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Retrospective Study

Differential analysis of lymph node metastasis in histological mixed-type early gastric carcinoma in the mucosa and submucosa

Qian Zhong, Qi Sun, Gui-Fang Xu, Xiu-Qin Fan, Yuan-Yuan Xu, Fei Liu, Shi-Yi Song, Chun-Yan Peng, Lei Wang

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Abstract**AIM**

To investigate the relationship between histological mixed-type of early gastric cancer (EGC) in the mucosa and submucosa and lymph node metastasis (LNM).

METHODS

This study included 298 patients who underwent gastrectomy for EGC between 2005 and 2012. Enrolled lesions were divided into groups of pure differentiated (pure D), pure undifferentiated (pure U), and mixed-

type according to the proportion of the differentiated and undifferentiated components observed under a microscope. We reviewed the clinicopathological features, including age, sex, location, size, gross type, lymphovascular invasion, ulceration, and LNM, among the three groups. Furthermore, we evaluated the predictors of LNM in the mucosa-confined EGC.

RESULTS

Of the 298 patients, 165 (55.4%) had mucosa-confined EGC and 133 (44.6%) had submucosa-invasive EGC. Only 13 (7.9%) cases of mucosa-confined EGC and 30 (22.6%) cases of submucosa-invasive EGC were observed to have LNM. The submucosal invasion (OR = 4.58, 95%CI: 1.23-16.97, $P = 0.023$), pure U type (OR = 4.97, 95%CI: 1.21-20.39, $P = 0.026$), and mixed-type (OR = 5.84, 95%CI: 1.05-32.61, $P = 0.044$) were independent risk factors for LNM in EGC. The rate of LNM in mucosa-confined EGC was higher in the mixed-type group ($P = 0.012$) and pure U group ($P = 0.010$) than in the pure D group, but no significant difference was found between the mixed-type group and pure U group ($P = 0.739$). Similarly, the rate of LNM in the submucosa-invasive EGC was higher in the mixed-type ($P = 0.012$) and pure U group ($P = 0.009$) than in the pure D group but was not significantly different between the mixed-type and pure U group ($P = 0.375$). Multivariate logistic analysis showed that only female sex (OR = 5.83, 95%CI: 1.64-20.70, $P = 0.028$) and presence of lymphovascular invasion (OR = 13.18, 95%CI: 1.39-125.30, $P = 0.020$) were independent risk factors for LNM in mucosa-confined EGC, while histological type was not an independent risk factor for LNM in mucosa-confined EGC ($P = 0.106$).

CONCLUSION

For mucosal EGC, histological mixed-type is not an independent risk factor for LNM and could be managed in the same way as the undifferentiated type.

Key words: Early gastric carcinoma; Mixed-type; Lymph node metastasis; Mucosa; Lymphovascular invasion

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Core tip: This retrospective study investigated the relationship between the histological mixed-type of early gastric carcinoma (EGC) in the mucosa and submucosa and lymph node metastasis (LNM). We found that the rates of LNM in the histological mixed-type and the pure undifferentiated type were not significantly different in the mucosal or submucosal EGC. Furthermore, histological type was not an independent risk factor for LNM in mucosa-confined EGC. Hence, according to WHO classification, histological mixed-type and pure undifferentiated EGC could be managed in the same way, and curative endoscopic submucosal dissection is feasible for patients with histological mixed-type mucosa-confined EGC.

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INTRODUCTION

Gastric carcinoma is the second leading cause of cancer-related death behind lung carcinoma, despite a worldwide decline in both its incidence and mortality since the late half of the twentieth century^[1]. Endoscopic resection can be curative for selected cases of early gastric cancer (EGC)^[2]. Endoscopic submucosal dissection (ESD), a recently developed technique, is a widely accepted treatment modality for EGC, including undifferentiated-type EGC within the expanded criteria (mucosal cancer measuring less than 2 cm without ulceration or lymphovascular tumor emboli). Some studies have shown that there is no risk of lymph node metastasis (LNM) in undifferentiated-type EGC, conforming to the expanded criteria for endoscopic resection^[3-5]. The incidence of LNM is the most important factor when deciding on endoscopic resection in EGC^[6]. Therefore, the criteria for ESD consist of factors related to the risk of LNM, including histological differentiation and tumor size.

