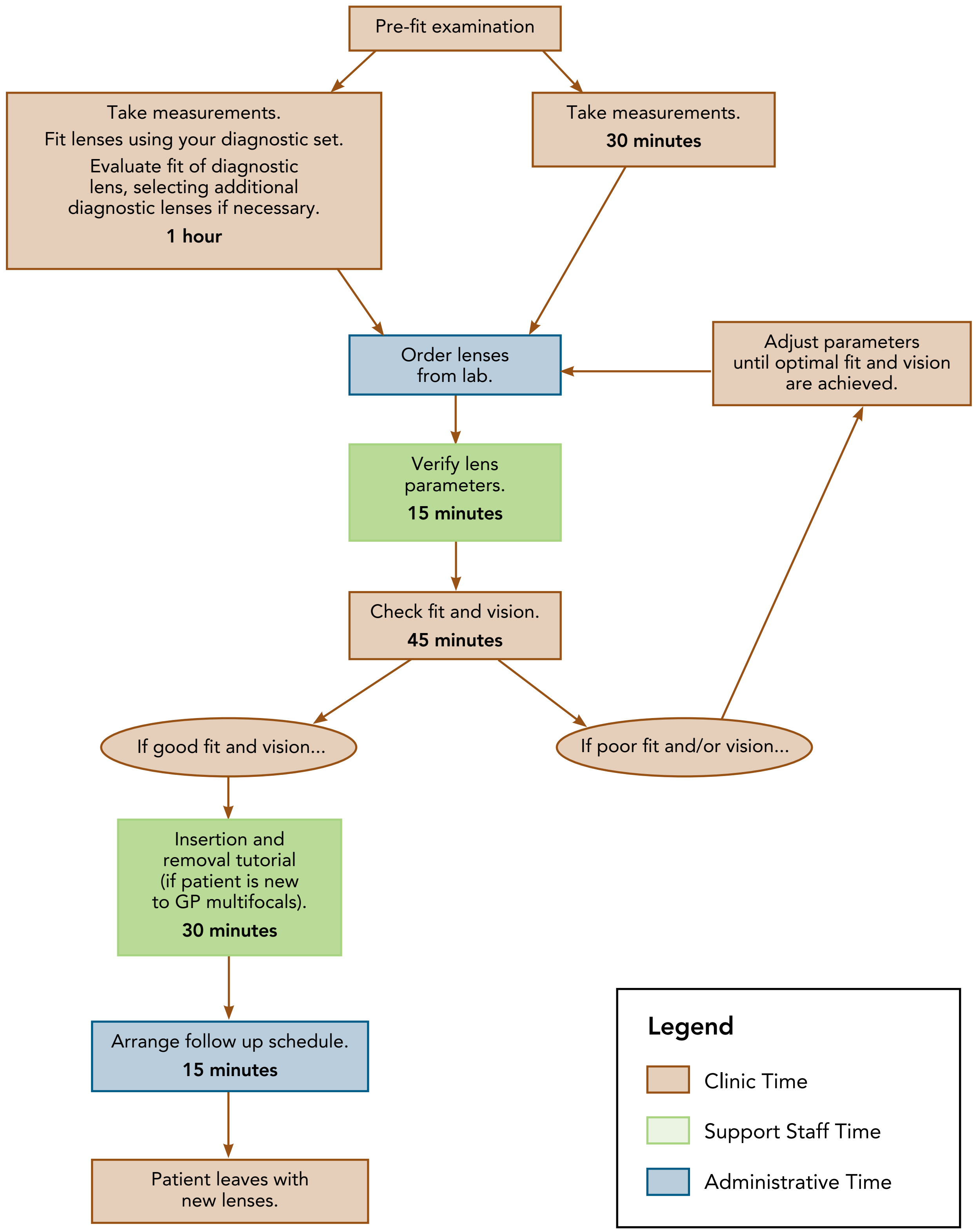
Decide whether you prefer to fit these lenses on an empirical or diagnostic basis. This decision may also relate back to your lab choice: not all labs offer a diagnostic fitting set.

