Course Title: The Future of Retinal Imaging Has Arrived!

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Goal

To provide current, clinically relevant information about posterior segment imaging and new diagnostic technologies.

Objectives

At the conclusion of this course, the participant will be able to:
1. Understand the basic principles and value of OCT and OCTA imaging.
2. Discuss the advantages of deeper and wider fundus imaging using various technologies, including enhanced depth OCT, OCTA, and fundus autofluorescence (FAF).
3. Evaluate current and new uses of en face, enhanced depth, and wide field OCT for diagnostic ocular disease imaging.
4. Discuss diagnostic capabilities of imaging for glaucoma, retina/macula, and choroidal disease.
5. Analyze and interpret en face, enhanced depth, and wide field images and data.
6. Understand and apply the basic principles of dark adaptometry in AMD.
7. Understand and apply the basic principles of electrodiagnostic testing, including ERG, VEP, and EOG.
8. Understand and apply the basic principles of ophthalmic A/B-scan ultrasonography.

Description

Posterior segment diagnostic technologies have greatly enhanced our ability to visualize tissue microstructure, as well as assess risk for and detect early signs of disease. This course provides the participant with clinically relevant information about the various methods of posterior segment imaging and other diagnostic testing. Emphasis is on the essentials of analysis, interpretation and clinical applications.

Course Outline

- Posterior Segment Examination and Evaluation

  - Biomicroscopy
    - o View the anterior segment, lens, anterior and mid-vitreous
  - Funduscopy
    - o Direct Ophthalmoscopy
    - o Binocular Indirect Ophthalmoscopy
      - § Scleral indentation to expand the reach of BIO § Multiple condensing lenses for wider field of view
    - o Fundus Biomicroscopy
      - § Contact fundus lenses
        - Goldmann 3-mirror
      - § Non-contact fundus lenses

- Posterior Segment Imaging and Other Diagnostic Techniques

  - Fundus Photography: color and red-free
  - Fluorescein Angiography
  - A and B-Scan Ultrasound
    A-scan: one dimensional
    A = Amplitude
    B-scan: two dimensional
    B = brightness
  - ICG Angiography (Digital)
  - SLO (HRT), SLP (GDX)
  - OCT first demonstrated
  - Wide field SLO
  - Fourier Domain SD-OCT
  - OCT Angiography
  - Confocal Scanner
    - o Posterior Pole
    - o Wide field
  - Microperimetry
  - Multispectral Imaging
  - Multicolor Imaging
  - Fundus Autofluorescence (FAF)
  - Macular Pigment Optical Density (MPOD)
  - Dark Adaptometry for AMD

- Electrophysiology
  - ERG: detection of photoreceptor disease
  - Types of ERG and their clinical use
    - Flash ERG
    - Multifocal ERG
    - PERG
  - VEP: cortical representation of the fovea
  - Types of VEP studies and their clinical use
  - EOG: RPE-involved diseases
  - Clinical uses of EOG

- History and Principles of OCT

  - 1991 James Fujimoto at MIT
  - Original research instrument 400 A-scans / second
  - SD-OCT 27,000 A-scans / sec
  - Swept Source-OCT 249,000 A-scans / sec
  - Swept Source OCT
    o Twice as fast (twice as many A-scans / second) as SD OCT o Allows for wide field imaging (12mm vs. 6-9 mm). Easily gets ONH and macula in the same scan
    o Longer wavelength of light, so can image much more effectively through media opacities, and penetrates much better in to the choroid (2.6 mm depth vs. 2.3mm)
  - Optical- the use of optics and optical systems
  - Coherence- coherent light
  - Tomography- cross sectional imaging
  - Non-invasive technology
  - OCT is analogous to ultrasound imaging, where a sound pulse is launched and the reflections (echoes) are measured to create an image of tissue.
  - In OCT light reflections are measured by an interferometer, using the low coherence properties of a broadband light source.
        o Only light that has traveled approximately the same distance in the two arms of the interferometer to within the coherence length of the source is able to create interference fringes.
        o By measuring this interference, the location and strength of the reflections can be determined.
  - Enhanced Depth OCT (EDI)
  - SD-OCT has a coherence gate (depth at which the interference image can be obtained) of about 2 mm. An interference signal can be obtained when the retinal tissue examined enters this coherence gate, but the signal intensity attenuates in the depth direction. o Consequently, to obtain high-quality images in SD-OCT, it is important to bring the retinal tissue to the upper imaging range.
  - In contrast, EDI-OCT creates an inverted mirror image. The reference surface of the inverted mirror image surface is on the choroidal side.

- OCT Angiography (OCTA)

  o "Dye-less" angiography
  o Great detail of vasculature down to capillary beds
  o No injection of dye, so can't show leakage
  o Can show abnormal vasculature
  o FDA approved, multiple instruments
  o Clinical applications and interpretation of OCTA

- Fundus Autofluorescence (FAF)

  • Is available in standard and wide field
  • Recently becoming more integrated into clinical practice, with applications in multiple disease states
  • May be performed with a confocal Scanning Laser Ophthalmoscope (CSLO), confocal scanner, multispectral imaging, or with an FAF Camera
  • CSLO: uses a low energy laser and averages up to 30 scans
  • FAF camera: uses a single, VERY bright flash (300 watt-seconds) yielding a single image
  • FAF Images are entirely based upon the presence of lipofuscin in the RPE
  • In the eye, a byproduct of photoreceptor outer segment phagocytosis
  • Accumulates in the RPE with age and certain diseases
  • Also accumulates in other tissues and organs with age or disease (brain, liver, heart)
  • Lipofuscin autofluoresces in the 300nm-600nm wavelength range, which is very close to visible light (400nm-700nm), so visible light can excite an emission
  • Valuable diagnostic and monitoring tool in an ever increasing list of ocular conditions
  • Can show damage well before it is visible to examination or in regular photos EDI, Wide Field, and FAF in Detail: Case examples and sample scans, with interpretation
  • Anatomy of choroid by En face OCT
  • Color retinal imaging and potential correlation with OCT En face images and FAF
  • Macular microstructure, FAF, and En face OCT in Macular Edema
  • Appearance and Progression of Geographic Atrophy Predicted by En Face OCT and FAF
  • En face OCT in Polypoidal Choroidopathy
  • FAF and En face OCT in retinal and Macular Dystrophies
  • FAF and En face OCT in Wet ARMD
  • FAF and En face OCT in Ocular Oncology
  • En face OCT angiography in vascular diseases of the retina