The prognosis of EGC is mainly dependent on histological differentiation, which determines the extent of LNM and can potentially assist in selecting the most suitable treatment strategy^[7-9]. However, gastric cancer tissues often present histological heterogeneity and comprise a mixture of several different cell types. Before a treatment has been selected, it is difficult for pathologists to accurately diagnose the histological type of the cancer tissue based on the histological differentiation state definitions as defined by the 14th Japanese classification of gastric carcinoma^[10] or the 7th tumor-node-metastasis classification^[11]. This is especially the case in mixed-type gastric cancer from several biopsy specimens. Approximately 5%-25% of gastric cancers are classified as having a histological mixed-type in previous studies^[12,13], consisting of undifferentiated and differentiated components.

Recently, several studies have reported that mixed-type EGC was associated with aggressive clinical features as well as poor outcomes^[12,14]. However, these studies did not consider the different biological behaviors of the mucosal mixed-type EGC and submucosal mixed-type EGC, although patients with submucosal EGC would undoubtedly be at a higher risk of LNM and poor prognosis than those with mucosal EGC. Therefore, the biological behavior of the histological mixed-type in mucosal EGC remains undetermined. In this study, we aimed to clarify the relationship of histological mixed-type EGC and the rate of LNM, and the feasibility of

endoscopic resection for patients with mixed-type EGC in the mucosa.

MATERIALS AND METHODS

Patients

A consecutive series of 298 patients diagnosed with EGC were examined. All patients, including 165 patients with EGC in the mucosa and 133 patients with EGC in the submucosa, underwent curative gastrectomy with lymph node dissection at the Department of Surgery at Nanjing Drum Tower Hospital from January 2005 to January 2012. Patients who were treated with chemotherapy before surgery were excluded from this study. Histopathological examination was performed by expert pathologists. Data on the clinicopathological factors, including age, sex, tumor location, macroscopic appearance, size, presence of stomach ulcer, infection with *Helicobacter pylori* (*H. pylori*), lymphovascular invasion, and presence of LNM, were obtained. After surgery, patients were told to visit our outpatient department for esophagogastroduodenoscopy and abdominal pelvic computed tomography, which were performed at 3- and 6-mo intervals during the first year and then annually thereafter. This study was approved by the Institutional Review Board of Nanjing Drum Tower Hospital.

Subgroups based on the histological differentiation state

Patients were divided into three subgroups according to the histological features of their tumors: (1) a pure differentiated component with no undifferentiated component (pure D group); (2) a pure undifferentiated component with no differentiated component (pure U group); and (3) a histological mixed-type that consisted of both differentiated and undifferentiated components (mixed-type group). The histological mixed-type includes the differentiated-predominant mixed-type with undifferentiated component making up less 50% (D > U group) and the undifferentiated-predominant mixed-type with undifferentiated component making up more than 50% (U > D group). According to the Japanese classification of gastric carcinoma, the pure D and D > U groups were classified as the differentiated type of gastric cancer, whereas the U > D and pure U groups were classified as the undifferentiated type. On the other hand, according to the tumor-node-metastasis classification, only the pure D group was classified as the differentiated type, and the remaining three groups were classified as the undifferentiated type. The Japanese classification of gastric carcinoma^[6] was used to classify the macroscopic type of the tumors as follows: elevated (I, IIa, I and IIa, IIa and IIb), flat (IIb), and depressed (IIc, IIc and III, III). According to the different histological classifications, the cases of EGC in the mucosa and submucosa are shown in Figure 1.

Statistical analysis

Analysis of variance was used to compare the mean values of the continuous variables among the three different histological subgroups, and the χ^2 test was performed on the categorical variables. Bonferroni correction for multiple comparisons suggested differences between two of the three histological subgroups. Multivariate logistic regression analysis was performed to determine the predictors of LNM. The significant difference was set at an alpha level of 0.05. When the Bonferroni correction was applied, the significant difference was set at an alpha level of 0.017, which was 0.05/number of tests^[15]. All statistical analyses were performed using SPSS software, version 22.0 (SPSS Inc., Chicago, IL, United States).

