# Tomorrow's Extended Wear Lenses?

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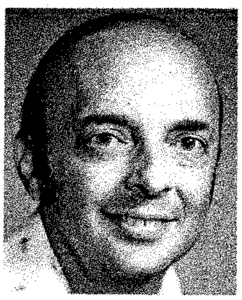

PAUL WHITE, OD

The use of hydrogel lenses for extended wear, as well as awareness of their inherent problems are both increasing. Practitioners are in the unenviable position of dealing with patients' desires for the exciting image surrounding extended wear while communicating our knowledge of the problems inherent in these lenses. Research is ongoing to improve hydrogel or to develop non-hydrogel contact lenses that can satisfy the demand for extended wear without its problems.

## OVERVIEW*

Contact lenses evaluated in a preliminary study by Deborah Sweeney included hydrogel contact lenses with high water contact (about 72%) and very thin center thicknesses (about 100 microns), butylacrylate contact lenses, silicone elastomer lenses and rigid fluorocarbon lenses (Table I).

Thin high-water-content hydrogel contact lenses created only about 40% of the overnight swelling produced by the same lenses in conventional center thickness. Unfortunately, the lenses

**Table I. Percent of Swelling Compared to Conventional Hydrogel Extended Wear Lenses**

| | |
|---|---|
| Ultra thin high $H_2O$ Hydrogels | 40% |
| Butylacrylates | 66% |
| Silicone Elastomers | 16% |
| Rigid Fluorocarbons | 50% |

were not only very fragile, but also, because of fluid evaporation and pervaporation, epithelial erosions and staining resulted from desiccation.

The butylacrylate lenses studied produced about 2/3 of the overnight swelling created by contemporary hydrogel extended wear contact lenses. However, there were problems of subjective discomfort and lens wettability on the eye.

Silicone elastomer lenses produced by far the least overnight corneal swelling, only about one-sixth of that caused by hydrogel contact lenses. But again, discomfort and poor lens wettability on the eye were evident. Rigid fluorocarbon lenses produced about 50% of the overnight swelling seen with hydrogel lenses. There were, however, problems with lens flexure and vision degradation.

Although all of the above-mentioned materials and others are being studied to improve extended

*Based upon the paper "New Alternatives for Extended Wear" presented by Deborah Sweeney.

wear, there are now more data available on silicone elastomer extended wear lenses, some of which are approved for use in the United States, and hard gas permeable contact lenses, which are not presently approved here for extended wear.

## SILICONE ELASTOMERS

Rex N. Ghormley, O.D., presented the results of a comparative study in his paper entitled "The Chemical Evaluation of Silicone Elastomer Lenses." Twenty-five patients were fitted with Silsight silicone elastomer extended wear lenses and 25 patients with Durasoft -3, a 55% hydrogel extended wear lens. The study patients were myopes with refractive spherical corrections of -0.50 to -4.75 diopters and cylindrical corrections of less than 0.75 diopters. Patients wore their contact lenses for 6 days and nights, then left them off for 12 hours, including sleep. This investigator limits extended wear to 6 days, except for aphakics.

Both types of lenses allowed relatively normal corneal health as observed with typical clinical procedures. This is in contrast to the research which has shown greater hypoxic changes with 55% hydrogel lenses than with silicone elastomer lenses. During the course of Ghormley's study, four patients had superficial, transient punctate staining with the Silsight lenses, while there was some inferior stipple staining, and two cases of bacterial conjunctivitis with Durasoft -3. Twenty-four Silsight lenses required replacement, 21 because of reduced surface wettability and 3 because of loss. Patients tended to view the lenses with reduced surface wettability as an inherent deficiency of the lens, and were disturbed by the replacement. Twenty-seven of the Durasoft-3 lenses had to be replaced, 11 because of damage, 14 due to deposits or discoloration, and 2 due to loss.

At the conclusion of the study, 18 of the 25 Silsight patients were still wearing their lenses. Three discontinued because of discomfort, and 4 discontinued because of the frequency of lens replacement. All 25 of the Durasoft-3 patients continued to wear their lenses. Although silicone elastomer extended wear contact lenses are by far the best for the oxygen needs of the cornea, their wettability and comfort problems somewhat mitigate this important advantage. Silsight lenses must be fitted with the proper position, movement, and fluorescein pattern (Figures 1, 2, and 3).

