Automated Detection of Retinoblastoma Tumour and Treatment Response Using Optical Coherence Tomography Analysis

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Introduction: Retinoblastoma (RB) is the most common ocular malignancy affecting pediatric populations. Optical coherence tomography (OCT) enables in vivo imaging of the retina and plays an instrumental role in the diagnosis and management of ocular diseases. There are several treatment options for RB, including enucleation and laser- or cryo-ablation. OCT is used to aid in the diagnosis of RB, guide treatment decisions, and assess treatment response. Extensive evaluation of multiple OCT scans over several visits is required to ensure adequate identification and treatment of RB tumors with focal ablation. This process is susceptible to human error, and automation is warranted to optimize patient outcomes. Therefore, the purpose of this study was to manually segment OCT scans of a patient with RB to develop automated methods for segmenting and co-registering sequential OCT scans.

Methods: OCT B-scans from an RB patient were manually annotated using 3D Slicer. Specifically, RB tumor margins, scar boundaries, and additional retinal landmarks (e.g., sclera, inner nuclear layer-outer plexiform layer junction, internal limiting membrane) were annotated to serve as a reference for quantitative and qualitative validation of an automated segmentation algorithm. A convolutional neural network (i.e., U-Net) was trained for each class for 50 epochs with a learning rate of 1e-4. The training dataset was composed of 75% of segmented images, and the model was subsequently evaluated on a test dataset consisting of 25% of segmented images. Jaccard index (JI) was computed for each segmentation class to evaluate the segmentation performance of the automated segmentation model..

Results: Performance of the automated segmentation model was variable across segmentation classes. Specifically, automated segmentation of RB tumour demonstrated the highest degree of similarity (n = 400; JI = 0.80), followed by scar (n = 223; JI = 0.63). RPE segmentation was moderately similar (n = 1553; JI = 0.50), followed by ILM (n = 1461; JI = 0.45) and INL (n = 1346; JI = 0.45). Segmentation of the sclera demonstrated the lowest segmentation similarity (n = 1430; JI = 0.38) when compared to all other classes.

Conclusion: The present study demonstrates the potential for an automated segmentation model in the detection and monitoring of RB tumours. Further refinement of the segmentation algorithm may improve the ability to automate detection of RB tumours with a higher degree of accuracy and capture temporal changes in tumour progression.