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Feasibility of Rapid, Automated Analysis of Macular Thickness in a Population Study: Approach to Analysis of Spectral-domain OCT Images from 67,321 Subjects in the UK Biobank Study

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Purpose

- To report the feasibility of automated segmentation of spectral-domain optical coherence tomography (OCT) images collected as part of the ocular module of the UK Biobank dataset.
- The primary outcome was the number and proportion of images successfully segmented using remote access to the Topcon 3D OCT-1000 Mark II OCT images collected and stored by UK Biobank. This research has been conducted using the UK Biobank Resource.

Methods

- The UK Biobank study is a very large, prospective, cohort study which has recruited 503,000 UK adults between 40 – 69 years of age between 2006 – 2010 at 22 recruitment centres in rented office space mainly in large UK cities (www.ukbiobank.ac.uk)
- Baseline data on lifestyle, environment, personal & family medical history, physical measures & biological samples were collected with the potential for follow-up for disease outcomes over 10-20 years.
- The aim of UK Biobank is to establish genetic and environmental determinants of common diseases of middle and old age and improve the prevention, diagnosis and treatment of diseases such as cancer, heart disease, stroke, arthritis and dementia
- A proportion of these subjects (approximately 100,000) had ocular assessments performed and a subset of these patients had spectral-domain optical coherence tomography imaging (SDOCT) using the Topcon 3D-1000 Mark II OCT.
- The images have been stored as *.fds* and *.fda* files at the UK Biobank data repository in Oxford, UK.
- We have formed a multi-disciplinary research group across academia, industry and the NHS to develop a rapid and automated analysis of the retinal thickness measurements derived from the stored OCT data files.
- The latest segmentation algorithm (Topcon Advanced Boundary Segmentation; TABS™)[1,2,3] developed by the Topcon Advanced Biomedical Imaging Laboratory (TABIL) was used to delineate the inner and outer retinal surfaces.
- As part of the UK Biobank data access rules and procedures for bulk data, the stored OCT files (source data) could not be copied, stored or removed outside the local Biobank network. Instead, researchers are given access to computers at the central Biobank data repository via remote, secure login and can then install any analysis software needed on the UKBB computers. A copy of the stored OCT image file needs to be fetched before running the segmentation analysis software. The derived data are then extracted, after which the OCT image file is deleted. Multiple logins can be implemented in parallel, increasing the processing throughput. After logging in remotely to the Biobank network, we used TABS™ to analyse the stored OCT images.

Example of segmentation

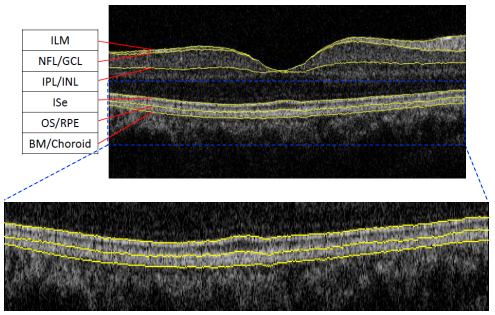

Fig. 1 Sample OCT image with segmented boundaries overlaid. ILM (Inner Limiting Membrane), NFL/GCL (boundary between nerve fibre layer and ganglion cell layer), IPL/INL (boundary between inner plexiform layer and inner nuclear layer), ISe (inner segment ellipsoids), OS/RPE (boundary between outer segment and retinal pigment epithelium) and BM/Choroid (boundary between Bruch's membrane and the choroid).

Results

- A total of 134,642 macular OCT images were available for processing from 134,642 eyes of 67,321 patients.
- Of these images, 134,611 images were successfully processed with 31 images failing segmentation analysis due to withdrawal of subject consent for UK Biobank study participation or corrupted OCT files (successful analysis in 99.98% of images).
- The mean (±SD) age of patients was 57 (±8) years with 36,623 females and 30,698 males.
- Average time taken to fetch each data set from the data base was approximately 70 seconds and to complete segmentation analysis was approximately 58 seconds. Effective throughput was up to 12 times greater than these per login times by utilizing multiple logins in parallel.
- The average signal strength (Q factor) for all images was 65 (±13).

Conclusions

- Rapid, remote, automated analysis is a feasible approach to analyze macular thickness measurements from stored OCT images. This approach may be used to analyze and extract OCT derived macular thickness measurements in future population studies.

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References

[1] Yang Q, Reisman CA, Wang Z, Fukuma Y, Hangai M, Yoshimura N, Tomidokoro A, Araie M, Raza AS, Hood DC, Chan K. "Automated layer segmentation of macular OCT images using dual-scale gradient information. " Opt Express. 2010; 18(20):21293-307.

[2] Topcon Corp. "Improved OCT Layer Measurement Repeatability Using Topcon's Advanced Boundary Segmentation (TABS™) Algorithm." 2013; 5 pages. https://www.topcon.co.jp/cgi/en/eyecare/download/index.cgi?filename=Topcon_whitepaper_01_Improved_OCT_Layer.pdf

[3] Topcon Corp. "OCT Layer Measurement Using the Topcon Advanced Boundary Segmentation (TABS™) Algorithm: A Comparison Study." 2013; 4 pages. https://www.topcon.co.jp/cgi/en/eyecare/download/index.cgi?filename=Topcon_whitepaper_02_OCT_Layer_Measurement.pdf