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DISEASES OF THE ESOPHAGUS

Original article

Prospective evaluation of narrow-band imaging endoscopy for screening of esophageal squamous mucosal high-grade neoplasia in experienced and less experienced endoscopists

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SUMMARY. **Narrow-band imaging (NBI) is a novel, noninvasive optical technique that uses reflected light to visualize the organ surface. However, few prospective studies that examine the efficacy of NBI screening for esophageal cancer have been reported. To compare the diagnostic yield of NBI endoscopy for screening of squamous mucosal high-grade neoplasia of the esophagus between experienced and less experienced endoscopists. Patients with a history of esophageal neoplasia or head and neck cancer received NBI endoscopic screening for esophageal neoplasia followed by chromoendoscopy using iodine staining. Biopsy specimens were taken from iodine-unstained lesions and the histological results of mucosal high-grade neoplasias served as the reference standard. The primary outcome was the sensitivity of NBI for detecting new lesions. The secondary outcome was the positive predictive value of NBI and the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of NBI in a per lesion basis. A total of 350 patients (170 by experienced endoscopists and 180 by less experienced endoscopists) underwent endoscopic examination. A total of 42 new mucosal high-grade neoplastic lesions (25 in the experienced endoscopist group and 17 in the less experienced endoscopist group) were detected. In the per-lesion-based analysis, the sensitivity was significantly higher in the experienced endoscopist group (100%; 25/25) compared with the less experienced endoscopist group (53%; 9/17) ($P < 0.001$). The positive predictive value of NBI was higher in the experienced endoscopist group than in the less experienced endoscopist group (45%, 25/55 vs. 35%, 9/26), although the difference was not significant ($P = 0.50$). The sensitivity of NBI in the less experienced endoscopist group was 43% in the former half of patients, and increased to 60% in the latter half of patients. In the per-patient-based analysis, the sensitivity of NBI was significantly higher in the experienced endoscopist group (100%) than in the less experienced endoscopist group (100 vs. 69%, respectively; $P = 0.04$). The positive predictive values of the experienced endoscopist group and the less experienced endoscopist group were similar, and were 48 and 47%, respectively. In conclusion, compared with the gold standard of chromoendoscopy with iodine staining, the sensitivity of NBI for screening of mucosal high-grade neoplasia was 100% with the experienced endoscopists but was low with the less experienced endoscopists. Electronic chromoendoscopy with NBI is a promising screening tool in these high-risk patients with esophageal mucosal high-grade neoplasia, particularly when performed by endoscopists with experience of using NBI.**

KEY WORDS: **carcinoma, digestive system/methods, endoscopy, esophageal neoplasms/pathology, esophagoscopy, squamous cell/pathology.**

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INTRODUCTION

Esophageal cancer is the sixth most common cause of cancer-related mortality worldwide.[1] Although the incidence of esophageal adenocarcinoma is rapidly increasing in Europe and North America, squamous cell carcinoma is still the most common tumor type in Asia.[2] Esophageal squamous cell carcinoma has poor prognosis when detected at an advanced stage;[3,4] therefore, the prevention of esophageal carcinoma has focused on the early detection of neoplasia and surveillance endoscopy, particularly in high-risk populations. Regarding squamous neoplasia, mucosal high-grade neoplasia appears to be a particularly good candidate to indicate intervention because of its malignant potential,[5] whereas mucosal low-grade neoplasia has lower risk for malignant transformation.[6] Favorable outcomes after treatment of mucosal high-grade neoplasia have been reported.[7,8]

The current use of conventional endoscopy is limited, however, because early neoplastic changes can not be readily identified by conventional endoscopy.[9,10] Consequently, diagnosis of early esophageal cancers is based on the detection and histological evaluation of iodine-unstained lesions,[11,12] because the prevalence of severe dysplasia derived from iodine-stained tissue is quite low (<1%).[13] However, iodine solution can cause mucosal irritation leading to retrosternal pain and discomfort, and can even result in erosions or ulcers in the esophagus and/or the stomach.[14] Therefore, this method is rather unpleasant when it is used as a part of surveillance algorithm.

