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Fundus Autofluorescence in Type 2 Idiopathic Macular Telangiectasia: Correlation with Optical Coherence Tomography and Microperimetry

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Abstract

Purpose—To employ multiple modality imaging to described patients with type 2 idiopathic macular telangiectasia (IMT) at different disease severity stages so as to characterize and categorize disease progression through the full spectrum of disease phenotypes.

Design—Observational case series.

Methods—Twelve patients with type 2 IMT (22 eyes) with type 2 IMT examined with fundus photography, angiography, optical coherence tomography (OCT) imaging, fundus autofluorescence (FAF), and microperimetry (MP) testing in an institutional setting.

Results—Eyes examined by multiple modality imaging were classified into five proposed categories (0–4): Category 0 (fellow) eyes were normal on all imaging modalities. Category 1 eyes had increased foveal autofluorescence on FAF imaging as the only imaging abnormality. Category 2 eyes had increased foveal autofluorescence together with fundusoscopic and angiographic features typical of type 2 IMT. Category 3 had additional evidence of foveal atrophy on OCT and while category 4 has all the above features plus clinically evident pigment clumping. FAF signal increased in intensity in the foveal region from category 0 through category 3, while category 4 eyes demonstrated a mixed pattern of increased and decreases FAF signal.

Conclusions—The findings here outline a sequence of progressive changes seen with multiple imaging modalities in advancing stages of disease. Increases in foveal autofluorescence is an early anatomical change in type 2 IMT that may precede typical clinical and angiographic changes. Loss of macular pigment density in the fovea and a changing composition of fluorophores in the retinal pigment epithelium may underlie these changes in FAF in the fundus.

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INTRODUCTION

Type 2 idiopathic macular telangiectasia (IMT) is a macular disease characterized by parafoveal retinal opacification and telangiectatic vascular changes, intraretinal crystalline deposits, foveal atrophy, retinal pigment epithelial (RPE) hyperplasia, and intraretinal/subretinal neovascularization (SNV) and fibrosis¹⁻³. This form of macular telangiectasia was distinguished by Gass and Blodi³ from other forms that involve aneurysmal features (Gass-Blodi Group 1) and occlusive features (Gass-Blodi Group 3). The disease occurs in both sexes equally and presents as gradual central vision loss at a mean age of 55–60 years^{3, 4}. Although this disease is often described as bilateral, disease severity in fellow eyes may be asymmetric⁴.

To date, the etiology, pathogenesis, and anatomical basis of type 2 IMT remain incompletely understood. Initial characterizations of the disease entity have relied on clinical observation and fluorescein angiography (FA). Newer imaging modalities used for studying retinal anatomy and function, such as optical coherence tomography (OCT), microperimetry (MP), and fundus autofluorescence (FAF), have the potential to more completely characterize type 2 IMT. Using OCT, investigators have recently detected patterns of foveal atrophy previously described by Gass as a lamellar hole³. These patterns include formation of foveal cysts in different layers of the retina, outer retinal atrophy, and overall thickness changes in the fovea and/or parafovea⁴⁻¹⁰. Functional deficits of macular sensitivity have been revealed by MP testing to be correlated with localized anatomical alterations¹¹. In addition, confocal blue reflectance imaging has revealed abnormal signals in parafoveal regions that correspond to areas of angiographic leakage in patients with type 2 IMT^{12, 13}. FAF imaging, which records the stimulated emission of light from endogenous fluorophores within the RPE¹⁴, can reveal other structural and composition changes not otherwise seen in fundus photography, as demonstrated in other retinal diseases such as age-related macular degeneration¹⁵, central serous chorioretinopathy¹⁶, pseudoxanthoma elasticum, and retinitis pigmentosa¹⁷.

In this paper, we report on the FAF characteristics of type 2 IMT across a wide spectrum of disease severities, and correlate them to anatomical and functional changes as revealed by fundus photography, FA, OCT, and MP testing. We have proposed 5 progressive categories based on these findings and correlations. Based on our observations, FAF changes in the fovea occur early in the course of the disease. These changes are likely to reflect pathological changes in macular pigment distribution within the retina as suggested by others¹⁸, and/or alterations in the composition of lipofuscin and melanin within the RPE. These progressive changes across imaging modalities can be helpful in the construction of a hypothesis concerning the pathogenic mechanisms leading from early to later stages of the disease.

