OCT Angiography

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OCT Angiography

Phase Variance OCT
Phase Variance OCT

- Using the complex data encoded within the OCT images (complex data is generally discarded by most commercial devices), structures with motion may be selectively isolated.

- After eliminating Brownian motion and fixation artifact, most of the residual motion in the eye is blood flow.
Phase Variance OCT: Captures microvasculature

OCT Angiography  Flourescein Angiography

Courtesy of Scott Fraser, Jeff Fingler, Dan Schwartz, Jack Werner
Large Composite PV-OCT Vascular Image

Color encodes depth: green= vitreal surface

Courtesy of Scott Fraser, Jeff Fingler, Dan Schwartz, Jack Werner
Comparing PV-OCT to FA (1.5mm x 1.5mm)

PV-OCT Retinal Vasculature

Cropped FA image

Courtesy of Scott Fraser, Jeff Fingler, Dan Schwartz, Jack Werner
Comparing PV-OCT to FA
(1.5mm x 1.5mm)

PV-OCT Retinal Vasculature

Cropped FA image

Courtesy of Scott Fraser, Jeff Fingler, Dan Schwartz, Jack Werner
Volume-Rendered Human OCT Angiography

Courtesy of Scott Fraser, Jeff Fingler, Dan Schwartz, Jack Werner
Comparing FA to PV-OCT

Diabetic Retinopathy imaged with 125kHz PV-OCT

Courtesy of Scott Fraser, Jeff Fingler, Dan Schwartz, Jack Werner
Comparing FA to PV-OCT (3mm x 3mm)

Courtesy of Scott Fraser, Jeff Fingler
3mm x 3mm vs 1mm x 1mm Retinal Scan

Courtesy of Scott Fraser, Jeff Fingler
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

Composite image – Sadda’s Eye Undilated

Collaborative work with Scott Fraser and Jeff Fingler (Caltech)
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

SLAB LEVEL:
Major Retinal Vessels

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

SLAB LEVEL:
Superficial Capillary Plexus

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

SLAB LEVEL:
Deep Capillary Plexus

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

SLAB LEVEL: Choriocapillaris

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

SLAB LEVEL:
Sattler’s Layer (medium choroid vessels)

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT

“OCT Angiography”

ADVANTAGES
• No Dye
• Depth Resolved

SLAB LEVEL:
Haller’s Layer (large choroid vessels)

Courtesy of Jeff Fingler, Scott Fraser
PV OCT pitfalls

• Motion artifact can be a problem for obtaining high-quality images in some patients.

• Fixation tracking may be a key requirement for optimal imaging
• Eye tracking can yield superb image quality
Phase Variance OCT for imaging CNV

Neovascular AMD, FVPED s/p >30 ranibizumab injections

Old lesion – mature vessels within membrane

Deep Retinal Capillary Plexus

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT for imaging CNV

Neovascular AMD, FVPED s/p >30 ranibizumab injections

Retinal – Choroidal Anastomosis

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT for imaging CNV

Neovascular AMD, FVPED s/p >30 ranibizumab injections

Retinal – Choroidal Anastomosis

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT for imaging CNV

Neovascular AMD, FVPED s/p >30 ranibizumab injections

Superficial vessels of CNV

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT for imaging CNV

Neovascular AMD, FVPED s/p >30 ranibizumab injections

Larger CNV Vessels

Courtesy of Jeff Fingler, Scott Fraser
Phase Variance OCT for imaging CNV

Neovascular AMD, FVPED s/p >30 ranibizumab injections

Larger CNV Vessels

Courtesy of Jeff Fingler, Scott Fraser
Increases confidence in our detection of CNV with OCT

Spectrum of Pigment Epithelial Detachments

Drusenoid PED
(medium homogenous)

Serous PED
(low homogenous)

Fibrovascular PED
(low heterogenous)
Vascular Detail with PV-OCT

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
Vascular Detail with PV-OCT

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
Diabetic Retinopathy

2 patients with NPDR --- note microaneurysms and enlarged foveal avascular zone

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
Depth resolved vascular imaging

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
Depth resolved vascular imaging

Choriocapillaris Level!

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
Depth resolved vascular imaging

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
Depth resolved vascular imaging

Zeiss SS-OCT prototype (investigational device, not FDA cleared)
OCT Angiography

Split-Spectrum Amplitude Decorrelation Angiography
“Decorrelation” refers to fluctuating values of OCT intensities.

Blood flow results in fluctuation in the amplitude of the OCT fringes as RBCs enter and exit a particular voxel.

Greater fluctuation means greater flow.

Jia et al, Biomed Opt Exp 2012
En face retinal and choroidal angiograms at different Z coordinates at macula.

Yali Jia, PhD; David Huang, MD, PhD. www.COOLLab.net
En face retinal and choroidal angiograms at different Z coordinates at ONH

Yali Jia, PhD; David Huang, MD, PhD. www.COOLLab.net
En face ONH angiograms separately showing the microcirculation within retina, choroid, and lamina cribrosa.
Flow and vessel density was reduced in glaucoma patients.
Summary

• OCT angiography is an exciting new development in non-invasive imaging

• The ability to acquire detailed imaging of the retinal and choroidal microvasculature in a depth-resolved fashion, without dye injection, represents a significant advance
  – The prospect of quantitative flow data is an additional major benefit

• Further refinement of the technology is required to allow ascertainment of leakage

• The scope/purview of conventional angiography will likely continue to narrow
Thank you!