Quantification of Aqueous Flare After Phacoemulsification With Intraocular Lens Implantation in Eyes With Pseudoexfoliation Syndrome

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Background: Impairment of the blood-aqueous barrier is a frequent finding in eyes with pseudoexfoliation syndrome (PEX).

Objective: To perform noninvasive quantification of aqueous flare using the laser flare-cell meter to analyze blood-aqueous barrier breakdown following phacoemulsification with intraocular lens implantation in eyes with and without PEX.

Methods: After other conditions that might account for impairment of the blood-aqueous barrier were excluded, 11 eyes with PEX and 11 eyes with senile cataract without PEX were included in the study. Aqueous flare was quantitatively determined using a laser flare-cell meter preoperatively as well as 1, 3, and 5 days postoperatively. Phacoemulsification with posterior chamber intraocular lens implantation was performed by one surgeon.

Results: On the first postoperative day, flare values (calculated as mean ± SD photon counts per millisecond) in eyes with PEX were higher (42.2 ± 21.3) than in eyes without PEX (30.6 ± 15.1) (P > .05). On days 3 and 5, postoperative flare values decreased slowly in eyes with PEX (23.9 ± 7.4 and 21.2 ± 5.7 photon counts per millisecond, respectively) and were significantly higher than in eyes without PEX (14.8 ± 5.4 and 10.5 ± 1.4 photon counts per millisecond, respectively) (P < .05).

Conclusions: Breakdown of the blood-aqueous barrier is significantly more extensive in eyes with PEX and may be an important risk factor for early postoperative complications. The altered response to surgery should be considered in eyes with PEX.

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CAREFUL CLINICAL examination of eyes with pseudoexfoliation syndrome (PEX) by means of a slit-lamp often shows signs of a mild irritation of the anterior chamber, with aqueous flare and pigmented “cells” indicating impairment of the blood-aqueous barrier (BAB). Alterations of the BAB have been detected in eyes with PEX by different methods, including fluorophotometry, iris angiography, tyndallometry with the laser flare-cell meter (LFCM), and biochemical analysis of the aqueous humor. An increased incidence of complications following cataract surgery has also been reported, especially inflammation and fibrin formation. Our study quantifies alterations of the BAB following cataract extraction in eyes with and without PEX by use of noninvasive quantification of aqueous flare using the LFCM.

RESULTS

Eleven eyes with senile cataracts only and 11 eyes with PEX and senile cataracts were included in the study. The age of the patients without PEX ranged between 51 and 87 years (mean, 65 years); with PEX, between 66 and 87 years (mean, 68 years). The phacoemulsification time was between 0.4 and 1.8 minutes for both groups. Before surgery, the measurement in eyes without PEX showed normal values between 1.2 and 4.2 photon counts per millisecond. However, preoperative flare values in eyes with PEX were increased to between 15.7 and 18.0 photon counts per millisecond. Although the differences between the flare values of the normal group and those of eyes with PEX were not significant (P > .05) on the first postoperative day (Table and Figure), eyes with PEX did show distinctly higher values than the normal eyes. Tyndallometrically, however, eyes with senile cataract and PEX did have clearly increased flare values on the third and fifth postoperative days compared with the group of normal eyes with senile cataract (P < .02 and P < .003, respectively) (Figure).
PATIENTS AND METHODS

Aqueous flare measurement was performed using the LFCM (model FC1000; KOWA, Tokyo, Japan). The LFCM was developed to allow noninvasive, quantitative determination of aqueous protein concentration. Using a photomultiplier, the scatter of a helium-neon laser light scanned into the anterior chamber was recorded. The apparatus and the techniques have been previously described in detail,9 and the sensitivity and reproducibility of the method have been confirmed by several groups in a series of studies.10-12 The flare measurements were performed by 2 examiners (S.S. and N.X.N.) following medical pupillary dilation according to previous protocols.13,14 The flare values were indicated as photon counts per millisecond and determined preoperatively and on the first, third, and fifth postoperative days. Five measurements were averaged. Individual measurements were controlled on a computer monitor by means of a diagram. Whenever there was an indication of artifacts, the respective individual measurement was discarded and repeated. Exclusion criteria were diabetic retinopathy, history of or active uveitis, previous penetrating eye injuries, or preceding intraocular surgery. In all cases, senile cataracts were present. No secondary open-angle glaucoma or antiglaucomatous medical treatment was present in the eyes with PEX.

