The effects of rubbing hard and soft contact lenses

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Pacific University

James Peterson  
Pacific University

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The effects of rubbing hard and soft contact lenses

Abstract
A study was conducted to test the hypothesis that rubbing a contact lens in the cleaning process, as recommended by the manufacturer, may develop scratches on the surface of the lens. Twenty-one hard lenses and 27 soft lenses were rubbed for 30 minutes each with a cleaning solution to simulate three months’ worth of cleaning. Each lens was photographed both before and after the rubbing process. Results from the study showed that, of the lenses received unscratched from the manufacturer, 80% were scratched due to the rubbing process. These scratches may become sites for deposits of contaminants on the surface of the lens, which may result in patient discomfort and dissatisfaction, and eventual lens replacement or discontinued wearing.

Degree Type
Thesis

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The Effects of Rubbing
Hard and Soft Contact Lenses

by

Isaac J. Kaopua, Jr.

Advisor: James Peterson, O.D.

A Thesis Presented to the Faculty
of Pacific University in Partial Fulfillment
of the Requirement for the Degree
Doctor of Optometry

March 1984
THESIS SUBMITTED BY

Isaac J. Kaopua, J.r.

ACCEPTED BY

James Peterson, O.D.

Grade A
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ABSTRACT

A study was conducted to test the hypothesis that rubbing a contact lens in the cleaning process, as recommended by the manufacturer, may develop scratches on the surface of the lens. Twenty-one hard lenses and 27 soft lenses were rubbed for 30 minutes each with a cleaning solution to simulate three months' worth of cleaning. Each lens was photographed both before and after the rubbing process.

Results from the study showed that, of the lenses received unscratched from the manufacturer, 80% were scratched due to the rubbing process. These scratches may become sites for deposits of contaminants on the surface of the lens, which may result in patient discomfort and dissatisfaction, and eventual lens replacement or discontinued wearing.
INTRODUCTION

Rubbing a lens in the cleaning process may develop scratches on the surface of a contact lens. These scratches may become sites for deposits of protein, mucous, crystalline materials and other contaminants. Neither surfactant cleaners nor enzymatic cleaners have been shown to be effective in removing such embedded deposits.

The literature briefly mentions the effects of rubbing on contact lenses. This literature review provides background information as well as supportive subject matter upon which the thesis assumptions and methodology are based.

This review, presented in the appendix, describes:

1) Recommended cleaning methods for both hard and soft contact lenses.
2) Deposits and Coatings - composition and causes.
3) Effects of cleaning solutions on deposits/coatings - both surfactant cleaners and enzymes.
4) Alternative methods of cleaning (by eliminating the rubbing technique).

This paper presents the results of rubbing lenses during the cleaning process, as recommended by the manufacturer.
METHODOLOGY

a. All lenses were properly labeled and photographed (Fig. 1) prior to the rubbing process. Surface quality was noted for any existing scratches on the lenses.
b. Each lens was rubbed with LC-65 for 30 minutes to simulate 3 months' worth of cleaning (assuming 20 sec/day for 90 days), then rinsed in saline solution.
c. All lenses were then examined and photographed (Fig. 2) under 10X magnification using the microscope.

RESULTS

a. Observations were documented to see if any scratches appeared on the lens surface due to the rubbing process. See Table 1.
Fig. 1 Typical Lens Surface Prior to Rubbing

Fig. 2 Typical Lens Surface After 30 Minutes of Rubbing (same lens as Fig. 1)
A - scratches
B - deposits on lens
C - water bubbles
# TABLE 1

<table>
<thead>
<tr>
<th>SCRATCHES OBSERVED</th>
<th>BEFORE RUBBING</th>
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## I. SOFT CONTACT LENSES

### A. Bausch & Lomb

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<td>B4</td>
<td>N</td>
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### B. Coopervision

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<td>Permalens (damaged)</td>
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<td>6</td>
<td>Permalens (damaged)</td>
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### C. Syntex

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### D. Barnes-Hind/Hydrocurve

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### E. Dow Corning

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* numbers appear out of sequence due to lens labelling process
## II. HARD LENSES

### E. Dow Corning

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</tr>
<tr>
<td>4.</td>
<td>PMMA</td>
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</tr>
<tr>
<td>5.</td>
<td>PMMA</td>
<td>+</td>
</tr>
<tr>
<td>6.</td>
<td>PMMA</td>
<td>+</td>
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</table>

N = no scratches observed  
Y = scratches observed due to the rubbing process  
+ = scratches observed before the rubbing process  
E = eliminated

* numbers appear out of sequence  
due to lens labelling process
CONCLUSION

Forty-eight lenses were rubbed for 30 minutes each to simulate 3 months' worth of cleaning. Of the 48 lenses observed, 10 were received from the manufacturer with visible scratches. Two lenses were eliminated from the study due to damage. Of the remaining 36 lenses, 29 (80%) were scratched due to the rubbing process. Of the 7 lenses not scratched, 6 were Bausch & Lomb lenses and 1 was a Dow Corning Silsoft lens.

