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Therapeutic benefits of blinking exercises in dry eye disease

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ABSTRACT

Purpose: Dry eye disease (DED) is an important public health concern given its increasing prevalence and impact on patient quality of life. Blinking frequency and completeness are reduced during digital screen exposure, compromising meibum secretion and distribution, causing tear film instability and leading to DED. This study evaluated the effects of blinking exercises on blink pattern and clinical signs and symptoms of DED.

Methods: Fifty-four participants with dry eye symptoms received instructions to perform a ten-second cycle of blinking exercises every 20 min during waking hours for four weeks. Symptoms were assessed using the 5-item Dry Eye Questionnaire (DEQ-5) and Ocular Surface Disease Index (OSDI); blinking patterns measured with the TearScience LipiView II; and tear film and ocular surface parameters assessed with the Oculus Keratograph 5M. Measures at baseline and on day 28 were compared.

Results: Forty-one participants completed the study, reporting an average of 25.6 daily blinking exercise cycles. Improvements were noted in DEQ-5 (from 11 ± 4 to 7 ± 3; $p < 0.001$), OSDI (36 ± 18 to 22 ± 17; $p < 0.001$), non-invasive tear film breakup time (6.5 ± 2.4 to 8.1 ± 4.8 s; $p < 0.04$), the proportion of incomplete blinks (54 ± 36 to 34 ± 29 %; $p < 0.001$), but not in tear meniscus height or tear film lipid layer thickness.

Conclusion: Blinking exercises can modify poor blinking patterns and improve dry eye symptomology, with modest changes in objective measures of tear film quality. Incorporating such routines into clinical care recommendations may improve blinking habits and help protect against the impact of digital device use on tear film quality and DED onset and evolution.

1. Introduction

Dry eye disease (DED) is an increasingly prevalent condition [1–3] and an important public health concern, given its impact on work productivity and quality of life of those affected. Reported symptoms include ocular surface burning, itching, and foreign body sensation, as well as photosensitivity, ocular hyperemia and intermittent poor vision [1]. Severe forms of DED are associated with anxiety and depression [4,5]. Risk factors for developing DED include female sex, advancing age, exposure to low humidity environments, contact lens wear, refractive surgery and use of digital devices [6]. Digital device use has been correlated to dry eye symptoms [7], low tear meniscus volume [8], and tear film instability [9]. An ageing population and increasing popularity and reliance on digital devices contribute to the global burden of DED [10], while rising costs from eye care professional visits, medications, and reduced work productivity [11] bear significant economic impact [12]. Recently, the impact of blinking on the tear film layer has gained attention in clinical and research settings. Blinking helps to mechanically secrete and distribute meibum over the tear film surface during the upstroke, stabilizing the tear film [13–16]. Aqueous tear evaporation occurs during the interblink period, and prolonged blink avoidance can decrease visual quality [17]. An adequate blink rate and completeness are vital in creating a stable tear film. Previous studies have associated incomplete blinks with dry eye symptoms [15,18,19], as well as clinical signs, such as lid parallel conjunctival folds (LIPCOF) and corneal staining [15,20]. The interblink interval, the proportion of incomplete blinks and tear film instability increase during highly focused work [13,21,22]. The Osaka study attributed exacerbated dry eye symptoms during digital device use to compromised blink patterns [9]. Studies have identified Asian ethnicity as a risk factor for developing primary DED [23] and post-LASIK dry eye [24]. Both studies identified a tendency for the Asian eye to blink incompletely, possibly associated with ethno-specific anatomical eyelid features [23,24]. These findings reinforce the potential role blinking plays in influencing meibomian gland

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function and tear film integrity. In the absence of clinically accepted alternatives, exercises to retrain and modify blink patterns may be recommended for patients, with the aim of overcoming poor blinking habits and potentially alleviating dry eye symptoms and improving clinical signs. Little evidence confirming the efficacy of such blinking exercises exists within the current literature, however. This study sought to evaluate the benefits of prescribed blinking exercises to help inform clinicians and lend scientific support for recommendations made in clinical practice.

2. Methods

2.1. Subject recruitment

The research was conducted with approval from the University of Auckland Human Participants Ethics Committee (reference number 019190) and in accordance with the Declaration of Helsinki. Written informed consent was obtained from eligible participants. Participants were required to be at least 16 years of age, with symptoms of dry eye disease (5-item Dry Eye Questionnaire (DEQ-5) score $\geq$ 6 or Ocular Surface Disease Index (OSDI) score $\geq$ 13), with no history of ocular surgery within the past year, no contact lens wear in the two weeks preceding or during the course of the study, and no systemic condition or medication known to affect the ocular surface.

