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In-vivo heat retention comparison of eyelid warming masks

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ABSTRACT

Purpose: Meibomian gland dysfunction (MGD) is one of the most common causes of evaporative dry eye. Warm compresses (WC) are recommended as adjunct therapy to slowly transfer heat to the meibomian glands to melt or soften the stagnant meibum with targeted temperatures of 40–45° C. This clinical study evaluated the heat retention profiles of commercially available eyelid warming masks over a 12-min interval.

Methods: Five eyelid-warming masks (MGDRx Eyebag®, EyeDoctor®, Bruder®, Tranquileyes XR™, Thera°Pearl®) were heated following manufacturer's instructions and heat retention was assessed at 1-min intervals for 12 min. A facecloth warmed with hot tap water was used as comparison.

Results: Twelve (n = 12) subjects participated in the study (10F:2 M, ranging in age from 21 to 30 with an average of 23.2 ± 3.8 years). Each mask demonstrated a unique heat retention profile, reaching maximum temperature at different times and having a different final temperature at the end of the 12-min evaluation. After heating, all eyelid warming masks reached a temperature near 37° C within the first minute. The facecloth was significantly cooler than all other masks as of the 2-min mark ($p < 0.05$).

Conclusions: Reusability, availability and heat retention profiles should be considered when selecting an eyelid warming masks for adjunct WC therapy in the management of MGD. All masks tested, with the exception of the facecloth, demonstrated stable heat retention throughout the 12 min, bringing further awareness that patient education is required to discuss the shortcomings of the heat retention of the facecloth, if only heated once.

1. Introduction

Meibomian gland dysfunction (MGD) appears to be the most common cause of evaporative dry eye [1–3]. Regardless of the driving factor for MGD, ultimately it leads to an inadequate lipid layer, which increases the evaporation of the underlying tear film. Although management options vary for MGD treatment, warm compresses (WC) are regarded as a primary home-based therapy [2,4–6]. Warm compresses aiming to provide a thicker lipid layer by softening the stagnant meibum in the glands in order to facilitate it's expression upon blinking [2,7,8]. The challenge in heating the eyelid surface is to have the appropriate temperature reach the meibomian glands (MG). The heat must dissipate through the eyelid tissue to reach the meibomian glands, which are located deep within the inner surface of the eyelids.

Although WC are commonly recommended, there is no standardization with respect to duration or frequency [9–12]. While the exact temperature for WC therapy has not been determined, temperature ranges of 40 °C [8] to 45 °C [13] have been reported to effectively soften meibum over a 5–15 min session. Historically, the use of a warm moist facecloth has been widely adopted by eye care practitioners (ECP) as an accessible and affordable option for WC. However, the heat quickly dissipates, rendering it ineffective unless it is reheated every 2–4 min [13]. It has been demonstrated that WC therapy can improve dry eye symptoms, tear film stability, tear evaporation, tear film lipid layer thickness, and decrease MG orifice obstruction [8,14–19].

Several eyelid-warming masks have become commercially available and it would be of clinical interest to compare their heat retention profiles to the traditional facecloth. Lacroix et al. [20] recently published *ex-vivo* heat retention profiles of five eyelid-warming masks and a facecloth. The experiment was performed on a non-conductive surface to remove the variability of eyelid thickness, tissue heat retention and distribution. The heat retention profiles differed for each mask, with the facecloth maintaining the desired temperature of 40–45 ° C for 3 min quickly degrading in temperature after this time [20]. Three masks in that study (MGD Rx Eyebag®, The Eye Doctor®, and Thera°Pearl Eye-essential mask (Bausch + Lomb)) had a stable heat retention profile over the first 8 min of the12-min evaluation.

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The objective of the present study was to evaluate the *in vivo* heat retention properties of commercially available eyelid-warming masks on human eyelids over a 12-min interval and compare them with the facecloth.

2. Materials and methods

Five eyelid-warming masks and a moist facecloth were used in this study to investigate their heat retention properties. The selected masks were the MGD Rx Eyebag®, The Eye Doctor®, Bruder® eye hydrating compress, Tranquileyes XR™ (Eyeeco), Thera°Pearl Eye-essential mask (Bausch + Lomb) and a moist facecloth. The description of each eye mask and facecloth, including the recommended heating instructions have been described elsewhere [20]. Each mask was heated using a microwave following the recommended times by the manufacturer. The facecloth was soaked with tap water that was heated in a microwave for 20 s. Once the facecloth was wrung out, it was folded three times to obtain a rectangular shape to cover both eyes [20]. Table 1 describes each eyelid-warming mask and the nature of the filler material.

Following approval from the University's ethics committee, consenting subjects 18–50 years of age were recruited. A higher degree of dry eye symptoms (as measured using the Ocular Surface Disease Index-OSDI [21], score >30/100), ocular surgery in the past 24 months, eyelid anomalies (including MGD) and damaged, broken or sensitive skin surrounding the eyelids were excluded from this study. Contact lenses, eye makeup, and creams were removed prior to the study.

