National Academy of Opticianry

Continuing Education Course

Approved by the National Contact Lens Examiners

Toric Soft Lenses: A Historical Perspective

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Toric Soft Contact Lenses: A Historical Perspective

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Mrs. Buckland has over five decades' experience as a contact lens fitter, consultant and clinician. Upon receiving her Optometric Sciences degree in 1971 she continued Ophthalmic technician training at the University of Florida Department of Ophthalmology. She holds Master Level Certification by the National Contact Lens Examiners, is a Fellow Ambassador and previous Board Member of the National Academy of Opticianry, Honored Fellow and previous Board Member, Fellow Exam Committee, for the Contact Lens Society of America. She served on the VICA advisory committee and is a past President of the Pacific Coast Contact Lens Society.

Previous and current capacities include corporate consultant for: Barnes-Hind, Unilens, Vistakon and Ciba. Guest faculty: Baylor CL Course, Tulane-Ellender CL Course, Vision Expo, Contact Lens Society of America, Contact Lens Association of Ophthalmologists, National Academy of Opticians, Pacific Coast Contact Lens Society, Opti-Con and SECO as well as numerous state organizations. Adjunct instructor for Hillsborough, Miami Dade and St. Petersburg Opticianry programs.

She has presented thousands of accredited hours throughout the US and abroad and authored numerous articles on contact lens fitting, design, and technology.

Proprietor of Space Coast Contact Lens Consultants.

Course Description:

This course is intended to demonstrate to the participant an historical overview of fitting and design techniques observed over four decades. Designed to aid the participant in achieving greater success in the selection and fitting of soft toric lenses. This presentation will explain the various types of lens designs and modalities available for the astigmatic patient. An explanation to the participant on how to gain skills to be able to objectively address fitting as well as follow up challenges will be discussed.

Objectives:

1. Identify various types of astigmatic visual anomalies requiring toric lens correction
2. Evaluate current soft toric designs and characteristics
3. Explain current soft toric fitting techniques, modalities and problems solving

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Introduction:

In the era of the electronic age, there remains today, a few contact lens pioneers who were thrust into the contact lens arena with few tools. "Pre-computer age" fitters met challenges by applying basic optical principals and "seat of the pants" experience.

Utilizing the wealth of knowledge acquired by hands-on experience as well as interactive experiences over a span of more than four decades; it is the author's intent to bring to anyone interested or engaged in the fitting of toric lenses, a treasure trove of fitting wisdom in a Q&A format.

In the annals of contact lens history, there was a time when the fitting and design of toric soft contact lenses struck terror in many the heart. Not unlike present day, early fitting concerns were in areas of vision, orientation, stability, and comfort. N area of concern was: "could the lens be replicated in the event of loss or damage?"

In earlier days, guidelines for toric soft lens fitting and manufacturing were erratic. The manufacturing process of a toric soft lens varied from one lab to the next with a lot of "guess work" involved. One of the major difficulties involved the process to create "toricity" in the lens. Some manufacturers utilized a technique called "hand crimping" (bending) of the plastic creating the toric surface of the lens. This process was commonly used on "rigid" Poly (methyl methacrylate) or: PMMA materials and was extremely difficult to replicate. Additional problems centered on finding out how hydrophilic materials reacted to lathes which were originally designed to machine rigid lenses. In a dehydrated state, the tremendous heat produced from these lathes created a significant amount of warpage and distortion in the finished soft lens products. Unlike their PMMA predecessors, who could withstand higher heat; soft lenses simply could not, without risk of damage. Supplemental water sources were introduced to cool lathes during the process. Another issue was there being no accurate method to verify or measure lenses once hydrated. Optics were measured utilizing handmade devices; originally designed for neutralizing spherical soft lenses. These "water cells" housed the lens suspended in a saline solution; so, the lens could be mounted and neutralized on a conventional lensometer. Tables were formulated to convert the power reading in a hydrated state, from the un-hydrated lens power.

Utilizing this gross method of measurement presented even more guess-work when it came to toric lens verification. These methods involved so much "guesswork"; it was a wonder that any of these lenses worked at all. There is a lot to be said for 'practice" makes perfect; in time the bugs were worked out and a new era of "mass produced" toric soft lenses was born.

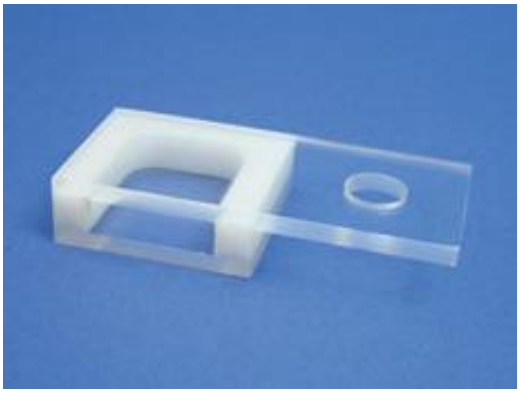


Fig. 1 *Modern version (Poster Wet cell for Inspection and neutralization)*

In the early 1980's there were a handful of "pioneers", utilizing toric soft lenses manufactured in the US, Canada, Japan and Europe. Some were fortunate to participate in early clinical trials and had the opportunity to work with many of the earliest designs.

Fig. 2 *Vistamarc® Toric Soft Lens*

ECPs at that time struggled for a successful fit and often relied on sheer luck when fitting earlier designs. Prototype lenses were thick, uncomfortable and had questionable optics. The manufacturing process was in its infancy as were soft lens materials. Many materials were not durable enough to support the rigors of the manufacturing process; some lenses disintegrated in the fitter's hands or worse yet, the patient's eye. Many were the times spent searching for fragments of split lens pieces under a patients' lid!

In the mid-1980's Barnes-Hind /Hydrocurve Inc. became one of the pioneers in the manufacture of specialty contact lenses and solutions. They helped set the stage as one of the first major contact lens manufacturers to implement a consultation team. It was the consultant's job to handle everything from designing the appropriate specialty soft lens; to addressing fitting and care system issues. During a typical phone consult, a tremendous amount of empathy ensued while dialoging with the ECP's regarding toric soft lens fitting frustrations; (note that manufacturers were dealing with similar issues.) Barnes Hind also instituted "in field" fitting sessions, seminars and produced training videos, designed to instruct ECPs on the most efficient way to design, select, fit and manage specialty contact lenses. The dawn of the digital age for the contact lens industry had begun!

Fitting guides or aids were grossly limited in their content; however, an attempt was made to provide relevant fitting guidelines as well as technical fitting advice in understanding how to best use products. Given the technology of the day, the end results were often less than hoped for; early lens designs were difficult to manufacture, it was considered a good day if several lenses in the same power and parameters could be replicated in bulk. Additional lenses were often kept in "batches," with lot numbers to identify their origin. Following inspection, lenses were autoclaved and placed in job trays to be kept "in reserve." When an ECP would call for a replacement lens, a consultant would scour through hundreds of pages of lofty computer printouts to locate the original order and lot number. Often remaining lenses in a given lot number would be sent to the ECP with a note stating: "this is the balance of remaining lenses from the original batch, once these lenses are depleted future duplication will be unlikely… especially in higher powered lenses."

As if duplication problems weren't enough, there were perplexing (albeit sometimes humorous) reminders of consultation dialog. Picture the scenario: an ECP calls to explain his patient is having stability issues with an XYZ toric lens; when inquiring as to the age of the lens, the ECP explains the present lens is approximately six months old. The ECP states he wants to replace the lens and order a new lens with a change in axis, based on a 30°-degree rotation observed in his evaluation. The thought of the consultant was; "how did the ECP arrive at the 30°-degree rotation?" At that time, there were only a handful of somewhat crude methods of rotation evaluation and measurement, (which will be discussed later in this paper.) Upon further deliberate questioning, the ECP was asked: "Was any sort of protractor or measuring device utilized in the evaluation of the rotation; was the ECP aware that 30° degrees of rotation equal an entire clock hour?" A common mistake at that time was that 30° degrees of rotation equaled 30 minutes on the clock face. The second question inquired if the patient's current refractive axis had changed, (the ECP stated it had not.) Then ever so politely the ECP was asked: "why do you feel adjusting the axis on the lens will correct the problem?" After allowing the ECP to ponder a few moments the direction was quickly moved to the final question, "can you describe the condition of the lens surface?" The ECP replied that the lens was entirely coated with some sort of "debris" and admitted that when the patient blinked the lens appeared to be rotating and "sticking" to the lid. After suggesting a thorough cleaning of the lens surface the problem was solved! Wouldn't it be great if all toric soft lens fitting issues had that happy an ending?

