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Review article

Diagnosis and remediation of blink inefficiency

C.W. McMonnies*

School of Optometry and Vision Science, 77 Cliff Avenue, Northbridge, New South Wales, 2063, Australia

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ABSTRACT

To examine the role of incomplete blinking in contributing to blink inefficiency, symptoms of dry eye and ocular surface disease. To review methods for diagnosing blink inefficiency (including both reduced overall blink rate and increased incomplete blink rate) and the role of remediation for efficient complete blinking as an essential part of the lacrimal functional unit in maintaining tear homeostasis. Diagnosis and remediation of blink inefficiency appear to have been somewhat misunderstood in the management of dry eye disease. To the extent that a high incomplete blink rate ranks in significance with low blink frequency in contributing to blink inefficiency, measures and remediation of only total blink rate are of reduced usefulness in the diagnosis and treatment of blink inefficiency-related ocular surface exposure, dry eye symptoms and ocular surface disease. In addition, a patient's blink performance during a biomicroscopy or any other clinical assessment of blink efficiency, is unlikely to be characteristic of or relevant to the blink inefficiency that develops and causes symptoms during their various day-to-day activities. There appears to be a strong case for prescribing blink efficiency exercises in the management of many cases of dry eye symptoms and ocular surface disease. Remediation of spontaneous blink inefficiency may require that a motor memory of voluntary complete, rapid, relaxed and natural looking blink formation is established and maintained as the basis for efficient spontaneous blinking. Voluntary forceful blinking may undermine the motor memory of efficient blinking and risk the depletion of any reserves of lipid.

1. Background

A healthy ocular surface depends on the maintenance of tear film homeostasis [1] which is sustained by the lacrimal functional unit which has been described as the tear secreting glands (lacrimal glands, conjunctival goblet cells and meibomian glands) and their neural and immunological components [2]. That description does not include a role for blink efficiency which, like the other components of the lacrimal functional unit, has a 'conditio sine qua non' or essential relevance to the maintenance of tear homeostasis and ocular surface health. Altered tear film is a consequence of disease or dysfunction in one or more components of the lacrimal functional unit [3] and this review examines the contributions from inefficient blinking due to low blink rate and high incomplete blink rate for example. Accurate diagnosis and classification of the loss of tear homeostasis and ocular surface disease is challenging but is necessary as the basis for the provision of the most appropriate therapy [4]. For example, many patients may only have dry eye problems when their blinking becomes inefficient while using a computer [4]. A review of computer vision syndromes found that dry eyes are by far the major symptoms associated with computer use [5]. It may be that some computer users have no lacrimal function unit deficiency other than blink inefficiency which is induced by the high attentional and cognitive demands of many screen-based activities. Apart from low total blink rates while using a computer, Chu and coresearchers found that compared to reading hard copy material, incomplete blink rates increased during computer-based reading of the same material [6]. Of course, loss of tear homeostasis may also be a consequence of tear component deficiencies in aqueous, lipid or mucin as well as exposure to provocative conditions such as air conditioning, contact lens wear and excessive time reading for example [1]. Inefficient blinking exacerbates the detrimental significance of all of these factors. Efficient blinking is not just a matter of an adequate blink rate because it also depends on a high ratio of complete blinks relative to incomplete blinks [7]. Conversely, key features of blink inefficiency include a low total blink rate and/or a high incomplete blink rate.

2. Specification of complete and incomplete blinks

Prior to 2013 a complete blink appears to have been understood to simply involve the top lid touching the bottom lid [8]. However, in 2013 Korb and coresearchers reported that the keratinized central portions of the upper and lower lid margins of healthy subjects do not

* Corresponding author.
E-mail address: c.mcmonnies@unsw.edu.au.

