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"Advanced Imaging in Colon"

Mini Review

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Advanced Imaging in Colon

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ABSTRACT

Colon cancer is one of the commonest cancers of the gastrointestinal tract leading to significant mortality and morbidity. This is one of few cancers that can be prevented by robust screening colonoscopy. Newer techniques can help in predicting histology by an endoscopist. There is no need for a histopathologist to make the diagnosis of an adenomatous or hyperplastic polyp which forms the bulk of the colon polyps. This technique will help in making the procedure cost-effective and thereby prove as an affordable service to prevent colon cancer. In pursuit of high quality colonoscopy and patient's safety, advanced imaging techniques have evolved from the traditional white light colonoscopy.

INTRODUCTION

Colonoscopy is widely used for colon cancer screening. This is to detect polyp and resect them before they go on to become cancer. However, white light colonoscopy cannot differentiate the histology of the resected polyp accurately.[1] Advanced imaging in colonoscopy was developed in view of improving the standards in screening for colorectal cancer. One of the aims of advanced imaging in colonoscopy was to accurately characterize the polyps as adenoma or hyperplastic. Better characterization will help in 'resect and discard practice' for adenoma polyps and for 'diagnose and leave' for distal colon hyperplastic polyps where in an endoscopist can predict histology accurately in real time without the need for the histopathologist to make the diagnosis. This method of predicting histology is also known as 'endohistology' or 'optical histology'. This makes screening colonoscopy more efficient and a less expensive affair at an estimated savings of $33 million annually in screening colonoscopy.[2,3] Also, there will be a decreased risk of perforation and bleeding by avoiding unnecessary polypectomies of hyperplastic polyp from distal colon.[4] Therefore, the aim of advanced imaging is to assist colonoscopy in making it efficient, inexpensive and safe with an ultimate goal to decrease colorectal cancer.

The rationale for real-time histology of colorectal polyps is based on the literature that more than 2 3rd of the polyps removed are diminutive polyps and they rarely will have advanced histology such as villous features, high-grade dysplasia or cancer[5-7] and the accuracy of pathologists in making polyp histology characterization is 85-95%.[8,9]

According to American Society of Gastrointestinal Endoscopy (ASGE) report on preservation and incorporation of valuable endoscopic innovations (PIVI),[10] endoscopic technology should provide a 90% agreement in assignment of post-polypectomy surveillance for polyps of <5mm in size to be resected and discarded without pathological assessment and negative predictive value for adenomatous histology of greater than 90% in order to diagnose and leave unresected recto-sigmoid hyperplastic polyps of <5mm.

HIGH DEFINITION WHITE LIGHT (HDWL) ENDOSCOPY

In the last decade, technology has evolved and we are in the era of high definition. We now have high definition endoscopy white light endoscopy, which has a million pixels unlike 300,000 pixels in the past.[11,12] High definition white light (HDWL) endoscopy has replaced the older

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generation endoscopy in most endoscopy centers. Although HDWL has improved adenoma detection, it is not accurate in predicting histology.

A randomized control study on 293 consecutive polyps measuring <10 mm reported no difference in sensitivity, specificity or accuracy in predicting histology of adenoma and hyperplastic polyps with standard colonoscopy compared to HDWL. They reported sensitivity (76% *vs*. 76%; p=0.96), specificity (59% *vs*. 67%; p=0.44) and accuracy (70% *vs*. 73%; p=0.6) to predict histology in Standard *versus* HDWL colonoscope.[12] Another prospective study compared 100 patients with 236 polyps. They initially predicted histology with HDWL followed by Narrow Band Imaging (NBI). NBI had a significantly higher sensitivity and greater accuracy (96 and 93% respectively) compared with HDWL (38 and 61% respectively) (all p<0.0001) in distinguishing adenoma from hyperplastic polyps.[1]

The quest for further improvement in predicting histology resulted in advanced imaging techniques evolving from HDWL. There are different advanced images that are currently available as described in Table 1.

Table 1: Different Advanced Images in Colon.

