Relationship between Narrow-Band Imaging Magnifying Observation and Pit Pattern Diagnosis in Colorectal Tumors

Nana Hayashi^a Shinji Tanaka^a Hiroyuki Kanao^a Shiro Oka^a Shigeto Yoshida^a
Kazuaki Chayama^b

Departments of ^aEndoscopy and ^bGastroenterology and Metabolism, Hiroshima University Hospital, Hiroshima, Japan

Key Words

Colorectal tumor · Narrow-band imaging · Magnification · Pit pattern

Abstract

Background/Aim: The aim of this study was to examine the relationship between narrow-band imaging (NBI) magnifying observation using the surface pattern as the main evaluation criterion and pit pattern diagnosis on the basis of magnifying observation using a dye in relation to the characteristics of colorectal tumors according to their morphologies. **Methods:** In this study, NBI observation and pit pattern diagnosis using a dye with magnifying observation were simultaneously performed in our hospital, and the consecutive 786 cases of colorectal lesions (hyperplasia, adenomata and early carcinomas) that had been endoscopically or surgically resected were retrospectively analyzed. NBI magnifying observation was in conformance with the Hiroshima classification and pit pattern diagnosis was in conformance with the Kudo and Tsuruta classification. The relationship between NBI magnifying observation and pit pattern diagnosis and that between NBI magnifying observation and the histological type/invasion depth were examined in relation to colorectal tumor morphology. **Results:** Type A correspond-

ed to the type II pit pattern, type B corresponded to the type III_S, type III_L and type IV regular pit patterns, type C1 corresponded to the type V_I slightly irregular pit pattern, type C2 corresponded to the type V_I highly irregular pit pattern and type C3 corresponded to the type V_N pit pattern. In the protruded type, the irregularity of type C1 or C2 lesions agreed with the type V_I slightly or highly irregular pit pattern, respectively, in 114 cases (64.0%). Moreover, the irregularity was higher with NBI magnifying observation than with pit pattern diagnosis in 58 cases (32.6%). In the superficial type, the irregularity of type C1 or C2 lesions agreed with the type V_I slightly or highly irregular pit pattern, respectively, in 63 cases (71.6%). Moreover, the irregularity was higher with NBI magnifying observation than with pit pattern diagnosis in 19 cases (21.6%). In the case of type C1 or C2 lesions, the irregularity tended to be higher with NBI magnifying observation than with pit pattern diagnosis in the protruded type compared to the superficial type ($p = 0.087$). **Conclusion:** The surface pattern, which was visible in NBI magnifying observation, differed from the pit pattern findings obtained by magnifying endoscopic observation using a dye. Findings were more detailed in pit pattern diagnosis using a dye than in NBI magnifying observation.

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Introduction

Previously we reported that both surface and vascular pattern are essential for characterization of colorectal tumor using narrow-band imaging (NBI) magnification [1–4]. The surface pattern, which has been termed pit-like structure or white zone, has a crypt opening (CO) and a marginal crypt epithelium (MCE) [5]. Colorectal tumors have a polypoid appearance and the glandular meanders in a complicated manner. It is difficult to adjust the light for NBI observation to perpendicularly illuminate a pit. Therefore, an observation of an actual dark pit is usually difficult. The structure with a CO and MCE appears white and is observed as a pit-like structure in many cases [5]. The microvessels become thicker and their density increases with cancerous cell infiltration and proliferation [6–8]. When CO destruction, inflammatory cell infiltration or stromal reaction occurs, the distribution of microvessels becomes heterogeneous and their shapes become irregular. On the basis of these characteristics, distinctions can be made between tumor/non-tumor and adenoma/carcinoma, and the invasion depth of early carcinoma can be determined [6].

However, the similarity and relationship of the surface pattern visible in NBI magnifying observation to findings obtained in conventional pit pattern diagnosis is so far unknown. In this study, NBI magnifying observation, performed in conformance with the Hiroshima classification with importance given to the surface pattern, was compared with conventional pit pattern diagnosis using a dye, and the characteristics of colorectal tumors were examined in relation to their macroscopic types.