This study produced two significant findings:

1. Of the lenses received unscratched from the manufacturer, 80% were scratched due to the rubbing process, according to the manufacturer's recommended cleaning method.

2. Not a single Bausch & Lomb lens was scratched due to the rubbing process.

This study supports the hypothesis that rubbing lenses in the cleaning process develops scratches on the surface of the lens. These scratches may become sites for deposits of protein, mucous, crystalline materials, and other contaminants which have a deleterious effect on the lens, resulting in patient discomfort and dissatisfaction, and eventual lens replacement or discontinued wearing.
REFERENCES


3. Ibid, p.558, 568


5. Ibid.


22. Ibid.


28. Ibid.

APPENDIX

RECOMMENDED CLEANING METHODS

Originally, hard lenses were cleaned by a very primitive method, i.e., friction cleaning by rubbing a wetting solution or detergent over the surface of the lens. Not only was this technique inefficient in cleaning, but it also resulted in scratching and warping of the lens. Later, more sophisticated methods (hydraulic cleaning, spray cleaning, and ultrasonic cleaning) were developed. Presently, friction cleaning is the primary technique used in cleaning soft lenses. This consists of applying the cleaner to all lens surfaces by finger rubbing immediately after removal of the lens. The cleaner mobilizes, emulsifies and dissolves debris accumulated during wearing. Then a thorough lens rinsing is performed with an isotonic, sterile, saline rinsing solution.¹

Mandell² affirms that when the contact lens is removed from the eye, it will be covered with ocular secretions of oil, mucous, crystalline deposits, protein build-up, etc. These contaminants must be removed prior to lens storage. It is not sufficient to clean the lens by rinsing with water, for not only do the deposits adhere tenaciously to the surface, but also oil and mucous are insoluble in water and, therefore, are not adequately removed by rinsing or by storage in the soaking solution. A recommended cleaning solution must be used in order to solubilize these oily films and deposits to permit their removal.

Today's manufacturers of both hard and soft contact lenses recommend that patients should clean the lens by applying several drops of cleaning solution or a small dab of gel cleaner and by rubbing the lens between thumb and forefinger or in the palm of the hand for a few seconds. Mandell³
recommends a surfactant cleaner for very dirty lenses prior to using an enzyme cleaner. The enzymatic cleaner contains a proteolytic enzyme, papain*, which is extremely effective in removing proteinaceous deposits from contact lens surfaces. Papain is not effective, however, against lipids, waxes or cosmetic contaminants. If the lens has a soap residue causing it to burn, it should be boiled in distilled water for at least one hour and then rinsed in saline solution before replacing it on the eye.

Concerning the proper care and handling of the soft lens, Malin4 states "Proper preparation prior to cleaning helps. After washing and drying the hands, the palm and lens-rubbing finger should be cleaned with the cleaning solution, washed off, and dried. This single added step of removing residual soap from the palm before cleaning the lens may extend the lens life. Otherwise, the cleaning solution places the soap film in suspension, and this contaminated cleaner is rubbed into the lens."

Malin5 further suggests that when removing lenses from the case, they should be poured out if possible. The next best method of removal is to grasp the lens by the edge. Picking up the lens by placing the finger into the concave side may dirty the area of the lens that must remain absolutely clean. A finger may carry soap residue or fibers from a towel; it should not come in contact with the concave surface of the lens. Furthermore, unwashed fingers can transfer a variety of contaminants to soft lenses - lipstick, mascara, lotion, food, oily creams, detergents, etc. The fact that bacterial contaminants occur in 43% of the makeup used by women, and fungal contaminants in 12%, demonstrates just how important proper hygiene, as well as proper cleaning and disinfection, really are.

Lieblein6 notes further that when a patient doesn't clean his lenses - or doesn't clean them properly, surface deposits will inevitably build up. Cleaning solutions aren't effective against markedly encrusted deposits and discolored lenses.

* Another enzymatic cleaner is derived from pork.
protein deposits cause a decrease in visual acuity, corneal injury and inflammation of the palpebral conjunctiva. Frequent replacement of lenses results in a substantial cost to the patient. While most hard lenses are made from a single material, PMMA, hydrophilic lenses are made from many materials. They vary widely in physical and physiological properties. This has led to many new ways of handling soft contact lenses.

