Visual performance 3 years after successful macular hole surgery

S Richter-Mueksch,¹ S Sacu,¹ E Osarovsky-Sasin,¹ E Stifter,¹ C Kiss,¹ M Velikay-Parel¹,²

ABSTRACT
Background/aims: To evaluate the visual performance of patients with successful macular hole surgery with a minimum follow-up of 3 years. Results were compared with the performance of the healthy fellow eyes.

Methods: 15 patients were studied. The healthy fellow eyes of the patients (13 eyes) served as a control group. Age, gender and best-corrected logMAR visual acuity were recorded. Reading acuity (in log reading acuity determination [RAD], reading equivalent of logMAR) and speed were tested monocularly. Scotoma size was measured with SLO perimetry, and hole closure was confirmed with an OCT scan.

Results: The mean distance visual acuity of the operated eyes (logMAR 0.32 (SD 0.21)) was significantly lower than that of the healthy fellow eyes (logMAR 0.05 (0.17)), but significantly higher than preoperatively (logMAR 0.71 (0.32)). The mean reading acuity was logRAD 0.47 (0.25) for the operated eyes (= 77.9% of logMAR), and statistically significantly higher (logRAD 0.16 (0.16)) for the fellow eyes (= 89.4% of logMAR). The mean maximum reading speeds were comparable for the operated eyes (168.3 (23.1) words per minute (wpm)) and the fellow eyes (178.7 (26.1) wpm) (p = 0.3). Within logRAD 1.3 and 0.5, the mean reading speeds of the two groups were comparable, but critical print size (CPS) for the operated group (logRAD 0.7 (0.2)) was significantly worse than those for the fellow eyes (logRAD 0.4 (0.2)). The SLO analysis showed absence of absolute scotoma in 12 eyes.

Conclusion: Distance and reading acuity showed remaining deficits compared with the healthy fellow eyes; however, mean maximum reading speeds of the operated eyes achieved results comparable with healthy eyes. The results show a long-term benefit in the visual function of eyes with closed macular holes.

Since 1991 the pars plana vitrectomy is used for treatment of macular holes. The success rate of anatomical hole closure is about 80–100%.³⁴ Accordingly, most previous studies⁵–⁷ have reported a statistically significant improvement in distance visual acuity after surgery. Although in only about 50% per cent of patients⁸–⁹ a visual improvement of two or more Snellen lines has been documented, an evaluation of the patients’ vision-related quality of life⁹ shown that 67–80% of patients gave a positive response to specific questions about vision-related quality of life.

Considering the major postoperative disruption of patients’ daily activities from posturing requirements and the possible occurrence of intra- and postoperative complications, which may compromise even further the final visual results, a possible bias in patients’ postoperative responses concerning the visual benefit might result from a desire to please the surgeon or to justify the pain and inconvenience of the procedure.

Still, analyses of the patients’ satisfaction suggest that the visual outcome measures presently used may underestimate the functional benefit of surgery and may fail to provide important information regarding aspects of visual function that may be vital for patients’ daily performance and well-being.

Macular function is the limiting factor for the two most important aspects of reading: reading acuity and reading speed. Therefore, evaluation of reading ability in patients with macular holes should provide a clearer image of their visual function. In particular, maximum reading speed¹¹ ¹² has been shown to be a direct expression of the macular function. Thus, a more detailed analysis of the visual function could give more insight to the process of recovery after surgery.

Previous studies have shown that in patients with an absolute central scotoma, reading speed is significantly reduced.¹¹–¹⁶ Additionally, Ergun and coworkers¹⁷ found a correlation between reading speed and the size of the absolute scotoma but no correlation with the relative scotoma for AMD patients. Hence, it seems obvious that the size of the absolute scotoma in macular hole patients should have an influence on the reading performance as well.

However, little attention has been given to the functional visual performance of patients with a successfully treated macular hole after a long follow-up, and no data concerning long-term expectancies for reading performance in patients with successful macular hole surgery are available.

The aim of the study was to assess the patients’ long-term functional benefit from macular hole surgery. We therefore tested the reading ability with respect to reading acuity, reading speed based on print size and critical print size of patients with successful macular hole surgery performed at least 3 years before. Additionally, we evaluated the size of absolute scotoma using microperimetry and correlated the results with the reading measurements.

MATERIALS AND METHODS
This observational study examined patients who had undergone macular hole surgery at least 3 years before. Patients were selected for this study series only if the surgery had induced anatomical closure of the macular hole. Anatomical success was defined through ophthalmoscopic and OCT examinations as the complete disappearance of the hole and the flattening of the entire circumference.
of the macular hole against the retinal pigment epithelium. This end point corresponds with the definition of the “flat/closed” status described by Tornambe et al.\(^{18}\)

Preoperatively, the eyes presented a macular hole stage 3 or 4. Only patients with idiopathic macular holes were included.

Exclusion criteria were eyes with traumatic or retinal vascular aetiologies; patients with additional ocular morbidity, such as glaucoma or diabetic retinopathy, cataract or other media opacities were excluded from the study as well as patients with surgically induced complications. Cataract was categorized and graded using the Lens Opacities Classification System (LOCS III).\(^{19}\) The presence of cataract was defined as greater than grade 1 nuclear opalescence, colour or cortical opacity, and any sign of subcapsular opacity.

Under these strict inclusion criteria, 15 eyes were included in the study (13 of these eyes were pseudophakic, and two were phakic).

**Operation methods**

The surgical procedure used standard three-port pars plana vitrectomy and complete removal of the vitreus and ILM peeling. Thereafter fluid–air (SF6) exchange was performed. Following the operation, a rigorous face-down positioning for 1 week was required.

The healthy fellow eyes served as a control group. This group consisted of 13 eyes. Two eyes were excluded due to additional pathologies: one eye had an open macular hole after unsuccessful surgery, and the other had a dense cataract.