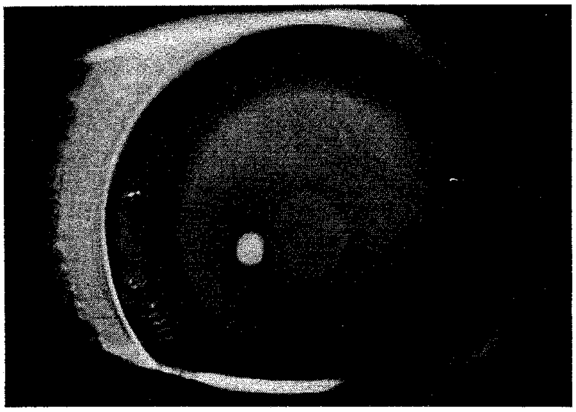

Figure 1 Silicone Elastomer Lens Fitted Too Tightly

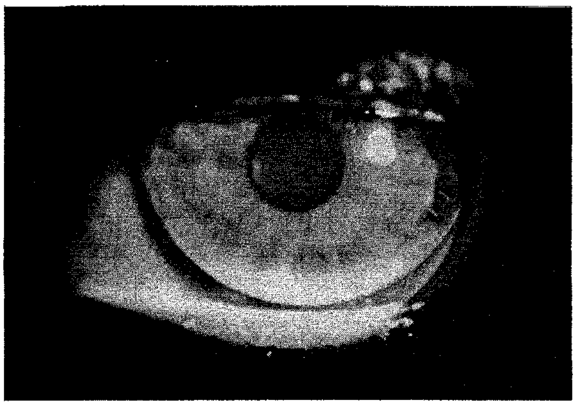

Figure 2 Properly Fitted Elastomer Contact Lenses on the Eye

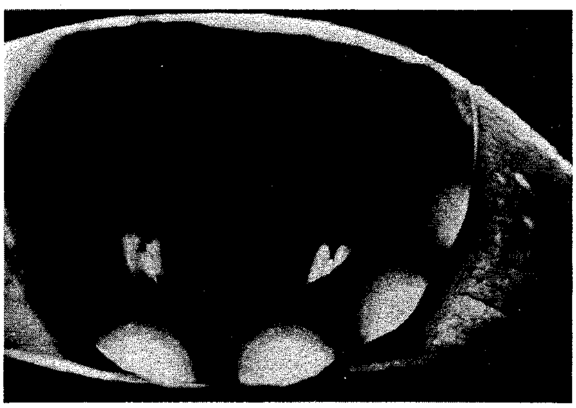

Figure 3 Well-fitted Silicone Elastomer Lens with Rippling

## HARD GAS PERMEABLES (HGP)

Both clinical and laboratory research are necessary to develop and evaluate the safety and efficacy of hard gas permeable lenses for extended wear. A number of hypothetical advantages and disadvantages have been determined, as compared to hydrogel extended wear lenses (Table II).

### HYPOTHETICAL ADVANTAGES

1. *Greater durability and longer lens life.*
   Not only should the inherent durability of the HGP material prolong useful lens life, but it should also aid the patients' ability to care for and clean their lenses. The practitioner should also be able to modify them, including polishing to remove scratches and debris, or to change power within limitations.

2. *Greater stability.*
   Flexure and dehydration of hydrogel lenses on the eye can alter their mechanical fit and the vision result. Because mechanical fit and vision result of HGP lenses are not altered nearly as much by dehydration or flexure compared to hydrogel lenses, a more stable and consistent fit and vision should result. In addition, corneal astigmatism should be reduced or eliminated by the lacrimal lens factor.

3. *Better tear pump.*
   It is well known that the tear pump to interchange fluid behind a contact lens during waking hours is about 20 times greater with hard lenses than with soft lenses. This not only increases the oxygen supply available to the cornea, but it also acts as a flushing system to remove debris and metabolic waste products from between the lens and the cornea. The cleaner precorneal fluid behind the contact lens is less likely to haze vision or initiate corneal responses such as infiltrates, infections, or "red eye."

