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Topic highlight on texture and color enhancement imaging in gastrointestinal diseases

Toyoshima O *et al*. TXI topic highlight

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Abstract

Olympus Corporation developed texture and color enhancement imaging (TXI) as a novel image-enhancing endoscopic technique. This topic highlights a series of hot-topic articles that investigated the efficacy of TXI for gastrointestinal disease identification in the clinical setting. A randomized controlled trial demonstrated improvements in the colorectal adenoma detection rate (ADR) and the mean number of adenomas per procedure (MAP) of TXI compared with those of white-light imaging (WLI) observation (58.7% *vs.* 42.7%, adjusted relative risk 1.35, 95% confidence interval [CI] 1.17-1.56; 1.36 *vs.* 0.89, adjusted incident risk ratio 1.48, 95%CI 1.22-1.80, respectively). A cross-over study also showed that the colorectal MAP and ADR in TXI were higher than those in WLI (1.5 *vs.* 1.0, adjusted odds ratio 1.4, 95%CI 1.2-1.6; 58.2% *vs.* 46.8%, 1.5, 1.0-2.3, respectively). A randomized controlled trial demonstrated non-inferiority of TXI to narrow band imaging in the colorectal mean number of adenomas and sessile serrated lesions per procedure (0.29 *vs.* 0.30, difference for non-inferiority -0.01, 95%CI -0.10 to 0.08). A cohort study found that scoring for ulcerative colitis severity using TXI could predict relapse of ulcerative colitis. A cross-sectional study found that TXI improved the gastric cancer detection rate compared to WLI (0.71% *vs.* 0.29%). A cross-sectional study revealed that the sensitivity and accuracy for active *Helicobacter pylori* gastritis in TXI were higher than those of WLI (69.2% *vs.* 52.5% and 85.3% *vs.* 78.7%, respectively). In conclusion, TXI can improve gastrointestinal lesion detection and qualitative diagnosis. Therefore, further studies on the efficacy of TXI in clinical practice are required.

Core Tip: Olympus Corporation has developed texture and color enhancement imaging (TXI) as a novel image-enhancing endoscopy technique. This highlights a series of hot-topic articles investigating the usefulness of TXI for gastrointestinal disease diagnosis in clinical practice. TXI showed improvement compared with white-light imaging and non-inferiority compared with narrow-band imaging in detecting colorectal neoplasia. TXI observation can predict the relapse of ulcerative colitis. TXI improved gastric cancer detection and diagnostic accuracy for active Helicobacter pylori gastritis compared to white-light imaging. In conclusion, TXI can improve detection and qualitative diagnosis.

INTRODUCTION

Image-enhanced endoscopy (IEE) improves the diagnosis of gastrointestinal lesions that are challenging in conventional white-light imaging (WLI). Narrow-band imaging (NBI) developing as an IEE modality is effective in diagnosing gastrointestinal disease[1-4]. Following NBI, blue-light imaging and linked color imaging (LCI) have been developed as our new IEE modalities. The utility of BLI and LCI has also been reported extensively[5-7]. Texture and color enhancement imaging (TXI), which is a novel technique to enhance images, was developed in the new endoscopy system EVIS X1 (Olympus Corporation, Tokyo, Japan) in 2020. TXI enhances three image factors, namely texture, brightness, and color, in WLI. This enhancement helps to define subtle tissue differences by applying the retinex-based method. TXI has two modes (i.e., modes 1 and 2). TXI mode 2 is composited with brightness adjustment in dark regions and texture enhancement for subtle contrast. Additionally, TXI mode 1 applies color enhancement to define slight color contrasts more clearly[8, 9]. Representative endoscopic images of colonic neoplasm are shown in **Figure 1**.

Many studies investigating the visibility and color differences of TXI have been published. For example, visibility scores and color differences of TXI for colorectal neoplasia[10-13], gastric neoplasia[14-19], gastritis[14, 20], Barrett's esophagus[21, 22], pharyngeal and esophageal cancer[23], duodenal neoplasia[24], and the papilla of Vater

have been assessed[25]. However, few studies have evaluated the detection and diagnosis of lesions using TXI. Therefore, this study highlights recent reports. We selected six comparative studies that examined the effects of TXI on neoplasia detection, disease prognosis, and diagnostic accuracy (**Table 1**).

TXI FOR DETECTION OF COLORECTAL NEOPLASIA

Two randomized controlled trials (RCTs) examined the utility of TXI in colorectal neoplasia detection. Antonelli *et al.*[26] conducted an international multicenter RCT (Italy, Germany, and Japan) assessing colorectal adenoma detection using TXI compared to WLI. Patients were randomly assigned to two arms, those who underwent colonoscopy using TXI or WLI. A total of 747 patients were enrolled (mean age 62.3 years; 50.2% male). Adenoma detection rate (ADR) was higher in the TXI group compared with the WLI group (58.7% *vs.* 42.7%; adjusted relative risk 1.35, 95% confidence interval [CI] 1.17-1.56, P = 0.001). The detection rate of adenomas < 10 mm was higher with TXI than with WLI (37.1% *vs.* 24.5%). The TXI group had a higher proportion of patients with high-risk polyps compared to the WLI group (26.7% *vs.* 19.9%, 1.31, 1.01-1.71, P = 0.046). High-risk polyps were defined as at least one adenoma ≥10 mm or with high-grade dysplasia, or at least five adenomas, or any serrated polyp ≥10 mm or with dysplasia, according to the most recent European Society of Gastrointestinal Endoscopy (ESGE) guideline[27]. The mean number of adenomas per procedure (MAP) with TXI was larger than that with WLI (1.36 *vs.* 0.89; adjusted incident risk ratio 1.48, 95%CI 1.22-1.80, P <0.001). This is the first RCT to compare colorectal neoplasia detection using TXI and WLI. Researchers demonstrated that TXI had a higher ADR than WLI and was useful for colorectal adenoma detection. They also reported that TXI increased the detection rate of small adenomas. Furthermore, TXI provided a larger MAP and a higher high-risk polyp detection rate, indicating that a different surveillance interval after colonoscopy is recommended compared to WLI.

Yoshida *et al.*[28] performed a multicenter RCT evaluating the efficacy of an additional 30-second (Add-30-s) observation of the right-sided colon (i.e., cecum to

ascending colon) using TXI compared with NBI observation. Patients were assigned to either the TXI or NBI group. The right colon was first observed with WLI in both groups; then, the right colon was examined with Add-30-s observations using either TXI or NBI. Three-hundred fifty-eight patients were enrolled (mean age 68.3 years, 63.4% male). This study showed the non-inferiorities of TXI to NBI (0.29 *vs*. 0.30, difference for non-inferiority -0.01, 95%CI -0.10 to 0.08, *P* = 0.02) in the mean number of adenomas and sessile serrated lesions (SSLs) per procedure (MASP). The difference in MAP between TXI and NBI groups was also significant for non-inferiority (0.23 *vs*. 0.24, -0.01, -0.09 to 0.007, *P* = 0.01). Multivariable analyses showed no significant differences in MASPs and MAPs between the TXI and NBI groups, regardless of bowel preparation, endoscopes, and endoscopist level. Increases in the ADR, adenoma and SSL detection rate, and polyp detection rate for the right colon from WLI to TXI were 10.2%, 13.0%, and 15.3%, respectively, and from WLI to NBI were 10.5%, 12.7%, and 13.8%, respectively. The increases in the TXI and NBI groups were not significantly different. This is the first non-inferiority RCT comparing TXI and NBI for colorectal neoplasia detection. The authors recommend that either TXI or NBI be used for Ad-30-s observation.

Sakamoto *et al*.[29] conducted a retrospective crossover study that compared colorectal neoplasia detection using TXI and WLI. They repeated the right colon observation twice with WLI or TXI as the first observation in the WLI and TXI groups, respectively. Then, the right-sided colon was re-examined as a second look using TXI or WLI, whichever was not used for the first observation. The remaining colorectal mucosa was examined using the first observation method. This study included 470 patients (mean age 64.0 years, 64.0% male). Multivariable analyses showed that the MAP and ADR in the TXI group were higher than those in the WLI group (1.5 *vs*. 1.0, adjusted odds ratio 1.4, 95%CI 1.2-1.6, *P* <0.001; 58.2% *vs*. 46.8%, 1.5, 1.0-2.3, *P* = 0.044), regardless of patient demographic characteristics, withdrawal time, bowel preparation, and endoscopes. TXI detected more adenomas in the ascending colon with a non-polypoid morphology and a size of 6-9 mm. Fewer non-polypoid lesions were missed in the TXI

group than in the WLI group (16.6% *vs.* 30.6%). This cross-over study indicated that TXI was more suitable than WLI for the detection of adenomas, especially small non-polypoid adenomas, in the ascending colon.