Fifty-four eligible participants were recruited and 41 participants completed the study, exceeding the sample size requirements. Sample size calculations were conducted with non-invasive tear film breakup time as the designated outcome, and showed that a minimum of 34 participants was required to detect a clinically significant difference of 3–5 seconds in breakup time from baseline measurements, at 80 % power ($\beta = 0.2$), at a two-sided statistical significant level of 5% ($\alpha = 0.05$), with the SD of normal values being estimated to be approximately 5–6 s [25]. Sample size estimates were determined using a uniform non-parametric adjustment with NCSS PASS 2002.

2.2. Blinking exercises

Blinking exercises followed previously published recommendations [26]. Each cycle involved closing both eyes normally for two seconds and opening, followed by normal closure again for two seconds and then squeezing the lids together tightly for two seconds before opening both eyes (Fig. 1).

2.3. Clinical measures

Clinical measurements were conducted in the same room with a temperature (mean ± standard deviation) of 20.0 ± 1.5 degrees Celsius, and relative humidity of 50.0 ± 8.0 %, over the course of the study. Measurements were performed on the right eye only. Symptom frequency and severity were assessed using the validated 5-Item Dry Eye Questionnaire (DEQ-5) [27] and Ocular Surface Disease Index (OSDI) [28] questionnaires, recommended by the TFOS DEWS II Diagnostic Methodology subcommittee [16]. LogMAR best corrected visual acuity (BCVA) was measured on a projection chart (CP-40 LED Chart Projector, Takagi Seiko, Takaoka, Japan). The Keratograph 5 M (Oculus, Wetzlar, Germany) was used to assess tear film quality and quantity. Three measurements of the tear meniscus height (TMH) from a single image within the central ±1 mm of the lid margin were averaged. The lipid layer quality grade (LLG) was evaluated by a masked observer, from a video recording collected during five non-forceful blinks under white light at 1.4x magnification and graded 0–5 (0 = non-visible or abnormal coloured fringes, 1 = open meshwork, 2 = closed meshwork, 3 = flow or wave, 4 = amorphous, 5 = coloured fringes) according to the modified Guillon-Keeler grading system [23,29]. To evaluate the non-invasive breakup time (NIKBUT), participants were requested to blink twice before refraining from blinking, and the first sign of disruption of the reflected mires was detected automatically by the Keratograph software. Three separate NIKBUT measurements were averaged in each case. Limbal and bulbar conjunctival hyperaemia scores for nasal and temporal regions were recorded according to proprietary Keratograph software (JENVIS 0–4 scale) [30]. Meibography of the upper and lower lids was performed by everting the lids in turn, with a cotton-tipped applicator and imaging the glands under infrared light. The degree of meibomian gland dropout was graded from 0 to 4 based on the coverage of glands across the tarsal plate, according to the Pult grading scheme (0 = 0% area of loss, 1 = $\leq$ 25 % area of loss, 2 = 26–50 % area of loss, 3 = 51–75 % area of loss, 4 = >75 % area of loss) [31]. The proportion of incomplete blinks as well as the lipid layer thickness (LLT) (limited to 100 nm by the device), were recorded objectively with the LipiView II Ocular Surface Interferometer (TearScience, Morrisville, NC). Tear osmolarity of the right and left eyes was measured with the TearLab Osmometer (TearLab Corporation, Escondido, CA) and the higher value and interocular difference recorded [16]. The lid margins, lashes, cornea and conjunctiva were assessed using a slit lamp biomicroscope (SM-70 N, Takagi Seiko, Takaoka, Japan) under white light, at 10−25x magnification. Signs of anterior blepharitis were graded clinically from 0 to 3 (0 = none, 1 = mild, 2 = moderate, 3 = severe) for each of the following features: lid margin thickening, rounding, surface telangiectasia, irregularity, hyperkeratinisation, eyelash crusting (dry indicating staphylococcal; greasy indicating seborrheic; cylindrical dandruff indicating ocular demodicosis), madarosis, poliosis and trichiasis. The degree of meibomian gland capping and foam in the tear meniscus were similarly graded from 0 to 3. The quality and quantity of meibum were evaluated following diagnostic expression with the Meibomian Gland Evaluator (TearScience, Morrisville, NC) [32]. The proportion of glands

