Determination of Thickness Profiles of Toric SCLs and New Relevant SHCLs Using Scheimpflug Technology

Introduction:
Oxygen transmissibility (DK/t) is one of the most important influencing values on the adjustment of soft contact lenses (SCL) to keep eyes healthy. As oxygen transmissibility depends on lens thickness, it can be measured by dividing oxygen permeability (Dk) by lens thickness (t). Typical Dk/t values are given for the centre thickness of a -3D SCL. There is no information about Dk/t for the centre or peripheral thicknesses of other dioptic powers. However, these are important too, because there is no lateral diffusion under thicker areas [1][2], so this can also induce characteristic signs of hypoxia [3][4]. In that fact oxygen supply could be estimated much better by generating a thickness profile of the complete SCL.

Purpose:
Primary objective was the characterization of thickness profiles and lens stabilization systems of eight toric SCL brands and the generation of oxygen maps to visualize the Dk/t values of two new launched silicone hydrogel contact lens (SHCL) brands in vitro. Another aim was to avoid dyeing the lenses like in previous studies to get results, which are comparable to the measurements with the cutting method and using the microscope.

Methods:
**Scheimpflug method:** A modified Scheimpflug camera (Pentacam, Oculus) was used to measure 18 spherical SHCL in a range from -6D to -12D and 63 toric SCL (n=33 Sihy: n=30 non-Sihy) from -1D to -6D with a cylinder of -0.75D up to -1.75D. With a rotating slit light of the camera, exact cross-sections of the SCLs were generated to create a colour-coded topographic map by calculating 138,000 real altitudinal data. To generate Dk maps the thickness profiles were combined with the Dk value of the manufacturer’s specification.

In case of a fall surface detection, the SCLs were dyed for five minutes with a solution of 2-10% sodium fluorescein.

**Cutting method:** To compare the results, every lens was cut into a thin profile slide, which includes the thickest and thinnest area of the SCL and examined under a microscope (Zeiss Axio Vision Software, Fig. 15).

Results:

- **Visualization of different thickness profiles of toric SCL (examples)**
- **Visualization of thickness profiles SHCLs (examples)**
- **Generated thickness profile by using cutting method and microscopy**
- **Optimization of the Scheimpflug technology**
  After modification the Scheimpflug camera detects thickness values of an area more than 14mm diameters without dyeing the lenses.

• Comparison between the results of the Scheimpflug and cutting method
  There is a significant positive linear correlation (r=0.983, p<0.001, p=0.297, p=0.066) between the Scheimpflug and cutting method, when lenses were not dyed and with dyeing the lenses (r=0.941, p<0.001, r=0.791, p=0.001).

<table>
<thead>
<tr>
<th>Brand</th>
<th>Dk/t Value</th>
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<tbody>
<tr>
<td>Comfilcon A</td>
<td>3.00 -1.25 180°</td>
</tr>
<tr>
<td>Etafilcon B</td>
<td>3.00 -1.25 180°</td>
</tr>
<tr>
<td>Vifilcon A</td>
<td>3.00 -1.25 180°</td>
</tr>
<tr>
<td>Lotrafilcon</td>
<td>3.00 -1.25 180°</td>
</tr>
<tr>
<td>Balafilcon A</td>
<td>3.00 -1.25 180°</td>
</tr>
<tr>
<td>Acrifilcon D</td>
<td>3.00 -1.25 180°</td>
</tr>
</tbody>
</table>

Fig. 19: Comparison of the thickness values between Scheimpflug and cutting method of Comfilcon A.
Fig. 20: Comparison of the thickness values between Scheimpflug and cutting method of a dried SCL.

Discussion:
Thick profiles and oxygen maps were generated successfully. However, it is necessary to continue doing comparison measurements by using the cutting method to control the results. There was seen a clear effect of increase in thickness values (Fig. 20), when SCL were dyed. This effect could be eliminated by optimizing the Scheimpflug camera.

Conclusion:
The thickness profiles can be used to characterize designs of SCLs and to visualize the oxygen transmissibility over the entire area of various lens types without dyeing. The better knowledge about the oxygen supply through the SCL can protect the eye from the impact of hypoxia, which still remains as a motivation for continuing studies.

References: