Advancements in GI Evaluation: Narrow Band Imaging™ Technology and the EVIS X1™ Endoscopy System

Faculty

David M. Poppers, MD, PhD, FACP, FASGE, AGAF

Professor of Medicine
Division of Gastroenterology
NYU Grossman School of Medicine
New York, New York

Introduction

Of image-enhanced endoscopy (IEE) tools designed to improve endoscopic evaluation of the gastrointestinal (GI) tract, Narrow Band Imaging™ (NBI™) technology currently is among the most widely used and intensively studied.[1] Introduced in 2005,[2] NBI technology has proved versatile for the prediction of several types of pathology relative to endoscopic evaluation with standard high-definition white light endoscopy (HD-WLE).[3,4] For real-time surveillance of colorectal polyps or Barrett's esophagus—which are the most common indications for diagnostic GI endoscopy[5,6]—NBI technology is recommended specifically by several professional associations, including the American Society for Gastrointestinal Endoscopy (ASGE).[7-9] Incremental advances in NBI technology have been introduced with every new generation of Olympus® endoscopes,[2] including one recently introduced by Olympus: the EVIS X1™ endoscopy system.[10]

Advancements in NBI Technology

In the evolution from the 2005 EVIS EXERA II™ endoscopy system to the next-generation EVIS EXERA™ III endoscopy system in 2012,[2,11] brightness was increased significantly and the viewable distance was approximately doubled, compared with older technologies.[12] The EVIS X1 endoscopy system employs different combinations of LEDs powered on and use of a filter to allow for deep-penetration visualization via Red Dichromatic Imaging (RDI™ technology) and shallow penetration via NBI technology.[10] Also, Brightness Adjustment Imaging with Maintenance of Contrast technology, or BAI-MAC™ technology, further aids in visualization by selectively brightening the image and viewable distance (Figure 1).[10]

Understanding NBI Technology

IEE is designed to improve visualization of the mucosal surface along with its architectural and microvasculature features.[13] In addition to NBI technology, IEE technologies include flexible spectral imaging color enhancement, scan digital contrast, and confocal laser endomicroscopy, and are unique to the endoscope platform to which they are coupled.[13] As they employ different strategies for image enhancement,[14] IEE technologies are not interchangeable across indications necessarily.

Like other IEEs, NBI technology is best understood as an adjunct to quality HD-WLE.[14] In the colon, where both NBI technology and WLE can contribute to an adequate exam,[4] the filtered blue light of NBI technology only penetrates the superficial layer,[15] which creates an advantage for predicting pathology while examining for altered vascularization, lesion color, and surface pattern following the NICE (NBI International Colorectal Endoscopic) Classification.[2,4,7] The improvement in the clarity of target mucosal surface structures has been associated with improved detection of low- and high-grade dysplasia as well as cancer.[16] However, the advantage of NBI technology over HD-WLE is dependent on multiple variables, including endoscopic experience and proper technique.[1] For example, in the colon, other factors—such as adequate bowel preparation[17]; use of mechanical devices to flatten mucosal folds like the Endocuff Vision™ device (Olympus)[18]; and withdrawal time[17]—cannot be ignored as each may have an impact on lesion detection whether HD-WLE, NBI technology, or both are applied.