Thanks to tremendous advances in materials and technology, early manufacturing problems have long since been eliminated. The advent of automatic lathes and molding processes has eliminated much of the earlier manufacturing as well as optics issues. Fitting toric soft contact lenses has become part of everyday practice. Designs, materials, and modalities, as well as custom lens availability, are numerous; manufacturers have been listening. Diagnostic fitting sets and inventories are available with such vast range powers and parameters, most patients can be fit out of inventory with little to no guesswork.

A major player in the increase of toric soft lens fitting success today is lenses are reproducible. They are manufactured from more durable plastics allowing lenses to be cut

thinner providing increased comfort, superior optical qualities, and consistent stabilization design characteristics. However, there is a key factor that must always be considered, each patient is unique and ECPs should be prepared for dealing with situations which are “out of the box” and often challenge clinical judgment.

The experience of conversing with ECPs from around the globe prompted an eagerness to understand the mechanics of toric soft contact lenses as well as how best to minimize chair time and maximize success. Ironically, consultants in the present day are tackling questions not that different from those asked in consultation decades ago.

Concerns that have grown to be commonplace with toric soft lens fitting may surprise the novice; for those ECPs new to fitting toric lenses, this advice will hopefully make the toric soft lens fitting experience easier and rewarding.

The following samplings were taken from a host of several of the most prevalent soft toric lens dialogs submitted by real ECPs and contact lens fitters. The following Pearls and gems” are a by-product of many of those dialogs.

Do toric soft lenses work for all types of astigmatism?
The answer is most likely yes but would depend on the choice of lens design. By nature, ATR (*against-the-rule*) and/or *lenticular* astigmatism tend to force rotation against the lenses instinct to rotate towards the steepest meridian. As long as the lens stays stable, the goal is to maximum neutralization of the refractive error. If this is not possible a sphero-cylinder over refraction (SCOR) must be performed to determine residual cylinder. [See accompanying definitions.]

Often, we hear astigmatism classified as regular or irregular. In “regular” astigmatism, the principal meridians are 90 degrees apart (perpendicular to each other). In “irregular” astigmatism, the principal meridians are not perpendicular. Most astigmatism is regular corneal astigmatism, which gives the eye a shape similar to a football.

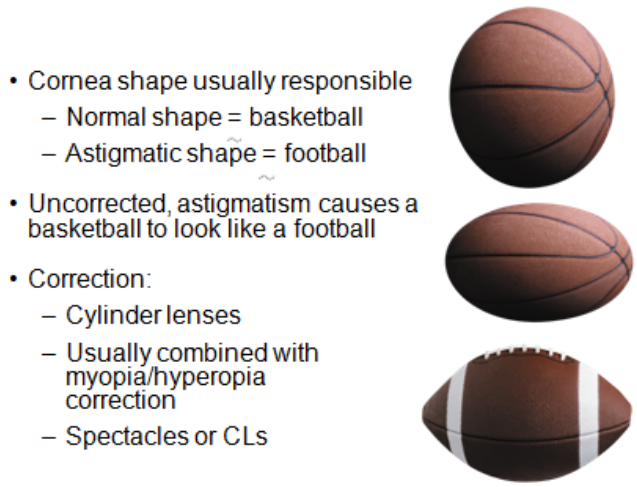


Fig. 3 Description of eye shapes

Key Points:

Corneal astigmatism: a result of the presence of abnormal curvatures on the anterior or posterior surface of the cornea

Regular astigmatism: the refraction changes gradually in power from one principal meridian of the eye to the other; the two meridians always being at right angles. This condition is classified as: *against- the- rule* (ATR) when the meridian of greatest refractive power tends toward the horizontal; it is classified as *with-the-rule* (WTR) when it tends toward the vertical. Lastly, it is classified as *oblique,* when it lies 45 degrees from the horizontal and vertical meridians.

Myopic astigmatism: one or both principal meridians of the eye are myopic; light rays are brought to a focus in front of the retina

Hyperopic astigmatism: one or both principal meridians are hyperopic; light rays are brought to a focus behind the retina

Mixed astigmatism: one principal meridian is hyperopic and the other myopic
compound astigmatism: both principal meridians are either hyperopic (*compound hyperopic astigmatism*, with rays coming into focus behind the retina) or myopic (*compound myopic astigmatism*, with rays coming into focus in front of the retina)

Irregular astigmatism: the curvature varies in different parts of the same meridian or in which refraction in successive meridians differs irregularly

Lenticular astigmatism: a defect in the curvature, position, or index of refraction of the crystalline lens

In cases involving *with-the-rule astigmatism*, (WTR); (-) minus cylinder is in the horizontal axis to correct or neutralize the refractive error; or in cases of *against-the-rule astigmatism*, (ATR); (+) plus cylinder is in the horizontal axis; Stability of the contact lens is tantamount.

In certain instances, *irregular astigmatism* can result from an eye injury or trauma which has led to scarring of the cornea; or in cases of post-surgical complications such as: Laser-assisted in situ Keratomileusis (LASIK), Photorefractive keratectomy (PRK), ocular disease such as Pellucid marginal degeneration (PMD) or; Keratoconus, a degenerative disease that causes a gradual conical steepening and thinning of the cornea. Often in cases such as these, custom designed toric soft contact lenses should be considered and discussed with manufactures specializing in custom products.

In cases of lenticular astigmatism, the preferred method of determining if the diagnostic (Dx) lens provides maximum correction is determined by an over-refraction. If the patient requires additional cylinder correction located at a different axis from the spectacle Rx; a front toric or bi-toric GP should be considered.

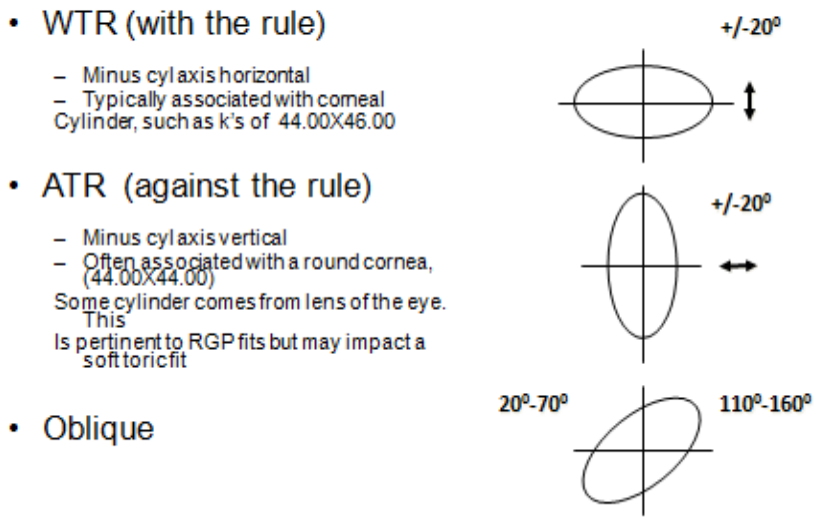


Fig. 4 Classification of Astigmatism Schematic View

Discuss methods of measuring/determining astigmatism

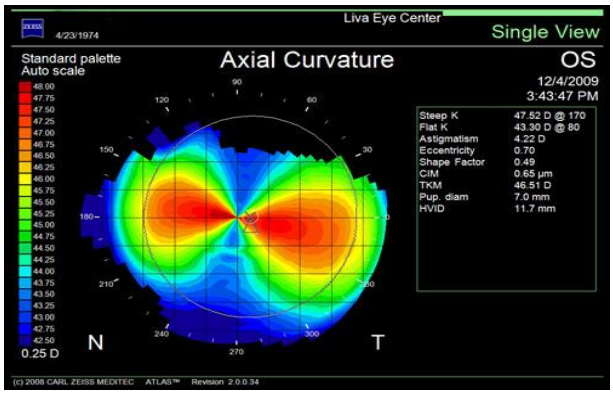
There are a number of diagnostic tests used by ECPs to aid in determining the presence of astigmatism as well as quantify cylinder amount and axis. One of the first instruments utilized to determine corneal curvature was the Keratometer which later went on to become a staple for all contact lens fitting. The Keratometer is used to evaluate the curvature of the cornea by measuring the steepest and flattest meridians on the cornea's front surface then estimating the amount of astigmatism by calculating the difference in power between the two primary meridians of the cornea.

