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ORIGINAL ARTICLE

Focal foveal atrophy of unknown etiology: Clinical pictures and possible underlying causes

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Background/Purpose: Focal foveal atrophy is defined as the presence of a small, focal, ill-defined, hypopigmented foveal or juxtafoveal lesion, with the remaining retina unaffected. The purpose of this study was to report the clinical characteristics and optical coherence tomography (OCT) in patients with focal foveal atrophy of unknown etiology.
Methods: The study was a retrospective observational case series. Data collected included complete ocular examination results for best corrected visual acuity (BCVA), ophthalmoscopy, fundus photography, fluorescein angiography, color sense discrimination tests, visual field tests, and OCT examinations.
Results: Twenty-three eyes in 21 patients were examined. The mean patient age was 49.2 ± 15.4 years. The mean BCVA was 20/25. The 21 patients were divided into three groups according to OCT results. Group 1 eyes ($n = 10$) had intact inner and outer hyperreflective layers (HRLs), with the signal of the inner HRL corresponding to the junction between the inner and outer photoreceptor segments and the outer HRL corresponding to the retinal pigment epithelium (RPE). Group 2 eyes ($n = 9$) had small hyporeflective defects with defects in the inner HRL at the fovea but an intact outer HRL. Group 3 eyes ($n = 4$) had small hyporeflective defects in both the inner and outer HRLs at the fovea. Groups 3 eyes had significantly lower visual acuity compared to Group 1 eyes and Group 2 eyes. There was no significant difference in visual acuity between Group 1 and Group 2 eyes. There were no significant differences among the groups with respect to color vision or foveal thickness.

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Conclusion: This is the first report of clinical presentations for patients with focal foveal atrophy of unknown etiology. OCT aided in the diagnosis and assessment of the degree of retinal structural abnormalities, but the real etiology of foveal atrophy remains unclear.

Introduction

Foveal atrophy can be observed in a variety of macular, vascular, hereditary, inflammatory, toxic, and traumatic retinal disorders.[1] It is generally included in the broad category of macular atrophy due to various retinal diseases, including geographic atrophy in individuals with age-related macular degeneration, myopic degeneration, angioid streaks, long-standing cystoid macular edema from any cause, and macular dystrophies.[1–9]

Atrophy can sometimes occur in the foveal or juxtafoveal area, and in some retinal disorders, including macular phototoxicity[10] and resolved central serous chorioretinopathy, usually appears as a small lesion.[8,10]

Here we report some cases of focal foveal atrophy of unknown etiology. The condition presents as a small, focal, ill-defined hypopigmented foveal or juxtafoveal lesion; the remaining retina is unaffected and there is no history of retinal disease or of a chronic systemic disease that might affect the retina. Most of our patients presented with mildly reduced visual acuity and were otherwise asymptomatic. Thus, the foveal atrophy might have been overlooked or underestimated by physicians.

Optical coherence tomography (OCT) is a noninvasive, commercially available imaging technique for evaluation of retinal structures. OCT imaging is widely used as a clinical tool for diagnosis and monitoring of a variety of retinal disorders. It enhances the visualization of intraretinal architectural morphology and facilitates delineation of structural abnormalities in the retina in patients with macular atrophy.[11–15]

The present study is the first to assess focal foveal atrophy of unknown etiology and further categorize patients according to OCT findings. We investigated the clinical characteristics and visual functions in a series of patients. Relationships between different patterns of retinal tomography and visual function tests, including best corrected visual acuity (BCVA) and color sense discrimination tests, were evaluated.

Materials and methods

This was a retrospective observational case series study of 23 eyes in 21 patients diagnosed with focal foveal atrophy of unknown etiology in the Department of Ophthalmology, National Taiwan University Hospital between January 2009 and December 2010. The medical records for each patient, including age, sex, past ocular history, past medical history, presenting complaint, and BCVA, were reviewed.

