RESEARCH ARTICLE

Short-term effect of eyelid-warming device on the tear film: a randomized observational comparative study

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Abstract

Objective: To evaluate the short-term effect of using an eyelid-warming device compared to artificial tears on the tear film parameters of dry eye subjects.

Method: The case-control study was conducted at the Optometry Department, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia, from January 5 to May 15, 2021, and comprised young females with dry eyes who were randomized into intervention group A and control group B. In group A patients, an eyelid-warming device called Blephasteam was applied for 10 minutes, while artificial tears were used for group B patients. The non-invasive tear breakup time and phenol red thread tests were used at the baseline as well as 5 minutes and 60 minutes after the application. Data was analysed using SPSS 22.

Results: Of the 38 female patients with a mean age of 21.4±1.5 years, 19(50%) were in group A with a mean age of 21.5±0.9 years, and 19(50%) were in group B with a mean age of 21.3±1.9 years. Both groups showed significant improvement in terms of stability and volume of the tear film after the application at both 5 minutes and 60 minutes ($p<0.05$). Intergroup comparisons indicate a significant difference at baseline NITBUT measurements ($p=0.035$), while the PRT score was significantly higher at 60 minutes ($p < 0.05$).

Conclusion: The short-term use of an eyelid-warming device increased the scores of tear breakup time and volume of tears in young females with dry eyes. Such devices could be used as an alternative to artificial tears.

Key Words: Dry eye disease, Tear, Cornea, Meibomian gland, lubricant eye drops.

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Introduction

Dry eye disorder leads to an alteration in the tear film function. It is associated with symptoms such as redness, itchiness, irradiation, inflammation, burning, and foreign body sensation symptoms.[1] A dry eye leads to the loss of homeostasis of the tear film.[2] In addition, it causes instability and hyperosmolarity in the tear film.[2] Aqueous-deficient and evaporative dry eyes are the most common types.[1] Lacrimal gland disorders mainly cause aqueous-deficient dry eyes.[1] Evaporative dry eyes are associated with meibomian gland dysfunction, which reduces tear secretion.[1] The prevalence of dry eyes varies based on location, gender, age, illnesses, and environmental factors. It has been estimated that 5-50% of the world's population has dry eyes.[1,3] In Saudi Arabia, the prevalence of dry eye was estimated to be high (32-93%), particularly among those wearing contact lens.[4–6] Questionnaires, such as the Ocular Surface Disease Index (OSDI), and various tests can be used to assess dry eye, but no single test can be used independently for diagnosis.[7] The most common methods used to diagnose dry eye are the tear evaporation rate,[8,9] osmolarity,[10] tear meniscus height,[10] non-invasive tear breakup time (NITBUT),[10] phenol red thread (PRT),[11] Schirmer,[11] and tear fering tests.[12]

Artificial tears are the first option to manage mild to moderate dry eye symptoms.[13] They tend to increase tear film stability and viscosity and depress the tear evaporation rate.[14] However, they are not always the solution, and, in particularly severe dry eye, artificial tears' consumption cost is enormous. For example, dry eye symptoms resulting from meibomian gland dysfunction cannot be relieved by using eye lubricants.[15] Therefore, other effective methods should be used to reduce dry eye symptoms. Antibiotics, eyelid wipes, massaging, warming the eyelids, masks, or goggles can help reduce the discomfort associated with dry eye. These methods increase tear secretion and liquefy the waxy lipids within the tear film.[16] Eye-warming devices have been proven to be effective in managing dry eye symptoms and improving visual acuity (VA) compared to other methods. Blephasteam is an eyelid-warming device that provides

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the eyelids with moist heat. It can manage dry eye symptoms from meibomian gland dysfunction.[17] It has been used efficiently in randomized clinical trials, particularly among older people.[17] In addition, eye masks are as effective in managing dry eye symptoms as Blephasteam.[17]

The current study was planned to evaluate the short-term effectiveness of using the eyelid-warming device Blephasteam compared to artificial tears on the tear film parameters of dry eye subjects.

Patients and Methods

The case-control study was conducted at the Optometry Department, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia, from January 5 to May 15, 2021. The study was approved by the institutional ethics review board, and informed written consent was obtained from the participants.