Fig. 5 *Traditional Keratometer*

The preferred method of measuring corneal curvature to date is corneal topography (often referred to as topographical keratometry) which may be used to obtain a more accurate representation of the cornea's actual shape, as well as location and dimension of the cylinder or irregularity.

Corneal topography has become an invaluable tool for evaluating high and/or unconventional cylinder. If the patient informs you they would just rather wear glasses, this is the time to show them their corneal map and explain how spectacles cannot correct for corneal aberrations and distortions. Explain to the patient that; a contact lens aids in creating a new corneal surface, which allows for a broader range of vision. Spectacles are limited to the edge of the frame and cannot minimize distortion or image size the way a contact lens can.

Fig. 6 *Topographer*



g. 7 *Topographical map of an Astigmatic cornea*

Retinoscopy may also provide an objective estimate of the eye's refractive error. The use of “Jackson” cross cylinders in a phoropter or trial frame may be used to subjectively refine those measurements. An alternative technique with the phoropter requires the use of the "clock dial" or "sunburst" chart in the phoropter to determine astigmatic axis and power.

Fig. 8 *Hand-held Cross Cylinder*

Fig. 9 *Phoropter*

Should patients expect good comfort initially when a toric soft lens is applied?
This depends on how the characteristics of the new contact lens differ from the previous contact lens, especially if the previous lens was a spherical design. A few patients may notice greater “awareness” when switching from one brand of toric lens to another; especially if the ballast mechanism is located in a different area on the lens. Some patients may experience the same type of sensation transitioning from a prism ballast design to a thin-zone design (“old shoe/new shoe” analogy). Assure the patient that they should feel completely comfortable with their contact lenses within the recommended adaptation time.

What is the purpose of orientation/scribe marks?
Orientation marks have a definitive purpose that of giving a “reference point” to aid in determining lens position and rotation. In prism-ballasted designs, the orientation (also referred to as scribe marks) will typically be in the same position as the prism base. Recent designs incorporating a horizontal ballasting system will generally have markings located at the 3 and 9 o/c position. Some earlier lens designs also incorporated this marking system as it was argued rotation amount was easier to calculate. What is important to note is that for each lens of similar design the rotation must be *consistent, verified and recorded.* It is important to be familiar with scribe mark position as well as the amount of separation (in degrees) for each modality of lens applied so that rotation can accurately be determined.

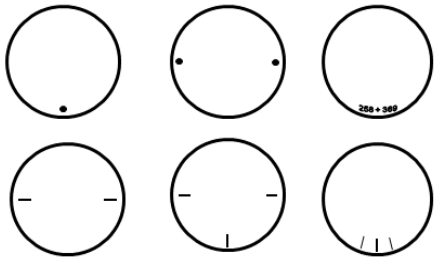


Fig. 10 *Orientation Marks*

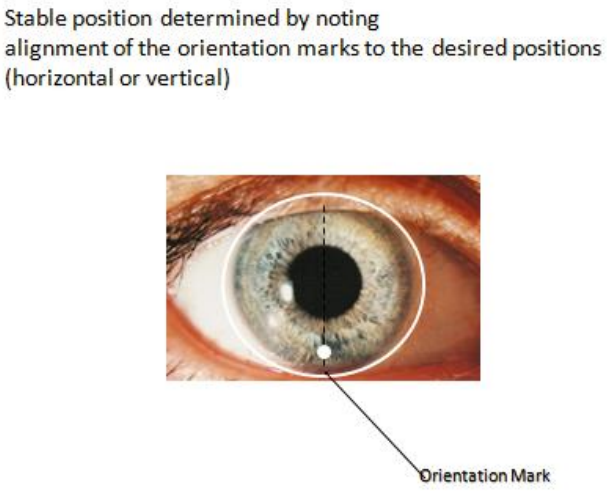


Fig. 11 Lens *Orientation at 6 O'clock*

KEY POINTS:

- *The orientation/scribe marks are placed on the lens to identify the location of the ballast or stabilizer*
- *Recognize the position of orientation marks for each selected lens modality*
- *Verify degree of separation of orientation marks*
- *Orientation mark(s) are present on all conventional soft toric lenses*
- *Orientation marks "DO NOT" indicate the location of the cylinder axis*

Is there a top or bottom of the lens, or can it be inserted either way?

Some toric lenses are stabilized with" prism-type" ballast, located at the 6 o'clock position on the lens. Prism ballasted lenses have a 'top' and 'bottom' – the bottom being the area of maximum thickness. This lens design should be placed on the patient's eye with the prism roughly in the inferior (6 o'clock) position. If the lens is not applied in this way, it will usually orient correctly after several light blinks. Occasionally, if placed on the eye with the thick base at 12 o'clock, the lens can get caught by the upper lid and prevented from orienting properly. Most toric lenses will be marked with a designated form of identification which alerts the ECP as well as the patient as to where the identification should be placed when positioning the lens.

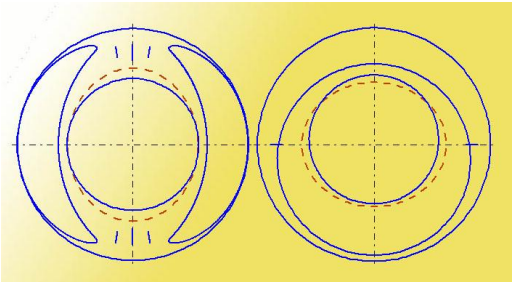


Fig. *12 Prism-Ballast soft toric lens inserted out of position*

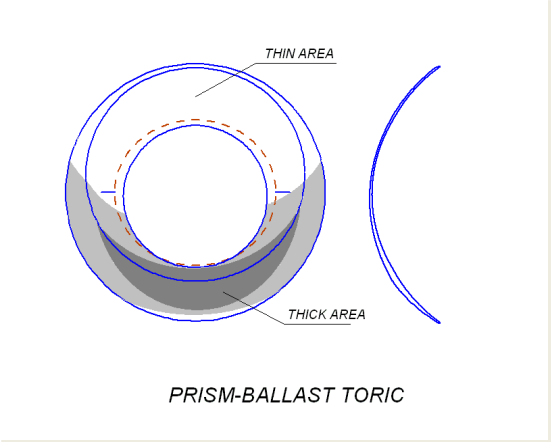


Fig. 13 Prism Ballast Stabilization

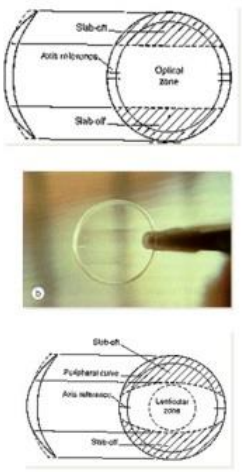


Fig. 14 *Dynamic Stabilization; also referred to as "thin zones"*

- Prism ballast designs position primarily by virtue of upper lid interaction, which may cause variation of lens positioning based on the direction of gaze; (such as downward gaze while reading.)
- Down-gaze creates torsional effects which may interfere with visual performance: **<u>Torsion</u>** (as defined by Merriam-Webster: "The twisting or wrenching of a body by the exertion of forces tending to turn one end or part about a longitudinal axis while the other is held fast or turned in the opposite direction; *also*: the state of being twisted."