Currently, an international research program known as Macular Telangiectasia (MacTel) project is conducted in 22 clinical centers in 7 countries with 5 basic science laboratories to evaluate the natural history of this condition and the pathophysiology of this condition. The findings in this collaborative effort can help us better understand the pathogenesis and evaluate potential therapies. Our classification will be tested with the data collected from this multi-center effort, using both the baseline data and the prospective data. Additional new technological modalities may also add to this working classification and help contribute to a definitive, multiple modality-based, classification for this ocular condition.

METHODS

Twelve patient records with the diagnosis of type 2 IMT, seen at the National Eye Institute between 2003 and 2007, were retrospectively reviewed. The diagnosis in all cases was made based on typical fundus findings such as parafoveal graying or opacification of the retina,

intraretinal crystalline deposits, and right-angled vessels, as well as the presence of parafoveal leakage on fluorescein angiography (FA). Patients received complete ophthalmic examinations including best-corrected visual acuity testing using Early Treatment of Diabetic Retinopathy Study (ETDRS) protocols, anterior segment biomicroscopy, indirect fundus ophthalmoscopy, color fundus photography, FA, OCT, MP, and FAF testing. High-speed video indocyanine green angiography (HSICGA) was performed in cases of subretinal hemorrhage. Patients with at least one eye with findings typical for type 2 IMT were included, provided they did not have other confounding ocular or systemic conditions. In order to detect early findings on OCT, FAF, or MP testing that may precede clinical or angiographic evidence for type 2 IMT, both eyes of all patients were included in the analysis.

Fundus photography and FA were performed using a standard digital imaging system (OIS, Sacramento, CA) and OCT was performed using the Stratus OCT (Zeiss Meditec, Dublin, CA). Microperimetry testing was performed using the MP1 microperimeter (Nidek Technologies, Padova, Italy). The following test configuration was used: background luminance was set at 4 apostilbs (or 1.27 cd/m²), and a single cross, 1° in diameter, served as a fixation target. A Goldmann III stimulus size and 200ms stimulus duration was used, and a Humphrey 10-2 pattern with a 4-2 staircase strategy was employed.

Fundus autofluorescence was imaged with a confocal laser scanning ophthalmoscope (HRA2, Heidelberg Engineering, Heidelberg, Germany) using an excitation wavelength of 488 nm and a barrier filter at 500 nm. In order to estimate the contribution of macular pigment changes to the qualitative changes in FAF seen in the HRA2 images, a second FAF image of the posterior pole was captured using a Topcon fundus camera with excitation light of wavelengths in the bandwidth of 550–600nm and a barrier filter that blocks all wavelengths of <660nm. This FAF image, captured in the same visit at the HRA2 FAF image, is unobscured by the presence of macular pigment in the fovea and may be compared to the HRA2 FAF image to assess the contribution of changing macular pigment distribution to the overall pattern seen. High-speed indocyanine green angiography was done using the HRA2.

Image analysis was performed to obtain quantitative estimates of macular pigment distribution. The HRA2 and Topcon FAF images were spatially aligned as guided by the invariant points on the fundus image using the Landmark - Thin Plate Spline image registration algorithm in the program MIPAV (Medical Image Processing, Analysis and Visualization, Center of Information Technology, NIH, Bethesda, MD). Macular pigment optical density was calculated using the registered images by the two-wavelength method^{19–21}. The macular pigment map is calculated as:

$$\text{MPmap}_{460}(i,j) = (1/(K(\lambda_1) - K(\lambda_2))) * [(\log((I(\lambda_1)_{\max} - I(\lambda_1)_{\min})/(I(\lambda_1)_{i,j} - I(\lambda_1)_{\min})) - \log((I(\lambda_2)_{\max} - I(\lambda_2)_{\min})/(I(\lambda_2)_{i,j} - I(\lambda_2)_{\min}))]$$

