Cytology of Human Intraocular Lenses
A Scanning Electron Microscopic Study

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\textbf{Abstract.} Scanning electron microscopy of 9 intraocular lenses, removed from patients mainly because of corneal problems, revealed the presence of different types of adhering elements. Independent of clinically significant symptoms of infection, macrophages and/or epitheloid cells and/or granulocytes were observed. On their anterior surface, 3 lenses showed flat cells or cellular remains which are supposed to represent corneal epithelial cells. Membrane fragments were found on 3 other lenses. Most of the polymethylmethacrylate optics of the lenses showed some deformation and/or cracking and to evaluate them some additional studies with new intraocular lenses were performed. High pressure during the preparation procedure for scanning electron microscopy was found to be the cause.

\textbf{Introduction}

Inspection of intraocular lenses (IOLs), removed from human eyes for varying reasons, reveals the presence of different types of adherent cells and other structures apparently of biological origin. For the study of these structures on the surface of the IOL, Wolter [1982a, b] developed the lens implant cytology technique. In this study we used a different technique, viz. scanning electron microscopy which has some advantages over the lens implant cytology technique but also some disadvantages. Advantageous are the clear 3-dimensional view and the higher resolution. However, scanning electron microscopy presupposes rather costly laboratory equipment and careful preparation and even then some artifacts remain. This report concerns the scanning electron microscopic study of 9 IOLs removed from human eyes after surgery. The results are discussed and related to literature.

\textbf{Materials and Methods}

During the past year various types of IOLs, removed for varying reasons, were sent to the Department of Morphology of the Netherlands Ophthalmic Research Institute.
Table 1

<table>
<thead>
<tr>
<th>Lens No.</th>
<th>Type of IOL</th>
<th>Implantation time</th>
<th>Reason for removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rigid tripod</td>
<td>5 months</td>
<td>inflammation</td>
</tr>
<tr>
<td>2</td>
<td>Binkhorst-2</td>
<td>approx. 7 years</td>
<td>?</td>
</tr>
<tr>
<td>3</td>
<td>Binkhorst-2</td>
<td>approx. 3 years</td>
<td>keratopathy</td>
</tr>
<tr>
<td>4</td>
<td>Medallion lens</td>
<td>12 years</td>
<td>keratopathy</td>
</tr>
<tr>
<td>5</td>
<td>Binkhorst-2</td>
<td>3 years (37 months)</td>
<td>keratopathy</td>
</tr>
<tr>
<td>6</td>
<td>Binkhorst-2</td>
<td>7 years (83 months)</td>
<td>keratopathy</td>
</tr>
<tr>
<td>7</td>
<td>Medallion lens</td>
<td>approx. 2 years</td>
<td>keratopathy</td>
</tr>
<tr>
<td>8</td>
<td>Binkhorst-4</td>
<td>5 years</td>
<td>trauma</td>
</tr>
<tr>
<td>9</td>
<td>Modified tripod</td>
<td>13 months</td>
<td>intermittent touch</td>
</tr>
</tbody>
</table>

Table 1 summarizes the type of IOL used, the implantation time and the reason for removal of each of the specimens studied. Obviously, most of the lenses were removed because of corneal complications. Of the 2 posterior chamber lenses, 1 was removed for inflammatory reasons and the other, a modified tripod lens with anterior loops on the optic, because of an intermittent touch. The implantation time varied between 5 months and 12 years. Each specimen was fixed in a cacodylate-buffered mixture of glutaraldehyde and paraformaldehyde [Peters, 1970] for several days with a maximum of 10 days. Consequently the specimens were dehydrated in a graded series of ethanols and critical point dried with CO₂. After gold coating the lenses were glued on a specimen mount using conductive carbon cement and inspected in a Philips SEM 505 scanning electron microscope.

In order to study the effect of scanning electron microscopic processing on the lenses, 10 new lenses with polymethylmethacrylate optics underwent various separate steps of these preparations. Different types of lenses, produced by different manufacturers, were used. Two lenses were studied after immersion in Peter’s fixative for 3 days, 2 lenses after ethanol dehydration, 2 lenses after critical point drying with CO₂, 2 lenses after gold coating and finally 2 new lenses were studied after the whole preparation.

