Quantified Measurement of Intraocular Inflammation after Phacoemulsification Cataract Surgery

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Abstract

Aim: To evaluate the time course of blood-aqueous barrier (BAB) disturbance in the early period after small-incision cataract surgery.

Material and Methods: A prospective study in which 20 eyes of 20 patients with senile cataract had small-incision cataract surgery by phacoemulsification with intraocular lens implantation. Care was taken to minimize trauma to the uvea during surgery. Postoperative inflammation was measured by aqueous flare and cell count with a laser flare cell-meter. Postoperative measurements were performed hourly for the first 4 hours, every 2 hours until 16 hours, every 4 hours until 40 hours, and every 8 hours until 56 hours.

Results: The aqueous flare and cell count time course differed significantly among patients. The peak inflammatory response in most cases was 1 hour after surgery, with the response decreasing thereafter. The pattern of the time course was classified into subgroups defined by the presence and size of an initial spike immediately after surgery and the intensity of the subsequent inflammatory reaction. A slight increase in flare and cells was seen in the morning hours of the first postoperative day.

Conclusions: Acute BAB disturbance within the first 48 hours after small-incision cataract surgery showed high inter-patient variability. However, many differences were not detectable 1 day after.

Key Words: Phacoemulsification – Aqueous flare – Cataract – Blood aqueous barrier.

Introduction

The laser flare cell meter (Kowa FC 1000) allows quantification of aqueous protein and particulate matter by computer analysis of light scattered by a helium neon beam projected into the anterior chamber [1]. The technique is rapid and noninvasive and requires minimal patient cooperation.

Flare measurements have been shown to be accurate, to have a high reproducibility both in vitro and in vivo (8-12%) [2,3], and to correlate well with clinical grading of flare [4] as well as with anterior chamber protein levels in the normal eye and in eyes with mild damage to the blood aqueous.

Barrier [5]: The technique is more sensitive and accurate than anterior chamber fluorophotometry in the assessment of BAB function [6].

The aim of this study was to describe the early time course of BAB disturbance after small-incision cataract surgery in non selected, consecutive patients with senile cataract. As surgical trauma in cataract surgery includes direct trauma to the anterior uvea during surgery and the later chronic immune reaction of the uvea to the implanted foreign body, the intraocular lens (IOL).

A measure of the uveal reaction to surgical trauma is the breakdown of the blood-aqueous barrier (BAB) [7-9], which clinically presents as flare in the anterior chamber in numerous studies have quantified BAB breakdown after cataract surgery using a laser flare-cell meter (LFCM) [10,11]. Typically, flare is highest on the first postoperative day and then significantly declines until day 2; this is followed by a continuous decline over the next months until reaching nearly preoperative values [12].

Material and Methods

Laser Flare Cell Meter The Kowa laser flare cell meter (FC 1000) measures aqueous flare and cells by the light scattering of a helium neon laser beam within the anterior chamber. The instrument

Abbreviations:
BAB : Blood aqueous barrier.
LFCM : Laser flare cell meter.
IOL : Intraocular lens.
BSS : Balanced salt solution.
I/A : Irrigation aspiration.
Quantified Measurement of Intraocular Inflammation

consists of three main components: A helium neon laser slitlamp, a binocular microscope fitted with a photomultiplier tube, and a personal computer. The helium neon beam is projected into the anterior chamber and light scattered from within a sampling window (volume 0.075mm$^3$) is detected by the photomultiplier tube. This scattered light is analyzed to produce an aqueous flare value expressed in photons/ms and a cell count as a number/0.075mm$^3$. All values for flare and cells in this study are reported in these units. Each scan takes 1 second.

Twenty eyes of 20 patients with senile cataract enrolled for cataract surgery were included in this prospective study. All patients provided informed consent. Preoperative inclusion criteria included clear cornea, anterior chamber depth 3mm or more, open angle of anterior chamber, fully dilated pupil with application of dilating eye drops, hardness of cataract is nuclear grade two to three not more. Preoperative exclusion criteria included Uveitis, diabetes mellitus, immune disorders and patients on immunotherapy and steroids treatment a history of ocular surgery or trauma, and other relevant ocular disease. A visual acuity of 20/50 or worse preoperatively, the mean age of the patients was 72±11 years (range 52 to 86 years). Aqueous flare and cells were measured with a Kowa FC-1000 LFCM. A baseline preoperative measurement was taken for cells and flare just before surgery. IOL calculations was performed using IOL master. Surgery was performed in the morning (between 8:00 AM and 10:00 AM) in all cases. Postoperative aqueous flare and cell measurements were taken hourly for the first 4 hours, every 2 hours until 16 hours, every 4 hours until 40 hours, and every 8 hours until 56 hours. Additional measurements were done between 9:00 AM and 11:00 AM 3, 7, 14, and 28 days postoperatively. Measurements were performed by the same examiner. All surgeries were performed by the same surgeon. Preoperatively, the pupil was dilated with 1 drop each of tropicamide 0.5%, cyclopentolate 1%, and phenylephrine 2.5%. Anesthesia comprised 1 subconjunctival injection of a mixture of lidocaine 2%, bupivacaine 0.5%, and hyaluronidase.