STRUCTURING YOUR FEES

To make fitting GP multifocals worth your while, it may be necessary to restructure your fee schedule, especially if you normally charge a flat fitting fee, as GP multifocals (any multifocal lens, in fact) take more time to fit than a single vision lens. Make sure this fitting time is covered by your fee structure.

Example for fee calculation: breaking the fitting process into segments of time

Use the following flowchart to assist in setting a fitting fee:



Prepare

YOUR STAFF

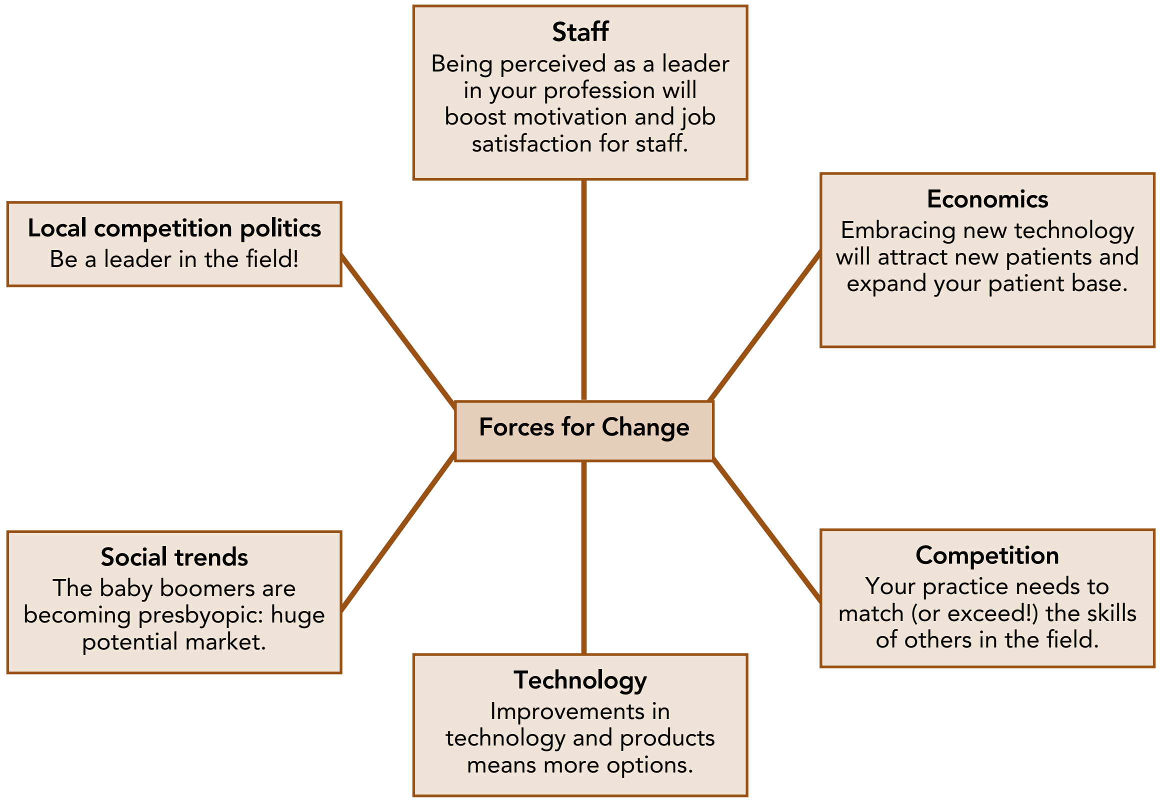
Ensure that your staff is equipped with enough information about the latest options in multifocals, so that they can comfortably answer basic questions in addition to conveying a positive attitude.

Advise staff members that they can and should assume multifocal contact lenses are an option for all presbyopic patients. It may be helpful for you to work with your staff to develop "Frequently Asked Questions" (FAQs), to assist with answering patient inquiries and scheduling appointments.