All patients received a complete ocular examination, including BCVA, measurement of intraocular pressure, anterior segment examination, dilated biomicroscopic examination of the macula, indirect ophthalmoscopy, fundus photography, fluorescein angiography, color sense discrimination test, visual field test, and OCT focusing on the macular area.

BCVA was measured using a Snellen visual chart. The results were used to calculate the logarithmic minimal angle of resolution (MAR) according to Snellen visual acuity = 1/MAR.

Color sense discrimination was evaluated using the Farnsworth–Munsell 100-hue test, in which a patient arranges four trays of colored caps in order by hue. The better the patient's color sense discrimination, the closer the arrangement matches the predetermined sequence for each tray. The results were scored using proprietary software and displayed in polar format. The total error score was recorded for analysis.[16,17]

Visual field was examined using a Octopus visual field analyzer with test spots of different size and illumination. The location and patterns of visual field defects were recorded.

OCT was performed using a Cirrus high-definition OCT (HD-OCT; Carl Zeiss Meditec, Dublin, CA, USA) for retinal tomography mapping and analysis under pupillary dilation by an experienced examiner. The retinal thickness was calculated using OCT retinal mapping software, which measures the thickness of the macular region using 6-mm horizontal and vertical line scans centered on the patient's fixation point by means of an inner fixation target. The results are expressed as a color map.[18,19] The foveal area is defined as the area within a 1-mm diameter from the fixation point. Foveal thickness was measured and retinal tomography was observed and investigated. If no abnormality was noted on retinal tomography, a repeat examination using multiple horizontal and vertical scans was performed.

Patient characteristics and visual function and OCT results were collected. We analyzed relationships between different retinal tomography patterns and visual function tests. Data analysis was performed using Stata 8.2 software (Stata Corp., College Station, TX, USA). Continuous data are presented as mean ± standard deviation (SD); a p value <0.05 was considered statistically significant. A Kruskal–Wallis test was used, followed by a Mann–Whitney test (Bonferroni correction method).

Results

Demography

We analyzed 23 eyes in 21 patients; two of the patients had bilateral involvement. There were 14 male and 7 female patients. Their mean age was 49.2 ± 15.4 years (range 8–68 years; Tables 1 and 2).

Table 1 Patient characteristics and clinical information.

Patient	Age (y)	Sex	Eye	Visual acuity	Presenting symptom	Angiographic finding	Color vision[a]	Foveal thickness (μm)	OCT status	
									Inner HRL	Outer HRL
1	50	M	OD	20/20	Blurred vision	Window defect	216	225	Intact	Intact
2	55	M	OD	20/25	Blurred vision	Window defect	96	235	Intact	Intact
3	55	M	OD	20/15	None	Window defect	38	293	Intact	Intact
4	32	F	OD	20/25	Blurred vision	Window defect	44	226	Intact	Intact
5	52	F	OD	20/30	Decreased vision	Window defect	136	272	Intact	Intact
6	22	F	OD	20/20	None	Window defect	136	228	Intact	Intact
7	65	M	OS	20/25	None	Window defect	136	215	Intact	Intact
8	59	F	OD	20/25	Asthenopsia	Window defect	260	254	Intact	Intact
9	48	M	OD	20/25	None	Window defect	28	243	Intact	Intact
10	52	M	OD	20/20	Blurred vision	Window defect	180	257	Intact	Intact
11	58	M	OS	20/70	Blurred vision	Window defect	66	238	Defect	Intact
12	65	M	OS	20/20	None	Window defect	384	251	Defect	Intact
13	40	M	OD	20/20	Blurred vision	Window defect	104	167	Defect	Intact
			OS	20/20		Window defect	104	174	Defect	Intact
14	8	M	OD	20/20	Blurred vision	Window defect	260	217	Defect	Intact
			OS	20/20		Window defect	272	217	Defect	Intact
15	68	M	OD	20/25	Binocular diplopia	Window defect	156	248	Defect	Intact
16	48	F	OS	20/30	Blurred vision	Window defect	172	243	Defect	Intact
17	67	M	OS	20/30	Decreased vision	Window defect	96	247	Defect	Intact
18	60	M	OS	20/40	Metamorphopsia	Window defect	97	222	Defect	Defect
19	38	F	OD	20/100	Blurred vision	Window defect	52	185	Defect	Defect
20	56	F	OD	20/50	Blurred vision	Window defect	97	222	Defect	Defect
21	35	M	OD	20/30	Blurred vision	Window defect	258	223	Defect	Defect

HRL = hyperreflective layer; OCT = optical coherence tomography; OD = right eye; OS = left eye.
[a] Total error score.