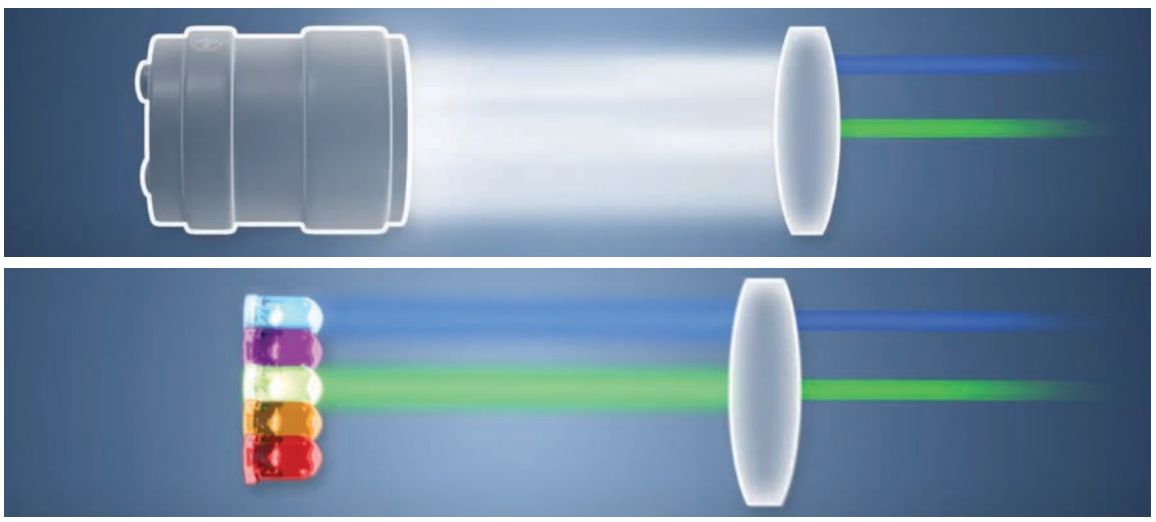

Figure 1. NBI™ technology within Olympus® endoscopy systems.

The EVIS EXERA™ III endoscopy system uses a xenon light bulb to create white light (top). This light is then passed through a filter to create narrow bands of light at 415 nm (blue/violet) and 540 nm (green) to create NBI™ technology.[a] The EVIS X1™ endoscopy system uses a 5-LED light engine (bottom). When NBI technology observation mode is selected, only the violet and green LEDs are powered on. This light is then passed through a filter to create narrow bands for observation of superficial blood vessels.[a]

[a] Data on file with Olympus.

NBI™, Narrow Band Imaging™ Technology.

Images courtesy of Olympus.

NBI Technology: Clinical Applications

NBI technology has a broad array of applications in the detection, diagnosis, and evaluation of pathology in the GI tract,[1] but its advantages in the surveillance of Barrett's esophagus and visualization of neoplasia in the colon are the most extensively documented.[8,9]

In an ASGE Technology Committee review published several years after the EVIS EXERA™ III endoscopy system became available, 9 studies were included in a meta-analysis to review the role of NBI technology in surveillance of Barrett's esophagus. Of the IEEs reviewed, NBI technology met predefined thresholds of sensitivity and specificity.[8] Credited for an ability to assist the clinician with detecting abnormal mucosal and vascular patterns to guide surveillance biopsies, NBI technology was recommended for routine use.[8] Studies comparing NBI technology–guided biopsy with the Seattle protocol consisting of unassisted targeted and random biopsies have shown a higher sensitivity, negative predictive value, and accuracy rate when using NBI technology.[19] Additionally, this data illustrates how NBI technology use in biopsy also requires fewer samples taken per case[19] and less time needed to complete each biopsy,[19] while other research shows NBI technology could act as a substitute for random surveillance biopsies due to the clinician's ability to identify suspicious lesions with high accuracy.[20]

According to the aforementioned ASGE summary, NBI technology is readily available and does not require a separate probe or processor, potentially reducing cost.[8] Cost savings using NBI technology has been reviewed more extensively: Adopting NBI technology has been shown to provide savings over WLE with random biopsy due to the reduced number of biopsies performed and fewer biopsy-related adverse events.[21] Guidelines from the American College of Gastroenterology for evaluation of Barrett's esophagus and screening for colorectal cancer note that use of IEEs, including NBI technology,

can facilitate detection of dysplasia beyond the use of standard tools (eg, WLE, unassisted colonoscopy) alone.[22-24] Overall, for these 2 major indications, there is strong evidence that NBI technology enhances the accuracy surveillance for abnormal tissue relative to WLE.[16,22] There also is growing literature to support the utility of NBI technology for the detection and diagnosis of other abnormalities in the GI tract, including gastric cancers.[3]

