Automated vertical cup-to-disc ratio determination from fundus images for glaucoma detection

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Purpose

To develop an automated deep learning system for deriving vertical cup-to-disc ratio (VCDR) in fundus images.

Methods

In this study, we develop an automated system employing deep learning (DL) techniques, specifically the YOLOv7 architecture, for the detection of optic disc and optic cup in fundus images and the subsequent calculation of vertical cup-to-disc ratio (VCDR). We also address the often-overlooked issue of adapting a DL model, initially trained on a specific population (e.g., European), for VCDR estimation in a different population. Our model was initially trained on ten publicly available datasets and subsequently fine-tuned through transfer learning on the REFUGE dataset, which comprises images collected from Chinese patients.

Results

The DL-derived VCDR displayed exceptional accuracy, achieving a Pearson correlation coefficient of 0.91 ($P = 4.12 \times 10^{-412}$) and a mean absolute error (MAE) of 0.0347 when compared to assessments by human experts. Our models also surpassed existing approaches on the REFUGE dataset, demonstrating higher Dice similarity coefficients and lower MAEs. Moreover, the derived VCDR achieved an area under the receiver operating characteristic curve (AUC) of 0.969 (95% CI: 0.95 – 0.99) for glaucoma classification.

Conclusions

Our approaches for detecting optic discs and optic cups and calculating VCDR, offers clinicians a promising tool that reduces manual workload in image assessment while improving both speed and accuracy. Most importantly, this automated method effectively differentiates between glaucoma and non-glaucoma cases, making it a valuable asset for glaucoma detection.