Impact of cosmetics on the ocular surface and in contact lens wear

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Introduction

Cosmetics such as mascara and eyeliner contain a range of ingredients including pigments, oils, waxes and preservatives, and their site of application brings these substances close to, and even in direct contact with, the lashes, the ocular surface and surrounding tissues. The effect of these substances on the ocular surface including the tear film and cornea is not well understood and the impact of cosmetics contaminating contact lenses has similarly received little attention to date. Whilst all cosmetics undergo rigorous testing before being made available to consumers, there have been a number of undesirable effects of cosmetics and toiletries described in the literature. This article reviews current knowledge about cosmetics and their impact on patient symptoms and contact lens wear.

The cosmetics industry has undergone another record breaking year with higher revenues than ever being generated. In addition, the cosmetics industry has seen changes in the demographics of consumers purchasing products; according to the market research company The NPD Group Inc., IN 2005 the average age that females began using beauty products was 17 years, compared with 13.7 years of age today.\footnote{1} There has also been an increase in the number of ‘age-defying’ products and hence the cosmetics industry appears set on ‘beautifying’ consumers well into their later years of life. Whilst the predominant users of cosmetics and eye make-up are female, increasingly more males have begun using cosmetic products than in previous years, especially those for the face and eyes.

Cosmetics and the eye

It is estimated that approximately 70% of women wear cosmetic products for use around the eyes. Cosmetics are commonly applied to the lid areas, the lashes and also with close proximity to the meibomian gland ducts on the lid margin. During recent years, eye make-up manufacturers have promoted their products based on their ability to resist fading, smudging or wearing off over time, which consequentially makes removal of these products more difficult. Often branded as “waterproof”, these cosmetics contain oil, wax or silicone-based agents to aid resistance to the effects of tears and perspiration. Currently there are no published papers that report on the effects of tear contamination by eye make-up on the normal function and physiology of the tear film. For most practitioners the sight of tiny pigmented particles floating in the tear film of make-up wearers is a relatively common slit-lamp finding and the migration of cosmetic products (mascara) onto the ocular surface has been investigated recently. Goto and co-workers\footnote{2} observed relatively large amounts of migration of cosmetic eye products onto the ocular surface after just 30 minutes following application, especially amongst those who applied their cosmetics close to or onto the eyelash line. However, studies that...
report on complications associated with cosmetic use implicate potential changes to ocular physiology that affect the tear film and previous findings have linked the use of make-up with meibomian gland dysfunction (MGD).³

The impact of cosmetic products adhering to a contact lens during wear has also received very little attention to date and the precise effects on vision, dry eye symptoms and contact lens tolerance is poorly understood.

**Cosmetics and contact lenses**

Patients who combine the use of eye cosmetics and contact lenses are more likely to expose their lenses to a relatively oil-rich environment during wear.⁴ The ability of different lens materials, particularly silicone hydrogels, to resist oil/lipid deposition has been reported previously.⁵ The effects of contact lens deposition/spoilation include changes to the physical and/or chemical characteristics of the lens surface⁶ and changes to the clinical performance of the lens including discomfort during wear and adverse events.⁷,⁸ Amongst monthly disposable lenses, several studies have highlighted the relative resistance of the silicone hydrogel material Lotrafilcon B (AIR OPTIX Aqua, Alcon) to lipid deposits over other commercially available silicone hydrogel lens types, in both in vitro and in vivo investigations.⁵,⁹ This may, at least in part, be attributable to the plasma surface treatment feature of the lens, which resists binding of foreign substances including lipid. The plasma surface treatment of Lotrafilcon B has also demonstrated utility in resisting lens deformation, which has been shown to occur to other types of re-usable lenses when exposed to and contaminated by oil-based eye make-up removers.⁴ Contamination of contact lenses in the eyes has been shown to occur by several routes, including:

1. The case – where eye cosmetic ingredients blend with tear fluid
2. The hands – that have previously been exposed to make-up or cleansing products
3. Direct adherence onto the lens surface during wear, either during application of make-up or by make-up floating freely in the tear film

In the case of point 2 above, hand creams contain an abundance of lipids such as cholesterol, mineral oil and glycerine that appear to readily adhere to silicone hydrogel lenses.⁴ It has been shown that this can cause the contact lens to swell and become brittle, making the surface of the lens more prone to scratching.⁴ Therefore thorough washing of hands prior to lens application and removal is strongly advised.

