Original article

Initial radiographic findings of early gastric cancer detected in health check programs and human “dry dock” collective health checks and treated by endoscopic mucosal resection

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Abstract

Background. The purpose of this study was to evaluate the capacity of detection (detectability), by radiographic examination, of minute gastric cancer that was indicated for endoscopic mucosal resection (EMR).

Methods. Fifty-five lesions in 55 patients with minute gastric cancer were endoscopically resected between 1992 and 2000 at the Foundation for Detection of Early Gastric Carcinoma. Of these 55 patients, 33 patients underwent indirect (with image intensifier and 100-mm roll film) and/or direct radiographic examination of the upper gastrointestinal tract as the initial screening examination, and subsequent upper gastrointestinal endoscopy. The remaining 22 patients underwent upper gastrointestinal endoscopy as the initial screening examination. As the first step, radiographic (indirect and direct) images were reviewed, and the abnormalities which had eventually led to the detection of the minute early gastric cancer (EGC) were reconfirmed. Then, they were analyzed in terms of the reproducibility of abnormal findings which enabled the detection of such a minute EGC, and in terms of whether they could be treated by EMR. The size, morphology, and location of the radiographically detected lesions were analyzed.

Results. Seventeen lesions of EGC were detected in the group in which indirect radiography was initially performed. Of these 17 lesions, some abnormality corresponding to the site of the lesion was pointed out in 7 lesions (2 lesions of type IIa and 5 lesions of type IIc). On the other hand, the remaining 10 lesions (type IIa, 3; type IIc, 5; type IIa + IIc, 1; and type IIb, 1) were detected by endoscopy, which was carried out to confirm the other abnormalities in the indirect radiographic images. Sixteen lesions of EGC were detected in the group in which direct radiography was initially performed. Of these 16 lesions, some abnormality corresponding to the site of the lesion was pointed out in 8 lesions (4 lesions of type IIa and 4 lesions of type IIc). The remaining 8 lesions (3 lesions of type IIa and 5 lesions of type IIc) were not detected by direct radiography.

Conclusion. Indirect and direct radiographic examination enabled the detection of approximately 50% of EGCs which could be treated by endoscopic resection. The significance of radiographic examination should not be underestimated, even in the detection of EGCs which can be endoscopically resected.

Key words Indirect and direct radiography · Endoscopic mucosal resection · Gastric carcinoma

Introduction

In Japan, gastric cancer is still the leading cause of death [1], although the mortality rate has recently been decreasing [2]. Early gastric cancer (EGC) has recently accounted for nearly a half or more of all resected cancers in representative Japanese institutions that specialize in gastroenterology [3]. The high detection rate of EGC in Japan, however, cannot be explained by the mass screening program of the asymptomatic population, which was started as public health policy by the government in 1983, as has been emphasized in Western countries [4,5] but can be attributed to the various types of screening systems for gastric cancer which had been implemented before the government-based mass screening was initiated. These include a total health check program for nongovernmental employees and their families, and human “dry dock” collective health checks [6].

As a matter of fact, according to the fourth and fifth National Cancer Surveys in Japan, only 10.6% of EGCs were detected by the mass screening program in 1985, and the remaining 89.4% were detected by other means [2]. Sasaki [7] also reported that, in Niigata Prefecture, the age-adjusted rate of EGC which was detected by the mass screening program in 1990 accounted for 28.4% of all operated cases of EGC.

Endoscopic mucosal resection (EMR) is the least invasive procedure for the radical treatment of EGC, and there have been many reports concerned with its methodology and end results. However, only one report [8] dealt with how such a minute lesion that can be resectable endoscopically was detected.

In our institution, screening of the stomach in health check programs and human “dry dock” collective health checks for asymptomatic people is basically implemented by indirect and/or direct radiographic examination. In the period of 9 years from April 1992 to April 2000, a total of 55 EGCs in 55 persons had been detected and endoscopically resected in recipients of the total health check program and human “dry dock” collective health checks whose stomachs were initially screened by indirect and direct radiographic examination.

The purpose of this article is, first, to clarify how these EGCs were detected by the radiographic examination, and, second to discuss the limit of the radiographic examination in the detection of minute EGCs which were indicated for EMR.

