Int J Clin Exp Med 2016;9(3):6237-6245
www.ijcem.com /ISSN:1940-5901/IJCEM0020652

Original Article

Mucinous subtype of gastric carcinoma is associated with lower number of lymph nodes examined

Gui-Chen Li[1], Peng Gao[2], Yong-Xi Song[2], Long-Yi Wang[2], Cong Zhang[2], Hong-Peng Liu[2], Chang-Wang Zhang[2], Hong-Chi Wang[2], Zhen-Ning Wang[2]

[1]Departments of General Surgery and Organ Transplant Unit, [2]Surgical Oncology and General Surgery, First Hospital of China Medical University, Shenyang 110001, China

Received November 27, 2015; Accepted February 15, 2016; Epub March 15, 2016; Published March 30, 2016

Abstract: Background: Gastric cancer (GC) is one of the most common causes of cancer-related mortality. Gastric mucinous adenocarcinoma (GMA) is a rare histological type of GC. We analyzed the clinicopathological characteristics and prognostic value of GMA in GC. Methods: We utilized the National Cancer Institute's Surveillance, Epidemiology, and End Results dataset. Patient survival was analyzed using Kaplan-Meier survival curves, and comparisons were performed using the log-rank test. Multivariate survival analysis was adjusted by multiple clinicopathological factors. Results: GMA occurred more frequently in patients with higher pT and pN categories, and higher tumor-node-metastasis (TNM) stage. GMA was not an independent predictor of mortality (Cox's hazard ratio, 0.954; 95% CI, 0.847-1.075; *P*=0.439). We found that the number of lymph nodes examined (eLN) for patients with GMA were significantly lower than that for non-GMA (NGMA) patients (10.943±8.656 vs. 12.729±10.164, *P*<0.001). This result was confirmed by stratification analysis and logistic regression. Conclusions: GMA was frequently detected at an advanced stage, but there was no significant difference of survival between GMA and NGMA. The eLN of patients with GMA was significantly less than that for NGMA patients.

Keywords: Stomach neoplasms, adenocarcinoma, mucinous, lymph nodes, prognosis

Introduction

Gastric cancer (GC) is one of the most common causes of cancer-related mortality [1]. Gastric mucinous adenocarcinoma (GMA) is a rare histological type of mucin-producing GC. Overall, GMA accounts for 2%-6% of GC [2-10]. GMA is defined by the Japanese Research Society of Gastric Cancer (JRSGC) as, "an adenocarcinoma characterized by a substantial number of mucous lakes due to mucin pooling in the tumor stroma" [11]. The World Health Organization (WHO) defines GMA as a gastric adenocarcinoma with a substantial amount of extracellular mucin (50% of tumor volume) within tumors [12].

Some researchers have reported that GMA has a poor prognosis compared with non-GMA (NGMA) [13, 14]. However, most recent studies indicate that GMA is often detected at an advanced stage, but GMA type is not an independently associated with survival [2, 5-7]. Furthermore, Ryu proposed that the prognosis of patients with early GMA was better than that with early NGMA [15].

Our knowledge of GMA is somewhat limited because of its rarity and the low number of GMA cases presented in previous reports. Almost all studies regarding GMA are from Asia, and to the best of our knowledge there are no published studies where GMA has been analyzed against NGMA using a large national database from the United States of America (USA).

Gastrectomy with D2 lymph node dissection is the standard treatment for curable GC in Eastern Asia. However, in Western countries, D2 lymph node dissection is not a required procedure in GC treatment. Regardless, it is suggested that at least 16 regional nodes be assessed pathologically [16, 17]. Stage migration occurs in patients with a lower number of lymph nodes examined (eLN), creating inaccuracies in survival predictions [18-20].