Narrow-band imaging (NBI) is a novel, noninvasive optical technique that uses reflected light to visualize the organ surface.[15] NBI can enhance the superficial structure and epithelial microvascular pattern, and can be used to differentiate between neoplastic and non-neoplastic esophageal lesions.[16–18] This method may also be used as a screening tool. However, squamous neoplasias of the esophagus are not always clearly displayed in this image and they are sometimes difficult to detect, not only for less experienced endoscopists, but also for experienced endoscopists. Thus, before NBI can be introduced as a screening tool, its relative diagnostic yield compared with chromoendoscopy using iodine staining should be evaluated. The objective of this study was to investigate the diagnostic yield of NBI for screening of squamous high-grade neoplasias of the esophagus in experienced and less experienced endoscopists.

PATIENTS AND METHODS

Endoscopists and patients

The current clinical investigation was performed during routine endoscopic screening or surveillance procedures by two experienced endoscopists (R.I. and Y.T.) and three less experienced endoscopists (R.T., T.I., and T.K.). The two experienced endoscopists had more than 9 years of experience as endoscopists. They both have used the NBI system for more than 2 years. The three less experienced endoscopists had 3 to 5 years of experience as endoscopists. They all have sufficient experience for screening of esophageal neoplasia using iodine staining and targeting the biopsies from iodine-unstained lesions. They have started NBI screening after receiving training of NBI diagnosis of esophageal neoplasia at conferences and 2 to 3 months' training of NBI observation. The patient inclusion criteria were: (i) patients with present esophageal neoplasias; (ii) patients with past history of esophageal neoplasias treated with endoscopic resection; and (iii) patients with present or past history of head and neck cancer. Patients were excluded if they had previously undergone an operation, chemotherapy, or radiotherapy for esophageal cancer, or had undergone chromoendoscopy with iodine staining within 6 months.

NBI

The NBI system is based on modification of the spectral features obtained with each optical filter by narrowing the bandwidth of the spectral transmittance. The bandpass ranges of the NBI filters are blue and green, 400–430 nm; and red, 530–550 nm. A standard videoendoscopy system (EVIS LUCERA system, Olympus Optical Co. Ltd., Tokyo, Japan) with two light sources was used for examination. One light source was for the standard optical filter (broadband) and the other was for the NBI system. The control knob on the grip of the endoscope allows single-touch switching from the standard filter to the NBI filter. This endoscopy system incorporates a structure enhancement function and an NBI function. The structure enhancement function of the video processor is set at a level of 8 for NBI observation.

Endoscopic examinations

The endoscopy procedures were performed using a high-resolution magnifying upper GI endoscope (GIF-Q240Z, Olympus Optical Co. Ltd.) or a high-definition magnifying upper GI endoscope (GIF-H260Z, Olympus Optical Co. Ltd.). A black soft hood (MB-162 for GIF-Q240Z or MB-46 for GIF-H260Z, Olympus Optical Co. Ltd.) was mounted on the tip of the endoscope to maintain an adequate distance between the tip of the endoscope zoom lens and the mucosal surface during magnifying observation. Upper gastrointestinal endoscopy was performed without any sedation. Initial routine inspection was performed using conventional imaging and NBI. For screening with NBI,

