Development of the tear film analysis system of a modified topographer for the assessment of the lipid layer

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Introduction

- In contact lens practice and dry eye diagnosis the assessment of the tear film lipid layer is very important. For the patient a thick lipid layer means a decreased evaporation rate and less symptoms of dry eye. Conversely for the contact lens wearer this means more prone to lipid deposition on the contact lens surface.
- A simple and convenient method of viewing the lipid layer and its interference patterns is the use of a Keeler Tearscope. If a Keeler Tearscope is not available in clinical practice, a slit lamp serves as an useful alternative.
- Both devices have a limited field of view, which does not allow an overall assessment of the spreading characteristic of the outer lipid layer. In comparison to slit lamp and Keeler Tearscope the Keratograph (OCULUS, Germany) offers a wide field of view.

Purpose

- Aim of this study was the development and realization of a new analysis technique for the assessment of the tear film interference pattern using the Keratograph (OCULUS, Germany).

Methods: Technical Modifications

- The Keratograph (OCULUS, Germany) offers a variety of non-contact tear film assessment tools and a comprehensive tear film analysis such as non-invasive tear film break up, tear meniscus height measurement and meibography. The following modifications were implemented in a the prototype, which was used in this study:
  - ✓ The illumination system of the Keratograph has been expanded and a high-resolution color camera was integrated.
  - ✓ The typical red ring illumination was replaced by a white one and additional white LED´s were installed to assess the tear film dynamics.
  - ✓ A magnification system was calculated and integrated.

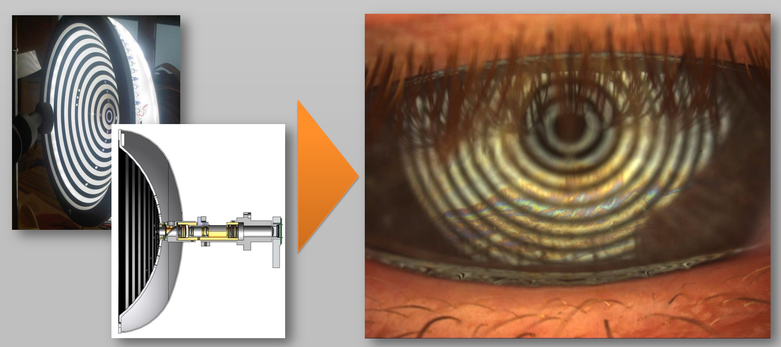

Fig. 1: left: modified Keratograph prototype, right: image showing the interference pattern of the lipid tear film layer

- The field of view using the Keratograph is about 9 mm. This is considerably larger than the field of view of the slit lamp (0.5 mm) or the Tearscope (4 mm). This enables an evaluation of the spreading characteristic of the tear film lipid layer.

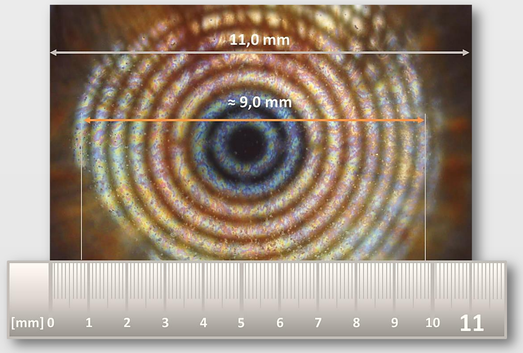

Fig. 2: Field of view of the Keratograph-Prototyp (Oculus)

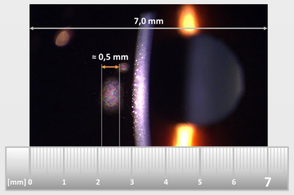

Fig. 3: Field of view of the slit lamp (Nidek SL 1800)

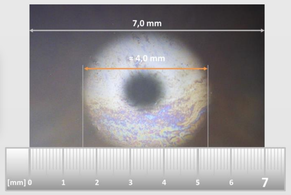

Fig. 4: Field of view of the Tearscope (Keeler)

Methods: Data Collection

- Regarding to their suitability these new applications were proofed in a first study (n = 41, mean age 27.2 ± 5.9 years, 46% female, 54% male).

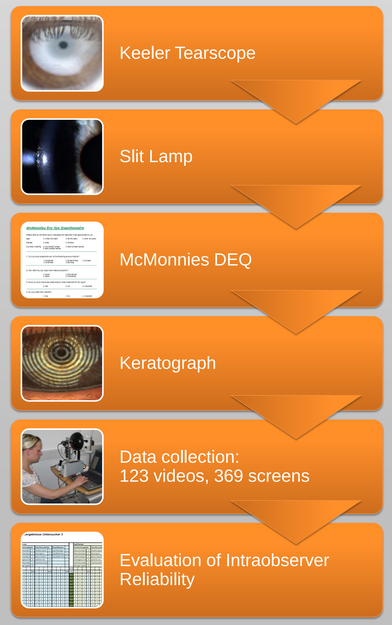

Fig. 5: Study design

- For the reference measurement, a corneal microscope and the Tearscope (Keeler) were used.
- A break of 15 minutes was taken between each measurement to minimize the risk of assessment induced reflex tearing.
- For the inter-observer comparison every taken video and screen was masked by a monitor. Every observer used the same PC and classification criteria to assess the lipid layer.
- The classification of the lipid layer based on the classification according to Guillon et al. [2] [3].

- 369 photographs and 123 videos of the tear film lipid layer were evaluated by three independent observers.

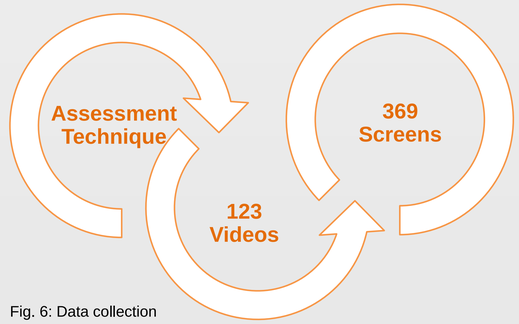

Fig. 6: Data collection

- ✓ During a defined interblink interval (3x) the lipid spreading was record with
  - Slit Lamp
  - Keeler Tearscope
  - Keratograph
- ✓ After every blink one screenshot was generated

Results

- For the inter-observer comparison of all results using Keratograph, Tearscope and slit lamp the lower and upper limits of the 95% confidence interval for the difference (T-Test) were calculated. All results were evaluated regarding to their visual appearance (E), interference color (I) and quantity (K).
- There was no significant difference in the inter-observer variation of the results. The best agreement was noted between the results of K, the lowest correspondence between the observers was found within E.
- A low correlation (product-moment correlation according to Pearson) between all results was found.

Conclusion

- An inter-observer comparison with well established procedures shows, that the developed system is a new alternative for the assessment of the tear film interference patterns.
- The Oculus Keratograph enables real-time measurements within a wider spatial range in comparison with Tearscope (Keeler) or slit lamp. Due to this it is also possible to evaluate the inter-blink spreading characteristic of the tear film lipid layer.

Literatur

[1] The Ocular Surface, Report of the International Dry Eye WorkShop (DEWS): Design and Conduct of Clinical Trials.: Report of the Diagnostic Methodology Subcommittee of the International Dry Eye WorkShop, 2007

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This study was performed as M.Sc. thesis project of Doreen Wiedemann at the University of Applied Sciences, Jena, Germany. Doreen Wiedemann has since taken up a position at OCULUS, Germany.