There are additional designs which incorporate "thin zones", as well as horizontal stabilization techniques. It is recommended that if the patient experiences rotation issues after adjusting the base curve, choosing a lens with a different stabilizing mechanism should be considered. Lid interaction; as well as lid configuration plays a vital part in lens positioning.

Note: The purpose of any stabilization system is to minimize rotation

A few designs are currently available, utilizing a uniformly increasing thickness gradient from the superior portion of the lens to the inferior portion of the lens. These designs may also be referred to as “dual thickness regions” which are located on either side of the optic zone. These designs are referred to as Accelerated Stabilization Design (ASD) and/or (Lo-Torque®.)

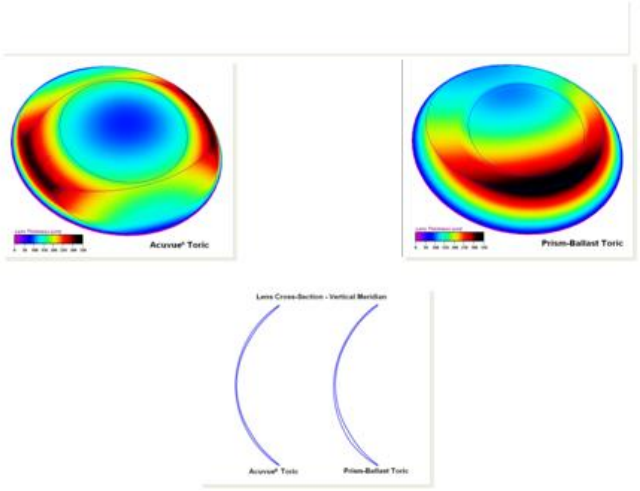


Fig. 15 *Horizontal “thin zone”, compared to prism ballast*

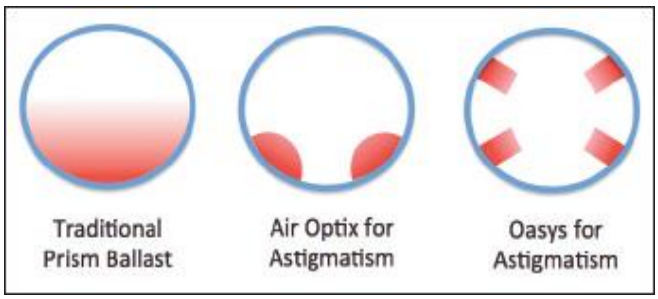


Fig. 16 *Traditional ballast design compared with two newer designs*

Key Points:

Factors affecting rotation:

- Soiled lens: (lens could stick to lid upon blink or move excessively)
- Lid configuration: (tight lids tend to force nasal decentration)
- Tight lens: (lens could flex causing the lid to “grab” lens)
- Flat/loose lens: (may cause inconsistent rotation or inability of the lens to stay on the eye)

Fig. 17 Narrow *palpebral aperture, ex: "epicanthal folds"*

Should it be assumed that a diagnostic lens (Dx) will rotate either nasally or temporally when applied, and how should the axis be selected?
It cannot be assumed that a soft toric lens will rotate. The initial diagnostic lens Rx choice should be as close as possible to the spectacle Rx. Do not make any assumptions about a clockwise or counterclockwise rotation before placing the first diagnostic lens on the eye and allowing time for the diagnostic lens to equilibrate.

Is rotation adjusted from the ECP's observation point or the patient's?
The adjustment for any toric lens rotation is made from the observers' position.

How much lens rotation is acceptable?
Whether rotation is considered acceptable is based more on the *stability* of the rotation than the *amount* of rotation. Therefore, if the lens is stable, after assessing visual performance, simply compensate for the amount of rotation.

It is important to recognize that while not all lenses have the same ballasting system, they all strive to accomplish the same thing – namely, a consistent and predictable rotational position. Patients differ from the configuration of their lids to individual corneal topography, tear film as well as chemistry. It is not uncommon for these differences to have an effect on the positioning of the lens. As will be later described the ballast or stabilizing mechanism is incorporated into the lens design to keep it *stable*, recognizing that a stable lens may not position in the identical location on every eye. Therefore, for any given toric contact lens design, if there is rotation, the ECP must initially assess the amount of rotation. To confirm that the lens stays stable, try the "rotation return test". Manually rotate the lens approximately 20 degrees and allowing it to re-position naturally. This simple test will provide confidence in the evaluation of the long-term lens rotational stability of the lens.

How is lens rotation measured?
ECPs engaged in fitting toric lenses for some time can generally judge rotation based on calculating from a clock face based on the; "one clock hour equals 30 degrees of rotation" technique. Most slit lamps today possess a built-in protractor on the slit lamp housing. An older technique used with good results is placing a Plano loose trial lens with a line drawn at the 180 meridian in a trial frame and positioning the line over the orientation marks on the lens and measure accordingly from the protractor on the trial frame.
Note: each clock hour = 30 degrees

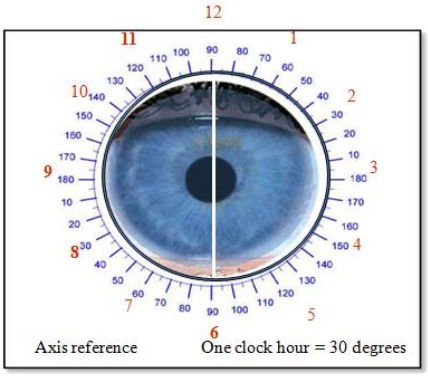
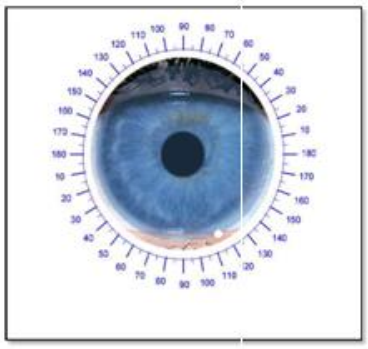


Fig. 18 *Clock hour rotation indicator*

When consistent rotation is observed, how is it compensated for?
Compensate for the amount that is indicated by the initial evaluation. Rely on the assessment of rotation by either using the protractor on the biomicroscope (slit lamp) or preferred method; scribe mark separation will assist in judging rotation.

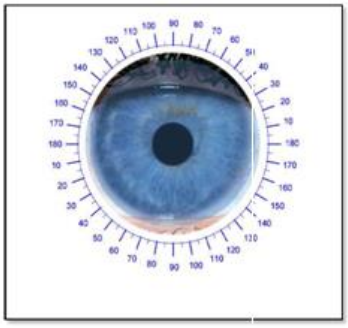
Consider using either the LARS or CATS method to determine the direction of the rotation compensation.

LARS method:
L= LEFT
A = ADD
R = RIGHT
S = SUBTRACT



A lens rotating 15° left (clockwise) like this one needs to have the optics "compensated" (turned) 15° *the opposite direction* (right) so that the optics will be in the correct place for the patient's vision. (next dx lens)
"Left Add"

Fig. 19 *15° clockwise rotation*



A lens rotating 15° right (counter-clockwise) like this one needs to have the optics "compensated" (turned) 15° *the opposite direction* (left) so that the optics will be in the correct place for the patient's vision. (next dx lens)
"Right Subtract"

Fig. 20 *15° counterclockwise rotation*

For lenses marked/scribed at the 3 and 9 o'clock position, it is traditionally easier to use the CATS method:

C = CLOCKWISE
A = ADD
T = COUN*T*ERCLOCKWISE
S = SUBTRACT

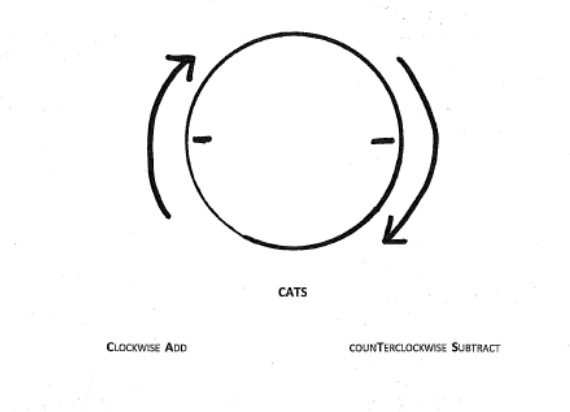


Fig. 21 *Description of: C.A.T.S.*

Key Points:

