Calculation and mapping of choroidal thickness in OCT images

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Abstract

Purpose : Although the choroidal thickness (ChT) is a pertinent sign to assess ocular health, its analysis is not common because it takes time to manually segment it. Recent imaging developments in Optical Coherence Tomography (OCT) enable a better observation of deeper structures of the eye, like the choroid. We developed an application that automatically estimates ChT, allowing the ophthalmologist to promptly analyze the data and reducing the subjectivity and time consumption of the manual segmentation.

Methods : To estimate the ChT, we used Enhanced Depth Imaging OCT B-scans from a Spectralis system (Heidelberg Enginnering, Germany). The automatic methodology can be split into three main parts: preprocessing, delineation of both choroidal limits - the Bruch's Membrane (BM) and Choroidal-Scleral Interface (CSI) - and finally ChT calculation. The preprocessing includes: contrast adjustment (different for each limit), reduction of the shadows cast by retinal vessels and the reduction of the speckle noise using a Stationary Wavelet Transform. The BM and CSI are delineated resorting to a minimum weight path algorithm (Fig. 1). The ChT is the distance between the two delineated limits in the scanned area. Measurements in a series of B-scans can be interpolated and mapped in the fundus image, as shown in Fig. 2; an application was developed for this purpose. A manual segmentation of BM and CSI was outlined by 2 OCT expert ophthalmologists in 8 macular volume videos with 19 B-scans each.

Results : The mean absolute errors (MAE) between the automatic and each manual segmentation (7,5±3,2% and 7,9±4,4%) were comparable to the differences between the two manual segmentations (7,8±3,6%).To assess precision, differences were calculated between interpolations of the ChT of orthogonal series of B-scans. The difference of the automatic ChT (4,4±4,5%) is lower than the differences in the manual segmentations (5,5±4,5% and 6,1±5,0%).
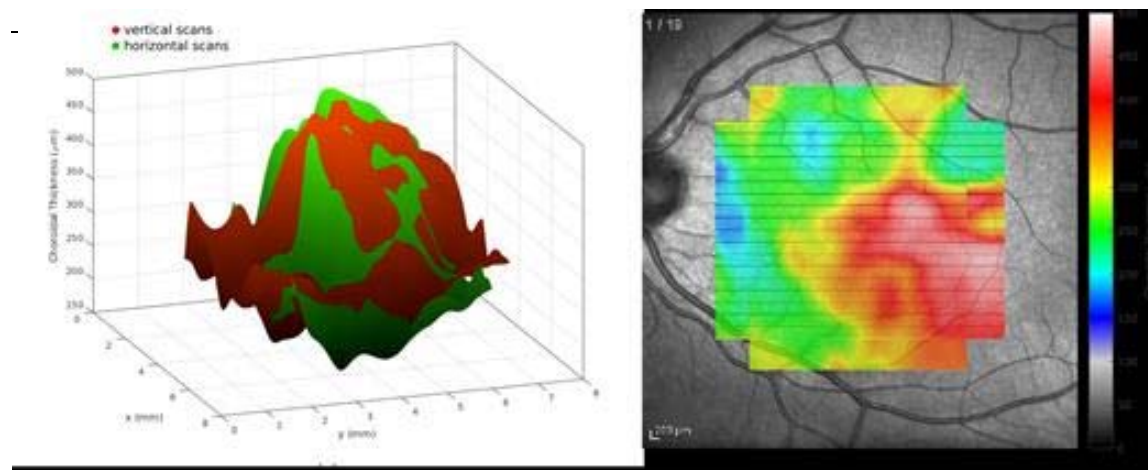
Conclusions : The automatic estimation of the ChT was successful, with a higher precision than the manual. The developed application allows the physician to easily access the ChT profile information, as well as, if necessary, perform a manual correction to the automatic segmentation.

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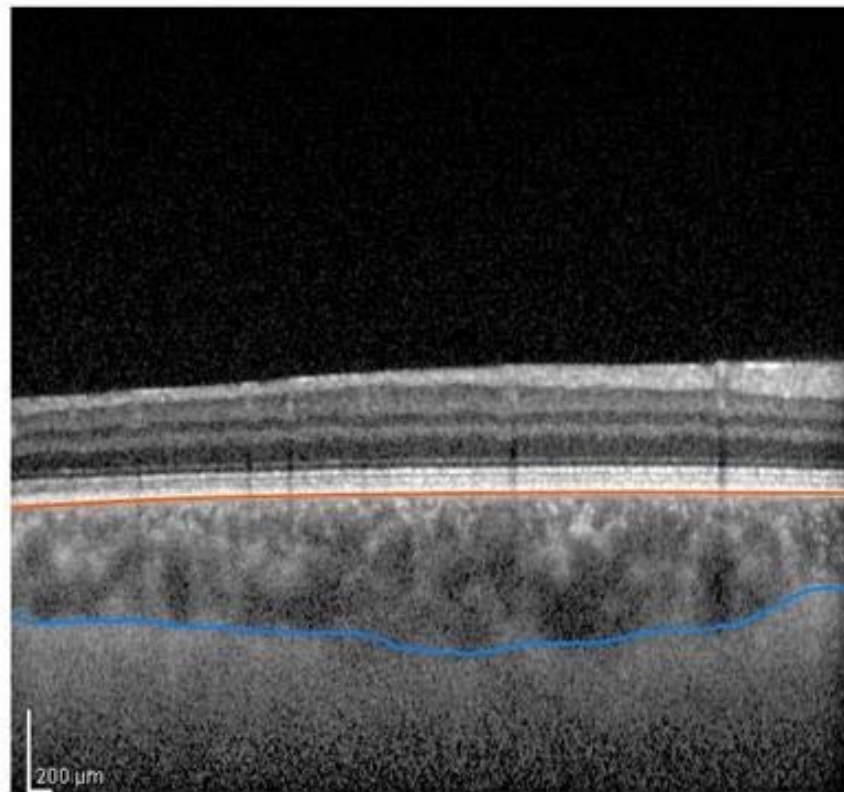
OCT image with automatically detected choroidal limits: BM (orange), CSI (blue).

Two orthogonal series of B-scans (a) interpolated and (b) mapped on the fundus image with a colormap.