Validation and Clinical Applicability of Automated Segmentation for Diabetic Macular Edema from Clinical OCT Scans Using Deep Learning

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Background

Diabetic retinopathy is a leading cause of vision loss in middle-aged working adults.
Diabetic macular edema (DME) is characterized by intraretinal fluid accumulation and retinal thickening.
Optical coherence tomography (OCT) reveals progressive structural loss of the neuroretina.
Disease progression and treatment response are often assessed subjectively based on fluid dynamics and structural changes in retinal layers.

Objectives

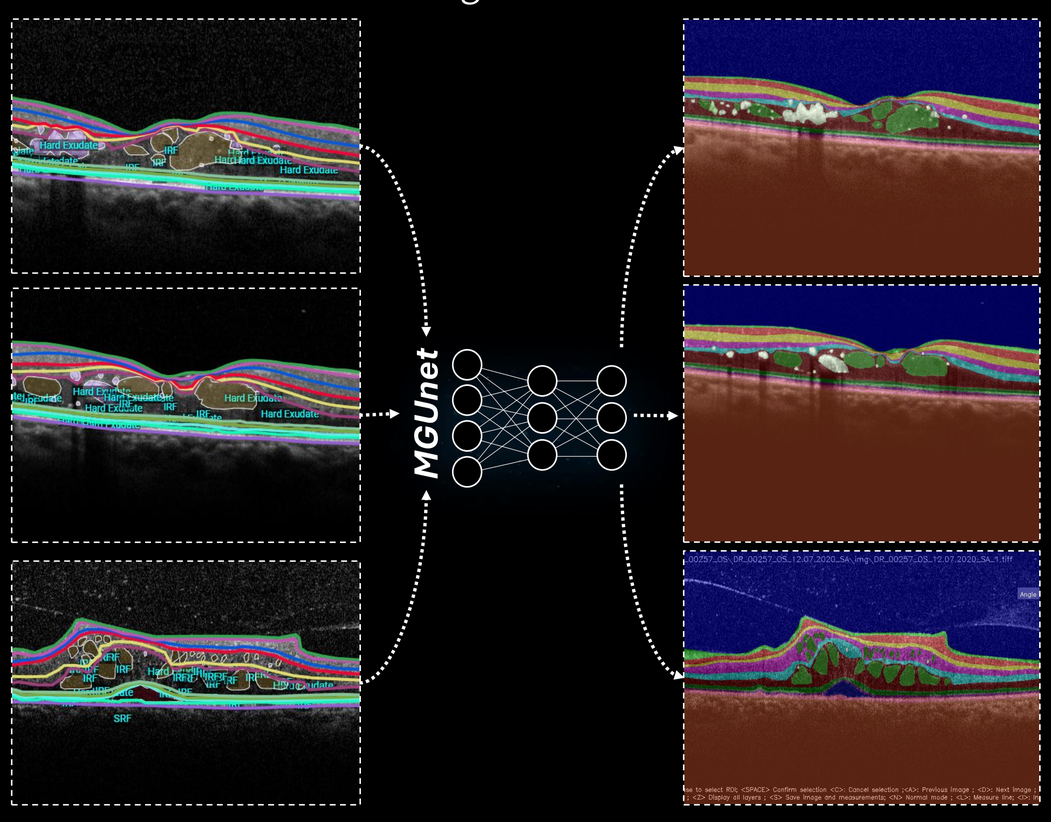
To evaluate the performance of a deep learning model in segmenting retinal layers, quantifying DME biomarkers and assess its clinical applicability.

Methods

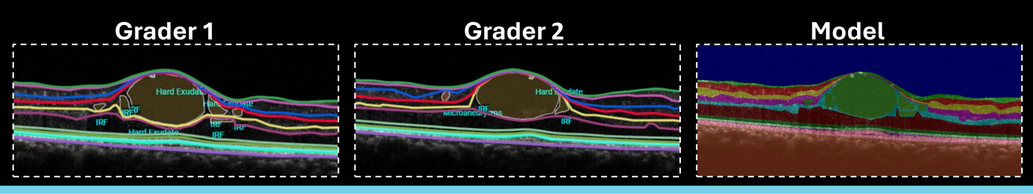
Model Architecture:
The **MGUnet[1]** model is a Convolutional Neural Network (CNN) pre-trained on an external dataset.
Pre-Processing:
Ground-truth segmentations were manually annotated by **Hadassah Reading Center** using **SuperAnnotate** platform.
Segmentation Classes (n=15):
Includes retinal layers, intra-retinal fluid (IRF), sub-retinal fluid (SRF), microaneurysms, and hard exudates.
Datasets:
OCT scans acquired using **Heidelberg Engineering** devices.
1.Model Training: n=100 manually segmented B-scans, 90% containing DME biomarkers.
2.Clinical Validation: n=1,200 segmented B-scans.

