Image-Enhanced Endoscopy

31

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Contents

31.1 Narrow band Imaging (NBI)

31.1.1 Principles

NBI is an innovative optical technology that modifies the wavelengths and bandwidths of an endoscope's light into narrow band illumination of 415 ± 30 nm and 540 ± 30 nm [1]. In this endoscopy system that uses the red (R), green (G), and blue (B) sequential imaging system, the gastrointestinal mucosa is illuminated sequentially with R, G, and B lights through a rotating RGB filter wheel [2]. When endoscopist presses the button at the handle part of the scope, a narrow band filter is inserted between the lamp and the RGB filter. Red with a long wavelength diffuses widely and deeply, whereas blue with a short wavelength diffuses within a smaller range and shallowly. Because such light with a short wavelength has strong reflection at the epithelial surface, it is suitable for visualizing the mucosal surface morphology. Accordingly, the application of this system has advantages in producing sharp images of microvascular architecture and microsurface structure.

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31.1.2 Clinical Applicability

NBI with magnification has been widely evaluated in the diagnosis of esophageal lesions (Fig. 31.1). In patients with Barrett's esophagus (BE), NBI with magnification showed the high diagnostic reproducibility and accuracy [3]. When esophageal neoplasia was assessed in a high-risk population, NBI was suitable for esophageal screening [4]. Compared to the Lugol chromoendoscopy, NBI presented the same detection rate of high-grade dysplasia and esophageal squamous cell carcinoma. In the differential diagnosis between esophageal neoplasia and other mucosal lesions, NBI was superior to Lugol chromoendoscopy.

