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Relationship cataract density and visual field damage

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ABSTRACT: In interpreting visual field results, two questions arise: a) what type of visual field damage is produced by cataract, and b) can the influence on the visual field somehow be predicted? To answer these questions, cataract density was quantified with the Opacity Lens Meter (OLM) 701, and visual field tests were done before and after IOL-implantation surgery with Octopus Program G1 in 58 eyes of 58 patients (mean age 71±8 years) with cataract but with no other detectable ocular diseases. The average improvement of mean damage (MD) after surgery was 5.4 dB, and that of D (20) (defect 20 on the Bebie Curve) was 5.7 dB. The improvement of the visual fields was, as expected, statistically highly significant ($p<0.0001$). The corrected loss variance (CLV), however, increased on the average only by 2.5 dB^2, which was not significant. The predictive value of the OLM reading for opacity-induced MD depends on the type of cataract. It is good for cortical and nuclear cataracts but poor for posterior subcapsular opacifications. The overall predictive value (R = 0.66) is, nevertheless, better than for preoperative visual acuity (R = -0.54). If OLM and visual acuity (VA) are considered together, the predictive value is slightly higher (R = 0.72). Thus, optical density influences on visual field performance can be substracted from general visual field results. (Eur J Ophthalmol 1993; 3: 1-5)

KEY WORDS: Cataract density, Visual field damage, Opacity lens meter, IOL-implantation, Cumulative defect curve (Bebie curve)

INTRODUCTION

Methods to detect and quantify visual field defects have been improved, but these results are still difficult for the clinician to interpret. Besides specific disease like glaucoma, many additional factors can influence the outcome of a perimetric test, such as pupil size (1), lens opacity (2-10), and fatigue (11). The majority of elderly glaucoma patients have lens opacities to some degree. Therefore, two questions arise: a) what type of visual field damage is produced by cataract, and b) can the influence on the visual field somehow be predicted?

The influence of cataract on the visual field is relatively diffuse, although not uniform (2). This influence is more pronounced in the central and pericentral area than in the midperiphery. In clinical practice, the influence of cataract on visual fields is normally judged subjectively, either by the extent of reduction in visual acuity (VA) or by judging the lens opacity at the slit-lamp.

A prerequisite for the establishment of a quantitative relationship between lens opacity and visual field damage is a method to quantify lens opacity reliably. Many methods have been described in the literature (12-24). Some are very sophisticated but also very time consuming. We reported earlier on the relationship between visual field changes and cataract density quantified with a Scheimpflug camera (2). In the present study we employed tool at hand, the Opacity Lens Meter 701 (25), with which lens-induced field changes can be substracted or differentiated from those due to alteration of the retina, optic nerve head (mainly glaucomatous), and visual pathway.

MATERIALS AND METHODS

The study included 58 eyes of 58 patients who came to our clinic for cataract extraction combined with intraocular lens implantation (IOL). Excluded from the study were patients with other eye diseases, such as glaucoma or senile macular degeneration (SMD), as well as patients with systemic diseases, such as diabetes or systemic hypertension. The age ranged from 44 to 84 years (mean 71 $\pm$ 8 years). The visual fields were examined three times for each patients: two weeks before surgery, one day before surgery, and three months after surgery. To avoid the influence of learning effects on visual field results, only the visual fields taken one day before and three months after surgery were included in the statistical analysis. The visual fields were tested with Program G1 on the Octopus automated perimeter 201 (26).

Cataract density was quantified with the Opacity Lens Meter 701 (OLM) (25) one day before surgery with a constant 4 mm pupil by adjusting the brightness of the light source directed at the patient's eye while comparing the pupil size with a graticule ring built into the observation system.

The cataracts were classified in four types: a) purely cortical (n=11) purely subcapsular (n=11), c) purely nuclear (n=11), and d) mixed (n=16). All mixed cataracts had posterior subcapsular opacification combined with either nuclear or cortical opacities. To analyze the influence of cataracts on the visual fields, cumulative defect curves (Bebie curves, 27) before and after surgery were plotted for each patient as well as for the total population.

To test the predictive value of the preoperative visual acuity, a correlation was calculated between visual acuity and change in mean damage (28) from preoperative to postoperative stages (Δ MD). To establish the relationship between lens opacity and visual field change, a correlation was calculated between preoperative lens opacity and Δ MD.