**Current legislation**

According to European Union law directive 93/35/EEC, a cosmetic product must not cause damage to human health when applied in normal or reasonably foreseeable conditions of use.¹⁰ Whilst rigorous testing of cosmetic products occurs before they are brought to market, there are many undesirable effects of cosmetics that may exist at mild levels across a particular user group. An undesirable effect of a cosmetic product is defined as a harmful reaction attributable to its normal or reasonably foreseeable use. However, the knowledge of undesirable effects at the population level is limited by the absence of a formal and reliable reporting system, which generally results in under-reporting. Guidance from the European Cosmetics Association (COLIPA) advises that both consumers and health care professionals have a role to play in reporting of undesirable effects. With respect to eye care, practitioners would be justified in reporting undesirable effects, including but not limited to, irritant or allergic conditions affecting the skin, eyes or mouth. Guidelines from COLIPA suggest that each individual cosmetics company should have their own processes for managing and following up on each
undesirable effect received.

**Implications for practitioners**

It is possible that cosmetics could play a role in dry eye, tear film instability, lacrimal gland dysfunction, dermatitis/hypersensitivity, allergy, infection and contact lens intolerance. Whilst toxic and serious undesirable effects associated with cosmetics are generally eliminated before the product comes to market, mild undesirable effects may go undetected and unreported. As the following examples describe, cosmetics can be responsible for a number of undesirable effects, which practitioners may be familiar with managing but may not necessarily attribute to a particular type of cosmetic or its normal use/application.

**Mascara**

The corneal surface is exposed to contamination by a wide range of cosmetic products, for example, hair spray, eye liner, eye shadow, blusher, foundation, make-up remover to name just a few. The precise effect of these products either individually or in combination is extremely difficult for scientists and clinicians to determine.

There are several reported cases where patients have exhibited reactions such as contact dermatitis and loss of eye lashes following application of mascara.\textsuperscript{11-13} Such reactions appear to be more common when using products such as tinting mascara, especially those containing the ingredients Para-phenylenediamine (PPD) or shellac.\textsuperscript{11-13}

In theory, all pigmented make-up products may contain metal allergens including nickel. Eye lid dermatitis has also previously been observed amongst nickel allergic dermatitis patients following exposure to mascara and eye shadow.\textsuperscript{14}

In addition to relatively acute conditions such as dermatitis, other long-term associations have been reported. These include infectious keratitis, pigmented conjunctival lesions and a rare case of canalicular obstruction caused by a mascara-laden dacryolith.\textsuperscript{15}

**The ocular surface, mascara and microbes**

Whilst relatively rare and typically of low severity, bacterial infections of the ocular surface are more prevalent amongst contact lens wearers than non-contact lens wearers.\textsuperscript{16} Soft contact lenses are implicated in half of all bacterial corneal infections, and bacterial infection often occurs where contact lens wear and cosmetic use are combined.\textsuperscript{16} When mascara and contact lenses are worn at the same time, the bacterial flora around the eye may be increased. Therefore the control of bacterial growth in the mascara tube is important to minimize the risk of infection. Manufacturers of cosmetics use preservatives to keep cosmetics free of microbial contaminants. However, the personal hygiene of the wearer is implicated in how well mascara tubes resist colonisation.\textsuperscript{17}

The efficacy of mascara preservatives in resisting colonisation has also been investigated previously. One study group concluded that preservatives in a range of brands of mascara were inadequate at preventing colonization of staphylococcus epidermis and pseudomonas aeruginosa organisms.\textsuperscript{17} The same study observed that 6 out of 7 cases of pseudomonas corneal infection occurred secondary to scratching the cornea with a mascara applicator brush.\textsuperscript{17}

The repeated use of mascara by multiple users, for example at cosmetics counters, creates greater exposure of microbial contamination to mascara tube contents. Even the repeated use of mascara by a single user has the same effect albeit at a slower rate.

