J Gastric Cancer. 2023 Apr;23(2):355-364
https://doi.org/10.5230/jgc.2023.23.e18
pISSN 2093-582X·eISSN 2093-5641

jgc Journal of Gastric Cancer

Original Article

A Nomogram for Predicting Extraperigastric Lymph Node Metastasis in Patients With Early Gastric Cancer

Hyun Joo Yoo [1], **Hayemin Lee** [2], **Han Hong Lee** [3], **Jun Hyun Lee** [4], **Kyong-Hwa Jun** [5], **Jin-jo Kim** [1], **Kyo-young Song** [3], **Dong Jin Kim** [6]

[1]Division of Gastrointestinal Surgery, Department of Surgery, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Incheon, Korea
[2]Department of Surgery, Bucheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Bucheon, Korea
[3]Department of Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea
[4]Department of Surgery, Uijeongbu St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Uijeongbu, Korea
[5]Department of Surgery, St. Vincent's Hospital, College of Medicine, The Catholic University of Korea, Suwon, Korea
[6]Division of Gastrointestinal Surgery, Department of Surgery, Eunpyeong St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

Received: Apr 9, 2023
Revised: Apr 11, 2023
Accepted: Apr 12, 2023
Published online: Apr 24, 2023

Correspondence to
Dong Jin Kim
Division of Gastrointestinal Surgery, Department of Surgery, Eunpyeong St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 1021 Tongil-ro, Eunpyeong-gu, Seoul 03312, Korea.
Email: djdjcap@catholic.ac.kr

ORCID iDs
Hyun Joo Yoo
https://orcid.org/0000-0002-3849-438X
Hayemin Lee
https://orcid.org/0000-0003-1057-0157
Han Hong Lee
https://orcid.org/0000-0002-7541-8490
Jun Hyun Lee
https://orcid.org/0000-0002-9950-5388
Kyong-Hwa Jun
https://orcid.org/0000-0003-3909-5230
Jin-jo Kim
https://orcid.org/0000-0003-1011-8793
Kyo-young Song
https://orcid.org/0000-0002-5840-1638
Dong Jin Kim
https://orcid.org/0000-0001-5103-5607

ABSTRACT

Background: There are no clear guidelines to determine whether to perform D1 or D1+ lymph node dissection in early gastric cancer (EGC). This study aimed to develop a nomogram for estimating the risk of extraperigastric lymph node metastasis (LNM).
Materials and Methods: Between 2009 and 2019, a total of 4,482 patients with pathologically confirmed T1 disease at 6 affiliated hospitals were included in this study. The basic clinicopathological characteristics of the positive and negative extraperigastric LNM groups were compared. The possible risk factors were evaluated using univariate and multivariate analyses. Based on these results, a risk prediction model was developed. A nomogram predicting extraperigastric LNM was used for internal validation.
Results: Multivariate analyses showed that tumor size (cut-off value 3.0 cm, odds ratio [OR]=1.886, P=0.030), tumor depth (OR=1.853 for tumors with sm2 and sm3 invasion, P=0.010), cross-sectional location (OR=0.490 for tumors located on the greater curvature, P=0.0303), differentiation (OR=0.584 for differentiated tumors, P=0.0070), and lymphovascular invasion (OR=11.125, P<0.001) are possible risk factors for extraperigastric LNM. An equation for estimating the risk of extraperigastric LNM was derived from these risk factors. The equation was internally validated by comparing the actual metastatic rate with the predicted rate, which showed good agreement.
Conclusions: A nomogram for estimating the risk of extraperigastric LNM in EGC was successfully developed. Although there are some limitations to applying this model because it was developed based on pathological data, it can be optimally adapted for patients who require curative gastrectomy after endoscopic submucosal dissection.

Keywords: Stomach neoplasms; Lymphatic metastasis; Lymph node excision; Nomograms; Prognosis

Funding
This work was partially supported by the Clinical Trials Center of Eunpyeong St. Mary's Hospital, The Catholic University of Korea.

Conflict of Interest
No potential conflict of interest relevant to this article was reported.