Ruben 10 found calcium deposits on lenses, especially on lenses worn by aphakes and by people with pathological corneas. Lowther11 found white crystalline deposits on lenses used on normal eyes for vision correction. These deposits were ascribed to the high calcium salt concentration in the waters used by some wearers to prepare their saline solution. Lowther also discovered protein surface deposits in a separate, staining experiment.

Research has been conducted to identify and simulate the variety of surface deposits. Karageozian12 used amino acid analysis and UV spectroscopy to chemically identify the opaque deposits on lenses. He found that they are proteinaceous in nature, composed mainly of the tear protein, lysozyme. Furthermore, he made up solutions of lysozyme with which he was able to simulate deposits on new lenses. Karageozian and coworkers studied a number of potentially useful materials for removal of the coating. These included surfactant cleaners, oxidative cleaners and enzymes. They found surfactant cleaners ineffective in removing medium to heavy deposits. Oxidative cleaners were able to remove the deposits but had a deleterious effect on the lens material - eventually destroying the lens through repeated use. They finally evaluated a series of proteolytic enzymes resulting in the development of a specially purified form of papain. Papain was shown to be highly effective in removing heavily deposited protein coatings. The Allergan enzyme cleaner was first marketed in the spring of 1976.
Protein coating is a problem with all soft lenses although some lens material is more affected than others. The proteins in the precorneal tear film are apparently the primary source of the varied coating build-up on lenses. Hathaway\textsuperscript{13} discovered a relationship between the quantity of tears produced and the rate that deposits form. However, he couldn't establish a correlation between the concentration of protein in the tears and the rate that deposits form.

Research\textsuperscript{14} at Allergan Pharmaceuticals identified deposits on soft lenses as human tear lysozyme (protein). This lysozyme bonds to the surface of the hydrophilic material and eventually becomes denatured (coagulated). The lens gradually becomes cloudy and opaque. Allergan research successfully developed a formula which acts specifically on the proteinaceous deposits on soft lenses. The cleaning agent used is a proteolytic enzyme which breaks down the denatured protein. It is not capable of penetrating or concentrating in the hydrophilic lens material because its molecular size is larger than the size of the pores in the lens. It has no effects on the physical and chemical nature of most hydrophilic lenses. Extensive toxicological and clinical studies have shown the cleaner to be both safe and effective.

Other serious deposits include ocular secretions, tap water contaminants, eye medication, dirt, makeup, and atmospheric contaminants on the lens surface. Many of these deposits come from the tear film itself. But if impure water has been used for rinsing and storage other deposits such as calcium, iron and insoluble divalent and trivalent metallic salts also collect.\textsuperscript{15}

Fowler and Allansmith\textsuperscript{16} investigated the possibility that surface deposits on soft contact lenses contribute to giant papillary conjunctivitis. They used scanning electron microscopy on 22 lenses worn for varying durations. Lenses worn for only 30 minutes showed surface deposits
(mucous-like material) over about 50% of their anterior surfaces. Eight-hours wear produced approximately 90% covering with more complex coatings composed of multiple layers. Routinely worn and cleaned lenses had even more complex coatings on more than 90% of the surface. The coatings examined consisted of mucous-like material which could be derived from secretory cells of the conjunctiva and the lacrimal gland. The authors concluded that all soft contact lenses develop coatings that become increasingly complex with time and may never be completely removed. They made no conclusions regarding giant papillary conjunctivitis.

Cumming and Karageozian17 describe protein conjunctivitis which is probably due to the irritation produced from denatured protein chemically bonded to the surface of hydrophilic soft lenses. They recommend a new method of cleaning the lenses which they claim to be a safe and effective method of removing opaque proteinaceous deposits from hydrophilic gel lenses. This cleaning method involves soaking the lenses overnight in distilled water into which one protein-cleaner tablet is dropped and dissolved. The lenses are then rinsed thoroughly and sterilized. No rubbing is mentioned.

**EFFECTS OF CLEANING SOLUTIONS**

There are several different approaches to preventing deposits from forming and binding to soft contact lenses. For example, the use of a dry heat ascepticizer that operates at a lower temperature might eliminate the problem. Cleaners are effective in removing the salts, mucous, and dirt that accumulate on the lens during daily wear. If a surfactant cleaner is used on a regular basis prior to thermal or chemical disinfection, then the replacement of lenses due to coating build-up can be greatly reduced.