Those included were female patients having OSDI score >137 and either a NITBUT score <10s10 or PRT length <10mm11. A slit lamp was used to evaluate the anterior segment abnormalities. Patients with ocular surface disorders and ocular surgeries were excluded, and so were those with systemic diseases that could affect the ocular surface, such as Sjogren syndrome, diabetes, and Stevens-Johnson syndrome.

The subjects enrolled were randomized into intervention group A and control group B. The names of the subjects were arranged alphabetically for randomization. In group A patients, eyelid-warming device Blephasteam (Laboratoires Théa, Clermont-Ferrand, France) was applied for 10 minutes, while artificial tears were used for group B patients. The application of artificial tears or other lubricants was discontinued one day before the intervention. None of the subjects had received any previous treatment with any moisturizing goggles.

NITBUT and PRT scores were recorded by two independent examiners three times for each subject at the baseline and 5 minutes and 60 minutes post-intervention. The NITBUT was conducted first, followed by the PRT test, with 5 minutes allowed between the tests.

Blephasteam is a pair of goggles designed to provide moisture and sensible heat to the periocular region through installed heaters. It needs to be preheated for 15 minutes; then, the two Blephasteam rings are moisturized with sterile saline. When the light turned from red to green, the goggles were worn for 10 minutes. The temperature inside Blephasteam was unknown. However, the temperature of the outer lid after the application of Blephasteam has been suggested to be as high as 12°C.[18]

In group B, Refresh Plus (Allergan, Marlow, UK), preservative-free lubricant eye drops were used, containing sodium carboxymethylcellulose 0.5%, sodium lactate, and chloride slats. They relieve dry eye symptoms, such as discomfort, burning, and irritation.[19]

Keratograph 4 (OCULUS, Wetzlar, Germany) was used to measure the tear breakup time on the right eye. The time that elapsed between the appearance of the first dry spot on the tear film and the last blink was recorded as the tear breakup time, with time <10s being considered the cut-off for dry eyes.[20]

The PRT test was performed on the right eye using a cotton thread. A cotton thread with a 3mm bent end was gently inserted in the lower fornix for 15s. The cotton thread was impregnated with phenol red, which is sensitive to the potential of hydrogen (pH). When the thread was wetted with tears, the yellow colour turned red. The length of the red portion of the thread was measured. PRT length <10mm was taken as the cut-off for dry eyes.

The sample size was calculated using OpenEpi calculator[21] with a significance level of 0.05 and a confidence interval (CI) of 80%.

Data were recorded in Excel 2010 and analysed using SPSS 22. Data normality was determined using the Kolmogorov-Smirnov test. Mann–Whitney test was used to analyse the data in both groups. Wilcoxon signed-rank test was used to investigate intragroup significance.[22] Data was presented as mean ± standard deviation, median with interquartile range (IQR), or frequencies with percentages, as appropriate. P<0.05 was considered significant.

Results

Of the 38 female patients with a mean age of 21.4±1.5 years, 19(50%) were in group A with a mean age of 21.5±0.9 years, and 19(50%) were in group B with a mean age of 21.3±1.9 years. Both groups showed significant improvement in terms of stability and volume of the tear

Table-1: Median (IQR) values for NITBUT and PRT.

Parameter	Group	Time (minutes)			P-value*	
		0	5	60	0 vs. 5	0 vs. 60(n)
NITBUT (s)	Study	7.0 (2.1)	10.3 (3.0)	9.6 (3.5)	<0.001	<0.001
	Control	8.4 (2.2)	10.0 (1.6)	9.0 (2.1)	<0.001	0.004
	P value	0.035	0.157	0.204		
PRT (mm)	Study	10.1 (5.5)	14.5 (3.1)	13.5 (4.5)	<0.001	0.003
	Control	9.1 (2.0)	13.0 (3.1)	10.5 (3.9)	<0.001	<0.001
	P value	0.122	0.118	0.004		

* Mann–Whitney test (P <0.05). IQR: Interquartile range, NITBUT: Non-invasive tear break-up time), PRT: Phenol red thread length.