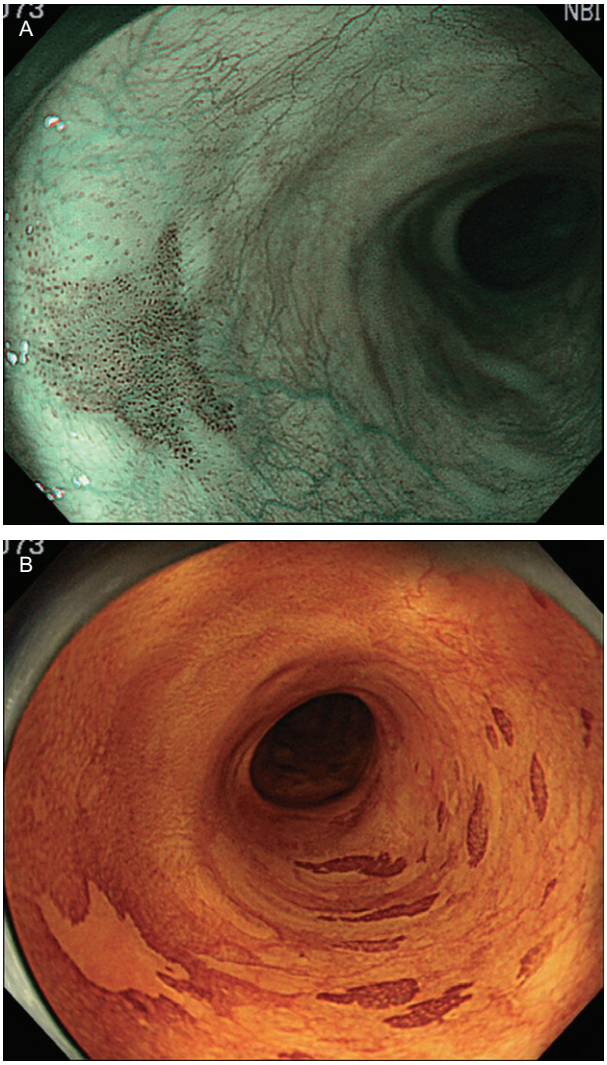

Fig. 1 (a) Endoscopic examination with narrow-band imaging reveals the presence of a brownish area and scattered brown dots. (b) Chromoendoscopy with iodine solution reveals an iodine-unstained lesion.

non-magnifying observation with NBI was performed. If suspicious lesions were detected, further observations were done at higher magnifications. When one of the following two morphological findings was visualized by NBI, the lesion was regarded as indicative for mucosal high-grade neoplasia: (i) the presence of a brownish area: well demarcated brownish change of the mucosa (Fig. 1a),[17]; and (ii) the presence of scattered brown dots or dilated and tortuous vessels of various sizes.[17]

Screening with conventional image and NBI was followed by chromoendoscopy with iodine solution. For all lesions, their location (distance and quadrant) and size were recorded by comparison with the known diameter of open forceps. The lesions detected in each method were matched based on the distance and quadrant of the lesions. Biopsy specimens were taken from iodine-unstained lesions (Fig. 1b). Some lesions, histologically diagnosed as mucosal high-grade neoplasias, were treated with endoscopic resection. Written informed consent was obtained from all patients before examination and endoscopic resection. Informed consent from the patients and approval by the local board for analysis of the collected data were obtained.

Histological evaluation

Biopsy or endoscopic resected specimens were embedded in paraffin and subjected to hematoxylin and eosin staining. All samples were evaluated separately by two pathologists (Y.T. and S.I.), who were blinded to the endoscopic findings. Histological diagnoses were made according to the Vienna criteria for the classification of early GI neoplasia.[5] For diagnoses that differed between the two pathologists, final diagnoses were reached after review with a senior pathologist (S.I.).

Statistics

The index lesion for the study was a newly diagnosed squamous mucosal high-grade neoplasia. For statistical analysis, the histological results of mucosal high-grade neoplasias served as the reference standard. The results of histological examination of endoscopic-resected specimens preceded those of biopsy specimens. Evaluation was performed on a per lesion and per patient basis. In analysis on per lesion basis, 'the lesion' was considered as the unit of analysis and, even though some patients had more than one lesion, each lesion was considered as an independent observation for statistical purposes.

The primary outcome variable in this study was the sensitivity of NBI on a per lesion basis. The secondary outcome variables in this study included: (i) the positive predictive value (PPV) of NBI in a per lesion basis; (ii) the sensitivity, specificity, PPV, negative predictive value (NPV) and accuracy of NBI in a per patient basis; (iii) the difference in sensitivities for the less experienced endoscopists on a per lesion basis; and (iv) the differences in sensitivities and PPVs in the less experienced endoscopists on a per lesion basis with regard to study periods (former half of patients vs. latter half of patients).

Yates' chi-square test was used for comparisons of categorical variables, and the Mann-Whitney *U* test was used to compare continuous variables. For all analyses, a two-sided *P*-value of less than or equal to 0.05 was considered statistically significant. All analyses were performed using StatView version 5.0 (SAS Institute, Cary, NC, USA).

