Computer-aided Analysis of Tear Film Velocity compared with established Tear Film Tests

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Introduction:

The quality and quantity of the pre-corneal tear film in contact lens fitting is becoming increasingly important. An additional and important part of a comprehensive tear film analysis is concerned with the tear flow behavior of the tear film. Based on this behavior a statement of the viscosity of the tear film can be made. [1] Analyses of the tear film dynamics are subjective and they are based on the experience of the examiner. [2] Furthermore, there is no valid classification of the tear flow behavior. The ability of measuring the particle velocity with a slit lamp and a topographer will be shown in this pilot study and velocities will be compared with established tear film tests.

Purpose:

Aim of the study was to compare and test a novel method to evaluate the tear flow rate using tear film particles captured with a slit lamp and a corneal topographer. The results, in combination with performed established tear film tests, were used in preparation for a subsequent objective analysis to classify tear film behavior.

Methods:

A conventional slit lamp (Nidek) and a previously modified corneal topographer (Keratograph 4.2, Oculus Optikgeräte GmbH) was used to asses the tear film velocity. The illumination of the corneal topographer was adapted to evaluate the tear flow behavior of the tear film by tracking its particles. The velocity of tear film particles of 34 participants (right and left eye; mean age 37.1±19.1 years; male 38%, female 62%) **were video tabed**.

Figure 1: Adapted illumination topographer

Figure 2: Tear flow behavior slit lamp

The velocity after 1 second was used for statistical analysis. The tear film velocity corresponds to the movement of these particles. The velocity was analyzed and calculated automatically using the VIANA video analysis software (Version 3.64; University Essen Germany). The velocities measured with the slit lamp were compared with those of the topographer (*Pearson* correlation). Furthermore, the correlation between the results of established tear film tests (tear meniscus height (TMH); lipid interference pattern; Phenol red test (PRT)) and the velocities were determined (Spearman correlation).

Results:

The median of tear film velocity assessed with the slit lamp was 1.15 mm/s (mean=1.24±0.47 mm/s) after 1 second, the velocity assessed with the corneal topographer was 1.19 mm/s (mean=1.10±0.39 mm/s) after 1 second. The particle velocity was found to be normally distributed (*Shapiro-Wilk* test) with both the slit lamp methods (p=0.216) and the topographer reference (p=0.365). No significant difference between the methods (p=0.113; t-test; 95 CI% (of differences) -0.34, -0.31 mm/s) was found and the results correlated (r=0.347, p=0.044).

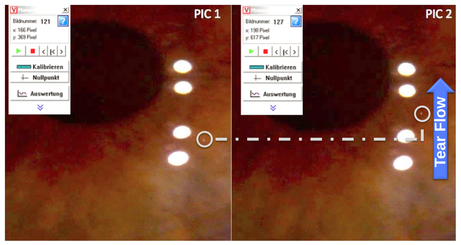

Figure 3: Tear flow behavior topographer

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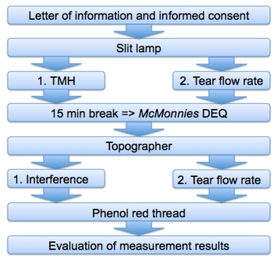

Figure 4: Study schedule

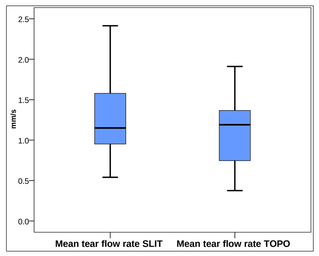

Figure 5: Comparison of tear flow velocities (n=34)

However, no significant correlations between particle velocity and established tear film quality or volume metrics (TMH; lipid interference pattern; PRT) were identified (p > 0.05).

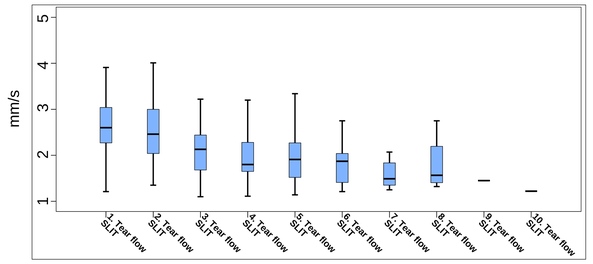

Figure 6: Tear flow rate (slit lamp) after blinking (n=34); Measuring time is one second and is divided into 10 partial measurements. (1.Tear flow SLIT = Value immediately after a blink; 10.Tear flow = Value rate after one second)

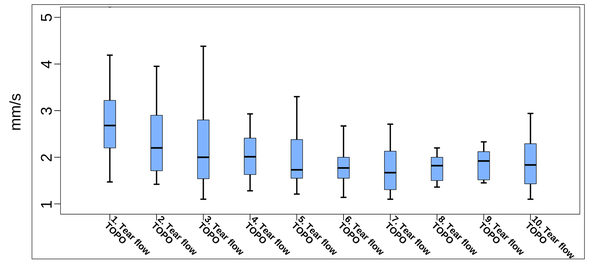

Figure 7: Tear flow rate (topographer) after blinking (n=34); Measuring time is one second and is divided into 10 partial measurements. (1.Tear flow TOPO = Value immediately after a blink; 10.Tear flow TOPO= Value rate after one second)

Conclusion:

The modified corneal topographer (Keratograph 4.2, Oculus Optikgeräte GmbH) allows a user-friendly assessment of the tear film velocity. A correlation between the flow rates and established tests could not be detected. However, particle movement does not relate to traditional measures of tear film quality and quantity. Further studies should be **durchgefuhrt** to carry out and develop an automatic detection of particles and valid classification of the tear film velocity.

References:

[1] Tomlinson, A. and S. Khanal, *Assessment of tear film dynamics: quantification approach.* The ocular surface, 2005. **3**(2): p. 81-95.

[2] Sickenberger, W.: Klassifikation von Spaltlampenbefunden1.Neuauflage, Großostheim. Ciba Vision Vertriebs GmbH, 2010. p. 37.

Acknowledgements:

The Keratograph 4 was provided by Oculus Optikgeräte GmbH. This study was accomplished without any financial support.

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