Br J Ophthalmol 2001;**85**:96–98

Predicting visual outcome after macular hole surgery using scanning laser ophthalmoscope microperimetry

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Abstract

***Aims*—To determine if postoperative visual outcome after successful macular hole surgery can be predicted with preoperative scanning laser ophthalmoscope (SLO) microperimetry.**

***Methods*—A prospective non-comparative study of 16 eyes in 15 patients examined before the surgery.**

***Results*—Visual outcome following macular hole surgery correlated with the "maximum parahole sensitivity", the highest intensity of stimulus to which the patient did not respond to any of the stimuli around the hole. Preoperative visual acuity, duration of the symptoms, size of the macular hole, and the "minimum parahole sensitivity", the lowest intensity to which the patient responded to all the stimuli around the hole, did not correlate significantly with postoperative visual acuity.**

***Conclusion*—Preoperative assessment of patients using SLO microperimetry is a good predictor of visual outcome after macular hole surgery.**

(*Br J Ophthalmol* 2001;**85**:96–98)

Idiopathic macular hole is a major cause of loss of central vision in the elderly. Although vitreous surgery has become a standard therapeutic modality,[1 2] a considerable number of patients do not show satisfactory improvement even if anatomical closure is achieved. Therefore, prediction of postoperative visual acuity is helpful to the patient contemplating such surgery.

Unlike conventional visual field testing, scanning laser ophthalmoscope (SLO) microperimetry allows the retinal sensitivity to be determined simultaneously with observation of the fundus. In the present study, we used SLO microperimetry to assess retinal function around the macular hole to see if this is useful in predicting postoperative visual acuity.

Patients and methods

Fifteen consecutive patients (five men and 10 women) who underwent surgery for idiopathic full thickness macular holes without other retinal disorders or previous ocular surgery were included in this study. All patients underwent best corrected visual acuity testing at baseline and 1 year after the surgery. Slit lamp biomicroscopy, funduscopy, fundus biomicroscopic examinations, and fundus photography were done. Preoperative Gass classification was stage 2, three eyes; stage 3, 10 eyes; stage 4, three eyes. The maximum diameter of the macular hole was calculated from fundus photographs.[3]

A standard three port vitrectomy was performed. Phacoemulsification and aspiration, followed by intraocular lens implantation,

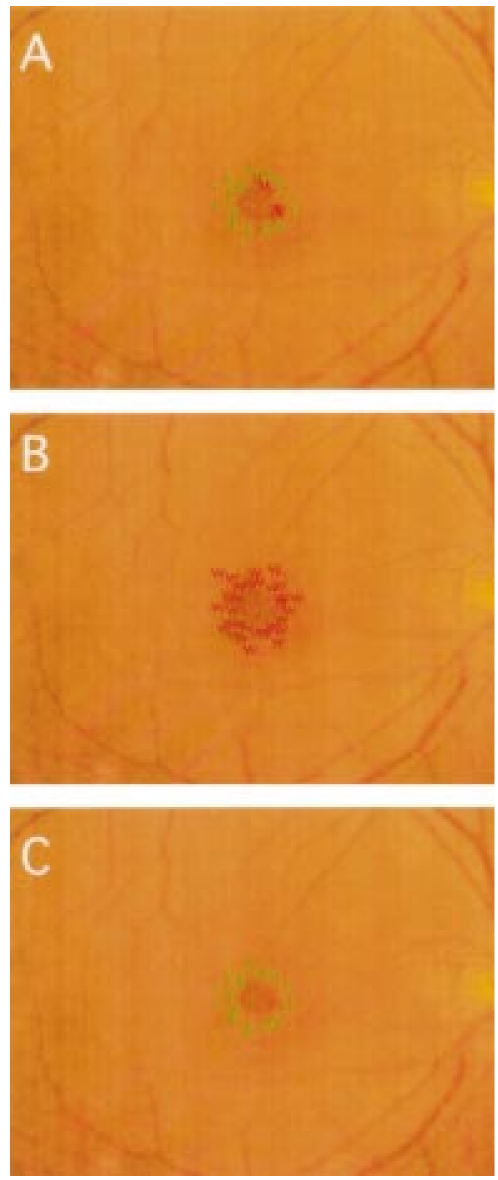

Figure 1 The actual procedure of SLO microperimetry to evaluate macular holes. (A) When the stimuli were presented at 20 dB, two different coloured spots that the patient recognised (green) and did not recognise (red) are shown. (B) The intensity was decreased until the patient did not recognise all stimuli around the macular hole, which was defined as the "maximum parahole sensitivity" (22 dB). (C) Thereafter, intensity was increased until the patient recognised all stimuli around the macular hole, which was defined as the "minimum parahole sensitivity" (17 dB).

