# Advanced endoscopic imaging technologies

Makoto Igarashi
Senior Product Engineer,
Endoscopic technology Department, Development Group1, Olympus Medical Systems Corp.

## 1. Introduction

Recently endoscopy has been increasingly important in not only tumor detection but also differential diagnosis of lesions. However conventional endoscopy with white light is not necessarily sufficient for effective endoscopic detection and diagnosis. We have developed the novel endoscopic imaging technologies; Narrow Band Imaging (NBI), Auto-Fluorescence Imaging (AFI), Infra-Red Imaging (IRI) and Endo-Cytoscopy System (ECS). The purpose of these technologies is to emphasize the important tissue features associated with early stage of cancer and to improve the quality of conventional endoscopy.

## 2. NBI

NBI is a novel endoscopic imaging technology that utilizes the narrow-band illumination with the central wavelengths of 415 nm and 540 nm. The shorter wavelength light of 415nm penetrates only the superficial layers of a mucosal tissue and is strongly absorbed by the capillaries in the surface layer[(1)]. Generally as the grade of tumors grow, the capillaries become more dilated, elongated and irregular[(2)]. Therefore the capillary network related to the grade of tumors can be enhanced by NBI. Medical efficacy of NBI for various gastrointestinal tracts such as pharynx, esophagus, stomach and colon has been reported[(3)～(5)].Machida et al indicate that the diagnostic accuracy with magnified NBI observations was higher than that with conventional colonoscopy (NBI;93.4%, conventional;79.1%)[(6)].

## 3. AFI

AFI is based on the autofluorescence derived from endogenous molecules(fluorophores) such as collagen, NADH, and FAD. AFI system generates excitation light(390nm-470nm) and can obtain autofluorescence signals with the high sensitivity CCD. DaCosta et al. show that the intensity of autofluorescence from tumors that cause angiogenesis and thickening of tissues is lower than that from normal tissues[(7)]. By utilizing the difference in autofluorescence intensity between normal tissue and abnormal tissue, AFI represents useful images to improve the detection rate of tumors that are left unnoticed with conventional endoscopy. Suzuki et al. show that AFI may have efficacy for detection of early squamous cell carcinoma in the esophagus[(8)].

## 4. IRI

IRI is the endoscopic imaging technique that visualizes deeper tissue using two kinds of near infrared lights with the central wavelengths of 805nm and 940nm. Mataki et al. show that IRI provides valuable information about the degree of invasiveness of early gastric cancer[(9)]. IRI may be useful to determine a therapeutic strategy because the strategy is determined by the degree of invasiveness of cancer.

## 5. ECS

ECS is the endoscopic optical video microscopy that is able to observe morphological features in vivo (e.g. cell structure and nucleus). Endocytoscope has single CCD with the tip of scope. Maximum magnification combined with electronic zoom(x1.6) of endocytoscope is about 600 times (on 19-inches monitor). In the near future ECS would be promising “endoscopic optical biopsy tool” because it has the potential to provide histological diagnosis for physicians during endoscopy.

## 6. Conclusion

It is our hope that advanced endoscopic imaging technologies(NBI, AFI, IRI and ECS) greatly contribute effective endoscopic detection and diagnosis. We believe that these techniques will lead directly to further improvements in the way physicians diagnose their patients.

## References


(1) K. Gono, T. Obi, M. Yamaguchi, N. Ohyama, H. Machida, Y. Sano, S. Yoshida, Y. Hamamoto, T. Endo, “Appearance of enhanced tissue features in narrow-band endoscopic imaging,” J. Biomed. Opt. 9, pp568-577 (2004).

(2) M. A. Konerding, E. Fait and A. Gaumann, “3D microvascular architecture of pre-cancerous lesions and invasive carcinomas of the colon,” British Journal of Cancer 84 [10], 1354-1362 (2001).

(3) Y. Sano, T. Horimatsu, Kuang I. Fu, A. Katagiri, M. Muto, H. Ishikawa,”Magnifying Observation of Microvascular Architecture of Colorectal Lesions Using a Narrow-Band Imaging System,” Digestive Endoscopy 18 [s1], S44-S51 (2006).

(4) M. Muto, M. Nakane, C. Katada, Y. Sano, A. Ohtsu, H. Esumi, S. Ebihara, S. Yoshida, ”Squamous Cell Carcinoma In Situ at Oropharyngeal and Hypopharyngeal Mucosal Sites,” Cancer 15, 1375-1381 (2004).

(5) T. Yoshida, H. Inoue, S. Usui, H. Satodate, N. Fukami and S. Kudo, “Narrow-Band System with Magnifying Endoscopy for Superficial Esophageal Lesions,” Gastrointes. Endosc. 59, 288-295 (2004).

(6) H. Machida, Y. Sano, Y. Hamamoto et al. “Narrow-band imaging for differential diagnosis of colorectal mucosal lesions:A pilot study,” Endoscopy 36, 1094–8 (2004).

(7) R. S. DaCosta, B. C. Wilson and N. E. Marcon, “Light-induced fluorescence endoscopy of the gastrointestinal tract,” Gastrointest. Endosc. Clin. North Am. 10, 37-69 (2000).

(8) H. Suzuki, Y. Saito, H. Ikehara, I. Oda, “Evaluation of visualization of squamous cell carcinoma of esophagus and pharynx using an autofluorescence imaging videoendoscope system,” J. Gastroenterol Hepatol 24, 1834-9 (2009).

(9) N. Mataki, S. Nagao, A. Kawaguchi, K. Matsuzaki, J. Miyazaki, Y. Kitagawa, H. Nakajima, Y. Tsuzuki, K. Itoh, H. Niwa, S. Miura, “Clinical usefulness of a new infrared videoendoscope system for diagnosis of early stage gastric cancer,” Gastrointest. Endosc. 57, 336-342 (2003).