Macular sensitivity in eyes with central serous chorioretinopathy

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PURPOSE. *To determine macular sensitivity and fixation characteristics in eyes with central serous chorioretinopathy (CSC) using fundus-related microperimetry.*
METHODS. *The authors reviewed 19 eyes with serous elevation within the central 10° due to CSC and 15 normal healthy eyes that had undergone fundus-related microperimetry. The macular sensitivity was measured using the fundus-related microperimeter, MP-1. The best-corrected visual acuity (BCVA), mean retinal sensitivity in the central 10° (central microperimetry, cMP-1) and in the paracentral 10° to 20° (paracentral microperimetry, pMP-1), and fixation stability and location were determined and compared with that of control eyes.*
RESULTS. *Eyes with CSC showed significantly lower logMAR BCVA ($p<0.001$), cMP-1, and pMP-1 sensitivity than control eyes ($p<0.001$, $p<0.01$, respectively). Eyes with CSC were not significantly different in fixation location ($p=1.00$) or fixation stability than control eyes ($p=0.45$). Fixation location was predominantly central in all eyes with CSC; fixation was stable in 17 (89%) and relatively unstable in 2 (11%).*
CONCLUSIONS. *Eyes with CSC showed significantly lower retinal sensitivity not only at the central but also in the paracentral area. Even with decreased BCVA and retinal sensitivity, our patients showed central and stable fixation in their affected eyes. (Eur J Ophthalmol 2008; 18: 799-804)*

KEY WORDS. *Central serous chorioretinopathy, Macular sensitivity, Microperimetry*

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INTRODUCTION

Central serous chorioretinopathy (CSC), a serous detachment of the sensory retina in the posterior pole, has been known to affect predominantly healthy adult men with a "type A" personality profile (1). Functional impairment of the retinal pigment epithelium (RPE), either focal or diffuse, has been proposed as a pathogenesis of the disease (2-4). Patients with CSC often experience decreased visual acuity (VA), ranging from 20/20 to 20/200, with an average of 20/30 (5). Visual disturbances associated with the disorder include micropsia, metamorphopsia, chromatopsia, and central scotomas (6). Without treatment, CSC usually resolves spontaneously, and the duration of the acute phase of serous retinal elevation varies from 4 weeks to 4 months (5, 6). After spontaneous recovery, patients may observe residual visual symptoms such as metamorphopsia or loss of contrast sensitivity, despite recovering normal VA (7).

VA is the gold standard of visual function examination in patients with CSC. Unfortunately, VA is inadequate to quantify the natural history of visual function, because VA determination is not strictly related to daily life activities (8). A more comprehensive approach for quantifying macular function in patients with CSC should be encouraged. A test of visual function which may help in understanding

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the characteristics of visual loss in these patients could be microperimetry. With this technique retinal fixation and macular sensitivity may be accurately tested, with strict correspondence of visual parameters to macular morphology (9, 10). The aim of this study was to determine fixation characteristics (location and stability) and macular sensitivity in eyes with CSC using an automatic microperimeter.

METHODS

We recruited 19 patients (all men) who had unilateral CSC. The mean age of the patients was 40±9 years (range 29–66 years). The diagnosis of CSC was confirmed by fluorescein angiography in each case and only eyes with serous elevation within the central 10° were included. We excluded patients with moderate to dense lens opacity, corneal opacities, a history of refractive surgery, glaucoma or ocular hypertension, a history of intraocular inflammation such as anterior or posterior uveitis, multifocal choroiditis, a history of retinal detachment, a history of ocular trauma, and optic neuropathy. In this consecutive series, no eyes had received previous laser photocoagulation or photodynamic therapy. No patients had signs or symptoms of previous CSC attacks in the clinically normal fellow eyes. None of the 19 patients had any medical or ocular conditions that might have affected their retinal function or altered their microperimetry results. The patients underwent complete ophthalmic examination, including best-corrected VA (BCVA) measurement (with ETDRS chart), slit lamp biomicroscopy, indirect ophthalmoscopy, color fundus photography, and fluorescein and indocyanine green angiography. BCVA expressed as logMAR was obtained at a distance of 4 meters. Fluorescein and indocyanine green angiograms were performed on a Heidelberg scanning laser ophthalmoscope (Heidelberg Engineering, Heidelberg, Germany). Macular sensitivity was evaluated by MP-1 microperimetry (MP-1, Nidek Technologies, Italy). The recently developed MP-1 was used for microperimetry using the version available in June 2003 (version: MP-1 SW 1.4.1 SP1). The MP-1 provides a 45º non-mydriatic view of the fundus with automated correction for eye movements. Goldmann III stimuli and a 4-2 staircase strategy were used, and a circular test grid with 74 stimulus locations covering an area of 20º was applied. The mean retinal sensitivities at the 28 locations covering the central 10° (central microperimetry, cMP-1) and at the 48 locations covering the paracentral 10° to 20° (paracentral microperimetry, pMP-1) were determined.