NBI system has been also applied in the further diagnosis of gastric lesions (Figs. 31.2 and 31.3). In the non-inflamed mucosa of gastric body, magnifying NBI endoscopy can observe the regular arrangement of collecting venules and subepithelial capillary network. The presence of these patterns was shown as good indicator of normal stomach without *Helicobacter pylori* infection. Magnifying NBI (M-NBI) endoscopic findings of early gastric cancer are (1) the presence of demarcation line between a lesion and the background mucosa and (2) the presence of an irregular microvascular pattern within the lesion. In conjunction with white light endoscopy (WLE), M-NBI identified small, depressed gastric mucosal cancers with high diagnostic
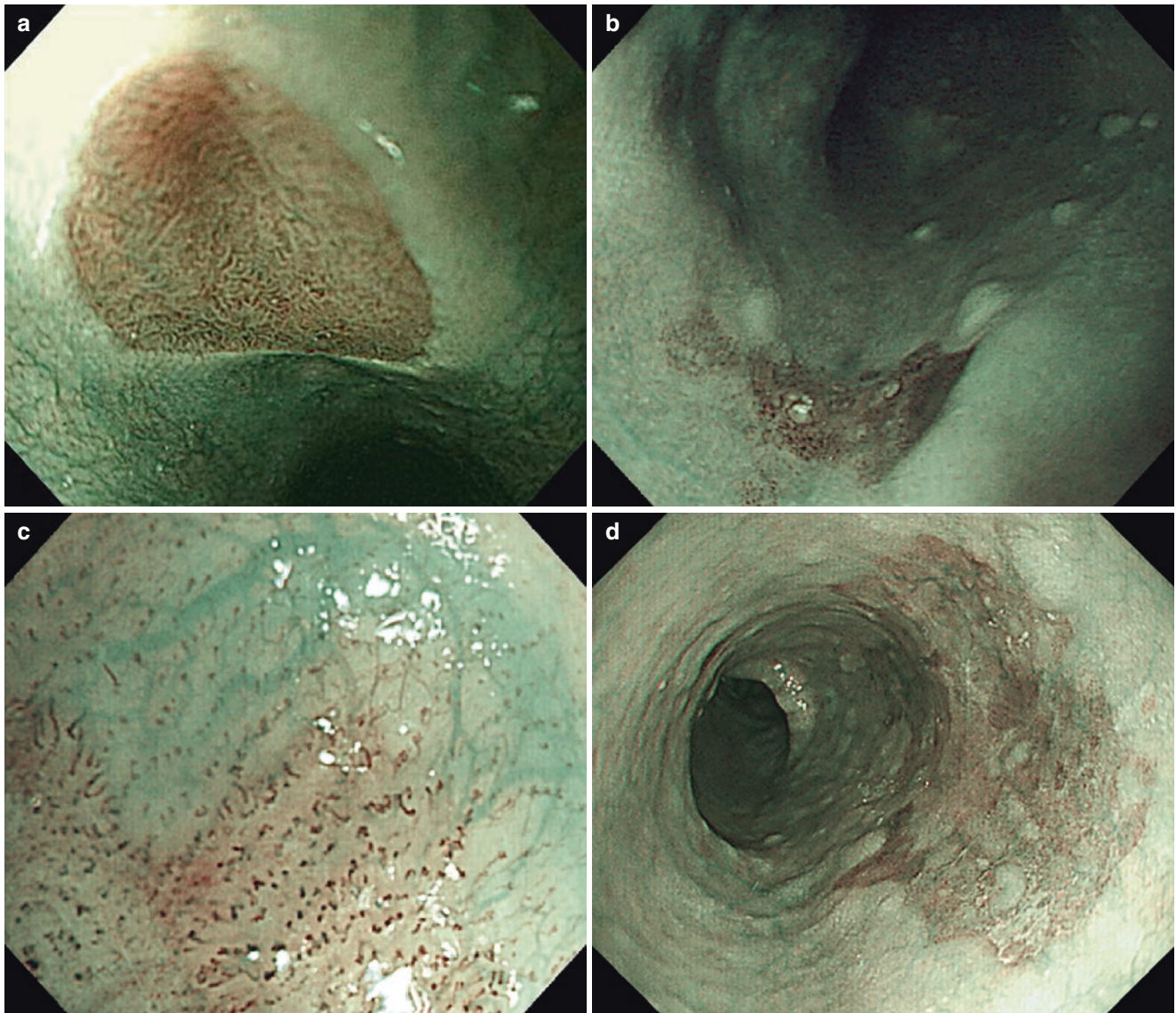
Fig. 31.1 Esophageal lesions observed by NBI system. (**a**) Ectopic gastric mucosa. An oval, brownish lesion was noted at the upper esophagus. Between the lesion and esophageal squamous mucosa, the border was distinct and smooth. (**b**) High-grade dysplasia. A small lesion (10 × 5 mm) was detected during endoscopic screening. When esophageal mucosa is examined, the detection rate of early stage neoplasia may increase with NBI endoscopy. (**c**) Magnifying endoscopic finding. Within the lesion, intra-papillary capillary loop (IPCL) type IV was observed. (**d**) Squamous cell carcinoma. A large lesion (31 × 25 mm) was located at the middle portion of esophagus. Without Lugol chromoendoscopy, a brownish area with irregular border was seen clearly

