Central serous chorioretinopathy (CSC) is a disease characterized by localized fluid accumulation in the subtretinal space. This, in turn, is caused by dysfunction of the retinal pigment epithelium (RPE) layer. Two well-known hypotheses have been advanced to explain the pathophysiology of CSC. One considers that dysfunction of the RPE triggers misdirection of fluid from the choroidal layer to the subtretinal space. The other hypothesis suggests that excess stress hormone production creates choroidal hyperpermeability, which in turn induces leakage of choroidal fluid and serous retinal pigment epithelial detachment (PED). The presenting symptoms in CSC patients are minor blurring of vision, central scotoma, hypermetropization (caused by anterior displacement of the retinal plane), and a variable level of metamorphopsia.

Metamorphopsia is a subjective symptom in which objects are perceived to be distorted. Metamorphopsia occurs in CSC patients, including those with an idiopathic epiretinal membrane (ERM), a macular hole (MH), and/or age-related macular degeneration. The subtretinal fluid (SRF) accumulation characteristic of CSC can be detected by optical coherence tomography (OCT). However, OCT has limitations, it cannot render it possible to quantify the extent of metamorphopsia. The cited authors evaluated metamorphopsia severity in patients with an ERM using M-CHARTS. CSC patients also often present with metamorphopsia. To the best of our knowledge, to date no study has sought to quantify metamorphopsia in CSC patients. In the present study, we explored this topic using M-CHARTS, and examined the relationships between the degree of metamorphopsia and characteristic OCT findings in CSC patients.

Materials and Methods

We selected 33 eyes of 33 consecutive patients who visited the eye clinic of our Hospital from August 2010 to 2011, and who were diagnosed with CSC. We retrospectively reviewed all medical records. At each follow-up, each patient underwent best-corrected visual acuity (BCVA; Snellen chart) testing; quantification of the extent of metamorphopsia using M-CHARTS, and OCT (Stratus™, Carl Zeiss Meditec Inc., Dublin, CA). Patients who had intraocular diseases other than CSC, or who had any systemic disease that could affect vision, were excluded from the study.

We recorded patient age, gender, and symptom duration at the first visit. We converted BCVA values from Snellen visual acuity figures to logarithm of the minimum angle of resolution (logMAR) scores; this allowed us to explore any statistical correlation of the values with metamorphopsia (M-CHARTS) scores. Each patient was examined at 1, 2, 3, and 6 months after the first visit. BCVA examination, OCT, and M-CHARTS evaluation, were performed at each follow-up visit. We performed the vertical and horizontal 5 mm cross hair mode of OCT.
retina, is perceived as irregular or curved. If an ophthalmologist next presents dotted (thus not solid) lines to the patient, and changes the dot interval from fine to coarse, line distortion gradually decreases, and finally disappears. The M-CHARTS test exploits this phenomenon. The chart contains 19 types of dotted lines; the dot intervals range from 0.2° to 2.0° of visual angle. When M-CHARTS is to be employed, refractive error is first corrected; visual acuity is optimized at a distance of 30 cm; and a vertical straight line (thus of angle 0°) is next presented, with the patient being asked to fixate on the center of the line. If a patient recognizes the straight line as being in fact straight, the M-CHARTS score is 0. If a patient considers that the straight line is irregular or curved, dotted lines, featuring dot interval changes from coarse to fine, are next presented to that patient. As the visual angle widens, the extent of metamorphopsia decreases; when the patient recognizes a dotted line as straight, the visual angle of that line is taken as the M-CHARTS score. After examination of vertical lines, the M-CHARTS presentation is rotated through 90°, and the same test procedure is repeated using horizontal lines. The extent of metamorphopsia (the M-score) is the sum of the horizontal and vertical M-CHARTS scores. Matsumoto et al. previously found that the M-score was 0 in all normal eyes and that intra-individual M-score variation in ERM patients was within one line (± 0.1 in terms of score). Therefore, we considered that metamorphopsia was present if the sum of the horizontal and vertical M-CHARTS scores was 0.3 or over.

