

# Clinical outcomes of the “resect and discard” strategy using magnifying narrow-band imaging for small (<10 mm) colorectal polyps



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submitted 1.3.2018

accepted after revision: 30.5.2018

## Bibliography

DOI <https://doi.org/10.1055/a-0650-4362> |

Endoscopy International Open 2018; 06: E1382–E1389

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ISSN 2364-3722

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## ABSTRACT

**Background and study aim** The “resect and discard” strategy is a new paradigm for the management of small colorectal polyps that reduces the cost and effort related to pathological diagnosis after polypectomy. This retro-

spective study aimed to clarify the clinical outcome of the “resect and discard” strategy for small colorectal polyps.

**Patients and methods** The clinical records were reviewed from 501 consecutive patients who underwent the “resect and discard” strategy for colorectal polyps smaller than 10 mm at our hospital between January 2008 and December 2010. All colorectal lesions were evaluated onsite under magnifying narrow-band imaging after careful conventional white-light imaging. In cases of low grade adenoma predicted with high confidence, colonoscopists selected the “resect and discard” option without formal histopathology. The mid-term outcomes were evaluated to validate the curability of the “resect and discard” strategy.

**Results** The present study included 501 consecutive patients with 816 lesions. The mid-term outcomes were examined for 476 (95%) patients who received follow-up for at least 1 year after undergoing the “resect and discard” strategy. The median observation period was 83 months (range 12–117 months). No patient died from colorectal cancer related to the procedure, resulting in a disease-specific survival rate of 100%. There were no local and/or distant recurrences detected during follow-up.

**Conclusions** The “resect and discard” strategy for small colorectal polyps under strict preoperative diagnosis achieves excellent mid-term outcome.

## Introduction

Colorectal cancer (CRC) is the third most common cancer in the world, and the incidence of CRC is rising rapidly in many Asian countries [1]. CRC development is considered to occur mainly via the adenoma–carcinoma sequence [2], and the development of CRC is effectively reduced by colonoscopy with polypectomy [3]. More than 90% of polyps detected at colonoscopy are small (6–9 mm) or diminutive ( $\leq 5$  mm), with most being diminutive [4]. The main reason for resecting small adenomas and sending them for histopathologic examination is to provide guidance on the appropriate intervals for future surveillance [5]. Being able to diagnose adenomas in vivo would allow for

them to be resected and discarded, eliminating the costs associated with histopathology.

Narrow-band imaging (NBI) is an optical endoscopic imaging technology that highlights the superficial mucosal vasculature, thereby accentuating and highlighting the surface pattern of polyps. These patterns can help characterize polyp histology [6]. In the “resect and discard” strategy proposed by Ignjatovic et al. [4], the surveillance interval is decided based on optical diagnosis (OD) using non-magnifying NBI without formal histopathology. The “resect and discard” strategy has the potential to change the standard management of small polyps, with a major reduction in the cost of screening and surveillance colonoscopy [7]. However, it carries the risk of discarding small ad-

vanced lesions (SALs), which are small (<10 mm) lesions with advanced histology (villous component, high grade dysplasia, and adenocarcinoma), as even small lesions may contain advanced features or cancer [8]. Although it is rare, the “resect and discard” strategy has a risk of discarding small invasive cancer that should be evaluated for its pathological characteristics to consider additional surgery.

OD using magnifying NBI (M-NBI) reportedly enables the assessment of dysplasia or the presence of colorectal neoplastic invasion, as well as differentiation between neoplastic and non-neoplastic lesions [9, 10]. Takeuchi and colleagues proposed that their “resect and discard” strategy using M-NBI could reduce the risk of discarding SALs, including small invasive cancer, as M-NBI provides more accurate diagnosis of SALs and enables the distinction between neoplastic and non-neoplastic lesions [11, 12]. The “resect and discard” strategy using M-NBI could be an attractive concept for patients, gastroenterologists, and health service providers.

To our knowledge, there are few reports on the mid- to long-term outcomes, including recurrence rate and survival rate, after performing the “resect and discard” strategy using M-NBI for small colorectal polyps. The aim of the present retrospective study was to clarify the short- and mid-term outcomes of the “resect and discard” strategy for small (<10 mm) colorectal polyps.