- *When a toric lens rotates, the power of the lens no longer corresponds to the power the eye requires*
- *Lens rotation can lead to blurred vision, depending on the power of the Rx and/or the amount of rotation*
- *Lens rotation can be adjusted for or: "compensated"; "compensation" simply means putting the optics where the eye needs them when a toric lens rotates*

- *Rotation, if any, must remain stable*
- *The new lens must rotate to the same position as the diagnostic lens*
- *Perform the "Rotation Return Test" to qualify/quantify rotation*
- *Rotation information is an integral part of the CL Rx*

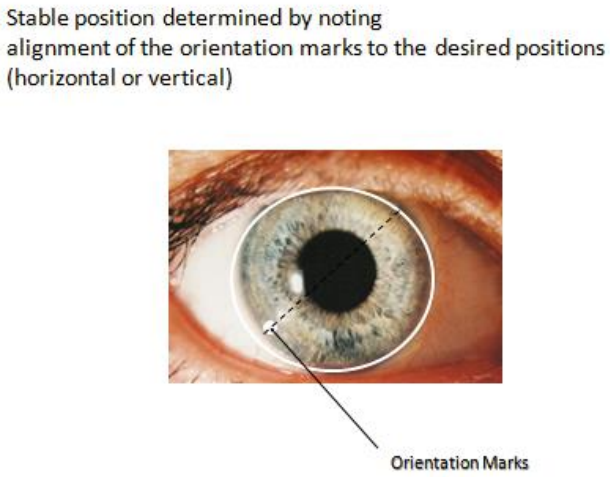


Fig. 22 Lens *Orientation*

What is meant by Nasal or Temporal?
Some ECPs will describe rotation as "nasal" or "temporal," try to discourage this calculation as it will add the additional element of error introduced because the affected eye must be determined.

- *Nasal rotation in OD is noted: Right or Counter Clockwise*
- *Temporal rotation in OD is noted: Left or Clockwise*
- *Nasal rotation in OS is noted: Left or Clockwise*
- *Temporal rotation in OS is noted: Right or Counter Clockwise*

Which axis should be selected if the refractive cylinder axis falls equally between available diagnostic lens axes?
If the refractive axis falls between the available diagnostic lens axis, it is recommended that either available diagnostic lens is used. Try using a lens axis closest to the 90 or 180 meridians. This is less important in lower cylinder powers where a 5-degree minimal rotation may not be clinically significant.

NOTE: *Not all lenses are available in "round the clock axis*"

How is the toric soft lens Rx calculated?
Follow the manufacturer's recommended guidelines, at least during the "initial" fit stage; or until familiar with the particular product.

Key Points*:*

- *Be certain to transpose first!*

SIMPLE TRANSPOSITION:

- Convert to minus cylinder
- For the new sphere power, algebraically add together the sphere power and the numerical amount of the cylinder.
- Change the sign of the cylinder power.
- Change the axis by 90°
    - if the axis numerical amount is 90° or less, add 90°
    - If the axis numerical amount is greater than 90° subtract 90°

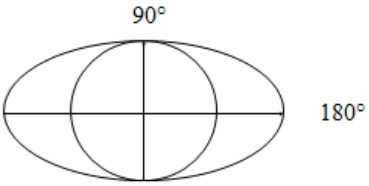
If adjusting for vertex distance is required, should the amount adjusted be included in the cylinder component of the Rx as well?

Do not forget to vertex the astigmatic meridian; this can result in the patient being over corrected in cylinder amount which adversely affects acuity.

- *Vertex distance = the distance between the corneal surface and posterior of any lens*
- *Refracted vertex distance has been historically measured at 12 (mm) millimeters however it must be determined/measured accurately when working with any refractive power greater than + or - 4:00 D*
- *As any prescription gets closer to the corneal plane, it requires more plus/less minus power to neutralize the corneal plane*
- *Vertex charts aid in illustrating the amount of adjustment required for vertex adjusted power*
- *NOTE: Adjustment amounts increase as the refractive Rx gets stronger*

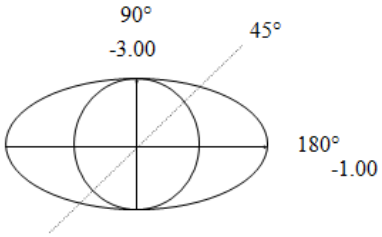
Ex: spec Rx = -9.75 CL Rx = -8.75
Ex: spec Rx = +6.00 CL Rx= +6.50
Ex: spec Rx = -5.00 CL Rx = -4.75

To visually describe the vertex distance component in a toric prescription refer to an optical cross and consider the total power in each principal meridian.



•The optical cross is a "map" of the power in the major meridians of a particular eye.
•Major meridians = the meridians of least and most power, always 90° apart. Ex: 90/180; 30/120; 53/143.
•There is a continuum of power between the two meridians (gradual change)

Fig. 23 *Optical Cross*



An astigmatic (toric) Rx means the meridians are differing powers
This demonstrates –1.00-2.00 X 180
The "cyl" is the difference between the major meridians (most and least powered meridians)

Fig. 24 *Optical Cross describing an astigmatic Rx:*

Example 1:
Spectacle Rx: -6.00 -1.75 x 090. In this example the - 6.00 vertex adjusted power is -5.50; the total combined power for both meridians is -7.75. The vertex adjusted power is -7.00; the resulting contact lens Rx would be: -5.50 -1.50 x 090. [Assumes a 12 mm vertex distance.]

Example 2:
Spectacle Rx: +6.00 -1.75 x 090. In this example, the +6.00-vertex adjusted power is + 6.50; the total combined power for both meridians is +4.25. The vertex adjusted power is +4.50; the resulting contact lens Rx would be: +6.50 – 2.00 x 090.

- Toric (astigmatic) lenses have two focal points, so both must be considered for vertex adjustment if the power exceeds +/-4.00D
- It is helpful to plot the optical cross to visualize power change

- Toric (astigmatic) lenses have two focal points, so both of them must be considered for vertex adjustment if +/-4.00 or greater
- Helpful to plot the optical cross to visualize

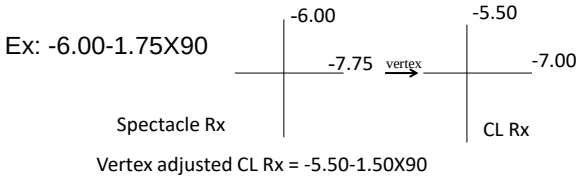
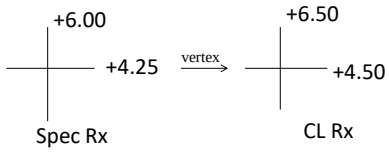


Fig. 25, Ex. 1

- Ex: spec Rx = +6.00-1.75X90



Vertex adjusted CL Rx = +6.50 – 2.00 X 90

Remember that the 'cyl' is the difference between the two meridians

Fig. 26, Ex. 2

Remember to vertex the combined powers of BOTH the axis and the meridian! Both meridians do not always require compensation. If the combined powers of both meridians DO NOT sum to 4.00D or greater, there is no need to vertex the cylinder.

Example:
Spectacle Rx: -3.00 -3.50 x 180. In this example, the -3.00 axis does not need to be vertexed because it is less than 4.00D; however, the combined power with the other meridian is -6.50 total power. The vertex adjusted power is -6.00. The resulting CL Rx would be -3.00 – 3.00 x 180.

