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Original Article

Characterization and functional correlation of multiple imaging modalities with focal choroidal excavation

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Abstract

Background: To investigate the clinical manifestations and imaging features of near-infrared autofluorescence (NIA), infrared reflectance (IR), fundus autofluorescence (FAF), indocyanine green angiography (ICGA) and fluorescein angiography (FAG) in the detection of patients with focal choroidal excavation (FCE) identified by cross-sectional spectral-domain optical coherence tomography (SD-OCT).
Methods: This retrospective cross-sectional study included 12 eyes of 10 Taiwanese patients with FCE diagnosed by SD-OCT. The areas and depths of FCE in serial cross-sectional and en-face OCT were compared in different imaging modalities. NIA, IR, FAF, ICGA and FAG images were obtained. Best corrected visual acuity, subjective distortion area in the Amsler grid and history of maculopathies were also recorded.
Results: In areas where the choroid started to excavate as shown in SD-OCT, hypo-autofluorescence in NIA was noted. The area of hypo-fluorescence in NIA of all the FCE lesions showed good correlation with the size. The area of FCE was associated with complications such as choroidal neovascularization and central serous chorioretinopathy ($p = 0.014$, d.f $= 1$) and the volume (NIA area $\times$ Depth measured by SD-OCT $\times$ 1/3) was associated with subjective distortion strongly ($p = 0.051$, Spearman's correlation $= 0.600$).
Conclusion: Among all image modalities, NIA was the most sensitive tool in area measurement of FCE and peripheral lesion detection. Also, the volume of FCE was associated with subjective distortion and the area was related to complications. Recording the area and volume of FCE could play an important role in monitoring complications.

Keywords: Choroid-retina disease; Focal choroidal excavation; Near-infrared autofluorescence; Spectral-domain optical coherence tomography

1. Introduction

Focal choroidal excavation (FCE), a localized depression of the choroid over the macula, was first identified by time-domain optical coherence tomography (OCT) in 2006,[1] and subsequently in other reports.[2–5] Patients with FCE are generally associated with good visual acuity, mild metamorphopsia or without symptoms. However, FCE has been reported to be accompanied with choroidal neovascularization

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(CNV) and central serous chorioretinopathy (CSCR),[4,6−10] and it may develop during follow-up in asymptomatic patients.[5] CNV complexes have also been reported to develop within the boundary of the excavation.[10,11] The characteristic morphology of FCE is similar to the findings in patients at high risk of CSCR and CNV.[2] Other retinal conditions including polypoidal choroidal vasculopathy and age-related macular degeneration have also been shown to be associated with FCE.[3,5,12−14] Therefore, patients with FCE should regularly be monitored for the potential development of other retinal diseases.

In most patients, the presence of FCE is not clearly evident on routine clinical examinations. Subtle abnormalities with mild to moderate pigmentary disturbances on fundoscopy have been reported. Invasive imaging modalities such as fluorescein angiography (FAG) show varying degrees of hyper-fluorescence and hypo-fluorescence depending on the level of alteration in retinal pigment epithelium (RPE). Indocyanine green angiography (ICGA) may show hypo-fluorescence at the excavation. Currently, spectral-domain optical coherence tomography (SD-OCT) is used to detect morphologic details of FCE, and it is the most widely used non-invasive tool. However, in cases with bilateral involvement or multiple lesions in one eye,[2−4,15] SD-OCT of the fovea which is confined to the posterior pole may not detect all lesions.

To detect FCE lesions precisely and to monitor the development non-invasively, image tools play an important role. However, associations between the area and volume of FCE, visual acuity, functional status and complications have not been elucidated. Therefore, this study aimed to investigate the clinical manifestations and image features in 10 patients (12 eyes) using near-infrared autofluorescence (NIA), infrared reflectance (IR), fundus autofluorescence (FAF), ICGA and FAG to evaluate FCE confirmed by cross-sectional SD-OCT.

2. Methods

In the cross-sectional study, a total of 13 consecutive Taiwanese patients were identified with FCE at Cheng Hsin General Hospital and Taipei Veterans General Hospital during the period between October 2012 and August 2015. 12 eyes of 10 patients were followed for 3−36 months and included in our research. None of the patients had a history of trauma, posterior uveitis, prior retinal or choroidal infections or surgery. Study protocols were approved by the Institutional Review Board of Cheng Hsin General Hospital.

2.1. Imaging studies

The medical records of the patients were reviewed. The findings of clinical examinations including best-corrected visual acuity (BCVA), refraction, slit-lamp, intraocular pressure (IOP), ophthalmoscopy, fundus photography, FAG, ICGA, SD-OCT, enhanced depth imaging optical coherence tomography (EDI-OCT), multidimensional en-face optical coherence tomography (en-face OCT), FAF, NIA and IR image findings were also reviewed.

FAG and ICGA were performed in five eyes of four patients presenting with CSCR (Figs. 3 and 4) and CNV (Fig. 2) by Heidelberg retinal angiography (HRA; Heidelberg Engineering, Heidelberg, Germany).

The choroidal excavation was detected by SD-OCT (Spectralis HRA-OCT; Heidelberg Engineering, Heidelberg, Germany). The factors investigated by SD-OCT were documented in cone-shaped, bowl-shaped, and mixed types of FCE. Lesions were further subdivided into conforming and non-conforming groups.[6] The conforming group was defined as no separation of the photoreceptor tips and RPE (Figs. 1, 2, and 4), and the non-conforming group was defined where the photoreceptors appeared to be detached from the RPE with an intervening hypo-reflective space (Fig. 3). The depth of each excavation was measured using internal caliper software with images crossing the center of the excavation (Fig. 4). Morphologic characteristics of the retina were analyzed by SD-OCT (Fig. 1) including the retinal nerve fiber layer (RNFL), ganglion cell layer (GCL), inner plexiform layer (IPL), inner nuclear layer (INL), outer plexiform layer (OPL), outer nuclear layer (ONL), external limiting membrane (ELM), myoid zone (MZ), ellipsoid zone (EZ), interdigitation zone (IZ), and the retinal pigment epithelial band (RPE/Bruch's band).

EDI-OCT images were taken to evaluate the choroidal morphologic features, including the shape of the chorioscleral border, the choriocapillaris (CC), the deeper choroidal vessels (Sattler's and Haller's layer), the choroidal thickness at the deepest portion of the FCE lesion, and the maximal thickness of choroid adjacent to the FCE lesion (Fig. 4). En-face OCT was used to evaluate the characteristics of FCE (Figs. 1 and 4).

FAF (diode laser light, short-wavelength; excitation 486 nm; emission > 500 nm), NIA (diode laser light; excitation 786 nm; emission 800 nm) and IR (diode laser light; excitation 815 nm) images were obtained using a confocal scanning laser ophthalmoscope (SLO) (Heidelberg Engineering Spectralis HRA) and were evaluated by two examiners.

2.2. Clinical manifestations

The complication of FCE such as CNV and CSCR were diagnosed by using SD-OCT and FAG.

2.3. Statistical analysis

The BCVA was converted to the logarithm of the minimal angle of resolution (logMAR) to facilitate a visual comparison and statistical analysis. In the univariate analysis, Mann−Whitney *U* test was calculated for continuous variables. Spearman correlation coefficient method was applied to investigate the relationship between volume, subjective distortion and associated continuous factors. The Kruskal−Wallis test was used to compare the area of FCE to the accompanied complication such as CNV and CSCR. Statistical analysis was performed using SPSS 20.0. A p-value of <0.05 was considered statistically significant.