Where MPmap(i,j) is the macular pigment optical density at 460 nm at pixel coordinate (i,j) of the image. $I(\lambda_1)_{\max}$ is the parafoveal reference value of intensity at excitation wavelength λ_1 taken to be the top 1% intensity range of the image. $I(\lambda_1)_{\min}$ is the background, typically the bottom 1% intensity range of the image, where, after subtraction the intensity values in at the two excitation wavelengths are nearly equal on the optic disk. $K(\lambda_1)$ is the extinction coefficient of macular pigment at wavelength λ_1 normalized relative to 1 at 460 nm. For the HRA $K(\lambda_1) = 0.781$ with $\lambda_1 = 488$ nm and for the Topcon 50-EX using a 550–600 nm excitation filter $K(\lambda_2) = 0.0007$ (obtained from averaging the normalized macular pigment absorption spectrum over the excitation spectrum). After obtaining a spatial map of macular pigment, we obtained 1-D radially averaged profiles of macular pigment optical density. The radially averaged value as well as the integrated total optical density enabled significantly

greater reproducibility that decreased bias due to illumination patterns and retinal fine structure. Our analysis was first validated with fundus cameras using two excitation wavelengths in 5 normals. We found good correlation with heterochromatic flicker photometry at 4 eccentricities and obtained good correlation with heterochromatic flicker photometry ($r^2 = 0.89$, in preparation). We then compared these results to validate our hybrid approach of using Topcon 50-EX and HRA2 images so that we could retrospectively analyze macular pigment in IMT patients. The results for normals correlated well, providing confidence for analysis of IMT patients for the purpose of detecting abnormalities, such as lack of macular pigment and/or irregular spectral profiles of foveal autofluorescence.

Analysis of differences of median visual acuities was performed with GraphPad Prism 4 (La Jolla, CA, USA) using a two-sided Mann-Whitney test at a significance level of 0.05.

RESULTS

Patient Population

Twelve patients (7 males and 5 females, with a mean age of 60 years) with findings of type 2 IMT in at least one eye were examined. One eye (Patient #8, OD) was excluded from the series due to the presence of central maculopathy from central serous retinopathy (CSR) as evidenced by the presence of pinpoint leakage on FA and subretinal fluid on OCT. Imaging data was unavailable in one eye (Patient #11, OS), with advanced subretinal fibrosis due to neovascularization; this eye was not included in further analysis. FAF and OCT imaging was obtained on all 22 remaining eyes, while MP testing was available on 21 eyes. HS-ICGA was performed in cases where subretinal hemorrhage was found (3 cases), and in these cases, the subretinal neovascular tissue originated from the retinal circulation. No cases of chorioretinal anastomosis were seen. Apart from Patient #8, patients had no other previous history of retinal disease. Three patients (Patients #2, #10, #12) have had a history of adult-onset diabetes but none had evidence of diabetic retinopathy.

Categorization of Fundus Autofluorescence Findings with Correlations to Other Imaging Modalities

All 22 eyes, with and without typical clinical findings of type 2 IMT, were classified into categories based on FAF imaging, and correlated with findings on fundus photography, FA, OCT, and MP testing. The Table summarizes the demographics, clinical features, findings on multiple modality imaging, and the categorization of all eyes in the series.

Category 0: Normal Fundus Autofluorescence—With the exception of one patient, all the cases in our series had bilateral abnormalities of some form on multiple modality testing. Patient #1 had a left eye with clinical features typical of type 2 IMT. The contralateral right eye (with visual acuity 20/16) however showed no fundoscopic or angiographic evidence of disease, and normal findings on OCT, FAF (Figure 1) and MP testing. Macular pigment mapping using FAF images obtained at two disparate wavelengths indicated the presence of macular pigment in the center of the macula. Quantitative estimation of macular pigment optical density in the fovea center also was found to be within the range detected in normal control patients. This eye was classified as category 0.