Arons18 reports on a three-year study of soft lens patients, in which lenses replaced because of coatings dropped from 51% to 13% when all of his patients used a prophylactic cleaner as part of their daily maintenance program.
Blanco et al\textsuperscript{19} studied the effects of enzymatic cleaning on the physical structure of soft lenses. They found that both ficin (derived from the fig tree) and papain (obtained from the papaya tree) effectively removed deposits from the lenses; however, only papain did not affect the physical characteristics of hydrophilic lenses after prolonged soaking in the solution. Both ficin and papain are proteolytic enzymes capable of hydrolyzing protein-like material. The ficin solution caused a yellowish discoloration of the lenses after prolonged soaking.

Kleist\textsuperscript{20} compared several surfactant cleaners and the enzyme tablet, Softlens Enzymatic Contact Lens Cleaner, in their ability to remove protein deposits from soft contact lenses. Both human worn and laboratory deposited lenses showing varying degrees of protein deposition were used in the study. The laboratory-deposited lenses were coated with lysozyme. All lenses were microscopically examined and photographed, rubbed with surfactant cleaner, examined and photographed again. Finally, the lenses were soaked in the enzyme cleaner for 1 to 3 hours. The results clearly showed that only the enzyme cleaner was effective in removing protein deposits from the lenses. The surfactant cleaners had little or no effect.

Lieblein\textsuperscript{21} recommends the use of the papain proteolytic enzyme made by Allergan Pharmaceuticals to remove protein deposits from soft contact lenses. The Softlens Enzymatic Cleaner should not be used daily because of its potentially harmful effects. Its recommended usage is once every seven days. Some practitioners prefer to use a surfactant cleaner daily and the enzymatic cleaner every two weeks or even monthly, even if the patient uses chemical disinfection. This is because some cleaners act against lipids while the enzymatic cleaner acts specifically on proteins.

"In general, if the patient uses a good surfactant cleaner, and rubs and rinses his lenses properly, he can use the enzymatic cleaner twice a month, instead of weekly."\textsuperscript{22}
While the enzymatic cleaner is satisfactory in removing protein coatings on lightly coated lenses, it isn't as effective, even when used repeatedly, on heavily coated lenses that are more than a year old. The protein is tenaciously bound to these older lenses and may even become embedded within the lens matrix, making it difficult for the enzyme to act upon it. The enzyme cleaner doesn't remove deposits, other than protein, such as salts and lipids. Some clinicians question whether the use of the enzyme opens up new lens surfaces for more rapid attraction and deposition of protein. With proper recommended use, the enzyme cleaner should extend the useful life of a lens from one to three years before replacement will be needed because of coating build-up.23

Two methods of rejuvenating lenses are 1) through the use of the Softlens Enzymatic Cleaner mentioned above, and 2) use of a rejuvenator called Ren-O-Gel, made by Smith-Miller-Patch. Ren-O-Gel should only be used by the practitioner since there's a high risk of ocular damage if misused. It is based on a principle of oxidative cleaning - that is, it chemically scrubs lenses free of both organic and inorganic matter. Ren-O-Gel can restore clarity to a very dirty lens, yet should only be used a few times as it has a deleterious effect on contact lenses.

Fowler and Allansmith24 used scanning electron microscopy to investigate the effectiveness of surfactant and enzymatic cleaners in removing coatings from soft contact lenses. They examined 10 continuously worn lenses which had never been cleaned and 15 lenses worn and cleaned regularly for at least six months. They found that 30% of the surface of the continuously worn lenses, cleaned with surfactant or enzyme, were smooth and uncoated. A matted coating covered the remaining 70% of the lenses. When cleaned with a combination surfactant and enzyme cleaner, 50% of the continuously worn lenses were smooth and uncoated while 50% were coated. This represents a marked improvement. Lenses worn and cleaned regularly for at least six months had more deposits.
after cleaning with a combination cleaner. About 25% of the lenses cleaned with the combination cleaner were coated with deposits. The deposits on both types of lenses were approximately 30% thinner after use of the combination cleaner than with either single cleaner. The authors found that no method of cleaning entirely removes the coating from lenses.

Thurben and Shively\textsuperscript{25} discuss two comfort concepts which may assist in effective lens cleaning: 1) multifunctional in-use drop and 2) thermal disinfection/cleaning solution. Among the reasons for use of the special eye drop are:

1. Reversal of excessive lens dehydration.
2. Correction of dry eye symptoms.
4. Lens insertion aid.
5. Promotion of lens cushioning.

Among 28 soft contact lens wearers using the drop, 78% reported improved comfort while 67% noted an improvement in vision.