RESULTS

Between October 2007 and January 2009, 350 patients who fulfilled our criteria have received

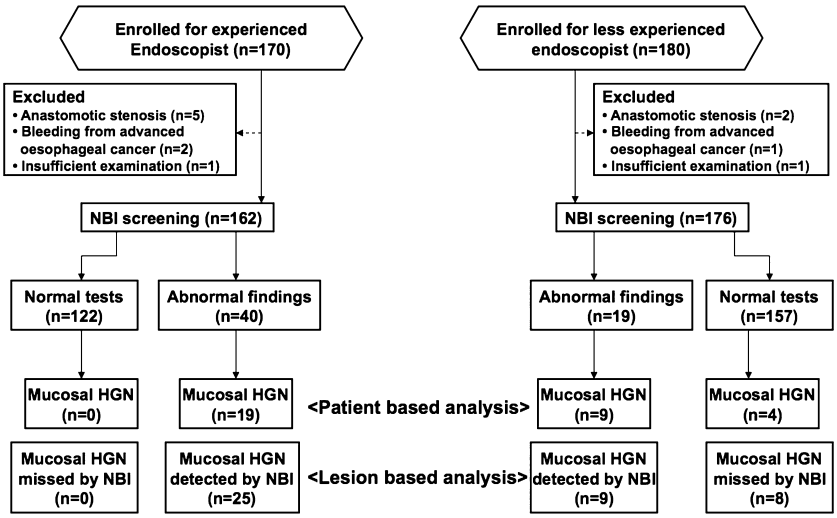

Fig. 2 Patient disposition. HGN, High grade neoplasia; NBI, Narrow-band imaging.

endoscopic examination by either of the two experienced endoscopists ($n = 170$) or by one of the three less experienced endoscopists ($n = 180$) (Fig. 2). Eight patients in the experienced endoscopist group and four patients in the less experienced endoscopist group were excluded because of incomplete examination. The remaining 338 patients were included in the analysis. Table 1 shows the patient characteristics. Significant differences were detected for sex and history of head and neck cancer or esophageal cancer.

A total of 42 mucosal high-grade neoplasias were detected in 32 patients. All 25 lesions in the experienced endoscopist group and 9 (53%) of 17 lesions in the less experienced endoscopist group could be detected by NBI (Fig. 2). Seventeen (68%) of 25 lesions in the experienced endoscopist group and four (24%) of 17 lesions in the less experienced endoscopist group could be detected by conventional image. A total of 30 lesions were resected by endoscopic resection, while 5 lesions were treated by other approaches because of co-existing advanced cancer and 7 lesions were left untreated because of patients' condition and patients' refusal. Two advanced cancers were detected in the less experienced endoscopist group.

In the per-lesion-based analysis (Table 2), the sensitivity of NBI was significantly higher in the experienced endoscopist group than in the less experienced endoscopist group (100 vs. 53%, respectively; $P < 0.001$). The PPV of NBI was higher in the experienced endoscopist group (45%) than the less experienced endoscopist group (35%), although the difference was not significant ($P = 0.50$). The PPVs were dependent on the size of the lesion (<10 vs. ≥10 mm), while the sensitivities were not dependent on size of the lesion.

The sensitivities of NBI in the three less experienced endoscopists were 71, 50 and 25%, respectively. The sensitivity of NBI in the less experienced endoscopist group was 43% in the former half of patients and increased to 60% in the latter half of patients (Fig. 3). The PPVs of NBI in the less experienced endoscopist group was 23% in the former half of patients and increased to 46% in the latter half of patients. The sensitivities of NBI were uniform for both endoscopists and periods; however, the values

Table 1 Patient characteristics ($n = 338$)

	Experienced endoscopists	Less experienced endoscopists	*P*-value
No. of patients	162	176	
Age (year)			
Median	67	66	0.13
Range	35–89	34–88	
Sex			
Male	128	159	0.004
Female	34	17	
History of			
Esophageal cancer	94	49	<0.001
Head and neck cancer	45	109	
Both of above	23	18	

Table 2 Per lesion-based analysis

	Experienced endoscopists	Less experienced endoscopists	*P*-value
Sensitivity			
Value (95% CI)	100% (84–100%)	53% (31–74%)	<0.001
No. of lesions	25/25	9/17	
<10 mm			
Value (95% CI)	100% (67–100%)	50% (19–83%)	0.07
No. of lesions	10/10	3/6	
≥10 mm			
Value (95% CI)	100% (76–100%)	55% (28–79%)	0.02
No. of lesions	15/15	6/11	
Positive predictive value			
Value (95% CI)	45% (33–59%)	35% (20–54%)	0.50
No. of lesions	25/55	9/26	
<10 mm			
Value (95% CI)	32% (18–49%)	21% (7–49%)	0.70
No. of lesions	10/31	3/14	
≥10 mm			
Value (95% CI)	63% (43–79%)	50% (26–75%)	0.72
No. of lesions	15/24	6/12	

CI, confidence interval.

were not sufficiently high. Although the demographics of the two groups of patients were different in some factors, there was no significant difference in the sensitivity of NBI according to sex ($P = 0.31$) or the existence of esophageal cancer ($P = 0.45$) or head and neck cancer ($P = 0.24$).

