Eye (2011) 25, 1317–1321

www.nature.com/eye

CLINICAL STUDY

The influence of cortical, nuclear, subcortical posterior, and mixed cataract on the results of microperimetry

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Abstract

Purpose **Microperimetry is a useful instrument for evaluating sensitivity threshold due to retinal pathologies. The aim of the study is to assess the impact of different forms of cataract on microperimetry results.**
Methods **In a prospective design, patients were recruited for cataract surgery at the Department of Ophthalmology, Medical University of Vienna. Exclusion criteria were any other ophthalmic disease except cataract, that is, macular pathology. Using the Lens Opacities Classification System III classification, patients were classified into four groups: nuclear, cortical, subcapsular posterior, and mixed cataract. Then patients underwent microperimetry: results were analyzed for magnitude of retinal sensitivity loss and correlated to the forms and density of the cataract.**
Results **Mean density of cataract was LOCS 3.2–3.5 in the four groups. Differences were not statistically significant. The best-corrected visual acuity (BCVA) was LogMAR 0.5 ± 0.13 in nuclear, LogMAR 0.49 ± 0.21 in cortical, and LogMAR 0.58 ± 0.12 in mixed cataract patients, and significantly worse in patients with subcapsular posterior cataract (LogMAR 0.64 ± 0.12). Microperimetry shows a mean sensitivity of 11.4–12.6 dB without significant group differences. The BCVA is correlated with microperimetry in patients with nuclear and cortical cataract. Density of cataract is highly correlated with microperimetry results in all groups.**
Conclusion **The present study shows a good correlation of microperimetry results with the BCVA of patients with nuclear and cortical cataract. In patients with subcapsular posterior cataract, microperimetry results were better than estimated by BCVA. Density of cataract is highly correlated with macular sensitivity. A reduction of 1 dB in microperimetry per 1 posterior capsule opacification score increase can be estimated for these patients.**
Eye (2011) **25,** 1317–1321; doi:10.1038/eye.2011.156; published online 8 July 2011

Keywords: microperimetry; retinal sensitivity; cataract; density of cataract; PCO score; best corrected visual acuity

Introduction

Age-related macular degeneration (AMD) is the leading cause of irreversible visual loss in the Western world in individuals over 60 years old.[1–4] For these patients a precise evaluation of functional vision is necessary, both for estimation of the need for therapeutic and supportive interventions and the measurement of the outcome of such care. However, high-contrast visual acuity measurements alone have been shown to be a poor predictor of visual function.[5–7] One test of visual function that may help to better understand the characteristics of visual loss in these patients is microperimetry. The information given by this functional test provides valuable information about the location of the retinal sensitivity loss, its magnitude, and its potential influence on central fixation. The knowledge of sensitivity parameters and fixation in eyes with AMD, and their relationship to duration of disease may help to understand the mechanisms of visual loss in the disease, and provide a useful instrument for the early clinical assessment of visual deficits, and following recommendations concerning visual rehabilitation with low-vision aids.

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Received: 16 November 2010
Accepted in revised form: 9 May 2011
Published online: 8 July 2011

In the past, the scanning laser ophthalmoscope (SLO, Rodenstock, Germany) was the only commercially available microperimeter. But important software features, such as real time fundus tracking, were lacking. Additionally, the SLO is no longer for purchase.[8] A few years ago, an instrument called the Microperimeter 1 (MP1, Nidek Technologies, Padova, Italy) has been introduced. This instrument allows for fundus perimetry a larger field with automated full-threshold perimetry software, and stability of fixation is measured automatically by an integrated eye tracking system. Furthermore, real-color fundus image acquisition is possible with an overlay of the perimetric findings onto the fundus image.[8,9]

As AMD-patients are aged over 50 years, most of them present cataract as well. However, until now, data concerning the influence of cataract on the evaluation of microperimetry are lacking. As there are different types of cataract (nuclear, cortical, mixed nuclear-cortical, and subcapsular), these might influence the microperimtery differently.

In a previous study by Stifter *et al*[10] it was found that for some types of cataract (dense nuclear and subcapsular posterior) maximal reading speed is significantly reduced preoperatively, but in patients with nuclear–cortical cataract maximal reading speed remained unaffected.

We therefore believe that different types of cataract might also influence the microperimetric results, as the heterogeneity of different cataract types directly influences the retinal image and visual function. If cataract had an influence on these measures in patients with AMD, a worsening of the microperimetric results can result either from a progression of the AMD or from the cataract. However, not knowing the influence of the cataract, recommendations concerning therapy or visual rehabilitation with low-vision aids might not be the correct form of treatment.

The objective of the present study is to investigate the influence of different forms of cataract, predominantly cortical, nuclear, or subcapsular posterior, on the evaluation of microperimetry.

