Improving the Experience of Contact Lens Wear: Avenues for Reflection and Change

BY LANGIS MICHAUD, OD, MSc, FAAO (Dipl.)

Contact lenses are used as a method of correcting refractive errors. However, their use can be associated with periods of discomfort as well as occasional pathophysiological reactions. This inaugural edition of Optometry Rounds presents the following specific points will be addressed:

- Physiological effects of contact lens wear
- Clinical significance of deposits and pathogens on the surface of contact lenses
- How to interpret corneal staining related to contact lens maintenance solutions
- Effects of method of wear on patient comfort

Effects of Contact Lenses

Wearing a contact lens induces multiple effects on the eye. Their mere presence, directly upon insertion, produces an imbalance of the tear film. The thickness of the tear film, found at the surface of the lens, decreases quickly within the first 30 minutes of wear. In addition to the lens, the maintenance solution could contribute to a reduction in thickness of the tear film.

Any disruption of the tear film leads to instability and, consequently, to a period of reduced breakup time. Tear film that is unstable results in altered image perception and contributes to the sensation of ocular dryness. Wearing flexible lenses (made from hydrogel and silico-hydrogel) is associated with a reduction in tear volume and an increase in tear osmolarity.

The thinning of the tear film, its quicker evaporation at the surface of the lens, and the increase in tear osmolarity cause rapid accumulation of deposits at the lens surface. These include deposits from tears and from the immediate environment of the wearer. The nature and the quantity of the accumulated deposits are directly related to the material and upkeep of the lens. This accumulation of deposits led researchers to recommend, as early as the 1980s, the use of disposable lenses.

In fact, it was discovered that the integrity of the ocular surface is affected by several characteristics of the contact lens, including the water content, the ionicity, the permeability to oxygen, the modulus of elasticity of the material, the nature of the surface deposits, and the wettability of the lens once soiled.

More frequent replacement of the lens reduces, in part, the impact of lens wear on ocular health. More generally, the selection of maintenance products also has an important impact on the clinical picture. This choice is made depending on the cleaning and disinfecting action, on the cytotoxicity of the product and on its biocompatibility, elements that are just as important as the selection of the lens material itself.

The method of lens wear and patient characteristics must also be taken into account. The risk factors are well documented (Table 1). The cumulative presence of these risk factors should encourage the eye care professional to recommend a safe product linked to a high compliance rate, namely daily disposable lenses.

**CLINICAL CONSEQUENCES:**
- Any contact lens that is placed on the eye can disrupt the ocular balance and the tear film
- Modification of tear film leads to symptoms of discomfort and of ocular dryness
- The more frequent replacement of the lens, in addition to its proper maintenance, will minimize potential complications
- The response to lens wear is personal and the professional must analyze the risk factors based on the personal characteristics of the wearer.

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Deposits and pathogens on the surface of contact lenses

The contact lens accumulates deposits as early as within the first minutes of wearing them.9 These deposits form a layer or a film that is comprised of tear film elements (proteins, carbohydrates, mucus, fat) as well as bacteria and polysaccharides that colonize.11 Bacterial toxins can also be trapped, and later released within the ocular environment.

Mechanical effect

Deposits have a primary mechanical impact, leading to complications. They contribute notably to immune reactions. Mechanical impact results in tissue irritation and the presence of papillary reactions. Giant papillary conjunctivitis (Figure 1), first identified following hydrogel lens wear, can also occur with lenses that are disposable,13 gas permeable,14 scleral,15 and hybrid.16 Secondary reaction to the deposits would be considerably less important with the use of silico-hydrogel lenses.17 The presence of these papillae is associated with symptoms of dry eye, but does not influence the tear film break-up time.19

Immune effects

Deposits alter the composition and the immune action of the tear film.20 This change can lead to a higher susceptibility of the eye to infections and also result in more significant deposits of material at the surface of the lens, thus increasing patient discomfort.17 Contact lenses also initiate immune system reactions (Table 3). The risk factors for developing such reactions have been previously identified (Table 1). The occurrence of inflammatory episodes, such as contact lens acute red eye (CLARE),21 may be related to an isolated factor or to a combination of factors.22 Thus, daily disposable lens factors associated with highest risk include individuals aged ≤ 25 years, males, contact lens wear longer than 6 months, and a correction of > 5.00 D of myopia.

