Calculating Vertex Corrected Contact Lens Powers

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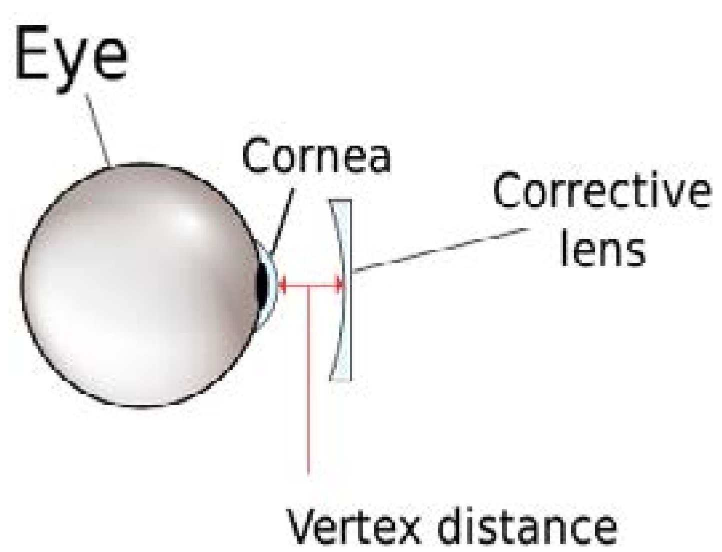
Consider the environment in which the eye examination is performed: the patient is refracted at a vertex distance of 12mm (on average). If the corrective lenses are going to be worn at a vertex distance other than 12mm, this will influence what's referred to as their *effective* power.

Prescribed power: refers to the refractive powers ordered by the doctor or examiner.

Effective power: is influenced by lens position. Changes in lens position from those used during examination will result in the lenses, effectively, behaving differently than intended. Basically, the patient will not "see" as the doctor intended.



The Effects of Changes in Vertex Distance

Changes to the worn vertex distance will influence the lens' effective "plus" power. In that, increasing vertex distance results in an increase in its effective plus power and reducing vertex distance, results in a decrease. For example, moving a "plus" lens closer to the eye, effectively reduces the amount of "plus" power it's providing; moving a minus lens closer to the eye also reduces its effective plus power, increasing the effective minus power it delivers.

NOTE: Industry standard is to reference changes in effective *plus* power, not effective *minus*.

Typically, changes in vertex distance are more of a concern when fitting contact lenses. For example, the patient may be refracted at a vertex distance of 12mm, but the correction will obviously be applied at the corneal plane. And for general purposes, we can consider the corneal plane to represent a vertex distance of zero. When fitting contact lenses, refractive powers over +/- 4D, in either power meridian, require compensation for changes in vertex distance; referred to as vertex corrected powers.

To determine vertex corrected powers, it's first necessary to calculate effective powers at the worn vertex distance. This can be accomplished using the Effective Power Formula. Of course, the handy, dandy conversion sheet, available from contact lens manufacturers, is a lot more efficient, but not nearly as much fun!

- Effective Power Formula = $\dfrac{\text{Original Power}}{1 + (\text{Change in vertex distance x Original Power})}$

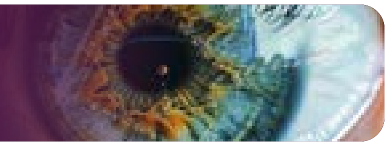
NOTE: Different variations of this formula exist, but in this form, "change in vertex distance" MUST be expressed in meters.

For accurate results, care must also be taken to use the correct sign for both the change in vertex distance and the original power.
For example:

- If vertex distance is increased, change is "-"
- If vertex distance is reduced, change is "+"
- Original power must include its related sign: "+" or "-"

A simple way to remember the sign rule for changes in vertex distance relates to the advice eyeglass wearers are given, with regards to how they wear their eyewear. For optimal vision, do opticians recommended the eyewear being worn closer to, or further from their eyes? Generally, patients are advised to wear them closer, because closer is better. Hence, closer is a "positive" change. So, reducing the vertex distance is "+".

1 Example #1



Let's work through two examples of how to calculate vertex corrected contact lens powers using the Effective Power Formula. First for a spherical prescription and second, a sphero-cylinder.

Consider a nine-diopter hyperope, refracted at a vertex distance of 12mm, who is being fit with a contact lens. How much influence will this 12mm change in vertex distance have on how the lens behaves for the patient - its effective power? And what contact lens power should be dispensed?

Let's first consider what we *should* expect. Vertex distance is being reduced from the original 12mm to zero; so, we *should* expect a reduced effective plus power. The question is, how significant will it be and does it require compensation to ensure the patient sees *as the doctor ordered*?