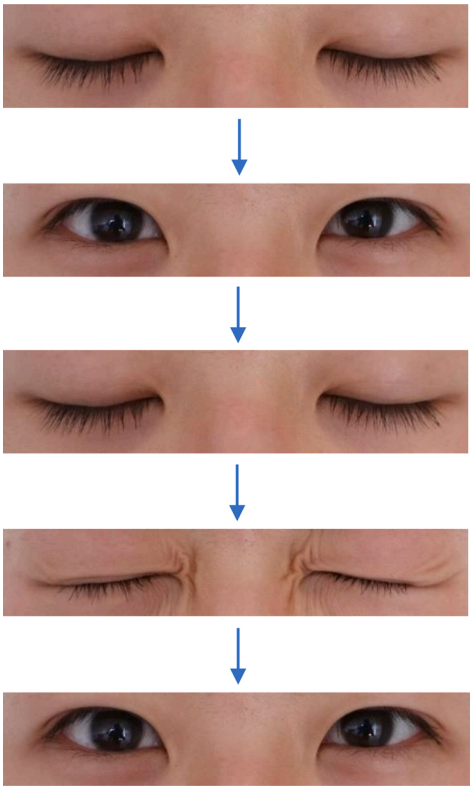

Fig. 1. One cycle of the blinking exercise.
Step 1. Gently close the eyes for 2 s;
Step 2. Open the eyes;
Step 3. Repeat step 1;
Step 4. While keeping the eyes closed, squeeze the eyes for 2 s;
Step 5. Open the eyes. Instructions provided to repeat one cycle of the blinking exercise every 20 min during waking hours, for a period of four weeks.

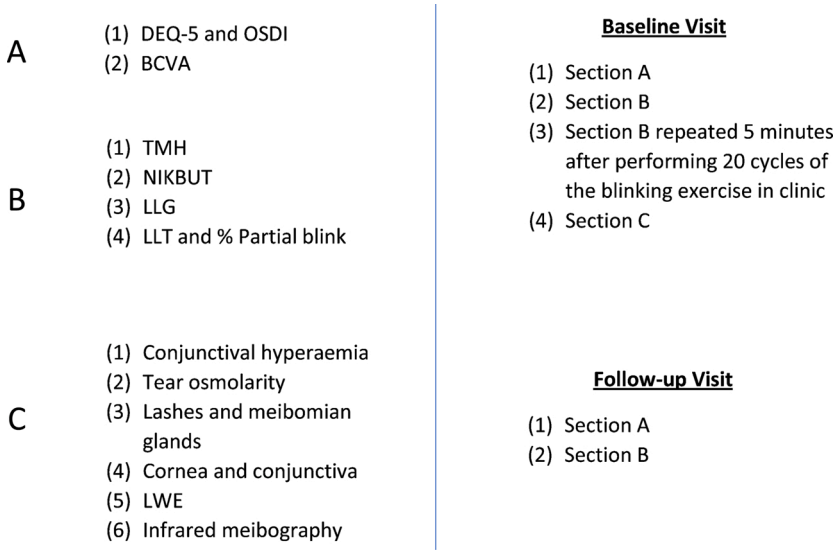

Fig. 2. Order of clinical measurements.
Sections A, B and C list the order in which clinical measurements were conducted during each visit.

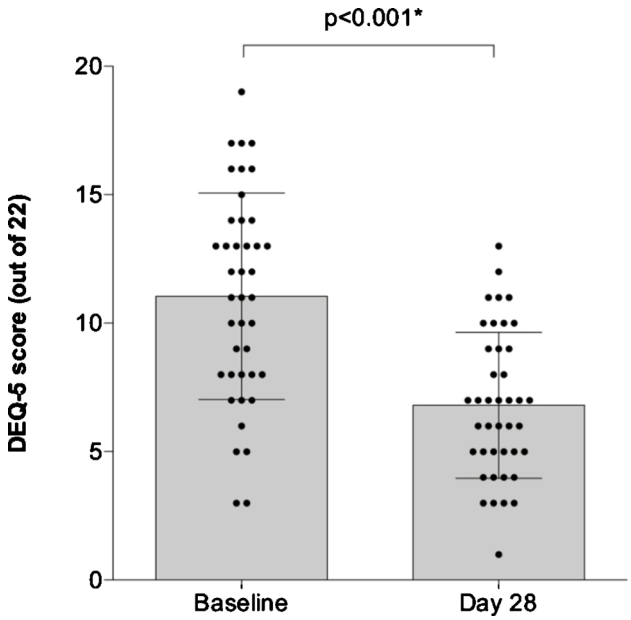

Fig. 3. DEQ-5 scores of participants at baseline and at Day 28 following 4 weeks of blinking exercises.
Each point represents the score of an individual participant. Bars represent the mean score, and error bars represent the standard deviation. Asterisks denote statistically significant differences ($p < 0.05$).