TXI FOR ULCERATIVE COLITIS

A cohort study established a score using the TXI as a predictor of ulcerative colitis (UC) relapse and investigated its usefulness. Hayashi *et al.*[30] did a prospective single-center, single-arm cohort study. They developed the TXI scores as follows: score 0 = no accentuated redness; score 1 = accentuated redness; and score 2 = accentuated redness and poor visibility of deep vessels. The endoscopic images of 146 patients with UC in remission were reviewed. Patients with a TXI score of 2 had lower UC relapse-free rates than those with TXI scores of 0 and 1 (log-rank test, *P* <0.01). When pathologic remission was defined as Matts grade ≤2, the rate of pathologic remission decreased with higher TXI scores (TXI score 0, 95.2%; TXI score 1, 67.8%; TXI score 2, 40.0%, respectively, *P* = 0.01). In multivariate analysis, TXI score 2 was associated with UC relapse (hazard ratio 4.16, 95%CI 1.72-10.04, *P* <0.01), whereas the Mayo endoscopic subscore (MES) was not. Furthermore, the relapse-free rate was lower in MES 1 with a TXI score of 2 than in MES 0 or MES 1 with a TXI score of 0 or 1. The authors concluded that TXI could identify populations with poor prognosis in MES 1, for whom treatment intensification has been controversial.

TXI FOR GASTRIC CANCER AND GASTRITIS

Two studies have investigated the efficacy of TXI in treating gastric lesions. Kemmoto *et al.*[31] performed a cross-sectional study analyzing gastric cancer (GC) detection during gastroscopic screening. They compared the GC detection rate in TXI mode 2 with that of the WLI observations. A total of 13440 patients (median age 57 years; 60.6% male) were included in this study. The GC detection rate was higher in the TXI group than in the WLI group (0.71% *vs.* 0.29%), especially among patients who had undergone *Helicobacter pylori* eradication (1.36% *vs.* 0.43%). The positive predictive value of GC on

biopsy was higher in the TXI group than in the WLI group (11.0% vs. 4.9%). Furthermore, the Expert-WLI group, which was limited to patients who underwent WLI by three endoscopists with the highest GC detection rates, was compared with the TXI group. The detection rates of GC after *H. pylori* eradication in the lower stomach, with 0-IIc endoscopic morphology according to the Paris classification, and with the histologically differentiated type were higher in the TXI group than in the Expert-WLI group (0.87% vs. 0.17%, 1.36% vs. 0.43%, and 1.36% vs. 0.52%, respectively). The authors concluded that TXI mode 2 improved the detection of GC after *H. pylori* eradication in the L-region with superficially depressed and differentiated types. This study demonstrated the usefulness of TXI observation in GC screening.

Kitagawa *et al.*[32] examined the diagnostic accuracy of *H. pylori* infections in the stomach. The patients were divided into three groups based on *H. pylori* infection status: current, past, and non-infection. The diagnostic accuracy for *H. pylori* infection status was compared in TXI with WLI observation. Endoscopic images of 60 patients (median age 73 years; 68.3% male) were reviewed. The sensitivity and accuracy for current *H. pylori* infection in TXI were higher than those of WLI (69.2% vs. 52.5%, P = 0.012; 85.3% vs. 78.7%, P = 0.034). The diagnostic odds ratio of diffuse redness for current infection, map-like redness for past infection, and regular arrangement of collecting venules (RAC) for non-infection in TXI observation were higher than those in WLI observation (56.21 vs. 22.00, 10.97 vs. 6.29, and 42.25 vs. 25.24, respectively). TXI may be useful for diagnosing *H. pylori* infection during gastroscopy.

CONCLUSION
CONCLUSION AND PERSPECTIVES
We have highlighted recent reports examining the usefulness of TXI for gastrointestinal diseases in clinical practice (**Table 1**). For colorectal neoplasia, an RCT and a crossover study demonstrated that TXI had a higher ADR and MAP than WLI, and an RCT showed that TXI had non-inferiority to NBI in terms of MASP and MAP. A scoring system using the TXI was shown to be useful in predicting UC relapse in a cohort

study. For the stomach, TXI was reported to improve GC detection and diagnostic accuracy of active *H. pylori* gastritis compared to WLI. TXI can selectively enhance brightness in dark areas of an endoscopic image and highlight subtle tissue differences, such as slight morphological or color changes, without over-enhancement[8]. These characteristics of TXI may aid in making more accurate diagnoses.

Further validation of the detection of neoplastic and inflammatory lesions using TXI is required. Furthermore, investigations on whether the use of TXI endoscopy is associated with better patient prognosis are desirable. Studies have shown that endoscopy with magnification, dye spraying[10, 11, 33, 34], and artificial intelligence[35-37] is useful for diagnosing neoplasia and inflammation, and validation of these modalities in combination with TXI is expected. Therapeutic applications of TXI are expected in the future[38]. The two modes of TXI have different features, so they should be separately described in future studies. There have been many reports from Japan, and further international research is required. In conclusion, TXI can improve the detection and qualitative diagnosis of gastrointestinal lesions.
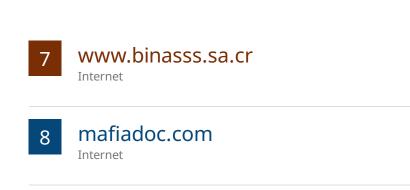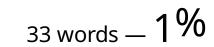
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