OCT – Art, Fact, or Artifact?

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Disclaimer
• This handout is designed as a take-home reference.
• It summarizes the core information from this presentation, but does not include all slides and info presented in the live lecture.

Optical Coherence Tomography
• Uses low-coherence interferometry to measure optical reflectivity by analyzing the “time-of-flight delay” of thousands of light pulses directed into the eye.

OCT Imaging
• Super luminescent diode light source
• Near-infrared wavelength: 820nm
• Analogous to ultrasound: time-of-flight delay (light echoes)

OCT Imaging
• Non-invasive, real time cross-sectional imaging.

Relative Reflectivity
• High
  • Silicone oil-retinal interface, scar tissue
• Moderately high
  • RNFL, RPE, scar tissue, CNV, hemorrhage
• Moderate
  • Retina, choroid, vitreous bands
• Low to moderate
  • Vitreous debris, posterior hyaloid, outer retina, noise
• Low
  • Vitreous, silicon oil, cysts, fluid, shadows
Spectral Domain OCT
- Latest generation of instrumentation.
- Spectral-domain OCT uses a spectrometer to process the light signal, eliminating the moving mirror used in time-domain OCT instruments.

Spectral Domain OCT

Anatomy of an OCT Scan
- Identifiable layers
  - Posterior hyaloid
  - RNFL
  - Plexiform layers
  - Photoreceptors
  - RPE
  - Choroid

Anatomy of an OCT Scan

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

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

Common/Practical Use

Anatomical Landmarks
- Fovea
- Optic Disc

Anatomical Landmarks
- Anatomically, the fovea sits 5-7 degrees below the midpoint of the disc.
Anatomical Landmarks

- What are these reflective spots/shadows?

Blood vessels (vertical scans)

RNFL Reflectivity

- Temporal
- Nasal

Topographic Anatomy

- OD
- OS

Topographic Anatomy
Scanning Technique
- Pupils dilated?
- Head/chin straight and square.
- Encourage normal blinking pattern.
- Start with fast scan protocol
- Optimize polarization.
- Don’t forget focus.
- Move joystick (or mouse controls) to maximize signal “sweet spot”.

Scanning Strategies
- Start with “Fast” or “HS” volume scans as a quick overview and watch for pathology during acquisition
  - Stratus: Macular Thickness or Fast Macular
  - SD instruments: Macular Cube Scan

Fast Scans for VOCT
- 6x6 cube 25 lines 240 µm
- 6x6 cube 97 lines 60 µm

Scanning Strategies
- High-resolution horizontal & vertical single line scans centered on fovea.

“Anchor” Scan
- Free-scan or pan to detect subtle pathology.
- “Anchor” scan on known landmark.
- “Repeat” function restores settings from previous scans for consistency when doing custom scans.
Fixation Issues
- Macular pathology often makes it difficult for patients to establish or maintain central fixation.

Eccentric Fixation
- Let patient establish fixation.
- Capture scans on fixation first.
- Then try to center scan pattern over fovea or area of pathology & repeat
  - click and drag the scan pattern over foveal depression (if visible).
  - "Anchor" scan on disc margin if depression isn't identifiable.

“Anchor” Scan to Disc

What Defines a Quality Scan?
- Centered on anatomy/pathology.
- Good edge-to-edge reflectivity.
- Good saturation/signal strength.
- As horizontally level as possible.
- Free from artifacts.

Scan Quality
- Scan quality numbers (S/N ratio)
  - Stratus & Cirrus Signal Strength of >5
  - Spectralis Quality Factor >25
  - Topcon Quality Factor >30-50
  - Optovue SSI >35-50 (different sources)

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- Don’t be a slave to the numbers!
  - How the image looks is more important than the quality number.

Signal Strength

- Focus
- Polarization
- Z-offset
- Alignment within pupil
- Media opacities
- Tear film disruption
- Dirt/debris on objective

Signal Strength/Focus

Images courtesy of Gary Miller, CRA, OCT

Z-Offset/Signal Strength

Images courtesy of Gary Miller, CRA, OCT
Z-Offset/Signal Strength
- **Stratus**
  - In bottom half of scan window
- **Cirrus**
  - In top half of scan window
- **Spectralis**
  - In top half of scan window
- Others?

Signal Interference
- Signal strength can be adversely affected by several common eye conditions/findings
  - Cataract
  - Corneal opacities
  - Floaters/Asteroids
  - Intraocular blood
  - Astigmatism
  - Poorly centered IOL/small capsulotomy

Media Opacities

Sampling
- Sampling reduces noise artifacts
  - Sampled 4x
  - Sampled 100x

Images courtesy of Gary Wilen, CRA, OCT-C

ART “Painting”
**Signal Interference**

- A major culprit is dry eye or inadequate tear film.
- Tear film can be disturbed by several routine eye examination procedures:
  - applanation tonometry.
  - diagnostic contact lens exam.
  - gonioscopy.

Whenever possible, perform OCT before any procedures that can compromise integrity of the tear film.

**Identifying Artifacts**

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

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

Movement Artifacts
Movement Artifacts

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.

SD Inversion

Inversion Artifacts

Images courtesy of Bridgette Staffaroni, COT

Inversion Artifacts
Sampling Artifacts

Analysis Artifacts
- Tissue boundary identification.
- Volume maps rely on image processing:
  - Align process.
  - Tissue boundary identification.
  - Interpolation.

Align
- Corrects for patient movement during the scan by aligning each a-scan with its neighbor.
- Effectively flattens RPE.

Align - Oops!

Sub-retinal Fluid/Map Failure
Map Artifacts (Stratus)

- Sharp demarcation line at any of the radial scan line locations:
  - Propeller
  - Fan blade
  - Bowtie

Boundary Line Artifacts

- Keep scan positioned in middle to lower third of window to correct.
Boundary Line Artifacts

- Push scan higher in window (SD-OCT) to move anterior pathology out of view.
- Beware of inversion artifact.

Review: Quality Tips

- Head/chin straight and square
  - Important for consistent alignment of serial scans.
  - Helps proper anatomic alignment when using a 7º offset scan.
- Encourage normal blinking pattern
  - It's our job to capture images between blinks!
- Use artificial tears on patients with DES or compromised tear film.

Review: Quality Tips

- Placement of scan image within scan window (z-offset) is very important for maximum signal quality.
- Placement of scan image within scan window (z-offset) can effect tissue boundary identification and image analysis.

Review: Quality Tips

- Look for subtle pathology.
- Be vigilant for both scanning and analysis artifacts and learn to correct them.

Review: Quality Tips

- “Anchor” scans to recognizable anatomy if scanning atypical areas or angles.
- “Anchor” scans to midpoint of optic disc margin if unable to detect fovea.

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