Advances in Endoscopic Imaging

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Amar R. Deshpande, MD
Asst Professor of Medicine
Division of Gastroenterology
University of Miami Miller School of Medicine
Objectives

- To recognize new technologies available to detect abnormal mucosal findings
- To gain an understanding of the principles of the various types of endoscopic imaging
- To appreciate the role of advanced imaging in endoscopic practice
Why do endoscopy?

- Many indications for upper and lower endoscopy
- We will focus on identification (and therefore removal) of precancerous lesions
  - adenomatous colon polyps
  - Barrett esophagus with dysplasia
  - flat dysplasia in inflammatory bowel disease
- Finding lesions in earlier stages leads to better survival and cure rates
Conventional Endoscopy

- Also referred to as white-light endoscopy (WLE)
  - current gold standard for detection and removal of pre-cancerous lesions
- However, there is a clear “miss” rate
  - up to 22% of polyps seen on tandem colonoscopy were missed on first study
  - non-raised lesions can be the hardest to visualize
- Therefore, new modalities are needed
  - improved crypt and capillary pattern visualization can help classify mucosal lesions/polyps

Armamentarium of Endoscopy

- Digital advances in white-light endoscopy
  - High definition (HD) endoscopy
    - uses high-density pixel CCD chips (resolution $\infty$ pixel density)
  - Magnification endoscopy
    - can magnify 1.5x to 150x
    - optical zoom maintains resolution, electronic zoom does not

Armamentarium of Endoscopy

- Using dyes to highlight mucosal surface abnormalities (chromoendoscopy)
  - 1st described in the 1920s in cervical dysplasia
    - with Lugol’s solution, squamous epithelium (highly glycogenated) was dark, dysplasia/neoplasia was not
  - described in the 1970s at colonoscopy; fine mucosal changes and inflammation seen with dye (indigo carmine and methylene blue) in patients with UC

Armamentarium of Endoscopy

- Different dye options
  - absorptive (methylene blue, Lugol’s iodine, toluidine blue): taken up by the mucosa of specialized epithelium (e.g. Barrett)
  - reactive (Congo red, acetic acid): change color on contact with specific cellular constituents expressed in diseased mucosa
  - contrast (Indigo carmine): pool in crevices and depressions within the mucosa, accentuating uneven mucosal surfaces

hyperplastic adenoma
(papillary) (nonbranched)

Armamentarium of Endoscopy

- Digital filtering techniques (virtual chromoendoscopy)
  - Narrow-band imaging (NBI)
  - Post-image acquisition techniques
    - Fujinon intelligent chromoendoscopy (FICE)
    - i-scan (Pentax)
NBI

- All colors have different wavelengths
- What we see is what is reflected (everything else is absorbed)
- In traditional white-light endoscopy, it is hard to see capillary patterns (red) due to scattering from other colors
- By narrowing the band-width (415-540nm – blues and greens, not reds), capillary definition can be noted
FICE and i-scan

- use post-image acquisition algorithms to modulate the light reflected from the mucosa, highlighting surface contrast, vessel pattern and pit pattern
Armamentarium of Endoscopy

- **Autofluorescence imaging (AFI)**
  - submucosa produces green fluorescence when exited by blue light
  - abnormalities in mucosa or its capillaries above the submucosa blunt the intensity
  - differences in fluorescence can suggest abnormal mucosa
    - green is normal mucosa
    - purple is areas of attenuated fluorescence → abnormal mucosa
WLE (a), AFI (b), NBI (c)

Armamentarium of Endoscopy

- Confocal microscopy + endoscopy
  - Confocal Laser Endomicroscopy (CLE)
  - Need to inject dye intravenously as well
- Endoscopically localize an abnormal area (e.g. tongue of Barrett, polyp), then apply confocal microscopy to evaluate on a cellular level
- Because of need for localization, may need to combine with chromoendoscopy for general dysplasia screening (e.g. UC)
Does it make a difference?

- Many trials have looked at each of these modalities vs WLE
  - dysplasia screening in Barrett esophagus
  - dysplasia screening in IBD
  - detection of subtle adenomatous lesions
- Most have shown improved detection of dysplastic or adenomatous changes and the ability to target biopsies
Drawbacks

- More time-consuming
- Most endoscopists would need training:
  - interpreting pit patterns and capillary formations
  - interpreting microscopic findings
- No convincing data to support improved survival in those whose <6mm adenomas are removed
  - perhaps CT colography (in which patients with small polyps are followed radiographically) will provide more insight
Conclusions

- There are many new endoscopic imaging modalities that have allowed:
  - visualization of subtle or flat lesions
  - improved detection of dysplasia
  - targeting of biopsies
- These modalities are more time-consuming and have not yet clearly shown to positively impact survival
- Still a work in progress…