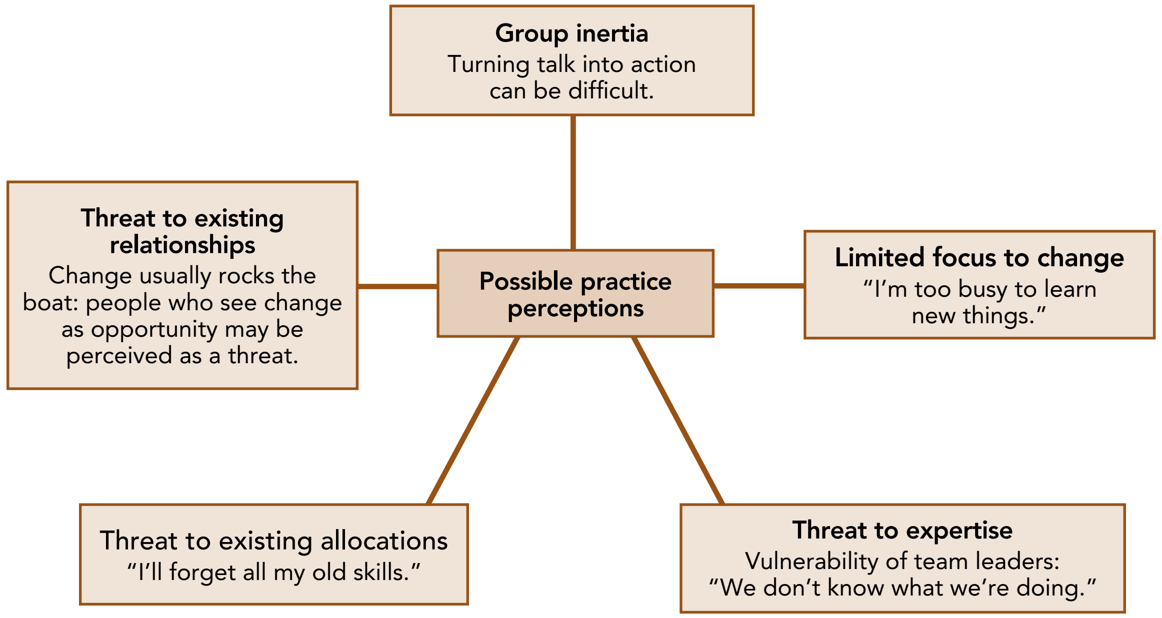
Encourage your presbyopic staff to try wearing GP multifocals so that prospective patients can see them in action, inspiring confidence.

Ensure that your staff is aware that the initial fitting and refining process is more complex and time-consuming for multifocal contact lenses than for single vision lenses. Explain clearly how this time is reflected in the fee structure so that each staff member is comfortable explaining the details to potential patients.

WHY SHOULD I CHANGE MY PRACTICE?



RESISTANCE TO CHANGE



YOUR PATIENTS

Normalize the idea of multifocal contact lenses as much as you can. Reduce the apprehension that prospective patients might otherwise feel if they perceive them as new, unusual and complicated.

Celebrate every successful step that you and your patient accomplish along the way, providing encouragement and assurance that you are getting closer to the final lens design and prescription.

Ensure that your patients understand that GP correction of presbyopia involves a compromise, no different than multifocal spectacles or soft lenses. Ask them to prioritize their vision: are near, intermediate or distance tasks most important in their daily activities?

> "We always discuss with patients the 'two out of three' rule. Patients have to decide which two distances they want to have corrected primarily out of the three options that exist: near, intermediate or distance. With today's large array of options, we can promise to correct two satisfactorily, and we will strive for number three but this is not a promise. First of all, they know better than anybody else what their visual needs are and they will tell you. Secondly, they immediately understand that there are limitations when it comes to multifocal contact lenses, and this will prevent disappointment later."
>
> **EEF VAN DER WORP,**
> Optometrist, Netherlands

Market your skills

To your patient base

Your current patient base is a 'captive audience' of sorts. Make sure your patients are aware of your skills in fitting GP multifocals.