Visual acuity

BCVA ranged from better than 20/20 to 20/100, with a mean of 20/25. Fifteen of the 23 eyes (65.2%) had BCVA ≥20/25. Five eyes (21.7%) had BCVA between 20/25 and 20/40. The other three eyes (13.0 %) had BCVA <20/40 (Table 1).

Symptoms

The most common symptom, noted in 11 patients, was blurred vision. Decreased vision was the presenting symptoms in two patients, and metamorphopsia in one patient.

One patient had asthenopsia and another had binocular diplopia. Five patients were asymptomatic in this series (Table 1).

Fundus and fluorescein angiographic appearance

An ill-defined focal hypopigmented foveal or juxtafoveal lesion was evident in all of the patients. The hypopigmented lesion was small and varied in size. No abnormality was found in the retinal vessels or optic discs in our patients.

Fluorescein angiography was performed in all patients. Early hyperfluorescence consistent with a retinal pigment epithelium (RPE) window defect located at the focal lesion was noted in all eyes. There was no evidence of late dye leakage or vascular disease (Table 1).

Color vision

Color vision was assessed in all patients using the Farnsworth–Munsell 100-hue test. The mean total error score

Table 2 Clinical information according to patient group.

Findings	Total	Group 1	Group 2	Group 3
Eyes (patients)	23 (21)	10 (10)	9 (7)	4 (4)
Age (y)	49.2 (8–68)	49 (22–65)	51 (8–68)	47 (35–60)
Visual acuity	20/25 (20/15–10/100)	20/20 (20/15–20/30)	20/25 (20/20–20/70)	20/50 (20/30–20/100)
Color vision (total error score)	147.3 (28–384)	127 (28–260)	179.3 (66–384)	126 (52–258)
Foveal thickness (μm)	230.5 (167–293)	244.8 (215–293)	222.4 (167–251)	213 (185–223)

Data are presented as *n* or mean (range).

was 147.3 ± 91.1. The results were normal in three eyes (3 patients) while color vision dysfunction was noted in the other 20 eyes (18 patients; Table 1).

Visual field

Visual field testing was performed in all patients using an Octopus visual field analyzer. No visual field defect or scotoma was noted.

Retinal tomography

Two specific signals on OCT were evaluated during this study: the superficial thin inner hyperreflective layer (HRL), corresponding to the junction between the inner and outer photoreceptor segments, and the deep thick outer HRL, corresponding to the RPE (Figs. 1–3).

The 23 eyes were divided into three groups according to the patterns of vertical and horizontal OCT line scans through the hypopigmented foveal lesions (Tables 1 and 2).

Group 1 eyes ($n = 10$; patients 1–10) had intact inner and outer HRLs (Fig. 1). The mean patient age was 49 years (range 22–65). The mean logMAR visual acuity was 0.03 ± 0.06. BCVA ranged from 20/15 to 20/30. Their average total error score was 127.0 ± 77.6 (range 28–260) in a color vision test. The mean foveal thickness in these eyes was 244.8 ± 24.3 μm (range 215–293 μm) (Table 2).

Group 2 eyes ($n = 9$; patients 11–17) exhibited a small hyporeflective defect, with a defect in a small part of the inner HRL at the fovea; the outer HRL was intact (Fig. 2). The mean patient age was 51 years (range 8–68). The mean logMAR visual acuity was 0.11 ± 0.18. BCVA ranged from 20/20 to 20/70. Their mean total error score was 179.3 ± 105.3 (range 66–384) in a color vision test. The mean foveal thickness was 222.4 ± 32.0 μm (range 167–251 μm) (Table 2).

