Quantification of Metamorphopsia in Patients with Epiretinal Membranes

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PURPOSE. To quantify the degree of metamorphopsia in patients with idiopathic epiretinal membranes (ERMs), by use of a new metamorphopsia chart (M-CHARTS) developed by the authors.

METHODS. These M-CHARTS had 19 dotted lines with dot intervals of between 0.2° (fine) and 2.0° (coarse) visual angles. As the dot intervals were changed from fine to coarse, a decrease in the severity of metamorphopsia was noted. In this study, the minimum visual angle of the dotted lines needed to cause the metamorphopsia to disappear was measured in 51 eyes of 51 patients with ERM. The metamorphopsia scores were compared with the stages of ERM classified by scanning laser ophthalmoscope (SLO) images.

RESULTS. In patients with ERM, the metamorphopsia score increased depending on the severity of membrane proliferation classified by SLO images. The scores obtained from the horizontal dotted lines were larger than those of the vertical lines in advanced stages of ERM.

CONCLUSIONS. M-CHARTS provide a very simple and useful method for evaluating the severity of metamorphopsia in patients with ERM. (Invest Ophthalmol Vis Sci. 2003;44: 4012–4016) DOI:10.1167/iovs.03-0117

In cases of macula disease, metamorphopsia is one of the most important symptoms for evaluating visual functions. Amsler charts are widely used for detecting metamorphopsia. However it is difficult to evaluate the degree of metamorphopsia quantitatively using Amsler charts. Previous investigators have tried to evaluate the quantification of metamorphopsia, micropsia, and macropsia. However, these methods used complicated procedures and could not be applied for clinical use. In 1989, we reported a method for quantification of metamorphopsia using a computer display and our own program. In this method, two circles were shown on the fixation point and in the central 10° visual field, respectively. The size of these circles was made to match using the computer mouse buttons to quantify the metamorphopsia. Using this method, it was possible to quantify the metamorphopsia in the cases of serious metamorphopsia. However, fine metamorphopsia near the fixation point was undetectable with this method.

In 1999, we developed a new metamorphopsia chart (M-CHARTS; Inami) for evaluating the degree of metamorphopsia. In this study, we tried to quantify the degree of metamorphopsia in patients with idiopathic epiretinal membrane (ERM) using this new metamorphopsia chart.

METHODS

Subjects

Forty-seven eyes of 27 normal subjects (29 women, mean age, 56.4 years; range, 23–78) and 51 eyes of 51 patients with ERM (31 women, mean age, 64.3 years; range, 44–80) were studied. Each subject underwent a complete ophthalmic examination, which included best corrected visual acuity, slit lamp biomicroscopy, applanation tonometry, dilated funduscopy, fundus photography and scanning laser ophthalmoscopy (SLO, Rodenstock). The inclusion criteria for normal subjects were as follows: corrected visual acuity of more than 0.1, pupil diameter of more than 3.0 mm, intraocular pressure of less than 21 mm Hg, no ocular and systemic diseases that were likely to affect their visual functions. One randomly selected eye was examined. The inclusion criteria for ERM patients were as follows: corrected visual acuity of more than 0.1, pupil diameter of more than 3.0 mm, intraocular pressure of less than 21 mm Hg, and no systemic diseases that were likely to affect their visual functions. If ERMs were observed in both eyes, one randomly selected eye was examined. Informed consent was obtained from all normal subjects and ERM patients. All experiments were performed in accordance with the Declaration of Helsinki for research involving human subjects.

Fundus Examination

Dilated funduscopy, fundus photography and SLO images with an argon blue laser beam were used for detection of ERMs. We classified the severities of the membrane proliferation by SLO images and fundus photographs according to the Nakajima’s classification: stage 1: water silk reflex and transparent membrane; stage 2: vascular tortuosity of muscular vessels and transparent membrane; stage 3, opaque or dense membranes.

Quantification of Metamorphopsia

In patients with metamorphopsia, a straight line projected onto the retina is recognized as an irregular or curved line. When a dotted line is used and the dot interval changes from fine to coarse, metamorphopsia decreases and finally disappears. Figure 1 showed the simulation of the metamorphopsia on a straight line and two different kinds of dotted lines. Originally, these three lines were completely straight. The same degrees of computer generated random distortion to the horizontal direction were added to all three lines. In this simulation, it is clear that the dot interval changes from fine to coarse, the distortion of lines decreases and finally disappears. Based on this phenomenon, we developed a new chart with 19 kinds of dotted lines with dot intervals of between 0.2° to 2.0° visual angles (Fig. 2). The type (I) dotted line was designed for patients with central scotoma such as a macular hole. The minimum visual angle of the dotted line needed to cause the metamorphopsia to disappear was measured. At first, a vertical straight
line (0°) on the first page of M-CHARTS is shown to patients, and the patients fixated on a fixation point on the center of the line. If the patients recognized the straight line as straight, the metamorphopsia score is 0. If the patients recognize the straight line as an irregular or curved line, then the following pages of M-CHARTS that have the dotted lines where interval changes from fine to coarse are shown to the patients one after another (Fig. 3). When the patients recognized a dot line as straight, its visual angle is considered as their metamorphopsia score. Also, the M-CHARTS are rotated 90° and the same test is performed using horizontal lines. In this study, the examinations were repeated three times for each subject to evaluate the reproducibility of the test. The patient’s fundus information was completely masked from the examiner during the examination.

RESULTS

The case was a 64-year-old woman with ERM in her right eye. Her right corrected vision was 0.4. Figure 4 shows an SLO image of his right eye. The fine metamorphopsia was detected by Amsler charts of her right eye (Fig. 5). The metamorphopsia was also detected by the horizontal line on the M-CHARTS. However, the dot interval changed from “fine” to “coarse,” and there was a noted decrease in the severity of metamorphopsia. When a dotted line of which the dot interval was a 0.6° visual angle was used, her metamorphopsia completely disappeared (Fig. 6). Therefore, her metamorphopsia score with the horizontal line was determined to be 0.6. The vertical lines of the M-CHARTS was also tested in a similar way. The metamorphopsia score with the vertical line was 0.4.