Wide field	Narrow field
Chromoendoscopy Narrow Band Imaging (NBI) Fuji intelligent chromoendoscopy (FICE) i-Scan Autofluorescence imaging (AFI)	Confocal microscopy (CLE) Endocystoscopy (EC)

CHROMOENDOSCOPY

This technique uses various dyes like Lugol's iodine, Methylene blue, Indigo carmine and Cresyl violet which can be manually sprayed on the polyp during colonoscopy to outline the polyp morphology and enhance its detection.[13-15]

ELECTRONIC/VIRTUAL CHROMOENDOSCOPY

It offers similar benefits as Chromoendoscopy without the use of the dye. However, there is no need for a dye in this technique but contrast is still achieved through an electronic technology. This is of three different types: Narrow Band Imaging (NBI) (Olympus, Japan), Fuji intelligent chromoendoscopy (Fujinon, Japan) and i-Scan (Pentax, Japan). We will focus on Narrow band imaging in this paper as by far it is the most studied technique.

NARROW BAND IMAGING (NBI)

Technique: This is by far the best-studied advanced imaging technique. This is incorporated into newer generation (180 series and beyond) high definition white light endoscopy. The NBI can be activated by pressing a button in the colonoscope. The principle behind NBI is to use light to enhance the polyp vascular pattern and the underlying mucosal surface. Adenomatous or hyperplastic polyps will have certain specific vascular and mucosal patterns associated with it due to its pathology. A standard white light at longer wavelength scatters less and therefore can penetrate the tissues deeper. NBI uses an optical filter behind the standard white light. It confines white light into this filter and flashes light at two different wavelengths to display blue (415 nm) and green (540 nm) light. Blue light penetrates superficially to enhance superficial vessels while green light penetrates deep structures to enhance sub-epithelial vessels. The two lights combined allow enhanced visualization of the mucosal surface architecture and microvasculature by optimizing absorbance and scattering of light.

NBI criteria for polyp: Initially kudo's pitt pattern designed originally for chromoendoscopy was extrapolated and used for NBI. However, with time and experience this was felt to be inaccurate. This was because the pitt patterns resulting from NBI was felt to be different from the pitt patterns of chromoendoscopy.[16] This resulted in newer and more accurate classifications. Initial classification used microvascular density as the criteria.[16] Vascular pattern was paler than the surrounding mucosa represented hyperplastic polyp while vascular pattern darker than the surrounding mucosa represented adenomatous polyp. Based on this classification, 62 patients with 116 polyps measuring <10 mm in size were evaluated in a prospective study with NBI without magnification.[17] Using this classification, the sensitivity, specificity, and accuracy in predicting polyp history were 94%, 89%, and 91.4% respectively. These results were similar for diminutive (≤5 mm) polyps in the subgroup analysis.[17] These classifications gave way to newer classifications based on mucosal surface architecture and microvasculature. The classification proposed by western endoscopists was based on NBI without optical magnification.[18] They took the mucosal pattern and the vascular pattern into consideration. A circular mucosal pattern with dark dots surrounded by clear white areas and a fine vascular capillary network but absent mucosal pattern was suggestive of a hyperplastic polyp. This has a bland appearance[18] A round or oval mucosal pattern which is a dark brown oval or circular lines surrounding clear white areas is suggestive of an adenoma. Also adenomas with vascular pattern that has a tubulogyrus appearance suggest of an adenoma. It will have dark brown linear or convoluted tubular structures and a prominent appearance.[18] Based on this classification, a prospective study with NBI without magnification was done on 100 patients with 236 polyps. They could predict polyp histology with a sensitivity, specificity, and accuracy of 96%, 89%, and 93%, respectively.[18] Unlike the westerners, the Japanese came up with a classification based on NBI with optical magnification.[19-21] They used a meshed capillary pattern for classification. If the meshed capillary network was absent, it was suggestive of hyperplastic polyp. Presence of a uniform meshed capillary network was suggestive of adenoma. Irregular meshed capillary network with lack of uniformity, dense vascular pattern or loose capillary networks were all suggestive of sub-mucosal invasive cancer. Based on this classification, a prospective study was done on a total of 92 patients with 150 polyps with NBI and magnification. By this classification,

