Toric Gas Permeable Lenses
Thomas Quinn, O.D., M.S., F.A.A.O.

Measure K’s and Rx
↓
Corneal toricity >2D
↓
YES → NO - consider other designs
↓
Poor Spherical RGP Lens centration/comfort/physiology?
Sphere lens flexure/warpage?
EW schedule?
↓
YES → NO – consider other designs
↓
Consider toric lens design
↓
Draw optical cross from K’s and Rx
↓
Adjust powers for vertex distance if necessary
↓
Determine lens diameter based on:
Lid Position/ Aperture Size/ Pupil Size
↓
Determine BCR/cornea relationship for selected lens diameter
↓
Adjust BCR and power in each meridian as needed
↓
Calculate difference in BCR power between major meridians (ΔBCR)
Calculate difference in power between major meridians (ΔBVP)
Is the ΔBCR equal to ΔBVP?
↓
YES → NO

This is a SPE Bitoric Design
No need to be concerned about lens rotation
This is a CPE Design
Is Δ BCR ≥ 2DC?
↓
YES → NO
↓
Is Δ BCR > 2/3 of corneal toricity?
↓
YES → NO
↓
Is Δ BCR x 1.5 = Δ BVP (±0.50D)?
↓
YES → NO
↓
Order Back Surface Toric
(specify power in more plus meridian)
This is a CPE Bitoric
(specify power in each meridian)
# Recommended Toric RGP Base Curve Selection with Varying Lens Diameter

<table>
<thead>
<tr>
<th>Lens Diameter (mm)</th>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (8.0 to 8.6)</td>
<td>0.25 D STK</td>
<td>0.50 D FTK</td>
</tr>
<tr>
<td>Intermediate (8.7 to 9.3)</td>
<td>On K</td>
<td>0.75 D FTK</td>
</tr>
<tr>
<td>Large (9.4 to 10.2)</td>
<td>0.25 D FTK</td>
<td>1.00 D FTK</td>
</tr>
</tbody>
</table>

* STK: Steeper than the keratometric reading  
** FTK: Flatter than the keratometric reading

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### If \( \Delta BC = \Delta BVP \), then SPE Design

```
e.g. 43.00/ 46.00, pl/-3.00
```

If the difference in base curve power (\( \Delta BC \)) between major meridians is equal to the difference in lens power (\( \Delta BVP \)) between major meridians, then the lens is a Spherical Power Effect (SPE) Design and you do not need to be concerned about lens rotation.

### If \( \Delta BC \neq \Delta BVP \), then CPE Design

```
e.g. 43.00/ 46.00, pl/-2.00
```

If the difference in base curve power (\( \Delta BC \)) between major meridians is not equal to the difference in lens power (\( \Delta BVP \)) between major meridians, then the lens is a Cylinder Power Effect (CPE) Design. Lens rotation will blur vision.

*To prevent rotation:*

1. BC toricity must be at least 2 diopters
2. BC toricity must be greater than 2/3rd's of the corneal toricity

### If \( \Delta BC \times 1.5 = \Delta BVP (\pm 0.50D) \), then order a BACK SURFACE TORIC Design

```
e.g. 43.00/ 45.00, pl/-3.00 (specify only the power in the more plus meridian)
```
Expected GP Toric Design
based on
Spectacle Cylinder versus Corneal Toricity

Spectacle = corneal → Bitoric (SPE)

Spectacle > corneal
  Very little corneal toricity → FS toric prism ballasted
  Spectacle 1.5x > corneal cyl → BS toric
  Others → Bitoric (CPE)

Corneal > spectacle Bitoric (CPE)
Flexing sphere
Imagine a lens that fully corrects the refractive error of an astigmatic patient by utilizing a durable material that exceeds the cornea’s oxygen requirements with a design that perfectly complements the cornea’s shape. Imagine that this lens offers the unheard of benefit of permitting the lens to rotate without affecting vision. All of this adds up to a lens that provides superior vision to the astigmatic patient, while providing good comfort, easy care and optimal safety. Sound too good to be true? Well it is true and it's available through your local lab. It is a spherical power effect (SPE) designed RGP contact lens. The following will explain how it works and how you can put it to work for you and your patients.