Being proactive and enthusiastic will highlight your expertise in this area of specialized care, encouraging and even increasing patient loyalty. Success with individual patients may breed new referrals and even more success.

To the public

Take this opportunity to expand your patient base by advertising your skills in the wider community: producing brochures, advertising in the local paper, or attending events frequented by presbyopes. Ask if your laboratory can offer any marketing support.

To your colleagues

Success in fitting GP multifocals will likely not go unnoticed by lens suppliers. You may find opportunities to become involved in clinical trials or practitioner training seminars, where you can share your experiences and showcase your talents in this field.

You have a good opportunity to be a leader within the profession as well as your local community.

Marketing GP multifocals in your practice

Make a point of offering contact lenses as an option at the end of every examination, whatever the age of your patient. Growing your contact lens base will ultimately grow your multifocal contact lens base too.

Make promotional material easily accessible to non: presbyopes and non: contact lens wearers too. You never know – your 22-year-old patient may bring her mother in next week for multifocal contact lenses!

Incorporate GP multifocals into all correspondence with your patients and the public, including newsletters, posters, leaflets, reminder letters and emails.

Add a notice to your contact lens solution display that reads "also suitable for GP multifocal contact lenses," to help raise awareness.

Host an open house at which current and prospective patients can view a presentation about multifocal lens designs. Invite a few successful multifocal lens wearers to spread the word.

Add staff incentives for finding and scheduling patients for presbyopic contact lens exams.

Find out whether your local lab has promotional material to help you market multifocals.

Communicating with your patients

Be proactive in educating your patients about GP correction for their presbyopia.

- Introduce the benefits of contact lenses as an effective alternative or addition to multifocal spectacles.
- Dispel myths relating to older presbyopic GP lens designs. Latest research published in Optometry and Vision Science indicates GP multifocals perform as well as spectacle progressives for critical visual needs!
- Explain the unique design of GP multifocals, including custom fittings.
- Remind patients that GP multifocals provide better peripheral vision, don't fog up like glasses, and can provide excellent vision for near vision tasks, including computer use.
- Remind patients that further adjustments are usually needed after the initial fitting.
- Explain the possible need for additional near corrections for some near tasks.
- Make sure your patients understand your fee structure and refund policy ahead of time.

Ensure that your patients understand how to optimize their vision with proper lighting and head posture

Both rotational and non-rotational lenses need to translate upwards as the patient looks down to read. While your patient is sitting in your examining room, demonstrate how to hold reading material and where to position extra lighting to enhance reading.

Just as with multifocal spectacles the patient should keep their chin up, lowering their eyes to look at reading material.

Ensure that all reading material is well lit with auxiliary lighting that is pointing away from the patient's eyes and onto the reading material without causing glare.

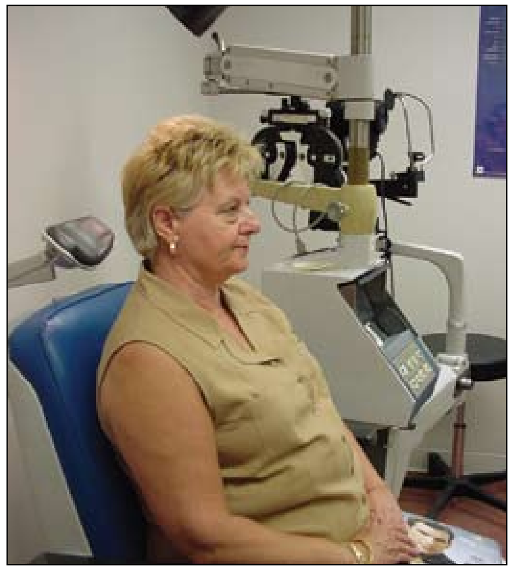


Figure 57a
Good distance lighting

Figure 57b
Good near lighting

take-home points:

- Introducing multifocal GPs to your practice requires an approach that is different from the way you approach other aspects of your practice, particularly with regard to visit schedule and fee structure.
- Be sure that your staff is thoroughly trained on the presbyopic options offered so they can confidently answer patient inquiries and promote the modality to current and prospective patients.
- Take a proactive approach by ensuring that all your patients are aware of this option.
- Make sure you communicate well with your patient.

