Systemic Associations of Dynamic Retinal Vessel Analysis: A Review of Current Literature

MICHELLE LIM,*† MUHAMMAD B. SASONGKO,*‡ MOHAMMAD K. IKRAM,*§ ECOSSE LAMOUREUX,*† JIE JIN WANG,*† TIEN YIN WONG,*†§ AND CAROL Y. CHEUNG†§

*Centre for Eye Research Australia, University of Melbourne, Melbourne, Australia; †Singapore Eye Research Institute, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; ‡Department of Ophthalmology, Faculty of Medicine, Gadjah Mada University, Yogyakarta, Indonesia; §Department of Ophthalmology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; ‡Centre for Vision Research, University of Sydney, Melbourne, Australia; ‡Centre for Quantitative Medicine, Duke-NUS Graduate Medical School, Singapore

Address for Correspondence: Carol Y Cheung, Ph.D., Singapore Eye Research Institute, 11 Third Hospital Avenue, Singapore 168751.
E-mail: carol.cheung.y.l@seri.com.sg

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ABSTRACT

Endothelial dysfunction is a key pathogenic mechanism of CVD. The retinal microvascular network offers a unique, non-invasive window to study endothelial function. Recently, dynamic measurement of retinal vessel caliber using flicker light stimulation has been used to evaluate potential endothelial dysfunction and other mechanisms in CVD. A variety of studies now indicate that retinal vasodilation during flicker light stimulation is reduced in diabetes, hypertension, hyperlipidemia and obesity, and may be influenced by age and race/ethnicity. These data suggest that flicker light-induced retinal vasodilation may be a unique and non-invasive measure of endothelial dysfunction. This review focuses recent studies on systemic associations of flicker light-induced retinal vasodilation, and discusses the potential for future research in this area.

Key words: cardiovascular diseases, retinal vascular imaging, dynamic vessel analyzer, endothelial dysfunction

Abbreviations used: AMD, age-related macular degeneration; BMI, body mass index; CVD, cardiovascular diseases; DR, diabetic retinopathy; DVA, dynamic vessel analyzer; ERG, electroretinogram; FMD flow-mediated dilation; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NO, nitric oxide; RVA, retinal vessel analyzer.


INTRODUCTION

There is increasing evidence that endothelial dysfunction plays a key role in the pathogenesis of atherosclerosis and CVD [58,73]. However, there remain few widely used methods to measure endothelial function. Brachial artery FMD, for example, has varying protocols of use across laboratories, and is also highly operator-dependent [5,71]. Therefore, there has been a growing interest for an even more reliable method of measuring endothelial function.

The retinal microvasculature provides a unique window to study the state of the microcirculatory system elsewhere in the body, and may reflect similar processes in the pathophysiology of a range of CVD such as stroke, coronary heart disease, and hypertension [77,80]. Retinal vascular caliber changes, assessed quantitatively from fundus photographs, have been shown to predict CVD (e.g., stroke and heart disease) independent of traditional risk factors, suggesting that retinal vascular changes may convey additional prognostic information than other risk measures of CVD [14,15,76,78,79]. However, assessments of retinal vasculature from fundus photographs only provide morphological information from a single point of measurement at a given time.

The DVA (Imedos, Jena, Germany) is a relatively new method that allows for online measurement of retinal vessel diameter changes during flicker light stimulation, and is a measurement of vascular reactivity in the retinal microcirculation. It has been suggested that retinal vasodilation during diffuse luminance flicker may reflect endothelial functioning of the retinal microvasculature [44,54], and therefore, functional assessments of the retinal microcirculation may be more useful in risk prediction of CVD than static analysis alone [36]. However, mechanisms underpinning these changes are complex, and several important issues need to be addressed before DVA can be used as a measure of endothelial dysfunction in the clinical setting.

The aims of this review were to (i) discuss potential mechanisms underlying changes in retinal vasculature measured...