Author Contributions
Conceptualization: K.D.J.; Data curation: Y.H.J., K.D.J.; Formal analysis: Y.H.J., K.D.J.; Investigation: K.D.J.; Methodology: K.D.J.; Project administration: Y.H.J.; Resources: name; L.H., L.H.H., L.J.H., J.K.H., K.J.J., S.K.Y., K.D.J.; Software: K.D.J.; Supervision: L.H.H., K.D.J.; Validation: L.H., L.H.H.,, L.J.H., J.K.H., K.J.J., S.K.Y., K.D.J.; Visualization: name; Y.H.J., K.D.J.; Writing - original draft: Y.H.J., K.D.J.; Writing - review & editing: K.D.J.

INTRODUCTION

With the increase in surgeries for early gastric cancer (EGC), various function-preserving and limited treatments have been studied and considered [1-3]. According to the latest Korean gastric cancer treatment guidelines, endoscopic submucosal dissection (ESD) can be adapted for differentiated mucosal cancer and undifferentiated cancer <2 cm without ulceration [4]. Other mucosal cancers and clinical T1b tumors are indicated for gastrectomy and D1+ lymph node dissection (LND) [4]. If the final pathological result of ESD does not meet the criteria for curative resection, additional gastrectomy with proper LND is needed. However, detailed information on whether D1 or D1+ LND should be performed has not yet been reported. In the Japanese gastric cancer treatment guidelines, the conditions for D1 LND are cT1a tumors that do not meet the criteria for ESD and cT1b differentiated tumor <1.5 cm [5].

Despite the guideline recommendations, no high-level data exist to support the standards for deciding between D1 and D1+ LND in T1 tumors. In fact, a large number of EGC cases involve only the perigastric lymph nodes [6,7], and the percentage of lymph node metastases (LNMs) beyond the perigastric group is relatively low compared to that in stage T2 tumors [6]. For these reasons, many patients do not require extragastric LND. Although D1+ LND may not be difficult for experienced surgeons, there may be definite advantages of omitting extraperigastric LND in some patients who are obese or have adhesions or fibrosis due to post-ESD status. Moreover, in patients with comorbidities or a history of liver cirrhosis and pancreatitis, complete extraperigastric LND of the suprapancreatic area can be dangerous, even in cases of EGC [8-10].

Under these circumstances, it is meaningful to define the patients who require D1+ LND and those who require only D1 LND. Therefore, we aimed to determine the risk factors of extraperigastric LNM in EGC. These risk factors should be considered in future risk estimation models. Using this risk model, a surgeon can determine a more precise plan for high-risk surgical patients who have been diagnosed with EGC, especially in cases of curative gastrectomy after non-curative ESD.

MATERIALS AND METHODS

Between April 2009 and December 2019, 10,716 patients who underwent standard curative gastric cancer surgery at the Catholic Medical Center in Korea were retrospectively reviewed. Patients who were diagnosed with mucosal or submucosal invasion at the final pathological stage, underwent curative (R0) resection without a history of previous chemotherapy, and did not undergo combined resection were enrolled. Patients who underwent additional surgery after an incomplete endoscopic submucosal resection were also included. Patients who had undergone a previous gastric operation, had synchronous cancer, or had an inadequate number of retrieved lymph nodes (<15) were excluded. Patients with insufficient data on differentiation and ambiguous detailed information, such as the depth of the submucosa (sm), existence of lymphovascular invasion, and gross shape, were excluded. Patients with uncertain lymph nodes stations were excluded. A total of 4,482 patients were enrolled in this study.

Basic clinicopathological characteristics including age, sex, American Society of Anesthesiologists (ASA) classification, underlying disease, clinical stage, pathologic stage, resection extent, operation time, type of approach, metastatic lymph node number and rate,

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

and final pathologic stage were investigated. Pathological staging was performed according to the American Joint Committee on Cancer/Union (for International Cancer Control 8th edition) staging system. The circumferential location of the tumor was categorized into 4 classes: great curvature, lesser curvature, anterior wall, and posterior wall. For detailed analysis, each circumferential location was converted into a dummy variable. Ulcerations were categorized into 3 groups based on the state of depression in the gross specimen.

