

# Silicone hydrogels –

## The future for extended wear

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In the fifth and final part of our series on extended wear, **Professor Deborah Sweeney, Kylie Knox and Professor Brien Holden** speculate on the future development of high-DK products and other more permanent vision correction devices

IN THIS SERIES OF ARTICLES we have reviewed the first stages of the rebirth of extended wear (EW). The development of new highly oxygen permeable silicon hydrogel materials is the first step towards achieving a truly safe and effective continuous wear lenses for both patients and practitioners.

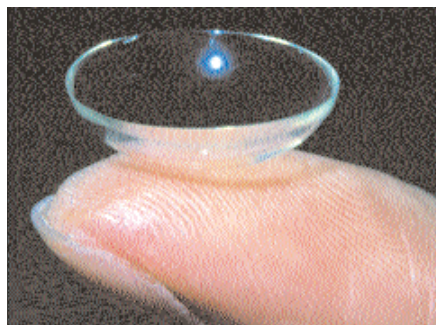
Hypoxia and its deleterious side-effects have been largely overcome, thus satisfying the cornea's metabolic needs and maintaining its physiological health. But we will not have achieved our ultimate aim until we have reduced the risk of microbial keratitis (MK) and other less serious adverse events to levels indistinguishable from daily wear and increased the comfort to challenge no-lens levels.

As you have read, the material properties of the new high-Dk products being launched now by the major corporations worldwide are such that the lenses are capable of metabolically supporting up to 30 nights of continuous wear for the vast majority of our patients.

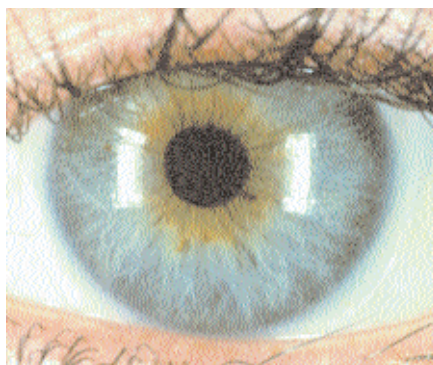
Their clinical performance has been similar to conventional hydrogel lenses in terms of comfort, movement and wettability. Patients however are extremely enthusiastic about the concept of wearing lenses on a 30-night continuous wear basis, especially once they have experienced the convenience and flexibility of wearing their lenses on such a schedule.

These new products provide:

- ◆ High oxygen transmissibility thereby avoiding physiological changes
- ◆ Lens performance, vision and comfort similar to conventional lenses



The new high-Dk lenses are capable of supporting 30 nights' continuous wear



Safe and effective continuous wear – the ultimate goal

- ◆ Reduced dehydration effects and improved handling
- ◆ Convenience

However, while patients and practitioners begin to come to grips with the new lenses and wear modality, and we wait for the verdict regarding whether or not the incidence of MK has been significantly reduced, researchers are already working on the next generation of products.

The next generation of the high-Dk products will hopefully include the ultimate contact lens – the 'spectacle killer'. A lens that truly competes with spectacles and actually makes the eye feel better when worn. We seek a lens that, like clothes, insulates the eye from the challenges of life. The ideal lens, because of its superb comfort and biocompatibility, will be able to be left in the eye for indefinite periods. Such a lens could answer the vision needs of over a billion people worldwide.

But to make the 'spectacle killer' a reality, several significant developments in key properties are required.

First, the oxygen permeability to satisfy all corneas is required. A Dk/t of over 125 will be required for all patients: hyperopes, presbyopes and astigmats. The lens will need to be able to be soft, easily manufactured (less expensive) and able to move freely on the eye without discomfort. We do not yet know how much tear exchange we need during a blink to remove debris and resurface the cornea. The material

needs to have sufficient biostability to allow it to last in eye for as long as the patient needs. Perhaps the ideal surface on the material will be as lubricious as the cornea to eliminate any problems with friction, biocompatibility or microbial contamination.

Design has only been addressed in a limited way with the currently released high-Dk lenses. We will need in the next generation the best mechanical (trauma), physiological (tear exchange) and optical (aberration-free) design possible. Optimising design will reduce physical challenge to the ocular surface ensuring no disturbance to either the ocular surface or the eyelid. This will avoid some of the mechanical complications that are observed with current products. Aberration correction will provide excellent visual performance. We will also need designs that will meet the needs of both astigmats and presbyopes.