Table 1. Clinicopathologic features of patients with GMA and NGMA

	NGMA	GMA	*P*
Age*	69.282±12.721	68.993±13.262	0.826
Sex			0.782
Male	7398	349	
Female	5218	252	
Year of diagnosis			0.002
1988-1993	2281	121	
1994-1998	2319	133	
1999-2003	3915	193	
2004-2008	4101	154	
Race			0.016
White	7343	359	
Black	1939	104	
Asian	3008	115	
Other	326	23	
Marital status			0.935
Married	7496	348	
Divorced/Separated	947	48	
Single	1268	63	
Widowed	2560	127	
Unknown	345	15	
Primary site			0.024
Fundus of stomach	550	20	
Body of stomach	4375	186	
Antrum/Pylorus	5242	289	
Overlapping	1142	54	
Unknown	1307	52	
Histological grade			<0.001
Well	734	30	
Moderate	3838	198	
Poor	7249	313	
Undifferentiated	288	6	
Unknown	507	54	
TNM stage			<0.001&
Ia	2152	49	
Ib	1241	43	
IIa	2014	106	
IIb	1909	101	
IIIa	1777	116	
IIIb	2234	116	
IIIc	1289	70	
pT category			<0.001&
pT1	2626	61	
pT2	1670	78	
pT3	4799	263	
pT4a	2242	134	
pT4b	1279	65	

We sought to determine the clinicopathological characteristics and prognostic significance of GMA, and compared them with those for NGMA.

Materials and methods

Patient population and clinical data

We utilized the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) dataset, 1973-2009; SEER collects and publishes cancer incidence and survival data from population-based cancer registries including 17 regional registries and covering approximately 28% of the population of the United States.

We retrospectively studied patients with GC who were treated surgically from 1988 to 2008. The primary study endpoint was cancer-specific survival. We restricted the cases included in this study by specific histologic type, defined by the International Classification of Diseases for Oncology third edition (ICD-O-3), to GMA (8480, 8481), and NGMA (8000-8152, 8154-8231, 8243-8245, 8250-8310, 8510-8576, 8940-8950, 8980-8990). Signet-ring cell carcinoma (8490) was not included in this study. Patients were staged according to the seventh edition of the American Joint Committee on Cancer (AJCC) tumor-node-metastasis (TNM) staging system [16]. Pathological stage (pTNM) was used.

Patients were excluded from this study if they exhibited: 1) prior non-GC; 2) *in situ* tumors; 3) pTNM stage IV; 4) incomplete pathological data entries

pN category			<0.001&
pN0	5350	206	
pN1	2643	139	
pN2	2546	144	
pN3	2077	112	
Radiation status			0.194
No	9916	459	
Yes	2700	142	
eLN			<0.001
<16	8948	477	
≥16	3668	124	

Abbreviations: GMA, Gastric mucinous adenocarcinoma; NGMA, non-GMA; eLN, the number of lymph nodes examined. *: Mean ± SD; &: Kendall's tau-b.

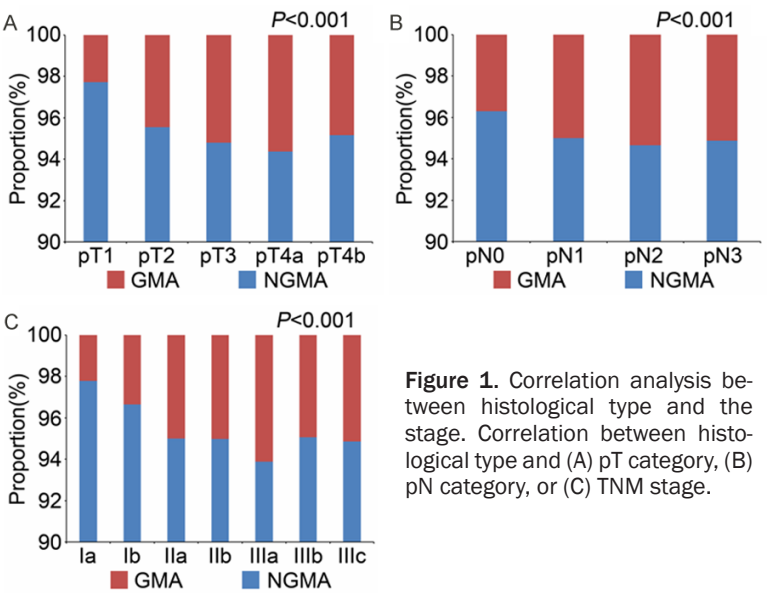

Figure 1. Correlation analysis between histological type and the stage. Correlation between histological type and (A) pT category, (B) pN category, or (C) TNM stage.