yielding lipid secretion was graded from 0 to 4 (0 = >75 %, 1 = 50–75 %, 2 = 25–50 %, 3 = <25 %, 4 = 0%) and the expressed meibum quality was also graded from 0 to 4 (0 = clear meibum, 1 = cloudy meibum, 2 = cloudy meibum with granular debris, 3 = thick, 4 = waxy and inexpressible). Lid parallel conjunctival folds (LIPCOF) were assessed nasally and temporally, adjacent to the lower lid margin, and graded from 0 to 3 (0 = no conjunctival folds, 1 = 1 permanent and clear parallel fold, 2 = 2 permanent and clear parallel folds, 3 = > 2 permanent and clear parallel folds). Corneal integrity was assessed under blue illumination and observed with a yellow Wratten barrier filter, following application of sodium fluorescein (Bio-Glo, Hub Pharmaceuticals, Rancho Cucamonga, CA). Corneal staining was graded from 0 to 3 (0 = 0 dots, 1 = 1–5 dots, 2 = 6–30 dots, 3 = > 30 dots) [33]. Conjunctival staining with Lissamine Green Ophthalmic Strips (Green-Glo, Hub Pharmaceuticals, Rancho Cucamonga, CA) was viewed under white light and graded from 0 to 3 (0 = 0–9 dots, 1 = 10−32 dots, 2 = 33–100 dots, 3 = >100 dots) [33]. Lid wiper epitheliopathy was scored for horizontal length and sagittal width from 0 to 3 (0 = < 2 mm, 1 = 2–4 mm, 2 = 5−9 mm, 3 = > 10 mm and 0 = <25 % of lid wiper, 1 = 25-<50 % of lid wiper, 2 = 50–75 % of lid wiper, 3 = > 75 % of lid wiper, respectively) and the scores averaged [34].

2.4. Study design

2.4.1. Baseline visit

Completion of the DEQ-5 and OSDI questionnaires and BCVA measurement preceded evaluations of tear film quantity and quality via TMH, NIKBUT, LLG, LLT and percentage partial blinks, with tests conducted in this same order each time, from least to most invasive, to minimise the impact on subsequent measures. To evaluate the short-term effects of performing the blinking exercise on the tear film, participants were then instructed to perform 20 consecutive cycles of the blinking exercise in clinic (as described in Fig. 1). The participants were instructed to return to step 1 immediately after step 5, to minimize the number of involuntary blinks that may occur between each exercise cycle. Measurements of TMH, NIKBUT, LLG, LLT and partial blinking were repeated after a 5-min wait period. Conjunctival hyperaemia and tear osmolarity values were recorded before examining the lid margins, lashes and meibomian glands for classification purposes. Fluorescein and lissamine green dyes were applied to allow assessment of corneal and conjunctival staining and LWE, and lastly, the lids were everted, in turn, for infrared meibography.

To evaluate the effects of longer-term intervention, participants were then requested to perform a single cycle of the same blinking exercise every 20 min during waking hours for four weeks. Participants estimated and recorded the number of cycles completed at the end of each day. To encourage compliance, a weekly reminder SMS text message about study participation and expectations was sent to participants.

2.4.2. Follow up visit

Participants returned after 28 days, and measures for the DEQ-5, OSDI, BCVA, TMH, NIKBUT, LLG, LLT and to determine the proportion of partial blinks were repeated, as described. Participants were masked to their baseline dry eye questionnaire responses. The self-reported average number of daily blinking exercise cycles was collected and recorded.

2.5. Data analysis

Statistical analysis was performed with Graph Pad Prism version 6.02 (California, USA) and IBM SPSS version 23 (New York, USA). Comparisons of continuous variables over the treatment period were performed using repeated measures one-way analysis of variance (ANOVA), where normal distributions had been confirmed by Kolmogorov-Smirnov testing ($p > 0.05$). Post-hoc analysis for pairwise comparisons was then conducted using the multiplicity-adjusted Tukey test. Non-normally distributed continuous and ordinal data were analysed using the Friedman test, and post-hoc pairwise comparisons performed using the multiplicity-adjusted Dunn test. All tests were two-tailed and $p < 0.05$ was considered significant. All continuous data are presented as mean ± SD, ordinal data as median (interquartile range (IQR)), and categorical data as number of participants (% of participants), unless otherwise stated.

3. Results

The demographic and baseline ocular surface characteristics of the 41 participants who completed the study (23 females, 18 males; mean ± SD age, 31 ± 13 years) are outlined in Table 1.

Measures of visual acuity, dry eye symptoms, tear film parameters and blinking patterns at baseline, 5 min following 20 cycles of the blinking exercise and at Day 28 following 4 weeks of daily prescribed blinking exercises, are summarized in Table 2.

The average number of daily blinking exercise cycles completed over the 4-week period was 25.6 ± 17.7. The BCVA, TMH and LLT did not change between baseline and Day 28 ($p > 0.05$ in all cases). However, the DEQ-5 (Fig. 3) and OSDI (Fig. 4) score showed a decrease from 11 ± 4 to 7 ± 3 ($p < 0.001$) and from 36 ± 18 to 22 ± 17 ($p < 0.001$), respectively.