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touch during what appears to be deliberate (voluntary) complete blinking [9]. Also in 2013, Pult and coresearchers reported asking healthy subjects to maintain normal blinking during which they found that most blinks were incomplete with a lack of contact of between the lids across the full length of the eyelid [10]. However, that study found that at the limit of closure, the central upper lid margin was seen to overlap the central lower lid margin [11]. In association with this lid overlapping, fusion of the upper and lower tear menisci, and presumed inter-menisci tear mixing, was found to occur at that point [11]. Patients and subjects who are asked to blink normally may become conscious of their blinking to the extent that they blink voluntarily rather than spontaneously [12]. Consequently, blinking during the study reported by Pult and coworkers may also have involved voluntary blinking. Nevertheless, to the degree that any blink fails to connect the tear menisci and re-establish tear layer thickness over the entire ocular surface, the area between the upper and lower tear menisci at the limit of downward spontaneous blink lid motion, is thus exposed to evaporation beyond the normal interblink interval. Extended exposure and evaporation results in above normal hyperosmolarity and risk of tear break up with associated epithelial insult and desiccation. For patients with manifest inferior corneal staining, 67% of their blinks were found to be incomplete [13]. For non-contact lens wearers who report symptoms of dry eye, inferior corneal staining was observed in 67.9% of subjects [14]. For subjects using a computer to perform a 15-min reading task, Portello and coauthors reported a significant positive correlation between the total symptom score and the percentage of incomplete blinks [8]. Golebiowski and coauthors reported increased rates of incomplete blinking during 30 min of smartphone reading while overall blink rates remained unchanged [15]. Wang and coauthors found that incomplete blinking was associated with an increased risk of dry eye disease [16].

3. The further significance of incomplete blinks

The ocular surface epithelium is exposed to atmospheric oxygen and the potential for the development of oxidative stress [17]. In a study of blink suppression in rats, an increase in oxidative stress markers in the corneal epithelium was found to be associated with increased exposure of the ocular surface [17]. There was an association between an increase in MMP-9 concentration and blink suppression, suggesting that, in addition to oxidative stress, MMP-9 plays a role in the pathogenesis of epitheliopathy due to exposure [17]. The ocular protection index is intended to provide a quantifiable indication of the interaction of the tear film integrity and blink processes in protecting the ocular surface from desiccation [18]. It is determined by dividing the tear film breakup time by the interblink interval duration which is calculated for the total blink rate [18]. Ideally the ocular protection index could include the additional desiccating influence of incomplete blinks.

For normal subjects, incomplete blinks were found, on average, to represent 10%, [19] 20% [20] and 22% [21] of the total number of blinks. In addition to the many factors which determine incomplete blink rates, these findings depend on the criteria used to specify an incomplete blink. Drew found that blinking occurs just before and just after periods of maximum difficulty of a task [22]. As a consequence, incomplete blinking rates increase with the attentional demand of visual activities [23]. For example, incomplete blink rates increase with computer use [6,8]. For subjects with computer vision syndrome symptoms, the percentage of blinks which were incomplete ranged between 0.9% and 56.5%, and a positive correlation was found between symptom scores and the percentage of incomplete blinks [8]. The pathological significance of longer interblink intervals may increase faster than linearly with their duration, and accordingly, provide a greater opportunity for osmolarity to increase. Incomplete blinks approximately double interblink intervals for the inferior ocular surface and its exposure to tear evaporation, hyperosmolarity and epithelial desiccation [7]. The significance of an incomplete blink increases as total blink rates reduce. For example, at a total blink rate of 10 per minute and an incomplete blink rate of 20%, the average interblink interval of 6 s would result in two incomplete blinks and associated interblink intervals being extended by them to approximately 12 s for the inferior areas of the ocular surface which are over-exposed by incomplete blinks. A blink rate of 5 per minute could extend incomplete blink over-exposure to about 24 s. The influence of interblink intervals as a measure of ocular surface exposure cannot be validly assessed by simple averaging calculations due to significant fluctuations and lack of periodicity in blink frequency [13]. To the degree that a complete blink contributes significantly to the maintenance of tear homeostasis, then the second of two immediately successive complete blinks has a reduced capacity to achieve any related benefits. However, the risk of epithelial desiccation due to over-exposure is much greater with successive incomplete blinks and associated excessive ocular surface exposure. By this reasoning, high incomplete blinking rates may contribute more to blink inefficiency and loss of tear homeostasis than low rates of complete blinks. The influence of inefficient blinking appears likely to increase in concert with the degree of deficiency in any other component of the lacrimal functional unit. For any other form of tear function deficiency, improvement in blink efficiency may be a contributor to, if not a key component in achieving restoration and maintenance of tear homeostasis and ocular surface health. However, remediation of blink inefficiency can be neglected [24,25], especially perhaps if other lacrimal functional unit deficiencies are more easily detected and identified as needing more immediate remediation. Also, dry eye patients may be disadvantaged by remedial information overload and be best able to gain optimum benefits from multiple treatment approaches if they are staged over time. For example, treatment for meibomian gland dysfunction might be usefully commenced before progressing to remediation of blink inefficiency. As discussed below, some benefits of improved blink efficiency are limited by meibomian gland dysfunction.