Groups 3 eyes ($n = 4$; patients 18–21) exhibited small hyporeflective defects in a small part of both the inner and outer HRLs (Fig. 3). The mean patient age was 47 years (range 35–60). The mean logMAR visual acuity was 0.40 ± 0.21. BCVA ranged from 20/30 to 20/100. Their mean total error score was 126.0 ± 90.5 (range 52–258) in a color vision test. The mean foveal thickness was 213.0 ± 18.7 μm (range 185–223 μm) (Table 2).

There were no significant differences in age among the three groups (Table 2).

We analyzed correlations between logMAR visual acuity, color sense, and foveal thickness among the three groups. Group 3 eyes, with small focal defects of both the inner and outer HRLs, had significantly lower visual acuity than Group 1 eyes ($p = 0.0037$) and Group 2 eyes ($p < 0.05$). There was no significant difference between Group 1 and Group 2 eyes ($p = 0.6071$).

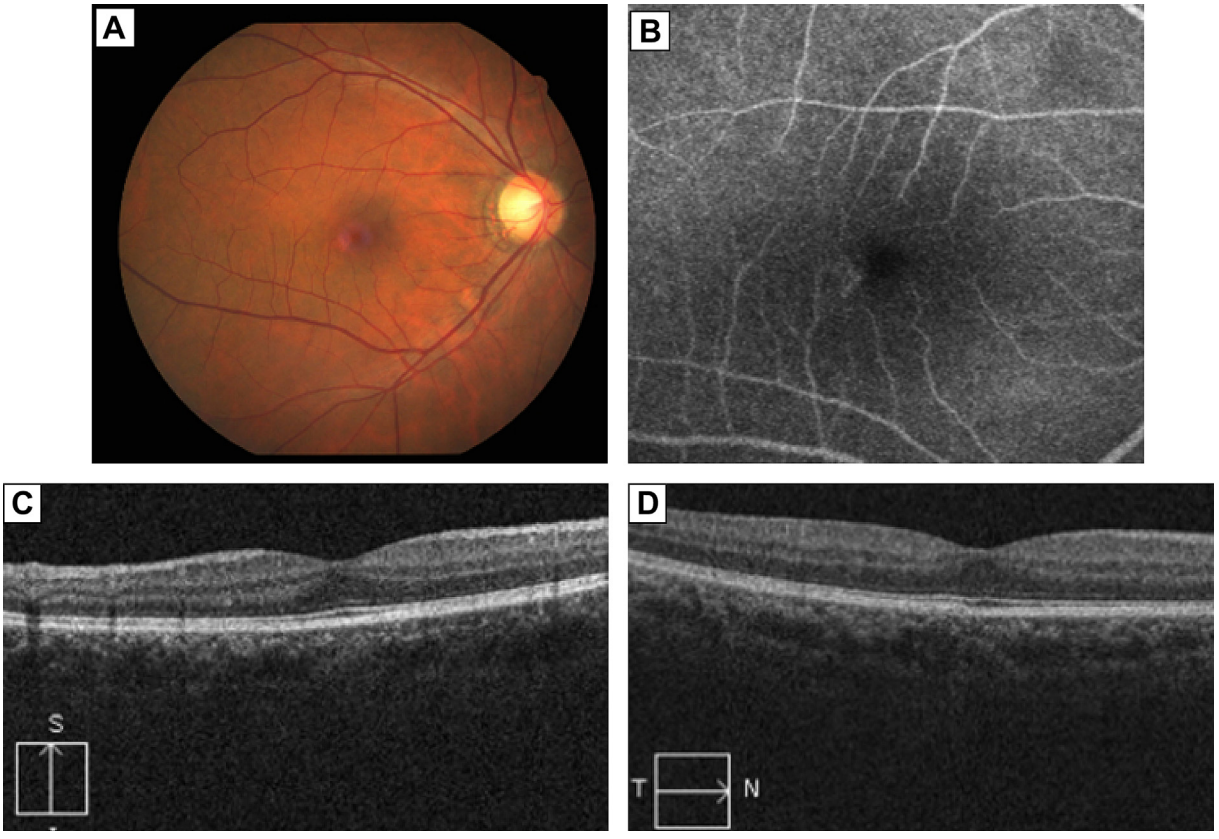

Figure 1 Group 1 focal foveal atrophy in Patient 3. (A) Color fundus photography demonstrates a small focal ill-defined hypopigmented lesion in the parafoveal region. (B) Fluorescein angiography demonstrates a hyperfluorescent window defect. (C, D) Optical coherence tomography shows normal scans, with both the inner and outer HRLs intact in vertical and horizontal sections.

