Tips and Tactics for Retinal Imaging

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Retinal Imaging
- Fundus camera
- Scanning Laser Ophthalmoscope (cSLO)
- SD-Optical Coherence Tomography

Universal Principles
- Focus
- Uniform illumination
  - Centered in pupil at appropriate working distance.
- Patient fixation
- Centered on known anatomic landmarks
- Centered on pathology

Anatomical Landmarks
- Fovea
- Optic Disc

Alignment
- Centered on anatomic landmark

Alignment
- Centered on pathology
Alignment
• Centered on pathology

Fundus Photography
• Fundus photographs are used for clinical documentation, teaching, retinal screening, remote consultation, and clinical trials.
• Some retinal details may be easier to identify in stereoscopic fundus photographs compared with direct examination.
• Serial photographs are commonly used to track disease progression.

Serial Fundus Photography
Baseline 1 year follow-up 2 year follow-up
Baseline 4 month follow-up 27 month follow-up
Baseline 34 month follow-up 44 month follow-up
Fundus Photography

- Fundus photographs are often used as a baseline to assist in interpretation of other diagnostic imaging procedures such as fluorescein angiography.

Fundus Camera

- The modern fundus camera is a horizontally mounted instrument with an internal electronic flash and an attached 35mm camera or digital sensor.

Fundus Cameras

- Traditional (mydriatic)
  - Requires pharmacologic dilation
- Non mydriatic
  - Relies on physiologic dilation in a darkened environment
  - Results are often better WITH pharmacologic dilation

Traditional Fundus Camera

- Requires pharmacologic dilation
- Variable magnification settings
- Best for peripheral imaging
- Easier to shoot stereo photos
- Required for many clinical trials

Non-Mydriatic Fundus Camera

- User-friendly system designed with an infrared video focusing system that promotes physiologic dilation in a darkened room.

Variable Magnification

- Wide Angle 50º
- Normal 35º
- High Mag 20º
**Fundus Camera Illumination**
- The optical system of the fundus camera projects a ring of light from the internal strobe axially through the dilated pupil.
- The ring shape allows a separation of the outgoing and incoming illumination.

**Dilation**

**Fundus Camera Focus**
- Fundus photography relies on the interaction between the optics of the fundus camera and the optics of the subject eye.
- The focus control of the fundus camera is used to compensate for refractive errors in the subject eye.
- Many fundus cameras have additional controls to compensate for refractive conditions such as myopia or astigmatism.

**Focus: Setting the Eyepiece**
- Fundus cameras employ an aerial image focusing system that relies on a properly set eyepiece reticle before attempting to focus the camera.
- Correctly adjusting the eyepiece reticle for proper focus is the single most important step in achieving sharp fundus photos.
- The photographer should relax their accommodation at distance to avoid accommodative shift during photography.
Focus: Setting the Eyepiece

- A popular and commonly taught technique involves adjusting the crosshairs at least three successive times, noting the diopter setting each time, and using the average.
- This technique actually promotes unnecessary accommodation and inaccurate settings.

Focus: Setting the Eyepiece

- Each time the photographer looks at the numbers marked on the eyepiece, they accommodate to near, then immediately try to relax at distance before looking through the viewfinder again.

Focus: Setting the Eyepiece

- Repeating these steps multiple times induces accommodative “gymnastics” and subsequent fatigue leading to improper settings when accommodation drifts during a photographic session.

Focus: Setting the Eyepiece

- The best strategy is to ignore the eyepiece numbers, but pay constant attention to the crosshairs and image of the retina.

Focus: Setting the Eyepiece

- As long as the crosshairs and the aerial image of the fundus both appear sharp at capture, the focus will be correct.

Focus

- Rock focus knob until image is sharp.
- Use myopic or astigmatic control if needed.
- Use green filter to increase contrast while focusing.
Scanning Laser Ophthalmoscope

- The confocal scanning laser ophthalmoscope (cSLO) is an instrument that can be used for several retinal imaging modalities including IR, red-free, fluorescein angiography, ICG angiography and fundus autofluorescence.

Clinical Confocal Imaging Devices

- Spectralis HRA
- Optos
- Nidek F-10
- Eidon

Scanning Laser Ophthalmoscope

- A monochrome laser scans across the fundus in a raster pattern to illuminate and record successive elements of the retina, point-by-point at speeds up to 24 milliseconds.
- Multiple monochrome laser images taken simultaneously can be combined to create pseudo-color images.
cSLO Pseudo Color

cSLO Confocal Imaging
• A confocal aperture positioned conjugate to the focal plane of the retina blocks non image-forming light from reaching the sensor to minimize scatter and improve contrast.

Focus/Wavelength
• The angle of refraction changes when switching between light sources/lasers of different wavelengths
• You will need to refocus the SLO when switching between different wavelengths to account for the change in focus.

Focusing the Spectralis
• Manual brightness control: spin gain up to a fairly bright level and shift focus knob until you see speckles.
• Then reduce gain to normal brightness before capturing the fundus image.

Instrument/Camera Technique
• When switching between the IR (820 nm) and blue laser (488 nm) for FA or FAF, turn the focus knob approximately ¼ turn clockwise.
Eye Tracking/Sampling

- Smoothes noise and increases exposure

The Eye in Cross-Section

Cross-Sectional Imaging

“Virtual Biopsy”
Cross-Sectional Imaging

• Measures both depth/distance and intensity of reflectivity.

Anatomy of an OCT Scan

• Identifiable layers
  – Posterior hyaloid
  – RNFL
  – Plexiform layers
  – Photoreceptors
  – RPE
  – Choroid

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

Anatomical Landmarks

Anatomical Landmarks
Anatomical Landmarks

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

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 “sweetspot”.

Scanning Strategies

- Start with “Fast” or “HS” volume scans as a quick overview and watch for pathology during acquisition
  — Fast Macular Thickness or Macular Cube Scan

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

- 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

Image courtesy of Gary White, CRA, OCT-C

“Anchor” Scan to Disc

Image courtesy of Gary White, CRA, OCT-C
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.

Scan Quality

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

Images courtesy of Gary Miller, CRA, OCT
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
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.
Signal Interference

- Frequent blinking and/or instillation of artificial tears often improves image quality.
EDI/FDI

- Start sampling image and engage EDI feature about half way through sample.

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.

Images courtesy of Bridgette Staffaroni, COT
OCT Angiography (OCT-A)

- Samples same area of the retina after correcting for eye movement.
- Detects motion (blood flow).
- Depth encoded en-face map of blood flow.

To Blink or Not to Blink?
To Blink or Not to Blink?

Oogies on My Lens!

Review: Tips for Fundus Photography

- Set the camera eyepiece correctly
  - Ignore the diopter numbers.
  - Relax accommodation to distance.
  - Make sure the reticle and the retina appear sharp at the same time.
- Use green filter to focus on vessels or with photophobic pt.

Review: Tips for Fundus Photography

- Maintain consistent technique from visit to visit with serial imaging.
- Facilitate best possible dilation (mydriatic or non-myd).
Review: Tips for OCT

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

Thank You!

• Questions?
  – timbennett@eye-pix.com
• Handouts:

Hands-on Workshop

• Don’t be intimidated.
  – Imaging can be fun!
  – Don’t be afraid to move the controls.
• Drive it like you stole it!

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