Original article

Adequate endoscopic mucosal resection for early gastric cancer obtained from the dissecting microscopic features of the resected specimens

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Abstract

Background. We have employed endoscopic mucosal resection (EMR), using a cap-fitted panendoscope (EMRC), for early gastric cancer since 1992. The presence of an adequate surgical margin is a requirement because of the radicality of EMR, and dissecting microscopic examination is useful in regard to the diagnosis of spread of the disease.

Methods. To devise an adequate method of EMR that allows no lateral residue, we examined gastric mucosal specimens obtained by EMRC. One hundred and sixty-seven specimens from 97 lesions in 85 patients treated by EMRC were examined in regard to characteristic features, the recovery of marks made around the lesion, and the frequency of residue, and comparisons were made between the dissecting microscopic and histopathological findings.

Results. The first specimen obtained with a large cap under full suction was a circular shape measuring 21×19 mm. The second specimen from fractionated resection was a half-moon or crescent shape, and the third specimen had a ginkgo leaf-like or irregular shape. In the elevated lesions, coincidence regarding the spread, as determined by dissecting microscopy and histopathology, was present in 62 (93%) of the 67 lesions. In 16 (53%) of 30 flat or depressed lesions, there was a difference of 2 to 5 mm between the spread determined by these two examinations.

Conclusion. It is important to place an adequate number of marks around the lesion and recover all marks by resection. When an elevated lesion measures 15 mm or more, and a flat or depressed lesion is not clearly demarcated, aggressive use of planned fractionated resection seems to be the best way to prevent a lateral residue in EMR.

Key words Early gastric cancer · Endoscopic mucosal resection · Dissecting microscopic examination

Introduction

Clinicopathological analyses of surgically treated early gastric cancers have revealed that some of them would have been curable by endoscopic treatment.

The main endoscopic treatment currently used for early gastric cancer is endoscopic mucosal resection (EMR), which allows histopathological examination of the resected specimen. In our department, since 1992, we have employed EMR in which we use, a cap-fitted panendoscope (EMRC) [1–4].

Because of the radicality of EMR, the presence of an adequate surgical margin is a requirement. Therefore, in examining the resected specimen, diagnosis of the spread, as well as the malignancy of the disease, is important, and dissecting microscopic examination is useful in this regard [5].

In the present study, we examined the characteristic dissecting microscopic features of gastric mucosal specimens obtained by EMRC in relation to macroscopic type, and diagnosis of the lateral spread of cancer obtained by dissecting microscopic examination was compared with that obtained by histopathological examination. Through this investigation, an appropriate method of mucosal resection that is related to macroscopic type and allows no lateral residue was devised.

Subjects and methods

Subjects

In this study, we investigated 97 lesions in 85 patients (66 men and 19 women) treated by EMRC and observed by dissecting microscopy between August 1992 and June 1999. The mean age of the men was 66 (± 9.2) and that of the women, 71 (± 7.1) years. The lesions were distributed over the entire stomach.

Sixty-seven lesions were elevated; 29 of these were adenomas, 3 were type 0I early cancers and 35 were type 0IIa early cancers. The remaining 30 lesions were flat or depressed, and consisted of 1 adenoma, 3 type 0IIb early cancers, and 26 type 0IIc early cancers.

All technical terms used in this report are in accordance with the *Japanese classification of gastric carcinoma (2nd English edition)* [6]. The statistical significance of differences was analyzed by Student's *t*-test, with the level of significance set at 5%.

Method of resection

According to the EMRC procedure reported previously [7], we treated the lesions by single (en-bloc) resection or multiple-fragment (fractionated) resection. Of the 97 lesions, en-bloc resection was indicated for 59 (46 elevated and 13 flat or depressed lesions), while fractionated resection was indicated for the remaining 38 (21 elevated and 17 flat or depressed lesions).

Method of observation

Each resected specimen was immediately extended and fixed with pins on a rubber board, where it was subjected to morphological observation, two-dimensional measurements, and the counting of marks that had been made around the lesion. In the specimens obtained by fractionated resection, the specimens were reconstructed on the basis of a copy of the endoscopic front view of the lesion taken after the lesion was marked prior to resection. After the mucus was washed out, the specimen was double-stained with Alcian blue and hematoxylin, and observed under an Olympus SZH-131 dissecting microscope (Olympus, Tokyo, Japan).