RESULTS

Clinicopathological characteristics of patients with EGC

The study group consisted of 206 male patients and 92 female patients with a median age of 59.5 years (range, 18-86 years). Seventy-one patients had tumors in the upper third of the stomach and 227 in the middle or lower third. One hundred and six patients had an elevated gross type and 192 patients had a flat or depressed gross type. There were 165 patients with EGC in the mucosa and 133 patients with EGC in the submucosa. Histologically, patients were divided into the following four groups: 188 (63.1%) patients with the pure D histological type, 24 (7.0%) with the D > U histological type, 17 (5.7%) with the U > D histological type, and 69 (23.2%) with the pure U histological type. The overall prevalence of the histological mixed-type, including the D > U and U > D histological types, was 12.7% (41/298) in EGC. The overall incidence of LNM was 14.4% in EGC (Table 1). In a univariate analysis of EGC, LNM was associated with younger age ($P = 0.005$), female sex ($P = 0.044$), tumor size ($P = 0.022$), middle/lower location ($P = 0.010$), lymphovascular invasion ($P = 0.013$), flat/depressed gross type ($P = 0.034$), depth of submucosal invasion ($P = 0.001$), pure U type ($P = 0.005$), and mixed-type ($P = 0.001$). Given that the criteria for ESD treatment of EGC consist of the invasion depth, histological type, tumor size, and ulceration, it is reasonable and meaningful to take these four covariates into a multivariate analysis to assess their main effect on the rate of LNM. The multivariate analysis showed that submucosal invasion (OR = 4.58, 95%CI: 1.23-16.97, $P = 0.023$), pure U type (OR = 4.97, 95%CI: 1.21-20.39, $P = 0.026$), and mixed-type (OR = 5.84, 95%CI: 1.05-32.61, $P = 0.044$) were independent risk factors for LNM in EGC. There was no interaction effect between the invasion depth and histological type ($P = 0.822$) (Table 2).

Clinicopathologic features among the histological mixed-type, pure undifferentiated, and pure differentiated EGC in the mucosa and submucosa