The change in the lipid layer quality grading between baseline and 5 min following 20 cycles of the blinking exercise was not statistically significant ($p = 0.88$). However, the interquartile range of the lipid layer quality grading increased from (2–3) to (3–4) by Day 28 and this change relative to baseline was statistically significant ($p = 0.04$) (Fig. 5).

The non-invasive tear film breakup time increased from 6.5 ± 2.4 (at baseline) to 7.1 ± 4.7 (5 min post blinking exercise) and to 8.1 ± 4.8

Table 1
Demographic and ocular surface characteristics of participants at baseline. Data are presented as mean ± SD, median (IQR), or number of participants (% of participants).

Characteristic	Value
Demographics	
Age (years)	31 ± 13
Female sex	23 (56 %)
European ethnicity	3 (7 %)
East Asian ethnicity	34 (83 %)
South Asian ethnicity	2 (5%)
Other ethnicity	2 (5%)
Ocular surface characteristics	
Tear osmolarity (mOsm/L)	313 ± 18
Inter-ocular difference in osmolarity (mOsm/L)	12 ± 11
Bulbar conjunctival hyperaemia score (out of 4)	0.8 ± 0.3
Limbal conjunctival hyperaemia (out of 4)	0.6 ± 0.7
Lid margin thickening (out of 3)	0 (0–0)
Lid margin rounding (out of 3)	0 (0–0)
Lid margin telangiectasia grade (out of 3)	0 (0–0)
Lid margin irregularity grade (out of 3)	0 (0–0)
Staphylococcal lash crusting grade (out of 3)	0 (0–0)
Seborrheic lash crusting grade (out of 3)	0 (0–0)
Cylindrical dandruff lash crusting grade (out of 3)	0 (0–0)
Madarosis grade (out of 3)	0 (0–0)
Poliosis grade (out of 3)	0 (0–0)
Trichiasis grade (out of 3)	0 (0–0)
Meibomian gland capping grade (out of 3)	0 (0–1)
Tear meniscus foam grade (out of 3)	0 (0–0)
Meibum expressibility grade (out of 4)	1 (0–2)
Meibum quality grade (out of 4)	0 (0–0)
Lid parallel conjunctival folds grade (out of 3)	1 (0–1)
Corneal staining score (out of 3)	0 (0–2)
Conjunctival staining score (out of 3)	2 (0–3)
Lid wiper epitheliopathy grade (out of 3)	1 (1–2)
Lid hyperkeratinisation grade (out of 3)	0 (0–0)
Superior meibography grade (out of 4)	1 (0–2)
Inferior meibography grade (out of 4)	1 (0–2)

Table 2
Clinical measurements at baseline, 5 min after performing 20 cycles of the blinking exercise, and after 28 days of performing a single blinking exercise cycle, every 20 min during waking hours. Data are presented as mean ± SD, median (IQR), or number of participants (% of participants). Asterisks denote statistically significant differences ($p < 0.05$) between baseline and Day 28.

Measurement	Baseline (n = 41)	5 min (n = 41)	Day 28 (n = 41)	p-Value
Visual acuity				
Best corrected visual acuity (logMAR)	0.02 ± 0.13	–	0.01 ± 0.14	0.30
Dry eye symptomology				
DEQ-5 score (out of 22)	11 ± 4	–	7 ± 3	<0.001*
OSDI score (out of 100)	36 ± 18	–	22 ± 17	<0.001*
Tear film parameters				
Tear meniscus height (mm)	0.23 ± 0.09	0.23 ± 0.09	0.25 ± 0.09	0.57
Tear film lipid layer quality (out of 5)	3 (2–3)	3 (2–3)	3 (3–4)	0.04*
Tear film lipid layer thickness (nm)	64 ± 20	63 ± 16	64 ± 18	0.94
Non-invasive tear film breakup time (s)	6.5 ± 2.4	7.1 ± 4.7	8.1 ± 4.8	0.03*
Blinking assessment				
Blink rate (min^{-1})	19 ± 10	18 ± 9	16 ± 7	0.02*
Proportion of blinks incomplete (%)	54 ± 36	43 ± 34	34 ± 29	<0.001*

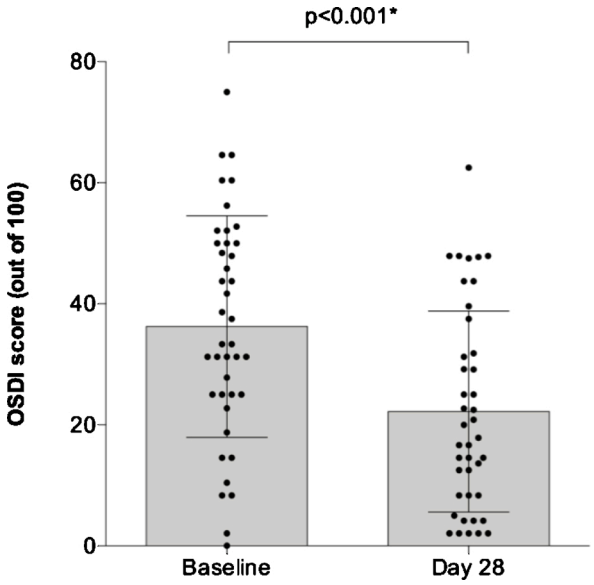

Fig. 4. OSDI scores of participants at baseline and at Day 28, following 4 weeks of blinking exercises.
Each point represents the score of an individual participant. Bars represent the mean score, and error bars represent the standard deviation. Asterisks denote statistically significant differences ($p < 0.05$).

