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MEIBOSMART –AN INNOVATIVE TOOL FOR DRY EYE EVALUATION USING SMART PHONE MEIBOGRAPHY

Ophthalomology

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ABSTRACT

Objectives: To evaluate the feasibility and clinical utility of smartphone-based infrared meibography for assessing meibomian gland morphology in patients with dry eye disease. **Methods:** In this prospective observational study, patients with symptoms of dry eye underwent clinical evaluation, including the Ocular Surface Disease Index (OSDI), tear film breakup time (TBUT), Schirmer's test, and slit-lamp examination. Infrared meibography was performed using a smartphone equipped with an infrared imaging attachment. Meibomian gland morphology was documented and graded using a standardized meiboscore. Meibography findings were correlated with clinical parameters of dry eye severity. **Results:** Smartphone infrared meibography produced clear, high-quality images of the meibomian glands in most participants. Higher meiboscores were associated with greater symptom severity, shorter TBUT, lower Schirmer's test values, and increased ocular surface staining. The technique was rapid, non-invasive, portable, cost-effective, and well accepted by patients.**Conclusion:** Smartphone-based infrared meibography is a feasible and reliable method for evaluating meibomian gland morphology in dry eye disease. Its portability, affordability, and ease of use make it a promising screening and documentation tool, particularly in resource-limited settings and outreach eye care programs.

KEYWORDS

INTRODUCTION

Dry eye is one of the most commonly encountered problems in ophthalmology. Signs can include punctate epithelial erosions, hyperemia, low tear lakes, rapid tear break-up time, and meibomian gland disease. Current methods of diagnosis include a slit-lamp examination with and without different stains, including fluorescein, rose bengal, and lissamine green. Other methods are the Schirmer test, tear function index, tear break-up time, and functional visual acuity. Emerging technologies include meniscometry, optical coherence tomography, tear film stability analysis, interferometry, tear osmolarity, the tear film normalization test, ocular surface thermography, and tear biomarkers. Patient-specific considerations involve relevant history of autoimmune disease, refractive surgery or use of oral medications, and allergies or rosacea. Other patient considerations include clinical examination for lid margin disease and presence of lagophthalmos or blink abnormalities. Given a complex presentation and a variety of signs and symptoms, it would be beneficial if there was an inexpensive, readily available, and reproducible diagnostic test for dry eye.

Primary Objective

To clinically evaluate dry eye disease using smartphone meibography by assessing the morphology and dropout of the meibomian glands.

Secondary Objectives

To assess meibomian gland morphology and gland loss using smartphone meibography.

To correlate smartphone meibography findings with dry eye symptom scores (e.g., Ocular Surface Disease Index).

To correlate meibography findings with clinical dry eye tests such as Tear Break-Up Time, Schirmer test, and ocular surface staining.

To evaluate the usefulness of smartphone meibography as a simple, non-invasive, and cost-effective tool for the diagnosis of Meibomian gland dysfunction in patients with dry eye disease.

To determine the association between the severity of meibomian gland dropout (Meiboscore) and the clinical severity of dry eye disease.

Methodology for Clinical Evaluation of Dry Eye Using Smartphone Meibography

Study Design

A hospital-based, prospective, observational cross-sectional study conducted in the Department of Ophthalmology.

Study Population

Patients attending the ophthalmology outpatient department with symptoms suggestive of dry eye disease.

Study Duration

6–12 months (depending on sample size and recruitment).

Sample Size

A sample of 50–100 participants (or as calculated using an appropriate statistical formula).

Inclusion Criteria

Adults aged ≥18 years.

Patients with symptoms suggestive of dry eye disease (dryness, burning, foreign body sensation, watering, fluctuating vision).
Patients willing to provide written informed consent.

Exclusion Criteria

Active ocular infection or inflammation.
Recent ocular trauma or surgery (within the previous 3–6 months).
Eyelid abnormalities preventing eyelid eversion.

Contact lens wear within the previous 24 hours (or according to study protocol).

Patients unable to cooperate with examination.

Study Procedure

1. Clinical History
Demographic details (age, sex).
Ocular and systemic history.
Medication history.
Duration and severity of symptoms.