## Patients and methods

### Patients

The clinical records were reviewed from 501 consecutive patients who underwent the “resect and discard” strategy for small colorectal lesions at our hospital between January 2008 and December 2010. The inclusion criterion was the use of the “resect and discard” strategy for the management of colorectal polyps smaller than 10 mm on the basis of evaluation using M-NBI. Exclusion criteria included: colorectal polyps equal to or larger than 10 mm, evidence of familial adenomatous polyposis, hereditary non-polyposis CRC, or inflammatory bowel disease; presence of active malignant diseases in any other organs; presence of synchronous or metachronous advanced CRC; and patient age older than 85 years. We analyzed the short-term outcomes of all 501 patients who underwent the “resect and discard” strategy on the basis of baseline and short-term outcome data collected prospectively on a computer database. For the analysis of mid-term outcomes, we excluded 25 patients with less than 1 year of follow-up data, leaving 476 patients who were treated between 2008 and 2010. Mid-term outcome data were retrospectively collected from electronic medical records (in the period between November and December 2017).

The present retrospective study was conducted at our hospital in Japan. The institutional review board of our hospital approved the collection of data, examination of past cases, and submission of the results of the present study, and written informed consent was obtained from all patients.

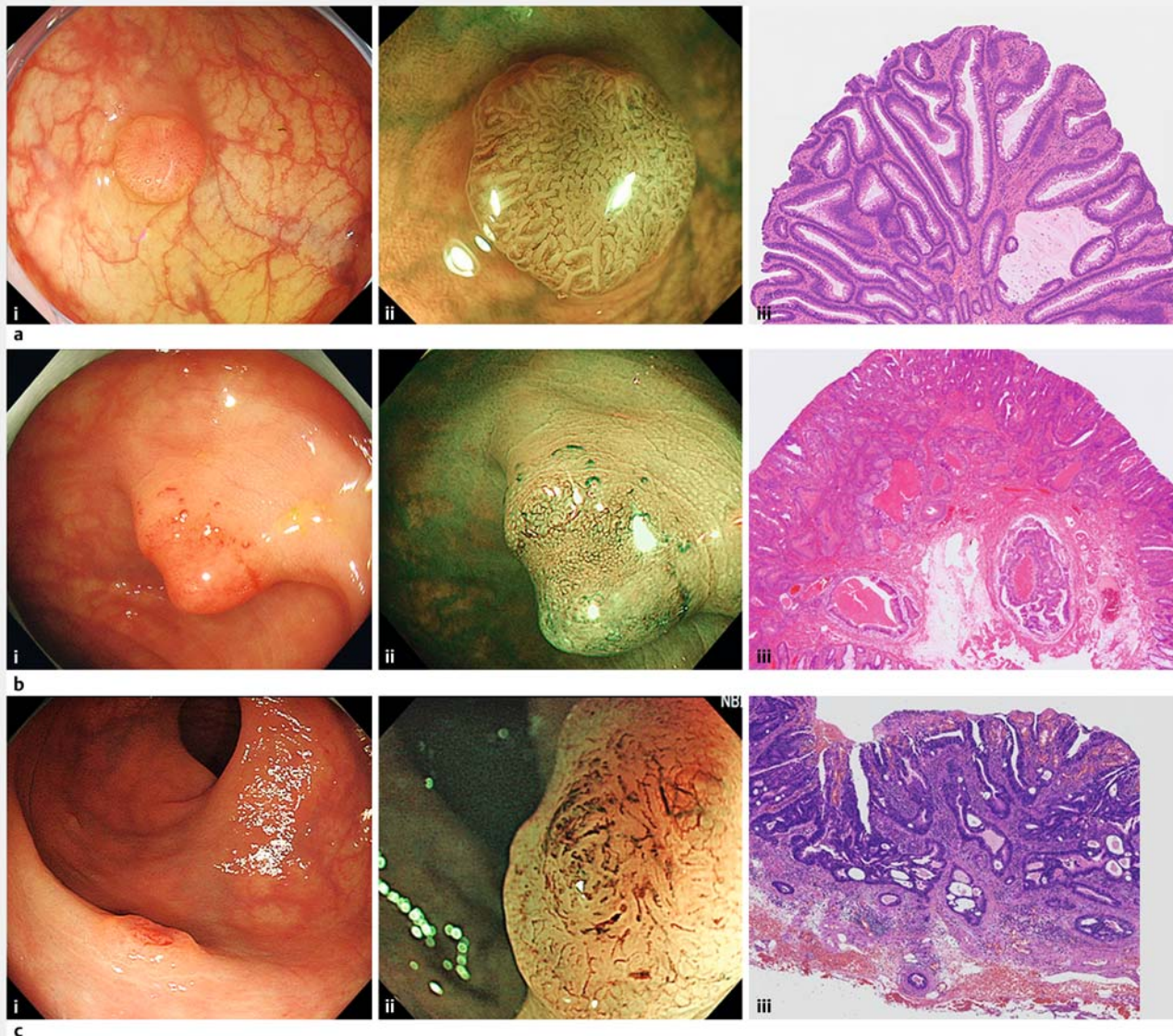
### Premedication and procedures

All patients were prepared for colonoscopy by the oral administration of 2 to 3 L of polyethylene glycol/electrolyte solution. To prevent bowel movements, 10 mg of scopolamine butylbromide or 0.5 mg of glucagon was intravenously administered to patients without contraindications before examination. All procedures were performed by 10 endoscopists who had each previously conducted more than 1000 colonoscopies. All of the endoscopists were familiar with M-NBI of gastrointestinal lesions, as they all had more than 1 year of experience with the technique. We used the electronic endoscopy system with NBI (Evis Lucera Spectrum System, Olympus, Tokyo, Japan) and high-resolution optical magnifying colonoscopes (Evis CF-H260AZI or PCF-Q260AZI; Olympus). To facilitate the identification and diagnosis of colonic lesions, M-NBI