4. Diagnosis of blink inefficiency

Blinking is a complex phenomenon that is profoundly affected by diverse endogenous and exogenous stimuli [13]. Diagnosis of blink inefficiency is problematic because, for instance, blink behaviour varies widely with the nature of visual and cognitive demands of the activity that is concurrent with the evaluation. Blink behaviour also varies with neural control (spontaneous, voluntary and reflex for example) as well as with air temperature, humidity and movement [12]. Blink behaviour is additionally influenced by factors such as fatigue, mood and the emotional influences associated with visual activities such as the level of reward (or dissatisfaction) that a particular activity engenders and the related dopamine level in the brain [26]. To the degree that the conditions of assessment in a clinical environment do not represent conditions typically experienced by the patient, the blink behaviour observed clinically appears unlikely to be relevant to making a global assessment of blink efficiency that could be relevant to dry eye disease symptoms [12]. For example, methods used to assess complete and incomplete blink rates are more or less invasive and so do not allow for an assessment of spontaneous blinking that is usefully representative of the patient to be assumed [7,12]. During biomicroscopy the patient's posture is abnormal and so to some extent uncomfortable, and unusual lighting conditions and glare might also contribute to discomfort as might any feelings of stress which are induced by an unfamiliar procedure. An unrepresentative blink performance appears likely to be observed. Instillation of sodium fluorescein greatly facilitates observations of the degree of blink completeness, but instillation of any staining agent alters blinking behaviour. For these reasons, a patient's blink behaviour during a biomicroscopy examination seems unlikely to have any relevance to their normal range of day-to-day spontaneous blink activity. Asking patients to blink normally appears likely to increase their awareness of blinking and risk voluntary control influence on their blink behaviour. Similarly, evaluation of blink efficiency while a patient performs a standardized clinically-based computer or video viewing task appears unlikely to be representative of that patient's performance under other conditions to which they are exposed. For example, their work conditions may involve the influence of factors such as pressures of time and fatigue as well as very high or very low levels of cognitive activity and dopamine influence on blinking [26]. In addition, a method of assessing incomplete blink rates that is appropriate for clinical use does not appear to have been developed. For instance, the frame-by-frame analysis of video recordings of blink activity to determine incomplete blink rates is too time consuming for routine use in a clinic.

However, after sodium fluorescein instillation, biomicroscopy may detect inferior epithelial desiccation which could be at least partly due to a low blink rate and/or a high incomplete blink rate with associated excessive ocular surface exposure [7]. For the superior ocular surface, the combination of benefit from both complete and incomplete blinks and associated reduced inter-blink interval tear thinning by evaporation, may be able to maintain its epithelial integrity despite the presence of some tear component deficiencies. However, over-exposure of the inferior ocular surface by incomplete blinks and associated greater tear thinning and breakup by evaporation, means that desiccation staining which is limited to the inferior cornea can be a very useful sign of abnormal levels of incomplete blinking and so a very strong indication of the need to prescribe blink efficiency exercises [7]. Sequential staining may be needed to elicit subtle evidence of incomplete blink-related inferior corneal over-exposure desiccation [27]. A differential diagnosis of lagophthalmos may be relevant. Even when epitheliopathy is evident in the superior cornea, a greater degree of stain in the inferior cornea can be a sign of abnormally high levels of incomplete blinking. However, evidence of incomplete blink-related inferior corneal stain may have disappeared at the time of an examination, especially when other tear functions are at least satisfactory. Because activities that are visually and/or cognitively demanding are known to reduce blink efficiency, [8,23] asking patients when their dry eye symptoms are worse can be useful. For instance, a history of activities such as intensive reading or screen-based activities, which are associated with task-specific dry eye symptoms, can be another indication of the need to prescribe remedial blink efficiency exercises. Chhadva and coresearchers found eyelid laxity in thyroid disease patients to be associated with abnormal tear parameters and so having the potential to support a diagnosis of dry eye [28]. The combination of eyelid laxity and incomplete blinks may be particularly detrimental for lipid delivery for instance.