- Effective Power Formula = $\dfrac{\text{Original Power}}{1 + (\text{Change in vertex distance x Original Power})}$
- Effective Power = +9 / 1+ (+0.012 x +9) = +9 / +1.108 = +8.12D

NOTE: Vertex distance is being reduced from 12mm to zero, so the change in vertex distance is "+".

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The result indicates a loss in "plus" power of 0.88D due to this change in vertex distance, which also agrees with our initial expectation. Our calculations appear to be correct.

It's important to <u>never</u> *just* rely on your calculator. For example, if the vertex distance is being reduced and your calculated answer indicates that the effective power has <u>NOT</u> changed as you would expect, something went wrong!

So now, how is this information utilized? Well, if this patient is fit with a +9.00D contact lens, they will be under-corrected by +0.88D. Will they notice? Most likely! Accordingly, to determine the vertex corrected lens power to dispense, consider the change that's occurred to the effective power: in this case, it has been reduced by +0.88D. The patient has been short-changed by +0.88D, so it must be returned, in advance.

Assuming the patient is being fit with a stock soft lens, the closest lens power to the required +9.88D (exercising care not to "over-plus"), would be +9.75D. So, a +9.75D lens should be dispensed. This way, when +0.88D is lost as a result of the change in vertex distance, the patient will see as the doctor ordered (or at least as close as possible with a stock lens).

Now, just for the sake of curiosity (watch out, cats), let's see what the outcome would be if we used the ***incorrect*** sign for the change in vertex distance (minus instead of plus):

- Effective Power = +9 / 1+ (-0.012 x +9) = +9 / 1 + - 0.108 = +9 / 0.892 = +10.09D

This ***incorrect*** answer shows an increase in effective plus from a reduced vertex distance, which goes against what we'd expect.

2 Example #2

Consider a patient with the following Rx: -5.50 -3.00 x 180

- Refracted vertex distance = 12mm
- Patient is being fit with a soft toric (non-custom)

How much influence will this 12mm change in vertex distance have on how the lens behaves for the patient - its effective power? And what contact lens power should be dispensed?

Once again, let's first consider what we *should* expect. Vertex distance is being reduced from the original 12mm to zero; so, we *should* expect a reduced effective plus power (increased minus). The question is, how significant will it be, and does it require compensation to ensure the patient sees *as the doctor ordered*?

Since this patient is both myopic and astigmatic, both power meridians must be taken into consideration.

Lens power in the spherical 180˚ meridian = -5.50D @ 12mm
Lens power in the cylinder 090˚ meridian = -8.50D @ 12mm *(combined sphere and cylinder powers)*

Each power meridian must be handled separately using the Effective Power Formula:

- Effective Power Formula = $\dfrac{\text{Original Power}}{1 + (\text{Change in vertex distance x Original Power})}$

Spherical power meridian:

- Effective Power = -5.50 / 1+ (+0.012 x -5.50) = -5.50 / +0.934 = -5.89D *(round to -6.00D)*

Cylinder power meridian:

- Effective Power = -8.50 / 1+ (+0.012 x -8.50) = -8.50 / +0.898 = -9.47D *(round to -9.50D)*

From this, at the corneal plane:

- Effective power in the spherical meridian = -6.00D
- Effective power in the cylinder meridian = -9.50D

So, the vertex corrected lens power to dispense must reflect the changes in effective power:

- Spherical power meridian: decreased in effective plus by 0.39D (more minus)
- Cylinder power meridian: decreased in effective plus by 0.97D (more minus)

This effective increase in minus for each power meridian must be factored in:

- Spherical power meridian:
  Original @ 12mm = -5.50D
  Effective @ 12mm = -6.00D (approx.)
  Vertex corrected power at the corneal plane = -5.00D

- Cylinder power meridian:
  Original @ 12mm = -8.50D
  Effective @ 12mm = -9.50D (approx.)
  Vertex corrected power at the corneal plane = -7.50D

- Vertex corrected soft toric lens power: -5.00 -2.50 x 180

Since the closest cylinder power to -2.50D in a stock soft toric is -2.25D:

- Vertex corrected contact lens power to dispense: -5.00 -2.25 x 180 *(Original: -5.50 -3.00 x 180)*

When fitting toric lenses, correcting for changes in vertex distance for both power meridians is often overlooked. Oftentimes, only the spherical component is factored into the calculation and the cylinder is assumed to have a negligible effect. However, as demonstrated, considering both spherical and cylinder power meridians is vital to provide your patients more efficient results and increased satisfaction.