Lymph node stations were defined according to the Japanese Gastric Cancer Association [11]. The numbers of retrieved and metastatic lymph nodes are described for each station. The lymph node stations were categorized into perigastric and extraperigastric groups. For example, in distal gastrectomy, the perigastric group comprises nos. 1, 3, 4sb, 4d, 5, and 6, whereas the total gastrectomy contains nos. 1–6. The D1+ group included nos. 8a and 9 for distal gastrectomy and nos. 8a, 9, and 11p for total gastrectomy. Lymph node station 7 was regarded as an extragastric lymph node similar to the D1+ lymph nodes because we believed D1+ LND was mandatory if there were metastatic lymph nodes in lymph node station 7 for clear dissection. Each group was labelled as positive if a metastatic node was present. The study was approved by the Institutional Review Board (IRB) of the Catholic Medical Center (IRB No. XC20RIDI0055).

Statistical analysis

SAS ver 9.4 (SAS Institute Inc., Cary, NC, USA) was used for the statistical analysis. To compare the clinicopathological characteristics between the study groups, the χ^2 test was used for categorical data and an independent t-test was used for continuous data. Regarding tumor size, the cut-off value was determined using the receiver operating characteristic (ROC) curve, which was 3.0 cm. Univariate and multivariate analyses were used to identify 5 significant risk factors.

We presented descriptive statistics for continuous variables, including the number of participants, mean, median, standard deviation, minimum and maximum values, and interquartile ranges. Subsequently, using the results of the normality test, we performed an independent t-test or the Wilcoxon rank-sum test for each variable. For categorical variables, we present the number of participants and their percentages. Finally, the 2 groups were compared using the χ^2 test or Fisher's exact test.

Logistic regression was used to calculate the odds ratio (OR) for prognosis using identified variables related to patient prognosis. Furthermore, we performed a univariate analysis for each variable to identify significant variables with a 95% confidence interval. Using these variables, multivariate analysis was performed. We selected the final significant variables for the complete model during the multivariate analysis. We developed a nomogram to visualize this new model and individually predict the prognosis of new patients.

RESULTS

A total of 4,482 of 10,716 patients were included based on the inclusion criteria mentioned above. Out of the 4,482 patients, 481 were confirmed to have LNM and 363 had LNM in the perigastric area only, without LNM in lymph node station No. 7 or lymph nodes consistent with the D1+ area. A total of 118 (2.63%) patients presented with extraperigastric lymph nodes. The number of patients with metastases in each lymph node group is shown in **Fig. 1**. Seventeen patients (0.38%) had LNM in all 3 regions.

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

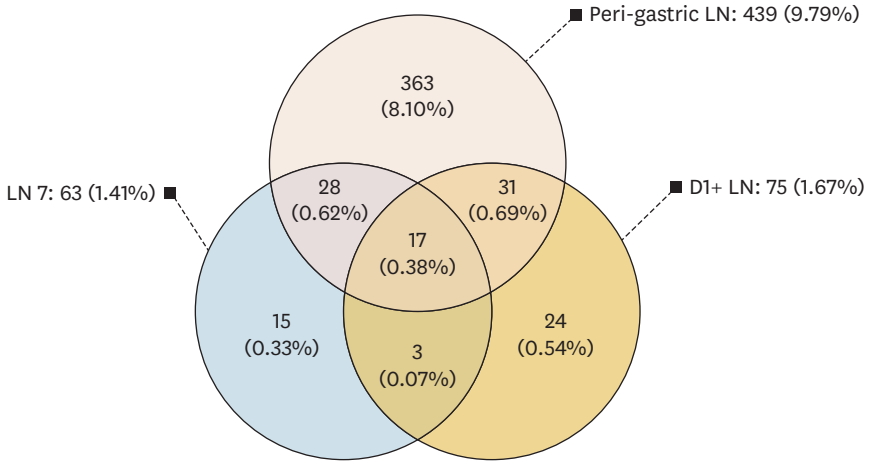

Fig. 1. Status of lymph node metastases according to lymph node station groups.
LN = lymph node.

The basic clinicopathological characteristics between the patient groups with extraperigastric LNM are shown in **Table 1**. The 2 groups showed significant differences in tumor depth, size, differentiation, and combined ulceration.