Table 3 shows the relationship between the clinico-

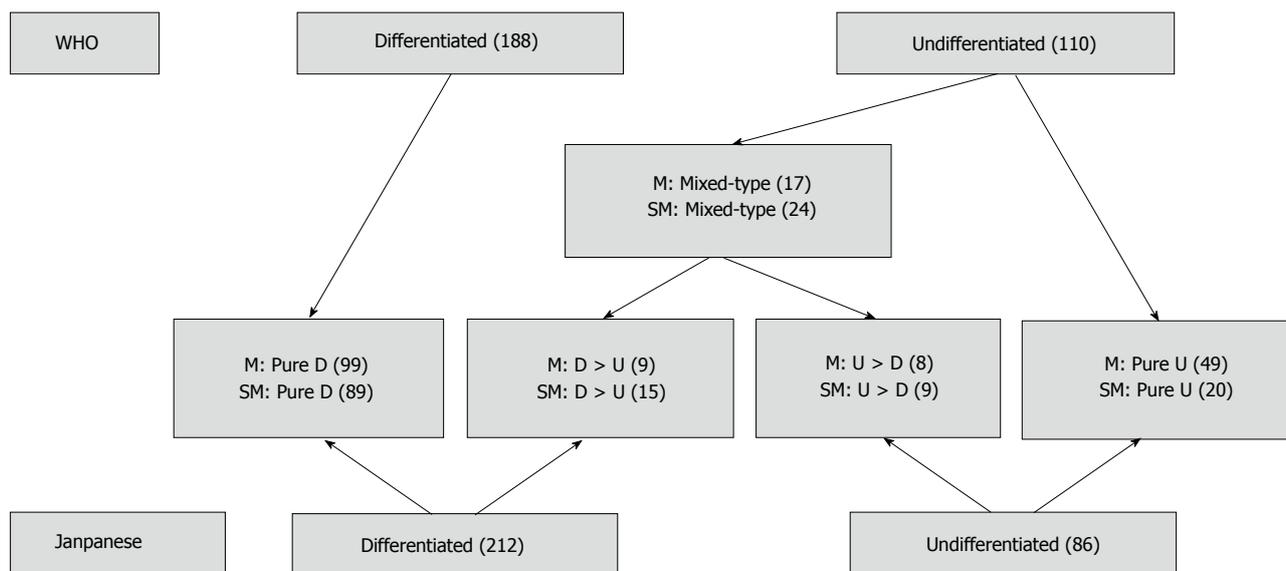


Figure 1 The relationship among the histological classifications of early gastric cancer in the mucosa and submucosa. Of the 298 cases, there were 212 with differentiated type gastric cancer and 86 with undifferentiated type gastric cancer based on the Japanese classification currently used as the endoscopic resection criteria. In accordance with the WHO classification, there were 188 patients with differentiated type and 110 patients with undifferentiated type gastric cancer. According to the histological differentiation and undifferentiation components, 41 patients were reclassified as mixed-type. For mucosal early gastric cancer (EGC), there were 99 patients in the pure differentiated (pure D) group, 9 in the differentiated > undifferentiated (D > U) group, 8 in the undifferentiated > differentiated (U > D) group, and 49 in the pure undifferentiated (pure U) group. For submucosal EGC, there were 89 in the pure D group, 15 in the D > U group, 9 in the U > D group, and 20 in the pure U group. Among the 41 patients with mixed-type EGC, there were 17 in the mucosa and 24 in the submucosa. D: Differentiated; M: Mucosa; SM: Submucosa; U: Undifferentiated.

Table 1 Clinicopathological characteristics of patients with early gastric cancer *n* (%)

Variable	Value
Age (yr), median ± SD (range)	59.5 ± 12.1 (18-86)
Gender	
Male	206 (69.1)
Female	92 (30.9)
Tumor size (cm), median ± SD (range)	2.2 ± 1.2 (0.5-6.0)
Location	
U	71 (23.8)
M/L	227 (76.2)
Gross type	
Elevated	106 (35.6)
Flat/depressed	192 (64.4)
Depth of invasion	
M	165 (55.4)
SM	133 (44.6)
Histological type	
Pure D	188 (63.1)
D > U	24 (7.0)
U > D	17 (5.7)
Pure U	69 (23.2)
Lymph node metastasis	
Present	43 (14.4)
Absent	255 (85.6)

SD: Standard deviation; U: Upper; M/L: Middle/lower; M: Mucosa; SM: Submucosa; Pure D: Pure differentiated; D: Differentiated components; U: Undifferentiated components; Pure U: Pure undifferentiated.

pathological factors and histological types, which included the mixed-type, pure undifferentiated type, and pure differentiated type, in mucosal EGC. The distribution of age ($P = 0.028$), gender ($P = 0.004$),

tumor location ($P = 0.003$), gross type ($P < 0.001$), ulceration ($P = 0.015$), *H. pylori* ($P = 0.025$), and LNM ($P = 0.016$) significantly differed among the three histological subgroups, while tumor size ($P = 0.802$) and lymphovascular invasion ($P = 0.589$) were similarly distributed among the three histological subgroups. Patients in the mixed-type group were more likely to have *H. pylori* infection than those in the pure U group ($P = 0.015$). Besides tumor size and lymphovascular invasion, age ($P = 0.525$), gender ($P = 0.151$), tumor location ($P = 0.759$), gross type ($P = 0.507$), and ulceration ($P = 0.490$) were similarly distributed between the mixed-type group and pure U group. Of note, the rate of LNM was similar between the mixed-type group and the pure U group ($P = 0.739$), although it was significantly higher in the mixed-type group ($P = 0.012$) and pure U group ($P = 0.010$) than in the pure D group. These data suggested that mixed-type group showed similar clinicopathologic features and aggressive behavior compared with the pure U group in mucosal EGC.

Table 4 shows the relationship between the clinicopathological factors and histological types, which included the mixed type, pure undifferentiated type, and pure differentiated type in submucosal EGC. Distribution of age ($P = 0.008$), gender ($P < 0.001$), tumor location ($P = 0.019$), gross type ($P = 0.028$), and LNM ($P = 0.008$) significantly differed among the three histological subgroups, while tumor size ($P = 0.166$), ulceration ($P = 0.369$), *H. pylori* infection ($P = 0.997$), and lymphovascular invasion ($P = 0.325$)

