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PHASE-WISE CHARACTERIZATION OF MULTIFOCAL CHOROIDITIS USING THE BLEND FUNCTION IN ULTRA-WIDEFIELD IMAGING

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UWFI is a cutting-edge dual-laser imaging system with a unique blend function dividing the fundus into two distinct channels for detailed visualization. The red-free imaging (green channel) captures structures from the neurosensory retina to the RPE, while the infrared imaging (red channel) provides visualization of deeper structures, ranging from the RPE to the choroid. An objective approach for evaluating disease activity in multifocal choroiditis using the blend function of UWFI has been previously described, highlighting its potential as a valuable adjunct to FAF.
Utilizing the unique capabilities of the red and green channels, we aim to characterize imaging features specific to different phases of choroiditis and compare these findings with FAF imaging. We believe this approach will aid in better delineation of active areas, particularly in diagnostically challenging cases, offering a valuable tool for comprehensive disease evaluation and facilitate assessment of response to treatment.

A total of 15 patients presenting with different phases of choroiditis were evaluated using Ultra-Widefield Imaging (UWFI) and Ultra-Widefield Fundus Autofluorescence (UWF-FAF). Imaging was performed under mydriasis to ensure optimal image quality. The captured UWFI images were analyzed using red and green channels to identify specific imaging characteristics associated with the three distinct phases of choroiditis- active, resolving, and healed. For patients with a first active lesion or a recurrent active lesion, the course of the disease was carefully analyzed to detect subtle imaging changes that could aid in accurately diagnosing the disease stage. These findings also serve as a valuable adjunct to FAF imaging. This study systematically examines and summarizes the key imaging features observed during each phase, offering insights into the phase-wise progression and resolution of choroiditis.

A total of 15 patients (17 eyes) were included in the study, of which 12 were female (80%). Among these, 6 eyes (35%) presented with an active lesion for the first time, 4 eyes (23.5%) had active lesions on a background of previously healed lesions, and 7 eyes (41.5%) had fully healed lesions at the time of imaging. The red and green channel changes, along with FAF alterations, were analyzed in 5 eyes to evaluate disease progression over time. The detailed description of the characteristic changes observed on the red and green channels is provided below.

Active Phase

Active choroiditis lesions appeared as brighter areas with well-demarcation of the active border on the green channel imaging, making the active inflammatory borders distinctly visible. In contrast, while the fresh lesions were also detectable on the red channel, they exhibited faint brightness and lacked the sharply defined borders observed on the green channel. Interestingly, the active lesions were more clearly visualized and appreciated on the green channel compared to FAF imaging, which provided relatively less detailed delineation of the active inflammatory areas.(Figure 1)
Patients with choroiditis exhibiting very subtle activity or active lesions in areas of previously healed lesions showed discernible bright areas on the green channel, whereas these lesions were barely

detectable on the red channel. The green channel distinctly outlined the border of the active lesion, whereas FAF imaging showed diffuse hyperautofluorescence within the zone of the active lesion but did not clearly demarcate its borders.

Resolving Phase

During the resolution phase, the intensity of brightness on the green channel gradually decreases, with a notable reduction in the brightness marking the active borders. Additionally, the lesions may exhibit focal areas of darkness within, indicating regions that have already healed. On the red channel, the lesions become barely discernible or may not be visible at all, depending on the severity of the activity. In FAF imaging, both the intensity and the area of autofluorescence diminish. However, the lesion remains more distinctly delineated on the green channel.(Figure 2)

Healed Phase

Healed choroiditis lesions are characterized by focal areas of pigment clumping caused by RPE hyperplasia, interspersed with regions of RPE atrophy. On the green channel, these healed lesions appear as dull bright areas with an equally dull margin.The hyperpigmented RPE areas are well visualized on the red channel, appearing as dark patches. On FAF imaging, the healed areas present as uniformly diffuse dark zones.

Additionally, vascular changes such as inflammatory neovascularization at disc or elsewhere or vascular abnormalities like venous looping are prominently visible on the green channel, whereas these changes are not discernible on the red channel or FAF imaging.(Figure 3)

OCT findings in active choroiditis

OCT image of an active choroiditis lesion illustrates the involvement of the outer retina, including the RPE-photoreceptor complex. This involvement contributes to the detection of activity on the green channel.(Figure 6)

In our study, we observed some interesting findings when comparing FAF images with red and green channel images simultaneously. The green channel consistently provided better delineation of the active margins of the lesion, whereas FAF primarily displayed a diffuse autofluorescence signal in the area of activity. This distinction is particularly useful for documenting the reduction in disease activity over time. While FAF shows diffuse hyperautofluorescence that may decrease in intensity and size, this reduction is often subtle and subject to interobserver variability. In contrast, the green channel demonstrated a marked reduction in lesion brightness, along with fading margins, which can be objectively measured, thereby minimizing interobserver bias.This is clearly evident in Figure 2, where the green channel demonstrates a significant reduction in the brightness of the lesion margins after treatment (red arrow in c, g).

Additionally, findings on the red channel can aid in evaluating treatment response when analyzed alongside the green channel. For instance, as shown in Figure 4, only a very subtle reduction in the choroiditis lesion is noticeable on fundus photographs (4a, e). FAF images do not provide significant additional insight, as both follow-up scans continue to display diffuse autofluorescence with no substantial reduction in size. A careful comparison may reveal a slight decrease in autofluorescence intensity, but this can be easily overlooked.The green channel shows a reduction in lesion brightness, though not prominently. The most striking observation is in the red channel, where faintly discernible bright spots seen at presentation become undetectable at the seven-day follow-up. This highlights the

importance of not overlooking red channel findings, as they can often provide crucial insights when assessed alongside green channel images. Evaluating both channels together may enhance diagnostic accuracy and aid in making a more informed clinical decision.

To conclude, the integration of the blend function with FAF offers a more comprehensive imaging strategy, which could be particularly valuable in challenging cases where FAF alone may not provide sufficient clarity on disease activity. There are no other studies till date in the literature assessing the same using blend function. Further studies with larger cohorts could help establish standardized imaging criteria using the blend function, making it a more widely adopted tool in clinical practice.

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