accuracy [5]. Furthermore, M-NBI allows reliable delineation of the horizontal extent of early gastric cancer (EGC) before endoscopic submucosal dissection [6].

In patients undergoing screening or surveillance colonoscopy, NBI did not increase the yield of colon polyps, adenomas, or flat adenomas [7]. NBI might be better than standard-definition WLC (white light colonoscopy) and equal to high-definition WLC for detection of patients with colorectal polyps or colorectal adenomas [8]. Accurate optical characterization of small colorectal polyps (<10 mm) at colonoscopy would allow only adenomas to be removed [9]. However, NBI optical diagnosis cannot currently be recommended for application in routine clinical practice.
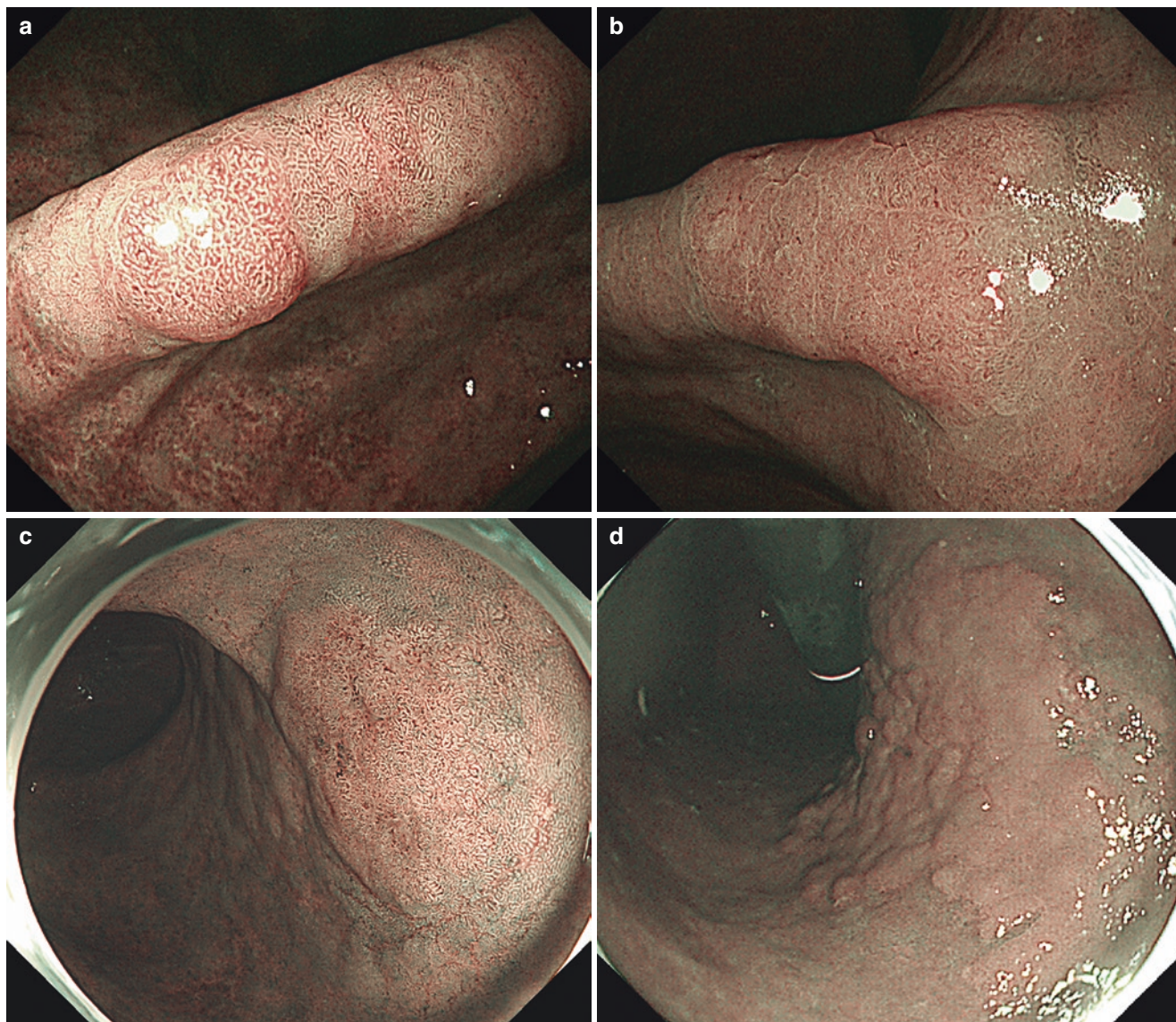
