Optimization of the non-contact meibography by means of an experimental Corneal Topographer

M.Sc., Dipl. Ing. (FH) M. Sinnig (formerly Michel) 1,2; Prof., Dipl.-Ing. (FH) W. Sickenberger, MS. Optom. (USA) 1,2
University of Applied Sciences Jena, Germany; JENVIS Research Institute, Germany

Introduction:
The term Meibomian Gland Dysfunction (MGD) describes abnormalities of the meibomian glands, which are commonly characterized by obstructions of the glands and changes of the gland secretion, respectively [1]. It is considered to be one of the most important causes of the evaporative Dry Eye [2]. It is believed, that the prevalence of MGD is at 70% [3]. Nevertheless there was no generally applicable definition and classification, especially in German speaking countries until recently. Not least this was accounted for by a lack of diagnostic opportunities. The so called meibography, an assessment to make the morphology of the glands visible takes a key role in the diagnosis of MGD and becomes more and more important. New devices are supposed to make the assessment more accessible in daily practice and more comfortable for the investigator and the patient as well. Consequently the causes of Dry Eye can be investigated more precisely and specific therapy options can be applied to alleviate the patients symptoms.

Purpose:
To optimize the non-contact meibography to improve the image quality and to make an assessment of the meibomian gland morphology more accessible in daily practice, easier for the practitioner and more comfortable for the patient. For this purpose different devices were tested regarding their capability for non-contact meibography. The focus was on a corneal topographer (Keratograph, OCELUS). Modifications of the Keratograph were determined and were implemented in terms of a prototype.

Methods:

Capability testing of different devices

General requirements for non-contact meibography:
- Infrared light source for the illumination of the eyelids or, respectively
- Two different cameras are necessary (one for normal illumination, one for infrared)
- No further facilities necessary
- Small display
- Light falloff in the periphery
- Not all glands can be assessed with filters of different wavelengths
- Small region of interest

For all tested devices the non-contact meibography is possible. However they are limited regarding their technical requirements or cost-intensive facilities are necessary. During the further procedure the Keratograph was used to test different modifications and to optimize the non-contact meibography with this device.

Development process with an experimental topographer

A commercial corneal topographer (OCELUS Keratograph 4) was used to assess meibography images regarding illumination, magnification and field of view. With different lenses which were adjusted in the calotte of the device the region of interest, the optimal magnification and in regard an appropriate working distance were determined to simplify the gland assessment for the investigator in the examination of the eyelids. With a 4.00 D lens the region of interest was optimized from 14.5mm to 25mm and a working distance of 12mm was realized, which was only at 4mm beforehand.

The morphology of the meibomian glands can be examined with the new device in an investigator and patient-friendly way. Using the modified topographer for the assessment of the meibomian glands is a novel approach with considerable advantages compared to other devices, e.g. the illumination. The excellent quality of the meibography images simplifies the evaluation of morphologic gland changes. The constant measuring situation concerning exposure time and gain. Also in bright light conditions it is not necessary to change the presetting concerning exposure time and gain.

Region of interest approx. 25 mm
- Entire range of the everted eyelid is visible
- Working distance approx. 12 cm
- Enough space to evert the eyelids and fix them during the measurement

Based on the OCELUS Keratograph 4 an experimental topographer was developed. The previous determinations were realized and specified by equipping the prototype with a manually adjustable, provisory magnification changer. Additionally the prototype was equipped with a high resolution color camera, which is equivalent to the ImageCam 2 (OCELUS) and ensures high quality images of the meibomian glands.

The illumination was modified, to achieve a good and uniform illumination over the entire area of the everted eyelid without reflex interferences. Therefore, different IR-diods with seven different wavelengths (720 nm, 770 nm, 810 nm, 840 nm, 880 nm, 950 nm and 1020 nm) were tested as well as the number and the arrangement of the diodes. The number of the IR diodes was determined to three vertically arranged diodes each in the mid-periphery of the calotte. Each diode radiates light in another orientation to ensure a diffused and uniform illumination over the entire region of interest. The brightness of the diodes was modulated by means of a separate power supply device.

Finally it was tested, if the quality of the images is influenced by the ambient light conditions. For this purpose non-contact meibography images were examined in different lighting situations (darkened room, moderate darkened room, artificial room illumination, daylight). It turned out that the ambient light conditions have bare influence on the image quality. Also in bright light conditions it is not necessary to change thepresetting concerning exposure time and gain.

Acknowledgements:
This study was supported by OCELUS Optikgeräte GmbH, Germany

References:

Contact:
Corresponding Author: Martina Sinnig E-Mail: m.sinnig@jenvis-research.com; Ernst-Abbe-University of Applied Sciences, Carl-Zeiss-Promenade 2, 07745 Jena, Germany