Training — Model — Test

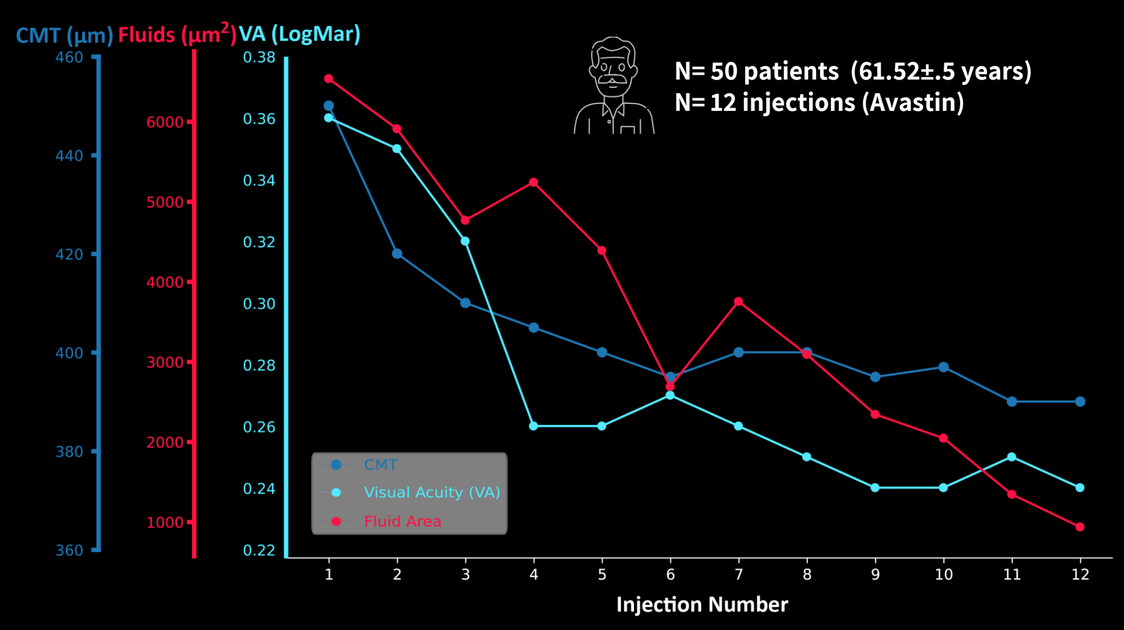
Ground truth: Hadassah Reading Center



ICC (95% CI)	Model-Grader	Intergrader
IRF	0.74	0.85
SRF	0.82	0.87
Microaneurysm	0.89	0.9
Hard Exudates	0.93	0.95
Inner retina (ILM-ONL)	0.88	0.92