Results

Cells adherent to the lens were often present in great number and only 1 lens showed an almost clear surface (lens 9). On lenses 1–3 (table I), ovoid to round cells were found with numerous microvilli or fine cytoplasmic processes and a width of 15–20 µm (fig. 1). The cells with the fine cytoplasmic processes were identical to the cells described by Sievers and von Domarus [1984] as either macrophages or epitheloid cells. The cells with the microvilli could not be named properly. According to Kessel and Kardon [1979] these cells can equally be lymphocytes or other types of granulocytes. On lenses 3–5 (table I) a varying number of cells or cellular remnants was found with a more or less flattened, round aspect and a diameter of 10 µm (fig. 2). Sugar et al. [1978] describe the same type of cells as corneal endothelial cells.

In addition to these cellular elements, membrane fragments were discovered on the lenses 4, 6 and 7 (fig. 3). These structures showed a wrinkled aspect and a varying outline and width. They were regarded as remnants of the proteinaceous capsule which is said to envelope the implant as a result of a fibroblastic response [Wolter, 1982a, b]. IOL No. 8, which was removed because of severe trauma, was covered with blood and fibrin (fig. 4).

The perspex (plexiglass, polymethylmethacrylate) optic of the implant proved to be
changed after critical point drying. This resulted in cracking and deformation of the central part of the lens as shown in figure 5. Experiments with the new IOLs revealed that exposure of the lenses to various steps in the preparation for scanning electron microscopy resulted in an unchanged surface of the lens as long as the specimen had not been in the pressure chamber of the critical point drying apparatus. The typical deformation of the optics could be produced by exposure of a lens to a pressure of more than approximately 40 atm. The critical point drying procedure with CO₂ makes a pressure of approximately 80 atm necessary.

Besides these changes, cracks and fissures in the polypropylene or nylon loops were also observed (fig. 6) in lenses 2, 3 and 6 (table I).
Fig. 3. High power scan of membrane fragments on the surface of a Binkhorst-2 IOL after 7 years of implantation. These fragments are regarded as the remnants of the fibroblastic response of the host versus the implant [Wolfe, 1982a, b].

Fig. 4. High power scan of a blood clot around the optic of a Binkhorst-4 IOL which was removed after 5 years of implantation because of a severe trauma. Erythrocytes and fibrin threads are clearly visible, demonstrating the good quality of the imaging of cellular material in scanning electron microscopy.

Fig. 5. Low power scan of a Binkhorst-2 IOL after 37 months of implantation after its preparation for scanning electron microscopy. One of the optics was cut during explantation, the other was separately studied. Deformation of the optic and the cracking of its surface, due to the critical point drying, is clearly visible.
Discussion

The presence of macrophages and/or epithelial cells and/or granulocytes on the surface of the implants 1–3 (table I) was not related to the presence of a clinically evident inflammatory reaction of the eye. This is in correspondence with the findings of Sievers and von Domarus [1984].

Lenses 4 and 5 (table I), on which endothelial cells were found, were both removed because of corneal complications. On 1 of the IOLs, not more than remnants of the adhering cells could be observed and, in this case (lens 3), it was hardly possible to determine the nature of the cellular material (fig. 7). Also fibroblasts or fibroblast-like cells could have been responsible for these remains, be-

Fig. 6. Cracks and fissures in the optic of a Binkhorst-2 IOL after 83 months of implantation. These changes are not regarded as artificial but as the results of a biodegenerative process.

Fig. 7. Remains of cells, adherent to the anterior surface of a Binkhorst-2 IOL after 3 years of implantation. They are regarded as remains of corneal endothelial cells or remains of fibroblasts. Proper determination is impossible. This picture is from the same IOL as figure 1, so it seems unlikely that the preparation for SEM has anything to do with the cell ruptures.
cause fingerprints of cell processes could be seen on the surface of the IOL (fig. 6). The membrane fragments are supposed to be parts of the capsule which was described by Wolter [1982a, b] and by Sievers and von Domarus [1984]. Wolter [1982a, b] speculated that this membrane may sequester the IOL in the course of a foreign body reaction. The reason why only fragments could be found might be the destruction of this capsule during surgery or during preparation for scanning electron microscopy.

The lens with an almost clear surface (lens 9; table I) had been kept in saline for several hours after explantation before fixing it. This circumstance makes the finding of the clear surface unreliable because biological material could have been washed away. For this reason immediate fixation of the IOL is necessary.

The deformation and cracking of the polymethylmethacrylate optics of the implants have already been described by Sievers and von Domarus [1984]. The finding that these changes were caused by pressure is remarkable. Critical point drying is an inevitable step in the preparation for scanning electron microscopy, being designed to avoid surface tension during the drying process, which would disrupt the cells.

The degenerative changes in the polypropylene or nylon loops have been described many times before and they were found mostly in the bent parts of the loops [Drews et al., 1978; Apple et al., 1984].

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References


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