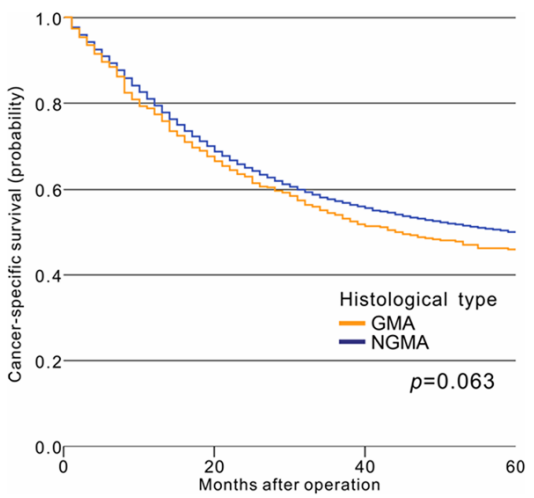

Figure 2. Comparison of survival between patients with GMA and NGMA.

for the tumor stage; or 5) died during the immediate postoperative period (within 1 month).

Data with information as follows were recorded: age, sex, year of diagnosis, race, marital status, histological type, primary tumor site, histological grade, pT category, pN category, radiation status, and eLN.

Ethics

This study was in compliance with the Helsinki Declaration. We have got permission to access the research data file in SEER program and the reference number was 101-88-Nov 2011. The written informed consent was not obtained because patient records/information was anonymized and de-identified prior to analysis. The study was also approved by the Research Ethics Committee of China Medical University.

Statistical analysis

The mean ± standard deviation (SD) were used to presented continuous data and the Mann-Whitney U test was used to determine the significantly difference of two sets of data. The χ^2 test was applied on comparing on categorical variables. Kendall's tau-b correlation coefficient test was used to assess the correlation between histological type and tumor stage. Kaplan-Meier (KM) survival curves were used to analyzing the Cancer-specific survival and log-rank test was used to determine the significantly difference of two sets of data. Multivariate analysis was performed using the Cox proportional hazards model. Stepwise logistic regression was used to assess the correlation between eLN (≥16 vs. <16), and histological type adjusted by other variables. Statistical analyses were performed using SPSS version 20 (IBM, Armonk, NY, USA). A two-tailed *P*-value less than 0.050 was considered statistically significant.

Table 2. Cox proportional hazards model of survival for all patients

	HR	95% CI	*P*
Histological type			
NGMA	1		
GMA	0.954	0.847-1.075	0.439
Age*	1.016	1.014-1.018	<0.001
eLN*	0.969	0.965-0.972	<0.001
Race			
White	1		
Black	1.175	1.093-1.263	<0.001
Asian	0.815	0.761-0.873	<0.001
Other	1.176	1.005-1.376	0.043
Marital status			
Married	1		
Divorced/Separated	1.062	0.961-1.174	0.240
Single	1.182	1.083-1.290	<0.001
Widowed	1.071	0.999-1.148	0.054
Unknown	1.106	0.937-1.305	0.235
pT category			
pT1	1		
pT2	1.537	1.337-1.768	<0.001
pT3	2.913	2.595-3.270	<0.001
pT4a	3.816	3.378-4.311	<0.001
pT4b	5.642	4.967-6.409	<0.001
pN category			
pN0	1		
pN1	1.863	1.723-2.016	<0.001
pN2	2.547	2.355-2.753	<0.001
pN3	4.034	3.709-4.389	<0.001
Histological grade			
Well	1		
Moderate	1.144	0.972-1.345	0.105
Poor	1.433	1.223-1.679	<0.001
Undifferentiated	1.739	1.401-2.157	<0.001
Unknown	1.333	1.087-1.634	0.006
Primary site			
Fundus of stomach	1		
Body of stomach	0.777	0.685-0.882	<0.001
Antrum/Pylorus	0.825	0.728-0.935	0.003
Overlapping	1.056	0.918-1.213	0.446
Unknown	1.000	0.869-1.150	0.997
Year of diagnosis			
1988-1993	1		
1994-1998	0.951	0.877-1.030	0.217
1999-2003	0.937	0.872-1.007	0.075
2004-2008	0.872	0.807-0.941	<0.001

