Editorial

Oculomics – The eyes talk a great deal

"The soul, fortunately, has an interpreter – often an unconscious but still a faithful interpreter – in the eye." - Charlotte Bronte

Retina being the only directly accessible extension of the brain allows non-invasive real-time characterization of the microvascular structure and function of the central nervous system. *Oculome* denotes the composite set of macroscopic, microscopic, and molecular ophthalmic features associated with health and disease.[1] Comprehensive decrypting of the oculome by integrating the information generated by multimodal imaging to identify the specific ophthalmic biomarkers of systemic diseases is termed *oculomics*.[1] The goal of oculomics is to develop rapid, noninvasive, cost-effective biomarkers to screen and diagnose systemic diseases and stratify the risks to prioritize treatment.[1] Biomarkers are defined as objective parameters that help predict, assess, or diagnose a disease and plan treatment.[2] The convergence of big data, artificial intelligence (AI), and oculomics and their robust integration has helped make the biomarkers reliable and reproducible enough to be used in clinical applications.[3]

The major driving force in the process of oculomics has been the development and refinement of optical coherence tomography (OCT) and OCT Angiography (OCTA), based on which specific "retinal fingerprints" can be generated. The origin of OCT dates to the 1980s when Adolf Fercher used white-light interferometry to image ocular tissues, followed by Naohiro Tanno's development of heterodyne reflectance tomography in 1990, and coining of the term OCT as we know it today by David Huang in 1991.[4] Evolution in OCT technology from time-domain to the spectral domain to swept-source has resulted in better image quality, axial resolution, and speed of acquisition. Reliable quantitative thickness measurement has been made possible using image processing and layered segmentation. OCT has revolutionized the understanding, diagnosis, and management of the entire spectrum of retinal diseases and has established itself as one of the most frequently used imaging tools in ophthalmology.

Developed as an extension to OCT using motion contrast to detect blood flow, and commercially available since 2014, OCTA allows visualization of depth-resolved retinal microvasculature in vivo.[5] Segmentation of volumetric data facilitates identification of retinal capillary plexuses individually in high resolution and improved visualization of the deep capillary plexus and choroid.[5] Specific details of retinal structure and microvasculature generated by OCT and OCTA and their correlation with systemic diseases have helped establish several retinal biomarkers for systemic health.[6,7] Some of the recent developments such as Doppler OCT to measure retinal blood flow, visible wavelength OCT, hyperspectral fundus imaging, and retinal oximetry have contributed to further understanding of the retinal biomarkers.[3] The application of deep learning, code-free deep learning and convolutional neural networks to information derived out of retinal imaging has tremendously improved the speed of identification of the biomarkers and their sensitivity and specificity.[3]

Oculomics has helped identify retinal biomarkers for several neurological (multiple sclerosis, Parkinson's disease, Alzheimer's disease, neuromyelitis optica, longitudinally extensive transverse myelitis, idiopathic intracranial hypertension, migraine, and chiasmal compression), psychiatric (schizophrenia, depression, bipolar disorder), cardiovascular (individual systemic risk factors associated with cardiovascular diseases, and coronary heart disease), hematological (sickle cell disease, thalassemia, leukemia), nutritional (vitamin B12 and D deficiency), respiratory (obstructive sleep apnea), autoimmune (rheumatoid arthritis, systemic lupus erythematosus, Bechet's), infectious (human immunodeficiency virus) and renal diseases, and drug toxicity (ethambutol, chloroquine, lead, deferoxamine, sildenafil, and tamoxifen, etc.).[6,7] This issue of the Indian Journal of Ophthalmology carries articles on OCTA in multiple sclerosis, celiac disease, and following caffeine intake.[8-10] With several multi-disciplinary teams passionately working on it and generating a tremendous amount of useful data, oculomics seems to have the potential to arrive bigtime at clinical applications fairly soon.

If "*eye is the lamp of the body*" (Matthew 6:22), then AI is the wick, retinal imaging the oil that feeds it, and oculomics is the light of the lamp, of course!

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