5. Remedial approaches for blink inefficiency

Miura and coworkers used a light emitting diode timer as a prompt to blink and so increase blink rates [29]. Wink glasses were also developed for the purpose of increasing blink rates [30]. These glasses achieve the increase by becoming opaque as a prompt to blink when interblink intervals extended beyond 5 s [30]. Ang and coauthors commented that the increase in blink rate was partly due to some subjects blinking twice in response to the prompt [30]. They also noted that some subjects found the associated interruptions to reading comprehension to be disturbing and that the prompts needed to be ignored after a few minutes in order that application to task could be maintained [30]. Cardona and coauthors reported increase blink rates prompted by computer screen changes but found that each method was judged to be intrusive with the associated possibility of reduced reading comprehension [31]. Rosenfield and coauthors used auditory prompts for voluntary blinking during computer use involving reading text [32]. However, the resulting increased blink rates failed to reduce symptoms of computer vision syndromes and several subjects reported that conscious blinking interfered with their ability to complete the reading task satisfactorily [32]. Nosch and coauthors developed animation software to increase blink rate when using a computer, although some subjects found the method distracting [33]. Miyake-Kashima and coauthors used anti-reflection film placed over a visual display terminal to reduce screen reflections and found that blink rates for healthy subjects were increased and symptoms of asthenopia reduced [34]. While this method is not intrusive, like other methods mentioned here, it does not address the mechanism whereby incomplete blink rates exacerbate tear homeostasis loss in patients with dry eye symptoms. To the degree that there is a focus on improving blink rates to the exclusion of reducing the rate of incomplete blinking, improvements in tear homeostasis and reduction in ocular surface exposure and symptoms may be limited. Chu and coworkers drew the conclusion that reducing the proportion of incomplete blinks may be a viable means of reducing symptoms of dryness [6]. Park and coauthors reported that their studies in thyroid eye disease patients showed how a relation between dry eye and incomplete blinking, and the loss of meibomian gland structure in the top lid [35]. Li and coauthors found that tear instability correlated with increased incomplete blinking in patients who received small-incision lenticule extraction [36]. The risk of tear instability appears to be highest during prolonged reading for example, when blink rate is significantly reduced [37] and incomplete blinks rates increased [8,16].

6. Lipid delivery from meibomian glands

The reciprocal contraction and relaxation of the muscles of Riolan and the pars palpebrae of the orbicularis during each blink, and associated milking pressure on the meibomian glands, facilitates the expression of lipid [38,39]. Reduced activity in those muscles due to incomplete blinking and/or a low blink rate, could help to explain deficiency in lipid delivery and associated evaporative dry eye. For example, Chou and coresearchers found reduced lipid layer thickness correlated with higher rates of incomplete blinking in a group of subjects with 44.3% of them having a severe dry eye syndrome [40]. Normal range lipid delivery depends on normal meibomian gland functions and associated reserves of lipid. Korb and coauthors reported increased lipid layer thickness following three forceful blinks in unselected volunteers (median age 35 years) [41]. Compared to subjects with a baseline lipid layer thickness of less than 75 nm, for subjects with a baseline lipid layer thickness between 75 and 150 nm, the degree of thickening after forced blinking was increased by 73.7%. These findings are consistent with lipid delivery subsequent to forced blinks being dependent on the availability of adequate lipid reserves [41]. In subjects with significant meibomian gland dysfunction and low or even negligible reserves of lipid, forceful blinking may not significantly increase lipid layer thickness and any such release of lipid would tend to deplete lipid reserves. Gland orifices being blocked with clusters of keratotic cells or any other forms of gland drop-out [42] could be the basis for the failure of forceful blinks to increase lipid flow. Pressing the car accelerator harder to increase the rate of petrol delivery does not help when the petrol tank of the car is empty. Even if the tank is nearly empty, harder acceleration will more rapidly result in depletion. Optimum benefits from the remediation of meibomian gland deficiency appear likely to depend on efficient blinking. There appears to be a strong case for prescribing blink efficiency exercises which reduce incomplete blinking in the management of dry eye symptoms and ocular surface disease. Apart from the possibility of improving the delivery of lipid, successful remedial blink efficiency exercises could also help reduce ocular surface exposure to excessive tear evaporation of tears and associated hyperosmolarity induced symptoms.

