OCTA-based Assessment of morphological changes in active *mCNV* during anti-VEGF therapy

Paper Summary by Aadit Deshpande

Introduction

- **Purpose**:
  - Profile quantitative changes of *mCNV* lesion using *OCTA* and explore biomarkers that could reflect outcome of *VEGF* inhibition.
- *mCNV*:
  - *Myopic choroidal neovascularization* (type 2 CNV) threatens vision.
  - 5-11% of individuals with Pathologic Myopia develop mCNV.
- *Treatment*:
  - *Anti-vascular endothelial growth factor* (VEGF) intravitreal injection.
- *Diagnosis*:
  - Standard Method: Fluorescein Angiography [dye-leakage risks]
  - *Alternative*: OCTA (*optical coherence tomography angiography*) [non-invasive, quantitative assessment.]

Patient Demographics, Data Acquisition

- **31 eyes** (29 patients between Feb 2017 and Oct 2020)
- **Subgroup** Analysis:

  Stable group (1 or 2 injections)

  Unstable group (>2 injections)
- **OCTA Imaging** using a commercial SD-OCT system.
- Provided **4 en-face images** (superficial and deep layers).

Patient characteristics ($n = 29$)	
Age, years, mean ± SD (range)	44.48 ± 12.51 (25~67)
Sex (male/female)	12/17
Eye characteristics ($n = 31$)	
Mean SE, diopters, mean ± SD (range)	−12.55 ± 3.24 (−18.00~-6.50)
Right eye	14
Left eye	17
Number of injections, mean ± SD	2.19 ± 0.87

SE, Spherical Equivalent.

OCTA Image Assessment

Qualitative Estimation

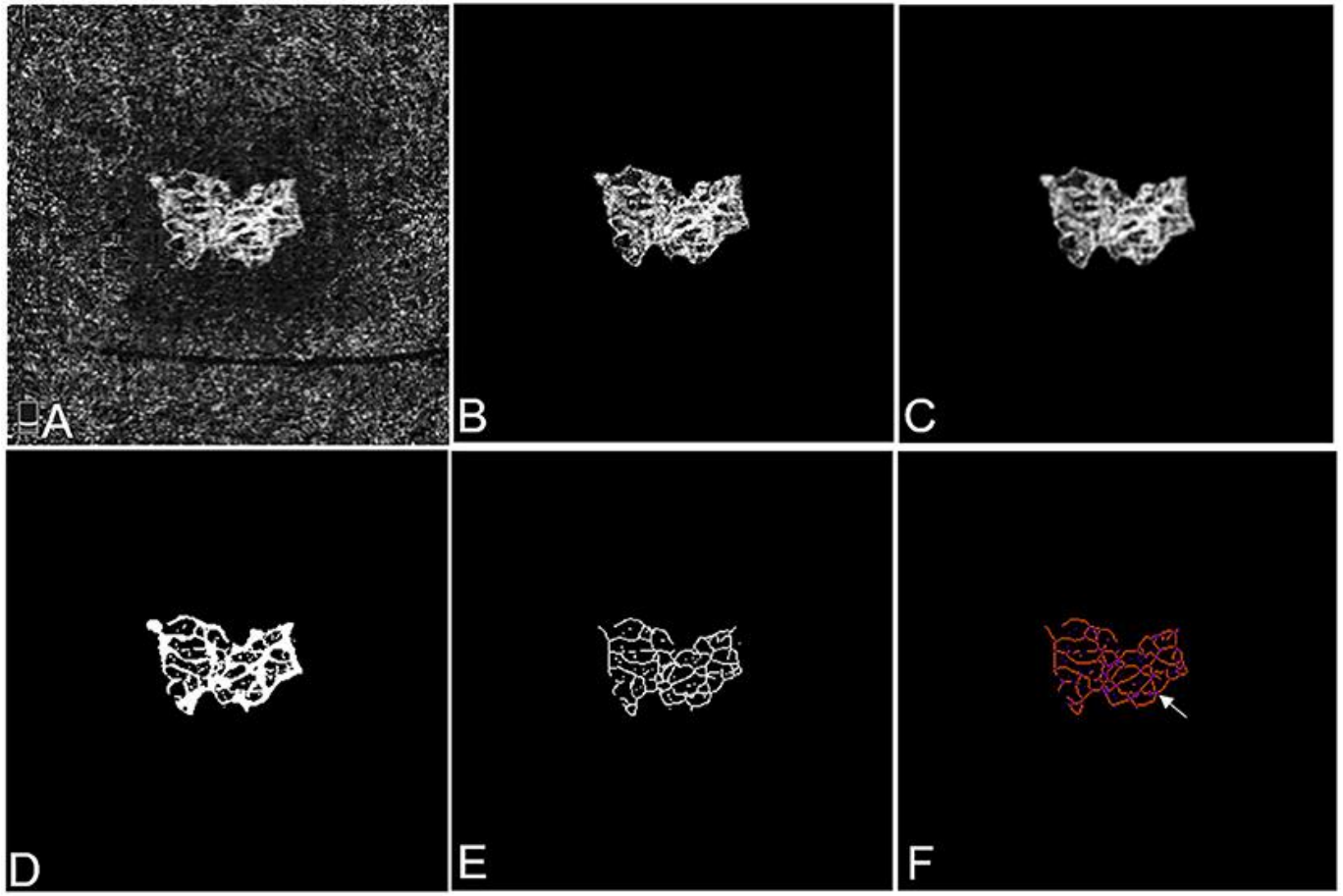
- **Two mCNV phenotypes**:
  1. *Organized Interlacing*
  2. *Disorganized Vascular Loops*
- Morphology described by 5 criteria.
- Organized Interlacing:
  i. Medusa
  ii. Sea-Fan
  iii. Tree-In-Bud