Choosing an SPE Design
Fitting a patient with more than 2.00D of astigmatism can be frustrating. A toric soft lens with this degree of astigmatic correction will compromise vision if rotational stability is the least bit variable. A spherical RGP lens on such an astigmatic eye may not center well, which can lead to poor comfort, flare and physiological compromise.

An SPE design lens is easy to identify. If the difference in base curves (in diopters) is equal to the difference in lens power, then you have an SPE design. The beauty of an SPE design contact lens is that it provides the physical fitting benefits of a toric base curve lens (i.e. good centration, good tear exchange) and the vision benefits of a nonflexing spherical RGP lens (i.e. impervious to lens rotation).

![Spherical Power Effect Design](image.png)

**FIG. 1: Example of an SPE designed RGP lens**
Employing an SPE Design

Employ an SPE design whenever a spherical RGP design will fully correct the astigmatic error (i.e. the vertexed spectacle cylinder amount equals the corneal toricity), but is not an option because the degree of corneal toricity would lead to an unstable fit.

For example, a patient with a refractive error of -1.00 -3.00 x 180 and K readings of 41.00 @ 180; 44.00 @ 090 is an ideal candidate. Choose base curves that will mimic a spherical RGP on a slightly with-the-rule cornea. Fitting the horizontal meridian on alignment and the vertical meridian 0.75D flat will provide a good tear pump without introducing concerns about flexure. The patient's aperture size dictates that we fit him with a 9.0mm diameter lens. Since this is an intermediate size, choose a horizontal base curve that is equal to the horizontal K reading (41.00D or 8.23mm) and a vertical base curve 0.75D flatter than the vertical K reading (44.00D -0.75D = 43.25D or 7.80mm). A bigger lens requires flatter curves to avoid vaulting, and a smaller lens requires steeper curves to avoid excessive touch.

Since the horizontal meridian is fit on -K, no tear lens will be present. However, the vertical meridian is fit 0.75D flat, resulting in a -0.75D tear lens. Therefore, instead of needing -4.00D lens power in the vertical meridian, only -3.25D is necessary. We end up with the base curves 43.25D (7.80mm)/ 41.00 (8.23) and associated lens powers -3.25D/ -1.00D. The difference in base curve powers (43.25D -41.00D = 2.25D) is equal to the difference in lens power (3.25D -1.00D = 2.25D), so we know that we have an SPE design. Now we can order the lenses knowing that even if they rotate slightly, we won’t end up with blurred vision and a wild oblique overrefraction!

Dr. Quinn is in group practice in Athens, Ohio, and has served as a faculty member at The Ohio State University College of Optometry.

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In my last column (June 1999), I explained that, with a toric RGP lens, if the difference in base curves (in diopters) is equal to the difference in lens power, then it is considered a spherical power effect (SPE) design toric lens. The advantage of this design is that the lens can rotate without adversely affecting vision.

On the other hand, if the difference in base curves does not equal the difference in lens power between the two meridians, then it is a cylinder power effect (CPE) design lens. It's important to be able to identify these designs so that you can take precautions to ensure that the lens does not rotate. Such rotation would lead to visual compromise and a spherocylinder overrefraction (SCOR) with an axis oblique to the major meridians of the cornea.

Tips to Avoid Rotation
In order to guard against lens rotation, there are two precautions you will want to take:

**Tip #1** -- First, make sure your final design has at least 2.00D of toricity in the base curve of the lens. Anything less than this may be too spherical to permit the lens to "lock" into a rotationally stable position. This is generally only an issue when fitting a cornea with around 2.00D of toricity.

Fitting the horizontal meridian nearly aligned with the cornea while flattening the fit in the vertical meridian helps to promote good lens movement and an efficient tear pump. However, on a with-the-rule (WTR) cornea, flattening the lens in the vertical (steeper) meridian will result in a lower degree of toricity in the base curve of the lens.