The percentage of differentiated tumors was 51.97% in the negative group, which was higher than that in the positive group (42.37%; P=0.034). Ulcerations were categorized into 3 groups. In the positive group, 19.49% of the patients had deep depression and 55.08% had slight depression, whereas it was 8.52% and 64.71%, respectively, in the negative group (P<0.001). Before comparing tumor size between the 2 groups, ROC curve analysis was performed to determine the cut-off value. The cut-off value was set at 3.1 cm with an area under the curve of 0.7 (P<0.001). The cut-off value was adjusted to 3.0 cm during univariate and multivariate analyses for clinical usefulness. The positive group had had larger tumors in size (positive vs. negative=3.94±2.11 cm vs. 2.69±1.80 cm; P<0.001). Tumor depth was also greater in the positive group. In the positive group, 83.90% of the patients with extraperigastric LNM had submucosal invasion, whereas only 41.55% in the negative group had invasion. Furthermore, the tumor depth was categorized as T1a, sm1, sm2, or sm3 according to the pathological report. Within this categorization, the difference between the 2 groups was striking. In the positive group, 69.49% of the patients showed invasion deeper than the sm2 level, whereas a similar proportion in the negative group remained only up to T1a (P<0.001).

Univariate and multivariate analyses were performed for factors that showed statistical significance in the clinicopathological characteristics (**Table 2**). In the univariate analysis, tumor size, presence of ulceration, tumor depth, and lymphovascular invasion showed OR>1. For differentiation, the OR was 0.680 (P<0.041), and the reference was established as an undifferentiated tumor. Tumor location in the greater curvature showed a negative effect (OR, 0.540, P=0.536) with marginal significance. In multivariate analyses, all variables with a P<0.1 were included. Non-greater curvature location, larger tumor size, undifferentiated histology, deeper tumor, and the presence of lymphovascular invasion are independent risk factors for extraperigastric LNM. Ulceration was not considered a risk factor in the multivariate analysis.

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

Table 1. Clinicopathologic characteristics between patient groups due to extraperigastric lymph node metastases status

Characteristics	Whole patients (n=4,482)	Extraperigastric lymph node metastases		P-value
		Positive (n=118)	Negative (n=4,364)	
Age (yr)	60.71±11.71	62.64±12.02	60.66±11.70	0.069
Sex				0.574
Male	2,845 (63.48)	72 (61.02)	2,773 (63.54)	
Female	1,637 (36.52)	46 (38.98)	1,591 (36.46)	
BMI (kg/m^2)	24.05±3.18	23.83±2.80	24.06±3.19	0.498
Longitudinal location				0.287
Upper third	401 (8.95)	12 (10.17)	389 (8.91)	
Mid third	1,709 (38.13)	52 (44.07)	1,657 (37.97)	
Lower third	2,372 (52.92)	54 (45.76)	2,318 (53.12)	
Circumferential location				0.194
Lesser curvature	1,670 (37.29)	47 (39.83)	1,623 (37.22)	
Greater curvature	709 (15.83)	11 (9.32)	698 (16.01)	
Anterior wall	957 (21.37)	27 (22.88)	930 (21.33)	
Posterior wall	1,116 (24.92)	31 (26.27)	1,085 (24.88)	
Gross type				0.007
0-I	167 (3.73)	4 (3.39)	163 (3.74)	
0-IIa	214 (4.77)	7 (5.93)	207 (4.74)	
0-IIb	679 (15.15)	13 (11.02)	666 (15.26)	
0-IIc	1,941 (43.31)	39 (33.05)	1,902 (43.58)	
0-III	240 (5.35)	16 (13.56)	224 (5.13)	
Combined	1,241 (27.69)	39 (33.05)	1,202 (27.54)	
Tumor size (cm)	2.72±1.82	3.94±2.11	2.69±1.80	<0.001
Differentiation				0.040
Differentiated	2,318 (51.72)	50 (42.37)	2,268 (51.97)	
Undifferentiated	2,164 (48.28)	68 (57.63)	2,096 (48.03)	
Ulceration				<0.001
No depression	1,198 (26.73)	30 (25.42)	1,168 (26.76)	
Slight depression	2,889 (64.46)	65 (55.08)	2,824 (64.71)	
Deep depression	395 (8.81)	23 (19.49)	372 (8.52)	
Depth				<0.001
Mucosa	2,569 (57.33)	19 (16.10)	2,550 (58.45)	
Submucosa	1,912 (42.67)	99 (83.90)	1,813 (41.55)	
LVI				<0.001
Positive	706 (15.75)	88 (74.58)	618 (14.16)	
Negative	3,776 (84.25)	30 (25.42)	3,746 (85.84)	
pT				<0.001
T1a	2,570 (57.34)	19 (16.10)	2,551 (58.46)	
sm1	586 (13.07)	17 (14.41)	569 (13.04)	
sm2+sm3	1,326 (29.59)	82 (69.49)	1,244 (28.51)	
pN				<0.001
N0	4,001 (89.27)	0 (0.00)	4,001 (91.68)	
N1	326 (7.27)	52 (44.07)	274 (6.28)	
N2	109 (2.43)	34 (28.81)	75 (1.72)	
N3a	38 (0.85)	27 (22.88)	11 (0.25)	
N3b	8 (0.18)	5 (4.24)	3 (0.07)	
p-stage (AJCC 8th)				<0.001
IA	4,001 (89.27)	0 (0.00)	4,001 (91.68)	
IB	326 (7.27)	52 (44.07)	274 (6.28)	
IIA	109 (2.43)	34 (28.81)	75 (1.72)	
IIB	38 (0.85)	27 (22.88)	11 (0.25)	
IIIA	0 (0.00)	0 (0.00)	0 (0.00)	
IIIB	8 (0.18)	5 (4.24)	3 (0.07)	