To avoid infection associated with contamination of mascara, historically it has been recommended that mascara is replaced every 6 months for non-contact lens wearers and every 3-4 months for contact lens wearers.\textsuperscript{18,19} However, more recent evidence suggests that both contact lens wearers and non-contact lens wearers should replace their mascara after 3 months.\textsuperscript{20} The reality perhaps is that most people will not

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Figure 2: Cosmetic ‘glitter’ contaminants suspended in pre-corneal tear film (Image courtesy of Alison Ng – Cardiff University)
replace their mascara until it is gone. Some patients will even add water or saliva to make their make-up last longer, which introduces further risk of contamination.\(^{18}\)

Other guidance for wearers of make-up include:\(^{21}\)
- Not sharing cosmetics
- Replacing cosmetics after infections
- Not using an old applicator with a new container of cosmetics
- Applying contact lenses before make-up

A survey conducted by the University of Alabama showed that amongst wearers, mascara age ranged anywhere between 6 months and 5 years.\(^{22}\) The investigators also reported that 37% of mascara tubes tested positive for microbial contamination.

A study by Pack and co-workers\(^ {20}\) concluded that ‘even though infection attributable to mascara contamination is rarely documented, it likely occurs. Often in a busy clinical environment, treating the infection is of greater concern [for practitioners] than determining the source of the infection.’\(^ {20}\)

### Impact on dry eye/discomfort symptoms

Clinical signs of ocular surface disorders do not always correlate with patient-reported symptoms, hence it is likely that many patients who experience dry eye/discomfort symptoms (both for contact lens wearers and non-wearers) may only have marginal dry eye and therefore do not have a pronounced tear film disorder or ocular surface pathology. Detection of dry eye/discomfort by clinical means produces a smaller prevalence than found by the use of specially constructed patient questionnaires. For example, a study by Caffery and co-workers\(^ {23}\) identified clinical signs of dry eye amongst 13% of a population of contact lens wearers.

However, a specially formulated dry eye questionnaire detected dry eye symptoms in 50.1% of the same study group.\(^ {23}\)

Whilst questionnaires are a sensitive means to detect dry eye and discomfort symptoms, they can often be seen as cumbersome in clinical practice. In search of a simple means to identify such symptoms, Michel Guillon and Cécile Maissa proposed a series of questions that can be incorporated into a primary care routine examination to permit more effective identification.\(^ {24}\) These simple questions were derived from a large study involving over 800 patients (502 non-contact lens wearers and 309 non-contact lens wearers) that sought to identify (a) the prevalence of symptoms, (b) the severity of symptoms, (c) the type of symptoms (e.g. burning, dryness, scratchiness, soreness), and (d) analysis of environments predisposing symptoms.\(^ {24}\)

The study observed a higher prevalence of dry eye/discomfort symptoms amongst contact lens wearers than non-wearers, but the most common type of symptom experienced by the two groups was different. Contact lens wearers were more likely to describe their symptoms (according to McMonnies dry eye questionnaire)\(^ {25}\) in terms of dryness whereas non-lens wearers are more likely describe their symptoms in terms of soreness.

Amongst contact lens wearers who were symptomatic 26% experienced symptoms at times when they were wearing make-up.\(^ {24}\) Amongst non-contact lens wearers who were symptomatic, 64% experienced symptoms at times when they were wearing make-up.\(^ {24}\)

Another observation made by this study was the high proportion of subjects who were symptomatic when using moisturisers (81% of symptomatic contact lens wearers and 84% of...
symptomatic non-wearers). However, the authors do not comment whether this observation was due to contamination of the ocular surface by the moisturizer products or whether individuals who use/require moisturizer (e.g. to treat dry skin) may be more susceptible to dry eye/discomfort symptoms. This study demonstrates that the contribution of make-up wear to symptoms of dry eye/discomfort is common both to contact lens wearers and non-wearers. Thus the importance of asking patients about the use of make-up products in clinical practice should not be underestimated.24

Despite contact lens wearers having a greater propensity to report symptoms of ocular discomfort than non-wearers, the association between eye make-up use and dry eye symptomology is common to both groups of individuals. For practitioners, deciding which lens material and/or lens wear modality is best suited to a patient who uses eye make-up has important consequences regarding how likely a patient may be to develop related symptoms.