Table 2 Risk factors for lymph node metastasis in early gastric carcinoma

Variable	Univariate analysis			Multivariate analysis		
	OR	95%CI	P value	OR	95%CI	P value
Age (yr)			0.005			
≤ 60	1.00					
> 60	0.37	0.18-0.74				
Gender			0.044			
Male	1.00					
Female	1.97	1.02-3.82				
Size (cm)	1.33	1.04-1.71	0.022			0.154
Location			0.010			
U	1.00					
M/L	4.85	1.45-16.19				
LV invasion			< 0.001			
Absent	1.00					
Present	18.4	8.31-40.72				
Gross type			0.034			
Elevated	1.00					
Flat/depressed	2.32	1.07-5.04				
Ulcer			0.031			0.256
Absent	1.00					
Present	2.15	1.07-4.31				
<i>H. pylori</i> infection			0.346			
Absent	1.00					
Present	1.46	0.67-3.19				
Depth of invasion			0.001			0.023
Mucosa	1.00			4.58	1.23-16.97	
Submucosa	3.41	1.70-6.83				
Histological type			0.001			0.054
Pure D	1.00					
Pure U	2.99	1.39-6.44	0.005	4.97	1.21-20.39	0.026
Mixed-type	4.45	1.91-10.36	0.001	5.84	1.05-32.61	0.044
Depth of invasion/histological type						0.822

MT: Mixed-type; PU: Pure undifferentiated; PD: Pure differentiated; U: Upper; M/L: Middle/lower; LV: Lymphovascular; LNM: Lymph node metastasis.

Table 3 Clinicopathologic features of mucosa-confined early gastric carcinoma according to histological type *n* (%)

Variable	MT, <i>n</i> = 17	Pure U, <i>n</i> = 49	Pure D, <i>n</i> = 99	P value	P (Bonferroni corrected)
Age (yr)				0.028	MT vs PU, 0.525
≤ 60	10 (58.8)	33 (67.3)	44 (44.4)		MT vs PD, 0.272
> 60	7 (41.2)	16 (32.7)	55 (55.6)		PU vs PD, 0.009
Gender				0.004	MT vs PU, 0.151
Male	7 (41.2)	30 (61.2)	77 (77.8)		MT vs PD, 0.002
Female	10 (58.8)	19 (38.8)	22 (22.2)		PU vs PD, 0.034
Tumor size (cm)	2.1 ± 1.1	1.9 ± 1.2	1.9 ± 1.2	0.802	
Location				0.003	MT vs PU, 0.759
U	1 (5.9)	4 (8.2)	29 (29.3)		MT vs PD, 0.042
M/L	16 (94.1)	45 (91.8)	70 (70.7)		PU vs PD, 0.004
Gross type				< 0.001	MT vs PU, 0.507
Elevated	4 (23.5)	8 (16.3)	51 (51.5)		MT vs PD, 0.033
Flat/depressed	13 (76.5)	41 (83.7)	48 (48.5)		PU vs PD, < 0.001
Ulcer				0.015	MT vs PU, 0.490
Absent	6 (35.3)	22 (44.9)	64 (64.6)		MT vs PD, 0.022
Present	11 (64.7)	27 (55.1)	35 (35.4)		PU vs PD, 0.022
<i>H. pylori</i> infection				0.025	MT vs PU, 0.015
Absent	1 (5.9)	18 (36.7)	22 (22.2)		MT vs PD, 0.119
Present	16 (94.1)	31 (63.3)	77 (77.8)		PU vs PD, 0.061
LV invasion				0.589	
Absent	17 (100.0)	47 (95.9)	97 (98.0)		
Present	0 (0)	2 (4.1)	2 (2.0)		
LNM				0.016	MT vs PU, 0.739
Absent	14 (82.4)	42 (85.7)	96 (97.0)		MT vs PD, 0.012
Present	3 (17.6)	7 (14.3)	3 (3.0)		PU vs PD, 0.010

MT: Mixed-type; PU: Pure undifferentiated; PD: Pure differentiated; U: Upper; M/L: Middle/lower; LV: Lymphovascular; LNM: Lymph node metastasis.