Category 1: Mild Increase in Foveal FAF—Patient #10 had clinical features typical for type 2 IMT in his right eye; however, in his contralateral left eye (Va 20/20), no clinical, angiographic, OCT or MP testing abnormalities suggestive of type 2 IMT were detected. The only observed abnormality was mildly increased FAF signal on HRA2 imaging that was limited to the central fovea (Figure 2). Compared to the foveal pattern of autofluorescence in normal fundi, in which there is a central depression in FAF signal (as seen in Figure 1), the foveal

autofluorescence pattern in this case, while not elevated beyond that seen in the parafoveal areas, lacks this central depression. We apply the term “mildly increased” to refer to this central deviation from the normal pattern. This mild elevation of FAF signal in the fovea was observed in autofluorescence images captured with both excitation in the 488nm and the 550–600nm ranges. Accordingly, macular pigment optical density in the fovea was also significantly decreased, correlating to the increase in FAF signal seen (Figure 2, bottom right). We designated this collection of findings as Category 1.

Category 2: Mild to Moderate Increase in Central Foveal FAF signal with Angiographic Abnormalities—Unlike eyes in Categories 0 and 1, eyes in this category (n = 5, Va range 20/20–20/32) exhibited typical clinical and angiographic signs of type 2 IMT (parafoveal retinal graying on clinical exam and late parafoveal leakage on FA) (Figure 3 and 4). On OCT imaging, although varying central foveal thicknesses were detected, all eyes demonstrated normal lamination and lacked any foveal cystic or atrophic changes, even in cases where imaging was performed with a spectral domain OCT device (Cirrus OCT, Carl Zeiss Meditec, Dublin, CA). Retinal sensitivity in the macula as measured by MP testing was normal in all eyes tested. FAF imaging with excitation in the 488nm and the 550–600nm ranges both demonstrated a higher than expected amount of FAF signal in the fovea. This ranged from cases in which a “mild” increase obscured the foveal depression in FAF that is seen in normal eyes, to cases in which further increases in foveal FAF slightly exceeds that seen in the parafoveal regions (termed “moderately” increased FAF) (Figure 4). Measurements of macular pigment optical density also indicated a loss of central macular pigments in these cases (Figure 3). We classified these eyes as Category 2 to indicate the emergence of typical clinical and angiographic findings of type 2 IMT in the context of abnormal foveal autofluorescence FAF, but without atrophic or cystic abnormalities on OCT imaging and deficits on MP testing. One to three years after the initial visit, two eyes in category 2 (the right eyes of patients #11 and #10, respectively) developed subfoveal hemorrhage secondary to neovascularization.

Category 3: Moderate to Marked Increase in Central Foveal FAF signal with Angiographic Abnormalities and Foveal Atrophy—Eyes in this category (n = 8; visual acuity range 20/25–20/160) demonstrated characteristic clinical and angiographic features of the disease with all these eyes having characteristic parafoveal graying on exam and parafoveal leakage on FA. Three eyes also had parafoveal intraretinal crystalline deposits. Compared to eyes in Category 2, OCT imaging in this category demonstrated central outer retinal atrophy, either as intraretinal cystic degeneration or as central thinning with loss of outer retinal lamination. Subretinal fluid was not observed in any of the cases. Figure 5 demonstrates further increases of foveal FAF signal on imaging using 488nm excitation wavelength. Ranging from “moderate” to “marked” where the FAF signal was qualitatively higher than in any other point of the image (Figure 5). In some cases, FAF imaging using the longer 550–600nm range also demonstrated a large marked increase in autofluorescence signal. These marked increases seen on both excitation wavelengths beyond the normal overall background of FAF signal make it unlikely that these changes are due only to a loss in central macular pigment (i.e. a loss of its shielding effect), and suggest an increase RPE endogenous fluorescence due to increased foveal lipofuscin, bleaching of RPE melanin or both. In these areas of increased FAF and central retinal atrophy, MP testing was also abnormal with centrally decreased retinal sensitivity. Eyes with scotomata affecting the fovea had poor visual acuity (20/80–20/160), while eyes with scotomata affecting only the temporal parafovea maintained relatively good acuity (20/25–20/40). Together, the combination of typical clinical and angiographic features, combined with the emergence of retinal atrophy on OCT, loss of retinal sensitivity on MP testing, and further increases of central FAF signal characterize this category of disease.