Quantitative Estimation

- *MATLAB & ImageJ* program to process OCTA images:
  A. Manual Delineation
  B. Denoising (Gaussian kernel)
  C. Frangi vesselness Filter
  D. Local Adaptive Thresholding
  E. Skeletonization
- Establish **OCTA biomarkers.**

Quantitative Estimation

Figure	Stage	OCTA Biomarker
A	Input image	
B	Manual Delineation	mCNV Area
C	Gaussian Blur	
D	Local Thresholding	Vessel Area
E	Skeletonization	Fractal Dimension, Tortuosity
F	Skeleton Analysis	Junctions, Vessel Length



Results

- Biomarkers **After anti-VEGF treatment**:

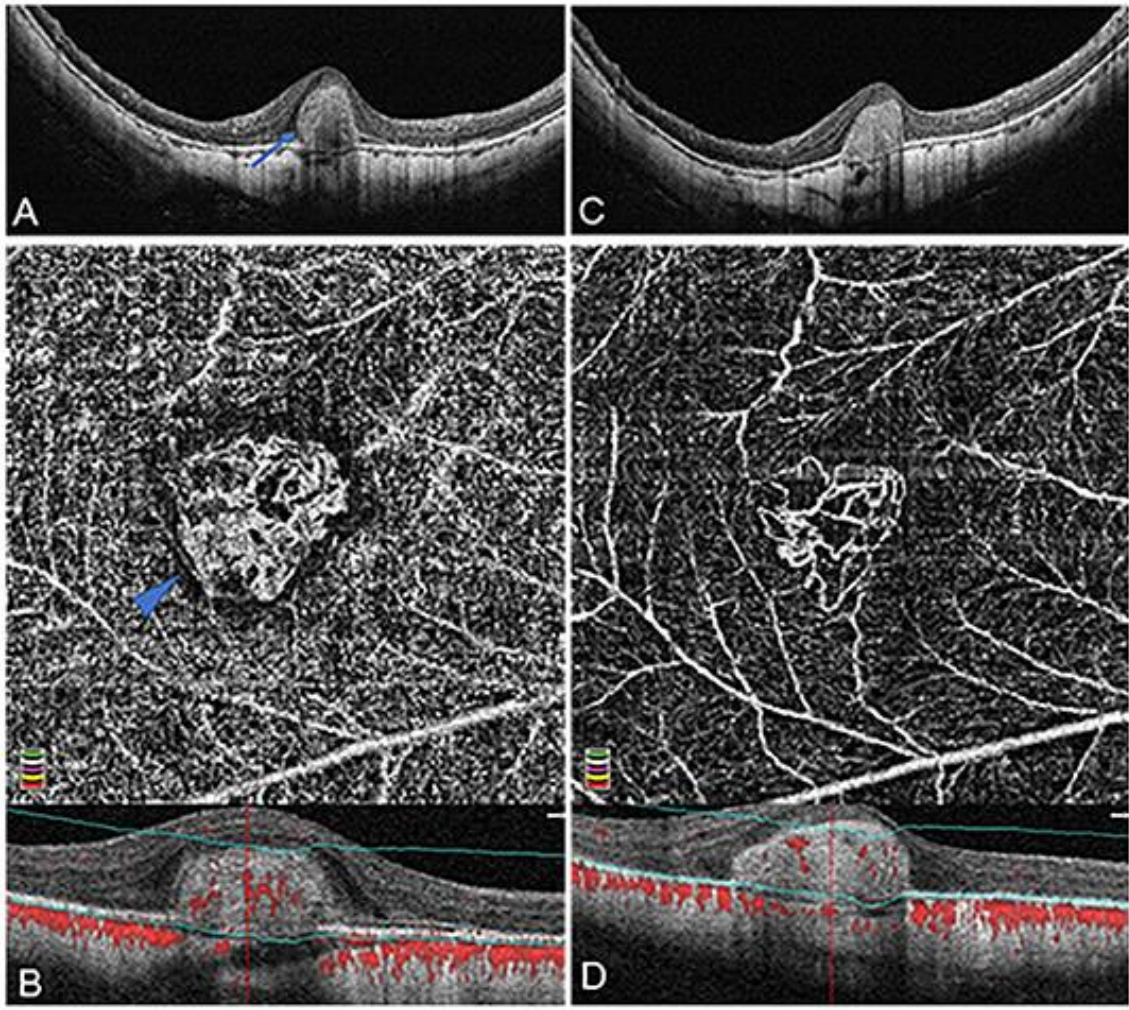
Decreased:

