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Advanced endoscopic imaging: Polyps and dysplasia detection

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A B S T R A C T

Colonoscopy is the gold standard for colorectal cancer screening and diagnosis. Colonoscopy is a minimally invasive procedure that provides visual inspection of colonic mucosa. The goal of imaging is to detect adenomatous changes that are the primary risk factor for colonic adenocarcinoma. Adenomatous polyps represent structurally visible low-grade dysplasia. Their detection is the key to screening for and preventing colorectal cancer. Many technological advances have been designed to improve the detection of colonic dysplasia. Some advances improve subtle changes in mucosal architecture, while others improved the field of view. Adjuncts such as chromoendoscopy were developed to improve visualization of colonic mucosal pattern. Other accessory devices improve the field of view.

Introduction

The key element of preventing colorectal cancer is removal of colonic neoplasms, which manifest as polyps. A high-quality colonoscopy remains the gold standard screening modality for colorectal cancer. Polyps can form in a variety of shapes. Pedunculated polyps may be easier to visualize, while sessile or flat lesions may be difficult to detect. Colonoscopy with polypectomy decreased mortality from CRC by 53%.[1] Unfortunately, 2–6% of CRCs develop in the interval time between colonoscopies. These "interval cancers" are believed to arise from missed polyps rather than new neoplastic lesions.[2] Polyps can be missed due to various variables; and, an adequate bowel preparation is important to consider. Polyp shape and location contributes to their miss rate if polyps are hidden behind folds or are flat and may resemble normal mucosa. Multiple advances have been made to improve visualization of the colonic mucosa to increase polyp detection.

Chromocolonoscopy

Techniques were developed to enhance colonic mucosa to better distinguish normal mucosa from abnormal. Certain vascular and morphological changes occur during dysplastic changes, which can be enhanced to improve detection of dysplasia. Chromoendoscopy helps to distinguish normal mucosa from neoplastic lesions by enhancing surface morphology of dysplastic lesions. The neo-angiogenesis of adenomatous polyps result in different "pit patterns" of the mucosa, which can be seen with dye or optical techniques.

This modality uses dye or optical techniques to enhance the observed endoscopic image. Chromocolonoscopy can act as an "optical biopsy" by predicting the lesion's microscopic morphology. Predicting histology based on endoscopic appearance is a valuable tool in endoscopic mucosal resection and endoscopic submucosal dissection. This technique can distinguish adenomatous polyps from hyperplastic polyps. Since small hyperplastic polyps (< 5 mm) are considered benign with no risk for malignancy, may be removed without the need for a histological evaluation. Predicting histology can cut down costs of excessive pathology fees if small hyperplastic polyps are diagnosed optically and discarded.

Dye-Assisted Chromocolonoscopy

Dye-based chromoendoscopy uses dyes that either absorb into the mucosa (vital dye) or remain on the surface of the mucosa (non-vital). The endoscopist can apply the dye to a targeted area, or to the entire colon (pan-chromoendoscopy). The topography of the neoplastic lesions is enhanced by the dye producing a pit pattern. Kudo et al.[3] showed that the histology closely correlated to the endoscopic pit pattern of dye-enhanced lesions. Adenomatous lesions had a "gyrus-like" pit pattern, while hyperplastic lesions had an "asteroid" pit pattern.

The two most commonly used dyes have a blue endoscopic appearance. Both are equally effective at distinguishing mucosal

Abbreviations: CRC, colorectal cancer; HD, high definition; ADR, adenoma detection rate; NBI, narrow-band imaging; CLE, confocal laser microendoscopy; EUS, endoscopic ultrasound.

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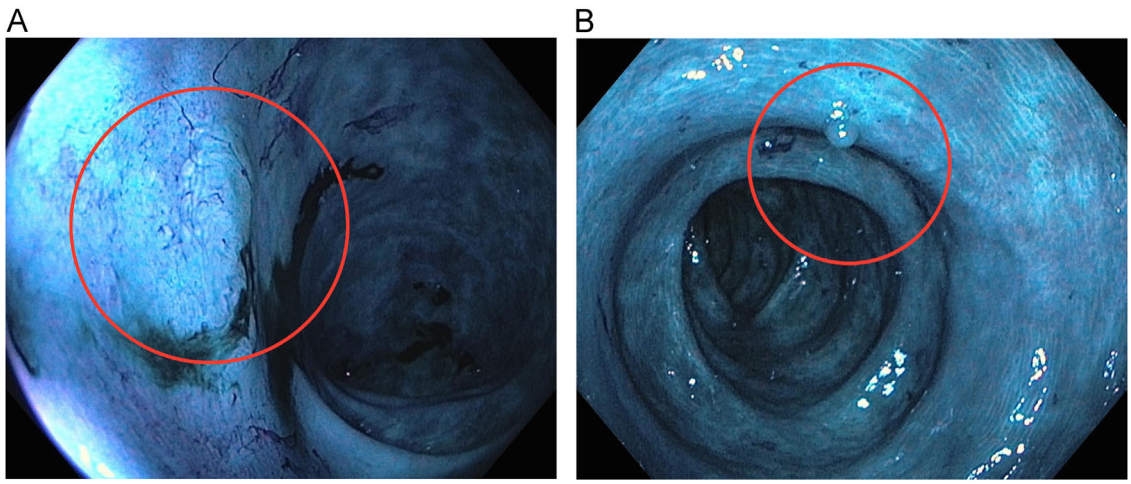

Fig. 1. Chromoendoscopy with methylene blue in a patient with UC. (A) Flat lesion with pale appearance showed tubular adenoma histology. (B) Inflammatory polyp showed the same take up of dye as surrounding tissue without the typical pale appearance or changes in the pit pattern.

abnormalities. Indigo carmine is a non-vital dye that coats the mucosa and outlines the pit pattern. It is applied with a concentration of 0.03–0.5%. Because it is not absorbed, it disappears as it becomes diluted throughout the colon; so, it lasts only a few minutes.