Re-useable silicone hydrogel contact lenses which incorporate a plasma surface treatment demonstrate better resistance to lipid deposition under normal contact lens wear conditions, specifically Lotrafilcon B.5

In addition, Lotrafilcon B lenses appear to demonstrate resistance to physical changes in the lens structure when exposed to common contaminants found in cosmetic products.4

One may assume that the surfactants in lens care products may at least in part be successful in removing cosmetic contaminants from lenses during cleaning. To date there are no studies that have investigated the ability of the various lens care products to remove cosmetic contaminants from lenses. However, even during normal conditions of wear (without the effects of make-up contamination) significant amounts of lipid and protein deposits have been shown to remain in lenses even after lens cleaning.26,27 Thus repeated exposure of re-useable lenses to cosmetic contaminants may be responsible for a cumulative reduction in lens performance over time despite daily cleaning. Based on this logic one may also assume that daily disposable lenses may also help to eliminate any decline in lens performance over time as a result of this form of contamination.

Conclusion

Whilst the precise association between cosmetic eye products and patient symptoms may be extremely difficult to determine, the association produces a high index of suspicion that warrants further investigation. The impact of eye make-up contamination of contact lenses may have effects that compromise the performance, physical properties and physical structure of the lens.

The use of eye make-up is strongly associated with dry eye/discomfort symptoms. Practitioners should therefore be wary of the contribution of cosmetics to marginal dry eye/discomfort symptoms in clinical practice and make appropriate recommendations to patients.

About The Author

Dr Cameron Hudson is the National Sales Manager for Alcon UK and Ireland.

Upon completing this article and MCQs, think about what you have read and learnt today. How can you apply it for the benefit of your patients and make yourself a better practitioner?”

References


MULTIPLE CHOICE QUESTIONS

1. According to market research, what is the current average age that females begin using cosmetics?
   a. 10.9
   b. 13.7
   c. 15.2
   d. 17.0

2. The silicone hydrogel contact lens material Lotrafilcon B demonstrates resistance to deposits owing to which of the following features?
   a. Plasma surface treatment
   b. Embedded wetting agents
   c. High water content
   d. Packaging saline additive

3. Investigators from the University of Alabama discovered microbial contamination in what percentage of mascara tubes?
   a. 25%
   b. 32%
   c. 37%
   d. 45%

4. An association between dryness symptoms and make-up wear was found in what proportion of non-contact lens wearing patients?
   a. 19%
   b. 26%
   c. 53%
   d. 64%

5. Contact lens contamination by make-up and/or make-up remover can cause which of the following?
   a. Compromise to the performance of the lens
   b. Changes to the physical structure of a lens
   c. Changes to the physical properties of the lens
   d. All of the above

6. Which of the following is the LEAST appropriate option to select for a contact lens wearer experiencing an undesirable effect from ocular cosmetics?
   a. Fitting a daily disposable contact lens
   b. Fitting a lens with a surface treatment that resists spoilation
   c. Use of a hydrogen peroxide cleaning regimen
   d. Fitting a RGP contact lens
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**MULTIPLE CHOICE ANSWERS**

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All completed answer sheets can be scanned and emailed to professional.affairsUK@alcon.com

CET articles MCQs, Professional Affairs, Alcon Eye Care UK Ltd, Park View, Riverside Way, Watchmoor Park, Camberley, Surrey GU15 3YL.

CET: C-33854a 93002198Q
Learning objectives

5.2.1. Manages the aftercare of patients wearing soft lenses.

3.1.1 Interprets relevant history and information obtained from the patient
Demonstrates an understanding of contraindications to contact lens fittings

5.4.2 Manages contact lens aftercare issues