Continuous variables were expressed with mean ± standard deviation and nominal variables were expressed with number (percentage).
BMI = body mass index; LVI = lymphovascular invasion; sm = submucosa; AJCC = American Joint Committee on Cancer.

https://doi.org/10.5230/jgc.2023.23.e18

Table 2. Univariate and multivariate analysis of possible risk factors for extraperigastric lymph node metastases

Characteristics	Univariate analysis			Multivariate analysis		
	OR	95% CI	P-value	OR	95% CI	P-value
Sex (ref. Female)	0.898	0.617–1.307	0.574			
Longitudinal location						
Mid (ref. Upper)	1.017	0.538–1.924	0.958			
Lower (ref. Upper)	0.755	0.400–1.425	0.386			
Cross-sectional location						
Lesser curvature (ref. No)	1.118	0.769–1.624	0.559			
Greater curvature (ref. No)	0.540	0.289–1.010	0.054	0.490	0.257–0.935	0.030
Anterior wall (ref. No)	1.096	0.709–1.694	0.681			
Posterior wall (ref. No)	1.077	0.711–1.632	0.727			
Circular (ref. No)	2.993	0.701–12.783	0.139			
Tumor size (ref. Small)*	3.277	2.232–4.810	<0.001	1.886	1.257–2.830	0.002
Differentiation (ref. Undifferentiated)	0.680	0.469–0.984	0.041	0.584	0.396–0.861	0.007
Ulceration						
Slight depression (ref. No depression)	0.896	0.578–1.389	0.624			
Deep depression (ref. No depression)	2.407	1.381–4.196	0.002			
pT						
sm1 (ref. T1a)	4.011	2.072–7.766	<0.001	1.853	0.908–3.784	0.090
sm2+sm3 (ref. T1a)	8.850	5.348–14.644	<0.001	2.197	1.208–3.996	0.010
LVI: Positive (ref. Negative)	17.780	11.647–27.143	<0.001	11.125	6.764–18.296	<0.001

LVI = lymphovascular invasion; sm = submucosa; OR = odds ratio; CI= confidence interval.
*Small: tumor size <3.0; Large: tumor size ≥3.0.

Using the possible risk factors in multivariate analysis, a nomogram was developed to estimate the risk of extraperigastric LNM (**Fig. 2**). After calculating the y-value, the probability of extraperigastric LNM was calculated using logarithmic transformation (**Fig. 3**).