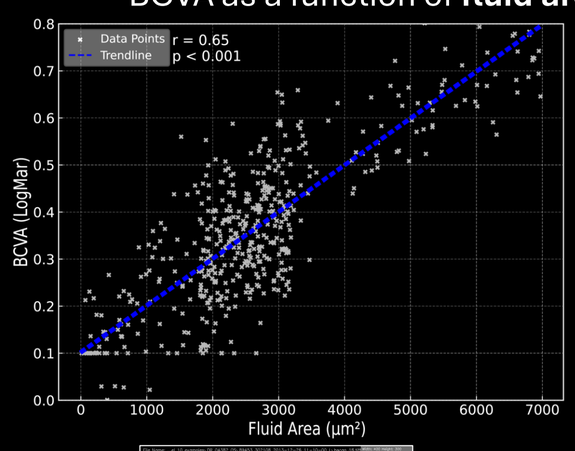


Longitudinal Dynamics — Validation — Clinical-Model Measurements Correlation

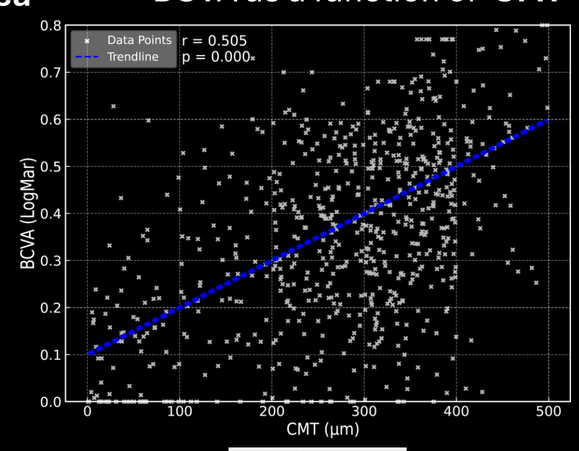


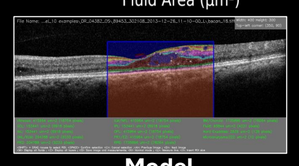
Pearson Correlation

BCVA as a function of **fluid area**



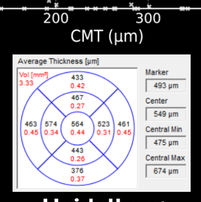
BCVA as a function of **CMT**





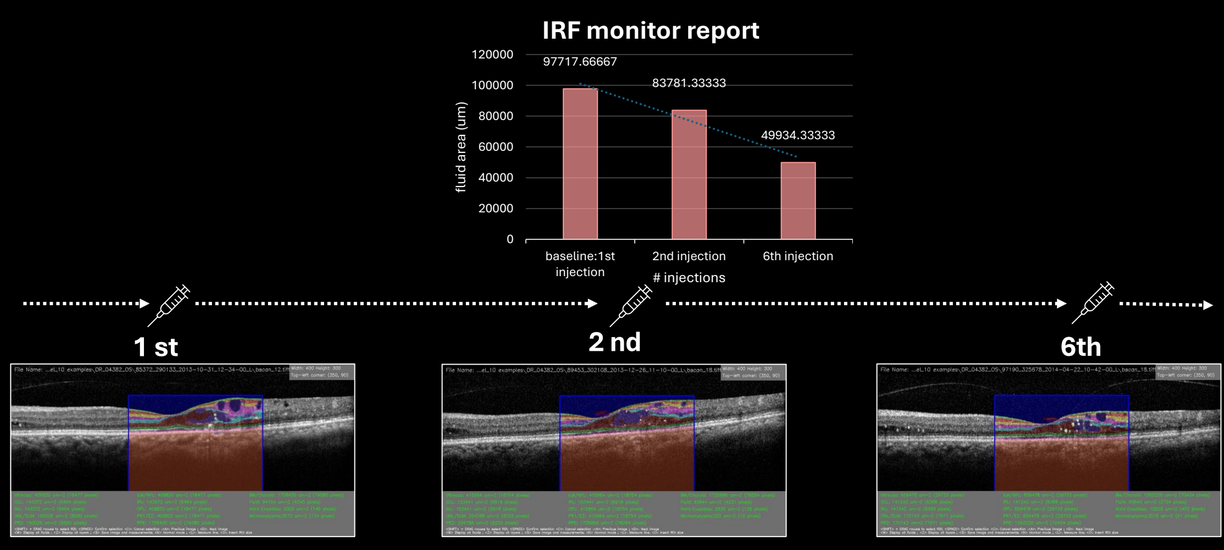
Model

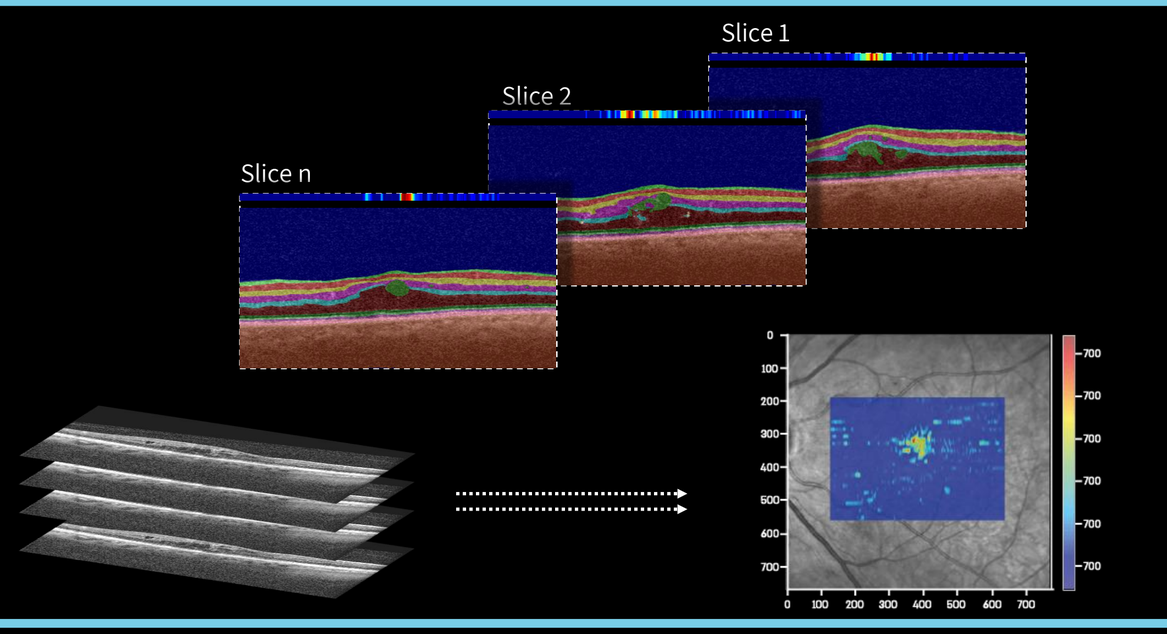
Fluids are more accurate prognostic factor than CMT



Heidelberg

Treatment Follow-up — Clinical Applicability — Heat-Maps





1. Jiaxuan Li, Peiyao Jin, Jianfeng Zhu, Haidong Zou, Xun Xu, Min Tang, Minwen Zhou, Yu Gan, Jiangnan He, Yuye Ling, and Yikai Su**, "Multi-scale GCN-assisted two-stage network for joint segmentation of retinal layers and discs in peripapillary OCT images,"** Biomed. Opt. Express 12, 2204-2220 (2021)