7 Frequently asked questions

QUESTIONS FROM PRACTITIONERS

1. Which lens design is most successful for the early presbyope?

The rotational aspheric design is the most successful for the early presbyope. With low adds, the lens fitting characteristics are closer to a spherical GP pattern, making it easier to tell if it is fitting properly while providing good vision at all distances.

2. Why should GPs be the lens of choice for presbyopia?

GP lenses offer high oxygen transmission. They also resist deposits, are easy to handle and care for, and offer optimal optics. Considering that the older patient is more likely to have symptoms of dryness, these are all positive features.

3. Which are the most important factors in patient selection?

Most importantly, the patient must be motivated to give the diagnostic fitting process some time. With time and the combination of your knowledge and the expertise of your lab consultant, every fitting will be a success. Proper assessment of your patient’s visual needs is also key: ask about their lifestyle, including habitual lighting conditions and working distances. Have a frank discussion with the patient regarding realistic expectations.

4. What can be expected during the initial adaptation period to a multifocal lens?

Initially, as with any GP lens, the novice wearer will have some lens awareness that should disappear as the upper eyelid becomes adapted to the rigid lens edge. A small study done by Dr. E. Bennett found that there was in fact little difference in comfort comparing single vision to multifocal lenses. The reduced lens movement with rotational lenses and smooth translation with non-rotational designs can contribute to this difference. Also, initially distance vision and or near vision may be blurred due to tearing, which will reduce in 4 to 10 days. Finally, the eyes may be initially redder than normal, due to a disruption in the patients' blink pattern and therefore less blinking, but this will improve as the patient adapts.

5. How has technology improved the reproducibility and comfort of GP multifocal lenses?

New technology – in particular, the introduction of computer-aided lathes – has improved the reproducibility of GP lenses. Smoother surfaces and thinner edge designs with higher oxygen transmissibility have improved the initial comfort of GP lenses. Modern high permeability materials also offer better wettability and deposit resistance than earlier high: Dk materials.

6. Which is the most successful design for the advanced presbyope?

An advanced presbyope requiring higher additions would probably do better with a non-rotational design, which allows higher additions within the segment. Non-rotational designs can also be made as trifocals, offering intermediate vision for those who need it.

7. What should I correct first if the bifocal lens is rotated on the eye?

Always ensure that you have the best BOZR: cornea relationship. Ensure that the lens is not too flat or too steep. Once the lens is properly aligned, consider other parameter changes, such as increasing prism ballast and/or truncation.

8. How can I increase the near addition power of a lens with an aspheric design?

Fit the lens steeper centrally to allow for an increased eccentricity value (and therefore higher addition) or keep the back surface with the same eccentricity value (addition) and the required additional addition power can be added to the front surface of the lens.

9. How does initial comfort of a GP multifocal compare to that of a spherical lens design?

There should be no difference in initial comfort. The higher edge clearance available with aspheric designs allows the lens to position slightly higher. With the lens positioned under the upper eyelid, lid sensation is minimal and comfort should be good from the beginning. The aspheric back surface also better matches the natural flattening of the cornea, which also contributes to initial comfort. Actually in some cases the rotational lens designs have been reported as being more comfortable.

10. When should I add truncation to a multifocal lens design?

Truncation should be added to a non-rotational lens only as a last resort, when lens translation on down gaze is insufficient despite a well: fitting lens. Truncation could then be added to encourage the lower lid to push the lens up with the down gaze. Ensure that your patient's lower lid is adjacent to the lower limbus, either just at or above the lower edge.