The white stimuli were projected on a white background with background luminance set to 1.27 cd/m^2 and a stimulus presentation time of 200 ms. The perimetric strategy of the current software version of the MP-1 starts at an initially defined threshold level for each stimulus. A 4-2 staircase strategy is then carried out, and the last seen threshold value is taken as the final threshold. The instrument tests same luminance levels at all test locations before moving on to the next luminance level (i.e., for all locations one luminance level is projected after the other). Differential light threshold values were compared by calculating selected points, which were averaged automatically by the MP-1 microperimetry software program for mean sensitivity in a polygon.

For the assessment of fixation, the fundus movements are tracked during examination while the patient gazes 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 stability analysis (stable, relatively unstable, unstable). Fixation is regarded as stable if more than 75% of the fixation points are inside the 2º diameter circle, as relatively unstable if less than 75% are inside the 2º diameter circle but more than 75% inside the 4º diameter circle, and as unstable if less than 75% of the fixation points are inside the 4º diameter circle. To assess fixation location, a standard, circular, central fixation area 2º in diameter (approximately 700 µm) centered on the fovea is defined. Eyes with more than 50% of the preferred fixation points located within the central fixation area are classified as having predominantly central fixation. Eyes with more than 25% but less than 50% of preferred fixation points located within the central fixation area are classified as having poor central fixation. Eyes with less than 25% of the preferred fixation points located within the central fixation are classified as having predominantly eccentric fixation. The classification of fixation characteristics is made automatically by the MP-1 microperimetry software, after a landmark has been positioned in the center of the foveal avascular zone. Results from age-matched control eyes (n=15, age 39±3 years) and eyes with CSC were compared by Student *t* test and the Mann-Whitney *U* test.

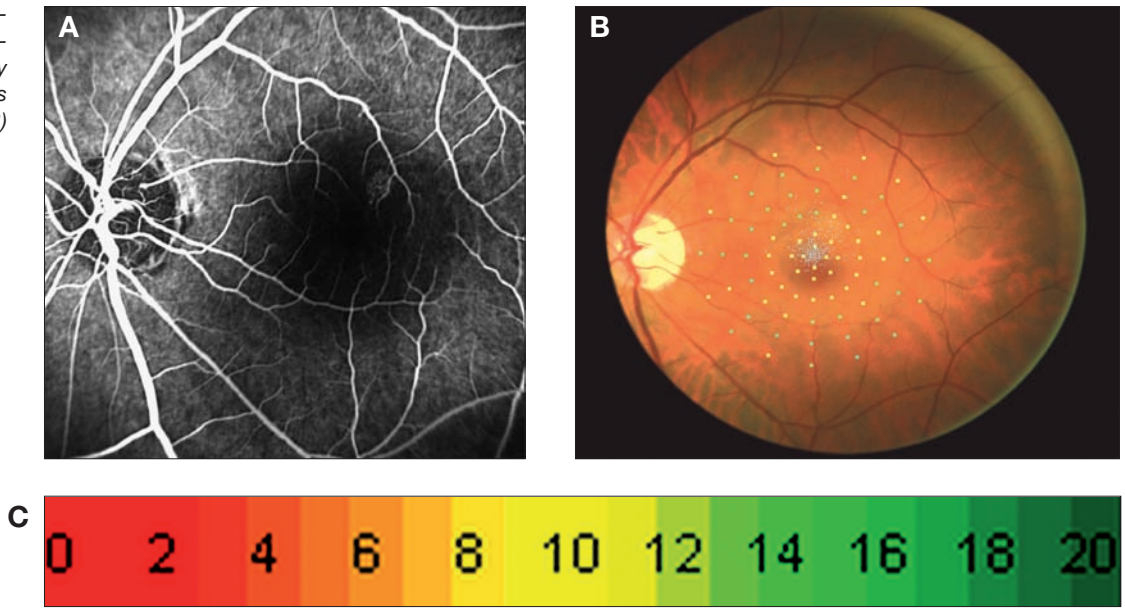

Fig. 1 - *Fluorescein angiography* **(A)**, *MP-1 microperimetry sensitivity and fixation properties* **(B)**, *and color scale (dB)* **(C)** *in Patient 10.*