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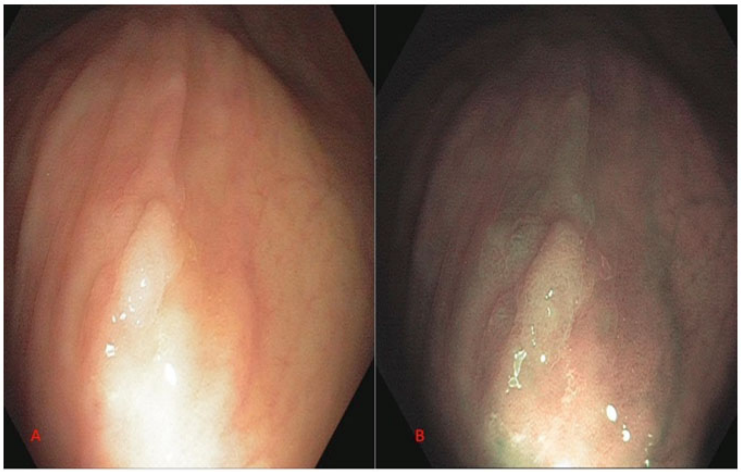
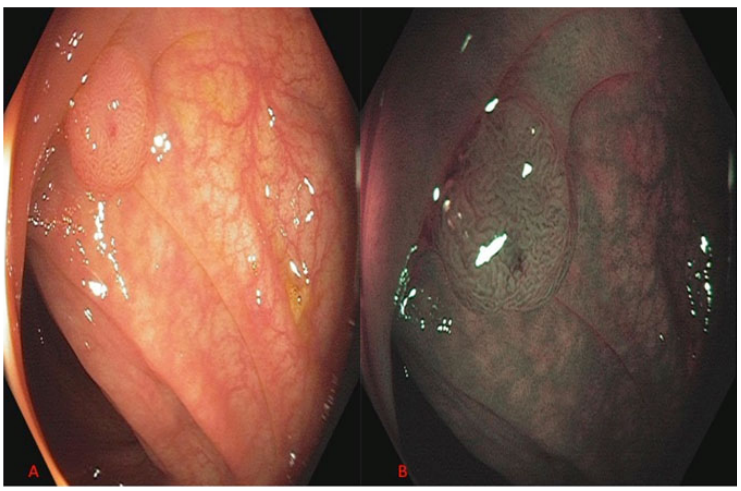
they could predict polyp histology with a sensitivity, specificity, and accuracy of 96.4%, 92.3%, and 95.3%, respectively. The Japanese classification was then used for NBI without magnification. This improved the diagnostic accuracy for polyp histology prediction to 91% with a sensitivity and negative predictive value of 93% and 91%, respectively. The sensitivity, negative predictive value and accuracy for predicting the histology of polyps <5 mm were 87%, 91%, and 90%, respectively.[22] The Europeans then classified polyps to predict histology based on intensity and shape of small blood vessels.[23] A hyperplastic polyp consisted of a fine capillary pattern, normal size and distribution while adenoma was described with a tortuous, increased density, branching vascularization and corkscrew-type. Using this European classification a study was done on a total of 131 patients with 200 polyps, NBI with and without magnification. This showed an accuracy of 91% and 89%, respectively, in predicting histology to differentiate adenoma from hyperplastic polyps.[23] Finally using all these different classifications and available evidence, experts reached consensus and proposed an NBI International Colorectal Endoscopic (NICE) classification to predict histology.[24] They classified polyps based on color of the polyp, vascular pattern and surface pattern. Hyperplastic polyps were lighter than background mucosa with none or isolated lacy vessels (Figure 1). The surface of the polyp had dark or white spots of uniform size or there was a homogenous absence pattern. The adenomatous polyp was relatively brown in color compared to the back ground with brown vessels surrounding white structures. The surface pattern was oval, tubular or branched white structures surrounded by brown vessels (Figure 2). Based on this NICE classification, a study was done to evaluate a total of 118 polyps of <10 mm. The histology of the polyps could be predicted with a sensitivity, negative predictive value and accuracy of 98%, 95%, and 89%, respectively.[24] Most recently, international experts validated specific endoscopic features of sessile serrated adenoma by NBI which was different from hyperplastic polyp. NBI features qualifying as sessile

Figure 1: Hyperplastic Polyp.



