OCT Angiography

David Huang, MD, PhD
Weeks Professor of Ophthalmic Research
Professor of Ophthalmology & Biomedical Engineering
Casey Eye Institute, Oregon Health & Science University
Portland, Oregon

OCT captures tissue function as well as structure

<table>
<thead>
<tr>
<th>Signal</th>
<th>Information</th>
<th>En Face</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude</td>
<td>Anatomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doppler shift (between consecutive A-scans)</td>
<td>Total retinal blood flow (global circulation)</td>
<td></td>
<td></td>
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<tr>
<td>Decorrelation (between consecutive B-scans)</td>
<td>Angiography (local circulation)</td>
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Imaging blood flow is important because the leading causes of irreversible blindness are caused by abnormal circulation.

**Glaucoma**

**Diabetic Retinopathy**

**Macular Degeneration**

David Huang, MD, PhD [www.AIGStudy.net](http://www.AIGStudy.net)

High-Speed Swept-Source OCT

Developed by MIT Optic & Quantum Electronic Group (Fujimoto) and OHSU Center for Ophthalmic Optics and Lasers (Huang)

**Performance features:**

- 100,000 axial scans/sec
- 1050 nm tunable laser (deep penetration)
- 5.3 µm axial resolution in tissue

Potsaid B, et al., Optics Express 2010; 18:20029

Experimental System - Not FDA-approved
Scan time of one 3D volume = 3.4 sec

OCT amplitude-decorrelation angiography uses intrinsic contrast – no dye injection!

Problem: 8 frames at one position do not provide sufficient angiography quality
Solution: Split-Spectrum Amplitude Decorrelation (SSADA) Algorithm

8 frames at one position now provides good angiography quality

Comparison of Angiography Algorithms

More continuous microvascular network

Less Noise >2x SNR

Split-spectrum amplitude-decorrelation angiography with optical coherence tomography. Optics Express 2012; 20:4710
3D OCT Angiography of Optic Nerve Head


3x3x3 mm OCT
3D angiography acquired in a 3-second scan

SSADA algorithm used

Reflectance (Structure) Decorrelation (Flow)

3D OCT Angiography of Optic Nerve Head – Layer by Layer


3x3x3 mm OCT
3D angiography acquired in a 3-second scan

SSADA algorithm used
OCT Angiography Showing Reduced ONH Blood Flow in Pre-Perimetric Glaucoma

Normal (OS)

ONH flow index = 0.159

Preperimetric Glaucoma (OS)

ONH flow index = 0.125

Pilot Study Subject Characteristics

- **Normal**
  - 24 eyes of 24 subjects
  - Age: 52±10 years (mean ± SD)
- **Glaucoma**
  - 11 eyes of 11 subjects
  - 8 perimetric glaucoma, 3 pre-perimetric glaucoma
  - Age: 68±10 years

David Huang, MD, PhD, John Morrison, MD, Yali Jia, PhD  www.AIGStudy.net
Variability of Disc Flow Index
(2x 2y registered OCT angiogram)

Normal Subjects

<table>
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<tr>
<th></th>
<th>Intra-Visit Repeatability (n = 4)</th>
<th>Inter-Visit Reproducibility (n = 4)</th>
<th>Inter-Subject Variability (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.2%</td>
<td>4.2%</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Less variable than OCT NFL measurement!

ONH flow index highly correlated with visual field

No overlap between normal & glaucoma groups
100% sensitivity
100% specificity
OCT Angiography of Age-Related Macular Degeneration: Type I Choroidal Neovascularization (CNV)

CNV between RPE & Bruch’s membrane

3-Color OCT Angiography
- Inner retinal flow
- Outer retinal flow
- Choroid flow
- Structural OCT

Yali Jia, PhD
David Huang, MD, PhD
www.COOLLab.net

Type II CNV

CNV above RPE

3-Color OCT Angiography
- Inner retinal flow
- Outer retinal flow
- Choroid flow
- Structural OCT

Yali Jia, PhD
David Huang, MD, PhD
www.COOLLab.net
3D OCT Angiography Fly-Through
Layer by Layer

Type II CNV

3-Color OCT Angiography
- Inner retinal flow
- Outer retinal flow
- Choroid flow
- Structural OCT

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OCT Angiography (SSADA) v. Fluorescein/ICG Angiography

OCT Advantages
- 3 dimensional
  - Easily separates disc, retinal, and choroidal circulations
  - Distinguish CNV above or below RPE
  - Sections & projections along any plane
- Quantitative
  - Flow index
- No injection
  - No vomiting or anaphylactic reaction

OCT Disadvantages
- Small field (3-4 mm)
  - Field will increase with higher speed
- No visualization of leakage and stain
  - But can visualize fluid space and retinal thickening

David Huang, MD, PhD www.AIGStudy.net
Grants & Material Supports

Unrestricted grant from Research to Prevent Blindness

Grant & material support from Optovue, Inc.

R01 EY013516 www.AIGStudy.net
Acknowledgements

**MIT**
Benjamin Potsaid, PhD
Jonathan J. Liu
Bernhard Baumann, PhD
Chen D. Lu
Woo Jhon Choi
James G. Fujimoto, PhD

**University Erlangen-Nuremberg**
Martin F. Kraus
Joachim Hornegger, PhD

**Casey Eye Institute, OHSU**

**Glaucoma service**
John C. Morrison, MD
Beth Edmunds, MD, PhD
Mansi Parikh, MD

**Retina service**
Steven T. Bailey, MD
Christina J. Flaxel, MD
Andreas K. Lauer, MD
Thomas S. Hwang, MD
Michael L. Klein, MD
David J. Wilson, MD

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