OCT Angiography in the Optometric Practice

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OCT Angiography: the Next Chapter in Posterior Imaging

- Time Domain
- Spectral Domain
- OCT Angiography (OCTA)...THE NEXT CHAPTER!!

2002: Time Domain OCT
2006: Spectral Domain OCT
2014: OCTA

BASIC CONCEPTS:

In order to understand angiography, you must understand OCT!!

If you understand simple clinical anatomy...
You will understand SD-OCT
   - AND you will then understand OCT Angiography

But if you do not..
You will NEVER understand EITHER!!
WHAT IS HAPPENING?

Basic Clinical Retinal Anatomy
The Basic Concept is....

INNER

Where it is....Tells you what it is!!

OUTER
Diseases of the Neurosensory Retina
Subretinal Disease

[Image of retinal layers and structures]

INL  IPL  ILM
INL  IPL  ILM
GCL  NFL
OPL  ONL  ELM  IS/OS
OPL  ONL  ELM  IS/OS
OPR  RPE  Choroid  Bruchs Membrane

Fovea
Diseases of the RPE and Choroid
Optical Coherence Tomography

Static Test

Pro:
- Excellent visualization of macular architecture
- Non-invasive
- Easy to perform

Con:
- Inability to evaluate vasculature/flow

Can we have the best of both worlds?
OCT Angiography: The Answer!

- See retinal vasculature without referring patients out of the practice
- Visualize signs of disease earlier and make more intelligent referrals
- Manage more pathology
- Elevate the practice with state-of-the-art imaging technology

Can My SD-OCT Do OCTA?

**Optovue AngioVue™**
* First commercially available OCT angiography system
* OCTA hardware (Avanti) and software (AngioVue)

**Zeiss AngioPlex™**
* OCTA hardware (Cirrus 5000) and software (AngioPlex)
Why do we need OCTA??
We have FA after all!!!!!

FA is not perfect….. Capillary visibility depends on:

• Diameter or size of the vessels
  • FA (larger vessels)
• Depth of vessels
  • FA (superficial)

• What about the smaller vessels and microvasculature?
• What about the deep plexus?

OCTA is depth resolved…. Allows for independent visualization of the vascular layers with outstanding resolution.

‘Therefore, current techniques may not detect the earliest nonperfusion of capillaries in vaso-occlusive diseases’

What do you get with OCTA?

- Conventional SD-OCT
  - Stationary tissue (structure) = time-independent images

- OCTA
  - Moving red blood cells (function) = time-dependent images

OCT angiograms co-registered with OCT B-scans from the same area allows simultaneous viewing of structure and function.

OCT-A vs. FA

- 3-D angiograms of retinal and choroidal vasculature
- Quicker acquisition than FA; 3-6 seconds
- No injection, no fluorescein (no dye leakage)
- Segmented visualization retinal/choroidal tissue
- OCTA easy to use, short learning curve
How does OCTA work??

Motion Contrast System
***SPEED and RESOLUTION

How does OCTA work?

- OCTA uses motion contrast to detect flow from OCT data
  - Rapidly acquires multiple cross-sectional images from a single location on the retina
  - Flow is the difference in signal between two sequential B-scans

![Difference of Two OCT B-scans](image1)

- Flow Signal (Red) Overlay on OCT B-scan

![Flow Signal Overlay](image2)
3D Angiograms Displayed as Individual Layers of Vasculature

- Superficial Plexus (RPE - ILM)
- Deep Plexus (N. - OPL)
- Outer Retinal Zone (ONL - BM)

En Face Visualization of Layers Based on Retinal Anatomy

Scan Size Selection

- Retina: 3x3, 6x6, 8x8 mm
- Disc: 3x3, 4.5x4.5, 6x6 mm
- Smaller scan sizes = highest quality image
- Larger scan sizes = wider area coverage, less resolution
- Automatic montage provides wider field of view (10x6) to aid multimodality comparisons
Automatic Segmentation of Retinal Layers

Layer indicators provide a reference to the retinal layer displayed.

- **White**: Superficial Capillary Plexus
- **Purple**: Deep Capillary Plexus
- **Red**: Chorocapillaris
- **Yellow**: Outer Retina

Apply This Clinically

Inner Retinal Pathology
Diabetic Retinopathy

- Positive Indicators
  - Retinal capillary non-perfusion - seen as blackened area without blood flow outside FAZ
  - Microaneurysms
  - Enlarged FAZ
Case Study | Diabetic Patient

- 45-year-old African American female
- HbA1C - 7.0 with “Good blood sugar control”

Looks pretty good...right??