7. Blink efficiency exercises and motor memory

There is strong evidence from studies involving the physical practice of movements that an important physiological component of behavioural performance gains is a lasting change of local cortical movement representations, a kind of motor memory [43]. For instance, voluntary active motor training results in improved motor performance following passive repetition of the same actions being performed correctly [44,45]. Once established, the memory of a motor skill can persist providing a related skill is not learned or re-established [46]. For example, voluntary forceful blinking may disturb the motor memory of relaxed natural-looking spontaneous complete blinks. An efficient way to form a new motor memory is to repeat short-term training many times [47]. The learning of a motor skill sets in motion neural processes that continue to evolve with additional practice and even after practice has ended, which is a phenomenon known as consolidation [48]. For instance, complex behaviours such as are involved in a successful golf swing are learned in the conscious mind and when mastered, muscle memory should take over without any conscious mind influence during the playing of a round [49]. Exacting demands in relation to golf swing-related requirements for eyes, head, shoulders, wrists, hips, knees, feet and weight transfer for example, need to be coordinated in practice so that they become routine [50]. Similarly, the following remedial blink exercises are intended to help establish a motor memory of optimum blink performance. Remedial blink exercises involving the conscious performance of all the features of efficient blinking should help establish and consolidate a motor memory which becomes the basis for spontaneous blinking. Thus, blink practice sessions should involve only full, complete, quick, rapid, brief, soft, light, relaxed blinks which appear natural and confident looking [7]. A hand-out for the patient [7] could be modified to explain how:

The type of blink required for optimum blink efficiency has the following characteristics:

1 An efficient blink is **complete** and full, meaning that the top lid lightly touches/reaches the bottom lid.
2 An efficient blink is **soft**, relaxed and light, meaning that only the muscles of the eyelid are involved in an unforced action. Specifically, the muscles of the eyebrows and cheeks are not involved in an unnaturally forced way.
3 An efficient blink is **brief,** quick and rapid, taking only about one third of a second to complete.

Finally, an efficient blink looks **natural** and confident to other people.

Increasing age results in motor training being less effective at establishing motor memories [50]. For instance, dopamine activity is one of the mechanisms implicated in motor memory formation but dopamine levels decline with age [51]. Floel and coworkers found that upregulation of dopamine activity (by oral ingestion of levodopa) accelerated memory formation in young subjects and restored the ability to form a motor memory in elderly subjects [51]. Given that remedial blink sessions can be viewed negatively by some patients, perhaps especially if, for example, they were hoping to receive treatment involving a change to a more effective tear substitute, the methods used to deliver remedial blink exercises may be crucial in motivating them to persist with the exercises. A photographic demonstration of staining of the inferior ocular surface resulting from an incomplete blink [7] can help patients to appreciate the consequences of inefficient blinking. For example, patients may benefit from knowing that blink efficiency exercises have the potential to be therapeutically beneficial during and immediately after the exercises. These benefits could include increased post-exercise tear layer thickness and circulation [52,53], promotion of lipid release from meibomian glands [38,39] and re-distribution of mucin over the inferior ocular surface with associated improved surface wetting. These changes have the potential to increase tear stability (with longer tear break-up times) and help repair desiccated epithelium as well as reduce symptoms. For some patients a therapeutically optimum time for the exercises can be immediately after any lubricating artificial tears are instilled when the ocular (or contact lens) surfaces have maximum lubricity. These immediate benefits are in addition to the exercises helping to establish and consolidate motor memory of efficient blinking which continues to be generated spontaneously in between remedial sessions.

8. Adherence to remedial exercises

It is important for patients to understand that while the number of blinks is an important feature of blink efficiency, the quality of blinks can be as important or even more important than the quantity. Advising patients for instance that “the exercises don’t help if you don’t do them” and that “nobody else can do the exercises for you” might help them to adhere to remedial blink efficiency instructions. Adherence can be addressed at subsequent consultations by asking patients to demonstrate how they perform the remedial exercises. However, rather than risk putting a non-adherent patient in an embarrassing position, it might be best to firstly ask patients how confident they would be if they were asked to provide such a demonstration. Their reaction to the question and related verbal response might be all the information a clinician needs to assess their adherence. For example, “I haven’t been able to find the time to do them” may be their explanation for non-adherence. This response can be countered by suggesting that commercial breaks or program promotions which interrupt television viewing, or time spent in a waiting room, or waiting for traffic lights to change when driving, or time waiting for or travelling on public transport, are all examples of potentially ideal opportunities for remedial blink exercises that make use of what would otherwise be unproductive time. Suggesting these kinds of opportune times for remedial blinking sessions from the outset helps but the need for reinforcement of them is realistic.