We first investigated, at each follow-up, whether a correlation existed between the M-score (indicating the extent of metamorphopsia) and the BCVA value. Second, we explored relationships between specific OCT findings and the extent of metamorphopsia. The 33 consecutive CSC patients were divided into two groups, one of which was the metamorphopsia group (with M-scores of 0.3 or over) whereas the other was the non-metamorphopsia group (with M-scores of 0.2 or below). We classified OCT-specific features into four categories: (1) focal retinal PED; (2) high-level reflectivity of the photoreceptor layer; (3) posterior clumping in the photoreceptor layer; and, (4) large areas of sensory retinal layer detachment that exceeded one retinal thickness in extent. Focal PED was defined as irregularity of the retinal pigment epithelial layer, as revealed by OCT. Posterior clumping in the photoreceptor layer was considered present when rounded clumps were evident in that layer. High-level reflectivity was defined as notable intrinsic reflectivity of the photoreceptor layer. Serous sensory retinal layer detachment was defined as detachment associated with the presence of SRF to a depth that was over twice the full thickness of the retina [Fig. 1].

Statistical analysis employed the Mann Whitney test, Fisher’s exact test, and Pearson correlation analysis. The frequency of occurrence of each specific OCT finding in the metamorphopsia and non-metamorphopsia groups was statistically analyzed using Fisher’s exact test. All tests were performed using SPSS version 18.0 (SPSS Inc., Chicago, IL) and a P value of less than 0.05 was considered to be statistically significant.

Results
The 33 eyes of the 33 patients examined in the present study were those of 26 men (80.6%) and 7 women (19.4%). All patients visited the retina clinic with at least 6 month follow-up. On initial examination, 15 of the 33 patients had metamorphopsia (the metamorphopsia group); all 15 yielded M-scores of over 0.3. The other patients formed the non-metamorphopsia group, with a mean M-score of 0. The mean age of the metamorphopsia group patients was 45.7 ± 8.3 years (range: 37-64 years); the figure was 45.2 ± 6.4 years in the non-metamorphopsia group (range: 36-56 years). Symptom duration was 9.6 ± 11.8 weeks (range: 1-48 weeks), and 10.2 ± 12.1 weeks (range: 1 to 48 weeks), respectively. The non-metamorphopsia group exhibited somewhat longer symptom duration, but this did not differ with statistical significance from that of the metamorphopsia group. At the first visit, BCVA (logMAR) was 0.28 ± 0.24 in the metamorphopsia group and 0.25 ± 0.28 in the non-metamorphopsia group; this difference was not clinically significant [Table 1].

Correlation between M-scores and BCVA values
All 15 patients in the metamorphopsia group had M-scores of over 0.3; we sought a correlation between these scores and BVCA data (logMAR values). No statistically significant correlation was evident (Pearson correlation analysis, P = 0.492) [Fig. 2]. At the 3-month follow-up, SRF had disappeared in all instances, as had metamorphopsia; the M-scores of all patients were 0.
Table 1: Baseline characteristics of the metamorphopsia and non-metamorphopsia groups

|                          | Metamorphopsia group (n = 15) | Non-metamorphopsia group (n = 18) | P value |
|--------------------------|-------------------------------|-----------------------------------|---------|
| Age (years)              | 45.7 ± 8.3                    | 45.2 ± 6.4                       | 0.91*   |
| Gender (male:female)     | 11:4                          | 15:3                             | 0.67*†  |
| Visual acuity (logMAR)   | 0.28 ± 0.24                   | 0.25 ± 0.28                      | 0.58*   |
| Duration of symptoms (weeks) | 9.6 ± 11.8                  | 10.2 ± 12.1                      | 0.91*   |
| Presence of focal PED    | 6/15                          | 1/18                             | 0.03†   |
| Presence of extensive SRF| 6/15                          | 5/18                             | 0.48†   |
| Presence of high-level reflectivity | 5/15                      | 6/18                             | 1.00†   |
| Presence of clumping     | 2/15                          | 3/18                             | 1.00†   |

PED: Pigment epithelial detachment, SRF: Subretinal fluid, *Mann-Whitney test, †Fisher’s exact test

Figure 2: The relationship between M-scores and visual acuity. No significant correlation was evident between these two parameters (Pearson correlation analysis; P = 0.492)

Relationship between specific OCT findings and metamorphopsia
We explored the frequencies of the specific OCT findings described above in the metamorphopsia and non-metamorphopsia groups [Table 1].

Relationship between focal retinal pigment epithelial detachment, and metamorphopsia
Six eyes (40%) in the metamorphopsia group and one (5.5%) in the non-metamorphopsia group exhibited focal retinal PED; this was significantly more common in the metamorphopsia group (P = 0.03).

Relationship between severe subretinal fluid accumulation and metamorphopsia
Six of 15 eyes (40%) in the metamorphopsia group and 5 of 18 (27%) in the non-metamorphopsia group showed severe SRF accumulation (associated with a large area of sensory retinal layer detachment that was greater than one retinal thickness in extent); the difference between the two groups was not statistically significant (P = 0.48).