Patients

A total of 88 833 indirect radiographic examinations and 43 114 direct radiographic examinations had been performed from April 1992 to April 2000 at the Foundation for Detection of Early Gastric Carcinoma. These radiographic examinations had been provided for asymptomatic persons as the initial screening examination in health check programs and human “dry dock” collective health checks. As a result, 324 EGCs were detected. Of these, 236 lesions were microscopically limited to the mucosal membrane, and 55 lesions in 55 patients were treated by EMR.

Of the 55 lesions which were endoscopically resected, the initial radiographic examination was done in 33 lesions in 33 patients at our institution; 17 lesions examined by indirect radiographic examination (group A) and 16 lesions examined by direct radiographic examination (group B), which were subsequently studied by endoscopy (Table 1). The remaining 22 patients had already been suspected of having small EGC or peptic ulcer of the stomach by the initial radiographic exami-

nations at other institutions, and were referred to our institution for detailed study by endoscopy, which confirmed the diagnosis of a small EGC (group C). This group C was excluded from the present study.

Age of patients with EGC treated by EMR

The ages of the patients in group A ranged from 48 to 69 years (mean, 58.5 years). The ages of the patients in group B ranged from 45 to 68 years (mean, 56.25 years). Of the 33 patients in groups A and B, there were 32 men and 1 woman.

Location of EGC treated by EMR (Table 2, Fig. 1)

Eleven lesions in group A were located in the gastric antrum, 1 in the incisura angularis (angulus), and 5 in the gastric body (body). Ten lesions in group B were located in the gastric antrum, 4 in the incisura angularis, and 2 in the gastric body.

Methods

As the first step, radiographic (indirect and direct) images were retrospectively reviewed, and the abnormalities which had eventually led to the detection of the minute EGC were reconfirmed. Then, the images were analyzed in terms of the reproducibility of the abnormal findings which enabled the detection of such a minute EGC, and in terms of whether they could be treated by EMR.

Results

Gross and histological findings of all lesions (55 lesions)

Of the 55 lesions of EGC which were resected endoscopically, 54 were well-differentiated adenocarcinoma limited to the mucosal membrane, and only 1 was poorly differentiated adenocarcinoma (signet ring cell carcinoma).

Macroscopically, of the 54 lesions which were diagnosed as well-differentiated adenocarcinoma, 20 lesions were classified as type IIa, 31 lesions as type IIc, 2 lesions as type IIa + IIc, and 1 lesion as type IIb. The size of the type IIa lesions ranged from 5 mm to 25 mm, the mean being 11.3 mm, and that of type IIc ranged from 2 to 20 mm, the mean being 8.22 mm.

Review of radiographic findings

Lesions initially examined by indirect radiography (group A; 17 lesions). Seventeen lesions of EGC were detected in the group in which indirect radiography was

Table 1. Radiographic detection of endoscopically resected lesions (Foundation for Detection of Early Gastric Carcinoma [1990–1999])

	Detected	Undetected	Total
Indirect radiography	7 (41.2%)	10 (58.8%)	17
Direct radiography	8 (50.0%)	8 (50.0%)	16
Total	15 (45.5%)	18 (54.5%)	33

Table 2. Clinicopathological data of detected and undetected cases by primary indirect or direct radiography

	Indirect radiography (group A; detected)	Indirect radiography (group A; undetected)	Direct radiography (group B; detected)	Direct radiography (group B; undetected)	Detected by endoscopy (group C)
Total number of cases	7	10	8	8	22
Tumor size (mm)	5–15	2–15	3–13	3–25	4–20
Mean size (mm)	9.1	8.1	8.4	10.8	10.6
Location 1					
Body	2	3	1	1	7
Angulus	1	0	2	2	3
Antrum	4	7	5	5	11
Cardia	0	0	0	0	1
Location 2					
Posterior wall	3	1	2	0	7
Anterior wall	1	2	3	2	4
Lesser curvature	2	6	2	2	8
Greater curvature	1	1	1	4	3
Macroscopic type					
IIa	2	3	4	3	8
IIc	5	5	4	5	12
IIa + IIc	0	1	0	0	1
IIb	0	1	0	0	0
I	0	0	0	0	1
Histology					
tub1	5	9	5	8	16
tub2	1	1	3	0	5
sig	1	0	0	0	0
pag	0	0	0	0	1

tub, Tubular adenocarcinoma; sig, signet-ring cell carcinoma; pag, papillary adenocarcinoma