Is it necessary to have diagnostic or "trial" lenses?
There will come a point in time when the comfort level increases as hands-on experience increases. Often ECPs inquire as to what is the best diagnostic lens to have available for trial application. This is a tough answer as most manufacturers have diagnostic sets or "dispensing" sets that allow fitting directly from inventory. This method can be extremely

successful with conventional fits as it allows the ECP to evaluate the fit and the rotational stability and provide “on the spot” service. It is recommended to communicate with multiple manufacturers and decide what your practice can afford. Most manufacturers offer diagnostic contact lens “fitting/dispensing” sets with minimal investment. It would be advised to incorporate several designs with varying stabilization properties as well as a broad range of powers and parameters. Disposable and/or frequent replacement diagnostic lens options offer the added advantage of allowing the patient to evaluate different lens modalities.

How much cylinder can a toric diagnostic lens compensate for?
It depends on the design as well as the vertex adjustment, as shown here:

Spectacle Rx: –5.25-2.75 X180 CL Rx: –5.00-2.25 X180
Diagnostic Lens: -5.00 – 1.75 x 180

In this example, the diagnostic lens applied is a lower cylinder than recommended because the only available diagnostic lens was a -1.75 cylinder power. In this case, the lower cylinder may be acceptable as many toric lenses are thicker by design and may “mask” a small amount of corneal cylinder. To determine if the lens thickness is providing additional correction; perform an over refraction to quantify results once the diagnostic lens has settled.

When using fixed cylinder diagnostic lens powers, it is important to determine whether the patient might tolerate a lower or higher cylinder power. It can be useful to over refract using 0.50D of cylinder power on axis as well as 90 degrees away; to determine if the amount of astigmatic power in the Dx contact lens is appropriate. If the patient accepts the 0.50D on axis, they may need additional cylinder power; if they prefer their vision with the 0.50D cylinder 90 degrees away, they may benefit from a reduction in lens cylinder power.

When in doubt try a lower cylinder power initially; and be aware that some toric soft lens designs are limited in cylinder power.

BE CERTAIN TO VERIFY WITH THE MANUFACTURER THAT THE LENS YOU ARE FITTING IS AVAILABLE IN THE PARAMETERS REQUIRED

How much should be compensated for rotation?
As much as is determined by observation techniques

Key Points:

- *Verify location of orientation marks*
- *Calculate the amount of rotation: (protractor or preferred method)*
- *Calculate over refraction, and/ or SCOR (sphero cylinder over refraction)*
- *Compensate for rotation: (LARS/CATS)*
- *Record the amount and location of the rotation as part of the Contact Lens Rx*

Following compensation for axis rotation of the diagnostic lens, where should the new lens position?
The new lens should orient identically to the initial diagnostic lens. The Dx lens should determine how a chosen lens design orients on a patient's eye. The orientation of some lens designs can be dependent on where the cylinder is located in the lens. Other designs are more likely to be consistent regardless of sphere, cylinder or axis changes; an example would be, that in which the stabilization system is independent of the optical system.

What is "Cross Cylinder?"

Fig. 27 Jackson *Cross*

The invention of the cross cylinder can be traced back to the early 19th century. The trial lens sets of that era contained no cylindrical lenses; when such lenses were prescribed, they could be obtained only on special order from a few laboratories…Although Jackson did describe his findings, it remained for W.H. Crisp, a more prolific writer, to bring this device to worldwide attention. The form of the instrument is a fixed arrangement of a plus and a minus cylinder, axes perpendicular, with a handle placed between the two axes…The question of the possible spherical component of the cross cylinder and its effect on the final correction has not been settled. This question has nothing to do with the rotation of the lens or whether it is ground as two cylinders or as one sphere and one cylinder, but it is concerned with the total effect of the lens on the object viewed, … Jackson et al believed that the cross-cylinder acts as two separate cylinders; ... but does not change the spherical power. Opposing arguments contend that spherical power has been added to the correction by the cross cylinder and that this must be compensated for when the cross cylinder is removed. [1]

What is a "Vector"?
A vector is a quantity or phenomenon that has two independent properties: magnitude and direction. The term also denotes the mathematical or geometrical representation of such a quantity.

This is a vector:

A vector has **magnitude** (how long it is) and **direction**:

What happens if the axis of the contact lens does not match the axis of the refraction?

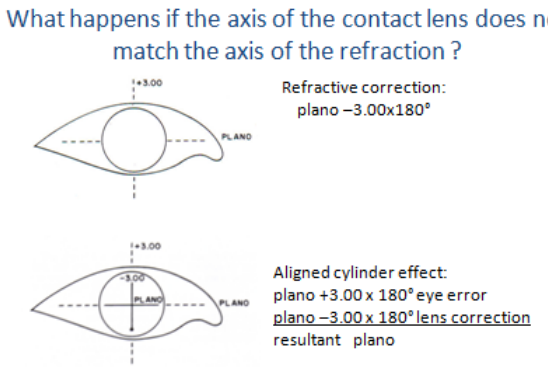


Fig. 28 *What Happens…*

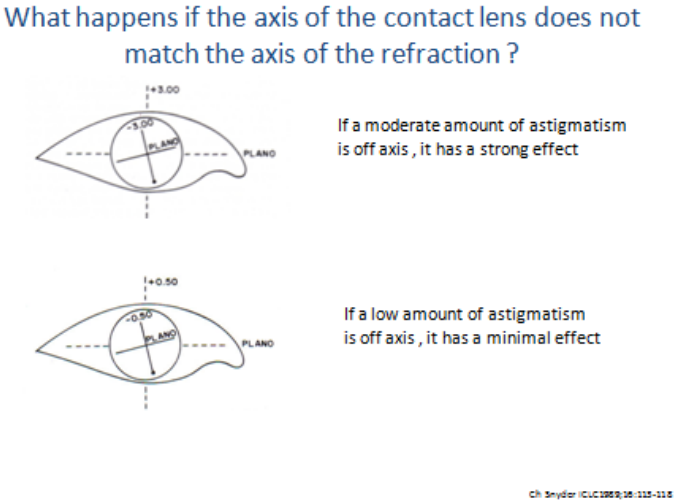


Fig. 29 *What Happens …*

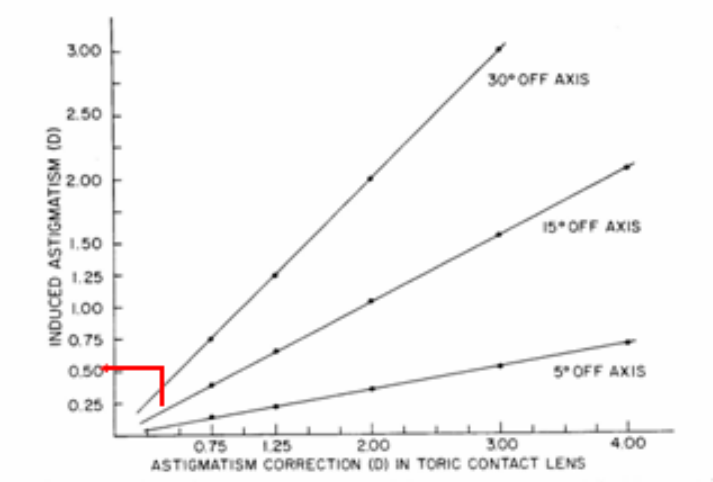


Fig. 30 15° misalignment

Axis misalignment	residual astigmatism
5°	0.12D cyl
13°	0.20D cyl
14°	0.30D cyl

Formula : $Ca = \frac{1}{2} \text{ Arc Cos}(1 - \frac{1}{2}(Co/Cr)^2)$

Ca = error in cyl axis
Co = residual cyl
Cr = cyl power

Fig. 31 Axis misalignment formula

It may not always be necessary to perform SCOR (sphero-cylindrical over-refraction) for today's soft toric lenses. The goal is for the lens axis to be rotationally stable and superimposed over the refractive cylinder axis of the eye. If the diagnostic lens rotates to a stable final orientation, it may not be necessary to compensate for the rotation. Small

amounts of rotation may be easily tolerated. Once the lens has stabilized, perform a sphero-cylindrical over-refraction and let the visual response be the guide. If vision is satisfactory, no axis compensation will be necessary. Adjust the sphere power if necessary and select from diagnostic lenses or order the appropriate lens. If the vision response is not satisfactory, an adjustment for axis rotation should be made according to the LARS or CATS method previously described; as well as calculation for over refraction if indicated.