Relationship between high reflectivity of the photoreceptor layer and metamorphopsia
When the presence of metamorphopsia was analyzed in terms of high-level reflectivity of the photoreceptor layer (as revealed by OCT), 5 of 15 eyes (33%) in the metamorphopsia group and 6 of 18 (33%) in the non-metamorphopsia group showed high-level reflectivity; the difference between the two groups was not statistically significant (P = 1.00). The M-scores of the five eyes in the metamorphopsia group ranged from 0.4 to 1.8. The level of reflectivity as revealed by OCT was reduced in all patients at the times of final visits. M-scores also improved (to 0) in all instances.

Relationship between posterior clumping in the photoreceptor layer and metamorphopsia
Two of 15 eyes (13.3%) in the metamorphopsia group and three of 18 (16.6%) in the non-metamorphopsia group showed posterior clumping in the photoreceptor layer; no clinically significant difference was evident between the two groups (P = 1.00). In one of the two eyes in the metamorphopsia group, and in all three eyes in the non-metamorphopsia group, posterior clumping disappeared during follow-up. At the first visit, in the metamorphopsia group, the M-scores of the two eyes showing posterior clumping were 0.8 and 0.4. At the 3-month follow-up, the scores had improved to 0, and metamorphopsia had thus disappeared.

Discussion
The symptoms of CSC include minor blurring of vision, central scotoma, hypermetropization, and metamorphopsia. Sometimes, visual disturbance persists, despite complete resolution of SRF accumulation at the site of a macular lesion. Some patients with CSC experience metamorphopsia symptoms in the region of central vision. Amsler grid charts have been used to evaluate the extent of metamorphopsia.[11] However, these charts do not yield quantitative data. To the best of our knowledge, no prior report has sought to assess metamorphopsia in CSC patients. Therefore, we aimed to quantify metamorphopsia in such patients using M-CHARTS. Also, we investigated possible relationships between specific OCT findings in CSC patients and the presence of metamorphopsia.

M-CHARTS, developed in 1999, was first used to evaluate patients with an idiopathic ERM. Shinoda et al.,[12] reported that the severity of ERM correlated positively with the M-score. The cited authors found that M-CHARTS was simple and useful when employed to quantitatively monitor the extent of metamorphopsia. Later, Arimura et al.,[13] showed that the extent of horizontal retinal contraction correlated positively with the vertical metamorphopsia score. Also, the extent of vertical retinal contraction was positively correlated with the horizontal metamorphopsia score in patients with an ERM. The cited authors thus successfully associated the metamorphopsia pattern with the direction of retinal contraction. In another report, Uei et al.,[14] investigated metamorphopsia in MH patients. The cited authors found that if the MH size was small pre-operatively, metamorphopsia improved more markedly after surgery.
In the present study of 33 eyes, 15 (45.5%) exhibited metamorphopsia and all 15 patients had M-scores of over 0.3. M-CHARTS reliably detected metamorphopsia. A search of the PubMed database revealed that no report on the frequency of metamorphopsia in CSC patients has yet appeared; we were thus unable to compare the frequency of metamorphopsia in our CSC patients with any prior data. However, we consider that a metamorphopsia rate of 45.5% is clinically meaningful (indeed being rather high) in CSC patients.

Although M-CHARTS could be successfully used to screen for metamorphopsia in CSC patients, we could not detect any relationship between the M-score and BCVA data. Metamorphopsia presented in various patterns, regardless of BCVA measurements. This finding is in line with that of Matsumoto et al.,[10] who found that M-scores did not correlate with BCVA data in ERM patients. We conclude that the extent of metamorphopsia is independent of BCVA measurements. Three possible explanations may be advanced. First, it is possible that the duration of morbidity may differ among patients. Second, M-CHARTS is a subjective test that uses data provided by the patient. Third, any decrease in the extent of central vision may render it difficult to discriminate between various dotted lines on the M-CHARTS. Thus, M-CHARTS is more appropriately used to detect the mere existence of metamorphopsia. The technique may not be suitable for quantitative analysis of the extent of the condition. We, thus suggest that M-CHARTS is a valuable, but supplementary, diagnostic tool for use in clinics that do not have expensive OCT equipment.

The causes of metamorphopsia remain unclear. Distortion of the retina by an ERM causes photoreceptor disarray, which may induce metamorphopsia.[13] We performed OCT at all follow-up CSC patient visits. At the first visit, we identified SRF in the macular area. We sought to identify characteristic OCT findings that were strongly associated with the presence of metamorphopsia. We defined four characteristic OCT findings (focal retinal PED, posterior clumping in the photoreceptor layer, high reflectivity of the photoreceptor layer, and a large region of sensory retinal layer detachment over one retinal thickness in depth) that might reflect changes in anatomic retinal arrangement.