11. When should I increase (or decrease) prism in a multifocal lens?

Increasing the prism power will add weight to the lens and thus pull the lens downward by changing the lens's center of gravity, if the lens is high-riding. The opposite will happen if you decrease prism, which may be needed if the lens is low: riding or too heavy.

12. How should I manage dryness with GP multifocal lens designs?

Make sure that the lens surface continues to be cleaned by ensuring that your patient includes a daily cleaner and an enzyme removal step to their lens care regimen. You may consider replacing older lenses with newer lenses that have better wetting surfaces. If you continue to see evidence of dryness on the cornea (3 and 9 o'clock staining and redness), examine the lid margins for blepharitis or meibomian gland dysfunction. Finally, check whether you can increase the lens diameter for better corneal coverage (and centration).

13. How can I help my nervous patients start to appreciate the visual benefits of multifocal GPs?

Remind the patient that the lens, when well: fitted, floats on the tears and is not felt – it is the eyelids and blinking over the lens that causes sensation and is where adaptation will occur. Consider using a topical anesthetic only as a last resort. Your patient will still be aware of the lens, but the initial adaptation will not feel as strange during the diagnostic fitting, in addition to stopping them from producing excess tears, facilitating a rapid settling time so they can focus on how the lens performs visually.

QUESTIONS FROM PATIENTS

1. How long can I wear my lenses daily?

Once you have adapted to your GP multifocals, you should be able to wear your lenses all day.

2. Can I read my sheet music with these lenses?

Yes, if you are wearing rotational lens designs you should be able to see your sheet music, looking up if you need to. You can also adjust your stool so that you are sitting a little higher than usual, and look slightly downward to see the music in front of you. If you are wearing non-rotational lenses, try trifocal or modified monovision lenses.

3. Will they be as comfortable as my current lenses?

Continue with daily cleaning and overnight soaking in fresh conditioning solution. On a weekly basis, remember to use the liquid enzyme cleaner or use solutions with built: in protein removers.

4. Will I be able to wear these lenses for driving at night?

Driving can sometime pose a problem to patients with pupils that become much larger at night. Generally, the pupils of presbyopic patients do not become large enough to cause this type of problem.

5. Where should I put my bedside light and reading material to best see with my lenses in bed?

Always make sure that your light is shining on the reading material and not at your eyes or face. The light should also not glare off the reading material when it is placed above and behind yourself as this may provide the optimal reading environment. Sit up with pillows behind you so that you can keep your head erect with your eyes lowered to read.

Appendix A: Sample form – Contact lens workup

Name: ______________________________ DOB: ____/____/____ ❑ M ❑ F File No. ____________ Date ____________
Surname Given Name(s) D M Y

Home Address ____ Tel. No. ______________(home) ______________(work)

SECTION A: History and Contraindications			
Reasons for Contact Lenses	**Medical History**	**Additional Information**	**Medication**
Yes No	Yes No		Yes No
❑ ❑ Cosmetic	❑ ❑ Allergies	Previous CL Name ____________	❑ ❑ Diuretic
❑ ❑ Inconvenience of Glasses	❑ ❑ Sinusitis	____________	❑ ❑ Dilantin
❑ ❑ Sports & Recreation	❑ ❑ Hayfever	Previous Care System ____________	❑ ❑ Tranquilizers
❑ ❑ Occupation	❑ ❑ Dryness of Mouth, Eyes or Mucous Membranes	____________	❑ ❑ Antihistamines
❑ ❑ High Rx		Current eye drops ____________	❑ ❑ Birth Control Pills
❑ ❑ Increased VA	❑ ❑ Convulsions/Epilepsy	____________	❑ ❑ Other ____________
❑ ❑ Astigmatism	❑ ❑ Fainting Spells	Currents drops with lenses ____________	(If yes see file)
❑ ❑ Aniseikonia	❑ ❑ Diabetic	____________	
❑ ❑ Aphakia	❑ ❑ Pregnant	Wearing Schedule ____________	
❑ ❑ Keratoconus	❑ ❑ Psychiatric Treatment	____________	
	❑ ❑ Thyroid Imbalance	Avocation/Activities ____________	