These are just some of the many aspects of lenses that will need researchers' attention in the years to come if we are to achieve the ultimate contact lens.

### CORNEAL ONLY

Contact lenses may soon be used also for more permanent methods of vision correction. The majority of patients who require some form of vision correction are looking for a permanent means of correcting this disability. As a result they are willing to undergo refractive surgery, which permanently affects their corneas, in the hope of gaining an end to wearing glasses or contact lenses.

The current ablative (subtractive) procedures may only have a limited life as they seriously challenge the long-term corneal structural integrity. A corneal onlay, or implantable contact lens (Figures 1 and 2), would provide an alternative to laser surgery for the treatment of moderate and high refractive errors such as high myopia and aphakia. Such materials could also be applicable to a partial thickness replacement of scarred or diseased corneal tissue.

The implantable contact lens should offer many advantages over current methods of refractive surgery, including:

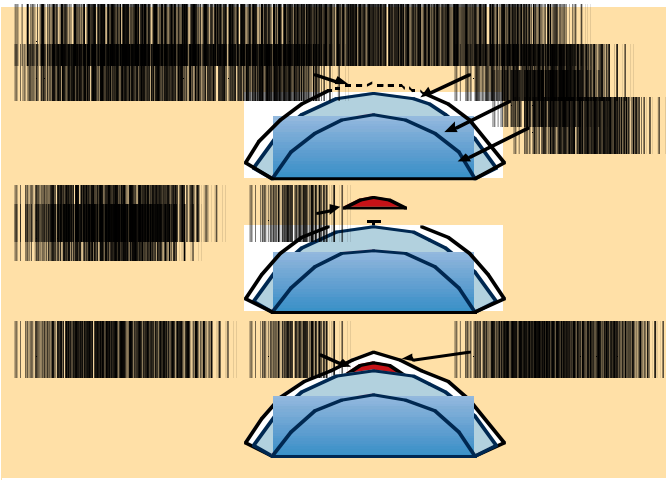


FIGURE 1. Corneal onlay procedure

- ◆ A reversible procedure, allowing modification by replacement or ablation of the lenticule surface if optical changes were required.
- ◆ A relatively simple in-office procedure.
- ◆ Less visual down-time for the patient.
- ◆ Stable refractive correction, as it does not involve a stromal wound healing response.
- ◆ Reduced ocular discomfort compared with PRK due to a bandage effect.

After removal of the central area of epithelium, the synthetic polymer onlay would be 'designed' to be placed on the corneal stromal surface and 'encourage' the epithelium to overgrow and attach to the lens (Figure 1).

Our surveys indicate that many ophthalmic surgeons believe that such a device is one of the most desirable for the correction of high refractive errors.

The issues which need to be overcome in the development of the onlay are movement through the implant of water, ions and nutrients – necessary for ocular health; and epithelial migration, proliferation and adherence over the synthetic implant. Currently, coated porous polymers are under investigation as the most promising materials to achieve these aims.

The future of contact lenses is based on a marriage between the patients' need for convenience, comfort and vision, and the eye's requirements for health. The union of these two elements will bring about safe, comfortable and effective vision correction for many millions of people in the next century. The onlay will take this program further offering hopefully, safe correction of higher refractive errors in an 'additive' manner without the need to destroy corneal tissue.

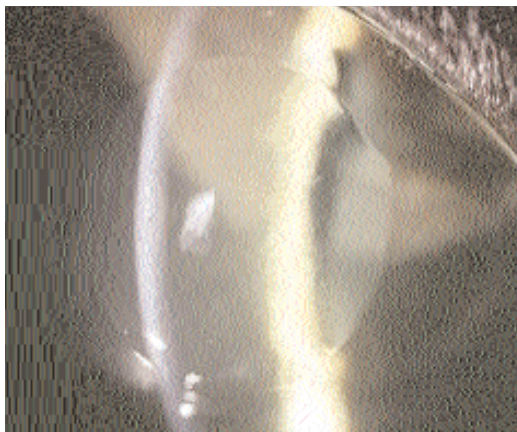


FIGURE 2. A corneal onlay or implantable contact lens

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