Outline

- History of angiography
- Introduction to OCT-A
- OCT-A interpretation
- OCT-A in pediatric patients
  - Healthy pediatric eyes
  - Pathologies
- Summary and future studies
History of FA

- Initially described in 1961
- Rapidly became most important imaging test for the retina
- Allowed identification and classification of a number of disorders

Utility of FA

- Permits identification of abnormal retinal and choroidal vessels (NVD, NVE, CNV)
- Locates areas of leakage or nonperfusion
- Helps determine therapeutic options and assesses treatment efficacy (laser, PDT)
- Still “gold standard” for diagnosis of new vessels (eg, CNV), retinal vasculitis, and assessment of peripheral nonperfusion
Introduction to OCT-A

Principle of OCT-A

- Stationary tissue: time-independent images
- Moving tissue (e.g., RBCs): time-dependent images
- Differences = decorrelation signal
  - High decorrelation signal = high flow
  - Low decorrelation signal = low flow
- Normally: no flow between Bruch’s membrane and the inner aspect of the outer plexiform layer

Principle of OCT-A

• En-face OCT-A can be obtained by segmenting the RPE

• OCT-A are coregistered with OCT B-scans from the same area, allowing for simultaneous visualization of structure and blood flow

FA and OCT-A

FA
• Invasive
• Dye can cause discomfort, nausea, anaphylaxis
• 2-dimensional image
• 5 to 30 minutes
• Dynamic flow: leakage, pooling, staining of abnormalities
• Wide-field view
• Blood flow information

OCT-A
• Noninvasive
• No dye
• 3-dimensional image that can scroll through
• 6 seconds per scan set
• Static flow: delineation and size of abnormalities
• Limited field of view
• Structural and blood flow information
Imaging With OCT-A Devices

Segmentation of Vascular Layers

Segmentation of Vascular Layers

OCT-A Interpretation

Unpublished data.
Artifacts: Incorrect Segmentation

Unpublished data.

Artifacts: Projection

Unpublished data.
Artifacts: Out of Focus

Artifacts: Motion
Artifacts: Blinking (Dry Eye)

Unpublished data.

Artifacts: Anterior Opacities (Floaters)

Unpublished data.
OCT-A in Pediatric Patients: Our Experience Thus Far


OCT-A Imaging in Clinic: Tabletop System

- Noninvasive, noncontact
- **Usually ages 6 years** and up without disability
- **Dilation not necessary**
- Imaging time can vary and may take a long time if lots of motion is present
- Cannot image patients with nystagmus; must be able to fixate

Expert opinion
OCT-A Imaging in the OR: Portable Flex Arm

- Can image **infants**, patients with **nystagmus**
- Image during **exams under general anesthesia with pupils dilated**
- Skill required in maneuvering the camera head for imaging
- Can also capture structural OCT and RNFL

Current Progress: Healthy and Diseased Eyes

- Imaged **297 eyes** of **178 pediatric patients**
  - Using the Flex OCT-A unit:
    - 97 eyes of 67 patients
    - Mean 2.4 ± 2.2 years old
    - Range **3 weeks**-11 years old
  - Using the tabletop OCT-A unit:
    - 200 eyes of 111 patients
    - Mean 11.5 ± 3.7 years old
    - Range **3-17 years old**

**Healthy, full-term infants and children without intraocular disease:**
- 135 eyes imaged of 89 patients
  - Mean age 8.5 ± 5.3 years
  - Age range 9 weeks-17 years

**Disease**
- Aniridia
- ROP
- Coats’ disease
- Retinoblastoma
- Congenital glaucoma
- Sturge-Weber syndrome
- CMV retinitis
- Uveitis
- Best disease
- Incontinentia pigmenti
- Stickler syndrome
- Optic nerve coloboma
- & more
Range of Normal/Unaffected Eyes

SVC + DVC  SVC  DVC

Normal (small FAZ)

Normal (medium FAZ)

Normal (large FAZ)

Unpublished data.

ROP

- Abnormal development of retinal blood vessels in premature infants
- Can potentially lead to retinal detachment and blindness
- Severity affected by birth weight and gestational age

ROP

• Female at 73 weeks’ postmenstrual age born at 24 weeks’ gestational age; birthweight: 410 g

Left eye: zone II stage 3 regressed ROP


ROP: Diving Vessels

Retinoblastoma

• Rare eye cancer that develops in early childhood, usually before 5 years of age
• May present with leukocoria, strabismus, change in iris color, poor vision
• Most cases caused by mutations in \textit{RB1} tumor suppressor gene

2-Month-Old Male With Bilateral Untreated Retinoblastoma

Summary

• Advantages of OCT-A:
  – Noninvasive, no dye used
  – 3-dimensional image, fast
  – Structural and blood flow information in tandem
  – Static blood flow information—delineation of pathology

• Disadvantages of OCT-A:
  – Static blood flow information—no leakage, pooling, or staining
  – Limited field of view

• Pediatric patients: much to be learned that will change our understanding of disease development

Future Directions

• Studying neurovascular development from birth on
• Establishing normative data
• Correlating with histology
OCT-A: Abbreviations and Acronyms

CMV = cytomegalovirus
CNV = choroidal neovascularization
DCP = deep capillary plexus
DVC = deep vascular complex
FA = fluorescein angiography
FAZ = foveal avascular zone
ICP = intermediate capillary plexus
NVD = neovascularization at the disc
NVE = neovascularization elsewhere
OCT-A = optical coherence tomography angiography
OPL = outer plexiform layer
OR = operating room
PDT = photodynamic therapy
PVD = posterior vitreous detachment
RBC = red blood cell
RNFL = retinal nerve fiber layer
ROP = retinopathy of prematurity
RPE = retinal pigment epithelium
SVC = superficial vascular complex