Deep Learning Assisted Quantification of Neovascular Lesions with Optical Coherence Tomography Angiography (OCT-A)

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Background

- OCT-A is a relatively new imaging modality allowing noninvasive visualization of macular neovascularization (MNV) in neovascular age-related macular degeneration (nAMD)
- Grader assessment of MNV area includes annotations on the angiogram using properly segmented OCT-A scans within defined slabs
- Full comprehensive examinations of OCT-A slabs can be time consuming and labor intensive

Purpose

- To improve efficiency of evaluation by developing an automated deep learning (DL) algorithm for quantitative assessment of MNV area from OCT-A

Methods

- A total of 160 planimetry annotations of MNV area from 6x6 OCT-A scans were made by the graders
- Training dataset included 118 annotated angiograms used to train a U-Net DL model with a ResNet backbone for binary image segmentation
- Predictions made by the algorithm were fitted with a binary mask to define borders and area measurements
- Validation dataset included 42 OCT-A scans
- Agreement between grader annotation and DL predictions was analyzed using area measurements and Dice Similarity Coefficient (DSC)

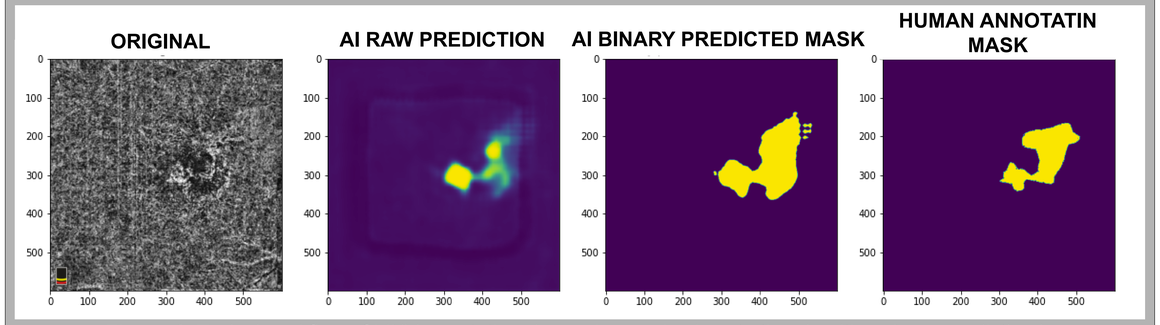

Figure 1. Typical workflow of MNV annotation. An angiogram is given to the algorithm. A raw prediction is then created and fitted with a binary predicted mask to define borders. Predicted mask is subsequently compared to the actual human mask

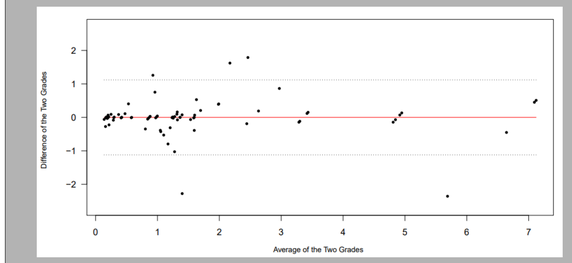

Figure 2. Bland Altman plot representing inter-grader agreement of MNV area on OCT-A.

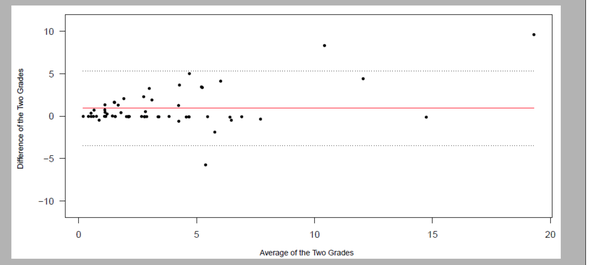

Figure 3. Bland Altman plot depicting the difference in MNV area between DL algorithm and human grader

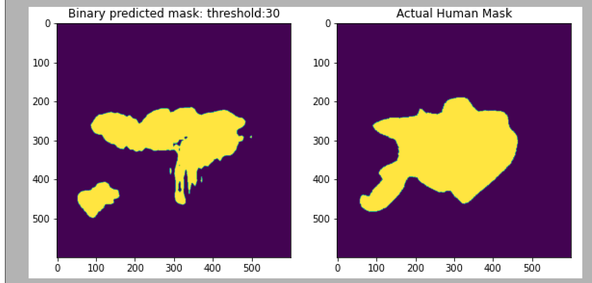

Figure 4. Angiogram with good agreement between grader and AI; grader area = 6.709mm^2, AI area = 4.833mm^2, DSC = 0.738

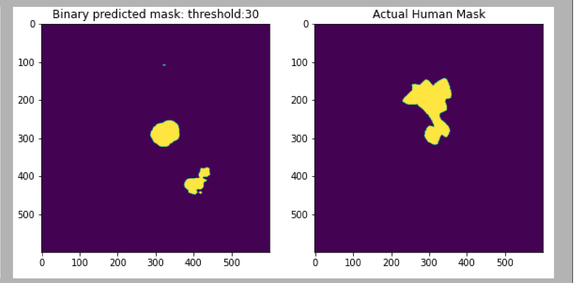

Figure 5. Angiogram with weak agreement between grader and AI; grader area = 1.10mm^2, AI area = 0.635mm^2 , DSC = 0.397

Results

- Mean area of MNV with graders was **3.23mm^2 +/- 3.11**
- Mean difference in MNV area between graders was **0mm^2 (95% CI -1.12 to 1.12)** (*Figure 2*)
- Mean area of MNV with DL algorithm was **4.16mm^2 +/- 4.17**
- Mean difference in area between DL algorithm and grader was **0.94mm^2 +/- 2.23 (95% CI -3.45 to 5.33)** with an intra-class correlation of **0.788** (*Figure 3*)
- Mean DSC between DL algorithm and graders was **0.54 +/- 0.23**
- Review of images with DSC<0.5 was **(n=27)** (*Figure 6*)

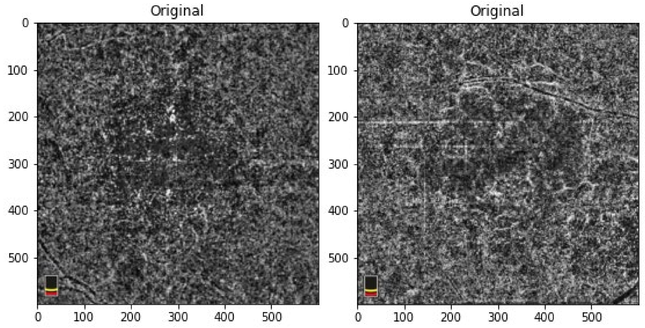

Figure 6. Examination of OCT-A annotations with DSC<0.5 showed quilting artifacts and absence of MNV network on the angiogram

Conclusions

- There is a moderate correlation between DL quantification of MNV lesions and grader's area measurements
- It is important to note that the algorithm's decision is limited by the angiogram whereas the grader has access to structural B-scans and flow data
- This study shows a very promising trajectory for the use of DL in the quantitative analysis of MNV lesions

Commercial interest disclosures: NONE