Optical Coherence Tomography of Barrett’s Esophagus

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6/16/09
Overview

• What is OCT?
• Clinical applications
• Management of Barrett’s esophagus
• OCT in Barrett’s esophagus
• Comprehensive OCT
• Summary
What is OCT?

- Optical signal acquisition/processing method that permits micrometer-resolution imaging from biological media
- Near-infrared light = tissue penetrance
- Cross-sectional imaging
- Allows visualization of tissue microarchitecture with ~1-mm depth
- “Optical ultrasound”
Theory of OCT

- Reference Mirror
- Axial (Z) Scanning
- $E_R(t), P_R(\omega)$
- Collimation Lens
- Lateral (X or Y) Scanning
- $E_g(t), P_g(\omega)$
- Beam Splitter
- Objective Lens
- Low coherence light source
- Sample under test
- Beam Reducer
- Computer & Display
- Photo detector
- Filtering
- Demod. processing
- ADC
Clinical Applications

• Retinal imaging\(^1\)
  – Deeper penetrance with transparent tissue
• Vascular system\(^2\)
  – Penetrates calcification and may differentiate lipid-rich vs. fibrous tissue
• GI tract\(^3\)
  – Epithelium, lamina propria, muscularis mucosa, and submucosa

Macular edema

Michael Colucciello MD
Layers of the Esophagus
Stratified squamous and gastric cardia epithelia
Barrett’s Esophagus

- **Definition**: Specialized intestinal metaplasia in the esophagus.
- **Spectrum of disease**:
  - Non-dysplastic BE --> LGD --> HGD --> CIS --> invasive adenoCA
- 13,000 cases of esophageal adenoCA annually, with increasing incidence.
- 11% 5-year survival once CA occurs
- Effective, less morbid treatments for dysplastic BE are becoming available¹

Surveillance endoscopy of BE

- EGD every 3 mo - 2 yrs depending on degree of dysplasia, with random 4-quadrant biopsies every 2 to 3-cm of involvement\(^1\)
- Endoscopic appearance of BE does not allow accurate focused biopsy of areas with the most advanced dysplasia/CA.

OCT in Barrett’s esophagus

• **OCT can**:
  – Differentiate specialized intestinal metaplasia from squamous or gastric epithelium with 97% sensitivity and 92% specificity
  – Identify HGD with a sensitivity of 70-85% and specificity of 65-74%

Normal esophagus
Non-dysplastic BE
HGD/Intramucosal CA
Comprehensive OCT

- Faster image processing allows OCT of large esophageal segments.
- Positioning the catheter within a balloon and withdrawing it in helical fashion permits imaging of the entire distal esophagus/squamocolumnar junction\textsuperscript{1,2}

Summary

• OCT uses near-infrared light to provide high-resolution real-time cross-sectional imaging of tissue to a depth of 1-2 mm
• “Optical biopsy” may allow the ability to discriminate histopathology without the need for biopsy, or may direct the clinician to the optimal location for traditional biopsies to be obtained.
• The enormous datasets generated by comprehensive OCT remain a barrier to adoption in clinical practice.
Thank you

- Joo Ha Hwang, MD, PhD
- Melissa Upton, MD
- Michael Cobb, PhD