Materials and methods

A total of 85 patients were recruited consecutively from the Department of Ophthalmology, Medical University of Vienna, and were assigned to the study. Patients signed informed consent before the study, and then underwent standard preoperative examinations: refractive status was determined and best-corrected LogMAR visual acuity was evaluated using the ETDRS charts. Slit-lamp examination followed. After dilating the pupil, cataract was categorized and graded using the Lens Opacities Classification System (LOCS III)[11] with grading of nuclear opalescence and color (N; 0.1–6.9), cortical opacity (C; 0.1–5.9), and subcapsular opacity (P; 0.1–5.9). Patients were divided into four groups according to the type of the present cataract: group 1, Nuclear cataract (N); group 2, Cortical cataract (C); group 3, Subcapsular posterior cataract (S); and group 4, Mixed cataract (M). Patients were selected for the pure cataract group if only one parameter of the LOCS grading system was higher than LOCS 2. If an eye presented more than one parameter with LOCS grading 2 or more, the patient was selected for mixed cataract group. For analysis of cataract density, the parameter with the highest LOCS was used.

Microperimetry was carried out using the MP1. For assessing visual threshold, a 4-2-1 staircase strategy was used, a test grid with 41 stimulus locations covering an area of 10° was applied. The stimuli were projected on a white background with black illumination set to 1.27 cd/m^2 and a stimulus presentation time of 200 ms. A single cross of 3° was used as fixation target. For assessment of fixation, the fundus movements are tracked during examination, while the patient gazed at the fixation target. The autotracking system calculates horizontal and vertical shifts relative to a reference frame and draws a map of the patient's eye movements during the examination. The recorded fixation points are classified into three categories for fixation analysis (stable, relatively unstable, and unstable).[8]

Inclusion criteria were age over 50 years, age-related cataract, and normal fundus findings with no signs of age-related maculopathy. OCT scan was performed to assure absence of macular pathology.

Exclusion criteria were preoperative findings of amblyopia, glaucoma, proliferative diabetic retinopathy, macular edema, retinal detachment, uveitis, previous intraocular, or corneal surgery, including refractive surgery or corneal transplant.

History of other pathologies potentially affecting visual acuity, for example, macular degeneration, and other macular disorders, retinal vascular disease, was considered.

Corneal irregularities potentially affecting visual acuity, for example, keratoconous or corneal dystrophy, were also considered.

The patients gave written consent for participating in the study.

Microperimetry results were analyzed for the existence of retinal sensitivity loss, its magnitude, and its potential influence on central fixation, and were correlated to the forms and density of the cataract.

Statistical analysis

Statistical analysis was performed with SPSS 11.0 (SPSS Inc., Chicago, IL, USA). Data were analyzed for significance by ANOVA if showing normal distribution. For non-parametric data the Mann–Whitney *U* test was used. Correlations were tested by linear regression analysis and analysis of variance with Pearson's correlation test. *P*-values <0.05 were considered clinically significant.

Results

Patient population

Of the 85 patients, 5 were excluded, as microperimetry could not be performed owing to cognitive or physical handicap. The remaining 80 patients were divided into four groups according to their form of presenting cataract:

Group 1: Nuclear cataract (N) ($n=21$)
Group 2: Cortical cataract (C) ($n=21$)
Group 3: Subcapsular posterior cataract (S) ($n=18$)
Group 4: Mixed cataract (M) ($n=20$)

The mean patients' age was 73.5 ± 7.8 years. There were no statistically significant differences in patients' age within the four groups. Gender distribution was similar in all four groups with a total of 72.5% female patients and 27.5% male patients. No side preference among the four groups was seen ($P=0.16$–0.8). Table 1 shows mean patients' age, distribution of women/men and side distribution.

Functional outcome

The best-corrected visual acuity (BCVA) was similar in patients with nuclear (N), cortical (C), and mixed cataract (M) ($P=0.4$–0.8) but significantly worse in patients with subcapsular posterior cataract (S) ($P=0.009$). Microperimetry shows a mean sensitivity of 11.4–12.6 dB without significant group differences. Table 2 shows LOCS grade of cataract, BCVA and mean retinal sensitivity of the four groups.

Relationship between functional outcomes

The correlation of visual acuity to retinal sensitivity was high in patients with nuclear and cortical cataract: $r=0.75$ (N) and $r=0.71$ (C), respectively. No correlation could be found in patients with subcapsular posterior and mixed cataract ($r=0.2$ and $r=0.14$, respectively). Although patients with subcapsular cortical cataract had worse BCVA, macular sensitivity was not statistically significantly reduced in comparison with the other groups.

Stability of fixation is illustrated in Table 3. There were no statistically significant group differences. Instability of fixation is highly correlated with density of cataract in all groups ($r=0.73$) ($P=0.02$).

Pearson's correlation coefficients for comparison of density of cataract and macular sensitivity in all four groups are high ($r=0.75$), and statistically significant ($P=0.015$).