Category 4: Mixed Patterns of FAF signal with RPE Hyperplasia—Eyes in Category 4 displayed a wide range of central visual acuities ($n = 7$; Va acuity range 20/20–20/200). Heterogeneous mixed patterns of autofluorescence, with areas of increased and decreased FAF signal, characterized this category. The FAF pattern was often configured in a variably-sized ring of increased autofluorescence surrounding an area of decreased autofluorescence (Figure 6). All eyes showed typical angiographic parafoveal signs of type 2 IMT. In addition, on clinical exam, these eyes exhibited pigment clumping in the form of RPE hyperplasia and retinal migration that were in all cases associated with a retinal venule. OCT imaging also revealed central outer retinal atrophy. One case (patient #12, OS) also had evidence of SNV in this setting. Correlation of findings between modalities showed that areas of pigment clumping observed on clinical exam coincided with areas of decreased FAF signal. These areas were also found on OCT to exhibit inner retinal hyperreflectivity indicative of pigment migration into the retina. On MP testing, central scotomas were detected and these correlated with either decreased FAF signal or retinal atrophy on OCT. Eyes with scotomata affecting the fovea had poor visual acuity (20/80–20/200), while eyes with scotomata affecting only the temporal parafovea maintained better acuity (20/20–20/50).

Relation of categories to visual function and subretinal neovascularization

The categories described here do not follow a strict pattern of decreasing central visual acuity. Eyes in categories 0, 1, and 2 have generally good visual acuities (median 20/25; range 20/16–20/32), but the visual acuities in the categories 3 and 4 are more variable (median 20/80; range 20/20–20/200). The difference in median visual acuities between eyes in groups 0–2 and 3–4 was statistically significant ($p=0.007$). Similar to observations by Charbel Issa et al.²², we noted that visual acuity depended less on the presence of retinal atrophy, pigment migration, or hypofluorescence signals *per se*, but more on their position relative to the foveal center. Because these structural changes are associated with decreased retinal sensitivity on MP testing, central visual acuity is decreased when they occur in the fovea, but it may be preserved if pathological changes are limited to the parafoveal or elsewhere in the macula.

The presence of subretinal neovascularization was also not confined to only one category. While we observed a progression of FAF changes occurring concurrently with the emergence of retinal atrophy and pigment clumping, we found that subretinal neovascularization occurred in eyes in which there is no retinal atrophy and only mild changes in FAF signal (category 2), as well as in eyes with advanced pigment clumping (category 4). Thus the setting of structural changes typical of type IMT can be quite varied for the development of new subretinal neovascularization.

DISCUSSION

In this retrospective, cross-sectional case series, we have used a multiple modality approach to examine the ocular features of 12 patients with type 2 IMT. We observed mild foveal increases in autofluorescence on FAF imaging as a very early detectable change on multiple modality examination, presenting in cases in which clinical or angiographic findings are absent (category 1). In eyes in which subtle and limited clinical and angiographic abnormalities first appear, this increase in central FAF signal becomes more prominent. However, MP findings are normal and OCT examinations are without overt signs of retinal atrophy or cystic change, even when examined at higher resolution with OCT devices (category 2). With the onset of central atrophy on OCT imaging (category 3), foveal autofluorescence further increases in intensity and MP testing reveals corresponding scotomas in retinal areas of atrophy. However, in category 4 eyes, where pigment migration and clumping are present, the pattern of fundus autofluorescence becomes mixed, containing both areas of increased and decreased fluorescence, the latter corresponding to the areas of hyperpigmentation.

