Comparison of the bioanalogic IOL material - WIGEL® - with various IOL materials

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The aim of the current study is to compare the proprietary material WIGEL® with different materials used in IOL manufacturing; namely with hydrophobic and hydrophilic acrylate, PMMA, silicone and Collamer®.

WIGEL® was compared *in vitro* with standard IOL materials: hydrophobic and hydrophilic acrylates, PMMA, silicone and Collamer®. The samples used in this study were: samples in form of IOLs including hydrophobic acrylic - AcrySof® ReSTOR® (Alcon), EyeCee One® (Croma); PMMA - GS55B-OUV (DGR), silicone and Collamer® - Visian®ICL™ (STAAR® Surgical) and materials in form of disks including hydrophilic acrylic - CI26 (Contamac), BENZ25 UV.

Comparison of selected material was made on basis of refractive index, water content and interaction of material with human fibroblasts.

The water content and refractive index of WIGEL® material was determined using gravimetric method and refractometer CLR-12-70, respectively.

Selected materials were tested *in vitro* interaction with human fibroblast cells. The materials were inserted into the 24 microwell-plate and the fibroblasts (30 000 per well) in the M1H medium with 10% FS were added. The cell viability in the vicinity of the materials, adhesion, spreading and proliferation of the cells to the surface were monitored within 7 days microscopically.
## Results: Refractive index and water content

<table>
<thead>
<tr>
<th>IOL</th>
<th>Sample</th>
<th>Material of IOL</th>
<th>Water content [w/w%]</th>
<th>RI</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIOL-CF® (MEDICEM)</td>
<td>Polyfocal IOL</td>
<td>WIGEL® (unique hydrogel)</td>
<td>44</td>
<td>1,4267</td>
</tr>
<tr>
<td>NCL</td>
<td>-</td>
<td>NCL</td>
<td>66</td>
<td>1,40 – 1,44²</td>
</tr>
<tr>
<td>AcrySof® ReSTOR® IQ (Alcon)</td>
<td>Multifocal diffractive aspheric IOL</td>
<td>Hydrophobic Acrylate</td>
<td>0</td>
<td>1,5548</td>
</tr>
<tr>
<td>EyeCee One® (Croma)</td>
<td>Monofocal aspheric IOL</td>
<td>Hydrophobic Acrylate</td>
<td>0</td>
<td>1,5177</td>
</tr>
<tr>
<td>CONTAFLEX 26% UV-IOL (STAN) (CONTAMAC)</td>
<td>Disk</td>
<td>Hydrophilic Acrylate</td>
<td>27,6</td>
<td>1,4582</td>
</tr>
<tr>
<td>BENZ 25 UV</td>
<td>Disk</td>
<td>Hydrophilic Acrylate</td>
<td>25,9</td>
<td>1,4582</td>
</tr>
<tr>
<td>Visian®ICL™ (STAAR® Surgical)</td>
<td>Monofocal IOL</td>
<td>Collamer®</td>
<td>40</td>
<td>1,442³</td>
</tr>
<tr>
<td>GS55B-OUV (DGR)</td>
<td>Monofocal IOL</td>
<td>PMMA</td>
<td>0</td>
<td>1,4957</td>
</tr>
<tr>
<td>TECNIS® CL Silicone IOL Z9002 (AMO)</td>
<td>Monofocal aspheric IOL</td>
<td>Silicone</td>
<td>0</td>
<td>1,46⁴</td>
</tr>
</tbody>
</table>

1 Reiss S. et al: IEEE transaction on bio-medical engineering 2012; 59(8):2348-54
Results: interaction with fibroblasts - acrylates

Hydrophilic acrylate

BENZ 25-UV

CI26 (CONTAMAC)

Hydrophobic acrylate

EyeCee One® (Croma)

AcrySof® ReSTOR® (Alcon)
Results: interaction with fibroblasts - hydrogels

Visian®ICL™ (STAAR® Surgical) from Collamer®

WIOL-CF (MEDICEM) from WIGEL®

On hydrophilic acrylates, individual cells adhered slightly but surface does not promote proliferation, in contrast to some previous findings\(^1\). Contrary to our expectation, hydrophobic acrylates formed dense cells colonies at the same level as in control. On Collamer® material, the cells form clusters and are sporadically spread. WIGEL® surface, however, does not support either adhesion, spreading or proliferation. This makes WIGEL®, in agreement with previous reports\(^1\), different from both hydrophilic acrylates and Collamer®.

Results: Summary

The refractive index (RI) of WIGEL® was 1.427 which is in the range of the reported values of the equivalent RI of natural crystalline lens. All other IOL materials have much higher refractive index except Collamer® that has RI higher than WIGEL® but just outside the RI range reported for NCL.

The equilibrium water content in WIGEL® material was higher than in other IOL materials.

None of the IOL materials was cytotoxic. However, WIGEL® in comparison to other IOL materials does not support adhesion, spreading or proliferation of fibroblasts on its surface. Fibroblasts adhesion, spreading and proliferation were most pronounced on the acrylates, surprisingly high on hydrophobic acrylates. Collamer® is in this respect worse than WIGEL® but better than the tested acrylates.

Conclusions

The RI and water content of WIGEL® is more similar to the water content and effective RI and of human crystalline lens than RI of most other tested materials.

In contrast to some other tested IOL materials, WIGEL® is highly resistant to cells attachment, spreading and proliferation on its surface. This is the underlying reason for WIGEL’s resistance to PCO and biofilm formation that is caused by adhesion and proliferation of fibroblasts. These findings fully support bioanalogic concept of intraocular lens WIOL-CF® manufactured from this unique hydrogel material.