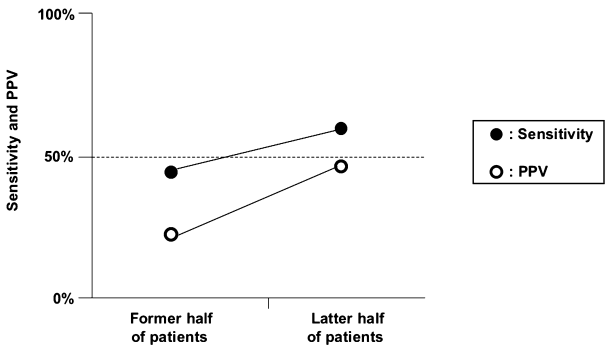

Fig. 3 Periodic change in the sensitivity and PPV. PPV, Positive predictive value.

In the per-patient-based analysis (Table 3), the sensitivity of NBI was significantly higher in the experienced endoscopist group (100%) than in the less experienced endoscopist group (100 vs. 69%, respectively; $P = 0.04$). The PPVs of the experienced endoscopist group and the less experienced endoscopist group were similar, and were 48 and 47%, respectively. The NPVs of the experienced endoscopist group and the less experienced endoscopist group were high, and were 100 and 98%, respectively.

DISCUSSION

In the experienced endoscopist group, the sensitivity was high (100%) and the PPV was considered to be acceptable (45%). The sensitivity of 100% in the

Table 3 Per patient-based analysis

	Experienced endoscopists	Less experienced endoscopists	*P*-value
Sensitivity			
Value (95% CI)	100% (80–100%)	69% (52–87%)	0.04
No. of lesions	19/19	9/13	
Specificity			
Value (95% CI)	85% (79–90%)	94% (89–97%)	0.01
No. of lesions	122/143	153/163	
Positive predictive value			
Value (95% CI)	48% (33–63%)	47% (27–68%)	0.79
No. of lesions	19/40	9/19	
Negative predictive value			
Value (95% CI)	100% (96–100%)	98% (93–99%)	0.20
No. of lesions	122/122	153/157	
Accuracy			
Value (95% CI)	87% (81–91%)	92% (87–95%)	0.13
No. of lesions	141/162	162/176	

CI, confidence interval.

experienced group indicates that NBI has a similar detection yield to chromoendoscopy with iodine staining. In the less experienced endoscopist group, the sensitivity was not acceptable at only 53%. However, the sensitivities improved from 43 to 60% during the study period.

Preliminary results suggest that NBI may be as sensitive as chromoendoscopy with iodine staining for the detection of superficial squamous cell carcinomas.[19–24] Because of the practical disadvantages of iodine staining (use of spraying catheters, risk of aspiration for hypopharyngeal and proximal esophageal imaging, iodine allergy, and retrosternal pain or discomfort), NBI offers a valid, alternative tool for early detection of esophageal squamous cancer. However, few prospective studies that examine the efficacy of NBI screening have been published in peer-reviewed journals.[22–24] This is the first study that investigated the screening yield of NBI in experienced and less experienced endoscopists with a large number of patients.

In this study, the main target of screening was mucosal high-grade neoplasia. Mucosal high-grade neoplasia has greater risk for malignant transformation compared with mucosal low-grade neoplasia.[6] Thus, the detection of mucosal high-grade neoplasia in the esophagus is critically important to prompt early endoscopic or surgical intervention, which may prevent the progression to invasive carcinoma. In this study, all mucosal high-grade neoplasias indicated for endoscopic resection were successfully resected, which confirms the benefit of endoscopic screening to prevent the progression to advanced cancer.

