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The application of optical coherence tomography angiography in uveitis and inflammatory eye diseases

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ABSTRACT

Since its introduction in the early 1990s, optical coherence tomography (OCT) has evolved in resolution and technological advances, and in recent years its initial application of assessing the morphology of a tissue has been implemented by the study of its functional blood flow, through optical coherence tomography angiography (OCTA). This novel technique details capillary networks by comparing the amount of light returned from static and moving targets without the need for intravenous dye administration. While this imaging modality has been used for various ocular conditions, the application OCTA to uveitis conditions remains sparse.

This review aims to establish the basis of OCTA and its current application to ocular inflammatory disorders, with an emphasis on monitoring progression and response to treatment, as well as predicting visual complications. In particular, this review explores the use of OCTA in iris vessel dilation seen in various forms of iritis, as a predictive factor for further episodes of inflammation. OCTA can also depict ischemia in the deep plexus layers of the retina and identify true choroicapillaris ischemia in cases of placoid diseases or masking of the indocyanine green dye, as in multiple evanescent white dot syndrome. In addition, OCTA can depict neovascularization in granulomatous disease of the retina or choroid not previously depicted with previous imaging methods. While OCTA provides several advancements in the imaging, management and prognosis of uveitis diseases, we emphasize that further studies are required to fully understand its application to these conditions.

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1. Introduction

The intraocular vascular networks are complex, multilayered and critical to ocular function (Gorczynska et al., 2016). Intraocular inflammation can be associated with various vascular flow abnormalities in a wide spectrum of uveitic disorders. Recognizing patterns of disruption is integral to the diagnosis and management of these conditions. In uveitic conditions in particular, abnormal flow has been documented in the iris (Pichi et al, 2016a) in patients with acute anterior uveitis, in the inner retina (birdshot chorioretinopathy) (Phasukkijwatana et al., 2016), in the inner choroid (acute posterior multifocal placoid pigment epitheliopathy) (Klufas et al., 2017; Salvatore et al., 2016) and in the outer choroid (birdshot chorioretinopathy (Phasukkijwatana et al., 2016), multifocal choroiditis (Cerquaglia et al., 2016), vogt-koyanagi-harada disease (Aggarwal et al., 2016), and tuberculosis [Agarwal et al., 2016]). Various imaging modalities exist, including optical coherence tomography (OCT), optical coherence tomography angiography (OCTA), fluorescein angiography (FA) and indocyanine green angiography (ICGA). This review aims to discuss the imaging modalities previously used for uveitis and review the importance of OCTA as an advanced tool for the evaluation of uveitic conditions.

1.1. Dye-based angiography of the vasculature of the eye

The gold standard modalities for the imaging of retinal and choroidal vessel morphology are fluorescein angiography (FA) and indocyanine green angiography (ICGA) (Gorczynska et al., 2016), but these procedures are invasive and require the injection of an intravenous dyes that may be poorly tolerated and associated with rare serious side effects (Yannuzzi et al., 1986; Hope-Ross et al., 1994). These imaging techniques are, in addition, time and labor intensive and require the skilled administration of contrast agents and the capture of flow at appropriate time frames. Further, leakage with IVFA can obscure the identification of morphological vascular detail, and window defects can prevent accurate analysis of retinal detail. The ICG molecule on the other hand is normally absorbed by the healthy RPE, contributing to the physiological background hyperfluorescence (Chang et al., 2005). RPE mottling or disruption of the ellipsoid zone can produce areas of hypofluorescence that may be misinterpreted as being located in the choroid.

Moreover, these modalities provide two dimensional evaluation of the retina and choroid and are unable to identify the level of vascular abnormalities. These drawbacks limit the routine use of dye-based angiography during each clinical visit for patients to monitor for disease presence and progression.

1.2. Optical coherence tomography angiography

Optical coherence tomography angiography has emerged a non-invasive alternative technique for the imaging of the retinal and choroidal vasculature (Fingler et al., 2007). It provides an accurate depiction of the microvasculature morphology of the retinal and choroidal blood vessels, without obscuration from leakage. This allows monitoring of disease processes in situations where vascular details can be obscured by leakage. Moreover, OCTA allows for segmentation of retinal and choroidal layers and localization of abnormalities (Fingler et al., 2008). The basis of OCTA relies on the reflectance of a light source off the surface of moving blood cells, eliminating the need for dyes.

OCTA is an expansion off the imaging processes of SD-OCT, in order to visualize flow through different segmented areas of ocular tissue. (Spaide et al, 2015a). OCT, in brief, is an imaging modality which creates cross-sectional representations of tissue from various, consecutive scans at varying depths. Initially, OCT images were gathered through time-domain detection, but later