Effect of Tilt & Vertex Distance on Spectacle Lenses

Examining the effects of tilt, face-form and vertex distance in detail would be far too lengthy and complex for this article. Instead, we will demonstrate in a simpler way the effects that these adjustments can have on the finished product.

**Tip:**

Ignore the application of the formulae below and order freeform lenses. Freeform lenses are computed after consideration of actual wear of the lenses by the px. The power that the px wearing freeform lenses experiences is that power prescribed by the optometrist. Read further to truly appreciate all the work that is done on your behalf when you order freeform lenses.

**Lenses are designed and fabricated** with a certain assumption that they will be fit a certain distance from the eye and have a certain acceptable amount of tilt, either pantoscopic or created by the addition of face-form. When any of these adjustments are made beyond the designer's expectations, the optical quality is then compromised. In weaker prescriptions, the effects caused by the above adjustments are negligible; however, when the prescription has a power of over 4.00 to 5.00 diopters, care must be given to not allow any adjustments to compromise the optical quality of the lens. We will first discuss the effects of vertex distance.

**Vertex distance** is the measurement from the back of the spectacle lens to the front of the eye. The average vertex distance is approximately 14mm. Adjusting the distance either further from the eye or adjusting the lens nearer will change the effective power of the lens. In the case of a minus or diverging lens, the further it is moved from the eye the weaker it becomes and the closer to the eye the stronger it becomes. The opposite is true in the case of a convergent or plus lens. The further it is from the eye, the stronger it will be. As mentioned before weaker prescriptions will not be effected as much as those that are -4.00 diopters.

Let's look at our example.

**OD:** -5.00 SPH

**OS:** -5.50 SPH

This patient comes in wearing glasses that are sitting 20mm away from the eye instead of 14mm, so what is the actual prescription? To determine this we need to use the vertex compensation formula:

\[
Dc = \frac{D1}{1 + d \times Dl}
\]

**Dc** = Compensated Power

**Dl** = Original Lens Power

**d** = Change in Vertex Distance in Meters
For the right eye we have a spectacle power of -5.00 SPH sitting 6mm further from the eye than it should.

\[
Dc = \frac{5.00}{1 + 0.006 \times 5.00}
\]

\[
= \frac{5.00}{1.03}
\]

\[
= 4.85
\]

The new sphere power is -4.85. The best way to determine vertex distance is though the use of an instrument called a distometer. This device places one arm on the eye lid while the other is placed on the back of the lens, and a small scale attached to the device measures the distance. Now let’s take a look and see what happens when tilt is added.

Generally some pantoscopic tilt and face-form is desired but when these adjustments are made too drastically, they can affect the optical quality of the lens. Unlike vertex distance, these two adjustments create something called marginal astigmatism. This monochromatic aberration is the result of light passing obliquely through the lens, creating two focal points much like a toric lens designed for those with astigmatism. Flat base curves and excessive tilt are the major causes of this. Let’s look at what happens to the above prescription when the pantoscopic tilt is changed from 14° to 22°.

\[
Fns = -\left(1 + \sin^2 \frac{22°}{2n}\right)Fsph
\]

\[
Fns = \left(1 + \frac{0.1369}{2.244}\right) -4.85
\]

\[
= -5.15
\]

Now we determine the cylinder power. Remember that face form will have its astigmatic error in the 90° meridian, while pantoscopic tilt will have it in the 180° meridian.

\[
Cyl = -4.85 \times \tan^2 22°
\]

\[
0.08 \text{ D of Cyl @ 180°}
\]

Actual Rx is -5.15/-0.08 X 180°

This change may not seem like much to us, but for the discerning patient such a difference may be noticeable. Plus if we compound errors, such a 0.12 diopter lab processing error can make the situation even worse. During our troubleshooting process we often overlook the effects of how the lenses are fitting and how this will ultimately effect the prescription. We need not go through a series of complicated equations and measurements as the patient waits, but instead keep these suggestions in mind while helping the patient during frame selection and during the dispensing process.