During dissecting microscopy, a magnifying power of 7.5 was used for observing the shape of the specimen, counting of marks within the specimen, and identifying the location of the lesion and its position in relation to the marks. The magnifying power was then increased to 15, 30, and 60, to observe the border between the lesion and the surrounding normal mucosa. In this way, the malignancy and the spread of the lesion were assessed, and the lesion was photographed with 35 mm color slide film.

The stainability of the lesion was rated as good if it was stained well overall, poor if staining was generally poor, and irregular if staining occurred in patches.

The pit pattern of the mucosal surface was classified as a foveolar pattern (FP) when there was a regular arrangement of gastric foveolae alone, a sulciolar pattern (SP) when there was a regular pattern of gastric sulci, or a foveolar/sulciolar pattern (FSP) when there was a mixture of FP and SP [8]. The appearance of the

pit pattern was expressed as regular, irregular (e.g., disordered or densely increased), or absent.

Dissecting microscopic observation was carried out by the first author alone. The spread of the lesion was diagnosed comprehensively in terms of the extent of elevation or concavity; the extent of the disordered, densely increased, or absent pit pattern; and the extent of irregular or poor staining with hematoxylin.

The extent of the lesion, as determined by dissecting microscopy, was recorded, and a cut line was determined that was vertical to the tangential line drawn for the surgical cut end closest to the lesion. The specimen was sectioned at 2-mm intervals, and histopathologically examined for histological type, depth of invasion, spread of lesion, and presence or absence of malignancy in the surgical margin.

In the diagnosis of the spread of the lesion, the findings of dissecting microscopy and the results of histopathological mapping were compared, and agreement between the results was expressed as discrepancy-negative (−), while disagreement was expressed as discrepancy-positive (+).

Specimens obtained by fractionated resection were also examined to determine the size of the specimen, the recovery of marks, the frequency of successful reconstruction, and the frequency of residue.

Results

Characteristic features of EMRC specimens

Fifty-nine specimens were obtained from the 59 lesions subjected to en-bloc resection, and from the 38 lesions subjected to fractionated resection, we obtained 108 specimens (34 specimens by two-fragment resection, 33 by three-fragment resection, 36 by four-fragment resection, 5 by five-fragment resection). In total, 167 specimens were obtained from the 97 lesions.

Morphology of the resected specimens (Table 1). The specimens obtained by en-bloc EMRC or by the first session of single fractionated EMRC were circular in 95 of the 97 lesions, with oblong specimens in two lesions. The second specimens of fractionated resection were half-moon or crescent-shaped, and the third or fourth specimens had ginkgo leaf-like or irregular shapes (Fig. 1).

Size of the resected specimens (Tables 2, 3, 4). The size of EMRC specimens depended on the size of the cap and the negative pressure applied for suctioning. Table 2 shows the average size of the first specimens resected from the 97 lesions. Application of the maximum negative pressure is expressed as full suction, and that of

Table 1. Morphology of specimens resected by EMRC

Shape of specimen	Number of specimens		
	First specimen <i>n</i> = 97	Second specimen <i>n</i> = 38	Third, fourth, or fifth specimen <i>n</i> = 21
Circular	95		
Oblong	2	1	
Half-moon or crescent-shaped		36	4
Ginkgo leaf-like			11
Irregular		1	6

EMRC, Endoscopic mucosal resection with cap-fitted panendoscope

Fig. 1. Morphology of the specimens obtained by endoscopic mucosal resection with cap-fitted panendoscope (EMRC); the first specimen was circular, the second was half-moon or crescent-shaped, and the third or fourth specimen had a ginkgo leaf-like or irregular shape

lighter negative pressure as moderate suction. Specimens obtained using a cap designed for the Olympus EVIS 2T200 under full suction were significantly larger than the other specimens.

When the 64 specimens obtained using the cap for the EVIS 2T200 under full suction were classified by location as in the upper third of the stomach, middle third, or lower third (UML), the size of specimens was generally similar regardless of their location, although there was slight variation within region U (Table 3).

Among the specimens obtained by fractionated resection, the second specimens showed marked differences between the major axis and minor axis, reflecting their half-moon or crescent shapes (Table 4).