Extended wear is particularly notable. In these cases, beyond the aforementioned risk factors, the presence of biofilm on the lens surface is a primary factor of the immune reaction.23 With daily disposable as with extended use, this would be directly related to the development of sterile corneal infiltrates while wearing silico-hydrogel lenses.24

The pathogens are mainly gram-negative bacteria of the Pseudomonas family, although other new microbes (Acrobact, Stenotrophomonas, and Delftia) have recently been identified.24 The environment of the wearer (contaminants, moist environment, agricultural setting, etc), the individual characteristics of the ocular health, and a lens with limited flexibility on the eye are likely to increase the risks of infiltrating keratitis (Figure 2).25 However, the development of these

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<tr>
<th>Table 1: Risk factors associated with the development of inflammatory episodes related to contact lens wear</th>
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<tr>
<td>• Type and material of contact lenses worn (avoid conventional lenses or first-generation disposable lenses)</td>
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<tr>
<td>• Adaptability (avoid tight lenses or those with restricted movement)</td>
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<tr>
<td>• Lens power (&gt;-5.00 D of myopia)</td>
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<tr>
<td>• Duration of wear (avoid prolonged wear)</td>
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<tr>
<td>• Frequency of contact lens replacement (daily disposable lenses are preferable)</td>
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<tr>
<td>• Maintenance system used (hydrogen peroxide versus all-in-one solutions)</td>
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<td>• Hygienic methods (compliance)</td>
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<td>• Age (&lt;25 years)</td>
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<tr>
<td>• Smoking</td>
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<td>• Sex (men are at greater risk, particularly younger men)</td>
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<th>Table 2: Treatment of giant papillary conjunctivitis</th>
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<td><strong>Initial therapy</strong></td>
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<td>1) Do not wear lenses for 2 weeks</td>
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<td>– Prescribe daily disposable lenses if the patient cannot or will not wear eyeglasses</td>
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<td>2) Prescribe topical steroids</td>
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<td>– loteprednol 0.5 % QID x 2 weeks, then BID once the lenses are re-introduced (x 2-4 weeks)</td>
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<td>3) Once the inflammation and the reaction have cleared up, consider the use of combined therapy with anti-allergy medications (olopatadine BID x 4-6 weeks)</td>
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<td><strong>Long-term support</strong></td>
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<td>1) Consider more frequent use of disposable (ideally daily disposable) lenses</td>
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<tr>
<td>2) Educate the patient on the importance of compliance and hygienic factors surrounding the use of contact lenses</td>
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QID = 4 times daily; BID = twice daily

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<th>Table 3: Inflammatory episodes associated with contact lens wear</th>
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<td>• Acute episodes of red eye</td>
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<td>• Corneal erosion</td>
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<td>• Conjunctivitis (allergic, viral, bacterial)</td>
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<tr>
<td>• Infiltrating keratitis</td>
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<tr>
<td>• Microbial keratitis</td>
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<tr>
<td>• Anterior and/or posterior blepharitis</td>
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Figure 1: Giant papillary conjunctivitis

Photo: Dr. Langis Michaud – Université de Montréal
infiltrates would not be linked to the presence of corneal staining, in contrast to what was suggested in a study conducted by Papas et al.27

A less significant accumulation of deposits reduces the symptoms of the wearer28 and minimizes the impact of contact lens wearing on eye health. This is an argument supporting the more frequent disposal of lenses. The daily disposable lens, therefore, has a clinical advantage over the other types.

**CLINICAL IMPLICATIONS:**

- All contact lenses accumulate deposits beginning within the first minutes of wear.
- Adsorption of deposits on the surface of the lens induces a mechanical effect and causes inflammatory reactions at the ocular surface.
- Prolonged wear is associated with additional risk factors.
- Presence of pathogens at the surface of the lens and in the storage case is the main factor for the development of corneal inflammatory reactions.
- Corneal staining is not associated with a greater risk of corneal infection.
- Frequent lens disposal minimizes the risk of complications.

**Interpretation of Corneal Staining**

Fluorescein staining of the cornea occurs in various cases: dry eye29, physical trauma to the cornea, and following contact lens wear.30 In the latter case, the lens type, its adaptation,31 as well as the lack of corneal oxygenation have been associated with the presence of dotted staining, which occasionally coalesce to form plaques. Contact with certain materials in solutions32 has also been identified as the probable cause of a different type of corneal staining: dotted, diffusely over the entire corneal surface, or affecting only the corneal limbus region, appearing at the beginning of wear, with no long-term clinical consequences. Because of these differences from classical metabolic staining, the relationship between materials and solutions has been the subject of much debate, and a consensus on the real cause of its occurrence has been difficult to reach.