In the per-lesion-based analysis, the sensitivity of NBI in the experienced endoscopists was very high (100%; 95% confidence interval, 84–100%). However, this high sensitivity was not replicated by the less experienced endoscopists, because the sensitivity of the less experienced endoscopists was significantly lower than that of the experienced endoscopists. In this study, the presence of brownish area or scattered brown dots was regarded as an index lesion. The light intensity with the NBI system is low and can be easily scattered *in vivo*. Thus, the field of view of NBI is darker than conventional imaging. Accordingly, detecting obscure changes, such as brownish-colored tissue or scattered brown dots, in dark fields of view is difficult, particularly for endoscopists with limited experience, such as the less experienced endoscopists in this study. Considering the fact that the sensitivity of less experienced endoscopists was low, even for lesions sized 10 mm or larger, the index lesions may be displayed but may not be detected by the less experienced endoscopists. Thus, ongoing development of NBI screening should be focused not only on the training of endoscopists but also on enhancing the display of lesions and brightening the field of view. There are some methods that can improve the display of lesions. Of particular interest is to enhance the display by modifying the emitting light source.[25] However, NBI may be useful for the less experienced endoscopists, since the sensitivity of NBI (53%) was higher than that of conventional endoscopy (24%).

The per-patient-based analysis revealed that the NPVs of NBI were quite high, ranging from 98 to 100%. Based on these data, patients without index lesions in NBI are at low risk of having mucosal high-grade neoplasia and do not need to undergo chromoendoscopy with iodine staining. By using NBI screening, we were able to avoid the use of chromoendoscopy with iodine staining in 279 of 338 patients (83%). The PPVs of NBI on a per patient basis were 48 and 47% for experienced and less experienced endoscopists, respectively. This indicates that 28 out of 59 patients (47%) with index lesions revealed by NBI have mucosal high-grade neoplasia. NBI, with magnification, may differentiate cancer and non-cancerous lesion with high accuracy. However, chromoendoscopy with iodine staining is unsurpassed for delineating the margins of cancerous foci. Many mucosal high-grade neoplasias are treated by endoscopic resection; therefore, it is important to know the extent of lesions. Thus, patients with an index lesion should receive chromoendoscopy with iodine staining to confirm the size and extent of the lesion.

The limitation of this study is its non-randomized trial design. We decided against using a randomized design, because randomization allocation to an experienced endoscopist or a less experienced endoscopist would not be accepted by most patients. However, the non-randomized approach does not negate the significance of our study. Although we could not adjust our findings for differences in patient characteristics because of the limited number of events, the sensitivity was not significantly different despite these differences.

Histology of the biopsy specimens taken from iodine-unstained lesions was used as the reference standard in this study. We can not ensure that all mucosal high-grade neoplasias were detected without taking biopsy specimens from iodine-stained areas. However, missed high-grade neoplasias may be very few, since the prevalence of high-grade neoplasias derived from iodine-stained areas is quite low (<1%).[13]

In conclusion, compared with the gold standard of chromoendoscopy with iodine staining, the sensitivity of NBI for screening of mucosal high-grade neoplasia was 100% with the experienced endoscopists but was low with the less experienced endoscopists. Electronic chromoendoscopy with NBI is a promising screening tool in these high-risk patients with esophageal mucosal high-grade neoplasia, particularly when performed by endoscopists with experience of using NBI.