Not as good as it seems 😞
FAZ Measurements in Diabetic Retinopathy

Image courtesy of Bernard C. Szirth, OD, Rutgers New Jersey Medical School Department of Ophthalmology and Visual Science
Aid in Disease Severity Assessment with FAZ Measurements

FAZ size and FAZ vessel density are correlated significantly with disease severity in DR.¹

Images courtesy of Richard Rosen, MD

Vessel Density Maps Enable Grading of Vascular Change

Images courtesy of Richard Rosen, MD

Non-proliferative diabetic retinopathy

OCTA Comparison to Fluorescein Angiography

Inner Retina Disorders

- Diabetic Retinopathy (DR)
- Proliferative Diabetic Retinopathy (PDR)
- Macular Telangiectasia
- Branch Retinal Vein Occlusion (BRVO)
- Coat’s Disease
- Retinal Ischemia
Case Study | Proliferative Diabetic Retinopathy

- 67 year-old male with history of decreased vision OD
- Type 2 diabetes for 14 years
- VA 20/60

PDR

1:48 FA

OCTA

Courtesy of S. Lee, East Bay Retina Consultants, Oakland, California, USA
But the cases are not always so clear cut!!
64 year old African American Female
Type 2 DM x 37 years

BS 221

Don’t forget to go through all B-scans!!!
Many anomalous areas of vasculature.... Is there proliferative disease?
Inner Retina Disorders

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Case Study | Branch Retinal Vein Occlusion

FAZ area in DCP positively correlated with a decrease in visual acuity; may be an indicator of visual prognosis
FA: SCP

SCP: FAZ findings mirror the FFA

FAZ area in DCP positively correlated with a decrease in visual acuity; may be an indicator of visual prognosis

DCP: FFA does not image the deep plexus; LOOK AT THE FAZ!!
Late Phase FA

OCTA

Inner Retina Disorders

- Diabetic Retinopathy (DR)
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Courtesy of S. Lee, East Bay Retina Consultants, Oakland, California, USA
Case Example

68 y/o Hispanic diabetic female
"Veil" over vision nasally
What about the B-scans?

Anything else anomalous?
Apply This Clinically

Outer Retinal Pathology
Outer Retina Disorders

- Choroidal neovascularization (CNV)
  - Type I (OCCULT)
  - Type II (CLASSIC)
  - Type III (RAP)
  - Type IV (MIXED)
- Central serous choroidopathy
- Pigment epithelial detachment
Type 1 “Occult” CNV

- New vessels develop in the choroid
- New vessels located BELOW RPE and ABOVE Bruch’s membrane

65 y/o Caucasian Male

- History of Dry AMD, Recent decrease in vision OS
- BCVA OD 20/80 OS 20/400
DRY!! Geographic atrophy.... Sick RPE!!

Is there a CNVM?
Use OCT-A for segmentation and lesion classification!!

63 y/o African American Male
AngioAnalytics: Trend Analysis
AngioAnalytics: Flow Area Measurements
Provide Quantification of CNV Area

- Manually outline a region for vessel detection

AngioAnalytics: CNV Multi Scan View for Follow-Up

Image courtesy of Paul Tornambe, MD, FACS, Retina Consultants San Diego, La Jolla, California
Another example....

Courtesy of: Palejwala NV
Outer Retina Disorders

- Choroidal neovascularization (CNV)
  - Type I (OCCULT)
  - Type II (CLASSIC)
  - Type III (RAP)
  - Type IV (MIXED)
- Central serous choroidopathy
- Pigment epithelial detachment

Type 2 “Classic” CNV

- New vessels develop in choroid
- New vessels located ABOVE the RPE and ABOVE Bruch’s membrane
Case Example:

48 y/o WM 2 week history of “dark spot” OD

B-scan with flow overlay

OCTA

Outer Retina (OPL - BRM)  Choriocapillaris (BRM - BRM+30μm)
Outer Retina Disorders

- Choroidal neovascularization (CNV)
  - Type I (OCCULT)
  - Type II (CLASSIC)
  - Type III (RAP)
  - Type IV (MIXED)
- Central serous choroidopathy
- Pigment epithelial detachment

CSR: The easy one...
Outer Retina Disorders

- Choroidal neovascularization (CNV)
  - Type I (OCCULT)
  - Type II (CLASSIC)
- Central serous choroidopathy
- Pigment epithelial detachment
Case Example: PED

Case Example 2: PED

72 y/o Hispanic male
20/30

(Courtesy of Optovue)
Case Study #2: PED

68 y/o WM
Chronic smoker
VA 20/30
Is there CNV?

What does the flow overlay show us?

**VASCULARIZED PED**

**Shadowing artifact:** Drusenoid PEDs attenuate the signal resulting in poor visibility of choriocapillaris
WATCH YOUR SEGMENTATION LINES

RIGHT  WRONG

WATCH THE SEGMENTATION LINES!!!
AVOID FALSE POSITIVES
What about these scans?

All 20/20!!!!
Outer Retina Disorders

- Miscellaneous
- Vitelliform
Superficial
Cill Pl
Deep Capillary
Pl
Outer Retina
Choriocapillaris

What about this patient??? Referral or Not???
So that one was OK... But what about this one?
Glaucoma

Normal Eye

Images and data courtesy of Robert Weinreb, MD and Linda Zangwill, PhD, UC San Diego
Glaucoma: CASE EXAMPLE

76 y/o WM
Sister with Glaucoma
CCT 513/515
VA 20/20

Vessel density is lower in glaucoma patients than healthy controls and glaucoma suspects and mirrors RNFL thickness loss for discriminating healthy subjects from glaucoma suspects and glaucoma patients.5

60 Y/O BM
(+) Fam Hx Glaucoma
Pachs: 455; 481
Max IOP: 24, 26
Ischemic Vasculopathy BEFORE clinical findings!!!

A NEW APPROACH TO GLAUCOMA MANAGEMENT!!!

Thank You for Your Attention
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