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Accepted for publication 16 June 2000

Table 1 Patient data

Case/age (years)/sex	*Stage of hole*	*Duration of symptoms (months)*	*Preoperative VA*	*Diameter of hole (μm)*	*Minimum parahole sensitivity (dB)*	*Maximum parahole sensitivity (dB)*	*Postoperative VA*	*Comment*
1/52/M	3	1.5	20/400	425	15	28	20/25	PEA + IOL
2/48/F	3	1	20/125	500	18	25	20/60	
3/66/M	3	1	20/125	475	23	26	20/40	PEA + IOL
4/56/F	2	1	20/100	400	8	27	20/40	PEA + IOL
5/72/F	3	8	20/200	625	14	25	20/100	PEA + IOL
6/67/M	3	6	20/200	500	23	25	20/20	PEA + IOL
7/73/M	4	5	20/125	400	22	26	20/40	PEA + IOL, ERM
8/65/F	2	2	20/125	375	24	25	20/25	PEA + IOL
9/80/F	3	2	20/400	500	8	20	20/400	PEA + IOL
10/62/F	3	8	20/400	500	14	23	20/100	PEA + IOL
11/56/M	3	3	20/400	500	16	26	20/25	PEA + IOL
12/67/F	4	20	20/100	1000	20	25	20/100	PEA + IOL, ERM
12/67/F	4	13	20/100	750	20	24	20/100	PEA + IOL, ERM
13/55/F	3	1	20/200	525	11	21	20/60	PEA + IOL
14/55/F	3	4	20/100	400	15	27	20/25	PEA + IOL
15/65/F	3	4	20/200	500	17	23	20/40	PEA + IOL, ERM

VA = visual acuity; PEA+ IOL, =phacoemulsification aspiration and intraocular lens implantation; ERM = peeling of the epiretinal membrane.

was also performed simultaneously on all but one patient. The posterior hyaloid was stripped from the retina and optic nerve. If an epiretinal membrane were present around the hole, this was removed. After removal of the vitreous gel, air was replaced by a mixture of air and SF_6 (25%). Patients were asked to remain face down for about 2 weeks.

All patients underwent macular microperimetry with a confocal SLO (SLO-101, Rodenstock, Danbury, CT, USA) by the same technician. Tests were performed with 40° fields on all patients. Flashing test stimuli measuring 6 × 6 pixels (24 × 24 minutes of arc) were presented for 100 ms by a helium-neon laser; background intensity was 10 cd/m^2. The stimuli were positioned on the retina around the macular hole (Fig 1). The first stimuli were presented at 15–20 dB. If the patient identified all stimuli around the hole or if none of the stimuli were seen, the intensity was adjusted until some stimuli were seen (Fig 1A). The intensity was then decreased gradually until the patient did not see any stimuli around the hole, which was defined as the "maximum parahole sensitivity" (Fig 1B). After that, the intensity was increased until the patient identified all stimuli around the hole, which was defined as "minimum parahole sensitivity" (Fig 1C). During the procedure, four paracentral fixation crosses (36 × 36 min of arc) were presented. The patient was asked to gaze at the central point among the four crosses. Eye movements were compensated by manual fundus tracking using a reference point on the retina, such as a vascular crossing. The test was repeated three times and the average value was used. When several inconsistent responses appeared, the test was excluded and re-examination was performed within 1 week.