Thurber and Shively found that the use of a nonionic detergent in the thermal disinfection solution, in addition to daily prophylactic cleaning, provides a built-in way to enhance lens wearer comfort through both static and dynamic cleaning.

Karageozian\textsuperscript{26} demonstrated an enzyme containing preparation, designed for use with soft contact lenses, to be notably effective in removing protein deposition from hydrophilic lenses. The author pointed out that the enzymatic cleaner (which is a protein) did not become adsorbed or attached to the hydrophilic lens material. This was an important finding since it indicated that the enzyme cleaner itself will not be the cause of additional protein deposits on hydrophilic lenses and should not present any foreign material problems to patients.

Eriksen\textsuperscript{27} reports on several cleaning techniques for soft contact lenses: surfactant cleaning, oxidative cleaning and enzymatic cleaning.
Surfactant cleaners were used according to their labeled instructions using the rubbing technique. Oxidative cleaners were tested both with cold soaking and using heat (boiling or asepticizing for 30 minutes). Lenses were placed in enzymatic solutions for varying amounts of time. The lenses were then removed and rinsed by rubbing with water or saline as necessary.

The test results of the surfactant products showed that cleaners dependent on surface activity will not remove all deposits. Although such products are relatively safe and have no harmful effects on lens material, they are unable to remove previously formed deposits on lenses.

Oxidative cleaning products were able to remove previously formed lens deposits, particularly when heated. "When used with appropriate detoxification, oxidative cleaning systems do remove deposited materials satisfactorily, but have a notably deleterious effect on the lens structure."28 Protein deposits actually appear to be enhanced when oxidative systems were used routinely.

Several types of enzymatic products were shown to be effective in removing denatured protein deposits. The enzyme treatment does not damage the lens material. Enzymes are, however, potentially sensitizing and must generally be viewed with caution as a routinely used product such as a lens cleaner. The enzymatic cleaning tablet used in this study contained a specially purified, stabilizing form of papain eliminating this potential.

ALTERNATIVE METHODS OF CLEANING

Only one product has been identified which promises to effectively clean soft contact lenses without finger rubbing the lenses. It is known as Soft Mate Weekly Cleaning System (Barnes-Hind). Soft Mate Weekly Cleaning System claims to solubilize, loosen and remove tenacious materials that accumulate on soft lenses during wear. The solution is said to remove protein and virtually all other normally occurring lens residues such as fats, oils, and cosmetics.
The lenses are placed in a clear plastic washing chamber, which is filled with cleaning solution. While holding the washing chamber upright with one hand, the other hand rotates the moveable top back and forth for 15-20 seconds to create a foam. The lenses are then allowed to soak for a minimum of two hours, after which the twisting action is repeated for 15-20 seconds. Although the Barnes-Hind Soft Mate Weekly Cleaning System is relatively new in the USA, it has been used for years in Canada, Australia, Europe, and the Orient with very favorable results.

A new disinfection system called Septicon has recently been introduced. The Septicon system uses a surfactant for cleaning the lens and a saline solution for rinsing and storage. Unlike other systems, it relies on a 3% hydrogen peroxide solution (Lensept) for disinfecting the lens and a catalyst for decomposing residual peroxide. While the author states that rubbing and rinsing are the principal cleaning actions used in the Septicon system, the article did not indicate that rubbing was actually necessary.

Lensept has two important characteristics which enable it to clean lenses so well. First, because distilled water is used, Lensept is hypotonic. Second, with a pH of 4, it's very acidic. A lens is placed in Lensept for a 10-minute disinfection cycle. It quickly swells due to the hypotonic solution, loosening the coatings or deposits bound to the lens surface. Once the lens reaches its swelling equilibrium, it begins to slowly shrink back to its normal size due to the dehydrating action of the acid. Since Lensept freely penetrates the lens matrix, the swelling and shrinking action involves the entire lens, loosening surface deposits.

The 3% hydrogen peroxide, used in Lensept, is a safe and effective disinfecting agent. It has several advantages over other disinfecting agents. It's faster than chlorhexidine, which needs at least four hours. It
requires no preservatives. And when decomposed, it leaves no residual chemicals.

To assure patient comfort, the Septicon system has a platinum catalyst to neutralize residual peroxide. This prevents stinging when the lens is inserted. The residual peroxide decomposes as the lens soaks in saline that has a preservative. In the morning, after soaking, a shake and a short rinse with clean saline will remove any floating debris and yield a clean, clear lens.

While it took 13 years for the FDA to approve the Septicon system, already other oxidizing agents are in the offing. Perborates, thiosulfates, and other substances could one day be part of other oxidizing systems.