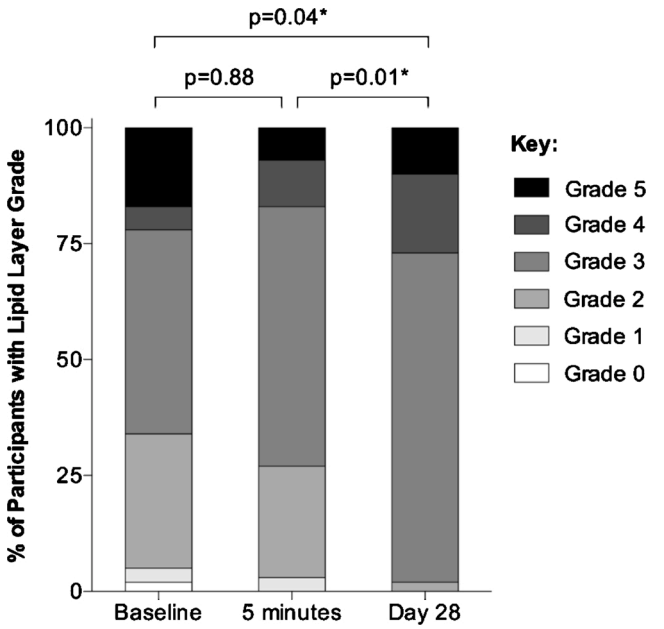

Fig. 5. Tear film lipid layer quality grades at baseline, 5 min after 20 cycles of the blinking exercise and at Day 28, following 4 weeks of blinking exercises.
Bars represent the percentage of participants with each lipid grade. The density of shading corresponds to the lipid layer grade. Asterisks denote statistically significant differences ($p < 0.05$).

(Day 28). The overall change after 28 days was found to be statistically significant ($p = 0.03$). (Fig. 6)

Both the blinking rates and the proportion of incomplete blinks showed statistically significant decreases after performing the blinking exercises for 28 days (Figs. 7 and 8). Notably, the proportion of incomplete blinks measured by the LipiView II decreased, within 5 min of performing 20 cycles of the blinking exercise in clinic ($p = 0.04$).

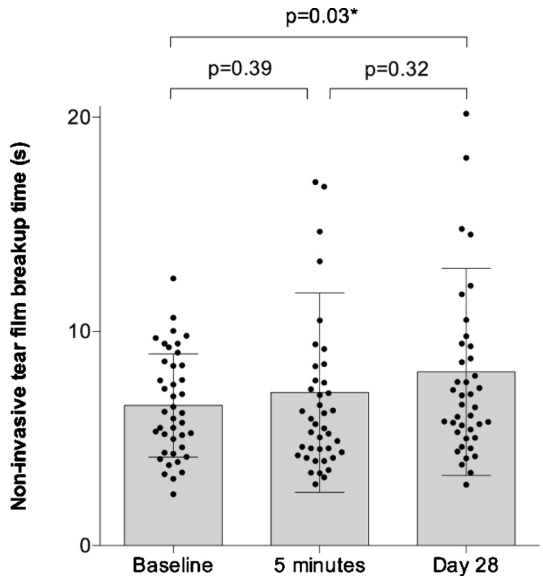

Fig. 6. Non-invasive tear film breakup time of participants at baseline, 5 min after 20 cycles of the blinking exercise and at Day 28, following 4 weeks of blinking exercises.
Each point represents the breakup time of an individual participant. Bars represent the mean breakup time, and error bars represent the standard deviation. Asterisks denote statistically significant differences ($p < 0.05$).