To evaluate the correlation between the four preoperative variables (visual acuity, duration of symptoms, size of the macular hole, and minimum and maximum parahole sensitivities) and postoperative visual acuity for all patients, multiple regression analysis was performed. Visual acuity measurements were converted to the logMAR scale.[4]

Table 2 Multiple regression analysis of preoperative variables with postoperative visual acuity

Variable	*Coefficient*	*Probability*
Preoperative visual acuity	0.142	0.522
Duration of symptom	0.538	0.196
Diameter of hole	0.318	0.615
"Maximum parahole sensitivity"	0.478	0.048
"Minimum parahole sensitivity"	0.304	0.148

Results

Characteristics of the patients are shown in Table 1. Sixteen eyes of 15 patients whose ages ranged between 48 and 80 years (mean 64.4 years) were included in this study. The macular hole was closed after the surgery in all eyes studied. Mean best corrected preoperative visual acuity was 20/160, while postoperative visual acuity was 20/60. Ten (62.5%) of the 16 eyes achieved best corrected postoperative visual acuity of 20/60 or better, and eight (50%) of the 16 eyes achieved 20/40 or better. Eleven (68.8%) of the 16 eyes achieved at least two lines of visual improvement.

Scanning laser ophthalmoscope microperimetry was done 2–4 days before surgery. No patients had media opacities, such as dense cataract or an opacified posterior capsule, that prevented adequate imaging with the SLO. The "minimum parahole sensitivities" ranged between 8 and 24 dB (mean 16.9 (SD 5.2) dB), and there were considerable intercase variations. The maximum parahole sensitivities were greater than the minimum sensitivities and less variable, ranging from 20 to 27 dB (24.5 (2.0) dB).

Using multiple regression analysis, the preoperative maximum parahole sensitivity was more highly correlated with postoperative visual acuity than any other variables studied (Table 2).

Discussion

Although anatomical closure of macular holes is obtained in an acceptable percentage of patients, functional improvement in visual acuity, resolution of scotoma, and improvement in binocular vision remain unsatisfactory.[5–8] Therefore, prediction of postoperative visual acuity is of critical importance for patients considering macular hole surgery.

Previous studies showed that presurgical interferometry and potential acuity meter were useful in predicting postoperative visual acuity.[9] Also, maximal macular hole diameter[3] or the size of hole[10] are known to correlate with postoperative visual acuity. Histopathological studies after successful macular hole surgery showed that there were residual defects of photoreceptors extending out about 50 μm or 16 μm defect in the external limiting membrane.[11 12] Optical coherence tomography (OCT) studies before and after pars plana vitrectomy also showed re-approximation of the macular hole edges after surgery.[13] These studies indicate that a defect remains even after successful macular hole surgery. In accordance with this view, Smiddy *et al*[9] examined six cases of macular hole before and after surgery by SLO microperimetry. In their results, absolute scotoma was surrounded by a relative scotoma in all cases before surgery; postoperatively, the absolute scotoma was undetectable and the relative scotoma was smaller. The data suggested that the absolute scotoma corresponds with the defect in the retina, and the relative scotoma with retinal detachment. Therefore, detailed examination of residual function of the retinal cuff that surrounds the macula may be important in predicting visual improvement after surgery.

Our results show that the preoperative maximum parahole sensitivity was correlated significantly with visual outcome, whereas preoperative visual acuity, duration of symptoms, size of the macular hole, and the minimum parahole sensitivity were not significantly correlated (Table 2). Several factors may explain why the maximum parahole sensitivity provides better prognostic information than does preoperative visual acuity. The most likely explanation is that the tiny laser beam is not markedly scattered as it passes through thickened or detached retina whereas the light is more widely scattered. The laser beam is more correctly projected at the intended area of photoreceptors under observation. We found that retinal sensitivities around the macular hole were usually unevenly distributed. In some cases, we found small areas of good retinal sensitivities around the hole. Visual outcome after macular hole surgery may depend on the sensitivity of such a small area around the hole. If that is the case, it would explain why the maximum parahole sensitivity is a better prognostic indicator than the minimum parahole sensitivity.

In this study, unlike previous reports, the size of the macular hole did not correlated well with postoperative visual acuity, although the small number of patients used in the present study may explain this discrepancy.

In conclusion, this preliminary study has shown that postoperative visual acuity after macular hole surgery can be effectively predicted by using the SLO microperimetry, making this technique helpful to both surgeons and patients who are considering macular hole surgery.

We thank William J Feuer, MS, Bascom Palmer Eye Institute, Miami, Florida, for his statistical analyses.

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