

# Comparison of established tear film tests with a new non-invasive tear film analysis method in patients with keratoconjunctivitis sicca



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## Introduction

The Keratoconjunctivitis sicca (KCS), also known as dry eye, is deemed to be a multifactorial disease and is one of the most common eye diseases. For this reason scientists, ophthalmologists and optometrists engage with this theme for more than 100 years. The decisive factor for dry eye is an imbalance of tear film production and evaporation or the removal of the tear film. Research methods, which are used to analyze the tear film and diagnosing dry eye, mostly have the disadvantage of being invasive or depending on the examiner or both. By using the new tear film scan software (TF-Scan) for the corneal topographer, developed<sup>[1]</sup> by JENVIS Research and Oculus, it is possible to analyze the tear film in its quality and quantity. With this method you get nearly non-invasive, examiner independent objective measurement results, the tear meniscus height (Non-Invasive Keratograph Tear Meniscus Height NIK-TMH) and the tear film break-up time (Non-Invasive Keratograph Break-Up Time NIK-BUT).

## Purpose

This study was conducted to investigate the applicability of the TF-Scan Software examining patients with dry eye. A control group with asymptomatic subjects and a similar test procedure was examined in a pilot study<sup>[2]</sup>. For categorising patients, especially with dry eye, the current grading scale must be adapted on a scientific base. Furthermore it is necessary to compare the classification results by means of established methods and the TF-Scan. Measurements have been repeated to check the reproducibility and to investigate whether a repeated measurement is preferable to a single measurement.

## Methods

The examinations were conducted in two different clinical test centres, the HELIOS clinical centre in Erfurt and the medical office from Dr. Richter in Saalfeld. The measurement period started in September and ended in November 2010. As measurement devices a corneal topographer (Oculus Keratograph 4) and a laser slit lamp (Zeiss Visulas) were used. The test procedure is shown in Tab. 1. It contained the determination of the tear meniscus height, the tear film break-up time, the McMonnies DEQ, the Schirmer Test (without anaesthetic) and both measurements from the TF-Scan. Thereby non- or minimal-invasive tests were placed at the beginning and invasive research methods at the end of every examination. All subjects were previously diagnosed as dry eye patients (n = 62) ranging in the age of 63 ± 15 years. A total of 44 women and 18 men participated in the study. The measurement results of the TF-Scan were classified compared with those of established tear film examination methods. For this purpose in each case the data were assigned in a three point scale, as can be seen in Tab. 1.

Tab. 1: Grading scales

Examination method	Grade 0	Grade 1	Grade 2
Tear Meniscus Height <sup>[3]</sup> [mm]	> 0,20	0,20	< 0,20
Break-Up Time <sup>[4]</sup> [sec]	≥ 10	6-9	≤ 5
Schirmer Test I <sup>[3][5]</sup> [mm]	≥ 15	6-14	≤ 5
McMonnies <sup>[6]</sup> [points]	0-9	9-20	> 20

## Results

Tab. 2: Examination methods and results (n = 62)\*

1. Non-Invasive Keratograph Tear Meniscus Height (NIK-TMH)  Mean, Standard deviation, Median: 0,26mm ± 0,14mm; 0,21mm	 Fig. 1: Non-Invasive Keratograph Tear Meniscus Height (NIK-TMH)
2. Non-Invasive Keratograph Break-Up Time (NIK-BUT)  NIKf-BUT (first break-up) Mean, Standard deviation, Median: 3,8sec ± 3,0sec; 3,5sec  NIKav-BUT (average break-up) Mean, Standard deviation, Median: 7,1sec ± 3,7sec; 7,5sec	 Fig. 2: TearMap
3. Tear Meniscus Height (TMH)  Mean, Standard deviation, Median: 0,28mm ± 0,13mm; 0,22mm	 Fig. 3: Left: tear meniscus height (slitlamp) <sup>[3]</sup> Right: tear meniscus height (schematic) <sup>[3]</sup>
4. Break-Up Time (BUT)  Mean, Standard deviation, Median: 7,3sec ± 4,3sec; 7,5sec	 Fig. 4: Tear film break-up left: peripheral break-up <sup>[3]</sup> right: schematic <sup>[3]</sup>
5. McMonnies Dry Eye Questionnaire  Mean, Standard deviation, Median: 22,27 points ± 4,32 points; 23 points	Dry eye questionnaire
6. Schirmer Test (without anaesthetic)  Mean, Standard deviation, Median: 15,2mm ± 8,1mm; 14mm	 Fig. 5: Schirmer Test schematic <sup>[3]</sup>

### Classification NIK-BUT

The following grading scale for both parameters of NIK-BUT determined using the Receiver Operating Characteristic (ROC)-curves:

Tab. 3: Classification NIK-BUT

Classification	NIKf-BUT [sec]	NIKav-BUT [sec]	Assessment
Grade 0	≥ 10	≥ 14	Stable tear film
Grade 1	< 10	< 14	Marginal tear film stability
Grade 2	≤ 3	≤ 7	Dry eye

### Test accuracy of NIK-BUT in prediction of KCS

- NIKf-BUT: sensitivity 76%, specificity 76%
- NIKav-BUT: sensitivity 67%, specificity 68%

### Mean Results in consideration of the single test classifications

Every test is based on a three point scale. There are the same expectation values for grading a patient within the quantitative (Schirmer test I, TMH, NIK-TMH) (p > 0.05, Wilcoxon) and also within the qualitative examination methods (BUT, NIK-BUT) (p > 0.05, Wilcoxon).

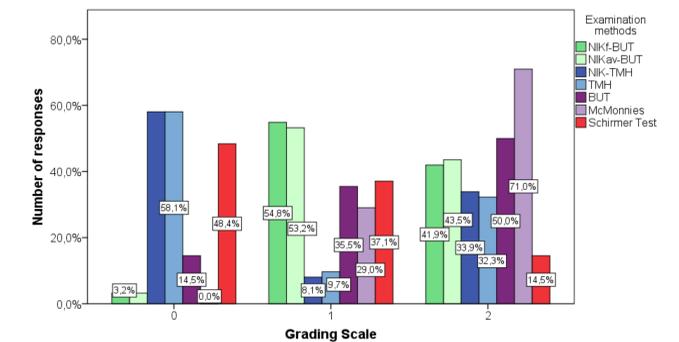


Fig. 6: Frequency distribution

A combination of quantitative and qualitative methods show significantly different expectation values in grading a patient (p < 0.001, Wilcoxon).

### Comparison of repeated measurements over a single measurement

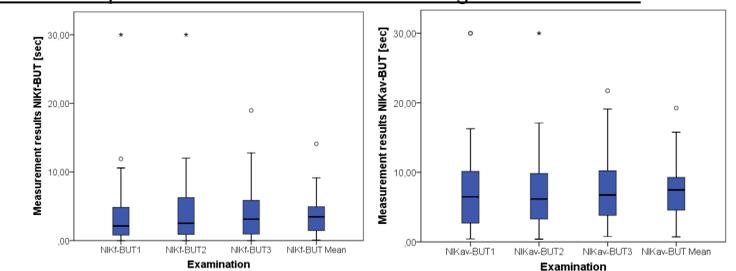


Fig. 7: Boxplot representation of the individual measurements from the mean

The repetition of a measurement has to be preferred to a single measurement to minimize the standard deviation and to ensure a reproducible tear film analysis.

## Conclusion

The combination of qualitative and quantitative testing in a single device provides a more comprehensive investigation of the disease KCS compared to the established single measurement procedures.

The classification of the NIK-BUT is suitable to categorize patients with KCS in optometric and ophthalmological application.

## References

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