or magnifying chromoendoscopy with 0.05% Crystal Violet was used in addition to white-light observation. Lesions were detected using the white-light mode. The location, size, and macroscopic type of all detected lesions were documented according to the Paris classification [13]. The size of the detected lesion was measured using 2.2-mm closed biopsy forceps (Radial Jaw 4; Boston Scientific, Boston, MA, United States) or a mini snare (10 mm diameter, oval snare, Olympus). Small polyps were defined as those that were less than 10 mm in diameter. When the detected lesion was a small polyp, all colorectal lesions were evaluated in real time via M-NBI after assessment using conventional white-light imaging (C-WLI). The endoscopists predicted the type of polyp (non-neoplastic, low grade adenoma, suspected SAL, or inconclusive) using M-NBI. The prediction of polyp type was used to decide polyp management.

### Magnifying narrow-band imaging-assisted optical assessment and polyp management

Following C-WLI, all colorectal lesions were evaluated by M-NBI. Diagnosis according to M-NBI was based on Sano’s capillary classification [14], and the microvascular architecture was classified into three types according to the capillary pattern (CP) (CP type I, II, or III). The CP assessed by M-NBI is useful for differentiating small colorectal non-neoplastic polyps from neoplastic polyps [15], and is highly accurate at distinguishing between low grade dysplasia (LGD) and high grade dysplasia (HGD) or invasive cancer; thus, the CP can be used to predict the histopathology of colorectal neoplasia [10]. CP type I is indicative of hyperplastic polyps (HPs), CP type II is indicative of LGD, and CP type III is indicative of HGD or invasive cancer [10, 15]. Diminutive tumors with depressions have a high frequency of carcinoma and submucosal invasion [8]. Low grade adenoma predicted with high confidence was defined according to the following endoscopic conditions (► Fig. 1a): 1) the absence of a depressed area within the lesion under careful C-WLI, and 2) CP type II under M-NBI.

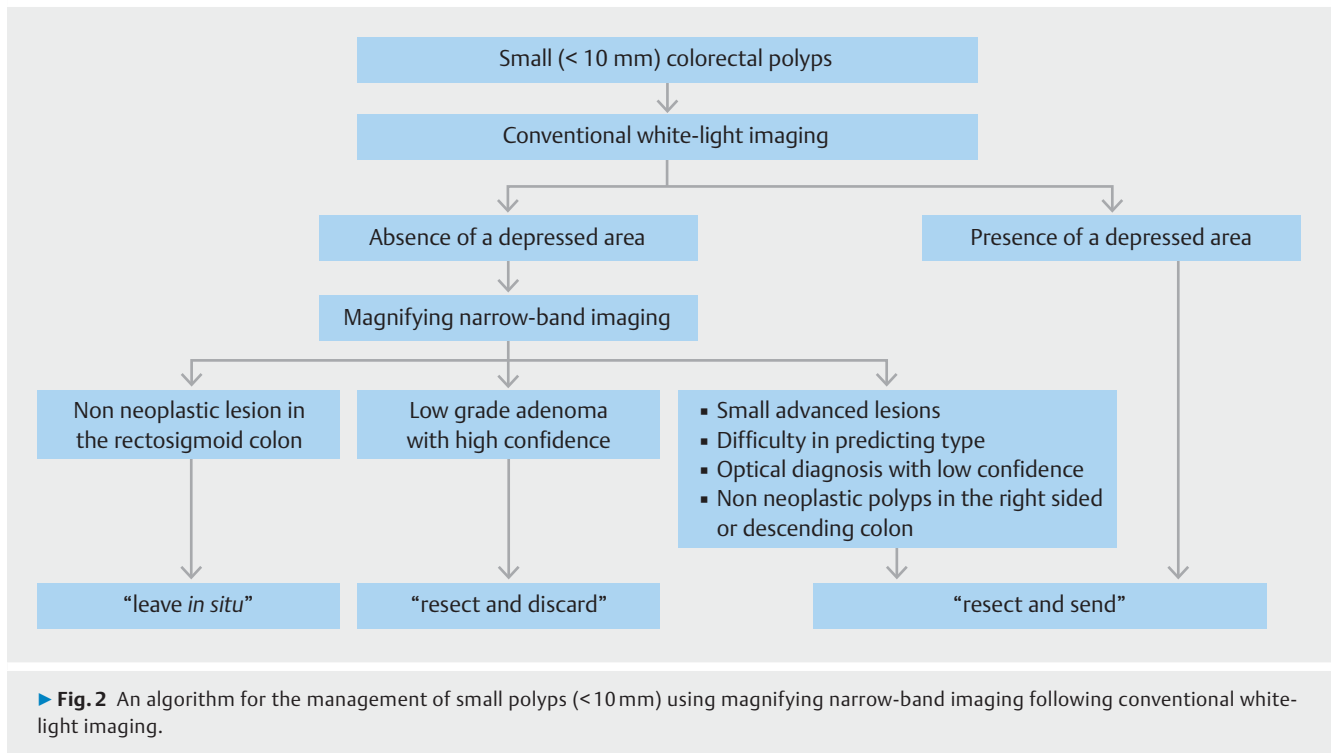
When the detected lesion was a small polyp (<10 mm), the polyp type (non-neoplastic, low grade adenoma, suspected SAL, or inconclusive) was predicted by the endoscopists using M-NBI following C-WLI, with their diagnostic confidence rated as high or low. One of three types of polyp management (“leave