RESULTS

The clinical characteristic of CSC eyes and control eyes are reported in Tables I and II. Fluorescein and indocyanine green angiography showed that all patients had unilateral active serous elevations within the central 10° area on the testing date. OCT findings showed that all patients had serous retinal detachment in the foveolar area. No patients showed retinal pigment epithelium detachment and intraretinal cystoid changes. Areas much larger than the locus of serous elevation have shown choriocapillary insufficiency on indocyanine green angiography. For the other eyes, VA was 20/20 in all patients, and fluorescein and indocyanine green angiography and OCT findings revealed no serous detachment. Figure 1 shows fluorescein angiography (A), MP-1 microperimetry sensitivity, and fixation properties (B) in Patient 10.

BCVA, mean central and paracentral sensitivity, fixation location, and fixation stability in diseased and control eyes are shown in Table III. Eyes with CSC showed significantly worse logMAR BCVA and microperimetry sensitivity than control eyes, but were not significantly different from control eyes in fixation location and fixation stability. Fixation location was predominantly central in all eyes; fixation was stable in 17 (89%) and relatively unstable in 2 (11%).

DISCUSSION

Abnormalities of macular function have been shown in eyes with CSC by subjective tests and also by objective methods such as focal macular electroretinography (ERG) and multifocal electroretinography (mfERG) (11-13). It is also possible to evaluate macular function by microperimetry. The fundus-related microperimeter, MP-1, can be used to obtain quantitative and reliable measurements of retinal sensitivity by tracking eye movements while the patient is focused on a fixation target (14). This system uses tracking software, which monitors fundus movements to ensure that the anatomic landmarks revealed in the fundus photographs are precisely aligned with the sensitivity maps generated by the perimeter. This instrument allows the overlaying of retinal sensitivities onto a real-color fundus image to indicate the retinal areas where visual defects coincide with visible structural anomalies. It also provides accurate determination of fixation location and fixation stability (14).

In our study, macular function, measured by the sensitivity of the macula with the MP-1 microperimeter, was analyzed in patients with CSC. Our MP-1 results showing significantly lower retinal sensitivity in the central area than control eyes are consistent with previous studies (11, 15). The focal ERG is subnormal in affected regions, and an mfERG report on affected eyes found similar results (12,

TABLE I - CLINICAL CHARACTERISTICS OF PATIENTS WITH CSC

Patient	Age, yr	MP-1 microperimetry sensitivity (dB), cMP-1	MP-1 microperimetry sensitivity (dB), pMP-1	MP-1 microperimetry fixation location*	MP-1 microperimetry fixation stability†	Visual acuity, logMAR
1	36	13.1	13.9	3	3	0.3
2	50	11	13.3	3	2	0.3
3	34	12.1	15.6	3	3	0.1
4	37	15.1	14.5	3	3	0
5	37	7.1	10.8	3	3	0.1
6	48	9	9.3	3	3	0.3
7	40	13.3	14.3	3	3	0.4
8	47	9.2	9.5	3	3	0.4
9	34	9.8	7.5	3	3	0
10	31	12.6	14.8	3	3	0.4
11	51	7.6	11.3	3	3	0
12	46	12.9	13	3	2	0.3
13	41	13.1	14.2	3	3	0
14	41	14.9	16.4	3	3	0.3
15	29	13.1	10.7	3	3	0.3
16	29	9.6	9.8	3	3	0.3
17	66	11.4	13.6	3	3	0.1
18	39	15.4	16	3	3	0
19	30	12.9	16.8	3	3	0

*Fixation location: 3 = predominantly central; 2 = poor central; 1 = predominantly eccentric.
†Fixation stability: 3 = Stable; 2 = Relatively unstable; 1 = Unstable.
CSC = Central serous chorioretinopathy; cMP-1= Central microperimetry; pMP-1= Paracentral microperimetry

