

Meeting the Cornea's Critical Oxygen Needs

The Rose K2 XL™ lens made with Menicon Z material delivers maximum oxygen to the cornea.



Paul Rose, DipOpt, BSc, FNZSCLP

Oxygen availability to the cornea with contact lens wear is one of the most important factors to consider for long-term corneal health and to reduce the risk of infection, as studies have shown that corneas deprived of oxygen are more susceptible to infection.¹ Ongoing material research continues to provide contact lens practitioners with higher-Dk materials with good wetting angles that easily meet the Holden-Mertz criteria for critical oxygen transmission for daily wear. In addition, some hyper-Dk materials meet extended-wear criteria, allowing overnight wear.² Laboratories also endeavor to keep GP corneal lenses to a minimum center thickness to reduce lens bulk and maximize Dk/t to ensure the lens transmits sufficient oxygen to the cornea.

The growing popularity of scleral and semiscleral lenses raises a concern that oxygen availability to the cornea has been largely ignored. Combine this with reduced tear exchange, as is the case with scleral lenses, and we have the potential to adversely affect long-term corneal health.

Total scleral system

GP corneal lenses typically have center thicknesses of 0.1 mm to 0.16 mm, depending on the power, whereas most scleral and semiscleral lenses are significantly thicker, anywhere from 0.25 mm to 0.7 mm. This dramatically increases the bulk of the lens, thus reducing the flow of oxygen to the cornea. Oxygen transmission was an important consideration when I designed the Rose K2 XL corneoscleral lens. I wanted to ensure

that a lens that covered the cornea and had considerably less tear flow than a corneal lens would maximize oxygen transmission to avoid long-term corneal complications created by anoxia. With the tear film having a Dk of about 80, the tear layer thickness under the lens must be considered when addressing oxygen availability to the cornea, as this layer also becomes a potential barrier to oxygen reaching the cornea.

Michaud and colleagues³ looked at oxygen at the cornea, taking into account the Dk of the material, the thickness of the lens and the thickness of the tear layer under the lens. By applying the formula:

$$\frac{Dk}{t_{scl}} = \frac{1}{(t_1/Dk_1) + (t_2/Dk_2)}$$

where Dk/t₁ refers to the lens and Dk/t₂ refers to the tear layer, it is possible to calculate the overall oxygen permeability of the total scleral system (Dk/t_{scl}). We can calculate this number for any lens with a center thickness of 250 microns (0.25 mm) to 500 microns and a tear layer (clearance) from 100 microns to 400 microns (see Table 1). Considering that most semiscleral designs require 200 microns of tear layer under the lens, none of the lenses with center thicknesses of 250 microns or more meets the minimum Holden-Mertz requirement of 24 x10⁻⁹ for daily wear.

Triple the minimum requirement

Let's now consider the Rose K2 XL lens, using Menicon Z (tisilfocon A) with a Dk of 163 (ISO/Fatt method). Assuming a tear layer that results from a minimum corneal

clearance over the highest part of the cornea of 20 microns, and a center thickness of 140 microns (0.14 mm), we can calculate the total scleral system (Dk/t_{scl}) is 81.8 x10⁻⁹, which is more than three times the minimum requirement for daily wear.

When you combine these factors with a lens design that has most of the bearing zone on the cornea and some movement to prevent binding, it is apparent that this goes a long way toward ensuring some tear exchange from behind the lens.

Ensuring that high levels of oxygen are available to the cornea is important for the long-term success of patients who wear semiscleral or scleral lenses. The Rose K2 XL lens goes a long way toward meeting these requirements.

Reference

1. Goodlaw E. Risk of infection from sleeping with contact lenses on: causes of risk. *Optom Vis Sci.* 1996;73:156-158.
2. Holden BA, Mertz GW. Critical oxygen levels to avoid corneal edema for daily and extended wear contact lenses. *Invest Ophthalmol Vis Sci.* 1984;25:1161-1167.
3. Michaud L, van der Worp E, Brazeau D, Warde R, Glasson CJ. Predicting estimates of oxygen transmissibility for scleral lenses. *Cont Lens Anterior Eye.* 2012;35:266-271.

Recommended in

 the most prescribed hyper Dk material worldwide. (Dk 163)

Table 1

Dk=100	Minimum Corneal Clearance (µm)						
Lens thickness (µm)	100	150	200	250	300	350	400
250	26.7	22.8	20.0	17.8	16.0	14.5	13.3
300	23.5	20.5	18.2	16.3	14.8	13.5	12.5
350	21.1	18.5	16.7	15.1	13.8	12.7	11.7
400	19.1	17.1	15.4	14.1	12.9	11.9	11.1
450	17.4	15.7	14.3	13.1	12.1	11.3	10.6
500	16.0	14.5	13.3	12.3	11.4	10.6	10.0

 : satisfies HM criteria