Fig. 1. Schematic representation of the location of lesions (groups A and B) resected by endoscopic mucosal resection (EMR)

Table 3. Initial radiographic findings

Radiographic findings	Indirect radiography		Direct radiography	
	Detected	Undetected	Detected	Undetected
Granular translucency ($n = 6$)	2	No abnormality visualized by retrospective review of radiographic images.	4	No abnormality visualized by retrospective review of radiographic images.
Small barium fleck ($n = 5$)	3		2	
Mucosal convergence ($n = 2$)	1		1	
Mucosal irregularity ($n = 1$)	0		1	
Poor distensibility ($n = 1$)	1		0	

initially performed. Of these 17 lesions, some abnormality corresponding to the site of the lesion was pointed out in 7 lesions (41.2%; 7/17) (Table 1); 2 of which were type IIa and 5, of which were type IIc (Table 2). The size of the 7 lesions ranged from 5 mm to 15 mm, the mean being 9.1 mm, and the location was the antrum in 4 lesions, and the posterior wall in 3 lesions (Table 2, Fig. 1). There was a tendency that the lesions in the posterior wall of the stomach could be detected easily, whereas those in the greater curvature were detected with difficulty.

The radiographic abnormality was visualized as a faint barium fleck in three lesions of type IIc (Fig. 2), and as a granular translucency in the two lesions of type IIa. In addition, 1 lesion of type IIc revealed a small mucosal convergence, and the remaining 1 lesion of type IIc, which was located at the lesser curvature of the antrum, was initially pointed out as localized poor distensibility by indirect radiography (Table 3), and its precise radiographic image was subsequently obtained as a barium fleck with surrounding translucency in the posterior wall of the prepyloric region by direct radiography, using a compression method (Fig. 3a,b).

On the other hand, the remaining 10 (58.8%; 10/17) lesions (type IIa, 3; type IIc, 5; type IIa + IIc, 1; and type IIb, 1) were detected by endoscopy which was carried out to confirm the other abnormalities in the indirect radiographic images (Table 1). In other words, these lesions were detected by endoscopy in a location that was different from that indicated by the radiographic images. The size of these 10 lesions ranged from 2 mm to 15 mm, the mean being 8.1 mm (Table 2). The location was the antrum in 7 lesions and the body in 3 lesions (Table 2, Fig. 1). In these lesions no abnormality was visualized at the location of the lesion, even by meticulous review of the indirect radiographic images.

Lesions initially examined by direct radiography (group B; 16 lesions). Sixteen lesions of EGC were detected in the group in which direct radiography was initially performed. Of these 16 lesions, some abnormality corresponding to the site of the lesion was pointed out in 8

Fig. 2. Case 1 (type IIc lesion, measuring 10 mm). Initial indirect film by double-contrast radiography showed a small collection of barium in the posterior wall of the incisura region, which could be diagnosed as a type IIc lesion because of its irregular shape, with surrounding translucency

lesions (50.0%; 8/16) (Table 1); 4 of which were type IIa and 4 of which were type IIc. The size of the 8 lesions ranged from 3 mm to 13 mm, the mean being 8.4 mm (Table 2). The location was the antrum in 5 lesions, the angulus in 2 lesions and the body in 1 lesion (Table 2, Fig. 1). There was no marked difference in the location of the lesions detected by direct radiography and those detected by indirect radiography.

The radiographic abnormality was visualized as a small granular translucency in the 4 lesions of type IIa, and as a faint barium fleck in 2 lesions of type IIc. In addition, 1 lesion of type IIc was found by mucosal convergence, as it was associated with a small ulcer scar. The remaining 1 lesion of type IIc was found by faint mucosal irregularity in the lesser curvature of the antrum (Table 3).