![Diagram](image)

**FIG. 1: Designing a CPE toric**
If this fitting approach causes the toricity of a CPE lens to drop below 2.00D, steepen the fitting approach vertically so that the contact lens in this direction is fit near alignment, as in the horizontal meridian. This increased toricity should enhance rotational stability, but it may also inhibit tear exchange during the blink.

Observe lens movement on the patient's eye and carefully inspect their cornea after they remove the contact lens to ensure that the physiological needs of the cornea are being met.

**Tip #2** -- The second precaution to take is to make sure that your CPE contact lens has at least two-thirds of the cornea's toricity in the base curve of the lens. For example, if a CPE toric lens is being fit to a cornea with 6.00D of toricity, then make sure that the toricity in the base curve of the lens is at least 4.00D. This approach allows the lens to position on the eye much like a saddle positions on a horse, thus limiting rotation.

As review, we have two types of toric RGP's -- SPE designs and CPE designs. SPEs can rotate, CPEs cannot. Simple enough, right?

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prescribing for astigmatism

Back Surface Toric RGPs

BY THOMAS G. QUINN, OD, MS
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There are two types of toric RGPs: spherical power effect (SPE) designs and cylinder power effect (CPE) designs. With SPE designs, the difference between the two base curves (expressed in diopters) is equal to the difference in the power needed between the two major meridians. With CPE designs, these two values are not equal.

When you find that you have a CPE design, take a moment to determine if multiplying the difference in base curve powers by 1.4 equals the difference in lens power needed between the two major meridians. If they are equal, then you have a back surface toric contact lens.

The CPE Design
A back surface toric lens is simply a special CPE design in which the amount of toric power needed in the lens is equal to the power created by the toricity in the base curve. This power is always about one and a half times the difference in the base curves.

Why? Because when we express the power of the base curve in diopters, we use our conversion chart (e.g. 7.5mm = 45.00D), which is based on the index of the keratometer (n=1.3375). The index of the keratometer is an artificial calculation which allows us to take into account the index of the tear (n=1.357), cornea (n=1.376) and aqueous (n=1.336) system as it affects the refraction of light entering the front of the eye.

![FIG. 1: Back surface toric design contact lens.](image)
Knowledge is Key
The index of a contact lens, which varies slightly depending on the material used, is higher than the index of the keratometer. Therefore, a contact lens will actually create more toric power (by about one and a half times) than what the stated toricity of the base curve suggests.

Do you need to know that a toric lens being ordered meets the special design requirements of a back surface toric lens? No, because it will work regardless. But being aware that you're working with this design is helpful because knowing that all of the toric power needed is being created by the back surface of the lens tells you that the front surface is spherical. This gives you the freedom to polish the front surface without being concerned about disturbing the toric optics, and also provides the ability to add spherical minus power to the lens if necessary.

Cutting Costs
If you discover that you have a back surface toric contact lens design, you only need to specify the power in the most plus meridian. Of course, when the lens arrives and the power is verified using the lensometer, two powers will be measured: the specified most plus power and a more minus power (more minus power = more plus power + [1.4 x difference in base curve power]). See Figure 1 for an example. By specifying a contact lens order with two base curves and only one power, you’ll tip off the billing clerk at the lab that you're ordering a lens with only one toric surface, and you might get a break on your cost. Now that's a reason to do this simple calculation! CLS

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GPLI Toric and Spherical Lens Calculator:
http://www.gpli.info/lens-calculator/
If $\triangle BC = \triangle BVP$, then SPE Design (lens can rotate without compromise to vision)

If $\triangle BC \neq \triangle BVP$, then CPE Design (take rotational precautions)
If \( \Delta \text{BC} \times 1.5 = \Delta \text{BVP} (\pm 0.50 \text{D}) \), then order a BACK SURFACE TORIC Design

*Rotational precautions: BC toricity at least 2D and 2/3\textsuperscript{rd}s of corneal toricity*