Materials and Methods

In this study, NBI magnifying observation and pit pattern diagnosis using a dye with magnifying observation were simultaneously performed at the Department of Endoscopy, Hiroshima University Hospital, between March 2005 and August 2011, and the consecutive 786 cases of colorectal lesions, which had been endoscopically or surgically resected, were retrospectively analyzed. Of these, 516 and 270 cases belonged to the protruded and superficial types, respectively, based on macroscopic classification. On the basis of histological characteristics the 786 cases were identified as: hyperplastic polyp (HP)/serrated adenoma (SA; 60 cases: HP 53, SA 7), tubular adenoma/tubulovillous adenoma (TA; 361 cases), mucosal carcinoma (Mca) to submucosal invasive carcinoma less than 1,000 μm (SM-s ca; 246 cases) and submucosal invasive carcinoma deeper than 1,000 μm (SM-d ca; 119 cases). In the evaluation of NBI magnifying findings we used the Hiroshima classification (fig. 1) [1–4]. In this classification, type A includes colorectal tumors that are normal or faded in color and

whose microvessels are invisible. Type B includes colorectal tumors with a regular surface pattern or a regular meshed capillary network. Type C includes colorectal tumors with an irregular surface pattern and no particular structure; this type is subclassified into C1–C3. Thus, colorectal tumors are classified on the basis of both their microvascular architecture and surface pattern. In the evaluation of pit pattern findings, we used the Kudo and Tsuruta classification [8, 9]. The instruments used in this study were a magnifying videoendoscope system (CF-H260AZI; Olympus, Tokyo, Japan). The resected lesions were pathologically diagnosed in accordance with the criteria of the World Health Organization [10]. The macroscopic types were classified as protruded or superficial type [11]. In this study, a carcinoma with SM-s or SM-d ca was defined as having an invasion depth of 1,000 μm or more, as described previously [11–14]. The relationship between NBI magnifying observation and pit pattern diagnosis, and that between NBI magnifying observation and the histopathological findings were examined using these cases in relation to the morphologies of the colorectal tumors in these 786 cases. Data were evaluated by the χ^2 test, with significance accepted at a p value of <0.05.

Results

Relationship between NBI Magnifying Findings and Pit Pattern Diagnosis in Protruded-Type Lesions

All lesions belonging to type A agreed with those belonging to the type II pit pattern, and 88% of lesions belonging to type B agreed with those belonging to the type III_S, type III_L and type IV pit regular pit patterns. All protruded lesions with both type II pit pattern and type B were SA. The rate of agreement between lesions belonging to type C1 and those belonging to the type V_I slightly irregular pit pattern was 66%, that between type C2 lesions and those with the type V_I highly irregular pit pattern was 59%, and that between type C3 lesions and those with the type V_N pit pattern was 65%. In the case of type C1 or C2 lesions, the irregularity was one rank lower in pit pattern diagnosis than in NBI magnifying findings. In other words, 30% of the lesions belonging to type C1 agreed with those belonging to the type III_S, type III_L and type IV regular pit patterns, and 41% of the lesions belonging to type C2 agreed with those belonging to the type V_I slightly irregular pit pattern (table 1).

Relationship between NBI Magnifying Findings and Pit Pattern Diagnosis in Superficial-Type Lesions

All lesions belonging to type A agreed with those belonging to the type II pit pattern, and 81% of lesions belonging to type B agreed with those belonging to the type III_S, type III_L and type IV regular pit patterns. The rate of agreement between lesions belonging to type C1 and

A type				Microvessel intensity is vague or invisible. None or isolated lacy vessels may be present coursing across the lesion. Brown or black dots, star or round shaped surrounded by white.
B type				Regular surface pattern is observed by the increased microvessel intensity around the pits and image enhance. Irregular meshed microvessel network pattern is observed.
C type	1			Irregular surface pattern is observed by the increased microvessel intensity around the pits and image enhance. Thickness and distribution of vessels are homogenous.
	2			More irregular surface pattern is observed by the increased microvessel intensity around the pits and image enhance. Thickness and distribution of vessels are heterogenous.
	3			Surface pattern is completely unclear. Thickness and distribution of vessels are heterogenous. Avascular area (AVA) and scattered microvessel fragments are observed.