Other characteristic features of resected specimens. Fissures were present in part of the mucosa in 32 (19%) of the 167 resected specimens, and all 167 exhibited congestion within the mucosal layer on histopathological examination.

Table 2. Size of cap, negative pressure applied for suctioning, and average size of EMRC specimen (mm)

Cap	Full suction	Moderate suction
T	21.1 (± 2.7) $\times$ 19.2 (± 2.8) <i>n</i> = 64	16.9 (± 2.2) $\times$ 15.3 (± 1.7) <i>n</i> = 23
Q	15.5 (± 2.1) $\times$ 14.2 (± 2.2) <i>n</i> = 10	

T, Cap designed for Olympus EVIS 2T200 (inner diameter, 13.5 mm; depth, 10 mm); Q, cap designed for Olympus EVIS Q200 (inner diameter, 11.5 mm; depth, 10 mm)

Table 3. Location and average size of EMRC specimens obtained using cap for Olympus EVIS 2T200 under full suction^a

Location	Size of specimen (mm)
U	21.9 (± 4.2) $\times$ 19.6 (± 4.3) <i>n</i> = 9
M	21.0 (± 2.2) $\times$ 19.4 (± 2.2) <i>n</i> = 24
L	21.0 (± 2.4) $\times$ 19.0 (± 2.6) <i>n</i> = 31

U, Upper third of the stomach; M, middle third of the stomach; L, lower third of the stomach

^aSee text for definition of “full suction”

Table 4. Average size of EMRC specimens obtained by fractionated resection

Specimen	Size of specimen (mm)
First	19.6 (± 2.8) $\times$ 17.6 (± 2.7) <i>n</i> = 38
Second	17.4 (± 3.3) $\times$ 11.6 (± 3.3) <i>n</i> = 17
Third	14.9 (± 3.3) $\times$ 11.5 (± 3.4) <i>n</i> = 11
Fourth	15.1 (± 6.0) $\times$ 10.7 (± 3.9) <i>n</i> = 9

Size of specimen, recovery of marks, frequency of successful reconstruction, and frequency of residue in fractionated resections

Elevated lesions (Table 5). Of the 21 elevated lesions subjected to fractionated resection, 1 lesion was resected without marking, another was resected after the placement of one mark, and 19 were resected after the placement of four to ten circumferential marks. The lesion resected without marking was able to be reconstructed because its elevation was distinct. The lesion resected with one mark was small and did not contain the mark; thus, reconstruction was not possible. All marks were recovered in 12 of the 19 lesions with circumferential marking, whereas some marks were not recovered in the remaining 7 lesions. In 1 of these 7 lesions, the lesion could not be reconstructed because the specimens were small and the number of marks insufficient. No residual cancer was found in any cases.

Flat or depressed lesions (Table 6). Of the 17 flat or depressed lesions subjected to fractionated resection, 1 lesion was resected without marking, and 16 lesions

Table 5. Size of specimen, recovery of marks, frequency of successful reconstruction, and frequency of residue in fractionated resection of elevated lesions

Size of lesion (mm)	No. of marks	No. of recovered marks in the specimen					Reconstruction	Residue
		1st	2nd	3rd	4th	5th		
12	6	2 (14)	3 (12)	1 (10)			○	—
14	4	3 (21)	1 (17)				○	—
20	10	4 (20)	4 (21)	1 (14)	1 (10)		○	—
17	8	3 (19)	2 (18)				○	—
25	0	0 (22)	0 (22)				○	—
18	6	3 (16)	2 (16)				○	—
13	7	1 (18)	0 (13)	1 (10)	0 (6)		×	—
8	1	0 (12)	1 (6)				×	—
16	5	2 (22)	2 (20)	1 (18)			○	—
25	5	1 (18)	1 (15)	2 (16)	1 (16)		○	—
15	4	1 (24)	2 (16)	1 (12)			○	—
15	8	4 (23)	2 (20)	2 (17)			○	—
16	9	3 (18)	2 (18)	1 (14)	1 (10)		○	—
16	9	3 (19)	2 (16)	1 (14)	2 (17)	1 (17)	○	—
13	6	3 (20)	3 (20)	0 (10)			○	—
24	10	5 (25)	3 (20)	1 (18)	1 (20)		○	—
14	10	6 (20)	2 (22)				○	—
18	9	3 (20)	3 (18)	2 (22)	1 (18)		○	—
23	13	6 (22)	5 (20)	1 (20)			○	—
10	5	2 (22)	1 (20)				○	—
17	4	3 (20)	1 (19)				○	—