The term “solution induced corneal staining” (SICS) refers to a punctate staining, of a minimal grade 1 intensity, affecting at least 4 out of the 5 areas of the cornea (superior, inferior, nasal, temporal, and central; Figure 3).33 Its presence is mainly associated with contact lens solutions and must be differentiated from other forms of staining that could affect the cornea. Unlike other types of staining that are associated with eye disease, a lack of oxygenation or surface erosions, SICS is transient in nature,34 disappearing within a few hours. The peak in observation usually occurs in the first 2 hours of lens wear, varying according to the composition of the solution. Certain agents, such as polyquaternium-1 (PQ-1), are quickly released into the ocular environment, causing a very brief staining, while polyhexamethylene biguanide (PHMB)-based solutions have a more noticeable and lengthy action.35 Irrespective of the agent in question, the cornea normally reveals no further symptoms 6 hours following exposure.36

The clinical significance of this transient staining remains a focus of research. Initially, such staining was believed to be associated with a tear in the cellular surface, threatening the epithelial barrier of the cornea,37 or even predisposing the wearer to inflammatory reactions of the cornea.38 Other hypotheses have been proposed, including that of a particular attraction between mucin and PHMB, a special relationship that would occur to a lesser extent with PQ-1.39 The hyperfluorescence theory explains the transitory nature of SICS, though it does not completely explain its presence. In fact, in the absence of staining dye, changes can be seen on the epithelial surface, which casts doubt on fluorescein-mucin attraction. None of these hypotheses can explain both the clinical features and the symptoms (or absence of symptoms) experienced by the wearer. In fact, contact lens wearers presenting with SICS report more severe discomfort and reduced vision compared to those who do not experience SICS.40

The most plausible hypothesis comes from the analysis of shed epithelial cells following staining. This analysis reveals that fluorescein accumulates to a greater extent in the cell rather than in the interstices, and therefore does not result in breakage or loss of tight junctions of the corneal surface. The transient staining would more likely be a sign of cell apoptosis, as an indication of imminent premature death.41 In this sense, the visible staining resulting from the solution-lens association could be interpreted as a sign of a physical-chemical challenge suffered by the cell during contact lens wear, beyond its tolerance threshold. The latter is, in part, a factor...
pointing to the variations of symptoms and clinical signs among individual wearers.

Studies have shown that limiting the exposure to solutions or, failing that, scrubbing and rinsing the lens prior to insertion, would contribute to the reduced incidence of SICS. Similarly, the use of hydrogen peroxide can largely eliminate the impact of cleaning solutions on the cornea. In addition, hydrogen peroxide solutions are associated with fewer risk factors that could trigger corneal infiltrations compared to PQ-1 or of PHMB-based solutions. In the latter cases, as previously mentioned, the presence of a bacterial biofilm that is not eliminated by solutions, when in conjunction with wearing rigid contact lenses, predisposes the wearer to infiltrates.

According to Bendamwar, the interpretation of staining should therefore be revised: moderate fluorescence is a sign of healthy cells, hyperfluorescence (only visible with a biomicroscope) is a sign of apoptosis, and the black regions, lacking fluorescence, identify zones of dead cells.

**Clinical Implications**

- Corneal staining caused by maintenance solutions should not be interpreted as being related to pathological causes: dry eye, trauma causing an epithelial tear and hypoxia.
- Corneal staining due to solutions translates into a physiological stress involving the epithelial cells: it includes an apoptotic (premature death) cellular state.
- Certain lens-solution interactions contribute to the generation of more pronounced corneal reactions. Hydrogen peroxide appears to be the least compromising solution for ocular health.
- The absence of any solutions – ie, daily disposable lenses – is the best alternative for eliminating SICS.

**Effects of the Method of Wear on Patient Comfort**

The change from conventional to disposable lenses has allowed prescribers to improve overall clinical ocular features. In fact, this has contributed to increased wearer satisfaction in terms of improved visual acuity, decreased corneal staining, lower intensity injections at the limbus, fewer deposits on the lens, and episodes of infection. Monthly disposable lenses are superior to those that are disposable every 3 months for all of these factors, which explains why these lenses dominate the Canadian market.