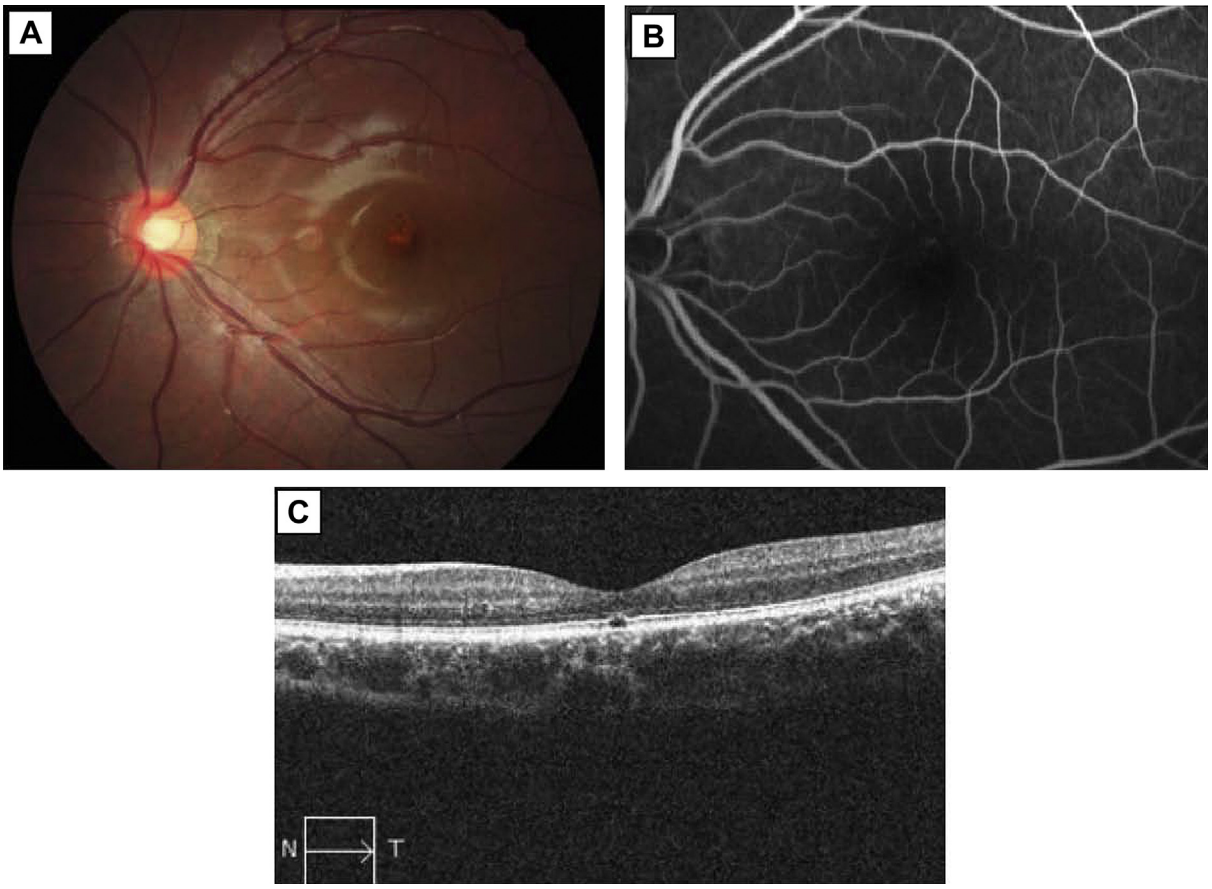

Figure 2 Group 2 focal foveal atrophy in Patient 14. (A) Color fundus photography demonstrates a small focal hypopigmented lesion in the foveal region. (B) Fluorescein angiography shows a central hyperfluorescent window defect. (C) Optical coherence tomography shows a small defect in the inner HRL but an intact outer HRL.

There were no significant differences among the groups in total error scores for a color vision test or in foveal thickness.

Discussion

We evaluated a cohort of 21 patients with focal foveal atrophy of unknown etiology. The lesions were small, irregular, ill-defined, focal hypopigmented foveal or juxtafoveal; the remaining retina was unaffected and no other retinal disease was observed.

The majority of our patients were either asymptomatic or presented with minimal symptoms, usually minimally reduced vision, but occasionally metamorphopsia or diplopia. For these reasons, diagnosis of such a lesion in patients with focal foveal atrophy can easily be underestimated or overlooked without a careful review of the patient's medical history and an ocular examination. Thus, the clinical characteristics and OCT study have not been evaluated yet.

Our patients were divided into three groups according to OCT scan patterns. These included OCT scans with intact inner and outer HRLs; a small defect in the inner HRL with an intact outer HRL; and a small defect in both the inner and outer HRLs at the fovea.

We compared the visual acuity of the three groups. Visual acuity was significantly lower in the group with small focal defects in both the inner and outer HRLs at the fovea than in the group with intact inner and outer HRLs and in the group with a small defect in the inner HRL but with an intact outer HRL.

Color vision was normal in three eyes (3 patients) and a color vision dysfunction was noted in the other 20 eyes (18 patients). The three patients with normal color vision all belonged to Group 1. However, the other seven eyes (7 patients) in Group 1 had color vision dysfunction even though OCT examination indicated intact inner and outer HRLs in these patients. It seems that development of a new OCT instrument with greater sensitivity and higher resolution may be necessary to demonstrate structural differences between patients with normal color vision and those with color vision dysfunction in Group 1. Most of our patients still had good visual acuity. Group 3 patients, with focal small defects in both the inner and outer HRLs at the fovea, had lower visual acuity compared to both Group 1 and Group 2 patients. Our results indicate that a defect in part of both the inner and outer HRLs at the fovea might lead to impairment of visual acuity. Our results for all 23 eyes (21 patients) reveal that color vision seemed to be affected more than visual acuity. Color vision dysfunction was noted in patients in all three groups and only three