These observations of altered autofluorescence indicate that FAF imaging may be useful in revealing the early fundus abnormalities in type 2 IMT. They also suggest the possibility that anatomical changes that result in FAF changes may precede the more typical vascular changes in the parafovea or the atrophic changes centrally. These early FAF changes may be partly attributed to a loss of macular pigment in the fovea as reported previously¹⁸, but is not likely to be the sole cause of FAF abnormalities. The moderate and marked increases in FAF signal that we observed may also arise from compositional changes in the RPE including endogenous fluorophores and melanin. Our observations also relate the changes in FAF to changes in retinal anatomy and function. Areas with mild and moderate increases in foveal autofluorescence are not associated with large decrements of retinal sensitivity on MP testing or in central visual acuity. However, areas with significantly elevated levels of foveal autofluorescence are correlated with areas of retinal atrophy on OCT, which are in turn correlated with areas of decreased retinal sensitivity on MP testing as also found in a recent study²³. Similarly, areas of decreased autofluorescence on FAF, occurring in areas of pigment migration on clinical exam, are also associated with scotomatous regions on MP testing. Summarizing, areas with mildly elevated FAF changes correlate with intact retinal structure and function, while areas of significantly elevated or decreased FAF abnormalities correlate with disrupted retinal structure and decreased function. It is interesting that the pigment clumps within the retina seen in this disorder differs in clinical appearance, physical location, and autofluorescent properties from the hyperpigmentary changes that may be seen in age-related macular degeneration and may represent different pathologic RPE changes. Pigment clumping and RPE hyperplasia in type 2 IMT tends to occur predominantly in the temporal parafoveal region³ while the varied RPE changes seen using FAF in patients with AMD tends to occur throughout the macula without a predilection for any specific area²⁴. Although we did not note any significant decrements in retinal sensitivity on MP testing or in central visual acuity in eyes with early disease, it should be noted that others have reported decreased scotopic sensitivity using fine matrix mapping as an early feature of type 2 IMT¹¹.

The changes seen in the later stages of the disease in the forms of moderate and marked FAF signal increase and pigment clumping allude to the possible involvement of the RPE in disease pathogenesis. In these stages, foveal RPE may experience deleterious changes that are revealed by, and perhaps secondary to, the accumulation of abnormally high levels of fluorophores. A disorganization and aberrant migration of these RPE cells may ensue, resulting in pigment clumping within the retina, and eventual death of these RPE cells, and a subsequent loss of autofluorescent properties. This progression is suggested by the FAF observations in eyes of Category 4, in which areas of low FAF are often surrounded by a penumbra of increased FAF, hinting at a progression from the latter to the former state.

Our observations have detailed the probable temporal sequence in which abnormalities in the different tissue compartments and layers of the retina arise in the course of the disease. How earlier changes relate to or may be causal of later changes are still unclear and remain a topic of future investigations. These relationships when clarified will be illuminating not only of the pathogenesis of type 2 IMT in particular but also of the intercellular interactions possible between different cell types in the retina.

The categorization that we proposed using multiple examination modalities suggests a schema for understanding and staging of this multifaceted disease affecting different retinal tissues and sub-compartments. Classification schemes previously proposed include that of Gass and Blodi³, which is based on fundoscopic and angiographic findings, and that of Yannuzzi⁴ classification, which was developed with additional OCT observations. Our present observations add to these schemas by taking into account additional aspects of anatomical and function such as FAF imaging and microperimetry testing, as well as characterizing earlier stages of disease. Confocal blue reflectance imaging is another recently developed imaging

modality that may be useful in the evaluation of this disease^{11, 12}. Abnormalities on confocal blue reflectance should be included in future multiple modality analysis of type 2 IMT.

In summary, we have employed a correlative multiple modality imaging approach in examining possible relationships between structural and functional changes in eyes with type 2 IMT. Our results indicate that early changes in the autofluorescent properties of the retina occur in the evolution of type 2 IMT, with typical pattern changes developing as the disease progresses. These changes in autofluorescent properties are likely due in part of macular pigment loss but also from composition changes in the RPE, which culminate in late stages in RPE disorganization, migration, and death. The changes in the RPE may be secondary to dysfunction of retinal cells but this also remains unknown. Future studies may consider in addition to other retinal cell types the RPE as a cellular target for therapeutic interventions, employing multiple imaging modalities to follow and better understand their effects on the different cellular components involved in this disorder.