Fig. 3.a Case 2 (type IIc lesion, measuring 5 mm). Initial indirect film by double-contrast radiography revealed localized poor distensibility of the gastric antrum (arrows). **b** Detailed compression radiograph delineated a tiny barium fleck with prominent surrounding translucency in the prepyloric region in the vicinity of the pyloric ring. But even this film was not sufficient to make a diagnosis of a type IIc lesion (arrow)

The remaining 8 lesions (50.0%; 8/16), 3 of which were type IIa and 5 of which were type IIc, were not detected by direct radiography (Table 1). The size of the 8 lesions ranged from 3 mm to 25 mm, the mean being 10.8 mm (Table 2). The location was the antrum in 5 lesions, the angulus in 2 lesions, and the body in 1 lesion (Table 2, Fig. 1). Two lesions of type IIa measuring more than 10 mm were undetected. One of these two type IIa lesions, measuring 25 mm and located in the greater curvature of the lower gastric body, escaped detection owing to the superimposing shadow of the duodenum, and the other of these type IIa lesions, measuring 16 mm and located in the posterior wall of the incisura region, was obscured by marked intestinal metaplasia and the superimposing shadow of the duodenum (Fig. 4a,b). No abnormality was recognized in the location of the 8 lesions, even by meticulous review of the direct radiographic images.

Lesions initially examined and detected by endoscopy (group C; 22 lesions). Twenty-two lesions of EGC were primarily detected by endoscopy. Their sizes ranged from 4 mm to 20 mm, the mean being 10.6 mm. The location was the antrum in 11 lesions, the angulus in 3 lesions, and the body in 7 lesions (Table 2, Fig. 1). Subsequent direct radiography delineated all lesions.

Discussion

It has been a recent international trend for endoscopy to be employed as the first choice of examination of the

gastrointestinal tract for symptomatic patients. According to the report of a multi-institutional registry of gastric cancer in Japan [9], 43.5% of the initial examinations of the stomach were carried out by endoscopy in 1990, whereas 54.8% were performed by radiology in the same period. At the present time, it is estimated that the number of upper gastrointestinal endoscopies has surpassed that of radiology examinations in representative institutions in Japan.

However, there has been very little evidence that supports the superiority of endoscopy over radiology in the detection and diagnosis of gastric cancer. In 1989, Shirakabe and Maruyama [10] reported that the sensitivity of the initial radiographic examination was 97.1%, specificity 32.3%, and accuracy 33.8%; whereas the sensitivity of endoscopy was 99.8%, specificity 39.7%, and accuracy 46.2%. They emphasized that only a minor difference was found in the sensitivity and specificity between radiology and endoscopy in the diagnosis of gastric cancer, including early and advanced cancers. In 2001, Hosokawa et al. [11] reported that the initial endoscopy missed 0.9% (32 patients) of gastric cancers for 1 year (1993).

The results of these authors could be evidence that endoscopy is not necessarily superior to radiology in the detection of gastric cancer. In other words, the efficacy of endoscopy is nearly equivalent to that of radiology in the detection of gastric cancer. Moreover, it is obvious that radiology is much safer and less expensive than endoscopy.

For the reasons mentioned above, indirect and direct radiographic examination has still been employed, in-

Fig. 4. **a** Case 3 (type IIa lesion, measuring 16mm). In this patient, a type IIc lesion was suspected in the posterior wall of the upper gastric body by the initial direct film by double-contrast radiography. Subsequent endoscopy, which was performed 8 months later, did not confirm the lesion in the location where the type IIc lesion was suspected, and disclosed a type IIa lesion in the posterior wall of the incisura region near the greater curvature (*arrows*). Only intestinal metaplasia of the gastric antrum was noted in this double-contrast radiograph. **b** Detailed double-contrast radiograph, taken after the lesion was detected by endoscopy, revealed a characteristic finding of a type IIa lesion in the posterior wall of the incisura region near the greater curvature (*arrows*)

cluding government-based mass screening, in health checks for nongovernmental employees and their families, and in human “dry dock” collective health checks. It is important to note that these various types of screening programs aim at the early detection of gastric cancer, especially that of early gastric cancer (EGC), and the screening program in Japan was reported to be effective in reducing the mortality associated with gastric cancer [12]. It was reported that EGC accounted for 67.0% (3447/5154) of all gastric cancers which were detected by the government-based mass screening with indirect radiographic examination in 1998 [13].

Based on the above-mentioned data in our institution, we tried to clarify whether radiographic examination is able to detect EGC which can be resected endoscopically. It was found that the indirect radiographic examination detected 41.2% (7/17) of EGCs which could be resected endoscopically, and the direct radiographic examination detected 50% (8/16) of EGCs which could be resected endoscopically.