The intraindividual variation of the metamorphopsia score was within one line (±0.1 score) in all subjects with ERM. The metamorphopsia scores were 0 in all normal subjects. The sensitivity of this method for detecting metamorphopsia was 97.3% and specificity was 100% using the result of the Amsler charts as a standard.

The stages of the ERM patients were as follow; 12 eyes with stage 1 (mean age, 68.08 ± 9.0 years), 13 eyes of stage 2 (mean age, 67.5 ± 6.2 years) and 26 eyes of stage 3 (mean age, 61.0 ± 7.5 years). Figure 7 shows the relationship...
between the metamorphopsia score and the stages of ERM. Metamorphopsia scores obtained from horizontal lines were significantly large in subjects with stage 2 and stage 3 ERMs (stage 2: \( P < 0.05 \); stage 3: \( P < 0.002 \); Mann-Whitney test; Fig. 7A). Metamorphopsia scores obtained from vertical lines were also significantly large in stage 3 ERM subjects (\( P < 0.02 \); Mann-Whitney test; Fig. 7B). Figure 8 shows the relationship between the metamorphopsia score of the horizontal lines and that of the vertical lines in 3 stages of ERM patients. The horizontal axis shows the metamorphopsia score of horizontal lines. The vertical axis shows the metamorphopsia score of horizontal lines. The scores obtained from the horizontal dotted lines were significantly larger than those of the vertical lines in advanced stages of ERM (all stages: \( P < 0.003 \); stage 2: \( P < 0.05 \); stage 3: \( P < 0.005 \); Wilcoxon rank-sum test).

The corrected vision of the subjects with ERM was as follows: 5 eyes were in the more than 0.1 to 0.2, 6 eyes were in the more than 0.2 to 0.4, 10 eyes were in the more than 0.4 to 0.6, 12 eyes were in the more than 0.6 to 0.8, 18 eyes were in the more than 0.8 to 1.5. There was no significant relationship between the corrected vision and the metamorphopsia score in patients with ERM (Fig. 9).

**DISCUSSION**

To evaluate the metamorphopsia using Amsler Charts, we have to ask to our patient carefully about their metamorphopsia and try to have them draw their image of distortion by themselves. However, this has been a difficult task for patients and also inaccurately quantified the degree of metamorphopsia. The advantage of the M-CHARTS is its simple task that the patients only have to answer if the line is distorted or not. Metamorphopsia is not a simple symptom and it contains several kinds of components. Especially, there are several kinds of frequency components of distortion in metamorphopsia. The fine high frequency component of metamorphopsia which is usually observed in early stages of ERM is detected by fine dotted lines; however, it is not detected by coarse dotted lines. In advance stages of ERM, the large amplitude and low frequency components of metamorphopsia increase, so it is easy to detect by all kinds of lines, including coarse dotted lines.

In this study, we chose only a vertical line and a horizontal line which included a fixation point for quantifying the metamorphopsia. Metamorphopsia is commonly qualitatively detected in the central 10° visual field using Amsler Charts. However, if we try to quantify the metamorphopsia on the peripheral line, it will be a very difficult task for patient and the results will be more inaccurate. Furthermore, metamorphopsia is most remarkable around the fixation area, so we chose a vertical and horizontal center line for this method.

There was no significant relationship between the metamorphopsia score and the visual acuity in our ERM patients. The metamorphopsia scores varied within the same visual acuity group. This suggests that the metamorphopsia score may show us new clinical information that is different from the visual acuity. In some patients, whose visual acuities were 0.1 or less, it was difficult to obtain metamorphopsia scores using the M-CHARTS because these patients could not recognize the dotted lines. It was also difficult to evaluate metamorphopsia scores in some patients with a large central scotoma. Therefore, we excluded these low visual acuity subjects in this study. Further study is needed to investigate the relationship between the degree of metamorphopsia and the visual acuity especially in the lower visual acuity patients.

The difference in the metamorphopsia between horizontal lines and vertical lines has already been reported by Amsler in 1953. We also reported that there are similar cases which have a difference in the metamorphopsia between the horizontal and vertical lines. In this study, our results using the M-CHARTS clearly show that the metamorphopsia scores obtained from the horizontal dotted lines were larger than those of the vertical lines in advanced stages of ERM. Increase in the severity of metamorphopsia for horizontal lines means that the vertical contraction increases on the retina. One of the possible explanations of

![Figure 5](https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/932921/) The result of Amsler charts described by the patient. The fine metamorphopsia was detected in her right eye.

![Figure 6](https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/932921/) The results of M-CHARTS. As the dot interval of the M-CHARTS changed from fine to coarse, there was a noted decrease in the severity of metamorphopsia. When a 0.6 dotted line was used, the metamorphopsia completely disappeared.
this result is that the vertical contraction on the retina is larger than horizontal contraction in ERM patients. The existence of the optic disc may resist the horizontal contraction of the retina in advance stage of ERM. Another possible explanation of this result is the difference of human visual sensitivities between horizontal and vertical visual fields. Some authors have reported that the ability of recognition is more sensitive in horizontally than vertically in the human visual system.\textsuperscript{11,12}

We conclude that the M-CHARTS is a very simple and useful method for quantifying the severity of metamorphopsia in patients with ERM. In addition, the M-CHARTS provide us more detailed information of metamorphopsia before and after macular surgery in patients with ERM or other macular diseases such as a macula hole and age-related macular degeneration.
References