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DIABETIC RETINOPATHY UPDATE

Predicting visual outcomes for macular disease using optical coherence tomography

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Abstract In recent years, the management of macular disease has undergone radical changes, in part because of new therapeutic approaches, but also due to the introduction of a new imaging modality – optical coherence tomography (OCT). The application of OCT imaging has clarified many aspects of chorioretinal disease pathophysiology and elucidated many hitherto unrecognized disease characteristics. From an early stage in its development, OCT has also been revolutionary in attempting to extract clinically useful measurements from image data in an automated fashion. As a

Abbreviations: ETDRS, Early Treatment Diabetic Retinopathy Study; MPS, Macular Photocoagulation Study; AMD, age-related macular degeneration; OCT, optical coherence tomography; logMAR, logarithm of the minimum angle of resolution; RPE, retinal pigment epithelium; CNV, choroidal neovascularization; ELM, external limiting membrane; IS–OS, inner segment–outer segment; PED, pigment epithelium detachment; CME, cystoid macular edema; ERM, epiretinal membrane; DME, diabetic macular edema; CRVO, central retinal vein occlusion; BRVO, branch retinal vein occlusion; CSC, central serous chorioretinopathy; GA, geographic atrophy.

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result, OCT-derived measurements of retinal thickness have been rapidly embraced in clinical and research settings. However, as knowledge of OCT image analysis has developed, it has become increasingly clear that even accurate measurements of retinal thickness may fail to predict visual outcomes for many diseases. As a result, the focus of much current clinical imaging research is on the identification of other OCT-derived anatomic biomarkers predictive of visual outcomes – such biomarkers could serve as surrogate endpoints in clinical trials and provide prognostic information in clinical practice. In this review, we begin by highlighting the importance of accurate visual function assessment and describing the fundamentals of OCT image evaluation, before describing the current state-of-the-art with regard to predicting visual outcomes, for a variety of macular diseases, using OCT.

Contents

1. Introduction

The advent of fundus fluorescein angiography in the 1960s heralded a revolution in our understanding of macular diseases, with the insights afforded by such imaging providing the basis for the development and application of many new therapeutic approaches (Keane and Sadda, 2010). At the same time, advances in color photography led to the acquisition of fundus images with enhanced resolution, stereopsis, and field of view, allowing medical retina specialists to segregate the retinal from the choroidal circulations and to isolate anatomic compartments within the fundus (Yannuzzi et al., 2004). Thus, fluorescein angiography and stereoscopic color fundus photography came to form the fundamental basis for the care of patients with macular disease and were quickly incorporated into related clinical trials. In these trials, photographic and angiographic derived parameters were adopted as anatomic endpoints, with the information providing helping to optimize many new therapeutic approaches (Fine, 2005). For example, in the Early Treatment Diabetic Retinopathy Study (ETDRS) color photography was used to define a subset of patients with diabetic maculopathy who were likely to benefit from laser photocoagulation (Early Treatment Diabetic Retinopathy Study Research Group, 1985); and in the Macular Photocoagulation Study (MPS) the importance of recognizing "classic" and "occult" patterns of fluorescein leakage was identified in patients receiving treatment for neovascular age-related macular degeneration (AMD) (Macular Photocoagulation Study Group, 1996).

More recently, evaluation of macular disease has undergone a further revolution, with the introduction of a wholly new imaging modality – optical coherence tomography (OCT) (Keane and Sadda, 2008). OCT is analogous to ultrasonography, but utilizes light waves instead of sound waves, thus providing cross-sectional images of the retina with unprecedented detail and resolution, and in a non-invasive manner (Drexler and Fujimoto, 2008; Schuman et al., 2004). The application of this imaging modality by medical retina specialists has clarified many aspects of chorioretinal disease pathophys-