After a temporal clear corneal incision was made, a capsulorhexis was performed using capsulorhexis forceps under viscoelastics with care not to touch the iris, hydrodissection were performed followed by phacoemulsification of the nucleus using the back chopping technique with low flow and low vacum (Alcon-Infinity). The cortical remnants were removed by irrigation/aspiration (I/A). One piece hydrophobic acrylic lens Alcon SN60WF implanted in capsular bag with injector care was taken to avoid iris touch during lens implantation and rotation. Balanced salt solution (BSS) was used for infusion and sodium hyaluronate 1% (Healon), as the viscoelastic agent. Care was taken to avoid iris touch during phacoemulsification and IOL implantation. To ensure complete removal of the viscoelastic material, the I/A tip was also positioned behind the IOL. Surgery was uneventful in all cases Postoperative treatment included Acular (Ketorolac tromethamin-Allergan), Vigamox (Moxifloxacin-Alcon), Predforte (prednisolon acetate 1%- Allergan). The drops were taken four times a day for four weeks for all patients. Gradual steroid withdrawal for all patients by the end of the four weeks. This study was performed in Magrabi hospital Saudi Arabia between 2012-2013.

Fig. (1): Median aqueous flare and cells (Left) and individual flare time course (Right) after 48 hours of surgery.
**Results**

The median baseline flare was 8.1 photons/ms ± 0.7, and the median cell count was, 0.0 ± 0.0 particles/0.075mm³ (Fig. 1). An initial flare peak one hour after surgery was followed by a steep decline until 6 hours after surgery. The lowest values within the first 48 hours after surgery were in the evening of the day of surgery. A slight increase was seen in the morning hours of the first postoperative day. The time course of cells in the anterior chamber was similar to that of the flare values; however, there was a slightly more pronounced increase in cells the morning after surgery. The median increase from 20 to 24 hours was 5.0 cells/0.075mm³. The time-course curves showed significant heterogeneity among the eyes in flare values (Fig. 1), which led to an attempt to classify the flare time course in the 20 eyes. The following flare classification was arbitrarily set: Below 30 photons/ms, low; above 30 photons/ms but below 50 photons/ms, moderate; above 50 photons/ms, high; steep rise followed by steep decline, spike. The absolute value reached by the spike defined it as low (<50 photon/ms) or high (≥50 photons/ms) Table (1).

<table>
<thead>
<tr>
<th>Classification</th>
<th>Flare (photons/ms)</th>
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<tr>
<td>Low response</td>
<td>&lt;30 photons</td>
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<tr>
<td>Moderate response</td>
<td>30-50 photons</td>
</tr>
<tr>
<td>High response</td>
<td>&gt;50 photons</td>
</tr>
<tr>
<td>Spike</td>
<td>Steep rise then steep decline</td>
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<th>Fig. (1): Aqueous flare time course plots of 19 patients.</th>
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<td>Top left : Mild response.</td>
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<tr>
<td>Top right : Low spike with mild response.</td>
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<tr>
<td>Bottom left : High spike with mild response.</td>
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<tr>
<td>Bottom right : High spike with a decline but moderately increased flare up to 48 hours after surgery (bottom right).</td>
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Nineteen of the 20 eyes could be classified (Fig. 2). Ten eyes had a low, or mild, response (top left), 3 eyes had a low spike followed by a mild response (top right), 3 eyes had a high spike with a significant and fast decline in flare followed by a mild response (bottom left), and 3 eyes had a high spike with a decline but moderately increased flare up to 48 hours after surgery (bottom right). The patient in the last group who had large peaks at 12, 20, and 32 hours had a pronounced decrease.
in flare each time following application of topical anti inflammatory drugs as defined in the study protocol. The time course of flare and cell counts in one patient were not well characterized by the flare classification. After a low initial spike and low flare values in the first 24 hours, the patient had a high spike (102 photons/ms) at 32 hours. This late spike followed a rise in cell count (57 cells/0.075mm²) that began 20 hours after surgery. Table 2).