Unlike screening of Barrett's esophagus, for which it is stated by multiple societies that NBI technology should be used uniformly for endoscopic surveillance,[8,22] colonoscopy with WLE can be considered alone for colorectal cancer screening in the absence of a history of colorectal cancer or dysplasia, or the history of colitis associated with inflammatory bowel disease.[25] NBI technology is supported in some patients: In a meta-analysis of 11 trials with approximately 4,400 patients,[16] second-generation NBI technology-based colonoscopy showed an increase in the adenoma detection rate (ADR) compared with WLE.[16] In this study, the quality of bowel preparation was shown to be a factor in quality metrics regardless of light source, but those using NBI technology had higher rates of adenoma detection (P=0.02 for patients with "best" bowel preparation), as well as higher rates of detection of polyps including flat polyps and adenomatous polyps.[16]

Practical Considerations

Data supporting the diagnostic value of NBI technology for evaluating pathology in both the upper and lower GI tract do not discount the critical importance of developing skills with this technology and employing proper overall endoscopic technique to maximize its advantages.[1] Following institutional use with NBI technology and other IEEs over time, it is clear that a learning curve exists for achieving expertise with these tools.[26] Although NBI technology may not be difficult to master, the skills and approach to its use in various indications of the upper and lower GI tract may vary. An adequate training program can provide useful instruction on how alterations in the patterns of mucosal architecture and vasculature are characterized using IEEs, including NBI technology, and have been shown to increase sensitivity and specificity in diagnosing GI metaplasia and dysplasia.[26]

The applications for NBI technology are continuing to expand. Following detection of neoplasia, NBI technology increasingly is being applied to guide and evaluate complete removal of abnormal tissue after endoscopic mucosal resection or ablation.[27] Often, it is employed over long-term follow-up to detect recurrent disease as well.[28]

EVIS X1™ Endoscopy System

With the introduction of the EVIS EXERA™ III endoscopy system, the utility of NBI™ technology in GI evaluation was enhanced with a device that provided 2 times the viewable distance and significantly increased brightness compared with earlier device iterations.[12] NBI technology on the EVIS X1™ endoscopy system (Figure 2) can be used in combination with a new post-processing application called BAI-MAC™ technology to increase the brightness and viewable distance of the endoscopic image. In addition to BAI-MAC technology, the EVIS X1 endoscopy system includes RDI™ and TXI™ technologies to support endoscopists to diagnose and treat GI diseases.[10]

Developed to reduce the risk of bleeding during endoscopy, RDI technology utilizes red dichromatic narrow band light and green illumination to penetrate deeper tissue regions, enhancing the detection of deep blood vessels and facilitating quick and effective hemostasis. This offers a contrasting effect to the shallow visualization provided by NBI technology.[10,29] TXI technology has been designed to support mucosal visualization by enhancing texture and color without compromising brightness or the familiar color spectrum of WLE. Early studies have shown that TXI technology may be capable of providing significantly higher colonic ADRs (54.6%) compared with WLE (40.99%; P=0.01).[10,30]

Figure 2. The EVIS X1™ endoscopy system provides a combination of diagnostic and therapeutic innovations, alongside well-established technologies, to streamline and improve endoscopic procedures and scope handling.[a]

[a] Data on file with Olympus.

Image courtesy of Olympus.

Conclusion

Real-time endoscopic evaluation of the GI tract has provided a broad array of often lifesaving interventions, not the least of which is the early detection of malignancy. In an extended and ongoing experience with NBI technology, multiple innovations have improved its utility.

Through both mechanical updates (replacement of the xenon bulb in the EVIS EXERA™ III endoscopy system with 5 LEDs in the EVIS X1™ endoscopy system)[10] and the addition of image processing technologies to aid in identifying GI structures and tissues, the EVIS X1 endoscopy system aims to be another step forward for clinicians seeking to enhance their ability to identify and diagnose GI diseases.

