Towards automated optical coherence tomography (OCT) data analysis for a real-world diabetic macular edema (DME) treatment cohort

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Purpose

To demonstrate an OCT image analysis pipeline that facilitates automated and fast interpretation of large real-world datasets and enables in-depth scientific and clinical investigations for retrospective quantitative image analysis

Background

- DME is one of the leading causes of vision loss.[1] Image biomarkers and structural changes are essential for DME clinical treatment decision making, research and patient management[2]
- OCT is the major image modality for DME treatment and management[2]
- To assess anatomic treatment response retrospectively in a large real-world data DME cohort from the UK National Health Service, an automated OCT image pipeline is needed

Methods

- A fully anonymized cohort of 858 patients with DME and anti-vascular endothelial growth factor (VEGF) treatment was extracted from the Medisoft electronic health record (EHR) based on predefined inclusion and exclusion criteria
- Corresponding anonymized Heidelberg OCT images were organized into a standard DICOM format. EHR and image data were matched at patient and eye level via metadata
- Macular 3D OCT volumes at first treatment and follow-up visits were automatically identified
- Full retinal thickness layer and fluids were segmented by an in-house automated algorithm[3] on extracted volumes
- 80 randomly selected baseline OCT volumes were manually graded for image quality, fovea centration, internal limiting membrane (ILM), Bruch's membrane (BM), intraretinal fluid (IRF), and subretinal fluid (SRF) segmentations to confirm the robustness of the automated segmentation

Conclusions

- A fit-for-purpose OCT image analysis pipeline was feasible for this patient cohort
- Automated tools such as macular volume identification and layer and fluid segmentation, enabled a fast retrospective quantitative analysis in a large volume of real-world images that yielded fair/good quality segmentations for most images
- Manual reviews on representative subsets of the data added confidence on the trustworthiness of the pipeline

1 Image Analysis Pipeline

Full data cohort
858 Patient-eyes, 11544 total Heidelberg[4] OCT acquisitions, 4 imaging acquisition protocols

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OCT volume cohort preparation
baseline OCT visit match at first anti-VEGF treatment
OCT eligibility screening: optic disc volume removal

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Automated segmentation
ILM, BM, IRF, SRF and associated ETDRS* grid measurements and visual board were generated

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Image and segmentation quality control (QC)
small cohort review (n=80)

↓

Analysis
EHR + OCT measurements

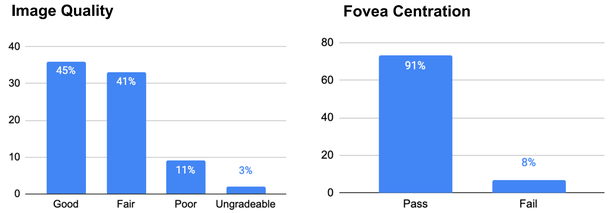
Image and Segmentation QC Small Cohort Review (n=80)

Randomly selected 80 baseline volumes → 1 grader, 1 reviewer → Image Quality: good, fair, poor and ungradable; Segmentation Quality: good, fair, poor, and unacceptable

by balancing age, sex, laterality, baseline visual acuity, IRF volume, SRF volume, CST, and image protocol

*ETDRS: Early Treatment Diabetic Retinopathy Study

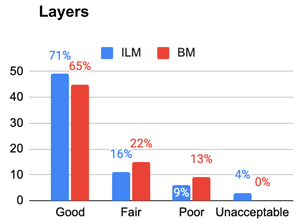
2 >86% Images Rated as Good/Fair Image Quality or Pass for Fovea Centration



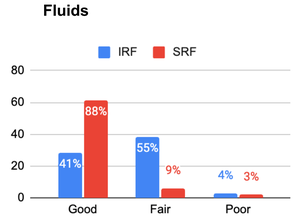
86% of images were rated as Good or Fair quality

91% of images were rated as Pass for fovea centration

3 High Segmentation Quality on Good/Fair Image Quality Cases



87% of layer segmentations were rated as Good or Fair



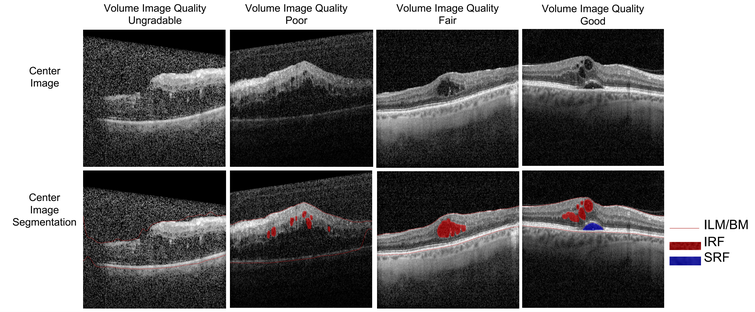
96% of fluid segmentation were rated as Good or Fair

4 Segmentation Quality is Associated with the Image Quality for ILM, IRF and SRF

	Segmentation Quality	n	Image Quality – n (%)			p*
			Good	Fair	Poor/Ungradable	
ILM	Good/Fair	63	35 (55.6)	25 (39.7)	3 (4.8)	<0.001
	Poor/Unacceptable	17	1 (5.9)	8 (47.1)	8 (47.1)	
BM	Good/Fair	68	34 (50.0)	26 (38.2)	8 (11.8)	0.09
	Poor/Unacceptable	12	2 (16.7)	7 (58.3)	3 (25.0)	
IRF	Good/Fair	73	34 (46.6)	32 (43.8)	7 (9.6)	0.002
	Poor/Unacceptable	7	2 (28.6)	1 (14.3)	4 (57.1)	
SRF	Good/Fair	74	35 (47.3)	32 (43.2)	7 (9.5)	<0.001
	Poor/Unacceptable	6	1 (16.7)	1 (16.7)	4 (66.7)	

*Fisher's exact test

5 Example Images



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XC, AG, GCC: Employee: Genentech, Inc.
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Study Disclosures

This study includes research conducted on human subjects. Study exempt from Institutional Review Board approval due to deidentified data.
Caldicott Guardian approval at each site was obtained prior to study initiation.

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