Abbreviations: CI, Confidential intervals; eLN, the number of lymph nodes examined; GMA, Gastric mucinous adenocarcinoma; NGMA, non-GMA. *: Continues variables.

Results

Patient and tumor characteristics

A total of 13,217 patients were studied, comprising 601 GMA and 12,616 NGMA cases. In comparison with NGMA, GMA was present in significantly fewer Asians and a low number of GMA cases were reported in recent years. Additionally, there were less GMA cases of undifferentiated grade, and more cases associated with the Antrum/Pylorus part of stomach. The disease state was more advanced with higher TNM stage, and higher pT and pN categories observed (**Table 1**; **Figure 1**).

Survival analysis

For all patients, the outcome of GMA was worse than that for NGMA, however this difference was not significant with 5-year survival rates of 45% and 49% for GMA and NGMA, respectively (P=0.063; **Figure 2**). Univariate analysis showed that prognosis of patients was significantly associated with age (Cox hazard ratio P<0.001), race (KM P<0.001), year of diagnosis (KM P<0.001), pT category (KM P<0.001), pN category (KM P<0.001), histological grade (KM P<0.001), primary tumor site (KM P<0.001), and eLN (Cox hazard ratio P<0.001). There was no significant association between prognosis and sex (KM P=0.429), or prognosis and radiation status (KM P=0.252). Results from the Cox proportional hazards regression analysis are listed in **Table 2**. Histological type (GMA *vs.* NGMA) was not an independent predictor of mortality (Cox hazard ratio, 0.954; 95% CI, 0.847-1.075; P=0.439) after adjustment for all variables that were significantly associated with prognosis in the univariate analysis. There were no significant differences in prognosis between GMA and NGMA after stratification by pT category, pN category, or TNM stage (P>0.050; **Figure 3**).

Association between histological type and eLN

The eLN for patients with GMA was less than that for NGMA patients significantly (10.943± 8.656 *vs.* 12.729±10.164, P<0.001). After stratification by age, pT category, pN category, primary site or year of diagnosis, this trend was still evident, although differences were not significant in groups of a low sample size (**Table 3**). We transformed eLN into a binary variable with