Table (2): Groups of patients according to flare classification.

<table>
<thead>
<tr>
<th>Group</th>
<th>Classification</th>
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<tr>
<td>G1</td>
<td>(10 patients) Low response</td>
</tr>
<tr>
<td>G2</td>
<td>(3 patients) Low response-low spike</td>
</tr>
<tr>
<td>G3</td>
<td>(3 patients) Low response-high spike</td>
</tr>
<tr>
<td>G4</td>
<td>(3 patients) Moderate response-high spike</td>
</tr>
<tr>
<td>G5</td>
<td>(last patient) Out of classification</td>
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One patient in group 4 who was categorized as having a mild response because flare values never reached 30 photons/ms. However, the patient had a late rise in flare and cells, slightly delayed, pronounced rise in cell count. In all other cases, the cell count behaved similarly to the flare value. The acute postoperative flare time course did not predict the follow-up flare values after day 3 and up to 1 month. The median postoperative flare value at 3, 7, 14, and 28 days was 14.3, 11.7, 10.4, and 12.3 photon/ms, respectively, and the median cell count was, 3.6, 1.0, 2.0, and 0.0 cells/0.075 mm², respectively. The mean duration of phacoemulsification was 26±8 seconds and the mean duration of surgery, 10±3 minutes. In the study many variables which may affect the results were fixed like the hardness of cataract, the size of the pupil preoperatively, and proper irrigation aspiration there were no significant differences in phacoemulsification time, total surgical time, patients' age, iris pigmentation among the 4 flare classifications groups.

Discussion

Acute postoperative BAB disturbance differs significantly among patients. However, many inter individual differences were not detectable 1 to 2 days after surgery [13-15], as shown by the difference in the mild response group (Fig. 2, top left) and high spike-mild response group (Fig. 2, bottom left). The mean flare values after 24 hours in these 2 groups were essentially the same (16 photons/ms versus 15 photons/ms), even though the initial postoperative time course was significantly different.

On the other hand, a single measurement on the afternoon of the first postoperative day could be misleading in a patient with a late, high spike. The median measurements at 24 hours in all eyes in the study were similar to those in previous studies [13,14]. The slight dip in average flare values and cell count after the initial spike, between 6 hours and 20 hours after surgery, was probably the result of the increase that occurs in some patients in the morning after the day of surgery. This slight increase occurred in 12 of the 20 patients. However, it cannot be attributed to anti inflammatory drugs as patients received them 20 and 24 hours after surgery in the early morning [16]. Under physiological conditions, there is a circadian rhythm of protein concentration in the aqueous humor that shows higher levels at the beginning of the light phase in the morning than during the dark phase at night [17,18]. Another explanation could be that these patients begin their daily activities in the morning hours, when they get up and walk about. This might explain the more pronounced cell count rise 24 hours after surgery. The count shortly after surgery not only consists of inflammatory cells but also of particles set free during phacoemulsification and I/A that remain in the eye. These particles, as well as inflammatory cells, reside in the chamber angle and on the iris during sleep. During daily activities, the cells are distributed throughout the anterior chamber as a result of movement and turbulence [19]. The high initial flare spikes in 6 of our 20 patients were probably a result of trauma to the iris. This may be caused by contact of the phacoemulsification sleeve or I/A tip with the subincisional iris or by heat dissipation from the phacoemulsification tip. In this study, care was taken to minimize direct trauma to the uvea and there were no cases of phaco bite of the iris or phaco burn of the incision [6]. Slight fluctuations in anterior chamber depth during phacoemulsification can cause indirect “trauma”. However, there may be significant interpatient differences in the extent of flare and cell reaction to trauma. Another possible reason for the high initial spikes is intraoperative hypotony at or toward the end of surgery, causing a reflux of serum into the anterior chamber via the trabecular meshwork [20,21]. In a previous study of Tsurimaki, the authors measured flare and cells daily in the first 7 postoperative days in a group of 49 eyes: 14 (31 %) of the eyes developed a fibrinous iritis. In these patients there was an initial decline in flare in the first 2 days and then an increase from day 3 onwards to reach a peak on day 5 [22]. Nishi’ found such a response in 7-6% of eyes studied (45/596 eyes) and postulated that the production of collagen or its precursors as
a result of lens epithelial cell fibrous pseudometaplasia produced a foreign body response in the anterior chamber with production of fibrin [23].

In summary, acute BAB disturbance within the first 48 hours after small-incision cataract surgery differed significantly among patients.

References