Numbers in parentheses show the size of the specimen (in mm)

Circles, Successful reconstruction; Crosses, unsuccessful reconstruction; —, negative for residue

Table 6. Size of specimen, recovery of marks, frequency of successful reconstruction, and frequency of residue in fractionated resection of flat or depressed lesions

Size of lesion (mm)	No. of marks	No. of recovered marks in the specimen					Reconstruction	Residue
		1st	2nd	3rd	4th	5th		
25	7	0 (23)	0 (16)	0 (15)			×	—
10	0	0 (20)	0 (18)				○	—
7	9	3 (17)	3 (17)	2 (16)	1 (16)		○	—
11	4	3 (20)	1 (12)				○	—
14	6	2 (21)	2 (18)				○	—
12	4	3 (17)	1 (14)				○	—
30	6	1 (25)	0 (25)	0 (15)	0 (18)		×	+
13	10	5 (22)	4 (19)				○	—
12	9	4 (18)	3 (18)	1 (10)			○	—
5	7	2 (15)	3 (15)	1 (14)	1 (10)		○	+
9	4	2 (18)	2 (18)				○	+
13	9	2 (18)	2 (18)	4 (17)			○	—
13	10	4 (19)	4 (18)	2 (17)			○	—
9	8	6 (20)	2 (18)				○	—
13	10	7 (21)	3 (17)				○	—
10	9	5 (17)	3 (15)	1 (13)			○	—
10	9	4 (18)	5 (18)				○	—

Numbers in parentheses show the size of the specimen (in mm)

Circles, Successful reconstruction; Crosses, unsuccessful reconstruction; —, negative for residue; +, positive for residue

Fig. 2. Elevated gastric adenoma; the *white lines* are the cut lines, the *orange line* is the dissecting microscopic spread, and the *red lines* are the histopathological mapping of the lesion. Although stainability was poor, dissecting microscopy revealed a well maintained sulciolar pattern (SP), and, thus, the poorly stained elevated area was diagnosed as adenoma. Histopathologically, the adenoma had extended to the area of the burn effect in the surgical margin, and the surgical margin was positive for adenoma

Fig. 3. 0IIa-Type early gastric cancer; the *white lines* are the cut lines, the *orange line* is the dissecting microscopic spread, and the *red lines* are the histopathological mapping of the lesion. The 0IIb component surrounding the elevation had been overlooked

were resected after the placement of four to ten circumferential marks. The lesion without marking was resected in two fragments, and therefore was able to be reconstructed on the basis of the shapes of the specimens. Although all marks were recovered in 11 of the 16 lesions with circumferential marking, some marks were left unrecovered in 5 lesions, and reconstruction failed in 2 of these 5 because of the absence or insufficiency of marks. There was residue in 3 lesions, which resulted from incorrect diagnosis of the spread of the lesion prior to resection.

Dissecting microscopic observation and histopathological examination of elevated lesions

In the 67 elevated lesions, coincidence regarding the extent of spread, as determined by dissecting micros-

copy and histopathology was present in 62 (93%). The reason for the discrepancy in 5 lesions was an overlooking of the surrounding flat lesion in 3 lesions and misdiagnosis, owing to the burn effect in the surgical margin, in 2 lesions.

Elevated gastric adenomas. The 29 elevated gastric adenomas measured 5–20 mm. En-bloc resection was applied to 25 of these lesions, and fractionated resection to the remaining 4 lesions. Dissecting microscopic observation revealed variable stainability, but the pit pattern was regular in 20 of the 29 lesions. With regard to the spread of the lesion, the results of diagnosis by dissecting microscopy and histopathological examination were identical in 27 of the 29 lesions, with a difference of 2 mm between the diagnoses in the other 2 lesions (Fig. 2). These discrepancies were a result of the overlooking

of the modification of the burn effect in the surgical margin and the overlooking of the surrounding flat spread of the adenoma.

0I-Type early gastric cancers. The 3 0I-type early gastric cancers showed irregular stainability, villous unevenness, and clear demarcation from the surrounding normal mucosa on dissecting microscopic examination. There was no discrepancy in the diagnosis of the spread of the lesion between dissecting microscopic diagnosis and histopathological diagnosis.