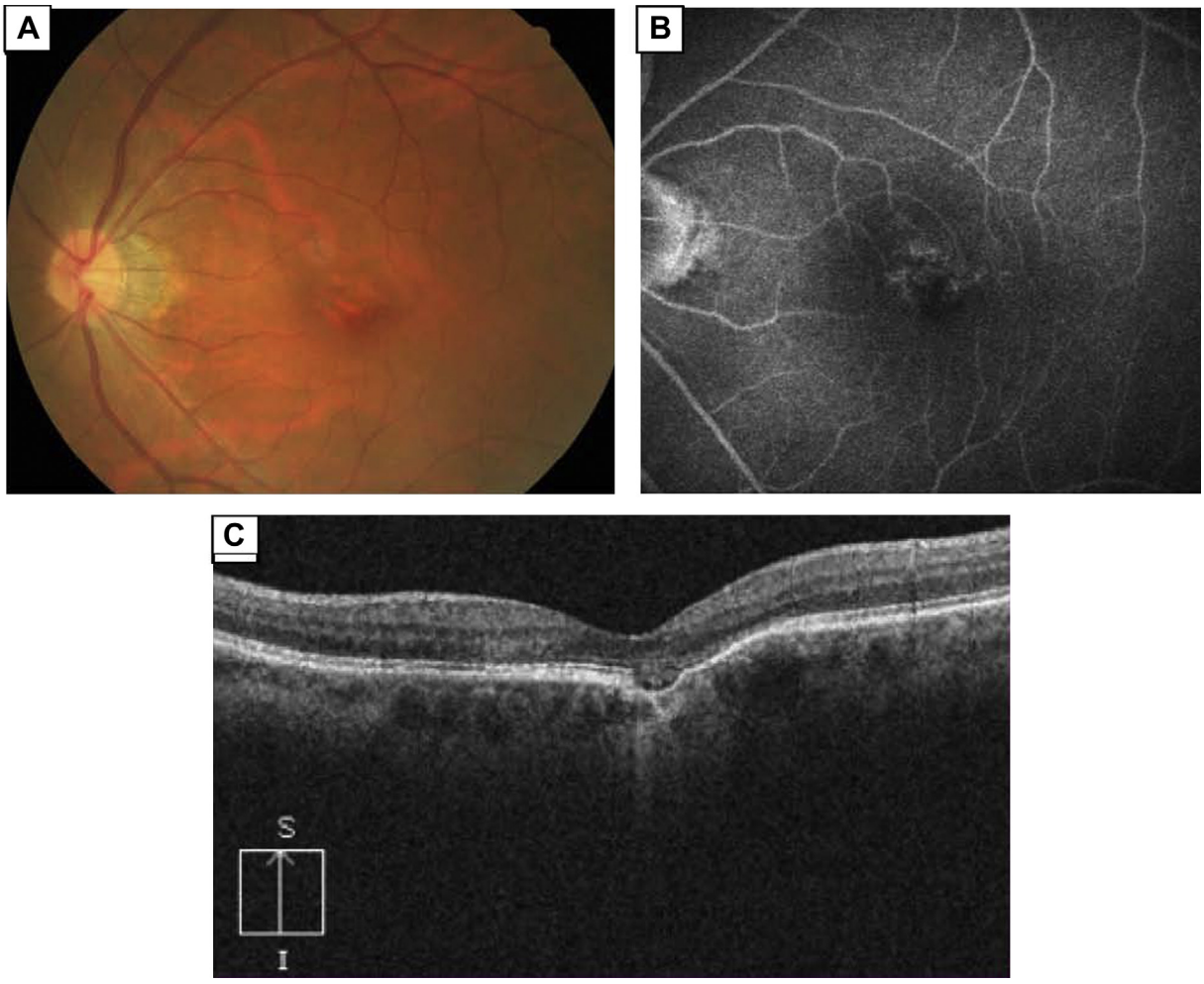

Figure 3 Group 3 focal foveal atrophy in Patient 18. (A) Color fundus photography demonstrates a small focal hypopigmented lesion in the foveal region. (B) Fluorescein angiography demonstrates a corresponding hyperfluorescent window defect. (C) Optical coherence tomography shows a localized defect involving both the inner and outer HRLs.

eyes (3 patients) with intact inner and outer HRLs had normal color vision. However, most of the patients still had good visual acuity and patients with decreased visual acuity were mainly in Group 3. Our results demonstrate that color vision can be affected more severely than visual acuity in these patients.

There were relatively large lesions in Group 3 patients, who had poor visual acuity compared to the other two groups. A different etiology for this group should be considered, but there were no great differences according to direct fundus examination and color fundus photography. However, the number of patients in this group was small (4 eyes), and further evaluation of a greater number of cases is needed.

Fluorescein angiography revealed early hyperfluorescence consistent with an RPE window defect located at the lesion in all patients. However, patients in Group 1 with intact inner and outer HRLs according to OCT did not have a corresponding RPE defect. We suppose that this discrepancy may be attributed to the OCT resolution. Possible lesions might be detectable by instruments with higher resolution.