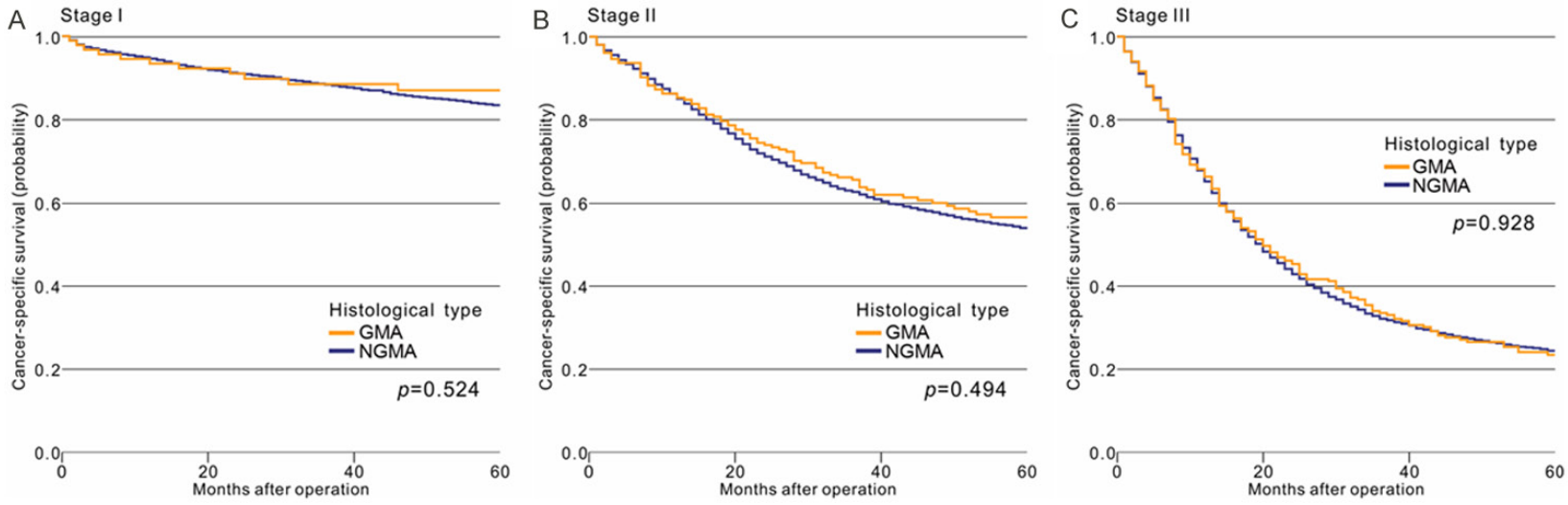

Figure 3. Comparison of survival between patients with GMA and NGMA stratified by TNM stage. (A) Survival curves of patients in stage I, (B) Survival curves of patients in stage II, (C) Survival curves of patients in stage III.

Table 3. Comparison of the mean number of eLN between the NGMA and GMA stratified by age, pT category, pN category, primary site and year of diagnosis

	NGMA	GMA	*P*
Age			
<60	14.518±11	13.618±9.585	0.475
60-69	13.249±10.334	9.737±6.727	<0.001
70-79	12.33±9.861	11.546±10.192	0.220
≥80	11.093±9.271	8.581±5.664	0.010
pT category			
pT1	11.262±9.958	9.656±7.113	0.519
pT2	12.642±10.074	10.731±8.279	0.143
pT3	13.541±10.441	11.452±9.607	<0.001
pT4a	13.361±10.306	10.903±8.219	0.006
pT4b	11.703±8.904	10.431±7.172	0.397
pN category			
pN0	11.147±9.774	8.743±6.91	0.002
pN1	11.309±10.199	9.748±8.324	0.143
pN2	13.28±9.877	11.465±8.917	0.006
pN3	17.938±9.649	15.804±9.66	0.003
Primary site			
Fundus of stomach	13.847±10.502	11.800±6.670	0.741
Body of stomach	13.525±10.968	10.995±7.941	0.006
Antrum/Pylorus	11.971±9.266	10.872±9.316	0.025
Overlapping	13.814±11.028	11.722±8.686	0.179
Unknown	11.686±9.523	10.019±8.116	0.167
Year of diagnosis			
1988-1993	11.573±9.986	10.165±10.052	0.136
1994-1998	11.86±9.728	10.038±6.67	0.146
1999-2003	12.084±9.613	10.575±8.61	0.020
2004-2008	14.48±10.772	12.799±8.852	0.097

Abbreviations: eLN, the number of lymph nodes examined; GMA, Gastric mucinous adenocarcinoma; NGMA, non-GMA.

a cutoff ≥16. Stepwise logistic regression analysis confirmed that the eLN of patients with GMA was lower than that for NGMA patients (**Table 4**).

Discussion

Research into clinicopathological features and survival of GMA has yielded inconsistent results. The clinicopathological characteristics and prognostic significance of GMA have not been studied using a large national database from the USA.