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Figure 1. Fundus Autofluorescence (FAF) of Category 0 (Patient #1, OS) Type 2 Idiopathic Macular Telangiectasia. FAF imaging showed on both 488nm wavelength excitation (*left*) and 550–660nm wavelength excitation (*upper right*) a pattern of autofluorescence that is similar to that seen in normal controls. Macular pigment optical density mapping demonstrates measureable levels of macular pigment present centrally (*lower right*).

Figure 2. Fundus Autofluorescence (FAF), Fundus Photography, Fluorescein Angiography (FA), Optical Coherence Tomography (OCT), and Microperimetry (MP) of eyes in Category 1 (Patient #10, OS) Type 2 Idiopathic Macular Telangiectasia. Fundoscopy (*top, left*), FA (*top, right*), OCT (*middle, left*) and MP testing (*middle, right*), were all without clinical findings typical of type 2 idiopathic macular telangiectasia. FAF imaging revealed mild increased levels of FAF signal in the fovea, as seen on 488nm excitation (*bottom, left*), and 550–600nm excitation (*bottom, middle*). Macular pigment optical density mapping demonstrates decreased levels of macular pigment centrally (*bottom, right*).

Figure 3.

Fundus Autofluorescence (FAF), Fundus Photography, Fluorescein Angiography (FA), Optical Coherence Tomography (OCT), and Microperimetry (MP) of Category 2 (Patient #6, OS) Type 2 Idiopathic Macular Telangiectasia. Fundus photography showed trace temporal parafoveal graying (*top, left*) and FA showed subtle late leakage in the same area (*top, right; arrows*). OCT imaging showed a slightly decreased central thickness but no cysts or atrophy (*middle, left*). MP testing was normal (*middle, right*). FAF imaging revealed mild increased levels of FAF signal in the fovea, as seen on 488nm excitation (*bottom, left*), and 550–600nm excitation (*bottom, middle*). Macular pigment optical density mapping demonstrates decreased levels of macular pigment centrally (*bottom, right*).

Figure 4.

Fundus Autofluorescence (FAF), Fundus Photography, Fluorescein Angiography (FA), Optical Coherence Tomography (OCT), and Microperimetry (MP) of Category 2 (Patient #10, OD) Type 2 Idiopathic Macular Telangiectasia. Moderate foveal hyperautofluorescence (*top, left*), more prominent than seen in Figure 3, were seen with Clinical indications of type 2 idiopathic macular telangiectasia in the form of parafoveal graying on fundus photography (*top, left*) and late temporal parafoveal leakage on FA (*top, middle*). Moderately increased central foveal FAF signal is seen on FAF imaging (488nm excitation), exceeding levels in the parafoveal region (*top, right*). OCT showed a mild parafoveal increase in retinal thickness without atrophic changes (*bottom, left*). MP testing (*bottom, right*) were within normal limits.

Figure 5. Fundus Autofluorescence (FAF), Optical Coherence Tomography (OCT), and Microperimetry (MP) of Category 3 Type 2 Idiopathic Macular Telangiectasia in 3 patients. The left eye of patient #1 demonstrated moderately increased FAF signal on FAF imaging with 488nm excitation (*top, left*), outer retina atrophy with photoreceptor loss on OCT (*top, center*), and a foveal scotoma on MP testing (*top, right*). The left eye of patient #5 showed markedly increased foveal FAF signal (*middle, left*), along with temporal foveal thinning (*middle, center*) and a temporal parafoveal scotoma (*middle, right*). The right eye of patient #6 demonstrated markedly elevated foveal FAF signal (*bottom, left*), an outer atrophic retinal cyst (*bottom, center*), and a foveal scotoma (*bottom, right*).

Figure 6.