0IIa-Type early gastric cancers. The 35 0IIa-type early gastric cancers measured 3–35 mm. Eighteen of them were resected en bloc, and the other 17 were subjected to fractionated resection. Dissecting microscopy revealed poor or irregular stainability in 33 of the 35 lesions, with the pit pattern being irregular or absent in 31 of the 35 lesions. The dissecting microscopic diagnosis and histopathological diagnosis of the spread of the lesion were identical in 32 of the 35 lesions, but there were differences of 2, 3, and 4 mm in three lesions, respectively. These discrepancies resulted from the overlooking of the spread of the surrounding 0IIb lesion in 2 lesions (Fig. 3) and overdiagnosis of the area modified by the burn in the surgical margin in 1 lesion.

Dissecting microscopic observations and histopathological examination of flat or depressed lesions

In 16 (53%) of the 30 flat or depressed lesions, there was a difference of 2 to 5 mm between the spread determined by dissecting microscopy and that determined by histopathology.

Depressed gastric adenoma (Table 7). The only depressed gastric adenoma, which measured 25 mm, was removed in three fragments by fractionated resection. Dissecting microscopy revealed irregular stainability and partially irregular SP in the depressed area, leading to a diagnosis of cancer. Histopathologically, however, it was diagnosed as adenoma. Adenoma present in the slightly elevated areas surrounding the concavity had been overlooked.

0IIb-Type early gastric cancers (Table 7). The three 0IIb-type early gastric cancers were 7–16 mm in diameter. One of them was resected en bloc, and the other two were resected by the fractionated technique. In all three lesions, the lesion could not be confirmed on the specimens immediately after resection, and the spread of the lesion was also difficult to diagnose by dissecting microscopy. In one lesion, dissecting microscopy failed to recognize the disease. In the remaining two lesions,

there were differences of 3 and 5 mm between the results of dissecting microscopic diagnosis and histopathological diagnosis (Fig. 4).

Depressed early gastric cancers (Table 7). The 26 0IIc-type early gastric cancers were 1–30 mm in diameter. Twelve of them were resected en bloc, and the other 14 were removed by fractionated resection. In 2 lesions, dissecting microscopy failed to recognize the disease. In 20 of the remaining 24 lesions, dissecting microscopy showed poor or irregular stainability. The pit pattern was irregular or no longer present in 23 of the 24 lesions. The results of diagnosis of the spread of the lesion by dissecting microscopy and histopathological examination were in agreement in 14 of the 26 lesions (Fig. 5), with differences found in the other 12 lesions. The discrepancies were explained by failure to recognize the lesion in 2 lesions, failure to diagnose the slight elevation surrounding the concavity as cancer in 2 lesions, overdiagnosis of the slight elevation surrounding the concavity as cancer in 3 lesions, overlooking the surrounding 0IIb spread in 2 lesions, and overlooking the cancer, owing to modification by the burn effect in the surgical margin, in 3 lesions.

Discussion

Our department (i.e., First Department of Surgery, Tokyo Medical and Dental University) defines the absolute indications for the endoscopic treatment of early gastric cancer based on clinicopathological analyses of early gastric cancers resected surgically [9], which are as follows: (1) lesions diagnosed as mucosal cancer preoperatively, (2) well differentiated cancer, (3) 0IIa type of 20 mm or less, or nonulcerative 0IIb or 0IIc type of 10 mm or less.

After EMR for early gastric cancer, a major concern is cancer residue, caused by incomplete resection. Therefore, to accomplish curative treatment by EMR, it is necessary to resect the lesion with sufficient surgical margins in both the lateral and vertical directions. In the present study, an appropriate method of resection to prevent cancer residue in the lateral direction was considered in relation to macroscopic type, by comparing the characteristic features of EMRC specimens, dissecting microscopic findings, and histopathological findings.