Table 4 Clinicopathologic features of submucosa-invasive early gastric carcinoma according to histological type *n* (%)

Variable	MT, <i>n</i> = 24	Pure U, <i>n</i> = 20	Pure D, <i>n</i> = 89	<i>P</i> value	<i>P</i> (Bonferroni corrected)
Age (yr)				0.008	MT vs PU, 0.423
≤ 60	14 (58.3)	14 (70.0)	32 (36.0)		MT vs PD, 0.048
> 60	10 (41.7)	6 (30.0)	57 (64.0)		PU vs PD, 0.005
Gender				< 0.001	MT vs PU, 0.069
Male	15 (62.5)	7 (35.0)	70 (78.7)		MT vs PD, 0.104
Female	9 (37.5)	13 (65.0)	19 (21.3)		PU vs PD, < 0.001
Size (cm)	2.6 ± 1.3	2.8 ± 1.4	2.3 ± 1.1	0.166	
Location				0.019	MT vs PU, 0.128
U	5 (20.8)	1 (5.0)	31 (34.8)		MT vs PD, 0.191
M/L	19 (79.2)	19 (95.0)	58 (65.2)		PU vs PD, 0.008
Gross type				0.028	MT vs PU, 0.199
Elevated	6 (25.0)	2 (10.0)	35 (39.3)		MT vs PD, 0.195
Flat/depressed	18 (75.0)	18 (90.0)	54 (60.7)		PU vs PD, 0.012
Ulcer				0.369	
Absent	5 (20.8)	7 (35.0)	32 (36.0)		
Present	19 (79.2)	13 (65.0)	57 (64.0)		
<i>H. pylori</i> infection				0.997	
Absent	7 (29.2)	6 (30.0)	26 (29.2)		
Present	17 (70.8)	14 (70.0)	63 (70.8)		
LV invasion				0.325	
Absent	15 (62.5)	15 (75.0)	69 (77.5)		
Present	9 (37.5)	5 (25.0)	20 (22.5)		
LNM				0.008	MT vs PU, 0.375
Absent	15 (62.5)	12 (60.0)	76 (85.4)		MT vs PD, 0.012
Present	9 (37.5)	8 (40.0)	13 (14.6)		PU vs PD, 0.009

MT: Mixed-type; PU: Pure undifferentiated; PD: Pure differentiated; U: Upper; M/L: Middle/lower; LV: Lymphovascular; LNM: Lymph node metastasis.

were similarly distributed among the three histological subgroups. Besides tumor size, ulceration, *H. pylori* infection, and lymphovascular invasion, age ($P = 0.423$), gender ($P = 0.069$), tumor location ($P = 0.128$), and gross type ($P = 0.199$) were similarly distributed between the mixed-type group and pure U group. The rate of LNM was higher in the mixed-type group ($P = 0.012$) and pure U group ($P = 0.009$) than in the pure D group, but was not significantly different between the mixed-type and pure U group ($P = 0.375$). These data suggested that the mixed-type group showed similar clinicopathologic features and aggressive behavior compared with the pure U group in submucosal EGC.

Risk factors for LNM in EGC in the mucosa

In a univariate analysis of mucosa-confined EGC, LNM was associated with pure undifferentiated type ($P = 0.019$), mixed-type ($P = 0.026$), female sex ($P = 0.005$), and presence of lymphovascular invasion ($P = 0.013$). However, in a multivariate analysis, only female sex (OR = 5.83, 95%CI: 1.64-20.70, $P = 0.028$) and presence of lymphovascular invasion (OR = 13.18, 95%CI: 1.39-125.30, $P = 0.020$) were independent risk factors for LNM of mucosa-confined EGC, while histological type was not an independent risk factor for LNM of mucosa-confined EGC ($P = 0.106$) (Table 5).

DISCUSSION

Endoscopic resection is a curative modality for EGC and its indications have been expanded^[16,17]. However,

histological mixed-type is not categorized in the present criteria for ESD. In this study, we found that submucosal invasion, pure U type, and mixed-type were independent risk factors for LNM in EGC. However, the distribution of tumor size, location, gross type, ulceration, lymphovascular invasion, and LNM rate were similar between the mixed-type group and pure U group in mucosa-confined EGC, and histological mixed-type was not an independent risk factor for LNM in mucosal EGC.