Wu *et al.* [21] proposed that GMA is often detected at the upper stomach, while Kawamura et al. [8] and Zhang et al. [2] reported that GMA is mainly found in the lower part of the stomach. In the study, we found that GMA was present mostly in the Antrum/Pylorus part of stomach. We also found that there was no difference with respect to age and sex between GMA and NGMA, which was consistent with most previous reports [2, 4, 6, 22]. Recently, the criteria for diagnosis of GMA have become strict, thereby accounting for the decreased incidence of GMA in this study. Additionally, GMA was rarely identified in Asian individuals, although the reasons for this remain unclear.

The majority of past reports indicate that GMA is frequently detected at an advanced stage, however GMA type is not associated with survival independently [2, 5-7]. Our findings also indicate that GMA was frequently detected at an advanced stage (**Table 1**). It is currently unknown why GMAs often present at an advanced tumor stage. It is possible that extracellular mucin acts as an infiltrating medium into the surrounding stroma and assists tumor cells in penetrating deeper layers [22].

We found that the 5-year survival rates were 45% and 49% for GMA and NGMA patients, respectively. The prognosis of patients with GMA was poorer than that for patients with NGMA, but this difference was not statistically significant (**Figure 2**). For patients at the same TNM stage, there was no significant difference in prognosis between GMA and NGMA (**Figure 3**). We also confirmed that histological type (GMA *vs.* NGMA) was not an independent prognostic factor of survival (**Table 2**). These findings correspond with those previously reported [2, 5-7], although they did conflict with the hypotheses proposed by Takeshita et al. [13], Koufuji et al. [14], and Ryu et al. [15]. We confirmed that the major factor which influences poorer prognosis for GMA is the advanced stage at the time of diagnosis.

The eLN in patients with GMA was significantly less than that in NGMA patients (10.943±8.656 *vs.* 12.729±10.164, *P*<0.001). This result was confirmed by stratification analysis (**Table 3**)

Table 4. Analysis of the correlation between eLN (≥16 vs. <16) and histological type using logistic regression adjusted by other variables

	OR	95% CI	*P*
Histological type			
NGMA	1		
GMA	0.635	0.515-0.783	<0.001
Age*	0.985	0.982-0.989	<0.001
Sex			
Male	1		
Female	1.134	1.046-1.229	0.002
Race			
White	1		
Black	1.009	0.899-1.132	0.885
Asian	1.661	1.511-1.825	<0.001
Other	1.597	1.263-2.020	<0.001
pT category			
pT1	1		
pT2	1.261	1.092-1.457	0.002
pT3	1.205	1.063-1.366	0.004
pT4a	0.982	0.848-1.138	0.814
pT4b	0.787	0.661-0.936	0.007
pN category			
pN0	1		
pN1	0.961	0.856-1.079	0.502
pN2	1.141	1.014-1.284	0.028
pN3	2.925	2.591-3.301	<0.001
Histological grade			
Well	1		
Moderate	1.315	1.082-1.599	0.006
Poor	1.217	1.004-1.476	0.046
Undifferentiated	0.998	0.719-1.384	0.991
Unknown	0.956	0.726-1.260	0.751
Primary site			
Fundus of stomach	1		
Body of stomach	0.810	0.669-0.980	0.030
Antrum/Pylorus	0.578	0.477-0.699	<0.001
Overlapping	0.775	0.622-0.965	0.023
Unknown	0.651	0.523-0.810	<0.001
Year of diagnosis			
1988-1993	1		
1994-1998	1.052	0.917-1.207	0.472
1999-2003	1.180	1.043-1.335	0.008
2004-2008	1.892	1.676-2.135	<0.001
Radiation status			
No	1		
Yes	1.175	1.062-1.299	0.002

Abbreviations: eLN, the number of lymph nodes examined; CI, Confidential intervals; GMA, Gastric mucinous adenocarcinoma; NGMA, non-GMA. *: Continues variables.

and logistic regression (**Table 4**). The reason for this decrease in eLN for GMA was unclear. It has been proposed that mucin interferes with the inflammatory response and the immunologic recognition of tumor cells [20, 23]. We hypothesized that the decrease in eLN was related to the reduced immune response. To the best of our knowledge, this has not been reported previously.