References

1. Kim JW. *Clin Endosc*. 2018;51(6):527-533.
2. Gono K. *Clin Endosc*. 2015;48(6):476-480.
3. Rodríguez-Carrasco M, Esposito G, Libânio D, et al. *Endoscopy*. 2020;52(12):1048-1065.
4. Barbeiro S, Libânio D, Castro R, et al. *GE Port J Gastroenterol*. 2018;26(1):40-53.
5. Ishimura N, Okimoto E, Shibagaki K, et al. *DEN Open*. 2021; 2(1):e73.
6. Kothari ST, Huang RJ, Shaukat A, et al; ASGE Standards of Practice Committee Chair. *Gastrointest Endosc*. 2019;90(6):863-876.e33.
7. Data on file with Olympus.
8. ASGE Technology Committee; Thosani N, Abu Dayyeh BK, Sharma P, et al. *Gastrointest Endosc*. 2016;83(4):684-698.e7.
9. ASGE Technology Committee; Abu Dayyeh BK, Thosani N, Konda V, et al. *Gastrointest Endosc*. 2015;81(3):502.e1-502.e16.
10. Data on file with Olympus as of 15/Jun/2023.
11. Data on file with Olympus.
12. Data on file with Olympus as of 01/10/2013.
13. East JE, Vleugels JL, Roelandt P, et al. *Endoscopy*. 2016;48(11): 1029-1045.
14. Sinonquel P, Vermeire S, Maes F, et al. *GE Port J Gastroenterol*. 2022;30(3):175-191.
15. McGill S, Soetikno R, Kaltenbach T. *Can J Gastroenterol.* 2009; 23(11):741-746.
16. Atkinson NSS, Ket S, Bassett P, et al. *Gastroenterology*. 2019; 157(2):462-471.
17. Staudenmann D, Liu K, Varma P, et al. *DEN Open*. 2021;2(1):e44.
18. Triantafyllou K, Gkolfakis P, Tziatzios G, et al. *World J Gastroenterol*. 2019;25(9):1158-1170.
19. Elsheaita A, El-Bially MA, Shamseya MM, et al. *Medicine* (Baltimore). 2020;99(8):e19261.
20. Hajelssedig OE, Zorron Cheng Tao Pu L, Thompson JY, et al. *J Gastroenterol Hepatol*. 2021;36(10):2659-2671.
21. Furneri G, Klausnitzer R, Haycock L, et al. *PLoS One*. 2019; 14(3):e0212916.
22. Shaheen NJ, Falk GW, Iyer PG, et al. *Am J Gastroenterol*. 2022; 117(4):559-587.
23. Shaukat A, Kahi CJ, Burke CA, et al. *Am J Gastroenterol*. 2021; 116(3):458-479.
24. Leung WK, Lo OS, Liu KS, et al. *Am J Gastroenterol*. 2014;109(6): 855-863.
25. Tziatzios G, Gkolfakis P, Lazaridis LD, et al. *Gastrointest Endosc*. 2020;91(5):1027-1036.e9.
26. Dias-Silva D, Pimentel-Nunes P, Magalhães J, et al. *Gastrointest Endosc*. 2014;79(6):910-920.
27. Namasivayam V, Wang KK, Prasad GA. *Clin Gastroenterol Hepatol*. 2010;8(9):743-754.
28. Zorron Cheng Tao Pu L, Chiam KH, Yamamura T, et al. *Gastrointest Endosc*. 2020;91(5):1146-1154.e5.
29. Uraoka T, Igarashi M. *Therap Adv Gastroenterol*. 2022;15: 17562848221118302.
30. Young E, Rajagopalan A, Tee D, et al. *Gastroenterology*. 2024; 166(2):338-340.

Disclosure: Dr Poppers reported that he is a consultant to AbbVie, Exact Sciences, Grail, Lucid Diagnostics, Micro-Tech Endoscopy, Olympus, Regeneron/Sanofi, Salix/Bausch Health, and Steris; has received grant/research support from Lucid Diagnostics; and has received speaking fees from Castle Biosciences, Regeneron/Sanofi, and Salix/Bausch Health.