► **Fig. 1** **a** An example of low grade adenoma imaged with typical magnifying narrow-band imaging. **i** Endoscopic findings using conventional endoscopy with white-light imaging. A reddish, slightly elevated lesion (6 mm in diameter) is observed in the sigmoid colon. **ii** Endoscopic findings using magnifying narrow-band imaging. Capillary pattern II was defined as microvascular architecture arranged in a round, oval, or honeycomb-like pattern. **iii** The final histological diagnosis was low grade adenoma. **b** An example of submucosal invasive cancer viewed by endoscopic modalities. **i** Endoscopic findings using conventional endoscopy with white-light imaging. A reddish, protruding lesion with a shallow depressed area (8 mm in diameter) is observed in the sigmoid colon. **ii** Magnifying narrow-band imaging containing visible microvascular architecture and high microvessel density with lack of uniformity and irregularity, indicative of capillary pattern III. **iii** The final histological diagnosis was submucosally invasive cancer (930  $\mu$ m) with blood vessel invasion. **c** An example of submucosal invasive cancer viewed by endoscopic modalities. **i** Endoscopic findings using conventional endoscopy with white-light imaging. A reddish, slightly depressed lesion (5 mm in diameter) is observed in the rectum. **ii** Magnifying narrow-band imaging showing thick and irregular vessels and the presence of a nearly avascular region, indicative of capillary pattern III. **iii** The final histological diagnosis was submucosally invasive cancer (590  $\mu$ m) with lymphatic and blood vessel invasion.

in situ”, “resect and discard”, or “resect and send” for formal histopathology) was decided upon in accordance with the prediction of polyp histology. In the case of presumably non-neoplastic lesions located in the rectosigmoid colon, endoscopists were not required to remove the lesions, as per the “leave in situ” option. In the case of low grade adenoma predicted with high confidence, endoscopists discarded the polyp without his-

tological assessment, as per the “resect and discard” option. In the case of SALs, including small invasive cancer (► **Fig. 1b, c**), polyps where there were difficulties in predicting type, or polyps for which OD was made with low confidence, endoscopists resected and sent the lesions for formal histopathology, as per the “resect and send” option. While non-neoplastic polyps located in the right-sided colon or descending colon



can potentially be sessile serrated adenoma/polyps, such polyps were also managed via the “resect and send” strategy in the present study. An algorithm for the management of small polyps (<10 mm) using M-NBI following C-WLI is shown in ► **Fig. 2**. M-NBI was used in all cases to confirm that there was no residual tumor in the post-endoscopic resection ulcer site.