EGC generally shows greater histological diversity than other types of cancer. Even tumors confined to the mucosa show histologic diversity, which tends to increase with deeper invasion and increased tumor diameter^[18]. In addition, histological mixed-type has been reported to have a higher LNM rate and more aggressive behavior than other histological types^[19]. New difficulties in determining the appropriate management for histological mixed-type EGC arose as a result of improvements in ESD, which allows *en bloc* resection of large superficial gastric lesions and precise histopathological evaluation^[20]. In fact, there are two distinct groups of differentiated and undifferentiated mixed-type EGC. The first group shows both differentiated and undifferentiated histological components in the mucosa. The second group shows differentiated components confined in the mucosa and undifferentiated components confined in the submucosa. We hypothesized that these two groups had different prognoses and should be evaluated and managed independently. In our study, we found

Table 5 Risk factors for lymph node metastasis in mucosa-confined early gastric carcinoma

Variable	Univariate analysis			Multivariate analysis		
	OR	95%CI	P value	OR	95%CI	P value
Age (yr)			0.082			
≤ 60	1.00					
> 60	0.31	0.08-1.16				
Size (cm)	1.36	0.90-2.06	0.145			
Gender			0.005			0.028
Male	1.00			1.00		
Female	5.89	1.72-20.17		5.83	1.64-20.70	
Location			0.630			
U	1.00					
M/L	1.47	0.31-6.95				
LV invasion			0.013			0.020
Absent	1.00			1.00		
Present	13.64	1.75-106.28		13.18	1.39-125.30	
Gross type			0.253			
Elevated	1.00					
Flat/depressed	2.17	0.58-8.22				
Ulcer			0.199			
Absent	1.00					
Present	2.14	0.67-6.85				
<i>H. pylori</i> infection			0.244			
Absent	1.00					
Present	0.50	0.15-1.61				
Histological type			0.035			0.106
Pure D	1.00					
Pure U	5.33	1.32-21.63	0.019	4.46	0.99-20.00	0.051
Mixed-type	6.86	1.26-37.77	0.026	5.31	0.86-33.01	0.073

PD: Pure differentiated; PU: Pure undifferentiated; U: Upper; M/L: Middle/lower; LV: Lymphovascular.

that submucosal invasion, pure U type, and mixed-type were independent risk factors for LNM in EGC. We next analyzed the clinicopathologic features of mucosal and submucosal EGC according to the histological type. The mixed-type group and pure U group showed similar clinicopathologic features and aggressive behavior in mucosal EGC, including the distribution of age, gender, tumor size, location, gross type, ulceration, lymphovascular invasion, and LNM rate. Furthermore, we validated that histological type was not an independent risk factor for LNM in mucosal EGC. Given the mucosal undifferentiated EGC has been included in the expanded criteria for ESD, we recommended that mucosal mixed-type EGC could be treated with ESD. For submucosal EGC, the mixed-type group also showed similar clinicopathologic features and aggressive behavior compared with the pure U group. Submucosal undifferentiated EGC has not been included in the criteria for ESD, due to the high frequency of LNM. Several studies have shown that mixed-type EGC with submucosal invasion carries a high risk of LNM, and endoscopic surgery should be limited to the differentiated type of invasive submucosal EGC without histological heterogeneity^[20,21]. Our data supported that the LNM rate of submucosal EGC was significantly higher in the mixed-type group (9/24) and pure U group (8/20) than in the pure D group (13/89). In accordance with the 7th tumor-node-metastasis classification, the mixed-type group and pure U group, including undifferentiated components, were all

undifferentiated EGC^[22]. Hence, the decision criterion of histological mixed-type in tumor-node-metastasis classification is better than Japanese classification^[23].

A study from Shimizu *et al.*^[23] showed that there was no significant difference in the clinicopathological factors between the D > U and U > D groups^[23]. This means that the mixture of differentiated and undifferentiated components contributes to a worse prognosis, no matter the ratio of undifferentiated components to differentiated components. Actually, the pathogenesis and aggressiveness of mixed histology are unclear. Zheng *et al.*^[24] suggested that the mixed-type components might originate from stem cells with similar genetic traits, but follow different histogenic pathways. Park *et al.*^[25] found that mixed-type gastric carcinoma frequently showed an enhanced CpG island hypermethylation status, implicating enhanced CpG island promoter hypermethylation in the histogenesis of mixed-type carcinoma. Studies of the mucin phenotype have reported that some cases of differentiated gastric cancer with a gastric phenotype are transformed into undifferentiated gastric cancer during tumor growth and development, increasing the risk of LNM^[26]. Although mixed-type carcinomas are thought to be more aggressive in some studies according to the Lauren classification^[24,27], a recent study reported that mixed histology, according to WHO classification, showed no LNM within the criteria for endoscopic resection^[13]. Our data supported that the rate of LNM was not significantly different in the mixed-type and