Discussion

The present study shows that the form and density of cataract highly influences macular sensitivity measure. Cataract patients of our study had a mean macular sensitivity of 12.0 ± 3.0 dB. The comparison to normal age-matched individuals with 14.7–15.5 dB[8,11,12] shows the distinct overall decrease of sensitivity in the absence of absolute scotoma (as our patients had a healthy macula). Previous studies have already discussed the influence of media opacities in SLO microperimetry.[13–15]

Table 1 Patient demographics

	Nuclear (N)	*Cortical (C)*	*Subcapsular posterior (S)*	*Mixed (M)*	*Total*
Number of eyes	21	21	18	20	80
Age (years) ± s.d.	75.8 ± 6.6	72.3 ± 6.8	70.0 ± 10.3	74.4 ± 7.4	73.5 ± 7.8
Sex (female/male)	15/6	14/7	13/5	15/5	57/23
Eye (right/left)	8/13	9/12	6/12	11/9	34/46

Table 2 Mean BCVA, mean LOCS grade, and mean macular sensitivity (dB) of the four groups and total

	Nuclear (N)	*Cortical (C)*	*Subcapsular posterior (S)*	*Mixed (M)*	*Total*
Mean BCVA (LogMar ± s.d.)	0.5 ± 0.13	0.49 ± 0.21	0.64 ± 0.12*	0.58 ± 0.12	0.55 ± 0.16
Mean LOCS grade	3.48 ± 0.56	3.46 ± 0.80	3.80 ± 1.07	3.80 ± 0.59	3.58 ± 0.76
Macular sensitivity (dB) Mean ± s.d.	12.19 ± 3.18	12.75 ± 2.05	11.8 ± 3.7	11.9 ± 3.9	12.0 ± 3.0

*$P<0.01$ indicates statistically significant result.

Table 3 Distribution of patients with stable, relatively unstable and unstable fixation

	Nuclear (N)	Cortical (C)	Subcapsular posterior (S)	Mixed (M)	Total
Stable	9	10	8	9	36
Relatively unstable	7	6	5	7	25
Unstable	5	5	5	4	19

However, for MP1 our study is the first to show the considerable influence of different types of cataract. The grading of the lens had a mean LOCS grade of 3.5–3.8 ± 0.6 in our patients. A double-masked quantification of cataract was not performed, and examiners were not blinded to microperimetry results. This might be a weakness of the present study, but the results show a high correlation of visual acuity to retinal sensitivity in patients with nuclear and cortical cataract. These data indicate well-performed LOCS grading. Additionally, a previous study of our study group[12] showed a good interobserver reliability for the mean threshold values in young and old people, indicating examiner-independent measurements.

As the correlation between LOCS score and microperimetry results was high, a reduction of 1 dB per 1 PCO score increase can be estimated for these patients.

In our study, patients show a relatively poor stability of fixation. This was already reported by Rohrschneider *et al*,[13] who also found a decrease of fixation stability with increasing age, even in normal subjects, evaluating SLO. The same was found by Weingessel *et al*.[12] As our data show that instability of fixation highly correlated with the density of cataract in all groups, we suggest that for patients with dense cataract the fixation cross should be increased to 5° instead of 3° to maintain stable fixation.

Roesel *et al*[16] and Kriechbaum *et al*[17] found that functional parameters like central visual acuity and fundus-related microperimetry are significantly related to morphologic parameters (eg, retinal thickness). Also, Varga *et al*[18] showed a good correlation of density of posterior capsule opacification (PCO) and PCO-induced decrease in BCVA and macular sensitivity.

This is in accordance to our study, where we found a high correlation of microperimetry results with the BCVA of patients with nuclear and cortical cataract, and high Pearson's correlation coefficients for comparison of density of cataract and macular sensitivity in all four groups.

These cataract data have to be taken into account when microperimetry is performed in the follow-up of patients with surgically treated macular pathology (eg, macular pucker and macular hole). Our study group[19] previously showed that visual distance acuity alone underestimated the functional benefit of surgery. However, the development of nuclear cataract in these patients is common. This has to be considered if follow-up of surgical results is scheduled for several months.

Previous studies regarding contrast sensitivity, glare and reading ability showed a more severe alteration in patients with subcapsular posterior cataract than in patients with nuclear and cortical cataract.[10,20,21] However, in our patients with subcapsular posterior cataract, microperimetry results were better than the results estimated by BCVA. This might be related to the inhomogenous opacities of subcapsular posterior cataract that often are very opaque centrally, but lighten up towards the mid-periphery.

In conclusion, our study shows that existence and specification of cataract highly influence central retinal sensitivity. Especially, in the evaluation of surgical macular results, these factors have to be kept in mind.

Summary

What was known before

- Microperimetry is a useful instrument for evaluating sensitivity threshold due to retinal pathologies.
- The influence of cataract is yet unknown.

What this study adds

- Density of cataract is highly correlated with macular sensitivity.
- A reduction of 1 dB in microperimetry per 1 PCO score increase can be estimated for these patients.

Conflict of interest

The authors declare no conflict of interest.

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