Morphological features of specimens obtained by EMRC depend on the size of the cap used and the negative pressure applied. Specimens obtained with a large cap under full suction almost always had a round shape, and measured 21×19 mm, regardless of the gastric portion where the lesion was located. This technique is disadvantageous in that: (1) the mucosa may occasionally be torn when it is drawn into the cap under

Fig. 4. 0IIb-Type early gastric cancer; the *white lines* are the cut lines, the *orange line* is the dissecting microscopic spread, and the *red lines* are the histopathological mapping of the lesion. Dissecting microscopy showed a well maintained foveolar-sulciolar pattern (FSP), and the area with slightly disordered FSP and the surrounding areas of poor stainability were diagnosed as cancer. However, histopathological examination showed malignancy in areas about 5mm greater than the extent diagnosed by dissecting microscopy, and severe congestion in the mucosal layer. The surgical margin was negative for cancer

Fig. 5. 0IIc-Type early gastric cancer; the *white lines* are the cut lines, the *orange line* is the dissecting microscopic spread, and the *red lines* are the histopathological mapping of the lesion. Absence of malignancy in the surrounding normal mucosa was ensured by targeting biopsy. After marking was done with reference to the biopsy sites, the lesion was re-

moved by two-fragment planned fractionated resection. Dissecting microscopy showed irregular and partially lost SP with poor stainability in the area consistent with the concavity, and the area was diagnosed as cancer. The extent diagnosed by dissecting microscopy was consistent with the findings of histopathological diagnosis

negative pressure, and (2) congestion occurs in the mucosal layer of the specimen. Although these disadvantages cause few problems with elevated lesions, they may make it difficult to diagnose the spread of flat or depressed lesions.

Considering the theoretical extent of EMRC resection in terms of fractionation, ideal overlapping of two circles with diameters of 20mm allows resection of an ellipse that has a major axis of 30mm and a minor axis of 17mm, and ideal overlapping of three circles with diameters of 20mm allows the resection of a circle with a diameter of 23mm (Fig. 6). A single fractionated resection of an extensive area according to this schema is called planned fractionated resection (Fig. 7) [10].

Planned fractionated resection involves fractionation of a marked area containing the lesion, rather than frac-

tionation of the lesion itself. Therefore, marking is a key issue in planned fractionated resection. In our analysis of specimens obtained by fractionated resection in the present study, reconstruction of the specimen was not possible when a small specimen contained no marks or only a single mark. In addition, only one of six marks was recovered in one of three lesions with cancer residue after fractionated resection. For reconstruction of the lesion and prevention of residue, it is important to place an adequate number of marks around the lesion and to recover all the marks by resection.

The use of clips has been reported [11,12] as a better method of reconstruction in fractionated resection. In fractionated resection by the EMRC procedure, the first specimen is circular, and the second specimen has a half-moon or crescent shape, with the concavity facing

Table 7. Dissecting microscopic observations and histopathological examinations of depressed gastric adenoma and 0IIb and 0IIc-type early gastric cancers