However, although the conditions of wear have improved in users of disposable lenses, at least half of wearers continue to report multiple adverse effects (Table 4). These symptoms vary from patient to patient, and they change depending on the wearer’s environment, on the products used, on the conditions of wear, and on patient compliance. The discomfort felt with contact lenses increases with time: beginning from the third week, monthly lenses become less and less comfortable. Simil-
ance improves, approaching nearly 90%. The introduction of daily disposable lenses, made from a material that is highly permeable to oxygen, ensures the necessary oxygenation of the cornea. Those that are less permeable nevertheless still provide a permeability that approaches the minimum thresholds established by the Morgan criteria (DK/t [permeability divided by thickness] of 24 in the centre and 35 on the periphery). This reduced permeability must be compensated for by the appropriate movement of the lens, in order to allow for optimal tear exchange. Debris is then removed and oxygen supply by the tear film can occur. A lens that can move also reduces the risk of inflammatory episodes.

A prescription for daily replaceable lenses must therefore no longer only be considered for part-time usage, but must become a common practice in order to maintain ocular health in short-, medium-, and long-term users.

These lenses can be adapted for both young patients, from the age of 8 years, and older patients. Additional features are becoming increasingly available, with efficient designs for the correction of common refractive errors as well as for the correction of astigmatism or presbyopia.

Daily replacement lenses have historically been ignored mainly because they were considered too costly for the patient; however, recent data indicate that the cost to the patient of lenses worn 5 days/week is similar to that of lenses that are replaced every 2 weeks or every month. At a lower frequency (worn <5 days per week), daily disposable lenses offer a significant economic advantage.

Other Advantages of Daily Disposable Lenses

Daily disposable lenses are associated with a reduced risk of developing eye complications, including microbial keratitis. That is largely due to the fact that the lens does not become contaminated through contact with pathogens that have colonized in the storage case. Studies show that up to 80% of cases are contaminated with bacteria and nearly 50% by fungi. Contamination increases with time: older cases are at greater risk than newer ones. This contamination by pathogenic agents represents a major risk of eye infections. To reduce the risk, it is recommended to avoid lens contact with the water in the case, to store the case somewhere other than in the bathroom (the bedroom is the ideal location), and to change the case every month. Here again, the use of daily disposable lenses helps avoid this problem.

Daily disposable lenses are also protective against the effects of allergens in the eye and against the sun’s harmful rays (ultraviolet protection), in some cases. According to a recent study, the clinical signs related to eye health (staining, hyperemia, papillary reaction) in addition to various symptoms (Table 4) were improved by wearing daily disposable lenses versus longer-wear lenses, even if daily disposable lenses were less permeable to oxygen than the monthly disposable ones.

### CLINICAL IMPLICATIONS

- Frequent replacement of lenses offers clinical advantages (Disposable versus conventional)
- Daily disposable lenses are the optimal solution to lens wear problems. These lenses improve patient comfort versus less frequently replaced lenses and reduce the risk of complications (clinical signs of infection, inflammation, and risk of microbial keratitis).
- Daily disposable lenses eliminate reaction to cleaning solutions as well as secondary contamination in the transmission of pathogens that have colonized in the lens case.

### Conclusion

Contact lens wear can be enjoyable and easy for many patients. However, a vast majority continue to wear their lenses despite signs and symptoms that are incompatible with long-term maintenance of optimal eye health.

There are several strategies to improve the experience of contact lens wear:

- Establish the needs and individual characteristics of the wearer
- Tailor the lenses according to these patient characteristics, avoiding potential risk factors
- Implement optimal strategies: minimize risk factors and recommend the use of maintenance products that cause the fewest possible adverse clinical consequences
- Recommend switching to daily disposable lenses, which is the most effective means to counter wearer symptoms and potential complications
- Educate and advise users and conduct regular follow-ups in order to increase compliance
- Comply with the norms and standards of practice in order to reduce noncompliance on the part of prescribers and of eye care practitioners

For many professionals, the above may represent a paradigm shift with respect to regular practice. Failure to adopt this approach reduces the number of patients who will become contact lens users, thereby limiting the economic potential of the practice, and potentially depriving patients of a method of vision correction that can be both pleasant and practical.

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**Dr. Michaud** is an Associate Professor and the Chief of the Contact Lens Department, Clinical Research, School of Optometry, University of Montreal, Diplomate of the American Academy of Optometry as well as of the Scleral Contact Lens Organization (US).

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**References:**


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