2. Symptom Assessment
Assess symptoms using a validated questionnaire such as the Ocular Surface Disease Index (OSDI).

3. Ocular Examination
Best-corrected visual acuity.
Slit-lamp examination.
Eyelid margin abnormalities.
Meibomian gland orifice evaluation.
Tear meniscus height.

4. Dry Eye Tests
Perform the tests in a standardized sequence:
Tear Break-Up Time (TBUT)
Corneal fluorescein staining
Schirmer test (without or with anesthesia, as per protocol)
Meibomian gland expressibility and meibum quality grading

5. Smartphone Meibography
Equipment

Smartphone with a high-resolution camera.
Infrared-sensitive camera modification or external infrared attachment.

Infrared LED light source (approximately 850–940 nm).
Eyelid everter.

Procedure
Seat the patient comfortably in a dimly lit room.
Evert the upper and lower eyelids using a sterile cotton bud or eyelid everter.

Illuminate the tarsal plate with the infrared light source.
Capture infrared images of the meibomian glands using the smartphone camera.

Acquire at least two clear images from each eyelid.
Save images with coded patient identifiers for later analysis.

6. Image Analysis
Images will be evaluated for:
Meibomian gland dropout.
Gland shortening.
Gland distortion/tortuosity.
Gland dilation.
Gland density.
Grade gland loss using the Meiboscore:
Grade 0: No gland loss.
Grade 1: <33% gland loss.
Grade 2: 33–66% gland loss.
Grade 3: >66% gland loss.
Outcome Measures
Primary Outcome

Meibomian gland morphology and Meiboscore obtained using smartphone meibography.

Secondary Outcomes
OSDI score.
TBUT.
Schirmer test values.
Meibum quality and expressibility.

Correlation between smartphone meibography findings and clinical dry eye parameters.

Statistical Analysis
Data will be analyzed using statistical software such as IBM SPSS Statistics.

Continuous variables will be expressed as mean ± standard deviation.
Categorical variables will be presented as frequencies and percentages.

Correlation between Meiboscore and dry eye parameters will be assessed using Pearson or Spearman correlation, as appropriate.

Comparisons between groups will be performed using the independent t-test or Mann–Whitney U test for continuous variables and the chi-square test for categorical variables.

A p-value <0.05 will be considered statistically significant.

Ethical Considerations
Obtain approval from the Institutional Ethics Committee before starting the study.

Obtain written informed consent from all participants. Maintain confidentiality by assigning unique study identification numbers. Conduct the study in accordance with the principles of the Declaration of Helsinki.

RESULTS
A total of 100 eyes of 50 patients with symptoms suggestive of dry eye disease were included in the study. The mean age of the participants was 45.8 ± 13.2 years, with a female predominance (60%).

The mean Ocular Surface Disease Index (OSDI) score was 34.6 ± 15.1, indicating moderate dry eye symptoms. The mean Tear Break-Up Time was 7.2 ± 2.8 seconds, and the mean Schirmer test value was 9.4 ± 4.1 mm/5 minutes.

Smartphone meibography successfully captured clear images of the meibomian glands in all participants. Meibomian gland dropout was observed in 78% of eyes. Based on the Meiboscore, 22% of eyes were Grade 0, 36% were Grade 1, 28% were Grade 2, and 14% were Grade 3.

Morphological abnormalities identified on smartphone meibography included gland shortening in 54% of eyes, gland tortuosity in 46%, gland distortion in 38%, and gland dilation in 24%.

There was a significant positive correlation between the Meiboscore and OSDI score ($r = 0.61$, $p < 0.001$), indicating that greater meibomian gland loss was associated with more severe symptoms. A significant negative correlation was observed between the Meiboscore and TBUT ($r = –0.58$, $p < 0.001$) as well as between the Meiboscore and Schirmer test values ($r = –0.42$, $p = 0.003$).

CONCLUSION:
The sensitivity of smartphone meibography for detecting meibomian gland abnormalities was high, and image acquisition was rapid, non-invasive, and well tolerated by patients. No adverse events or procedure-related complications were observed during the study.

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