### Validation of magnifying narrow-band imaging for classifying colorectal polyps

M-NBI observation was performed at our hospital between January 2007 and December 2007. During this time period, there were 425 consecutive cases of colorectal lesions that had been endoscopically or surgically resected; these cases were retrospectively analyzed. On the basis of histological characteristics, the 425 lesions were identified as: HPs/sessile serrated polyps (n=33 lesions), LGD such as tubular adenoma/tubulovillous adenoma (n=316 lesions), HGD (n=60 lesions), superficial submucosal invasive (SM-s) carcinoma located less than 1000µm below the mucosa (n=5 lesions), and deep submucosal invasive (SM-d) carcinoma located deeper than 1000µm (n=11 lesions). We evaluated the relationship between the CP classification and the histologic findings of these lesions.

### Clinical outcomes

To evaluate the efficacy and safety of the “resect and discard” strategy, we analyzed the following short-term outcomes: 1) en bloc resection rate, 2) postoperative bleeding rate, and 3) perforation rate. To validate curability using the “resect and discard” strategy, we evaluated the following mid-term outcomes: 1) overall survival rate, 2) disease-specific survival rate, 3) local recurrence rate, and 4) distant recurrence rate. Data are presented as median (range) or mean ± standard deviation. Survival

time was calculated as the interval between the date of the treatment and the date of death or, for survivors, the last date on which they were confirmed to be alive.

In principle, surveillance colonoscopy was performed once a year after the initial colonoscopy to detect local recurrence and new lesion occurrence. As post-endoscopic resection ulcer scars were not recognized in most cases, local recurrence was defined as the presence of adenomatous or carcinomatous tissue on follow-up examination at or near the site of prior endoscopic treatment. Follow-up computed tomography (CT) of the abdomen and pelvis was not scheduled; however, many included patients underwent CT of the abdomen and pelvis for other reasons during the follow-up period. In these cases, we assessed the presence of lymph node or distant metastasis.

Post-colonoscopy colorectal cancer (PCCRC) rates have been proposed as a key quality indicator of colonoscopy procedures [16]. We investigated the occurrence of PCCRC during the follow-up period in the present study. Based on a previous research method, we defined PCCRC as CRC that had been diagnosed 7 to 36 months after colonoscopy, when no cancer had been detected before the procedure [17]. CRC was defined as a tumor that had penetrated through the muscularis mucosae into the submucosa, in accordance with the classification of the World Health Organization.

### Statistical analysis

Overall and disease-specific survival rates were retrospectively assessed and calculated using the Kaplan–Meier method. All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria); more precisely, it is a modified

version of R commander designed to add statistical functions frequently used in biostatistics [18].

## Results

### Characteristics of the patients and the small (<10 mm) lesions

The present study included 501 consecutive patients with 816 lesions (► **Table 1**). The mean patient age was  $64.5 \pm 9.6$  years, and the mean size of the detected lesions smaller than 10 mm was  $5.6 \pm 1.6$  mm. Among these lesions, 444 (54%) were diminutive ( $\leq 5$  mm), and 372 (46%) were small (6–9 mm). The morphological structure of the lesions was: 785 polypoid (0-I); 31 slightly elevated (0-IIa); and no depressed lesions (0-IIc, 0-IIa + IIc). There were 484 (59%) polyps located proximal to the splenic flexure, while 332 (41%) were situated distal to the splenic flexure.

### Diagnostic performance of magnifying narrow-band imaging analysis

The relationship between M-NBI findings and the histologic features of the colorectal lesions is shown in ► **Table 2**. Histologically, 100% (29/29) of CP type I lesions were identified as HP. In addition, 1.1% (4/358), 87.4% (313/358), and 11.5% (41/358) of CP type II lesions were identified as HP, LGD, and HGD/SM-s carcinoma, respectively. Moreover, 7.9% (3/38), 63.2% (24/38), and 28.9% (11/38) of CP type III lesions were identified as LGD, HGD/SM-s carcinoma, and SM-d carcinoma, respectively. M-NBI provided a sensitivity of 99.1% and a specificity of 46.1% in differentiating LGD from HGD/invasive cancer, and the overall accuracy was 88.9%. The positive predictive value was 88.5%, and the negative predictive value was 92.1%. No CP type II lesion was diagnosed as SM-d carcinoma.

### Short-term outcomes

En bloc resection was achieved in 100% of cases. No adverse events (such as perforation and delayed bleeding) occurred after the “resect and discard” strategy.

### Mid-term outcomes and patient clinical course

The mid-term outcomes were examined in 476 patients who were reliably followed-up for at least 1 year after undergoing the “resect and discard” strategy. The median observation peri-

► **Table 1** Clinicopathological features of the patients and the small (<10 mm) lesions.