TABLE II - CLINICAL CHARACTERISTICS OF CONTROL GROUP

Patient	Age, yr	MP-1 microperimetry sensitivity (dB), cMP-1	MP-1 microperimetry sensitivity (dB), pMP-1	MP-1 microperimetry fixation location*	MP-1 microperimetry fixation stability†	Visual acuity, logMAR
1	36	16.8	15.8	3	3	0
2	35	16.6	15.2	3	3	0
3	42	16.3	15.1	3	3	0
4	43	15.6	14.2	3	3	0
5	35	15.5	13.8	3	3	0
6	37	17.7	17.4	3	3	0
7	38	15	14.7	3	3	0
8	41	15.9	16.4	3	3	0
9	43	14.7	12.5	3	3	0
10	41	15	14.6	3	2	0
11	35	17.7	16.4	3	2	0
12	36	16.8	15.5	3	3	0
13	39	17	16.5	3	3	0
14	43	16.4	15.9	3	3	0
15	37	16	15.3	3	2	0

*Fixation location: 3 = predominantly central; 2 = poor central; 1 = predominantly eccentric.
†Fixation stability: 3 = Stable; 2 = Relatively unstable; 1 = Unstable.
cMP-1= Central microperimetry; pMP-1= Paracentral microperimetry

TABLE III - BCVA (LOGMAR), MEAN CMP-1 AND PMP-1 RETINAL SENSITIVITY, FIXATION LOCATION, AND FIXATION STABILITY IN EYES WITH CSC AND CONTROL EYES

	Control eyes (mean ± SD)	Eyes with CSC (mean ± SD)	Statistic	p
BCVA (logMAR)	0.00±0.00	0.19±0.16	t=5.18	<0.001
Sensitivity (cMP-1, dB)	16.20±0.93	11.75±2.45	t=7.29	<0.001
Sensitivity (pMP-1, dB)	15.29±1.23	12.91±2.70	t=3.43	<0.01
Fixation location (median)*	3	3	z=0.00‡	>0.99
Fixation stability (median)†	3	3	z=0.76‡	0.45

*Fixation location: 3 = Predominantly central; 2 = Poor central; 1 = Predominantly eccentric.
†Fixation stability: 3 = Stable; 2 = Relatively unstable; 1 = Unstable.
‡Mann-Whitney U test.
BCVA = Best-corrected visual acuity; cMP-1= Central microperimetry; pMP-1= Paracentral microperimetry; CSC = Central serous chorioretinopathy

15). Toonen et al (16) also found decreased retinal sensitivity in the affected areas with scanning laser ophthalmoscope (SLO) microperimetry. These results reflect the wide range of visual and functional difficulties that have been found in serous detachments (7, 17). These functional defects have generally been attributed to the retinal separation, which affects the transport of nutrients and visual pigments and also may allow some disruption of photoreceptor orientation (12). However, evidence is increasing that in CSC pathologic changes involve over a larger area than the detachment itself, in which case some of the functional abnormalities may originate from underlying choroidal dysfunction (18). Electroretinographic data in CSC have been ambiguous concerning diffuse abnormalities. Most authors have reported no full-field ERG changes in CSC, but subtle and somewhat variable abnormalities have been seen in a few studies (12, 19). Vajaranant et al (13) showed that mfERG abnormalities were limited to regions where serous elevation and/or pigment changes were ophthalmoscopically apparent in the macula. On the other hand, according to the mfERG findings, Marmor and Tan (12) showed that macular electrical function was abnormal beyond the area of detachment. Our results showed that eyes with CSC had significantly lower retinal sensitivity in both central and paracentral area. This means that the annular area between 10º and 20º also had decreased retinal sensitivity. It must be remembered that in all eyes, serous elevation was within the central 10º area. This result is consistent with the indocyanine green angiography findings of Iida et al (20), who showed choroidal filling delay in early phase and focal choroidal hyperfluorescence in late phase, not only in the leakage site but also in the posterior pole.

