

## A New Insight into Ophthalmology: Calculation of Choroidal Vascularity Index

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The significance of the choroid in ophthalmology is increasing day by day. The unknowns about the choroid continue to be elucidated in light of many studies in the literature thanks to the development of optical coherence tomography (OCT) technology and the use of enhanced depth imaging (EDI) features.

The primary function of the choroidal layer, which is mainly composed of blood vessels, is to provide blood supply to the outer retina. Interstitial stroma containing melanocytes and connective tissue are other structures that make up the choroid along with blood vessels [1]. Today, the choroidal layer has at least three other main functions, which are thermoregulation, adjustment of retinal position by choroidal thickness change and secretion of growth factors. Any defect that may occur in the choroidal layer may lead to degeneration, neovascularization, myopia, or hyperopia due to impaired emmetropization and possibly the initiation of various pathological processes that would be revealed through further studies [2]. The choroid plays a crucial role not only in choroidal inflammation but also in retinochoroidal diseases, which are common in populations, such as diabetic retinopathy (DRP) and age-related macular degeneration (AMD) [1].

There are many studies in the literature assessing the relationship of the choroidal thickness (CT) with various eye and extra-ocular diseases. On the other hand, in most of these studies, physiological factors, such as age, sex, diurnal variation and refractive error, are emphasized as limitations that may affect CT. Besides, the inability of CT measurement to assess the stromal and luminal components, which make up the choroid, separately, and the

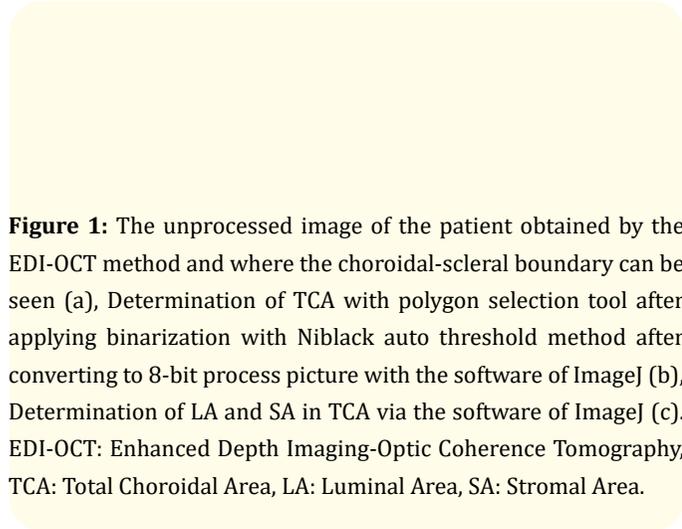
non-uniform vascular structure of the choroid make morphometric measurements challenging. When the results of the studies and the limitations are considered together, the findings suggest that CT is not a robust parameter that can be used alone in clinical research [1,3,4].

For the first time, in 2013, Branchini, *et al.* were able to evaluate the luminal and stromal areas of the choroidal layer separately using the software of MATLAB (Natick, MA: The Math Works Inc.). Subsequently, in 2015, Sonoda, *et al.* succeeded in evaluating the luminal and stromal components of the choroidal layer using the Niblack binarization method through an open-source program called ImageJ (National Institutes of Health, Bethesda, MD, USA). Following this study, Agrawal, *et al.* analyzed the luminal area (LA) and stromal areas (SA) using a method very similar to the study of Sonoda, *et al.* in 2016, and they have introduced the new parameter, namely the choroidal vascularity index (CVI), which is calculated as the ratio of luminal area to total choroidal area (TCA), to the ophthalmology literature [1,3-5]. In general terms, in images taken by EDI-OCT (Figure 1a), the area between the retinal pigment epithelium and sclera (TCA) is determined by marking, while LA and SA analysis (Figure 1c) is performed by binarization method with Niblack or other methods (Figure 1b) and CVI is calculated.

Hitherto, we have seen many studies in which CVI has been calculated, such as studies evaluating healthy volunteers, hereditary retinal diseases, inflammatory chorioretinal diseases, spectrum of pachychoroid disease, and common diseases such as AMD, myopia, DRP, glaucoma, as well as the studies comparing patients with ar-

teritic/non-arteritic anterior ischemic optic neuropathy, and evaluating hemodialysis patients, amblyopic patients, and patients who underwent cataract and macular surgery [4].

5. Branchini Lauren A., *et al.* "Analysis of Choroidal Morphologic Features and Vasculature in Healthy Eyes Using Spectral-Domain Optical Coherence Tomography". *Ophthalmology* 120.9 (2013): 1901-1908.



**Figure 1:** The unprocessed image of the patient obtained by the EDI-OCT method and where the choroidal-scleral boundary can be seen (a), Determination of TCA with polygon selection tool after applying binarization with Niblack auto threshold method after converting to 8-bit process picture with the software of ImageJ (b), Determination of LA and SA in TCA via the software of ImageJ (c). EDI-OCT: Enhanced Depth Imaging-Optic Coherence Tomography, TCA: Total Choroidal Area, LA: Luminal Area, SA: Stromal Area.

In conclusion, thanks to the studies based on CVI calculation are increasing day by day, our knowledge about the choroid increases even more. Choroidal vascularity index is considered to be a much more powerful parameter and predictor compared to CT, as well as promising. Further studies in many more diseases, on patient/control groups with higher populations are needed.

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