4. *Formulation for high permeability (DK) values.*
   HGP lenses could be designed with a relatively thin overall configuration so that they have high average transmissivity values (DK/L). Current thinking indicates that a DK/L value of about 75(±15) is required for safe extended wear, and HGP lenses have been made with transmissivities in this range. If these facts are correct, such lenses should reduce or eliminate many of the corneal changes which are thought to result from excessive hypoxia. These include edema, reduced sensitivity, microcysts, and polymegathism. In addition, a more normal corneal metabolic cycle should reduce the incidence of infections.

5. *Less peripheral corneal injection or neovascularization.*
   Peripheral corneal edema loosens the matrix of the peripheral cornea to allow the invasion of blood vessels, while acting as a stimulus to neovascularization. Bearing, or pressure, of lenses on the marginal plexus may cause injection or neovascularization. The smaller diameter and greater oxygen transmissivity of HGP lenses may be helpful in this regard.

### HYPOTHETICAL DISADVANTAGES

HGP lenses may also have some hypothetical disadvantages as compared to hydrogel extended wear lenses:

1. *More apt to be lost or dislocated.*
   During both sleeping and waking hours, hard lenses in general are more prone to dislocation than are hydrogel lenses.

**Table II. Hypothetical Advantages and Disadvantages of HGP Lenses for Extended Wear**

| Advantages | Disadvantages |
|---|---|
| 1. Durability and lens life | 1. Increased lens loss or dislocation |
| 2. Stability of fit and vision | 2. Reduced comfort |
| 3. Good tear pump | 3. Increased topographic and refractive changes |
| 4. High permeability | 4. Increased peripheral desiccation staining |

2. *Possibly less comfortable.*
   A greater eyelid adaptation is necessary for hard lens use on a daily-wear basis. Environmental factors such as wind and dust produce more discomfort than with hydrogel lenses.

3. *Changes in corneal topography.*
   HGP lenses might produce more changes of the shape and regularity of corneal topography and the spectacle refractive correction. Even excluding any clinically detectable corneal edema, hard lenses tend to produce more corneal topographic changes from pressure than do hydrogels.

4. *More peripheral corneal desiccation staining.*
   Because they do not cover the entire cornea as do well-fitted hydrogel lenses, the incidence of peripheral desiccation staining with hard lenses is greater.

Slit-lamp findings were essentially the same for daily or extended wear, including the absence of central circular clouding or corneal striae.

CLINICAL RESEARCH

Does present research affirm or deny these hypotheses? Three representative studies dealing with evaluation of HGP lenses for extended wear were presented. It is important to note that these are preliminary short-term studies, and only time and subsequent evaluations will produce more comprehensive and long-term information.

A three-month study by Gary N. Osborn, OD, Joseph Barr, OD, and Gary Andrasko, OD presented "Extended Wear with Gas Permeable Hard Contact Lenses" in which they reviewed the results of their three-month study evaluating the Boston EW, Optacryl K, Paraperm EW, and Silcon lenses. Twenty-four patients were fitted with the various lenses, six for each material, but one eye used the lens on an extended-wear basis while the other used it on a daily-wear basis. A centered and alignment fit was used, and there was no daily-wear adaptation period before the start of extended wear. The observations were:

1. Slit lamp findings were essentially the same for daily or extended wear, including the absence of central circular clouding or corneal striae.
2. As measured pachometrically, there was a slightly greater increase of corneal thickness with extended wear. After about 30 days, corneal thickness decreased in relation to the pre-fitting baseline, but this rebounded after about two months.
3. Somewhat more polymegathism and small cells occurred with extended wear.
4. Few refractive or keratometric changes occurred with either daily or extended wear, but the latter produced a somewhat greater keratometric miral distortion.
5. Comfort was equal or better for most patients with extended wear. This may be due to a more constant adaptation of the eyelids on a neural stimulus basis.
6. Lens replacements were required approximately 3 times more frequently with daily wear, and lens dislocation during sleep was infrequent with extended wear.
7. Twenty-two of the original 24 patients completed the study. It should be noted that many of the patients in this study were previous PMMA lens wearers and that the HGP extended lenses used may be only prototypes of future generations of materials.