We included patients with otherwise healthy eyes. If a patient had larger scotomas, the influence on Δ MD would be expected to be less. Let us assume that a cataract would influence the threshold by an average of 4 dB. If such a case had hemianopsia, the influence on Δ MD would just be about 2 dB. To predict changes for such cases, we further correlated the preoperative lens opacity with the D (20) on the cumulative defect curve (Bebie curve, 27). In this cumulative defect curve, the defects are sorted by the program in ascending order, D(1), D(2), ... D(R)... D(59), where D(59) denotes the test location with the deepest defect. We correlated preoperative OLM readings with the preoperative D(20) value.

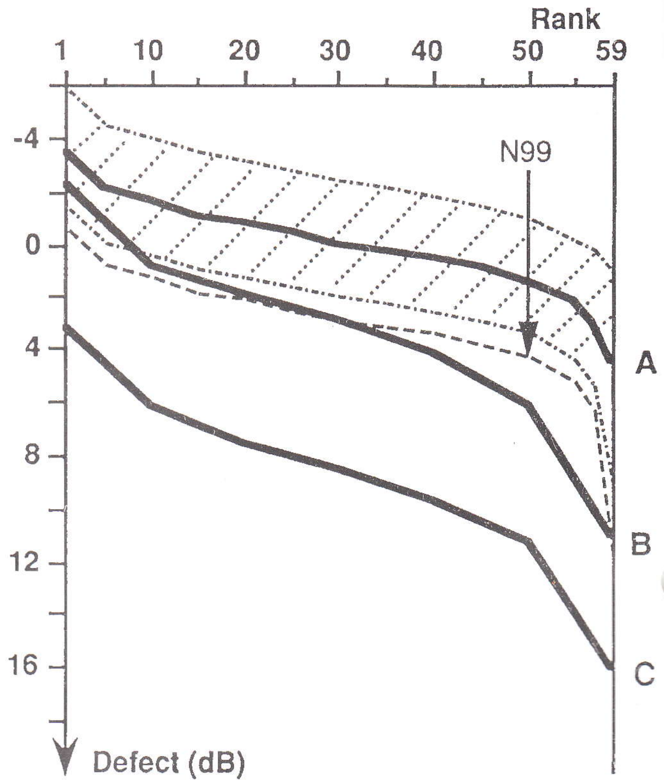

Fig. 1 - *Bebie-curves: A - Average of a normal population; B - Average after cataract operation; C - Average before surgery.*

RESULTS

The influence of cataracts on visual fields was analyzed with the cumulative defect curve (Bebie curve) and is represented in Figure 1. Curve A represents the average of a normal population, curve B, the average visual field after cataract operation and implantation of an IOL, and curve C, the visual field before surgery. This type of analysis provides the following information:

a) Cataract produces more or less diffuse damage. Curve C is nearly parallel to curve A.

b) Cataract extraction improved the visual field (there is a shift from curve C to curve B).

c) Although the visual field was improved by surgery, it was not totally normal (there was still a difference between curves B and A).

The average improvement of MD after surgery was 5.4 dB, and that of D(20) was 5.7 dB. The improvement of the visual fields was, as expected, statistically highly significant, ($p<0.0001$). The corrected loss variance (CLV), however, increased on the average only by 2.5 dB^2, which was not significant. All patients had postoperative visual acuity of 20/15 or better.

Next, we correlated the surgical improvement of the visual field (Δ MD) with the preoperative visual acuity (Fig. 2) as well as with the preoperative OLM reading (Fig. 3). There was a weak but nevertheless significant correlation with preoperative visual acuity (R = 0.54) and slightly better correlation with the preoperative lens opacity (R = 0.66). We then grouped the cataract patients and found the relationships listed in Table I. There was an excellent correlation for patients with cortical cataracts, a good one for patients with nuclear cataracts, and a very poor one for posterior subcapsular cataracts (pure or mixed). The relationship between Δ MD and opacity was very similar to that between Δ D(20) and opacity.

Next, we calculated a multiple regression with Δ MD as dependent variable and OLM reading and preoperative VA as independent variables. This resulted in a multiple R = 0.72 for the total population. The equation of the multiple regression was as follows:

Δ MD (dB) = [1.8dB] + [0.17 (OLM)] – [11.1 (preop. VA)].