For statistical analysis, preoperative distance visual acuity of the operated eyes was converted into logMAR visual acuity.

Age, gender and postoperative best-corrected logMAR visual acuity (Early Treatment Diabetic Retinopathy (ETDRS) charts) in the eyes were recorded.

Reading ability was tested with the Radner Reading charts (RR charts).\(^{20,21}\) The RR charts consist of 24 sentences (two sets of each 12 sentences) that have been developed to be highly comparable in terms of grammatical difficulty as well as number, length and position of words. The print sizes of the sentences decrease in 0.1 log units like the letters in the ETDRS number, length and position of words. The print sizes of the sentences decrease in 0.1 log units like the letters in the ETDRS charts.

The patients read with best distance correction with an addition of +3 dioptres at a reading distance of 30 cm. Tests were performed monocularly. The luminance was 80–90 cd/m\(^2\). The reading distance was determined with a ruler and maintained by constantly verifying the distance during the examination. The sentences were covered with a piece of paper, and the volunteers were asked to uncover them sentence by sentence and then read them aloud as quickly and accurately as possible. The patients were instructed to read each sentence to the end before correcting any reading errors. Reading length of each sentence was measured with a stopwatch. Reading speed in words per minute (wpm) was calculated on the basis of the number of words in a sentence (14 words) and the time needed to read the sentence (14 words ×60 min divided by the reading time).

Reading acuity was expressed in terms of logRAD. The critical print size (CPS) was set at the smallest print size that could be read with a reading speed of at least 90% of the maximal reading speed.

Microperimetry was performed using the scotometry software program (version 2.01) of the scanning laser ophthalmoscope (Rodenstock, Weco Optik Maschinen GmbH D-40231, Duesseldorf, Germany) Stimuli were projected into the macula with maximal intensity. Scotoma size was measured manually based on the planimetry results using the Rodenstock OphthaShare 2.5 software delineating the border at which the stimulus was not seen.

OCT was performed using the Zeiss model Humphrey 2000. The patients’ pupil was fully dilated, and the fundus was scanned with a probe beam positioned so that the horizontal and vertical scans crossed the central fovea.

Statistical analyses were performed using SPSS for Windows, Version 8.0 (SPSS, Chicago). Group differences between the three groups with respect to the reading speed were analysed for significance with the t test. For non-parametric data, the Mann–Whitney U test was used. For the calculation of the correlation between scotoma size and reading acuity and speed, the Pearson correlation test for bivariate parameters was used. The cut-off level for statistical significance was set at p<0.05 (two-tailed).

**RESULTS**

**Patient population**

The average patient age was 73.31 (SD 7.2) years with a range of 62–83 years. Ten patients were women, and five were men.

**Visual acuity and reading acuity**

The best-corrected distance visual acuity was logMAR 0.32 (0.21) (range logMAR −0.1 to 0.58) for the operated eyes and logMAR 0.05 (0.17) (range logMAR −0.2 to 0.2) for the healthy fellow eye-group. Preoperatively, the eyes showed a distance acuity of logMAR 0.71 (0.52) (range logMAR 0.56 to 1.0). The difference between the pre- and postoperative measurement of the study eyes was statistically significant (p<0.001). A statistical significance was also found between the fellow eyes and the postoperative visual acuity of the study eyes (p<0.001).

The reading acuity was logRAD 0.47 (0.25) (range logRAD 0.1 to 0.8) for the operated eyes (\(= 77.9\%\) of logMAR) and logRAD 0.16 (0.16) (range logRAD 0.0 to 0.5) in the fellow eyes (\(= 89.4\%\) of logMAR). For both groups, a high correlation between logMAR and logRAD was noted (p<0.001, r = 0.8). The reading acuity of the operated eyes was statistically significantly lower than that of the healthy fellow eyes (p = 0.002) (fig 1).

**Reading speed**

The mean maximum reading speed was 168.3 (38.1) wpm for the operated eyes and 185.0 (55.4) wpm for the fellow eyes; the difference was not statistically significant (p = 0.3). The same applies for the mean reading speed: no significant difference was found between the study eyes (119.6 (34.1) wpm) and the

![Figure 1](http://example.com/figure1.png)
patients (p = 0.045/r = 0.65). but reading speed was statistically significant reduced in these correlation between the reading values and absolute scotoma. The further off-centre the fixation is located, the more reduces the maximum reading speed in patients with central visual improvement after macular hole surgery. However, if this deficit in reading acuity remain. In addition, the results of the reading performance show continued long after cataract surgery. In our study, comparing visual acuity years after macular hole surgery, which also visual function is at least as important as commonly documented measures of successful intervention in the current literature, which fails to provide any information regarding substantial improvement in their quality of life. Our results demonstrate for patients 3 years after macular hole surgery remaining deficits in reading acuity, but a normalisation of maximal reading speed and therefore a long-term functional benefit of surgery.

ACKNOWLEDGEMENTS: We would like to thank W Radner, for having invented the RR charts.

COMPETING INTERESTS: None.

REFERENCES


Visual performance 3 years after successful macular hole surgery

S Richter-Mueksch, S Sacu, E Osarovsky-Sasin, E Stifter, C Kiss and M Velikay-Parel

Br J Ophthalmol 2009 93: 660-663 originally published online December 9, 2008
doi: 10.1136/bjo.2008.154963

Updated information and services can be found at:
http://bjo.bmj.com/content/93/5/660

These include:

References
This article cites 30 articles, 3 of which you can access for free at:
http://bjo.bmj.com/content/93/5/660#BIBL

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections

- Retina (1600)
- Neurology (1346)
- Vision (622)
- Ophthalmologic surgical procedures (1219)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/