Any one of the following factors could lend to the rotation assessment and/or over refraction becoming unreliable. The fit of the lens can significantly alter the over refraction, especially in higher powers. Previous experience dictates: a lens fit too steep will produce a plus tear lens requiring additional minus to compensate, a lens fit too flat fit will require additional plus to compensate for the negative tear film.

Although some manufacturers will suggest less equilibration time, if possible allow ALL diagnostic lenses to equilibrate for a minimum of 30 minutes to verify that the lens is fitting optimally.

When an over refraction does not indicate a power change, how should rotation be adjusted?
Calculate the amount of rotation using a protractor or other preferred means. Add or subtract the rotation amount from the axis of the spectacle Rx; NOT the axis of the diagnostic lens when calculating the final parameters.

Is there help available for the math challenged?
Some manufacturers assist in the fitting process by recommending SCOR, as well as offering “computer assisted” conversion methods to calculate cross-cylinder. These devices and formulas have been extremely beneficial when vision results are less than optimum.

Most ECPs today simply do not have the time or resources available to calculate formulas and vector conversions, fortunately, most toric lens manufacturers offer “toric calculators.” These amazing tools are readily available online to allow the fitter the option to enter all necessary fitting data. Although these calculators are a wonderful tool, the fitting characteristics of the lens must still be considered; was it an acceptable fit; OR was it too steep, too flat, or decentered?

To use the calculators, input the spectacle Rx, contact lens power, and the SCOR, the calculator will then take into account; the power of the diagnostic lens, over refraction, rotation, then mathematically compute the new power and axis.

When would an aspheric modality be recommended?
For a patient with minimal corneal cylinder (usually less than 0.75D); it may be possible to correct most if not all the cylinder utilizing an aspheric design. If the patient has a similar

Rx in both eyes, consider trying an aspheric design initially in one eye, and evaluate the outcome. If no significant change is noted and/or the over refraction results in the patient still requiring more cylinder, then it is recommended a toric design be utilized.

Key Points:

- The “normal” human cornea is aspheric - it is flatter in the periphery than it is in the center
- Correcting the aspheric cornea with spherical lenses can result in optical aberrations
- Correcting the aspheric cornea with aspheric contacts can reduce aberrations

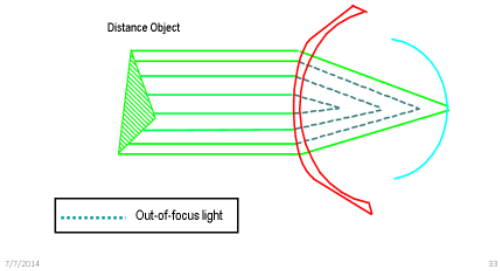


Fig. 32 *Aspheric Design Definition*

What has been the visual performance on refractive low cylinder with toric soft lenses?

Correcting even low amounts of refractive astigmatism has proven to lead to high levels of patient satisfaction

Key Points:

- *On most astigmats correcting even low cylinder provides:*
- *Improved Snellen acuity over spherical lenses*
- *Snellen acuity equal to or better than spectacles*
- *Reduced glare at night*
- *Reduced eye strain relating to extended electronic device viewing*
- *Consistency of vision*

Describe a “plus” toric

Plus Toric means the cylinder component of the Rx is written in plus form. Contact lenses are not prescribed or available in plus cylinder.

Ex.: +2.50 – 1.25 X 90 (hyperopic astigmatism) = +1.25 + 1.25 x 180

“Plus cylinder” is just a different way of writing an astigmatic Rx. It is traditionally used by Ophthalmologists; although many have switched to a minus cylinder format.

Does “dry eye” or “OSD” (ocular surface disease) affect the fit of a toric lens?
Yes, if the dry eye or OSD condition requires ancillary drops (artificial tears) or medical intervention as described in a “clinical” dry eye; MGD (meibomian gland dysfunction) or GPC (Giant Papillary Conjunctivitis.). Dry eye or OSD can affect the fit of any soft lens, especially toric soft lenses as they tend to be thicker by design. A thorough examination of the quality and quantity of the patient’s tear film should be assessed. A poor quality tear film will most likely create lens soilage, which could lead to erratic lens movement. A reduction in tear quantity could create lens dehydration which could result in the lens tightening. Dehydration could also lead to a change in lens power potentially causing the lid to drag the lens superiorly. Treatments such as artificial tears, punctal occlusion or therapeutic Rx treatments such as Restasis®; need to be evaluated or considered as to their viability with the contact lens fit.

What is the benefit of a frequent or daily disposable toric soft lens?
The benefits of disposability are the same regardless if discussing spherical or toric soft lenses. Frequent replacement of soft lenses has been demonstrated clinically to reduce the incidence of giant papillary conjunctivitis (GPC) and improve patient comfort and lens wear performance; due to cleaner, more wettable surfaces. An additional consideration is, unlike spherical lenses, which constantly rotate; a toric soft contact lens needs to remain virtually stable. As mentioned previously, most toric soft lenses have certain ‘thick” areas, which tend to build up deposits more readily. Areas of greater lens thickness could impact the oxygen permeability/transmissibility of the lens. A disposable lens modality can be especially beneficial for the patient with an increased Rx; since these lenses would generally tend to build debris more frequently. Unfortunately, higher powered lenses are custom made and not available in frequent or daily disposable options. For those patients, a silicone hydrogel (SyHy) might be considered an optimal material of choice.

Are there toric soft lenses available in SyHy materials, and what are the benefits?
Yes, there are several Silicone Hydrogel designs emerging. As mentioned earlier in this paper toric soft lenses are inherently thicker by design, utilizing materials which possess greater oxygen transmission is recommended especially when dealing with higher Rx powers or compromised corneas.

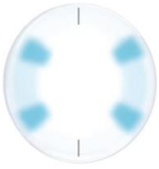


Fig. 33 *Acuvue® Oasys®*

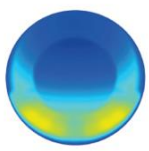


Fig: 34 *B&L PureVision® 2HD*

Fig. 35 *(Alcon) Ciba® AirOptix®*

What are the benefits of a custom toric soft lens?
There will be times when a patient presents with a refractive error or corneal irregularity, which require powers or parameters that extend beyond the standard range of parameters. Fortunately, there are manufacturers offering toric soft lenses custom designed to accommodate such needs; higher distance powers, higher cylinder powers, extended axis range as well as extended parameter range; i.e.; base curve and diameter.

***Note*:** There are also manufacturers offering scleral and semi-scleral options as well as soft/rigid hybrid lens designs for patients with irregular corneas, or abnormalities requiring a non-conventional lens design.

If the patient is a presbyope, are there toric bifocal/multifocals available?
Yes, there is help for the presbyopes who possess moderate amounts of astigmatism; there are several manufacturers producing bifocal/multifocal toric soft lenses.

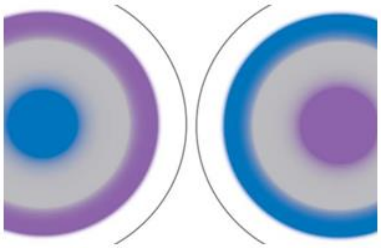


Fig. 36 *CooperVision® Proclear® Multifocal Toric*

How can toric soft lenses be promoted in the practice?
Promoting any specialty lens in a practice presents a tremendous opportunity for ECPs. How might this strategy be applied without appearing as though “selling” a product? It is quite simple; provide patient information pieces throughout the practice. This professional touch could be achieved by having a “welcome to the office pamphlet,” newsletter or information piece that identifies the practice as providers of specialty contact lens services. If the practice has a website, that would make an ideal location to post contact lens services. Be certain the staff is well informed and current regarding specific services and products offered; as they are often the first to be queried.