Do you plan to be in the area for at least 6 months? Yes ❑ No ❑ Have you worn contact lenses before? Yes ❑ No ❑
If yes, what was the reason for discontinuing ____

SECTION B: Ocular Exam Without Lenses

Uncorrected VA. (OD) 6/ ________ (OS) 6/ ________ (OU) 6/ ________

Spherocylindrical Refraction and VA (Balanced) (OD) ± ____ ______ ± ____ Sphere ________ Cylinder ________ Axis 6/ ______ VA 6/ ________ (OU)
(OS) ± ____ ______ ± ____ Sphere ________ Cylinder ________ Axis 6/ ______ VA

Keratometry (OD) ______ D ______ mm Horizontal @ ______ / ______ D ______ mm Vertical @ ______
(OS) ______ D ______ mm Horizontal @ ______ / ______ D ______ mm Vertical @ ______

Slit Lamp Are there any Positive Slit Lamp Findings? (OD) Yes ❑ No ❑ (OS) Yes ❑ No ❑
(If yes please complete Slit Lamp Form.)

Binocular Vision Status at Far ❑ Near ❑ | Tear Break-up Time OD ________ Sec. OS ________ Sec.

Diameter (mm) **Lid Tension** | **Schirmer Test** **OD** **OS**

Fissure Cornea Pupil
OD ______ ______ ______ Tight ❑ =1
OS ______ ______ ______ Loose ❑ =2
Medium ❑ =3

Hypersecretor 17mm/0-15 Sec. __________ __________
Normal 17mm/30-200 Sec. __________ __________
Subnormal 17mm/214-300 Sec. __________ __________
Hyposecretor 4-16mm/300+ Sec. __________ __________
Phenol Red Thread Test (15 sec.) OD __________ mm OS __________ mm

Preliminary Evaluation Pachymetry: OD ________ mm OS ________ mm
Motivation: High =1 ❑ Moderate =2 ❑ Slight =3 ❑
Suitability: Yes ❑ No ❑ If no, specify
Working Distances ____
Computer Work? ____
Vocation ______________________ Retired? ______________________

Appendix B: Keratometer readings conversion chart

To convert millimeters (mm) to diopters (D), use the following formula:

$$\frac{337.5}{\text{mm or}} = \text{D or mm}$$ (See appendix B: Keratometer readings conversion chart)

mm to D

mm	D	mm	D
4.70	71.81	6.65	50.75
4.75	71.05	6.70	50.37
4.80	70.31	6.75	50.00
4.85	69.59	6.80	49.63
4.90	68.88	6.85	49.27
4.95	68.18	6.90	48.91
4.75	71.05	6.95	48.56
4.80	70.31	7.00	48.21
4.85	69.59	7.05	47.87
4.90	68.88	7.10	47.54
4.95	68.18	7.15	47.20
5.00	67.50	7.20	46.88
5.05	66.83	7.25	46.55
5.10	66.18	7.30	46.23
5.15	65.53	7.35	45.92
5.20	64.90	7.40	45.61
5.25	64.29	7.45	45.30
5.30	63.68	7.50	45.00
5.35	63.08	7.55	44.70
5.40	62.50	7.60	44.41
5.45	61.93	7.65	44.12
5.50	61.36	7.70	43.83
5.55	60.81	7.75	43.55
5.60	60.27	7.80	43.27
5.65	59.73	7.85	42.99
5.70	59.21	7.90	42.72
5.75	58.70	7.95	42.45
5.80	58.19	8.00	42.19
5.85	57.69	8.05	41.93
5.90	57.20	8.10	41.67
5.95	56.72	8.15	41.41
6.00	56.25	8.20	41.16
6.05	55.79	8.25	40.91
6.10	55.33	8.30	40.66
6.15	54.88	8.35	40.42
6.20	54.44	8.40	40.18
6.25	54.00	8.45	39.94
6.30	53.57	8.50	39.71
6.35	53.15	8.55	39.47
6.40	52.73	8.60	39.24
6.45	52.33	8.65	39.02
6.50	51.92	8.70	38.79
6.55	51.53	8.75	38.57
6.60	51.14	8.80	38.35