The actual rate of LNM and the estimated rate calculated using the newly suggested model were compared. The predicted metastatic rates of all patients were classified into 6 groups according to the metastatic rate: <0.5%, <1%, <3%, <5%, <10%, and ≥10%. The internal validation results are listed in **Table 3**. In risk group 1, in which the predicted risk was <0.5%, the actual risk was 0.422%. For risk group 6, which predicted a risk >10%, the actual value was 15.708%. From the results of the internal validation, there were no significant differences between the model and actual results.

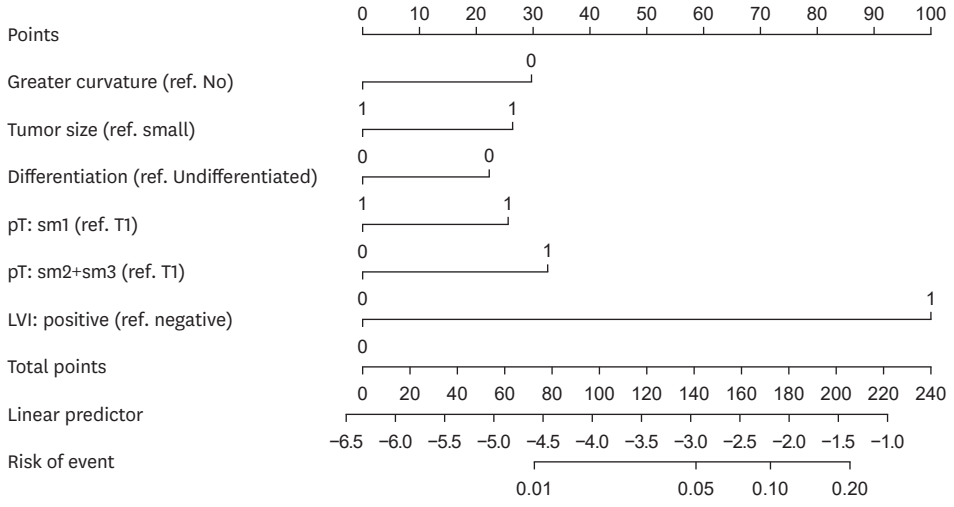

Fig. 2. Nomogram for estimating probability of extraperigastric lymph node metastases and risk factor scoring.
LVI = lymphovascular invasion; sm = submucosa.

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

$$y = -5.0873 - 0.7129 * (Greater\ curvature: Yes) + 0.6345 * (Size: Large) - 0.5386 * (Differentiation: Differentiated) + 0.6169 * (pT: sm1) + 0.7870 * (pT: sm2 + sm3) + 2.4092 * (LVI: positive)$$

$$p = \frac{1}{1 + \exp(-\sum \beta x_i)}$$

Fig. 3. Estimating probability of lymph node metastasis using risk estimation equation.
LVI = lymphovascular invasion; sm = submucosa.

Table 3. Internal validation of a nomogram in current study group

Risk group	Predicted risk of extraperigastric lymph node metastases (%)	Real risk of extraperigastric lymph node metastases (%)	Extraperigastric lymph node metastases		
			Yes (n=118)	No (n=4,364)	Total (n=4,482)
1	<0.5	0.422	5	1,179	1,184
2	<1.0	0.837	12	1,422	1,434
3	<3.0	1.116	13	1,152	1,165
4	<5.0	2.174	1	45	46
5	<10.0	7.960	16	185	201
6	≥10.0	15.708	71	381	452

DISCUSSION

The determination of the extent of lymphadenectomy in EGC has drawn the attention of surgeons. Because the rate of extraperigastric LNM in early-stage patients is relatively low, there are no detailed guidelines for defining the extent of LND. The present study investigated the risk of extraperigastric LNM in patients with EGC who underwent surgical resection. We analyzed 4,482 EGC patients with EGC, with or without LNM. The incidence of LNM was 10.73% (n=481). Most LNM were limited to the perigastric nodes. The incidence of extraperigastric nodes, including No. 7 lymph nodes was only 2.63% (n=118). Univariate and multivariate analyses showed that tumor location, size, depth, differentiation, and lymphovascular invasion were possible risk factors for extraperigastric LNM. Among these factors, we built a risk estimation model for extraperigastric LNM. The model fit well with the study group and could be used to determine precise surgical plans for surgeons with EGC patients, especially those who underwent ESD. To the best of our knowledge, this is the first study to develop a detailed nomogram to identify patients at risk of extraperigastric LNM. This means that we can calculate the percentage of extraperitoneal LNM and differentiate patients who need D1+ LND from those who only require D1 LND. The power of this study comes from the difficult patient situations.