Fig. 1. Hiroshima classification of NBI magnification for colorectal lesions.

Table 1. Relationship between Hiroshima classification of NBI magnification and pit pattern (protruding type)

NBI Hiroshima classification	No. of cases	Pit pattern				
		II	III _S /III _L /IV	V _I -L	V _I -H	V _N
A	21 (100)	21 (100)				
B	263 (100)	5 (1)	234 (87)	24 (12)		
C1	137 (100)		41 (30)	90 (66)	6 (4)	
C2	41 (100)			17 (41)	24 (59)	
C3	54 (100)				19 (35)	35 (65)
Total	516	26	275	131	49	35

Figures in parentheses are percentages.

Table 2. Relationship between Hiroshima classification of NBI magnification and pit pattern (superficial type)

NBI Hiroshima classification	No. of cases	Pit pattern				
		II	III _S /III _L /IV	V _I -L	V _I -H	V _N
A	39 (100)	39 (100)				
B	113 (100)		92 (81)	21 (19)		
C1	69 (100)		14 (20)	49 (71)	6 (9)	
C2	19 (100)			5 (26)	14 (74)	
C3	30 (100)				12 (40)	18 (60)
Total	270	39	106	75	32	18

Figures in parentheses are percentages.

those belonging to the type V_I slightly irregular pit pattern was 71%, that between type C2 lesions and those with the type V_I highly irregular pit pattern was 74%, and that between type C3 lesions and those with the type V_N pit pattern was 60%. In the case of type C1 or C2 lesions, the irregularity was slightly higher in NBI magnifying findings than in pit pattern diagnosis. In other words, 20% of the lesions belonging to type C1 agreed with those

belonging to the type III_S, type III_L and type IV regular pit patterns, and 26% of the lesions belonging to type C2 agreed with those belonging to the type V_I slightly irregular pit pattern. In the case of type C1 or C2 lesions, the rate of agreement between NBI magnifying findings and pit pattern diagnosis tended to be higher in the superficial type than in the protruded type ($p = 0.087$; table 2).

Fig. 2. An LST-G lesion, 50 mm in diameter. **a** Standard colonoscopic view. **b** Standard colonoscopic view with indigo carmine dye spraying. **c** NBI magnifying colonoscopic view reveals type C3. **d** Magnifying colonoscopic view with crystal violet staining reveals type V₁ high-grade pit pattern. **e** Cross section (HE staining). Carcinoma with TA, SM 3,300 μ m, ly1, v0 tumor margin negative.

Relationship between NBI Magnifying Findings and the Invasion Depth/Histological Type in Protruded-Type Lesions

All lesions belonging to type A were diagnosed as HP/SA, 77% of the lesions belonging to type B were diagnosed as TA, 73% of the lesions belonging to type C1 were diagnosed as M-SM-s ca, 54% of the lesions belonging to C2 were diagnosed as SM-d ca and all lesions belonging to type C3 were diagnosed as SM-d ca (table 3).

Relationship between NBI Magnifying Findings and the Invasion Depth/Histological Type in Superficial-Type Lesions

All lesions belonging to type A were diagnosed as HP/SA and 82% of the lesions belonging to type B were diagnosed as TA. With regard to type C1, 43% of the lesions were diagnosed as TA and 47% of the lesions were diagnosed as M-SM-s ca. With regard to type C2, 37% of the lesions were diagnosed as M-SM-s ca and 63% of lesions

were diagnosed as SM-d ca. All lesions belonging to type C3 were diagnosed as SM-d ca. In nearly half of the cases that were diagnosed as TA, irregular surface patterns appeared in NBI magnifying findings. In TA the ratio of irregular surface patterns was significantly higher in the superficial type than in the protruded type ($p = 0.017$; table 4).