It is generally accepted that EMR is indicated for a polypoid early gastric cancer with differentiated type which measures 20 mm or less, and for a depressed early cancer with differentiated type which measures 10 mm or less, without peptic ulceration. In 1990 Hamada et al. [14] stated that the limit of initial radiographic detection was 6 mm for early polypoid cancer and 5 mm for early depressed cancer. They also stated that the detection rate was 52% for early polypoid cancer, 50% for early depressed cancer less than 5 mm, and 56.9% for early depressed cancer ranging from 6 to 10 mm. In this respect, our result is nearly comparable to that of Hamada et al. Most depressed cancers smaller than 10 mm are not accompanied by ulceration [15]. Consequently, it is extremely difficult to radiographically detect such a lesion that is indicated for endoscopic mucosal resection (EMR).

Actually, however, the radiographic examination could only delineate some abnormality in the majority of the lesions, which prompted the subsequent endoscopy. The radiographic examination is considered to be a tool for the screening for cancer, but one which is not required to make the diagnosis of malignancy, and it may be sufficient if it is able to point out an abnormality which should be scrutinized by a subsequent detailed study, such as endoscopy with biopsy.

As to the detectability of the lesions in relation to their location, those in the posterior wall could be detected much more easily than those in the other locations. It seems that the most difficult site for detection is the greater curvature. This difficulty may be attributed to the prone double-contrast radiography which has recently been employed in both indirect and direct radiographic examinations and this method could explain

why the anterior wall lesions could be detected in four out of eight lesions (Fig. 1).

Review of the radiographic images enabled the visualization of nearly correct gross morphology in six of the seven lesions detected by indirect radiography and in seven of the eight lesions detected by direct radiography, although the diagnosis of EGC was established with difficulty. However, all lesions were delineated by the detailed radiographic examination which had been performed before the EMR.

As mentioned above, the diagnosis of EGC could not be established in all cases by the indirect and direct radiographic examination. If a lesion is situated in an area where double-contrast radiography provides a good view of the mucosal details, malignancy can be diagnosed by adhering to the general principles of radiographic diagnosis [16]. When a lesion is smaller than 5 mm in its largest diameter, the radiographic diagnosis of malignancy is not always possible, because the lesion is too small to be eligible for the criteria of malignancy. Sometimes an irregular surrounding translucency, which is unusual in the context of a benign erosion, strongly suggests malignancy [16].

In our institution, EGCs, detected by health checks for nongovernmental employees, accounted for 89.0% (161/180) of all gastric cancers in the period of 11 years between 1989 and 1999, and the EGCs detected by human "dry dock" collective health checks comprised 82.6% (38/46) of all gastric cancers in the same period. On the other hand, EGCs detected in the outpatient clinic for symptomatic patients accounted for 78.1% (454/581). These actual data may explain the reason why radiographic examination of the stomach has still been playing an important role for the detection of gastric cancer.

It often happens in mass screening that gastric cancer, especially the early one, is incidentally encountered in a location other than that pointed out by the radiographic examination [17]. There were ten such lesions in our group in which the indirect radiographic examination was provided, and eight such lesions in our group in which the direct radiographic examination was provided. In the patients, no abnormality was recognized in the location of the 18 lesions, even by meticulous review of the indirect and direct radiographic images.

In our series there were three lesions in which biopsy revealed well differentiated adenocarcinoma, but finally resulted in the absence of malignancy in the materials retrieved by EMR. They had been diagnosed as depressed early cancer (type IIc) before EMR. The histological examination finally confirmed depressed type adenoma in two lesions and normal gastric mucosa in one lesion. The case of the adenoma is considered to be an example which indicates the limit of biopsy-based histological diagnosis of gastric cancer, although Kim

et al. [18] recently emphasized that depressed type adenomas of the stomach have greater potential for malignancy. In this respect, it also deserves attention that Hamada et al. [19] stressed the importance of performing EMR for flat and elevated lesions whose biopsy diagnoses are adenoma and/or suspected malignancy. The normal gastric mucosa in the endoscopically resected material suggests that the focus of the cancer was so small that it was eliminated by one biopsy procedure [20].

In conclusion, indirect radiographic examination detected 41.2% of EGCs which were treated with EMR, and direct radiographic examination detected 50.0% of EGCs which were treated with EMR. It is anticipated that those lesions which escape the first detection by radiographic examinations may have another chance to be discovered by annual health check programs and/or human "dry dock" collective health checks. The significant role of the radiographic examination should not be underestimated, even in the detection of EGC which is resectable endoscopically.

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