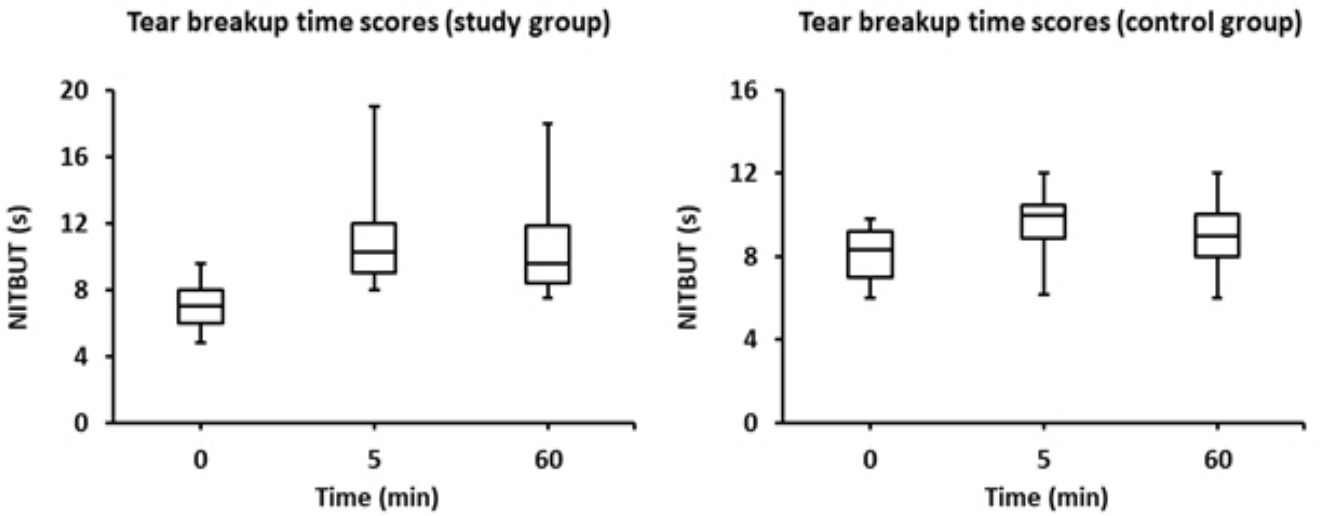

Figure-1: Side-by-side boxplots for the non-invasive tear breakup time (NITBUT) measurements in the study groups.

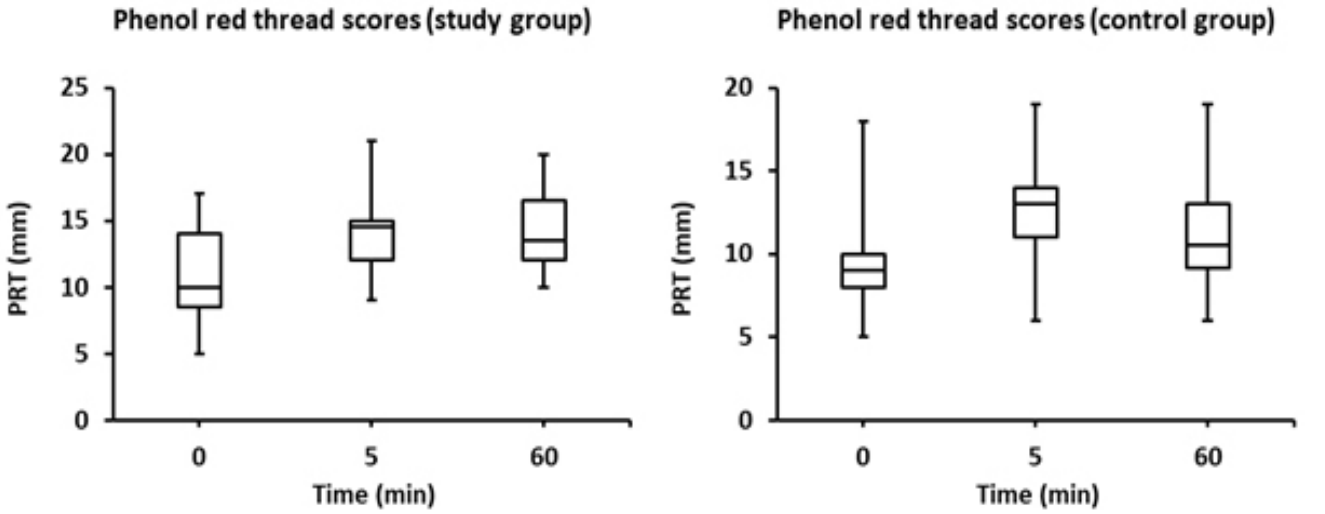

Figure-2: Side-by-side boxplots for phenol red thread (PRT) measurements in the study groups.

film after the application at both 5 minutes and 60 minutes (Table).