Discussion

In NBI magnifying findings in conformance with the Hiroshima classification, type A was used as an index for hyperplasia, Type B as an index for intramucosal lesions consisting mainly of adenoma, type C1 as an index for intramucosal lesions consisting mainly of M ca and type C3 as an index for deep SM-d ca. Although type C2 was used as an index for SM ca, its accuracy was as low as 56.7%. With regard to conventional pit pattern diagnosis

Table 3. Relationship between Hiroshima classification of NBI magnification and histologic findings (protruding type)

NBI Hiroshima classification	No. of cases	Histologic findings			
		HP/SA	TA	M-SM-s	SM-d
A	21 (100)	21 (100)			
B	263 (100)	5 (1)	199 (77)	59 (22)	
C1	137 (100)		33 (24)	100 (73)	4 (3)
C2	41 (100)			19 (46)	22 (54)
C3	54 (100)				54 (100)
Total	516	26	232	178	80

Figures in parentheses are percentages.

in conformance with the Kudo and Tsuruta classification, it was predicted that type A corresponded to the type II pit pattern, type B to the type III_S, type III_L and type IV regular pit patterns, type C1 to the type V_I slightly irregular pit pattern, type C2 to the type V_I highly irregular pit pattern and type C3 to the type V_N pit pattern. Although the rate of agreement between type A and the type II pit pattern and that between type B and the type III_S, type III_L and type IV regular pit patterns were as high as 100 and 80%, respectively, those between types C1, C2 and C3 and the corresponding pit patterns were as low as 60–70%.

Regular surface patterns visible in NBI magnifying observation were in almost complete agreement with pit pattern findings, whereas irregular surface patterns visible in NBI magnifying findings did not perfectly agree with pit pattern findings. As mentioned above, the rates of agreement between types C1, C2 and C3 and the corresponding pit patterns were more than 50%. However, the irregularity was one link lower in pit pattern diagnosis than in NBI magnifying findings. This tendency was observed in both macroscopic types.

As mentioned above, the surface pattern (pit-like structure) visible in NBI magnifying observation differed from an actual pit pattern, and it was obtained by evaluating both the CO and MCE. Pit pattern diagnosis using magnifying observation with a dye, such as indigo carmine or crystal violet, is the gold standard for fine surface structures of lesions. Therefore, the surface pattern (pit-like structure) visible in NBI magnifying observation was clearly revealed to be inferior to the fine surface structure obtained by pit pattern diagnosis. However, as shown in tables 3 and 4, NBI magnifying observation is also a use-

Table 4. Relationship between Hiroshima classification of NBI magnification and histologic findings (superficial type)

NBI Hiroshima classification	No. of cases	Histologic findings			
		HP/SA	TA	M-SM-s	SM-d
A	39 (100)	39 (100)			
B	113 (100)		93 (82)	20 (18)	
C1	69 (100)		30 (43)	39 (57)	
C2	19 (100)			7 (37)	12 (63)
C3	30 (100)				30 (100)
Total	270	39	123	66	42

Figures in parentheses are percentages.

ful modality for characterizing tumors, similar to pit pattern diagnosis, even though the object to be observed is different. In both protruded and superficial types, the discriminant ability of NBI magnifying observation for adenomata belonging to types B and C1 differed slightly from that for M-SM-s ca. However, since both adenomata and M-SM-s ca are adaptable to endoscopic therapy, no particular problems are likely to occur when determining therapeutic strategy. Since NBI magnifying observations can be easily performed without any dye, localized colorectal lesions should be first diagnosed qualitatively by using NBI magnifying observation. Conventional pit pattern diagnosis using a dye [15] should be used for lesions belonging to only type C2 or when the diagnosis is unclear. By this way, colonoscopy can be efficiently performed at low cost.

In lesions possessing regular structures, the fine surface structure centering on the surface pattern (pit-like structure) visible in NBI magnifying observation was in almost perfect agreement with pit pattern findings based on magnifying observation using a dye. However, in lesions possessing irregular structures, irregular findings were more detailed in pit pattern diagnosis based on magnifying observation using a dye than in NBI magnifying observation.

Disclosure Statement

None of the authors have any disclosures to make.