No correlation was found between the extent of metamorphopsia and any of posterior clumping in the photoreceptor layer, high reflectivity of the photoreceptor layer, or large-scale sensory retinal layer detachment. However, patients showing focal retinal pigment layer epithelial detachment on OCT had high M-scores. Previously, it was shown that distortion of the retina caused by ERM traction could cause metamorphopsia.[13] We consider that focal retinal epithelial layer detachment distorts the retina at the site of detachment and induces development of metamorphopsia. We performed the vertical and horizontal 5 mm cross hair mode of OCT. M-CHART examination collects the metamorphopsia score of vertical line and horizontal line involving the macula area. M-CHART examination field is in accordance with vertical and horizontal 5 mm cross hair mode of the OCT. Therefore, we could compare the PED of OCT and M-CHART score.

Our study had several limitations. The work was retrospective in nature, the study was non-randomized, and the sample size was relatively small. Also, the “characteristic” OCT findings that we describe have not been previously accepted as appropriate. Furthermore, although M-CHARTS is very simple and inexpensive diagnostic method, M-CHARTS has the limitation of subjective scoring system. Further large prospective randomized studies are required.

In conclusion, M-CHARTS is useful for determining the presence of metamorphopsia in CSC patients. Although the degree of metamorphopsia does not correlate with BCVA data, we nonetheless suggest that M-CHARTS is a valuable screening test. In clinics lacking expensive OCT facilities, or in developing countries, M-CHARTS may be useful to observe clinical courses and to identify therapeutic outcomes in CSC patients.

References

1. Guyer DR, Yannuzzi LA, Slakter JS, Sorenson JA, Ho A, Orlock D. Digital indocyanine green videoangiography of central serous chorioretinopathy. Arch Ophthalmol 1994;112:1057-62.
2. Gelber GS, Schatz H. Loss of vision due to central serous chorioretinopathy following psychological stress. Am J Psychiatry 1987;144:46-50.
3. Yannuzzi LA. Type-Abehavior and central serous chorioretinopathy. Retina 1987;7:111-31.
4. Garg SP, Dada T, Talwar D, Biswas NR. Endogenous cortisol profile in patients with central serous chorioretinopathy. Br J Ophthalmol 1997;81:962-4.
5. Tittel MK, Spaide RF, Wong D, Pilotto E, Yannuzzi LA, Fisher YL, et al. Systemic findings associated with central serous chorioretinopathy. Am J Ophthalmol 1999;128:63-8.
6. Spitznas M. Pathogenesis of central serous retinopathy: A new working hypothesis. Graefes Arch Clin Exp Ophthalmol 1986;224:321-4.
7. Klein ML, van Buskirk EM, Friedman E, Gragoudas E, Chandra S. Experience with nontreatment of central serous chorioretinopathy. Arch Ophthalmol 1974;91:247-50.
8. Frisén L. The Amsler grid in modern clothes. Br J Ophthalmol. 2009;93:714-6.
9. Amsler M. Earliest symptoms of diseases of the macula. Br J Ophthalmol 1953;37:521-37.
10. Matsumoto C, Arimura E, Okuyama S, Takada S, Hashimoto S, Shimomura Y. Quantification of metamorphopsia in patients with epiretinal membranes. Invest Ophthalmol Vis Sci 2003;44:4012-6.
11. Bouwens MD, Van Meurs JC. Sine Amsler Charts: A new method for the follow-up of metamorphopsia in patients undergoing macular pucker surgery. Graefes Arch Clin Exp Ophthalmol 2003;241:89-93.
12. Shinoda K, Ishida S, Kawashima S, Matsuzaki T, Yamada K, Katsura H. A new method for quantification of metamorphopsia in patients with epiretinal membrane. Nihon Ganka Gakkai Zasshi 1999;103:806-10.
13. Arimura E, Matsumoto C, Okuyama S, Takada S, Hashimoto S, Shimomura Y. Retinal contraction and metamorphopsia scores in eyes with idiopathic epiretinal membrane. Invest Ophthalmol Vis Sci 2005;46:2961-6.
14. Uei B, Lee Z, Shimada H, Yuzawa M. Preoperative factors for postoperative resolution of metamorphopsia in idiopathic macular hole surgery. Nihon Ganka Gakkai Zasshi 2005;109:591-5.

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