Focal foveal atrophy is easily underestimated by physicians because patients are asymptomatic or have minimal symptoms. Our results demonstrate that detailed visual function tests and OCT examination are helpful in detecting the degree of involvement in this disorder. Clinical diagnosis of the disorder can be further confirmed by OCT examination.

Some retinal diseases localized mainly in the foveal region can exhibit a disrupted inner HRL with a preserved outer HRL, similar to the Group 2 patients in our study. These include solar retinopathy,[10,20,21] resolved central serous chorioretinopathy,[8,22,23] nonproliferative group 2a idiopathic juxtafoveal retinal telangiectasis (IJRT),[24,25] foveal spots,[26,27] and certain types of macular holes.[28]

Solar retinopathy is a well-recognized clinical entity with a definitive history of sungazing and visual loss. The characteristic clinical appearance includes a yellow—white spot on the fovea, often surrounded by a granular gray pigmentation in the first few days after exposure. The lesion evolves into a reddish, sharpened, demarcated or faceted cyst-like lesion.[10] Previous OCT studies have demonstrated reversible hyperreflectivity of all retinal layers at the fovea after viewing an eclipse.[20] Huang et al observed outer retinal defects and alternation of the RPE with cystic changes in late-stage solar maculopathy.[21] The

clinical history and appearance of the lesions in the present cohort are not characteristic of solar maculopathy.

Retinal atrophy has been noted in relation to chronic or recurrent central serous chorioretinopathy.[8,22] Discontinuity of the inner HRL line at the macular area is observed in patients with resolved central serous chorioretinopathy; however, the area of the discontinuity of the inner HRL line is wide at the macular area instead of being only near the fovea. A decrease in central foveal thickness has also been noted in patients with resolved central serous chorioretinopathy.[23] The clinical history and the presence of a small hyporeflective defect of the inner HRL in the present cohort are not characteristic of resolved central serous chorioretinopathy.

Patients with nonproliferative group 2a IJRT might exhibit loss of the inner HRL as a punctate defect in which the RPE remains intact. This is often associated with foveal cysts at all retinal depths, outer retinal atrophy, and hyperreflective pigment plaques.[24,25] All of the above changes can be observed by OCT and could help to differentiate these findings from those in the present cohort.

A foveal spot presents as a single foveal or juxtafoveal red lesion with sharply defined borders. The lesion size is very small, approximately 100 μm, and appears to be intraretinal.[26] Further study by OCT shows a focal defect of the band, indicating an abnormality of the outer retina and/or RPE. However, the lesions are not associated with any abnormalities when studied with fluorescein angiography.[27] In our cohort, fluorescein angiography showed an RPE window defect in all of the patients.

It has been reported that a foveal pseudocyst is the first step in full-thickness macular hole formation and is the result of incomplete separation of the vitreous cortex at the foveal center. Foveal pseudocysts have a lobulated reddish appearance. There are striae present either in the vitreous cortex overlying the fovea or within the inner retina. The striae usually radiate outward from the fovea in a spokelike pattern. On OCT, a pseudocyst occupies the inner part of the fovea, resulting in foveal thickness and elevation of the foveal floor.[28] Incomplete separation of the vitreous cortex, striate formation, and elevation of the foveal floor help to differentiate findings of foveal pseudocyst from the findings in the present cohort.

Disruption of both the inner and outer HRLs has been noted in some diseases with large-area macular atrophy, including advanced age-related macular degeneration. However, a small focal area of foveal abnormality with a focal small defect of both the inner HRL and outer HRL at the fovea, with no other pathological changes, has not been reported in the literature.

All of our patients denied any previous ocular disease history and there were no other clues from the retina except from the foveal lesion. We termed these lesions as focal foveal atrophy of unknown etiology with current clinical evaluation tools. It is difficult to judge whether this was a different type of foveal atrophy or only foveal atrophy of unknown etiology.

In conclusion, we present a series of patients with a well-defined foveal abnormality and corresponding clinical presentation. OCT imaging is helpful in the diagnosis and prediction of visual function for this retinal condition.

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