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References

1 Parkin D M, Bray F, Ferlay J *et al.* Global cancer statistics, 2002. CA Cancer J Clin 2005; 55: 74–108.
2 Enzinger P C, Mayer R J. Esophageal cancer. N Engl J Med 2003; 349: 2241–52.
3 Muller J M, Erasmi H, Stelzner M *et al.* Surgical therapy of oesophageal carcinoma. Br J Surg 1990; 77: 845–57.
4 Daily J M, Karnell L H, Menck HR. National Cancer Database report on esophageal carcinoma. Cancer 1996; 78: 1820–8.
5 Dixon M D. Gastrointestinal epithelial neoplasia: Vienna revisited. Gut 2002; 51: 130–1.
6 Wang G Q, Abnet C C, Shen Q *et al.* Histological precursors of oesophageal squamous cell carcinoma: results from a 13 year prospective follow up study in a high risk population. Gut 2005; 54: 187–92.
7 Ishihara R, Tanaka H, Iishi H *et al.* Long-term outcome of esophageal mucosal squamous cell carcinoma without lymphovascular involvement after endoscopic resection. Cancer 2008; 112: 2166–72.
8 Kodama M, Kakegawa T. Treatment of superficial cancer of the esophagus: a summary of responses to a questionnaire on superficial cancer of the esophagus in Japan. Surgery 1998; 123: 432–9.
9 Hashimoto C L, Iriya K, Baba E R *et al.* Lugol's dye spray chromoendoscopy establishes early diagnosis of esophageal cancer in patients with primary head and neck cancer. Am J Gastroenterol 2005; 100: 275–82.
10 Dawsey S M, Fleischer D E, Wang G Q *et al.* Mucosal iodine staining improves endoscopic visualization of squamous dysplasia and squamous cell carcinoma of the esophagus in Linxian, China. Cancer 1998; 83: 220–31.
11 Shiozaki H, Tahara H, Kobayashi K *et al.* Endoscopic screening of early esophageal cancer with the Lugol dye method in patients with head and neck cancers. Cancer 1990; 66: 2068–71.
12 Yokoyama A, Ohmori T, Makuuchi H *et al.* Successful screening for early esophageal cancer in alcoholics using endoscopy and mucosal iodine staining. Cancer 1995; 76: 928–34.
13 Fagundes R B, de Barros S G, Puten A C *et al.* Occult dysplasia is disclosed by Lugol chromoendoscopy in alcoholics at high risk for squamous cell carcinoma of the esophagus. Endoscopy 1999; 31: 281–5.
14 Kondo H, Fukuda H, Ono H *et al.* Sodium thiosulfate solution spray for relief of irritation caused by Lugol's stain in chromoendoscopy. Gastrointest Endosc 2001; 53: 199–202.
15 Gono K, Obi T, Yamaguchi M *et al.* Appearance of enhanced tissue features in narrow-band endoscopic imaging. J Biomed Opt 2004; 9: 568–77.
16 Yoshida T, Inoue H, Usui S *et al.* Narrow-band imaging system with magnifying endoscopy for superficial esophageal lesions. Gastrointest Endosc 2004; 59: 288–95.
17 Muto M, Nakane M, Katada C *et al.* Squamous cell carcinoma in situ at oropharyngeal and hypopharyngeal mucosal sites. Cancer 2004; 101: 1375–81.
18 Kumagai Y, Inoue H, Nagai K *et al.* Magnifying endoscopy, stereoscopic microscopy, and the microvascular architecture of superficial oesophageal carcinoma. Endoscopy 2002; 34: 369–75.
19 Chiu P W, Cheung F K, Tsang R K *et al.* Narrow band imaging (NBI) against conventional lugol chromoendoscopy for detection of superficial esophageal neoplasia in high risk patients – a prospective comparative study. Gastrointest Endosc 2007; 65: AB332 (abstract).
20 Lee I L, Wu C S, Hwang T S *et al.* A prospective comparative study of narrow-band imaging, Lugol's chromoendoscopy and conventional endoscopy for the detection of esophageal cancer in patients with head and neck cancer. Gastroenterology 2007; 132: AB168 (abstract).
21 Muto M, Saito Y, Ohmori T *et al.* Multicenter prospective randomized controlled study on the detection and diagnosis of superficial squamous cell carcinoma by back-to-back endoscopic examination of narrowband imaging and white light observation. Gastrointest Endosc 2007; 65: AB110.
22 Takenaka R, Kawahara Y, Okada H *et al.* Narrow-band imaging provides reliable screening for esophageal malignancy in patients with head and neck cancers. Am J Gastroenterol 2009; 104: 2942–8.
23 Huang L Y, Cui J, Wu C R *et al.* Narrow-band imaging in the diagnosis of early esophageal cancer and precancerous lesions. Chin Med J 2009; 122: 776–80.
24 Kuraoka K, Hoshino E, Tsuchida T *et al.* Early esophageal cancer can be detected by screening endoscopy assisted with narrow-band imaging (NBI). Hepatogastroenterology 2009; 56: 63–6.
25 Osawa H, Yoshizawa M, Yamamoto H *et al.* Optimal band imaging system can facilitate detection of changes in depressed-type early gastric cancer. Gastrointest Endosc 2008; 67: 226–34.