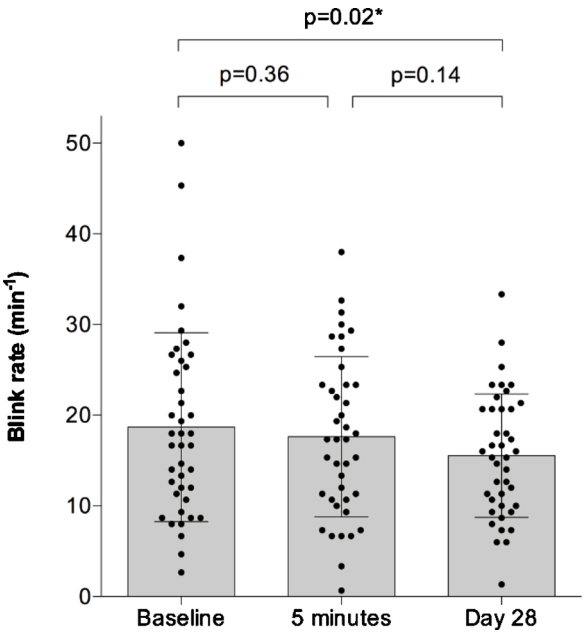

Fig. 7. Blink rates of participants at baseline, 5 min after 20 cycles of the blinking exercise and day 28, following 4 weeks of blinking exercises.
Each point represents the blink rate of an individual participant. Bars represent the mean blink rate, and error bars represent the standard deviation. Asterisks denote statistically significant differences ($p < 0.05$).

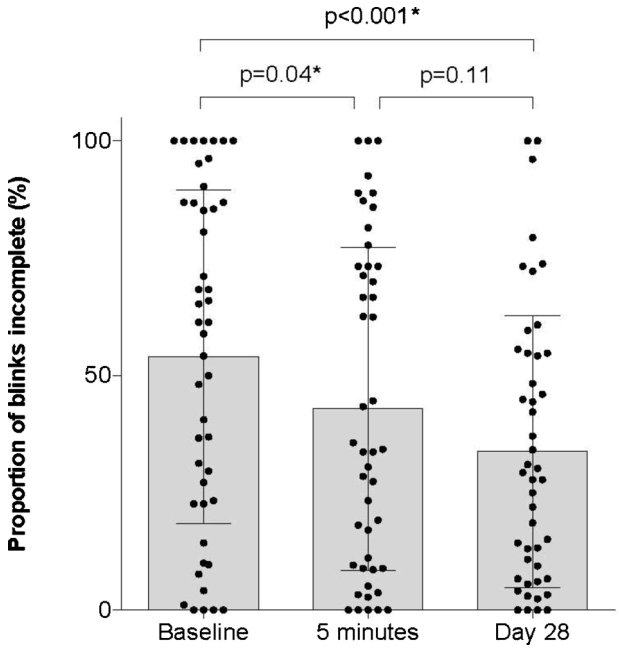

Fig. 8. Proportion of incomplete blinks for participants at baseline, 5 min after 20 cycles of the blinking exercise and at day 28, following 4 weeks of blinking exercises.
Each point represents the proportion of blinks of an individual participant. Bars represent the mean proportion of blinks, and error bars represent the standard deviation. Asterisks denote statistically significant differences ($p < 0.05$).

4. Discussion

Performing blinking exercises has previously been demonstrated to lead to decreased partial blinking and an improved proportion of functional meibomian glands in dry eye patients [26]. However, this

evidence is limited due to the relatively modest sample size of 10 participants. Another study showed that blinking exercises performed for two weeks resulted in an increased frequency of complete blinks in soft contact lens wearers [35]. In the current study, data from 41 participants were analysed at two time points to evaluate both the immediate and the longer-term effects of performing blinking exercises. Consistent with the previous findings, the proportion of incomplete blinks statistically significantly decreased after four weeks of prescribed exercises (Fig. 8) and, more notably, even within five minutes of having performed 20 consecutive cycles of the blinking exercise. Such immediate results highlight the potential for blinking exercises, as proposed by Korb's group [26], to help correct poor blinking habits. In the current study, participants were deliberately kept unaware about the importance of the blink measures to encourage natural blinking during clinical evaluations.

Dry eye patients tend to have higher blink rates due to increased tear film instability, and the use of artificial tears has been shown to decrease blink rate to within the normal range [36]. The significant reduction in blink rate in the current study after four weeks (Fig. 7) may be suggestive of an overall improvement in tear film integrity, and potential for the blinking exercise to assist in the management of DED. Indeed, the improved blinking patterns were accompanied by a statistically significant decrease in the OSDI and DEQ-5 scores after 4 weeks (Figs. 3 and 4), as well as statistically significant improvements, albeit more subtle in clinical terms, in lipid layer quality grade and NIKBUT (Figs. 5 and 6). The participants recruited in this study were predominantly Asian (88 %). Asian ethnicity has been reported as one of the consistent risk factors for DED [10], and shows a tendency towards partial blinking from a young age [37]. Seeking solutions for dry eye is thus particularly relevant for this population. The pathophysiology of dry eye disease is recognised to be multifactorial, however, and aside from blinking patterns, blepharitis, meibomian gland dysfunction, ocular allergy, autoimmune disease, systemic drug use, environmental factors and refractive surgery can also disrupt ocular surface homeostasis, and these factors need to be considered in managing DED [38]. At baseline, the degree of incomplete blinks was variable amongst the participants. While this particular study was not sufficiently powered to allow subgroup analysis, it is hypothesised that those with poorer blinking habits at the outset might have greater potential to benefit from blinking exercises. Broad inclusion criteria in the present study, that allowed for enrolment of participants with DED arising from a range of etiologies unrelated to blink pattern, may have served to dilute our findings.