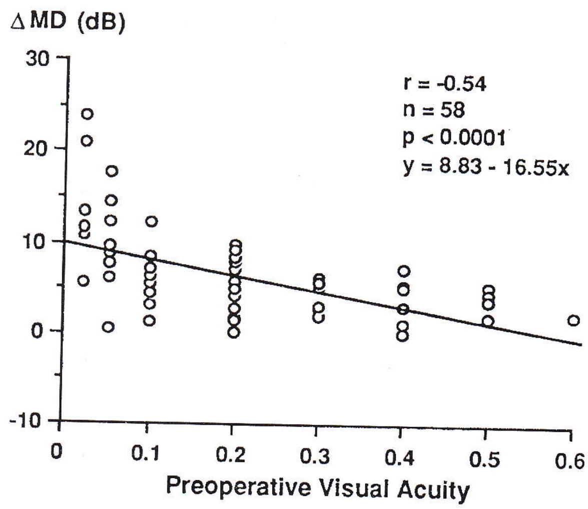

Fig. 2 - *Relationship between visual field improvement (Δ MD) and preoperative visual acuity.*

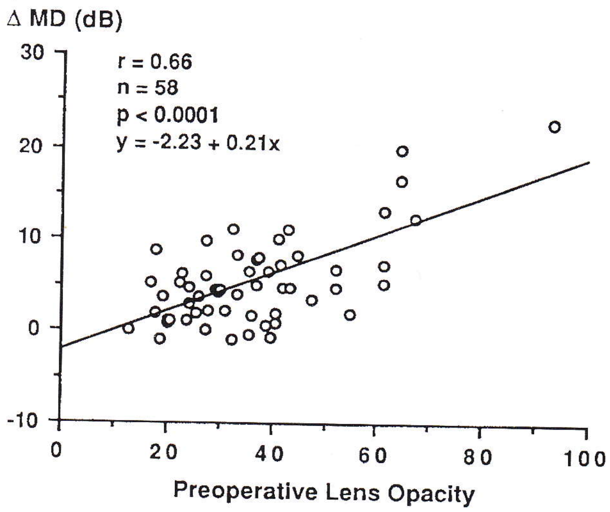

Fig. 3 - *Relationship between visual field improvement (Δ MD) and preoperative lens-opacity.*

TABLE I - CORRELATIONS BETWEEN VISUAL FIELD CHANGE AND PREOPERATIVE OLM-READING CORRESPONDING TO THE TYPE OF CATARACT

	n	Δ MD R	Δ MD P	Δ D(20) R	Δ D(20) P
Total population	58	0.66	<0.0001	0.67	<0.0001
cortical	11	0.98	<0.001	0.98	<0.001
nuclear	19	0.78	<0.001	0.74	<0.001
posterior subcapsular	11	0.23	N.S.	0.11	N.S.
mixed	16	0.05	N.S.	0.08	N.S.

N.S. = not significant

DISCUSSION

Cataracts virtually always produce some type of visual field defect. The present study confirms that the different types of lens opacities cause diffuse but not uniform depression. Three months after cataract surgery and IOL-implantation, the visual field was significantly improved but not normal (29-38). The type of depression remaining was similar to the preoperative defects, but less severe. This persistent deficit remains to be clarified. No major secondary cataract could be detected in our patients at the last examination.

The predictive value of the OLM reading to opacity-induced MD depends on the type of cataract. It is good for cortical and nuclear cataracts but poor for posterior subcapsular opacifications. The overall predictive value (R = 0.66) is nevertheless better than for preoperative VA (R = -0.54). We emphasize that biomicroscopically recognizable SMD had been excluded. If OLM and VA are considered together, the predictive value is slightly greater (R = 0.72). The fact that the intercept D(20) on the Bebie cumulative defect curve behaves very much the same as the MD in patients with no other eye diseases that might cause scotomas enables us to conclude that the established relationship between the overall sensitivity and the cataract density can also be applied to the plateau portion of the Bebie curve in patients with localized visual field defects, such as in glaucoma. Thus, optical density influence on visual field performance can, indeed, be substracted from general visual field results.

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