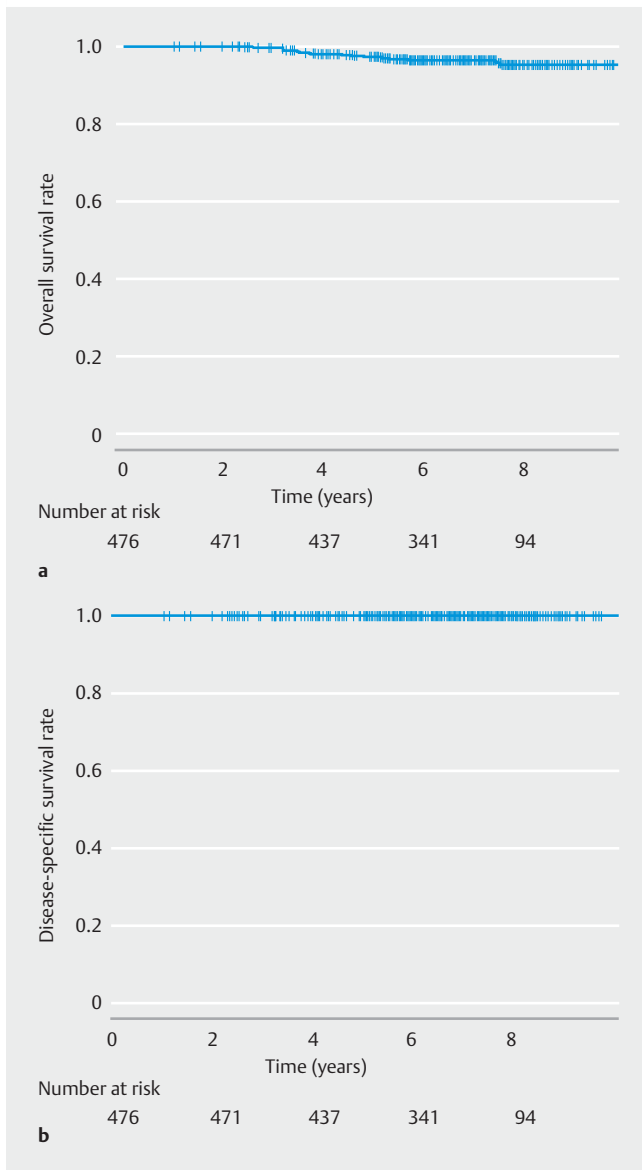
	Total (n = 816)	
Total no. of patients	501	
Male, n (%)	377	(75.2)
Female, n (%)	124	(24.8)
Age, mean $\pm$ SD, years	64.5 $\pm$ 9.6	
Lesion size, mean $\pm$ SD, mm	5.6 $\pm$ 1.6	
▪ $\leq 5$ mm, n (%)	444	(54.4)
▪ 6–9 mm, n (%)	372	(45.6)
Macroscopic type, n (%)		
▪ 0-Ip	74	(9.1)
▪ 0-Is	711	(87.1)
▪ 0-IIa	31	(3.8)
▪ 0-IIc, 0-IIa + IIc	0	(0)
Location, n (%)		
▪ Cecum	39	(4.8)
▪ Ascending colon	213	(26.1)
▪ Transverse colon	232	(28.4)
▪ Descending colon	86	(10.5)
▪ Sigmoid colon	177	(21.7)
▪ Rectum	69	(8.5)
SD, standard deviation.		

od was 83 months (range 12–117 months). ► **Fig. 3** shows the long-term survival rate determined using the Kaplan-Meier method. The overall survival rate of patients who underwent the “resect and discard” strategy is shown in ► **Fig. 3a**. During the follow-up period, all 15 patient deaths were caused by diseases other than CRC. Causes of death were cerebral hemorrhage (n = 2), pharyngeal cancer (n = 2), esophageal cancer (n = 1), gastric cancer (n = 1), liver cancer (n = 1), lung cancer (n = 2), pancreatic cancer (n = 1), acute myocardial infarction (n = 2),

► **Table 2** Relationship between Sano's capillary classification and the histological findings in colorectal lesions examined during 2007.

Capillary pattern	n (%)		Pathological diagnosis, n (%)									
			Hyperplastic polyps		LGD		HDG		SM-s		SM-d	
Type I	29	(100)	29	(100)	0	(0)	0	(0)	0	(0)	0	(0)
Type II	358	(100)	4	(1.1)	313	(87.4)	40	(11.2)	1	(0.3)		
Type III	38	(100)			3	(7.9)	20	(52.6)	4	(10.5)	11	(28.9)
Total	425		33		316		60		5		11	

LGD, low grade dysplasia; HDG, high grade dysplasia; SM-s, superficial submucosal invasive carcinomas (<1000  $\mu$ m); SM-d, deep submucosal invasive carcinomas ( $\geq 1000$   $\mu$ m).



