Development of an Advanced Retinal Imaging System

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Technology description

This diagnostic device enables tests for early stage detection of diabetic retinopathy (DR) and age-related macular degeneration (AMD) through in vivo non-invasive imaging of retinal sO2 measurement and retinal pigment epithelium imaging. The device integrates three imaging modalities: photoacoustic ophthalmoscopy (PAOM), optical coherence tomography (OCT), and auto-fluorescence (AF) on a slit lamp bio-microscope. Visual and quantitative data is collected in one pass and presented in an integrated view for research or diagnostic use.

The inventors have developed techniques for functional photoacoustic ophthalmoscopy (PAOM) of the eye to provide structural and functional information of the retinal vessels. This method provides a novel non-invasive technique to detect and study early development of DR and AMD. Existing technologies are less sensitive and provide only indirect measurements with less rigorous calculation methods. Dr. Zhang and Jiao' s photoacoustic imaging technique is the only single technology that permits direct imaging of both the anatomy and blood hemoglobin oxygen saturation of the retinal vessels with high spatial resolution.

Visual loss is often considered the most feared complication of human disease, other than death [1]. Among all the causes that lead to irreversible vision loss, diabetic retinopathy (DR) remains a leading cause. DR is a retinal vascular disorder that occurs as a complication of diabetes mellitus (DM). It is estimated that 25.6 million adults 20 years of age and older known to have DM in the U.S. If DR can be detected, treated, and managed successfully, the economic impact would be tremendous. For example, laser treatment and surgery for DR lead to an annual societal savings of $1.6 billion. The current clinical treatment for late stage DR is associated with unavoidable side effects such as diminished peripheral and night vision and decreased vision sensitivity. Increasing importance has been placed on treatments that detect the progression of DR earlier in order to prevent the damage which leads to vision loss.

Application area

Retinal diseases are the major cause of blindness in developed countries. The accurate diagnosis and management of retinal diseases is highly depend on non-invasive imaging techniques. Currently, there is no ophthalmic imaging modality suitable for early detection of DR and AMD through quantitative sO2 and RPE imaging. The American Diabetes Association tallied 25.8 million people with diabetes in the United States in 2011 and many of them are at risk to develop DR. According to the U.S. Centers for

Disease Control and Prevention, about 5 million people are affected by DR with new cases increasing at 8% each year. Up to 50% of patients are not getting their eyes examined or are diagnosed too late for effective treatment. DR is the leading cause of blindness in adults aged 20-74 in the U.S. The CDC estimates that 1.8 million Americans over age 40 are affected by AMD, and it is expected to reach 2.95 million in 2020. These large populations represent a significant patient pool that would benefit greatly from more routine and reliable testing for early stage DR or AMD.
Other potential applications include diseases that can be diagnosed through morphology and function of the retinal vessels such as stroke, Alzheimer’ s disease, and hypertensive retinopathy. There is also a potential use in the study of glaucoma in which OCT is utilized to diagnose central retinal vein occlusion.

Advantages

Non-invasive –A non-invasive instrument for detection of early stage DR and AMD
High Resolution –Design provides high imaging speed and localization precision
Early Detection –DR and AMD can be treated before irreversible damage occurs
More informative –Capable of providing comprehensive physiological information
Large patient pool –DR numbers continue to rise; earlier detection is essential for positive outcomes

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