Fig. 31.2 Gastric dysplasia examined by NBI endoscopy. NBI system can allow the dysplastic lesions to be clarified within the background mucosa of intestinal metaplasia. (**a**) A small tubular adenoma at the gastric angle. (**b**) A high grade dysplasia (24 x 13 mm) at the gastric angle. (**c**) A well-differentiated adenocarcinoma (15 x 9 mm) at the posterior side of gastric antrum. (**d**) A large tubulovillous adenoma (46 x 36 mm) at the lesser curvature side of gastric mid-body
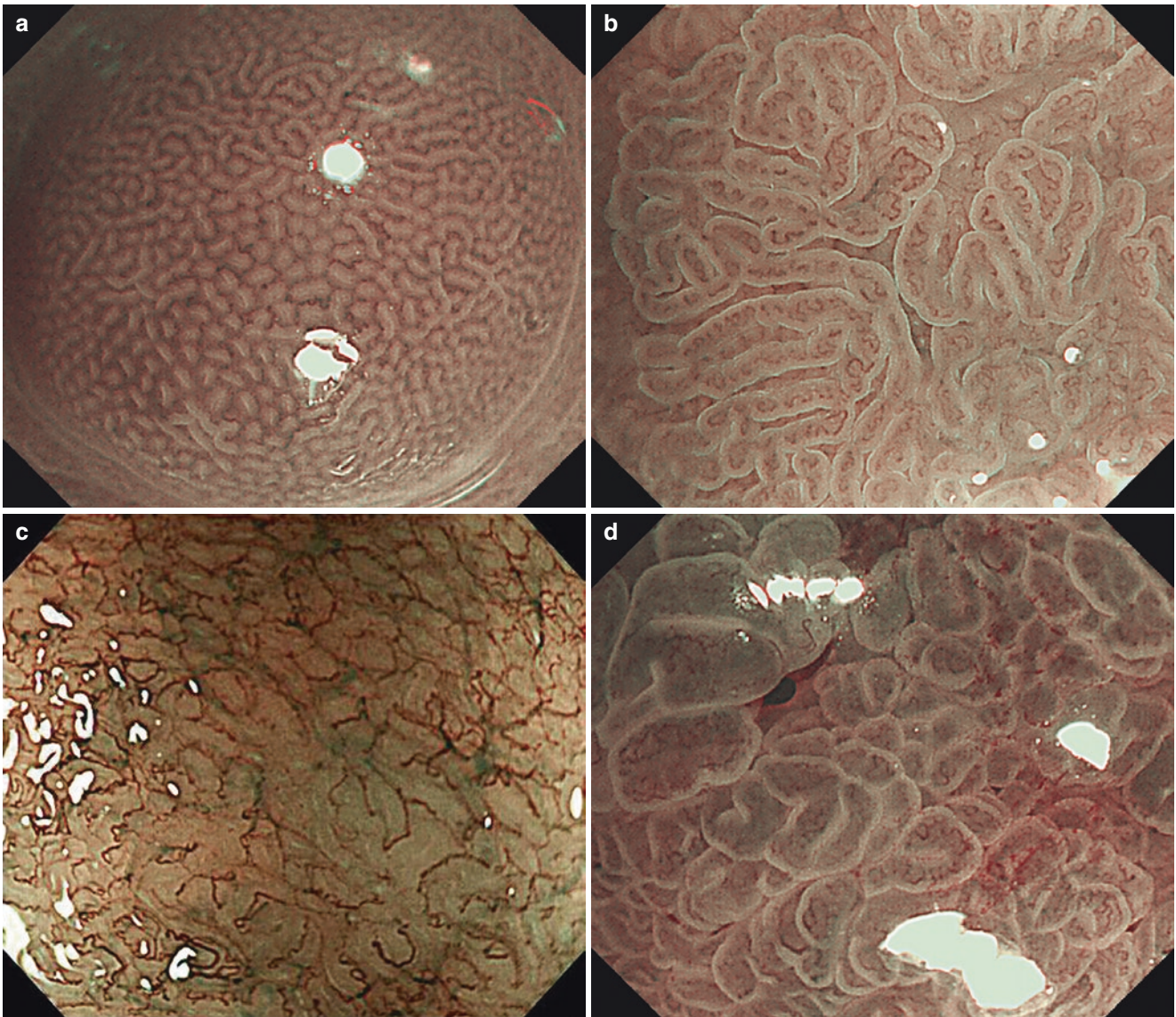
Fig. 31.3 Magnifying NBI endoscopic images of various gastric lesions. (**a**) Nonneoplastic polyp. (**b**) Metaplastic gastritis showing light blue crest. (**c**) Atrophic mucosa with irregular arrangement of coiled vessels. (**d**) Adenocarcinoma with destruction of gastric pit patterns