The side-by-side boxplots for NITBUT (Figure 1) and PRT scores (Figure 2) were generated.

The baseline NITBUT and PRT scores in group A ranged from 4.8-9.6s and 5-17mm, while in group B, the corresponding values were 6.7-9.8s and 6-19mm. NITBUT increased to be in the range of normal eyes in 12(66.7%) group A patients after 5 minutes and in 9(50%) after 60 minutes. In group B, NITBUT improved in 10(55.6%) subjects after 5 minutes, and in 5(27.8%) after 60 minutes. The PRT score increased in 6(33.3%) group A patients after 5 minutes and in 7(38.9%) after 60 minutes. In group B, PRT scores increased in 11(61.1%) patients after 5 minutes and in 8(44.4%) after 60 minutes.

The results showed no significant differences in PRT scores between the two groups at baseline or after 5 minutes. However, Group A exhibited a higher PRT score after 60 minutes ($p = 0.0043$), suggesting improved tear secretion. A significant difference in TBUT at baseline ($p = 0.035$) was observed, but no significant differences were found after 5 or 60 minutes, indicating that improvements were more evident at later time points. (Table).

Discussion

To our knowledge, the current study is the first conducted among the Saudi population and involves eyelid-warming devices. The study revealed that the NITBUT and

PRT scores improved significantly 5 minutes and 60 minutes after applying either the eyelid-warming device or artificial tears for a short duration. PRT scores improved significantly between the groups after 60 minutes ($p = 0.0043$), suggesting better tear production in the study group. This may indicate enhanced ocular hydration and tear film stability.

It is not easy to directly compare the results of the current study and those previously reported since the duration was entirely different. The current results were based on the short-term use of eyelid-warming devices, while the earlier results were obtained after 6 months of use.[17]

Several reports have shown that eyelid-warming devices, such as Blephasteam, can effectively improve the tear film and relieve dry eye symptoms, particularly in subjects with meibomian gland dysfunction.[23-26] The warmth generated around the eye is believed to liquefy the lipid content of the tears. Therefore, improvements in tear breakup time and reductions in the tear evaporation rate were observed. OSDI scores also improved significantly after using Blephasteam.[17] A few studies, on the other hand, assessed the immediate effect of using eyelid-warming devices on tear film stability. For example, using a warm compress for a short duration (5-10 minutes) significantly improved NITBUT scores.[26,27] Similarly, applying a warm, moist air device for 10 minutes increased tear breakup time in subjects with meibomian gland dysfunction.[25] In addition, the thickness of the lipid layer increased after applying different eyelid-warming methods for a short duration (5 minutes), and the follow-up continued for up to 30 minutes.[27]

Recently, it has been reported that the fluorescein breakup time significantly increased after the use of Blephasteam for 6 months, while the use of the TheraPearl eye mask improved the OSDI score.[17]

Following a three-month course of Blephasteam treatment, OSDI scores and fluorescein tear break-up time were improved.[17] Nevertheless, no significant difference in effectiveness was observed after six months of treatment. It is important to note that a six-month period is considerable, during which various factors can influence the tear film, such as environmental conditions and dietary choices. The current results clearly indicate that the use of an eyelid-warming device for a short period can effectively improve tear film parameters.

The current study has limitations, such as a small sample recruited from a single centre, using only two diagnostic tests, and performing the follow-up assessments for only up to 60 minutes. Large-scale, multi-centre, comprehensive studies comprising both genders are needed to validate the current findings.

Conclusion

Short-term use of an eyelid-warming device led to an increase in tear breakup time and tear volume scores in young females with dry eyes. Eyelid-warming devices were found to be an effective option for alleviating dry eye symptoms due to their lower cost and ease of use compared to artificial tears.

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Conflict of Interest: None.

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AUTHOR'S CONTRIBUTION:
MMA: Concept, design, literature search, data analysis, statistical analysis, discussion, project administration, supervision, preparation, editing, review and final approval.
MOB & SA: Data acquisition, literature search and final approval.
AA: Statistical analysis, data analysis, original draft writing and final approval.
NA: Preparation, review, data interpretation and final approval.
NA: Editing, review, resources and final approval.
GAREH: Design, editing, review, data analysis, supervision and final approval.