► **Fig. 3** **a** Kaplan-Meier curves for overall survival rates after the “resect and discard” strategy for small (<10 mm) colorectal polyps in 476 patients. **b** Kaplan-Meier curves for disease-specific survival rates after the “resect and discard” strategy for small (<10 mm) colorectal polyps in 476 patients.

hematological malignancy (n=2), and sudden death of unknown cause (n=1). None of the patients died from CRC related to the procedure, resulting in a disease-specific survival rate of 100% (► **Fig. 3b**). Among the 476 patients who underwent the “resect and discard” strategy, there was no local recurrence detected in the 293 patients (62%) who underwent follow-up colonoscopy, and no distant recurrence detected in the 309 patients (65%) who underwent CT of the abdomen and pelvis during the follow-up period. Overall, the median follow-up periods during which patients received colonoscopy and CT of the abdomen and pelvis were 61 months and 70 months, respectively. Only one CRC was diagnosed between 7 and 36 months after colonoscopy in the 293 patients who underwent follow-up co-

lonoscopy, and so the PCCRC rate was 0.3% (1/293). The PCCRC was endoscopically resected, and was histologically diagnosed as a SM-s carcinoma.

## Discussion

We achieved excellent mid-term outcomes after the “resect and discard” strategy using M-NBI following C-WLI for small (<10 mm) colorectal polyps. The present study shows that M-NBI following C-WLI results in appropriate evaluation of SALs, and confirms that the “resect and discard” strategy using M-NBI is feasible and acceptable. There was no local recurrence or distant metastasis detected in patients who underwent the “resect and discard” strategy.

In vivo OD at the time of colonoscopy is an attractive approach for physicians, patients, and health-care providers. The original “resect and discard” strategy involving OD using non-M-NBI proposed by Ignjatovic et al. [4] did not take advanced histology into consideration, whereas the US Multi-Society Task Force guidelines for colonoscopic surveillance include advanced histology as one of the factors required for determination of the surveillance interval [5]. Takeuchi et al. reported that the “resect and discard” strategy using M-NBI reduces the risk of discarding SALs, including small invasive cancers [12]. CP observation using M-NBI provides high accuracy for distinguishing between LGD and HGD/invasive cancer, and thus can be used to predict the histopathology of colorectal neoplasia in vivo [10]. Our validation results in the present study show a high level of accuracy for OD using CP to distinguish between LGD and HGD/invasive cancer; CP type II had an overall accuracy of nearly 90%, and there was no SM-d carcinoma in CP type II lesions. Depressed tumors have a significantly higher frequency of carcinoma and submucosal invasion regardless of tumor size, so it is important to carry out careful observation to ensure the detection of all diminutive depressed tumors [8]. Therefore, LGD predicted with high confidence was defined according to the following endoscopic conditions: 1) the absence of a depressed area within the lesion under C-WLI, and 2) CP type II under M-NBI.

Many clinical studies on M-NBI classifications (such as Sano’s capillary classification) advocated in Japan have reported the usefulness of M-NBI for qualitative and quantitative diagnosis of colorectal lesions [19]. The Japan NBI Expert Team (JNET) established in 2011 unified four previous M-NBI classifications (the Sano, Hiroshima, Showa, and Jikei classifications), and has proposed a universal M-NBI endoscopic classification of colorectal tumors [20]. Regardless of the gross type, the JNET classification provides useful criteria for optical histological diagnosis of colorectal lesions, and is expected to contribute to daily colonoscopic practice. The JNET classification could not be used in the present study, as it was a retrospective study; further studies are required using the JNET classification.

The recently proposed Preservation and Incorporation of Valuable Endoscopic Innovations (PIVI) statement issued by the American Society of Gastrointestinal Endoscopy (ASGE) suggested that the resect-and-discard model could be implemented if a minimum accuracy and negative predictive value could

be achieved [21]; this aim may be facilitated by the introduction of new generation colonoscopes with improved optics, high definition, and fixed zoom functioning such as M-NBI. A previous meta-analysis assessing the ASGE PIVI statement indicated that optical biopsy technology using NBI can meet this PIVI threshold, and supports a “resect-and-discard” strategy for colorectal adenomas  $\leq 5$  mm [22]. We think that the target lesion for the “resect and discard” strategy should be carefully discussed. Some studies have reported on diminutive invasive carcinoma, although the prevalence of diminutive invasive carcinoma is quite low [23, 24]. Hotta et al. reported the presence of diminutive submucosally invasive cancers of the colon and rectum; therefore, careful endoscopic observation is strongly recommended when adopting the “resect and discard” strategy [25]. M-NBI is effective for the precise diagnosis of invasion depth in CRC [26]. Hence, although the “resect and discard” strategy involving OD using non-M-NBI carries the risk that small invasive carcinomas may be discarded, the “resect and discard” strategy involving OD using M-NBI has the potential to prevent such small invasive carcinomas from being discarded.