Methylene blue, a vital dye, actively absorbs into the intestinal epithelial cells. Normal mucosa appears darker as it absorbs the dye, while neoplasia and inflamed mucosa appear brighter as they do not absorb the dye (Fig. 1). Dye is applied at a concentration of 0.1%. After application, the dye stains tissue for approximately 1 min and lasts up to 20 min.[2] Both stains have been shown to be safe with no significant side effects. There was concern that methylene blue may cause DNA damage, but no clinically significant DNA injury has been proven.[2]

Excellent bowel preparation is required for adequate visualization of the mucosa with chromoendoscopy. The endoscopist should aspirate any remaining liquid material when advancing through the colon. When the cecum is reached, the dye is applied directly into the accessory channel using a 60-mL syringe or a spray catheter. The dye can also be diluted into 1 L of sterile water and applied by the endoscopist by using the foot pedal of the water pump. Decompressing the colon improves the dye coverage. For pan-chromoendoscopy, segments of 20–30 cm are sprayed. When using indigo carmine, immediate inspection can be performed. Methylene blue requires 60 s to absorb. Methylene blue-coated tablets have been reported for the use in chromoendoscopy, with delivery of dye directly to the colon, but more studies will need to be done to determine the efficacy of dye delivery.[4]

In average-risk individuals, dye-based chromoendoscopy has shown significant benefit in detection of lesions that are commonly missed (dimunitive polyps, proximal adenomas, and flat polyps), when compared to white light endoscopy [or high definition (HD) endoscopy]. In comparison with standard white light colonoscopy, or HD colonoscopy, chromoendoscopy showed a small increase to no effect in adenoma detection rate (ADR). Dye-based chromoendoscopy had a significant benefit in detecting more diminutive polyps.[5] Most of the impact of chromoendoscopy is seen in significant increase in detection of more proximal, flat and serrated lesions. Although this technique can significantly increase detection of frequently missed lesions, the main disadvantage of dye-assisted chromocolonoscopy is the length of the procedure.

This technique is especially useful in patients with inflammatory bowel disease (IBD), who are at increased risk for colorectal cancer, and require dysplasia surveillance after 8 years of diagnosis. A 3–4.5-fold increase is seen in dysplasia detection with use of dye-assisted chromoendoscopy with standard biopsies, when compared with white light endoscopy.[6] European guidelines currently recommend chromocolonoscopy with standard biopsies for dysplasia surveillance in IBD patients. In the USA, chromoendoscopy is the preferred choice for dysplasia screening in IBD patients; but is not considered standard of care. More studies need to be done prior to establishing chromoendscopy as the gold standard. Of note, the pit pattern may not be as clear to differentiate normal mucosa from dysplasia in patients with long-standing inflammation as the background mucosa may appear abnormal. Because dysplasia may not be clear to identify, the American Gastroenterology Association recommends only for experienced physicians to perform chromoendoscopy.

Digital Chromocolonoscopy

Dyeless or digital chromocolonoscopy uses imaging-enhanced optical technique to enhance lesions. Narrow-band imaging (NBI; Olympus, Tokyo, Japan) uses optical filters in the light source to enhance superficial and deep vessels by filtering light absorbed by hemoglobin. Normally, white light bandwidth has red–green–blue. Hemoglobin absorbs green and blue light. NBI filters the white light to allow blue light (415 nm) and green light (540 nm) to pass, but blocks red wavelengths. Neoplastic lesions in the colon have altered mucosal vessels, which absorb the light, while normal mucosa reflects it. As a result, NBI enhances neoplastic lesions. It enhances the gyrus-like pit pattern of adenomas (Fig. 2), and asteroid pit pattern of hyperplastic lesions (Fig. 3).

Similarly to the dye-assisted chromoendoscopy, NBI utilizes the pit pattern and vascular pattern to distinguishing abnormal lesions. The NICE (NBI International Colorectal Endoscopic) classification was developed to determine type I (hyperplastic) and type II (adenomatous) lesions based on appearance of color, surface pattern, and vessels (Table).[7]

Studies have compared ADR using NBI or white light colonoscopy. NBI improved ADR in comparison with conventional white light colonoscopy, but showed no improvement in ADR when compared to HD colonoscopy.[8] The main disadvantage of NBI is the dark color, which limits its use as a screening technique. The dark screen does not allow for efficient screening of the entire colonic mucosa. NBI is helpful for a targeted evaluation once a lesion is identified in order to classify it based on its pit pattern and the vascular pattern.