When a patient is aware that the practice offers a variety of contact lens options they will more than likely want to “try them out.” One of the simplest ways of convincing a patient with astigmatism that they are a good candidate for a toric soft lens is; allow them to experience the benefits of the lens first hand, especially when wearing spherical lenses. Over refract existing single vision lenses and place the refractive cylinder in a trial frame or the phoropter. Most ECPs still prefer handheld lenses, or a trial frame to avoid the pinhole effect of the phoropter. Allow the patient to view the real world, invite them to go outside, look at a computer or electronic device and; “see” how much sharper their vision is with

their cylinder correction in place. Most patients will immediately notice a significant improvement and wonder why no one previously offered the toric soft lens option. That response probably stems from the: “don’t fix it if it ain’t broke” mentality”; patients have been walking around in many instances for years with less than optimal vision because no one took the time to address their astigmatic needs!

Uncorrected cylinder, (especially if it is against the rule) can create undue eyestrain at near; especially when reading for long periods of time or viewing electronic devices. Patients complaining of headaches seek all sorts of remedies from headache medication to purchasing expensive computer devices. Having substantial diagnostic fitting sets of varying modalities and parameters will allow the patient to evaluate the benefits of correcting their astigmatic error; patient and ECP will have a rewarding experience.

Cautionary advice: Once the advantage of cylinder correction has been identified, the patient may insist on receiving the updated prescription for the toric contact lens, in an attempt to purchase the lens elsewhere for what they perceive as a more “competitive” price. In the event you encounter a patient who asks for a contact lens Rx and insists on searching for less expensive options elsewhere; be prepared with a definitive response. Although ECPs are legally obligated to give the patient a contact lens Rx; they do not have to write “OK for contact lenses,” if the fitting of that lens has not been completed or paid for. A simple way of explaining the benefit of a “professionally fit” toric soft lens is by way of comparison. When toric lenses are dispensed the lens must be evaluated to assess: fit rotation and vision; that outcome cannot be accomplished in a “virtual” order; (kind of like having a cavity filled over the phone.) It can only occur by evaluation with expertise and equipment designed for proper evaluation. Most patients will understand they are paying for time and professional expertise. For those patients who refuse to comply, simply explain: ECPs are not legally required to provide a prescription for contact lenses if the fit is not complete. Requiring patients read and sign a copy of practice fees and policies is a great way to prevent fitting “misunderstandings.”

How do we address patients who insist on getting their contact lenses from “outside sources”?

The philosophy of most patients reflects the adage: “if you don’t have it I will find someone who does”; or worse, they go to the internet to price shop! There was a time when the more specialized lens designs were harder to come by on the internet; however, in a day when patients can get almost any type of contact lens over the internet, even some specialty contact lens options are popping up as well. Since most patients are not “savvy” in contact lens verbiage’ they are often misled by the hype. In an effort to conserve money, they convince themselves that they are getting the lens they need because as a “current” TV commercial states; “I saw it on the internet, so it must be true.” Sadly, by the time the internet wary patient reaches the office of a qualified ECP they have spent lots of money on lenses that don’t work.

Most ECPs have had patients who presented to their offices “incensed”; because they were unable to see with lenses they had purchased through the internet or other non-regulated means. Often their issues could have been solved by adjusting axis or rotation.

In many instances, cylinder powers were over corrected; largely in part because whoever converted their spectacle Rx to the contact lens Rx did so without taking into consideration the vertex adjusted power. Another problem when ordering toric lenses without proper evaluation is the inability to adjust for rotation or an over-refraction. If the virtual order offers the use of a toric calculator (which is highly unlikely) or if the over refraction was performed utilizing an auto refractor, the rotation assessed would be inaccurate. If the power of the trial lens was calculated incorrectly, the results will be meaningless.

What if the patient strays or objects to a refit?
If presented with a disgruntled patient who does not return for designated follow-up care, attempted a “virtual” toric lens fit online, or attempted to procure their lenses by other means; the present ECP may experience a difficult situation. This patient probably invested money for lenses they probably cannot use and will want you to fix them! Explain the reasons why their internet lens experience was less than rewarding and offer to evaluate the lenses they received for a marginal fee. In this process, if it is discovered that the problem was simply a matter of rotation or a small power adjustment; a reduced fitting and/or follow up fee arrangement might be the way to go.

If the practice utilizes some form of corneal topography, it can become an invaluable tool for evaluating high or unconventional cylinder. If the patient informs you they would just rather wear glasses this is the time, explain how spectacles cannot correct for aberrations and distortions as well as a contact lens. The contact lens will aid in creating a new corneal surface and additionally allow for a much broader range of vision. Spectacles are limited to the edge of the frame and cannot minimize distortion or image size the way a contact lens can.

If the patient presents with a more complicated concern due to having developed corneal issues, such as Keratoconus or post-surgical complications; be prepared for a lengthy discourse. In the case of the patient with Keratoconus, it is anticipated that somewhere down the fitting chain the patient was correctly diagnosed and is aware of their progressive condition.

Unfortunately, in the early stages of Keratoconus, patients are often misdiagnosed and manage to “get by” with conventional toric lenses. As time progresses, their corneas steepen and become so irregular they are no longer able to wear conventional toric modalities. They will more than likely be discouraged when they are informed; it might be wise at this point, to interject the use of corneal topography. Show and tell can significantly aid in the explanation of how corneas change over the years; and why a custom lens could be the solution to maximize optimal success. If the patient was never accurately diagnosed, they will inquire as to why conventional toric lenses can no longer work for them. If previous topographies are available, that information could be beneficial. If not, you could show the patient a non Keratoconic eye and compare it with their present topography.

How should refunds be managed?
In the event a particular modality is not successful, it makes good sense to work with a lab or manufacturer that has a sensible warranty and/ or exchange program. Become informed of manufacturer policies PRIOR to the fit. The fitting process can often be time consuming, so be prepared to adjust fees accordingly. A rule of thumb should be based on the value of chair time; this will vary from practice to practice depending on: overhead, staff volume, and salaries' etc. If the practice is located in a rural community, fees shouldn't be calculated based on a colleague who may have a practice in a metropolitan area. Don't short change fees, as the patient is paying for expertise and the ability to satisfy their challenging fitting demands. Traditionally, specialty lens providers DON'T provide refunds; however, they may apply a portion of the fee to other services. It is recommended that fees are broken down, so the patient knows precisely what services they are paying for. If the lens manufacturer offers some type of refund, that amount could be negotiated. A word of advice, if fitting fees are refunded, it could appear to the patient as devaluing the ECPs expertise. The ECP might try comparing the services of a contact lens professional to the services of dental professionals; have you ever known of anyone receiving a refund from a dentist on any services?

What is the recommended wearing time for toric lenses?
Toric lenses by design are thicker than spherical and aspheric lenses. Custom lens designs and higher powers tend to increase thickness. Concerns of "over-wear" and compliance must be considered as well as duration of wear time. Choose the lens material wisely and follow the manufacturer's recommended wearing schedule.

Is lens care and maintenance different for toric lenses?
When fitting lenses of the frequent or daily replacement modality, conventional multi-purpose systems are acceptable; barring any issues such as "dry eye," or GPC. These conditions generally require an adjunct cleaner and appropriate lid cleansing management, as lenses tend to become soiled easier. In addition, when fitting a custom lens or an increased power, the lens may be thicker in specific areas. This presents issues when using "No Rub" or "multi-purpose" solutions; as most of these systems do not come with adjunct cleaners. Most custom lens designs are recommended for monthly or "quarterly" replacement. Since these lenses are being worn for longer periods of time, there is the potential for greater lens deposition which could lead to multiple problems; dryness, irritation, reduced vision, and most importantly LENS ROTATION!

If the surface of the lens is not wetting well, the lens has a greater potential to rotate! (Recall the earlier consultation story.)

Fig. 37 *Lens Care*

Summary

With the abundance of toric lens designs, modalities and fitting aids, there is no reason for any patient requiring even a minimal cylinder correction not to be offered the benefits of a toric lens. As Opticians we would never dream of making a pair of “spherical” equivalent” spectacles just to reduce the cost or chair time. The benefit of cylinder correction should be offered to ALL patients.

*Author claims no partiality to specific brand or manufacturer and has no financial interest in any company or product name mentioned.

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