OCT - Anatomy of a Scan

- A systematic approach to understanding what we see in retinal OCT images including descriptive features such as:
  - Retinal landmarks
  - Contour/thickness
  - Reflectivity/shadowing
  - Artifacts
  - Common pathologic features

OCT Imaging

- Super luminescent diode light source
- Near-infrared wavelength: 820-850nm
- Analogous to ultrasound
- Time-of-flight delay (light echoes)
- Real time cross-sectional imaging
- Non-invasive

Cross-Sectional Imaging

“Virtual Biopsy”
Cross-Sectional Imaging
- Measures both depth/distance and intensity of reflectivity.

Eye Tracking/Sampling
- Sampled 4x
- Sampled 100x

Common/Practical Use
- Line scans for structural changes
- Line scans for detection of subretinal or intraretinal fluid
- Volume scans for quantification of thickness or edema

False Color vs. Grayscale

Common/Practical Use
- Optic nerve volume scan
- Radial lines centered on cup
- Cube Scan centered on disc
- RNFL scan
- Circle around disc
What Defines a Quality Scan?

- Centered on target anatomy/pathology.
- Good edge-to-edge reflectivity.
- Good saturation/signal strength.
- As horizontally level as possible.
- Free from artifacts.

Anatomical Landmarks

- Fovea
- Optic Disc

Anatomically, the fovea sits 5-7 degrees below the midpoint of the disc.
Anatomical Landmarks
- Blood vessels (vertical scans)

Layers of the Retina

RNFL Reflectivity

RNFL Reflectivity - Which Eye?
**RNFL Reflectivity - Which Eye?**

Topographic Anatomy

**Topographic Anatomy**

Relative Reflectivity: Normal

- Reflective/bright:
  - RNFL
  - RPE
  - Blood vessels
  - Optic Nerve

Relative Reflectivity: Abnormal

- Reflective/bright:
  - Hemorrhage
  - Exudate
  - Scar tissue
  - Drusen
  - Pigment
  - ERM

Relative Reflectivity: Normal

- Transparent/dark
  - Vitreous
  - Deep Choroid
  - Inner nuclear layer
  - Outer nuclear layer
Relative Reflectivity: Abnormal
- Transparent/dark
  - Fluid
  - Cysts
  - Shadowing from reflective structures, blood, or vitreous opacities

What to look for in Line Scans
- Contour
  - Is the ILM smooth?
  - Is the foveal depression visible?
  - Is the RPE smooth/intact?
- Thickness
  - Does the retina seem thin or thick?

What to look for in Line Scans
- Brightness/reflectivity
  - Are there any unusual bright spots?
  - Are there any unusual dark spots?
- Shadowing
  - Are there reflective structures causing shadows in deeper layers?

What to look for in Line Scans
- At what level are the significant findings?
  - Vitreous
  - Pre-retinal
  - Intra-retinal
  - Subretinal
  - Sub RPE
  - Choroid

Contour
- Epiretinal Membrane
- Drusen
Choroidal Folds

Myopia

AMD

AMD

Epiretinal Membrane

NPDR/DME
Thickness

Glaucoma with loss of RNFL/GCC

Thickness

Glaucoma with loss of RNFL/GCC

Thickness

Retinitis Pigmentosa

Thickness: Tracking Change

Reflectivity: High/Bright

Exudates

Reflectivity: High/Bright

Hemorrhages (multi-layer)
Reflectivity: High/Bright
DME: Exudates & Hemorrhage

Reflectivity: High/Bright
AMD with CNV

Reflectivity: High/Bright
Vitelliform Lesion

Reflectivity: Low/Dark
Chronic CME

Reflectivity: Low/Dark
Macular Hole

Reflectivity: Low/Dark
Wet AMD
What to look for in Line Scans

- Contour
- Thickness
- Reflectivity: Bright/Dark
- Shadowing
- Layers/Location

Location of Findings

- Vitreous
- Preretal
- Intraretinal
- Subretinal
- Sub RPE
- Choroid

Location: Vitreous

Location: Preretal

Location: Intraretinal

Location: Subretinal
What to look for in Line Scans

- Contour
- Thickness
- Reflectivity: Bright/Dark
- Shadowing
- Layers/Location
- Artifacts

Identifying Artifacts

- Scan artifacts
  - Movement
  - Inversion
  - Sampling
- Analysis /algorithm artifacts
  - Misidentified tissue boundaries

Identifying Artifacts

- Repetitive lines or shapes
- Mirrored images
- Upside down images
- Sharp lines on volume maps

Movement Artifacts
OCT works on the principle of time-of-flight delay.
- Signal is strongest close to the zero time-delay line.
- Sensitivity falls off as image gets farther from zero-delay line.

SD instruments cannot distinguish between positive and negative time delays.
- Produce mirror images near the 0-delay line.
SD Inversion

- “Negative” mirror image is truncated, or cropped during processing to remove it.

Zero-Delay Line

- The zero-delay is near the top of the window in SD-OCT, so we push close to the top to get the best signal.

SD Inversion/EDI

- Moving the instrument forward moves the choroid of the inverted image closer to the zero-delay line and improves signal strength in choroid.
- The EDI feature places the zero point closer to the choroid without inversion.

SD Inversion

- “Negative” mirror image is truncated, or cropped during processing to remove it.

Inversion Artifacts

- Pathology is “too tall” for scan window
  - > 2mm
  - High myope, RD, traction, etc.
- Too close to eye/top of scan window.
- Only part of image inverts.
- Image may partially or completely flip for a few frames during sampling.
Inversion Artifacts

Images courtesy of Bridgette Staffaroni, COF

EDI to Eliminate Inversion

Analysis Artifacts

- Tissue boundary identification.
Boundary Line Artifacts
- Push scan higher in window (SD-OCT) to move anterior pathology out of view.
- Beware of inversion artifact.

Putting it all Together
- Contour
- Thickness
- Brightness
- Shadowing
- Layers
- Artifacts

Descriptive Interpretation
- Resist the temptation to make a dx.
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