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Clinical relationship of meibometry with ocular symptoms and tear film stability☆,☆☆

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ABSTRACT

Purpose: To evaluate the relationship between meibometry with both ocular symptoms and tear film stability by: (1) to find out whether meibometry is able to differentiate between dry eye symptomatic and asymptomatic subjects classified by standardized dry eye questionnaires (OSDI and McMonnies), and (2) to assess the clinical relationship between meibometry with both tear break-up time (BUT) and maximum blink interval (MBI).

Methods: 140 Patients were recruited for the study. Using Meibometer MB550, five curves were generated for each patient. Subjects performed OSDI and McMonnies questionnaires and were stratified following a two- and a three-subgroup stratification for each questionnaire. BUT/MBI were repeated three times (by video recordings), and they were determined by counting their frames.

Results: Subjects grouped by OSDI showed a trend to present lower meibometry values as the OSDI score were higher (ANOVA, $p \leq 0.044$). For McMonnies questionnaire this was only true for the two-subgroup stratification (ANOVA, $p = 0.04$), but not for three-subgroup stratification (one-way ANOVA, $p = 0.30$). On the other hand, meibometry values showed a statistical correlation with both BUT ($r = 0.305$, $p < 0.001$) and MBI ($r = 0.265$, $p < 0.001$). When the sample was divided in three groups regarding BUT value (≤ 5 s, between 5 and 10 s and ≥ 10 s), significant differences of meibometry values were found between BUT subgroups ($p = 0.008$).

Conclusion: Meibometer MB550 can discriminate asymptomatic from dry eye symptomatic patients. Furthermore, there is a relationship between meibometry and the tear film stability.

1. Introduction

Meibomian gland dysfunction (MGD) is a chronic, diffuse abnormality of the meibomian glands, commonly characterized by terminal duct obstruction and/or qualitative/quantitative changes in the glandular secretion [1–3]. This may result in alteration of the tear film, symptoms of eye irritation, clinically apparent inflammation, and ocular surface disease. It is believed that MGD may be the most common cause of evaporative dry eye [1,4–7]. In addition, It was suggested that the meibomiam gland plays an important role as an intrinsic factor associated with dry eye disease (DED) [1–4,7].

Good balance in tear film production is necessary to be able to fulfil its numerous functions and for ocular surface health. The lipid layer of the tears, derived primarily from the meibomian glands, is an important determinant of the tear physiology [8,9]. It has potential to retain ocular surface fluid by inhibiting evaporation of the underlying aqueous layer and hence promote tear film stability. One of the main test used to evaluate the tear film stability is the break-up time (BUT) [10–13], a simple test widely used to diagnose common tear problems such as DED [6,12,14–19]. However, the significance and interpretation of BUT have not yet been clearly defined, despite the attempts to improve variability by standardized volumes of fluorescein [15,20–23] and video recording instead of “real-time” to avoid misinterpreting tear film rupture [14,23]. Additionally to this analysis, maximum blink interval (MBI), defined as the time that subjects are able to keep the eyes open, has also been used as an indicator of tear film quality [23–25].

When the tear film becomes destabilized, it can break down quickly, creating dry spots on the surface of the eyes and ocular symptoms [8,9,26]. These symptoms are commonly graded using the Ocular Surface Disease Index (OSDI) or the McMonnies questionnaires [27–32]. Previous reports have been suggested that there is a correlation between the number of meibomian glands,yielding lipid secretion in the lower eyelid, and dry eye symptoms [33].

In order to evaluate the eyelids and meibomian glands it has been proposed a wide number of tests, such as the Meibomian Gland Expression evaluation [19,34], Meiboscopy [19], Meibography [35,36],

☆ All procedures followed the Declaration of Helsinki and the protocol was reviewed and approved by the Ethics Committee of the University of Santiago de Compostela.

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Confocal microscopy [37] or Symptom questionnaires' [27,28,30–32,38,39]. Another device designed to evaluate MGD is the Meibometer MB550, which allows a rapid and in situ evaluation of meibomian secretion or meibometry [14,40–46].

The Meibometer® MB550 (Courage-Khazaka electronic GmbH, 50829) is a device linked to a computer that consists of two parts: a photometer unit and a cassette of plastic tape (with a bright and a matt surface for measurement). A loop of matt synthetic tape with fixed standard measured is pulling over the patient eyelid to obtain a lipid trace of the meibomian glands. This trace is read by the photometer to obtain an index of the resting amount of lipid on the lid margin, which is named the "casual oil level" [41]. However, there is not yet consensus of the averaging procedure of the data or what cut-off criteria has to be considered in the diagnosis [44].

Therefore, the purpose of this study was to assess the relationship between meibometry with symptoms and tear film stability as follows:

a To evaluate whether meibometry is able to differentiate between health and abnormal subjects classified by standardized dry eye questionnaires (OSDI and McMonnies).
b To assess the clinical relationship between Meibometry with both BUT and MBI results acquired by video-recordings and quantified with the aid of a designed software.