Stipulating a minimum eLN was attempted to minimize the impact of surgical dissection on staging, and to improve the ability of prognostic prediction for pN categories. It has been suggested that at least 16 regional lymph nodes be assessed pathologically [16, 17]. If this minimum is not achieved pathologically, stage migration might occur, thereby resulting in inaccuracies with respect to survival prediction [18-20]. Since that, for patients without enough eLN, some arduous methods such as alcohol fat clearing [24], methylene blue injection [25] may be used. Furthermore, it has been reported that inadequate LN assessment directly affects patient survival for the worse [26, 27]. In short, low eLN is always considered as a negative factor. For now, it is unknown whether the standard of minimal eLN is suitable for GMA. According to our results in the current study, it is hard to reach the current recommendations on eLN for GMA. Maybe the standard minimum eLN for GMA should not be similar to that for NGMA.

Our study does have some limitations. It is a retrospective exploratory study. Clinical and pathologic patient information can be heterogeneous because SEER collects information from 12 population-based cancer registries. Moreover, the impact of chemotherapy on the research could not be assessed because the details of adjuvant chemotherapy are not supported by the SEER.

We conclude that GMA is frequently detected at an advanced stage; however the type of GMA is not an independent prognostic factor of survival. The eLN in patients with GMA was significantly less than that for NGMA patients.

Acknowledgements

We thank the department of Surgical Oncology of First Hospital of China Medical University and the College of China Medical University for

technical assistance in this analysis. This work was supported by Natural Science Foundation of Liaoning Province (No. 2014029201) and Program of Education Department of Liaoning Province (L2014307). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Disclosure of conflict of interest

None.

Address correspondence to: Dr Zhen-Ning Wang, Department of Surgical Oncology and General Surgery, The First Hospital of China Medical University, Shenyang 110001, China. Tel: +86-24-83283556; Fax: +86-24-22703578; E-mail: josieon826@sina.cn

References

[1] Siegel RL, Miller KD, Jemal A. Cancer statistics, 2015. CA Cancer J Clin 2015; 65: 5-29.

[2] Zhang M, Zhu GY, Zhang HF, Gao HY, Han XF, Xue YW. Clinicopathologic characteristics and prognosis of mucinous gastric carcinoma. J Surg Oncol 2010; 102: 64-7.

[3] Choi MG, Sung CO, Noh JH, Kim KM, Sohn TS, Kim S, Bae JM. Mucinous gastric cancer presents with more advanced tumor stage and weaker beta-catenin expression than nonmucinous cancer. Ann Surg Oncol 2010; 17: 3053-8.

[4] Kunisaki C, Akiyama H, Nomura M, Matsuda G, Otsuka Y, Ono HA, Shimada H. Clinicopathologic characteristics and surgical outcomes of mucinous gastric carcinoma. Ann Surg Oncol 2006; 13: 836-42.

[5] Yin C, Li D, Sun Z, Zhang T, Xu Y, Wang Z, Xu H. Clinicopathologic features and prognosis analysis of mucinous gastric carcinoma. Med Oncol 2012; 29: 864-70.

[6] Isobe T, Hashimoto K, Kizaki J, Matono S, Murakami N, Kinugasa T, Aoyagi K, Akagi Y. Characteristics and prognosis of mucinous gastric carcinoma. Mol Clin Oncol 2015; 3: 44-50.

[7] Zu H, Wang H, Li C, Xue Y. Clinicopathologic characteristics and prognostic value of various histological types in advanced gastric cancer. Int J Clin Exp Pathol 2014; 7: 5692-700.

[8] Kawamura H, Kondo Y, Osawa S, Nisida Y, Okada K, Isizu H, Uebayasi T, Takahasi M, Hata T. A clinicopathologic study of mucinous adenocarcinoma of the stomach. Gastric Cancer 2001; 4: 83-6.