31.2   I-Scan

31.2.1   Principles

I-scan technology is the newly developed image-enhanced endoscopy technology from PENTAX (Tokyo, Japan) [10]. This consists of three types of algorithms: surface enhancement (SE), contrast enhancement (CE), and tone enhancement (TE). SE allows a detailed inspection of a mucosal surface structure. CE allows close observation of subtle irregularities and mucosal vascular pattern around the surface. SE and CE modes are suitable for screening endoscopy to detect an early stage gastrointestinal tumor. TE consists of three modes such as TE-e for the esophagus, TE-g for the stomach, and TE-c for the colon. TE is mainly proper for additional characterization of the detected lesions during a screening endoscopy. Three modes (SE, CE, and TE) are serially converted by pressing a button, and it enables to apply two or more modes simultaneously.

31.2.2   Clinical Applicability

In comparison with chromoendoscopy with Lugol's solution, i-scan is simple and useful for evaluating the reflux esophagitis-associated lesions. Compared to WLE, i-scan endoscopy increased the diagnostic yield of reflux esophagitis by detecting more minimal changes in the squamocolumnar junction of the esophagus [11]. For colon polyps, diagnostic accuracy of i-scan was similar to chromoendoscopy using methylene blue [12]. Compared to standard colonoscopy, i-scan colonoscopy detected significantly more patients with colorectal neoplasia [13]. Also, i-scan was effective for histologic prediction of colorectal polyps [14]. After a short training session and a review of standardized images, a learning curve may be obtained rapidly [15]. In patients with inflammatory bowel diseases (IBD), i-scan has the potential to increase assessment of disease severity and extent, leading to new implications for decision making in management of IBD [16]. When superficial gastric lesion of less than 1 cm was detected during WLE, i-scan endoscopy with magnification was performed for diagnosis of gastric neoplasia (Fig. 31.4) [17]. However, only limited data using i-scan for gastric lesions is available. Further studies will be required to confirm its value.
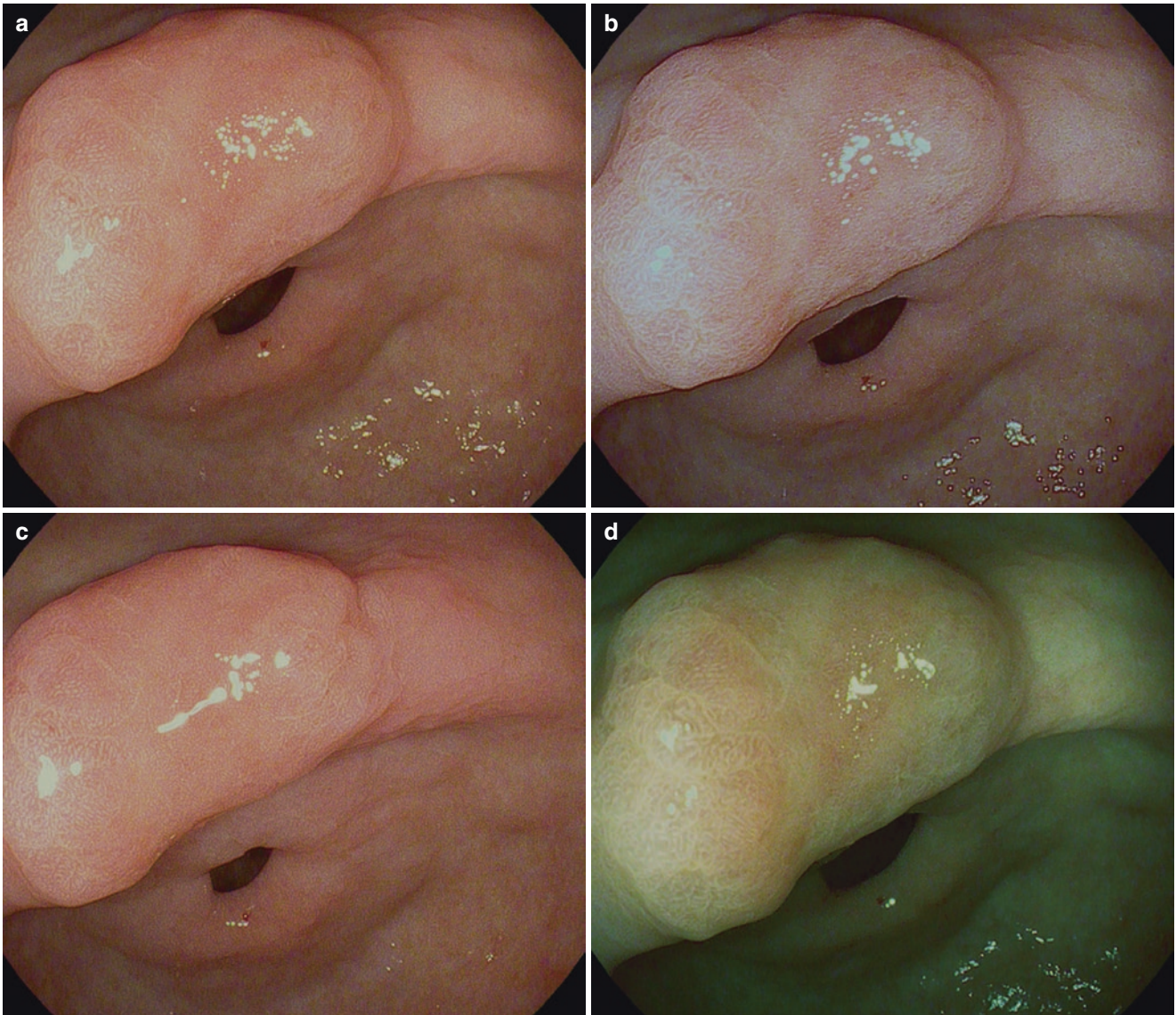
Fig. 31.4 I-scan endoscopic images of gastric dysplasia. (**a**) Conventional white light image. (**b**) I-scan with surface enhancement. (**c**) I-scan with contrast enhancement. (**d**) I-scan with tone enhancement (from Cho JH. Advanced imaging technology other than narrow band imaging. Clin Endosc 2015;48(6):506)