The 20:20:20 rule recommends that every 20 min computer users look to a target about 20 feet distant from their screen for 20 s so that their eyes have some respite from eyestrain [54]. That recommendation can be usefully supplemented by including the performance of 20 blinks for a 20:20:20:20 rule [55] which involves only optimally performed efficient, conscious and therapeutic blinks so that it is relevant to patients with dry eye symptoms and ocular surface disease. Using multiple descriptors for ideal, efficient, therapeutic blinks that have very similar meanings may be helpful in achieving a better understanding of the nature of an efficient blink and may be particularly important for patients for whom English is not their native language. The four key ideal blink descriptors highlighted in the handout can be prompts, one by one in turn, as each of these features is consciously and accurately produced in successive blinks which eventually involve all these features in every blink. Five sets of the four key descriptors result in 20 optimum therapeutic blinks per session. Apart from computer use and reading, the 20:20:20:20 rule could be particularly applicable to any task involving the risk of blink inefficiency such as intensive proof reading and complex fine motor tasks requiring sustained delicate eye-hand coordination for instance. Ideally patients would have control over the timing of exposure to remedial blink methods including exercise sessions, so that, as described herein, the benefits can be optimised by being able to give full attention to them. Optional responses to mobile phone prompts to follow the 20:20:20:20 rule and perform this routine may be helpful providing such interruptions are acceptable in relation to the continuity and completion of work or other activity. The awareness of dryness symptoms is an ideal prompt for blink exercises which have the potential to reduce symptoms as well as to contribute to the embedding of motor memory.

Some patients may be concerned that practice of efficient blinking could appear to family, friends or co-workers as a sign of a problem such as a tic [56] or choreic blinking as seen in Huntington’s disease [57]. These concerns are valid if forceful complete blinks are prescribed. Stefan and coresearchers found experimental support in motor learning for a role of observation of another individual performing the desired motor activity [43]. Patients who watch a practitioner’s or an assistant’s demonstration of efficient blinking might benefit by having any concerns about their appearance allayed and so acquire greater confidence and motivation to improve their blink efficiency.

Alternatively, having been more or less dissatisfied with previous dry eye remedial approaches, some patients can be pleased to have the opportunity to improve their blink behaviour after having the benefits explained to them and being given the handout to take home.

9. Discussion

The symptoms which are typical of dry eye are one of the most common complaints reported by patients presenting to eyecare practitioners [58]. Digital eye strain and associated dry eye symptoms are an emerging public health issue [59]. However, dry eye syndrome should be included in the differential diagnosis of any patient presenting with symptoms of ocular discomfort [60]. The prevalence of diagnosed dry eye disease in the United States for example, ranges from 2.7% for ages 18–34 years to 18.6% for ages 75 years and older [61]. A variety of blink inefficiency remediation methods have been concerned with blink rates to the exclusion of incomplete blink rates [30–34]. Collins and coresearchers showed that blink exercises can be used to increase the frequency of complete blinks rates [62]. Because efficient blinking re-establishes tear layer thickness and promotes tear circulation, lipid secretion, and mucin distribution, it is possible that any patients with dry eye disease could benefit from exercises to improve blink efficiency which are prescribed in addition to patient-specific remediation for other lacrimal function unit deficiencies. Rosenfield and coresearchers concluded that reducing the percentage of incomplete blinks, rather than increasing the overall blink rate, will have a greater impact on the discomfort associated with computer vision syndrome [32]. The same approach appears to be needed for any dry eye symptoms.

Contact lens wearers too often discontinue wear because of discomfort and dry eye symptoms specifically [63]. Because contact lens wear is a challenge to tear homeostasis, contact lens wearers who report dry lens symptoms appear likely to also benefit from improved blink efficiency. A reduction in incomplete blink frequency has the potential to reduce surface deposits on contact lenses and improve front surface wetting so that symptoms of dryness could be reduced [7]. Video recordings of natural blinking were recorded for three minutes in healthy normals and successful soft contact lens wearers [21]. For both groups 22% of blinks were incomplete [21]. Both groups showed evidence of a correlation between the degree of corneal staining and the degree of incomplete blinking, but the association was stronger in contact lens wearers [21]. There appears to be no reason for patients to completely abandon blink exercise sessions when their symptoms have been reduced to a tolerable level. Continued exposure to the conditions which are more demanding of blink efficiency (computer use, reading, contact lens wear, adverse atmospheric conditions for example) and continuing risk for the development or persistence of other forms of dry eye disease such as those that are related to aging for example, are indications for maintaining the habit of doing blink efficiency exercises, at least at a reduced frequency level, to ensure that motor memory of efficient blinks remains consolidated.

Requests for a copy of the author's Blink Exercise instructions handout are welcome [c.mcmonnies.@unsw.edu.au].

Declaration of Competing Interest

There are no conflicts of interest, funding or other financial interests to declare in relation to this review.

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