ABSTRACT

This course reviews morphologic characteristics of the retina & optic nerve as defined by optical coherence tomography (OCT). A methodological approach is utilized to define diseases based upon OCT imaging. Utilization of OCT in the diagnosis and management of vitreal, macular, neurosensory retinal, sub-retinal and optic nerve diseases is examined and discussed.

LEARNING OBJECTIVES

To review the morphology of the vitreous, neurosensory retina, retinal pigment epithelium, and choroid as defined by optical coherence tomography.

To understand anatomic properties of the eye, which results in variations of transmission, absorption and scattering of incident light with OCT.

To develop clinical correlates between normal and abnormal OCT findings for the vitreous, macula, retinal nerve fiber layer and choroid.

To review the utilization of qualitative vs. quantitative OCT data in the management of ocular diseases.

To examine emerging technologies in optical coherence tomography.

KEY WORDS

Imaging technology, retina/retinal diseases, optic disc/nerve
I. Principles of optical coherence tomography (OCT)
   a. Analogous to orbital ultra-sonography which assesses the time delay response to the transmission of sound waves
   b. Provides non-invasive in situ cross-sectional imaging of tissue via low coherence interferometry
   c. Ultra-structural visualization is achieved through the assessment of echo time delay and intensity of back-scattered / back-reflected light from ocular tissues

II. Optical coherence tomography imaging
   a. Temporal vs. spectral domain (spectral domain layer segmentation & 3D visualization)
   b. Tomography (transverse tomograph and longitudinal tomograph)
   c. Scans (line scan and circular scan)

III. Interpretation of OCT
   a. Optical reflectivity of incident light
      i. Normal ocular structures demonstrating increased optical reflectively
         1. Retinal pigment epithelium
         2. Photoreceptor junction
         3. Nerve fiber layer
   b. Optical scatter
      i. High scattering
         1. Enhanced reflectivity
         2. Increased attenuation of incident light – shadowing of deeper retinal structures
         3. Causes of high backscattering include hyper-reflective entities
            a. Hard exudates
            b. Hemorrhages
            c. Detached retinal pigment epithelium
               i. Drusenoid
               ii. Serous
               iii. Hemorrhagic
               iv. Serosanguinous
      ii. Moderate scattering
         1. Intermediate appearance of OCT images
         2. Causes of moderate backscattering
            a. Retinal edema
            b. Alterations in cellular structure
      iii. Optically transparent
         1. Devoid of backscatter
         2. Causes
            a. Normal vitreous body / vitreo-retinal interface
            b. Serous fluid
            c. Subretinal fluid
   c. Fundus Auto-Fluorescence (FAF)

IV. Morphologic approach for the methodological analysis and characterization of abnormal OCT imaging studies
   a. Vitreous
      i. Vitreous
      ii. Asteroid hyalosis
b. Vitreo-retinal interface
   i. Posterior vitreous detachment (complete vs. partial)
   ii. Vitreo-macular adhesion vs. vitreo-macular tractional syndrome
   iii. Epi-retinal membrane (ERM)
      1. Macular pseudo-hole
      2. Characterization of membranes
         a. Globally adherent membranes
         b. Locally adherent membranes
      3. OCT - surgical outcome predictor
   iv. Macular cyst
   v. Lamellar hole
   vi. Macular hole (OCT characterization of macula in order to stage disease according to the Gass classification scheme)

c. Macular
   i. Macular degeneration
      1. Drusen
      2. Non-neovascular
         a. Geographic atrophy (OCT tomograph & autofluorescence)
         b. Macular atrophy
      3. Neovascular macular degeneration
         a. Posterior to anterior originating membranes
            i. Classical choroidal neovascular membranes (CNVM)
            ii. Occult CNVM
         b. Anterior to posterior membranes
            i. Retinal Angiomatous Proliferation (RAP)
   ii. Plaquenil® maculopathy
      1. AOA 2002 management guidelines
      2. AOA 2011 management guidelines
   iii. Macular edema
      1. Disease etiology (retinal vascular occlusive disease, DM, post-surgical)
      2. Qualitative and quantitative analysis of treatment
         a. Medical therapy
         b. Intra-vitreal intervention
   iv. Neurosensory retinal detachment
   v. Retinoschisis

d. Optic nerve
   i. Drusen
   ii. Optic nerve edema
   iii. Peri-papillary atrophy

e. Choroidal
   i. Choroidal nevus
      1. Amelanotic
      2. Pigmented
   ii. Choroidal tumors
      1. Choroidal melanoma
      2. Choroidal osteoma
   iii. Polypoidal Choroidal Vasculopathy (PCV)
iv. Central serous choroidopathy
v. Focal choroidal excavation

V. Emerging advances in optical coherence tomography
   a. Handheld OCT
   b. Intra-operative OCT
   c. Functional OCT