The efficacy of colonoscopy with polypectomy to reduce CRC incidence and mortality has been demonstrated by the US National Polyp Study published in 1993, in which a cohort of patients undergoing colonoscopy with polypectomy of neoplasia had a 76–90% reduction in CRC incidence [3]; this same cohort experienced a 53% reduction in mortality associated with CRC [27]. Sending diminutive and small polyps for formal histopathology is time consuming and resource intensive, and results in an inevitable delay in providing patients with advice about future surveillance intervals. In cases involving multiple polyps throughout the colon, it is sometimes difficult to retrieve and submit all polyps for formal histologic assessment. The primary benefit of the “resect and discard” strategy is the cost savings that can be achieved by reducing the number of polyps that are sent for histopathological examination [28, 29]. The potential cost savings of not sending diminutive polyps for formal histopathology is thought to exceed \$1 billion USD per year in the United States [29]; even greater cost-effectiveness will be achieved by also applying the “resect and discard” strategy to small ( $< 10$  mm) polyps, rather than just to diminutive ( $\leq 5$  mm) polyps. The Japanese guidelines indicate that diminutive ( $\leq 5$  mm) neoplastic lesions without carcinomatous findings may be left untreated, and just followed-up [30], and recent reports have shown that removal is not necessarily required for diminutive low grade adenoma ( $\leq 5$  mm) detected and characterized using magnifying chromoendoscopy [31, 32]. A large, multicenter, prospective study and a clinical trial using M-NBI are required to validate these results.

The Japanese Society of Gastroenterology guidelines [30] recommend that follow-up colonoscopy should be done within 3 years after endoscopic resection (ER), in accordance with the pilot data of the Japan Polyp Study [33]. The Japan Polyp Study was a large multicenter prospective cohort study carried out to determine the appropriate interval period for surveillance colonoscopy after ER [34]. Based on the results of the Japan Polyp Study, Matsuda et al. proposed that the detection of a clean co-

lon in two complete colonoscopies may enable the surveillance interval to be lengthened to 3 years after polypectomy [35]. According to the latest US guidelines published in 2012, the interval for colonoscopy after screening and ER is defined based on the characteristics of the resected lesion [5]. It is desirable to determine an appropriate follow-up period for surveillance colonoscopy based on risk stratification for the incidence of CRC in Japanese guidelines.

In the present study, the PCCRC rate was 0.3% during follow-up. Several methods of calculating PCCRC rates have been published, with reported rates ranging from 2.1% to 7.5% [16]. The present study had a lower PCCRC rate than that reported in previous studies, and there was no advanced CRC histologically. The possible reasons for this are that the use of high definition colonoscopy might have enabled us to detect a relatively larger number of premalignant polyps at the time of initial examination, and that all colonoscopies were performed by experienced gastroenterologists.

The present study had several limitations. First, it was a retrospective single-institution study, and some patients were lost to follow-up at other institutions. The number of patients who underwent the “resect and discard” strategy in 3 years is small because the procedures were performed only by endoscopists experienced in endoscopic diagnosis including M-NBI, and the patients who had colorectal lesions equal to or larger than 10 mm were excluded. Second, the present study included endoscopists at a high-volume center who were familiar with M-NBI, making it difficult to extrapolate the results to colonoscopists outside of this medical institution. Non-experts should be particularly cautious when adopting the “resect and discard” strategy in clinical practice. Third, results for surveillance colonoscopy and CT of the abdomen and pelvis after endoscopic treatment were not available in more than 30% of patients. However, the follow-up rate was about 95%, and the median follow-up period was more than 6 years. Fourth, M-NBI is still unpopular in Western countries, as it is generally considered to be technically difficult and time consuming.

In conclusion, the mid-term outcomes of the “resect and discard” strategy for small ( $< 10$  mm) colorectal polyps under strict preoperative diagnosis were excellent. The use of M-NBI following C-WLI can decrease the number of specimens that need to be sent for histopathological examination, and this could potentially decrease the cost of colon cancer detection and prevention. Further prospective multicenter studies involving a larger number of patients with a high rate of follow-up are required to confirm the present findings.

## Acknowledgements

We thank Kelly Zammit, BVSc, from Edanz Group ([www.edanzediting.com/ac](http://www.edanzediting.com/ac)), for editing a draft of this manuscript.

## Competing interests

None

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