31.3 Flexible Spectral Imaging Color Enhancement (FICE)

31.3.1 Principles

FICE, also known as multiband imaging, is based on a spectral image processing technology. NBI uses physical filters, whereas FICE system takes an ordinary endoscopic image from the video processor and arithmetically processes, estimates, and produces an image of a given, dedicated wavelength of light. By switching a button on the endoscope, FICE system can select an optimal wavelength between 400 and 700 nm for various mucosa of gastrointestinal tract. Single-wavelength images are randomly selected and assigned to red, green, and blue to build and display a virtually enhanced color images.

31.3.2 Clinical Applicability

When BE is diagnosed by endoscopy, palisade vessels is more clearly observed in BE mucosa with FICE than WLE [18]. Demarcation line between whitish BE mucosa and brownish gastric mucosa was more distinct by FICE images, thereby leading to accurate diagnosis of BE. When the extent of EGC is diagnosed, FICE system can be used to evaluate the demarcation lines between a depressed-type and an elevated-type EGC and surrounding tissue (Fig. 31.5). Both expert and non-expert endoscopist determined the tumor margins with higher accuracy, compared to WLE. Also, FICE may be useful for the diagnosis of gastric lesions such as nonneoplastic lesion, adenoma, and cancer [19]. For the diagnosis of colon adenomas of less than 10 mm, the overall accuracy achieved by FICE with/without magnification was 87.0% and 80.4%, respectively [20]. For identifying adenomas, sensitivity and diagnostic accuracy by FICE were significantly higher than those of WLE and comparable to those of conventional chromoendoscopy [21].
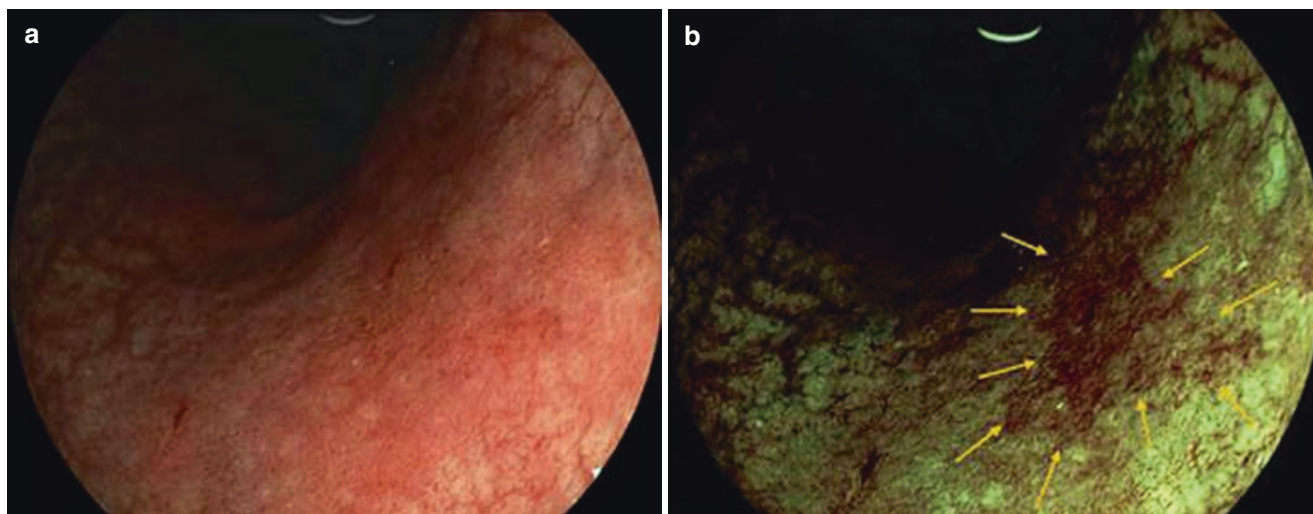
Fig. 31.5 FICE endoscopic images of early gastric cancer. (**a**) White-light endoscopy. (**b**) FICE endoscopy [22]

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