The pressure exerted by the orbicularis muscle and Riolan's muscle during each blink is believed to stimulate meibum expression and forceful blinks have been shown to increase lipid layer thickness in the normal population [39]. In this study, the lipid layer was observed by interferometry and graded according to its morphology, providing a qualitative surrogate for relative thickness and quality [40]. It is not inconceivable that an increase in the proportion of complete blinks could encourage greater meibum expression and lead to a thickened lipid layer. Indeed, a subtle but statistically significant increase in lipid quality grade was observed in the present study over the four week follow-up period (Fig. 5), although this was not confirmed by the LLT measurements of the LipiView II. Interestingly, a recent study found that intense pulsed light therapy followed by meibomian gland expression was not accompanied by an increase in LLT, despite clinically significant improvements in tear breakup time and reduced symptom severity [41]. It was proposed that such clinical improvements may be better explained by the qualitative changes in the meibum composition, rather than the thickness itself. Indeed, Fenner et al. [42] also found that NIKBUT did not significantly correlate with LLT, and agreed with the suggestion of King-Smith et al. that the tear film stability is impacted by not only its thickness but its structure [43].

It should be noted that the potential for improvement from the blinking exercise may depend on the underlying meibomian gland status, as meibum expression under the force of a natural blink may be somewhat compromised in obstructed glands. Expression of nonliquid meibum requires pressures ranging from 5 to 40 psi (mean = 16.1 ± 8.2 psi) and between 10 and 40 psi (mean = 25.6 ± 11.4 psi) for full expression [44]. Given that a normal blink is approximated to produce a pressure of 0.3 psi [44], these forces are likely much greater than that achievable even by a forceful blink, and it may be that patients might benefit from preparatory lid margin debridement and concurrent warm compress therapy with regular in-office therapeutic meibomian gland expression to further enhance lipid flow and maximise the efficacy of the blinking exercises. The therapeutic potential of self-administered therapies such as warm compress, lid hygiene and blinking exercise is naturally limited by patient compliance [45]. Noncompliance is not uncommon, especially in the setting of chronic, incurable diseases, and is the most common cause of nonresponse to therapeutic interventions [46]. Treatments that must be performed regularly and indefinitely are least popular amongst patients, while treatment types with rapid discernible benefits are most popular [47-]. Notwithstanding the limitations associated with the subjective evaluation of symptoms, the blinking exercise showed a considerable decrease in OSDI and DEQ-5 scores, with some participants even reporting significant immediate improvement in comfort after performing 20 cycles in-office. Symptom improvement may provide the necessary affirmation to motivate patients to adhere to clinician recommendations. Self-reported data rely heavily on participant honesty and accuracy. The average number of blinking exercise cycles performed daily was 25.6. Participants described forgetfulness as the principal difficulty, and this resulted in some individuals performing the exercise irregularly throughout the day. The degree of impact this may have had on the study results is not quantifiable. The weekly SMS reminder was intended to strike a balance between study benefit and participant inconvenience or irritation. Perhaps more frequent and convenient reminders may be necessary. It is recognised that this non-incentivised study, by design, was fairly impactful on daily life, requiring 3 participant interactions every waking hour for four weeks. In total, 13 participants were lost to follow-up. Participants are at liberty to withdraw from research studies without providing a reason but it is speculated that the perceived intrusiveness of this study protocol on daily life may have affected compliance for some individuals, and that those aware of their poor compliance were less likely to attend the followup visit. Therapy adherence is heavily influenced by patient health beliefs [48] and education [49] and understanding the decision-making process of patients and encouraging co-operation is key to ensuring compliance and achieving the follow-up target. Exploring subjective experiences and difficulties during participation in such a study may provide valuable insight for guiding future research and clinical recommendations. The mean scores of the baseline ocular surface characteristics were generally low for the participants of this study (Table 1) and future research would benefit from including a broader range of DED severity. It is also possible that collecting DED classification data (section C, Fig. 2) after non-invasive assessment of the impact of 20 cycles of the blinking exercise (section B, Fig. 2), could affect scores, and DED classification at a separate visit could overcome this risk.

Limitations notwithstanding, the study outcomes suggest that prescribing blinking exercises has the potential to modify poor blinking patterns to help improve dry eye symptoms and clinical signs.

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