The experiment was conducted in a closed space protected from drafts. The room temperature and skin temperature were monitored to ensure environmental stability. Each of the eyelid-warming masks was heated with the same microwave oven (Sharp Carousel 1100W) following manufacturer's recommended heating times. The order of the masks was randomized using a random Latin Square generator and the subjects had a 15-min pause between each warming mask, allowing the outer eyelid to return to ambient temperature. All six warming devices (5 masks plus the facecloth) were evaluated in a single session.

A digital thermometer probe with a resolution of 0.1° C (Fisher Scientific Traceable Total range) was secured to the right upper eyelid with surgical tape, such that only the probe end was underneath the mask or cloth as shown in Fig. 1. The subject was comfortably reclined in an examination chair to simulate an at-home scenario. The subject's skin temperature was measured prior to heating and served as a baseline measure. The eye mask was then placed on the subject's eyelids (t = 0) within 5–10 s of heating and the temperature was measured at one-minute intervals for 12 min (t = 1 to t = 12). The temperatures for each eyelid-warming masks were averaged across subjects and plotted for comparison.

The subjects were also asked to report the comfort level of each eye mask. After each of the tested masks, the subjects were asked to rate their comfort between 0 and 10, with higher numbers reflecting better comfort. In an attempt to control for possible order effects, the order of the masks, were randomized. At the end of the experiment, the subjects were asked to identify their favourite and least favourite masks.

Statistical analysis was performed using the non-parametric Mann-Whitney U-Test at an alpha level of 0.05 using SPSS (version 17.0 for Windows).

Table 1
Description of eyelid-warming masks.

Mask	Content
MGDRx EyeBag® The EyeBag Company	Flax seeds
The Eye Doctor® The Body Doctor	Mixed natural grains
Bruder Eye Hydrating Compress	MediBeads®
Tranquileyes XR™ goggles Eyeeco	Thermoeyes Beads
Thera°Pearl Eye-ssential mask Bausch & Lomb	Pearl Technology®
Warm face cloth	None

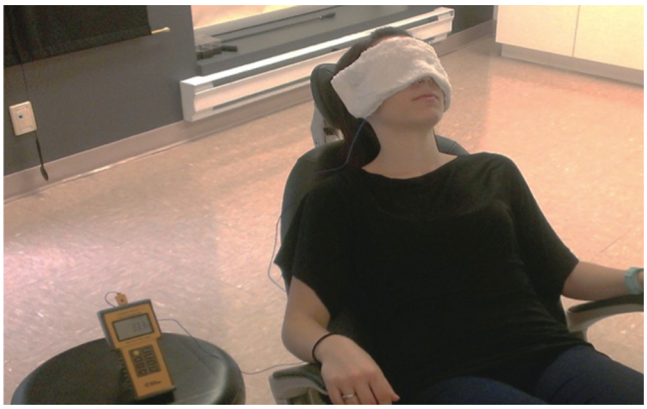

Fig. 1. Experimental set-up. The thermometer probe was secured to the lid with surgical tape such that the end of the probe was directly under the mask/cloth. The temperature could be read from an external digital reader.

3. Results

Twelve (n = 12) subjects participated in the study (10F:2 M, age 21–30 with an average of 23.2 ± 3.8 years). The average ambient temperature remained constant at 22.6 ± 0.9 °C, and the average eyelid skin temperature was 33.5 ± 0.9 °C prior to the experimentation. All masks were at room temperature prior to heating.

Each mask demonstrated a unique heat retention profile, reaching maximum temperature at different times and having a different final temperature at the end of the 12-min evaluation (Table 2). The MGD Rx Eyebag®, Bruder® and Tranquileyes XR™ all reached their maximum temperature at the 2 min mark. Of those, the Bruder® was the warmest at 40.1 °C. At the end of the 12-min evaluation, the warmest masks were the Bruder® and the Thera°Pearl at 37.9 °C, with the other masks (MGD Rx Eyebag®, The Eye Doctor®, Tranquileyes XR™) being within 1–2° C cooler. The facecloth recorded the coolest temperature at the end of the 12 min at 29.2 °C.

Table 2
Peak and final temperatures of eyelid-warming masks.

Mask	Peak Temperature (°C)	Time to reach peak temp (minutes)	Final Temperature (°C)
MGDRx EyeBag® The EyeBag Company	37.6	2	36.8
The Eye Doctor® The Body Doctor	38.4	4	37.8
Bruder Eye Hydrating Compress Bruder Healthcare	40.1	2	37.9
Tranquileyes XR™ goggles Eyeeco	38.7	2	36.1
Thera°Pearl Eye-ssential mask Bausch & Lomb	38.7	3	37.9
Warm face cloth	39.2	0	29.2