2. Material and methods

2.1. Subjects

The study participants were 140 subjects (60 men, 80 women) with an age range from 18 to 51 years and a mean age of 21.2 ± 5.1 (mean ± SD) years recruited among patients of the Optometry Clinic of the Optometry Faculty (Universidad de Santiago de Compostela, Spain). Subjects were excluded if they had a history of conjunctival, scleral or corneal disease, prior eye surgery (including refractive surgery or eyelid tattooing), glaucoma, diabetes mellitus, thyroid disorder, were pregnant or breast-feeding, wore contact lenses or had systemic inflammatory/autoimmune disease [32,47–49]. No participant was under any type of medication, used artificial tears at the time of the testing session, or presented dermatologic diseases affecting ocular surface [32,47–50]. Subjects were asked not to wear eye makeup prior to the clinical revision [28–32].

2.2. Measurement conditions

To avoid the effects of overstating the precision of statistical estimates, only the right eye was examined [51]. To minimize diurnal or seasonal variations, measurements were taken in the afternoon between 5.00 and 6.00 P.M. during one month [52–56]. All measurements were made under similar conditions of light, temperature (20–23 °C) and humidity (50–60%) [41].

The procedures followed the Declaration of Helsinki and the protocol was reviewed and approved by the Ethics committee of the Universidad de Santiago de Compostela.

2.3. Ocular surface index (OSDI)

The OSDI [28,30,31] (provided by Allergan, Inc. Irvine, CA, USA) was used to quantify the impact of dry eye symptoms on vision-related quality of life. This disease-specific questionnaire includes 12 questions with reference to a 1-week recall period. The scoring of the OSDI was performed according to the published guidelines based on the following formula [30,31]:

$$\text{OSDI} = \frac{\text{Sum of scores} \times 25}{\text{Number of questions answered}}$$

Due to the discrepancy in the cut-off criteria of DED with OSDI questionnaire [28–32], a cluster analysis was performed on two data sets regarding two OSDI cut-off criteria:

- *OSDI with a two-subgroup stratification (asymptomatic subjects − patients with dry eye symptoms):* following previous reports the subjects were divided as asymptomatics (score lower than 15) and patients with dry eye symptoms (score equal or higher than 15) [29,31].
- *OSDI with a three-subgroup stratification*: following previous reports the subjects were divided as asymptomatics (score lower than 13), mild symptomatics (score between 13 and 23) and severe symptomatics (score equal or higher than 23) [28–32].

2.4. McMonnies

Subjects completed a modified McMonnies dry eye questionnaire to assess dryness symptom number, type and frequency [27,38]. This 12-item questionnaire elicits information about recent medical and medication history that could affect tear production. Symptoms included in the questionnaire are eye soreness, scratchiness, dryness, and grittiness (from the original McMonnies questionnaire) along with burning, stinging, foreign body sensation, and itchiness. The scoring of the McMonnies was performed according to the published guidelines [27,38].

As done for OSDI questionnaire, different cut-off criteria were used in the literature [27,32,38,39], so a cluster analysis was also performed on two data sets regarding two different McMonnies criteria:

- *McMonnies with a two-subgroup stratification (asymptomatic subjects − patients with dry eye symptoms)*: following previous report the subjects were divided as normal or asymptomatic or free from dry eye (score lower than 14.5) and patients with dry eye symptoms (score equal or higher than 14.5) [27,32,38,39].
- *McMonnies with a three-subgroup stratification*: following previous report the subjects were divided as normal (score lower than 10), mild symptomatics (score between 10 and 20) and severe symptomatics (score equal or higher than 20) [27,38].

2.5. Meibometry

Meibometry was carried out by a Meibometer® MB550 (Courage-Khazaka electronic GmbH, Cologne, Germany) linked to a computer [4,14,40–43,45,46]. A matt synthetic loop with standard size (17 cm of length and marked at 3 and 6 cm) to guarantee a constant shape was used (Fig. 1). With the central portion of the subject's lower eyelid retracted, the tape was pressed during ten seconds on the central region of the lower eyelid margin under enough standard pressure to pick up the meibomium oil with a minimal distortion of the lid [41,42]. Lipid was blotted from the central third of the lower lid and then a line of contact was seen across the full width of the tape like a translucent band [14,42,43]. If the patient blinks during the measurement, it was repeated. The tape was air dried for one minute at laboratory temperature (for evaporation of the aqueous component of the tear film). The tape was then inserted into the photometer and scanned across the reading window, where a photocell measured the change in light transmittance by moving the tape slowly upwards and downwards. The maximum reading was taken from the densest part of the blot as it passes the line of the window, and readings indicate zero in the areas of the tape loop free of meibomian lipid [40]. Results were displayed on the computer as charts (excel file) and curves (Fig. 2).

Each tape loop was measured five times photometrically, so a total of five curves were obtained per eye [45]. Then, the peak value (maximum value) of each curve was averaged as a mean value [45]. To reduce variability on Meibometer results all measurements were performed by a single investigator [43]. Data were provided on Meibometer Units (MU) [14,40,43,45].