Fundus Autofluorescence (FAF), Optical Coherence Tomography (OCT), and Microperimetry (MP) of Category 4 Type 2 Idiopathic Macular Telangiectasia in 3 patients (*top row, Patient # 7 OD; middle row, Patient #8 OS ; bottom row, Patient #9, OS*). These eyes displayed a mixed pattern of areas of increased and decreased FAF signal, often in the configuration of a rim of increased signal surrounding a central area of decreased signal (*left panels*). Areas of pigment clumping on OCT appeared as zones of hyper-reflectivity in both the inner and outer retina, with varying amounts of retinal atrophy and disruption (*middle panels*). Scotomatous areas were evident in all cases in this category; with central positioning of the scotomata corresponding with decreased visual acuity (*right panels*).

Table

Clinical Characterization and Categorization of Type 2 Idiopathic Macular Telangiectasia in 12 patients using Multiple Modality Imaging Studies

Patient	Age/Sex	Eye	Visual Acuity	Fundus Autofluorescence	Fundus examination	Fluorescein angiography	Foveal Atrophy on OCT	Position of scotomata on microperimetry (MP)	Category
1	59/F	OD	20/16	Normal	Normal	Normal	Absent	Absent	0
		OS	20/100	Moderate ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Present	Foveal/Parafoveal	3
2	59/M	OD	20/25	Moderate ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Present	Parafoveal	3
		OS	20/40	Moderate ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Present	Parafoveal	3
3	67/M	OD	20/32	Mild ↑ FAF	Parafoveal Graying, Right-Angle Venules	Parafoveal Leakage	Absent	Absent	2
		OS	20/32	Mild ↑ FAF	Parafoveal Graying, Right-Angle Venules	Parafoveal Leakage	Absent	Absent	2
4	46/M	OD	20/160	Marked ↑ FAF	Parafoveal Graying, Crystalline Deposits	Parafoveal Leakage	Present	Foveal/Parafoveal	3
		OS	20/80	Marked ↑ FAF	Parafoveal Graying, Crystalline Deposits	Parafoveal Leakage	Present	Foveal/Parafoveal	3
5	44/M	OD	20/100	Marked ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Present	Foveal/Parafoveal	3
		OS	20/25	Marked ↑ FAF	Parafoveal Graying, Crystalline Deposits	Parafoveal Leakage	Present	Parafoveal	3
6	57/M	OD	20/125	Marked ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Present	Foveal	3
		OS	20/20	Mild ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Absent	Absent	2
7	60/F	OD	20/100	Mixed ↑ and ↓ FAF	Pigment Clumping	Parafoveal Leakage	Present	Foveal/Parafoveal	4
		OS	20/50	Mixed ↑ and ↓ FAF	Pigment Clumping	Parafoveal Leakage	Present	Parafoveal	4
8	69/M	OD	-	-	-	-	-	-	-

Patient	Age/Sex	Eye	Visual Acuity	Fundus Autofluorescence	Fundus examination	Fluorescein angiography	Foveal Atrophy on OCT	Position of scotomata on microperimetry (MP)	Category
		OS	20/80	Mixed ↑ and ↓ FAF	Pigment Clumping, Crystalline Deposits	Parafoveal Leakage	Present	Foveal/Parafoveal	4
9	70/F	OD	20/125	Mixed ↑ and ↓ FAF	Parafoveal Graying, Pigment Clumping	Parafoveal Leakage	Present	Foveal/Parafoveal	4
		OS	20/32	Mixed ↑ and ↓ FAF	Parafoveal Graying, Pigment Clumping	Parafoveal Leakage	Present	Parafoveal	4
10	57/M	OD	20/25	Moderate ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Absent	Absent	2
		OS	20/25	Mild ↑ FAF	Normal	Normal	Absent	Absent	1
11	47/F	OD	20/25	Moderate ↑ FAF	Parafoveal Graying	Parafoveal Leakage	Absent	N/A	2
		OS	-	-	-	-	-	-	-
12	80/F	OD	20/20	Mixed ↑ and ↓ FAF	Pigment Clumping	Parafoveal Leakage	Present	Parafoveal	4
		OS	20/200	Mixed ↑ and ↓ FAF	Pigment Clumping, Subfoveal Blood	Parafoveal Leakage	Present	Foveal/Parafoveal	4

FAF = Fundus autofluorescence, OCT = Optical coherence tomography, MP = Microperimetry