The possibility of extraperigastric LNM has been the reason for extensive LND in gastric cancer treatment. Traditionally, LNM is believed to occur at a station close to the tumor [12]. For early gastric tumors, LNM in the extraperigastric group was relatively low [6]. LNM has been reported in approximately 1% of ESD candidates [13]. The incidence of LNM varies from 2.6%–10.6% in tumors with submucosal invasion [11], and overlooking LNM can lead to poor outcomes. Extraperigastric LNM is also a poor prognostic factor compared with perigastric LNM [14]. In addition, skip metastasis to the extraperigastric area is associated with poor prognosis [15]. Those studies were performed in both early and advanced gastric cancers. In EGC, one study showed 2.4% and 2.8% of extraperigastric LNM through stepwise and skip patterns, respectively [16]. The authors focused on the risk of extraperigastric skip metastasis

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

and revealed that tumor size and lymphatic invasion were independent risk factors. This result is similar to that of our study; however, ours is the first to present a detailed nomogram for extraperigastric LNM in EGC.

Analysis of the risk factors for LNM for EGC subgroups is beneficial. Therefore, we conclude that limited D1 LND, which can reduce perioperative complications without increasing the risk of LNM, should be scrutinized. Defining patients who are suitable only for D1 LND is important for safety and to avoid unnecessary procedures. A previous study showed a trend of longer operation time and more blood loss in extended lymphadenectomy, especially for beginners who performed the surgery in <20–25 cases [17,18]. For experienced surgeons, extensive dissection of the extraperigastric lymph nodes may not be a significant burden. However, it is true that complete extraperigastric LND is not an easy procedure for experienced surgeons. Extraperigastric LND can be related to postoperative complications, including bleeding around major vessels, anastomotic leakage, and ileus [19]. Another example is the difference in the morbidity rate of extensive lymphadenectomy between Eastern and Western patients. Due to the limited number of gastric cancer cases and the high number of obese patients who have difficulty obtaining adequate intra-abdominal exposure, Western surgeons have reported higher morbidity and mortality rates [20]. This is a major reason why several Western surgeons do not reach the threshold for extended lymphadenectomy [18].

We can identify candidate patients who can benefit from minimizing LND. As elderly patients tend to have a higher incidence of cardiopulmonary and neurological comorbidities and higher ASA classification scores [21], the general risk during the perioperative period increases. Furthermore, patients with various underlying diseases should be considered. Patients with end-stage renal disease (ESRD) have a higher risk for operation because of the difficulty in volume status management [22]. In addition to ESRD, patients with liver cirrhosis are problematic because of their bleeding tendencies due to inadequate hepatic function [23].

This study had some limitations. Because the data were reviewed retrospectively, not all details could be recognized. For example, tumor depth data must be collected from the pathology report, which does not reveal the actual clinical T-staging. Generally, clinical staging depends on gross findings. Therefore, the results may have been underestimated or overestimated. In cases of underestimation of the T stage, insufficient LND may be performed. Thus, more frequent post-operative surveillance, such as every 3 months, may be needed.

Furthermore, these data included patients with final pathology that fulfilled the indications for ESD. Because preoperative studies cannot predict the pathological stage, physicians decided to perform preoperative imaging studies based on personal experiences. In this context, the nomogram is notable because it shows the actual circumstances after surgery.

Although this study aimed to develop a prediction model for extraperigastric LNM, the model itself requires considerable information. Some information was accessible only after surgery. Furthermore, the suggested model has only been proven by internal validation; external validation has not yet been performed. When further external validation supports the results, it could be widely used, and further precise adjustments would also be available. Particularly, it may be a helpful reference for patients requiring curative gastrectomy after ESD. Further prospective studies are required for external validation and long-term outcomes.