[9] Lim SW, Kim DY, Kim YJ, Kim SK. Clinicopathologic features of mucinous gastric carcinoma. Dig Surg 2002; 19: 286-90.

[10] Yasuda K, Adachi Y, Shiraishi N, Yamaguchi K, Shiromizu A, Kitano S. Pathology and prognosis of mucinous gastric carcinoma. J Surg Oncol 2001; 76: 272-7.

[11] Japanese Gastric Cancer Association. Japanese Classification of Gastric Carcinoma-2nd English Edition. Gastric Cancer 1998; 1: 10-24.

[12] Jass JR, Sobin LH, Watanabe H. The World Health Organization's histologic classification of gastrointestinal tumors. A commentary on the second edition. Cancer 1990; 66: 2162-7.

[13] Takeshita K KF, Maruyama M, Ochi K, Sunagawa M, Habu H, Endo M. Clinocopathlogical evaluation on mucinous adenocarcinoma of the stomach. Jpn J Gastroenterol Surg 1986; 19: 1711-7.

[14] Koufuji K, Takeda J, Toyonaga A, Kodama I, Aoyagi K, Yano S, Ohta J, Shirouzu K. Mucinous adenocarcinoma of the stomach-clinicopathological studies. Kurume Med J 1996; 43: 289-94.

[15] Ryu SY, Kim HG, Lee JH, Kim DY. Prognosis of early mucinous gastric carcinoma. Ann Surg Treat Res 2014; 87: 5-8.

[16] Edge SB; American Joint Committee on Cancer. AJCC Cancer Staging Manual. 7th edition. New York: Springer; 2010. pp. 648.

[17] Laurent-Puig P, Lievre A, Ducreux M, Loriot MA. [The biological point of view on pharmacogenetics of anticancer agents in colorectal cancer]. Bull Cancer 2008; 95: 935-42.

[18] Lee HK, Yang HK, Kim WH, Lee KU, Choe KJ, Kim JP. Influence of the number of lymph nodes examined on staging of gastric cancer. Br J Surg 2001; 88: 1408-12.

[19] Ichikura T, Ogawa T, Chochi K, Kawabata T, Sugasawa H, Mochizuki H. Minimum number of lymph nodes that should be examined for the International Union Against Cancer/American Joint Committee on Cancer TNM classification of gastric carcinoma. World J Surg 2003; 27: 330-3.

[20] Seevaratnam R, Bocicariu A, Cardoso R, Yohanathan L, Dixon M, Law C. How many lymph nodes should be assessed in patients with gastric cancer? A systematic review. Gastric Cancer 2012; 15 Suppl 1: S70-88.

[21] Wu CY, Yeh HZ, Shih RT, Chen GH. A clinicopathologic study of mucinous gastric carcinoma including multivariate analysis. Cancer 1998; 83: 1312-8.

[22] Choi JS, Kim MA, Lee HE, Lee HS, Kim WH. Mucinous gastric carcinomas: clinicopathologic and molecular analyses. Cancer 2009; 115: 3581-90.

[23] Papadopoulos VN, Michalopoulos A, Netta S, Basdanis G, Paramythiotis D, Zatagias A, Berovalis P, Harlaftis N. Prognostic significance of mucinous component in colorectal carcinoma. Tech Coloproctol 2004; 8 Suppl 1: s123-5.
[24] Duldulao M, Booth C, Denham L, Choi A, Friedman G, Kazanjian K. Alcohol fat clearing increases lymph node yield after surgery for colorectal cancer. Am Surg 2014; 80: 1054-8.
[25] Jepsen RK, Ingeholm P, Lund EL. Upstaging of early colorectal cancers following improved lymph node yield after methylene blue injection. Histopathology 2012; 61: 788-94.
[26] Coburn NG. Lymph nodes and gastric cancer. J Surg Oncol 2009; 99: 199-206.
[27] Hundahl SA. Staging, stage migration, and patterns of spread in gastric cancer. Semin Radiat Oncol 2002; 12: 141-9.