Lesion	Age (years)-sex	Location	Macroscopic	Size (mm)	Dissecting microscopic findings				Diagnosis		
					Depression	Stainability	Pit pattern	Dissecting microscopic	Histopathological	Discrepancy in the spread of the lesion ^a	
Adenoma	84, M	L, AW	Adenoma	25	Slight	Irregular	Partially Irregular SP	0IIc, margin (-)	Adenoma, margin (-)	+	(4 mm)
0IIb	68, F	L, AW	0IIb	10	Flat	Poor	Irregular, and absent SP	0IIb, margin (-)	tubl, margin (-)	+	(3 mm)
	58, M	U, PW	0IIb	16	Flat	Poor	Partially irregular FSP	0IIb, margin (-)	tubl, margin (-)	+	(5 mm)
	68, M	M, GC	0IIb	7			Undetectable	Unknown	por, margin (-)	+	(Unknown)
0IIc	76, M	L, PW	0IIc	11	Slight	Good	Irregular, and absent SP	0IIc, margin (-)	tubl, margin (-)	+	(4 mm)
	67, M	L, AW	0IIc	10	Marked	Poor	Irregular and absent SP	0IIc, margin (-)	tubl, margin (-)	-	
	71, M	U, PW	0IIc	10	Marked	Irregular	Irregular FSP	0IIc, margin (-)	tubl, margin (-)	-	
	72, M	U, PW	0IIc	1			Undetectable	Unknown	tubl, margin (-)	+	(Unknown)
	71, M	L, AW	0IIc	8	Slight	Irregular	Absent, SP	0IIc, margin (-)	tubl, margin (-)	+	(2 mm)
	56, M	L, PW	0IIc	12	Marked	Good	Irregular FP	0IIc, margin (-)	tubl, margin (-)	-	
	80, M	U, LC	0IIc	30	Marked	Irregular	Irregular and absent FP	0IIc, margin (+)	tubl, margin (+)	+	(4 mm)
	71, M	L, GC	0IIc	10	Slight	Poor	Partially irregular FSP	0IIc, margin (-)	tubl, margin (-)	+	(3 mm)
	69, M	L, AW	0IIc	9	Slight	Irregular	Irregular and partially absent FSP	0IIc, margin (-)	tubl, margin (-)	-	
	71, F	L, PW	0IIc	13	Slight	Irregular	Absent FSP	0IIc, margin (-)	tubl, margin (-)	-	
	67, M	M, LC	0IIc	1	Slight	Poor	Irregular and partially absent SP	0IIc, margin (-)	tubl, margin (-)	+	(5 mm)
	64, M	L, PW	0IIc	9	Slight	Poor	Partially irregular SP	0IIc, margin (-)	tubl, margin (-)	+	(3 mm)
	59, M	L, LC	0IIc	12	Marked	Irregular	Irregular and partially absent FP	0IIc, margin (-)	tubl, margin (-)	+	(2 mm)
	65, M	L, GC	0IIc	5	Marked	Poor	Undetectable	Unknown	tubl, margin (-)	+	(Unknown)
	81, F	M, LC	0IIc	9			Irregular and absent SP	0IIc, margin (-)	tubl, margin (-)	-	
	72, M	L, PW	0IIc	9	Slight	Good	Regular SP	Adenoma, margin (-)	tubl, margin (+)	+	(5 mm)
	47, M	M, AW	0IIc	13	Marked	Poor	Irregular and partially absent FP	0IIc, margin (-)	tubl, margin (-)	-	
	70, M	L, PW	0IIc	10	Slight	Good	Partially irregular, SP	0IIc, margin (-)	tubl, margin (-)	-	
	69, M	L, AW	0IIc	13	Marked	Poor	Irregular and absent SP	0IIc, margin (-)	tubl, margin (-)	-	
	66, M	L, PW	0IIc	9	Marked	Poor	Irregular SP	0IIc, margin (-)	tubl, margin (-)	-	
	63, M	L, PW	0IIc	13	Marked	Poor	Irregular and partially absent SP	0IIc, margin (-)	tubl, margin (-)	-	
	68, F	M, GC	0IIc	5	Marked	Poor	Irregular and absent FP	0IIc, margin (-)	tubl, margin (-)	-	
	78, M	M, LC	0IIc	10	Slight	Poor	Irregular and absent FP	0IIc, margin (-)	tubl, margin (-)	+	(5 mm)
	72, M	M, GC	0IIc	10	Marked	Poor	Absent FSP	0IIc, margin (-)	tubl, margin (-)	-	
	60, M	M, PW	0IIc	8	Slight	Poor	Partially irregular and absent FSP	0IIc, margin (-)	tubl, margin (-)	+	(3 mm)
	78, M	L, GC	0IIc	10	Marked	Poor	Irregular and partially absent SP	0IIc, margin (-)	tubl, margin (-)	-	

L, Lower third of the stomach; AW, anterior wall; U, upper third of the stomach; PW, posterior wall; M, middle third of the stomach; GC, greater curvature; LC, lesser curvature; SP, sulciolar pattern; FP, foveolar pattern; FSP, foveolar/subcircular pattern; tubl, well differentiated adenocarcinoma; por, poorly differentiated adenocarcinoma

^a Numbers in parentheses (mm) show degree of discrepancy

Fig. 6. Theoretical extent of EMRC resection in terms of fractionation

Fig. 7. Schema of planned fractionated resection by EMRC procedure. *Gray ellipses*, Lesions; *dots*, marking

the ulcer area made by the first resection, and with the arc made on the opposite side by the resecting line. By collating the marks on the two specimens with those on the lesion in a photograph taken prior to resection, the positional relation of the two specimens becomes apparent, enabling reconstruction. The third specimen has a ginkgo leaf-like shape. By determining the direction against the first and second specimens and by collating the marks, the positional relation of the third specimen becomes apparent.