Cataract surgery followed standardized procedures of phacoemulsification and intracapsular implantation of a posterior chamber lens: a 6.5-mm sclerocorneal tunnel incision was followed by capsulorhexis, removal of the lens nucleus by phacoemulsification, and aspiration of the cortex. After the injection of a viscoelastic substance (Healon; Pharmacia-Upjohn, Erlangen, Germany), a 1-piece polymethyl methacrylate posterior chamber lens was implanted into the capsular bag. After complete aspiration of the viscoelastic substance, the corneoscleral tunnel was closed with a 10-0 nylon suture. All operations were performed by one of us (G.O.H.N.). No intraoperative complications, such as defects of the posterior lens capsule or vitreous loss, occurred. Postoperative complications like fibrin reaction, hyphema, or synchiae were not seen. The difference of maximal pupillary dilation in eyes with PEX ranged between 1.0 and 2.5 mm compared with the normal eyes, but no iridectomy, sphincterotomies, or mechanical dilation of the pupil was performed. Medical treatment was identical in both groups. Before surgery, all eyes were treated for 1 day with a topical noncorticosteroidal antiphlogistic agent (1% diclofenac natrium). For pupillary dilation, mydriatic eyedrops (0.5% tropicamide benzeneacetamide, 5% phenylephrine hydrochloride, and 1% cyclopentolate hydrochloride) were given preoperatively. Following surgery, the patients in both groups were treated with combined antibiotic and corticosteroidal eyedrops (0.03% dexamethasone sodium phosphate and 0.3% gentamicin sulfate) 3 times a day and a regular mydriatic agent (0.5% tropicamide) 2 times a day. The dexamethasone-gentamicin eyedrops were changed to 1% prednisolone acetate eyedrops after 5 days; these eyedrops were administered 5 times a day. The data were processed using personal computers and statistically analyzed with the nonparametric Wilcoxon-Mann-Whitney test.

Informed consent was obtained from all patients who participated in this study.

### Aqueous Flare After Phacoemulsification With Intracapsular Lens Implantation in Eyes With and Without Pseudoexfoliation Syndrome (PEX)

<table>
<thead>
<tr>
<th>Time of Postoperative Examination</th>
<th>Aqueous Flare, Photon Counts per Millisecond*</th>
<th>Eyes With PEX and Senile Cataract Only</th>
<th>( P )†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative Day</td>
<td></td>
<td>16.7 ± 5.9</td>
<td>.001</td>
</tr>
<tr>
<td>Day 1</td>
<td></td>
<td>42.2 ± 21.3</td>
<td>.07</td>
</tr>
<tr>
<td>Day 3</td>
<td></td>
<td>23.9 ± 9.4</td>
<td>.02</td>
</tr>
<tr>
<td>Day 5</td>
<td></td>
<td>21.2 ± 5.7</td>
<td>.003</td>
</tr>
</tbody>
</table>

*Data are given as mean ± SD. For both groups, \( n = 11 \).
†Significance of differences between the 2 groups (Mann-Whitney test).

By slitlamp examination, eyes with PEX appear to show more signs of intraocular inflammation with aqueous flare and cells. However, eyes with PEX tend to develop fibrinous reactions or posterior synechiae postoperatively more frequently. Eyes with manifest PEX frequently showed impairment of the BAB with protein leakage into the aqueous resulting in increased anterior chamber protein concentration and aqueous flare. Various investigators have provided evidence of a defective BAB in eyes with PEX. Vannas,3 using iris fluorescein angiography, observed marked leakage of fluorescein in eyes with PEX. Other authors also found much higher fluorophotometric concentrations in the anterior chamber of eyes with PEX vs control eyes. Similarly, inflammatory reactions following intraocular surgery seem to be more frequent and more intense in eyes with PEX. In this study, the tyndallometric results illustrate and quantify the alterations of the BAB in eyes with PEX follow-
ing cataract surgery. With the LFCM we found significantly increased overall protein concentrations in the anterior chamber of eyes with PEX on the third and fifth postoperative days. Flare values in eyes with PEX were roughly twice as high compared with normal eyes with senile cataract. The origin of the increased aqueous proteins in eyes with PEX appears to be mostly the iris vessels. Recent electron microscopic studies of iris vessels in eyes with PEX have revealed deposition of PEX material in the vessel walls, with consecutive disorganization of the normal vessel structure, loss of endothelial and adventitial cells, and thinning and fenestration of the endothelial lining.\textsuperscript{2,16,17} Light and electron microscopic immunohistochemical albumin staining localized the primary sites of protein leakage in the iris root and the anterior ciliary body by using immunoelectron microscopy.\textsuperscript{2,18} The impairment of the BAB often leads to inflammatory irritation and to the formation of fibrin in eyes with PEX. Hence, distinct intraocular inflammatory reactions after intraocular surgery, such as cataract surgery, are comprehensible. The barrier disturbances observed in these cases, as opposed to eyes with normal cataract, should, therefore, be taken into consideration in the treatment of patients with PEX.\textsuperscript{19-22} Another aspect to be considered is the fact that cataract surgery in eyes with PEX is associated with several additional risks and complications, including decreased pupillary dilation and melanin dispersion.

Many authors\textsuperscript{23-27} have previously reported the increased incidence of intraoperative and postoperative complications when extracapsular surgery was performed in eyes with PEX. The frequent occurrence of phacodonesis, as well as spontaneous and intraoperative lens dislocation, in eyes with PEX has been attributed to a weakness and fragility of the zonules.\textsuperscript{20,28} The tendency toward phacodonesis and even spontaneous dislocation or subluxation of the lens posteriorly into the vitreous\textsuperscript{29} is also known in eyes with PEX. A further risk factor to be considered is the fact that cataract surgery in eyes with PEX is associated with several additional risks and complications, including decreased pupillary dilation and melanin dispersion.

All these factors, as well as the impaired BAB, should be taken into account when planning and performing intraocular surgery in eyes with PEX and when observing these patients postoperatively.

**References**