References

- 1 Oba S, Tanaka S, Matsumoto A, Kanao H, Oka S, Yoshida S, Hiyama T, Ueno Y, Itou K, Kitadai Y, Yoshihara M, Chayama K: Clinical usefulness of NBI (narrow band imaging) magnification for diagnosis of colorectal tumors (in Japanese with English abstract). *Stomach Intestine* 2010;45:829–840.
- 2 Oba S, Tanaka S, Oka S, Toshida S, Shimamoto F, Chayama K: Characterization of colorectal tumors using narrow-band imaging magnification: combined diagnosis with both pit pattern and microvessel features. *Scand J Gastroenterol* 2010;45:1084–1092.
- 3 Kanao H, Tanaka S, Oka S, Hirata M, Yoshida S, Chayama K: Narrow-band imaging magnification predicts the histology and invasion depth of colorectal tumors. *Gastrointest Endosc* 2009;69:631–636.
- 4 Tanaka S, Sano Y: Aim to unify the narrow band imaging (NBI) magnifying classification for colorectal tumors: current status in Japan from a summary of the consensus symposium in the 79th annual meeting of the Japan gastroenterological endoscopy society. *Dig Endosc* 2011;23(suppl 1):131–139.
- 5 Yao K, Anagnostopoulos GK, Ragunath K: Magnifying endoscopy for diagnosing and delineating early gastric cancer. *Endoscopy* 2009;41:462–467.
- 6 Hirata M, Tanaka S, Oka S, Kaneko I, Yoshida S, Yoshihara M, Chayama K: Magnifying endoscopy with narrow band imaging for diagnosis of colorectal tumors. *Gastrointest Endosc* 2007;65:988–995.
- 7 Machida H, Sano Y, Hamamoto Y, Muto M, Kozu T, Tajiri H, Yoshida S: Narrow-band imaging in the diagnosis of colorectal mucosal lesions: a pilot study. *Endoscopy* 2004;36:1094–1098.
- 8 Konerding MA, Fait E, Gaumann A: 3D microvascular architecture of pre-cancerous lesions and invasive carcinomas of the colon. *Br J Cancer* 2001;84:1354–1362.
- 9 Kudo S, Hirota S, Nakajima T, Hosobe S, Kusake H, Kobayashi T, Himori M, Yagyuu A: Colorectal tumours and pit pattern. *J Clin Pathol* 1994;47:880–885.
- 10 Imai Y, Kudo S, Tsuruta O, Tanaka S, Terai T, Fujii T, Hayashi T: Problems and clinical significance of V type pit pattern diagnosis: report on round-table consensus meeting (in Japanese). *Early Colorectal Cancer* 2001;5:595–613.
- 11 Hamilton SR, Aaltonen LA (eds): *World Health Organization Classification of Tumors: Pathology and Genetics of Tumors of the Digestive System*. Lyon, IARC Press, 2000, pp 104–119.
- 12 Japanese Society for Cancer of the Colon and Rectum: *Japanese Classification of Colorectal Carcinoma*, English ed 2. Tokyo, Kanehara & Co. Ltd., 2009.
- 13 Tanaka S, Haruma K, Oh-E H, Nagata S, Hirota Y, Furudoi A, Amioka T, Kitadai Y, Yoshihara M, Shimamoto F: Conditions of curability after endoscopic resection for colorectal carcinoma with submucosally massive invasion. *Oncol Rep* 2000;7:783–788.
- 14 Kitajima K, Fujimori T, Fujii S, Takeda J, Ohkura Y, Kawamata H, Kumamoto T, Ishiguro S, Kato Y, Shimoda T, Iwashita A, Ajioka Y, Watanabe H, Watanabe T, Nagasako K: Correlations between lymph node metastasis and depth of submucosal invasion in submucosal invasive colorectal carcinoma: a Japanese collaborative study. *J Gastroenterol* 2004;39:534–543.
- 15 Tanaka S, Kaltenbach T, Chayama K, Soetikno R: High magnification colonoscopy. *Gastrointest Endosc* 2006;64:604–613.