Sugano et al. [13] reported that, in the diagnosis of the extent of infiltration of flat or depressed early gastric cancer by electronic endoscopy, 78% of misdiagnosed lesions had obscure borders of the concavity and 56% contained the IIb component. With EMR specimens from flat lesions or ill demarcated depressed lesions, it is often difficult to diagnose the presence and spread of the lesion macroscopically, because the procedure does not allow on-site determination of whether malignancy is present in the surgical margin. Dissecting microscopic findings occupy a position between macroscopic findings and histopathological findings, enabling us to make a more accurate diagnosis of the malignancy and spread of lesions.

Yoshii [14–16] reported the following characteristic features of dissecting microscopic findings of the mucosa in gastric cancer: disordered, obscured, or absent FP or SP; irregular or poor stainability of the mucosa with hematoxylin; and the appearance of villous unevenness. Yoshii [14–16] also stated that the borders between the noncancerous and cancerous mucosae were generally clear in 0IIa-type lesions, variable on 0IIc-type lesions (because some lesions were surrounded by the 0IIa-type component and some were surrounded by the 0IIb-type component), and extremely difficult to determine in 0IIb-type lesions. In the present study, in the lesions showing a difference between the spread of the lesion as diagnosed by dissecting microscopy and histopathological examination, the misdiagnosed surrounding components were 0IIb- or 0IIc-types.

Nakamura [17], reporting from the pathological standpoint, reported that, in lesions characterized by artificial destruction of tissue or located near the cut end of the resected specimen, it was difficult to determine the spread of the lesion.

In the present study, five lesions were associated with a discrepancy between the dissecting microscopic and histopathological diagnoses of the extent of the lesion, because of the burn effect in the surgical margin. Adenoma was overlooked in one elevated lesion removed by en-bloc resection; overdiagnosis occurred in one elevated lesion resected by planned fractionated resection; and the presence of cancer was overlooked in three depressed lesions resected by planned fractionated resection. Planned fractionated resection seems to be more likely to cause the burn effect, resulting in diagnostic discrepancy, because the resection line often runs in the vicinity or border of the lesion.

In the elevated lesions, 93% showed coincidence regarding the extent of spread as determined by dissecting microscopy and histopathology, and it seems apparent that sufficient surgical margins were secured by marking the intact mucosa adjacent to the endoscopic border of the lesion and resecting the mucosa to contain all marks. In contrast, in 53% of the flat or depressed lesions, there was a difference of 2 to 5 mm between the spread determined by the two diagnostic procedures. Therefore, surgical margins are not sufficient unless the circumferential marking is at least 5 mm outside the endoscopic border of the lesion, and an extensive area of mucosa containing the marks is resected.

Thus, in relation to macroscopic type, an appropriate method for endoscopic mucosal resection of early gastric cancer using the EMRC procedure can be summarized as follows.

Elevated lesions measuring 10 mm or less should be subjected to en-bloc resection after marking is done to indicate the presence of the lesion. Suctioning power at the time of resection should be moderate for lesions of

Fig. 8a–d. Planned fractionated resection for flat or depressed lesion after targeting biopsy. **a** Flat or depressed lesions with unclear demarcation. **b** Targeting biopsy of the surrounding, apparently normal mucosa is performed at four or more sites, each about 5 mm distant from the border of the lesion, prior to EMR. **c** Eight or more marks, with reference to the biopsy sites, are placed circumferentially around the lesion. **d** Extensive area of the mucosa containing the marks is resected. Gray elliptical areas, Lesions; crosses, biopsy sites; dots, marks

about 5 mm and full for those of about 10 mm. Elevated lesions measuring about 15 mm or more should be resected in two fragments by planned fractionated resection when they are elliptical and in three fragments by planned fractionated resection when they are circular or nearly circular.

Flat or depressed lesions should be subjected to targeting biopsy of the surrounding, apparently normal mucosa at four or more sites 5 mm distant from the border of the lesion prior to EMR, and the biopsied sites of normal mucosa should be recorded. For resection, marks with reference to the biopsy sites should be placed circumferentially around the lesion, keeping a distance of at least 5 mm from the border of the lesion, and an extensive area of the mucosa containing the marks should be resected (Fig. 8).

When an elevated lesion measures approximately 15 mm or more, and a flat or depressed lesion is not clearly demarcated, aggressive use of planned fractionated resection seems to be the best way to provide an adequate surgical margin and, thus, to prevent lateral residue.

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