mm to D

D	mm	D	mm	D	mm
38.00	8.88	49.00	6.89	60.00	5.63
38.25	8.82	49.25	6.85	60.25	5.60
38.50	8.77	49.50	6.82	60.50	5.58
38.75	8.71	49.75	6.78	60.75	5.56
39.00	8.65	50.00	6.75	61.00	5.53
39.25	8.60	50.25	6.72	61.25	5.51
39.50	8.54	50.50	6.68	61.50	5.49
39.75	8.49	50.75	6.65	61.75	5.47
40.00	8.44	51.00	6.62	62.00	5.44
40.25	8.39	51.25	6.59	62.25	5.42
40.50	8.33	51.50	6.55	62.50	5.40
40.75	8.28	51.75	6.52	62.75	5.38
41.00	8.23	52.00	6.49	63.00	5.36
41.25	8.18	52.25	6.46	63.25	5.34
41.50	8.13	52.50	6.43	63.50	5.31
41.75	8.08	52.75	6.40	63.75	5.29
42.00	8.04	53.00	6.37	64.00	5.27
42.25	7.99	53.25	6.34	64.25	5.25
42.50	7.94	53.50	6.31	64.50	5.23
42.75	7.89	53.75	6.28	64.75	5.21
43.00	7.85	54.00	6.25	65.00	5.19
43.25	7.80	54.25	6.22	65.25	5.17
43.50	7.76	54.50	6.19	65.50	5.15
43.75	7.71	54.75	6.16	65.75	5.13
44.00	7.67	55.00	6.14	66.00	5.11
44.25	7.63	55.25	6.11	66.25	5.09
44.50	7.58	55.50	6.08	66.50	5.08
44.75	7.54	55.75	6.05	66.75	5.06
45.00	7.50	56.00	6.03	67.00	5.04
45.25	7.46	56.25	6.00	67.25	5.02
45.50	7.42	56.50	5.97	67.50	5.00
45.75	7.38	56.75	5.95	67.75	4.98
46.00	7.34	57.00	5.92	68.00	4.96
46.25	7.30	57.25	5.90	68.25	4.95
46.50	7.26	57.50	5.87	68.50	4.93
46.75	7.22	57.75	5.84	68.75	4.91
47.00	7.18	58.00	5.82	69.00	4.89
47.25	7.14	58.25	5.79	69.25	4.87
47.50	7.11	58.50	5.77	69.50	4.86
47.75	7.07	58.75	5.74	69.75	4.84
48.00	7.03	59.00	5.72	70.00	4.82
48.25	6.99	59.25	5.70	70.25	4.80
48.50	6.96	59.50	5.67	70.50	4.79
48.75	6.92	59.75	5.65	70.75	4.77

Appendix C: Conversion chart– Near vision nomenclature

Snellen	J notation	N notation	Min. of Arc	M notation	Parinaud
20/200	J16	N32	.10		
20/160	J13	N25	.125		
20/100	J10	N16	.20		
20/80	J8	N12.5	.25	1.25M	
20/70	J7			1.0M	P 8
20/63	J5	N10	.32		P 6
20/50	J4	N8	.40	.75M	
20/40	J3	N6.3	.50	.62M	P 4
20/32	J2	N5	.64	.50M	P 3
20/25	J1	N4	.80		P 2
20/20	J1+	N3.2	1.0	.37M	P 1.5