1. mCNV Area
2. Fractal Dimension
3. Vessel Area
4. Vessel Length
5. Vessel Junction
6. CRT (Central Retinal Thickness)

Increased:

1. Vessel Density
2. Vessel Diameter
3. Tortuosity

- **Moderate Correlation** 4 between OCTA Biomarkers (mA, FD, VA, VL) and **CRT**



Organized Interlacing mCNV: (A, B) Baseline (C, D) Post Therapy

Statistical Analysis

	Baseline	Post-IVI	*p*-Value	RR (%)
Quantitative biomarkers, mean (SD)				
mCNV area, mean (SD), mm^2	0.40 (0.52)	0.28 (0.41)	< 0.001	70.00
VA, mean (SD), mm^2	0.20 (0.20)	0.13 (0.14)	< 0.001	65.00
VLD, mean (SD)	0.55 (0.09)	0.56 (0.14)	0.829	102.82
FD, mean (SD)	1.08 (0.15)	0.95 (0.23)	< 0.001	87.96
VD, mean (SD), μm	31.11 (3.78)	37.47 (13.94)	0.027	120.44
VL, mean (SD), mm	6.96 (7.92)	4.38 (5.81)	< 0.001	62.93
VT, mean (SD)	1.26 (0.07)	1.36 (0.33)	0.276	107.93
VJ, mean (SD)	49.36 (47.43)	24.50 (28.25)	< 0.001	49.64
JD, mean (SD), n/mm	7.52 (1.65)	5.09 (2.26)	< 0.001	67.69
CRT, mean (SD), mm	316.75(72.72)	257.39(30.66)	< 0.001	81.26

mCNV, Myopic Choroidal Neovascularization; VA, Vessel Area; VLD, Vessel Density; VD, Vessel Diameter; VL, Vessel Length; VT, Vessel Tortuosity; VJ, Vessel Junction; JD, Junction Density; FD, Fractal Dimension; RR, relative ratio; IVI, Intravitreal anti-VEGF Injection.

Highlighted Biomarkers reported an increase post-treatment.

Conclusion

- Distinguished **Two subtypes** of mCNV (Organized interlacing and Disorganized vascular loops)
- MATLAB and ImageJ to analyze morphological, spatial vessel biomarkers.
- **Anti-VEGF** safe and efficacious treatment:
  - Vessel junctions (-50.36%)
  - Vessel length (-37.07%)
- **Challenges**: Segmentation errors artifacts for highly myopic patients.
- **Limitations**:
  - 1. Small sample size and short follow-up period.
  - 2. Measurement accuracy compromised by automation.

Thank You