pure undifferentiated EGC confined in the mucosa. Limited by the small sample sizes, our data showed considerably wide confidence interval of the OR ratio of lymphovascular invasion, in the univariate and multivariate analyses of mucosal EGC. Although similar data were reported in some studies^[28,29], it should be confirmed by additional clinical research with larger sample sizes.

In conclusion, our results demonstrated that the histological mixed-type showed a similar low rate of LNM compared with the pure undifferentiated type in mucosa-confined EGC, and histological type was not an independent risk factor for LNM in mucosa-confined EGC. According to the tumor-node-metastasis classification, mucosal histological mixed-type and undifferentiated EGC could be managed in the same way, and curative ESD is feasible for patients with histological mixed-type EGC confined in the mucosa.

ARTICLE HIGHLIGHTS

Research background

Endoscopic submucosal dissection (ESD) is a curative modality for mucosa-confined early gastric cancer (EGC) and its indications have been expanded. However, EGC tissues often present histological heterogeneity and comprise a mixture of several different cell types. The present criteria for ESD does not take consideration of the histological mixed-type EGC. The rate of lymph node metastasis (LNM) is the most important factor when deciding on endoscopic resection in EGC. Therefore, there is a current pressing need to clarify the relationship of histological mixed-type and the rate of LNM, and the feasibility of endoscopic resection for patients with histological mixed-type EGC confined in the mucosa.

Research motivation

According to the latest research, histological mixed-type EGC was associated with aggressive clinical features as well as poor outcomes, but these studies did not consider the different biological behaviors of the mucosal mixed-type EGC and submucosal mixed-type EGC. Given the mucosal undifferentiated EGC measuring less than 2 cm without ulceration has been included in the expanded criteria for ESD treatment, it is necessary to assess the feasibility of endoscopic resection for patients with histological mixed-type EGC confined in the mucosa.

Research objectives

In this study, we investigated the clinicopathologic features of EGC according to histological type classification to evaluate the biological behavior of mixed-type EGC and the predictive value of histological type on the rate of LNM in mucosa-confined EGC.

Research methods

This study included 298 patients who underwent gastrectomy for EGC between 2005 and 2012. Enrolled lesions were divided into groups of pure differentiated (pure D), pure undifferentiated (pure U), and mixed-type according to the proportion of the differentiated and undifferentiated components observed under a microscope. We reviewed the clinicopathological features, including age, sex, location, size, gross type, lymphovascular invasion, ulceration, and LNM, among the three groups. Furthermore, we evaluated the risk factors for LNM in mucosal EGC.

Research results

Submucosal invasion, pure U type, and mixed-type were independent risk factors for LNM in EGC. The rate of LNM in mucosa-confined EGC was higher in the mixed-type group and pure U group than in the pure D group, but no significant difference was found between the mixed-type group and pure U group. Similarly, the rate of LNM in the submucosa-invasive EGC was higher

in the mixed-type and pure U group than in the pure D group, but was not significantly different between the mixed-type and pure U group. Multivariate logistic analysis showed that histological type was not an independent risk factor for LNM in mucosa-confined EGC.

Research conclusions

The distribution of tumor size, location, gross type, ulceration, lymphovascular invasion, and LNM rate were similar between the mixed-type group and pure undifferentiated group in mucosa-confined EGC, and the histological mixed-type was not an independent predictor of LNM in mucosa-confined EGC. According to the tumor-node-metastasis classification, the histological mixed-type and undifferentiated EGC could be managed in the same way, and curative ESD was feasible for patients with mucosal histological mixed-type EGC.

Research perspectives

Endoscopic resection is a curative modality for EGC and its indications have been expanded. Our study indicated that the mucosal histological mixed-type EGC could be managed with curative ESD. With the gradual understanding of the pathogenesis and biological behavior of mixed-type EGC, more patients with mixed-type EGC would benefit from the ESD treatment.

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