The lenses were usually mobile, had an effective pump, and dissipated debris from the post-lens corneal film well.

Steve G. Zantos, Ph.D., and Penny Duren, O.D., presented the results of a five-week study evaluating a silicone acrylate material with relatively low DK of $13 \times 10^{-9}$ in the study "Extended Wear with Gas Permeable Hard Contact Lenses." All patients had previously worn PMMA lenses, and 9 were fitted for extended wear with a control group of 8 patients fitted for daily wear. Findings were similar to those of Osborn, et al., with some additional observations:

1. The lenses were usually mobile, had an effective pump, and dissipated debris from the post-lens corneal film. Debris was not fragmented and central as with hydrogel extended wear lenses,

but in three instances the lens adhered temporarily to the eye. No damage occurred, nor was this phenomenon repeated.

2. There were no infiltrates or microcysts, which have been observed to some degree with all similar hydrogel lens studies.

3. Although only very small keratometric changes occurred, some large spectacle refractive changes were seen. These caused a reduction of myopia, with exceptional cases showing up to a 2-diopter change.

4. Punctuate 3- and 9-o'clock corneal staining was mild but present during 75% of the extended wear patients' visits and 87% of the daily wear, control group patients' visits.

> It appears that HGP do have durability, stability, and pumping advantages over hydrogel extended wear lenses.

The fact that all of these patients were previous hard lens wearers might be related to the changes of spectacle refractive changes and to the 3- and 9-o'clock staining.

Zantos also reported that in a similar study done with hydrogel lenses of a comparable DK value, corneal swelling upon awakening was slightly over 11% for both the extended wear hard- and hydrogel-lens wearers, but the corneas deswelled during the day. Somewhat more secretions and trapped debris were present upon awakening with the hard lenses, but it flushed away more readily and there was less during the day.

Kenneth A. Polse, O.D., presented the results of another five-week study in his paper "HGP for Extended Wear." This study included 15 patients using HGP lenses and a control group of daily wear lens patients. Comparisons were also made to similar studies of hydrogel extended wear lenses. The results were comparable to those of the Osborn and Zantos studies, with emphasis on:

1. Both HGP and hydrogel extended wear lenses averaged approximately 11% corneal swelling. A 10% deswelling and 8% deswelling occurred during the day with HGP and hydrogels, respectively. Deswelling was rapid with HGP extended wear; approximately 5 hours after awakening there was no significant difference in deswelling between HGP extended and daily lens wearers.

2. HGP extended lens wearers had no infiltrates, microcysts, or debris problems, although these all have occurred to varying degrees in similar hydrogel lens studies. In addition, the incidence of red eyes was only 20% of that reported in hydrogel extended wear studies. Somewhat more staining occurred in HGP wearers, but no infections, which are commonly seen in hydrogels. Finally, there was no significant change of corneal sensitivity.

These three studies on the use of various HGP lenses for extended wear and other comparable studies are providing similar evidence to support the hypothetical advantages of HGP lenses. It appears that HGP lenses do have durability, stability, and pumping advantages over hydrogel extended wear lenses. Also, corneal deswelling is more rapid with extended wear HGP lenses, and microcysts, infiltrates, infections and red eyes either do not occur or appear much less frequently than with hydrogel extended wear.

In addition, the hypothesized disadvantages of lens loss/dislocation or discomfort do not seem to occur to a significant degree. However, there appears to be more change of spectacle refractive correction and peripheral corneal desiccation with HGP extended wear lenses.

> It is becoming more apparent that lenses made from materials other than conventional hydrogels are needed.

## CONCLUSION

The extended wear lenses of the future and the place of hydrogel, silicone elastomer, hard gas permeable, collagen, butylacrylate and fluorocarbon lenses in our clinical regime are not clear at the present time. However, it is becoming more apparent that lenses made from materials other than conventional hydrogels are needed.

Silicone elastomer extended wear lenses solve the oxygen transmission problem, but their comfort and wettability problems prevent them from being the complete solution to every patient's needs. The present data about HGP extended wear lenses are encouraging, but only time, long-term studies, and improved materials will indicate how well their promise is realized.

## SUGGESTED READING


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