In this study, fixation characteristics (location and stability) were also determined. It is well known that important daily tasks, such as recognition of symbols, orientation, and reading, are strongly dependent on fixation stability and fixation location. Like other macular disorders, CSC can affect fixation properties. With SLO microperimetry, Toonen et al (16) studied fixation stability in 21 patients with CSC and found that fixation stability was significantly worse in the affected eyes than in normal eyes. At this point, it has to be kept in mind that fundus tracking in Toonen et al's study occurred manually and fixation analysis therefore might be more fragile for artefacts. Our results are not consistent with these results. According to our results, eyes with CSC are not significantly different from control eyes in fixation location and fixation stability. In eyes with CSC, fixation localization was predominantly central in all patients and fixation stability was stable in 17 out of 19 patients. This means that even though the BCVA and retinal sensitivity were decreased, our patients showed central and stable fixation in their affected eyes.

The authors have no commercial interest in the materials used in this work.

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REFERENCES

1. Yannuzzi LA. Type-A behavior and central serous chorioretinopathy. Retina 1987; 7: 111-30.
2. Carr RE, Noble KG. Central serous chorioretinopathy (central serous retinopathy). Ophthalmology 1980; 87: 841-6.
3. Marmor MF. New hypotheses on the pathogenesis and treatment of serous retinal detachment. Graefes Arch Clin Exp Ophthalmol 1988; 226: 548-52.
4. Negi A, Marmor MF. Experimental serous retinal detachment and focal pigment epithelial damage. Arch Ophthalmol 1984; 102: 445-9.
5. Spitznas M. Central serous retinopathy. In: Ryan SJ, ed. Retina. 2nd ed, vol 2, ch 70. St. Louis: Mosby, 1994.
6. Gass JDM. Stereoscopic Atlas of Macular Diseases: Diagnosis and Treatment, 4th ed, vol 1. St. Louis: Mosby, 1987; 52.
7. Folk JC, Thompson HS, Han DP, Brown CK. Visual function abnormalities in central serous retinopathy. Arch Ophthalmol 1984; 102: 1299-302.
8. Hazel CA, Petre KL, Armstrong RA, Benson MT, Frost NA. Visual function and subjective quality of life compared in subjects with acquired macular disease. Invest Ophthalmol Vis Sci 2000; 41: 1309-14.
9. Fletcher DC, Schuchard RA. Preferred retinal loci relationship to macular scotoma in a low-vision population. Ophthalmology 1997; 104: 632-8.
10. Doris N, Hart PM, Chakravartthy U, et al. Relation between macular morphology and visual function in patients with choroidal neovascularization of age related macular degeneration. Br J Ophthalmol 2001; 85: 184-8.
11. Miyake Y, Shiroyama N, Ota I, Horiguchi M. Local macular electroretinographic responses in idiopathic central serous chorioretinopathy. Am J Ophthalmol 1988; 106: 546-50.
12. Marmor MF, Tan F. Central serous chorioretinopathy: bilateral multifocal ERG abnormalities. Arch Ophthalmol 1999; 117: 184-8.
13. Vajaranant TS, Szlyk JP, Fishman GA, et al. Localized retinal dysfunction in central serous chorioretinopathy as measured using the multifocal electroretinogram. Ophthalmology 2002; 109: 1243-50.
14. Rohrschneider K, Springer C, Blültmann S, Völcker HE. Microperimetry—comparison between the Micro Perimeter 1 and scanning laser ophthalmoscope fundus perimetry. Am J Ophthalmol 2005; 139: 125-34.
15. Nagata M, Honda Y. Macular ERG in central serous retinopathy. Jpn J Ophthalmol 1971; 15: 9-16.
16. Toonen F, Remky A, Janssen V, Wolf S, Reim M. Microperimetry in patients with central serous retinopathy. Ger J Ophthalmol 1995; 4: 311-4.
17. Chuang EL, Sharp DM, Fitzke FW, Kemp CM, Holden AL, Bird AC. Retinal dysfunction in central serous retinopathy. Eye 1987; 1: 120-5.
18. Marmor MF. On the cause of serous detachment and acute central serous chorioretinopathy. Br J Ophthalmol 1997; 81: 812-3.
19. Sverak J, Wassermannova V, Peregrin J. Electroretinographic approach to the problems of the pathogenesis of central serous retinopathy. Acta Ophthalmol 1962; 40: 54-64.
20. Iida T, Kishi S, Hagimura N, Shimizu K. Persistent and bilateral choroidal vascular abnormalities in central serous chorioretinopathy. Retina 1999; 19: 508-12.