A: Hyperplastic polyp in white light B: Hyperplastic polyp in NBI

Figure 2: Tubular Adenoma.



A: Tubular adenoma in white light B: Tubular adenoma in NBI

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serrated adenoma were a cloud-like surface (OR, 4.91; 95% CI, 2.42-9.97), indistinct borders (OR, 2.38; 95% CI, 1.14-4.96), irregular shape (OR, 3.17; 95% CI, 1.59-6.29), and dark spots inside the crypts. Based on these features, 45 patients with serrated polyposis syndrome patients underwent surveillance and 50 serrated adenomas were evaluated. The sensitivity, specificity, and accuracy of NBI for differentiating serrated polyps containing either none or all 4 endoscopic features were, respectively, 89%, 96%, and 93%.[25]

Execution of the NBI technique: A multicenter prospective study was performed to evaluate the histology prediction with high degree of confidence. They evaluated 278 patients with 574 polyps and it showed excellent results in predicting histology with sensitivity, specificity, and accuracy of high confidence.[26] The sensitivity, specificity and accuracy to predict adenomatous histology with high confidence under NBI in lesions ≤10 mm were 93%, 84% and 90%, respectively and they could predict adenomatous histology with a high confidence under NBI in lesions ≤5 mm with a sensitivity, specificity and accuracy of 90%, 88% and 89%, respectively.[26] Negative predictive value for adenomatous histology for the recto-sigmoid colon lesions ≤5 mm was 92%. The predicted surveillance intervals for polyp ≤5 mm based on endoscopic diagnosis were same as histology in 92% to 99% of cases.[26] A meta-analysis from 35 studies on 20925 polyps revealed encouraging results in differentiating adenomatous and non-adenomatous polyps.[27] The reported diagnostic performance in predicting histology are sensitivity (91.5% [95% CI 88.2 to 93.9]), specificity (85.2% [95% CI 80.0 to 89.3]) and negative predictive value (82.5% [95% CI 75.4 to 87·9].[27] A total of 5205 polyps measuring <5 mm were assessed and histology could be predicted with a high sensitivity (86.9% [95% CI 81.0 to 92.8]) and specificity (84.4% [95% CI 76.7 to 92.1]).[27] These results were similar to a prior meta-analysis performed on 28 studies involving 6280 polyps.[28] The overall sensitivity was 91.0% (95% CI 87.6% to 93.5%) and specificity was 82.6% (95%CI 79.0% to 85.7%) with a negative predictive value exceeding 90% to predict polyp histology.[28] The histology prediction of polyps measuring 5 mm made with a high confidence had a high sensitivity 93.4% (95% CI 87.4% to 96.7%) but with a slight low specificity 84.0% (95% CI 76.6% to 89.3%).[28] The predicted surveillance intervals based on endoscopic diagnosis were same as histology in 92.6% of patients (95% CI 87.9% to 96.3%) which suggested that most studies carried an accurate endoscopic diagnosis of histology.[28]

Practical Use: This imaging technique appears to be promising to predict and make a diagnosis of the exact histology of the colon polyps. NBI can be changed to white light and *vice versa* easily, which makes it efficient and quick. Also, there is no added cost with this technique as it is incorporated into the existing colonoscopes.

Limitations: Although there are no technical limitations, training the general endoscopists to use it in the community to predict histology of colon polyps with high degree of confidence will be a challenge.

CONCLUSION

NBI technique is a great addition to perform colonoscopy. It helps in predicting histology with a high accuracy in expert hands. This minimizes the costs involved in the procedure. The challenge will be to train the community gastroenterologists who perform the bulk of colonoscopies. With appropriate training and time, it should give them the confidence to adapt the NBI technique to their practice.

CONFLICTS OF INTEREST

The author has no conflicts of interest.

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