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

In conclusion, we successfully developed a nomogram for estimating the risk of extraperigastric LNM. Although there are some limitations to applying this model in clinical practice because it was developed based on pathological data, it can be optimally adapted for patients who require curative gastrectomy after ESD.

REFERENCES

1. Hirai Y, Abe S, Makiguchi ME, Sekiguchi M, Nonaka S, Suzuki H, et al. Endoscopic resection of undifferentiated early gastric cancer. J Gastric Cancer 2023;23:146-158.
PUBMED | CROSSREF
2. Booka E, Takeuchi H. Recent advances in sentinel node navigation surgery for early gastric cancer. J Gastric Cancer 2023;23:159-170.
PUBMED | CROSSREF
3. Information Committee of the Korean Gastric Cancer Association. Korean Gastric Cancer Association-led nationwide survey on surgically treated gastric cancers in 2019. J Gastric Cancer 2021;21:221-235.
PUBMED | CROSSREF
4. Kim TH, Kim IH, Kang SJ, Choi M, Kim BH, Eom BW, et al. Korean practice guidelines for gastric cancer 2022: an evidence-based, multidisciplinary approach. J Gastric Cancer 2023;23:3-106.
PUBMED | CROSSREF
5. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2021 (6th edition). Gastric Cancer 2023;26:1-25.
PUBMED | CROSSREF
6. Asao T, Hosouchi Y, Nakabayashi T, Haga N, Mochiki E, Kuwano H. Laparoscopically assisted total or distal gastrectomy with lymph node dissection for early gastric cancer. Br J Surg 2001;88:128-132.
PUBMED | CROSSREF
7. Tokunaga M, Ohyama S, Hiki N, Fukunaga T, Yamada K, Sano T, et al. Investigation of the lymphatic stream of the stomach in gastric cancer with solitary lymph node metastasis. World J Surg 2009;33:1235-1239.
PUBMED | CROSSREF
8. Shinohara T, Hanyu N, Kawano S, Tanaka Y, Murakami K, Watanabe A, et al. Clinical significance of medial approach for suprapancreatic lymph node dissection during laparoscopic gastric cancer surgery. Surg Endosc 2014;28:1678-1685.
PUBMED | CROSSREF
9. Schwarz RE, Smith DD. Extended lymph node dissection for gastric cancer: who may benefit? Final results of the randomized Dutch gastric cancer group trial. J Clin Oncol 2005;23:5404-5405.
PUBMED | CROSSREF
10. Lee JH, Kim J, Cheong JH, Hyung WJ, Choi SH, Noh SH. Gastric cancer surgery in cirrhotic patients: result of gastrectomy with D2 lymph node dissection. World J Gastroenterol 2005;11:4623-4627.
PUBMED | CROSSREF
11. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2018 (5th edition). Gastric Cancer 2021;24:1-21.
PUBMED | CROSSREF
12. Maruyama K, Gunvén P, Okabayashi K, Sasako M, Kinoshita T. Lymph node metastases of gastric cancer. General pattern in 1931 patients. Ann Surg 1989;210:596-602.
PUBMED | CROSSREF
13. Gotoda T. Endoscopic resection of early gastric cancer. Gastric Cancer 2007;10:1-11.
PUBMED | CROSSREF
14. Son T, Hyung WJ, Kim JW, Kim HI, An JY, Cheong JH, et al. Anatomic extent of metastatic lymph nodes: still important for gastric cancer prognosis. Ann Surg Oncol 2014;21:899-907.
PUBMED | CROSSREF
15. Choi YY, An JY, Guner A, Kang DR, Cho I, Kwon IG, et al. Skip lymph node metastasis in gastric cancer: is it skipping or skipped? Gastric Cancer 2016;19:206-215.
PUBMED | CROSSREF
16. Lee SE, Lee JH, Ryu KW, Cho SJ, Lee JY, Kim CG, et al. Sentinel node mapping and skip metastases in patients with early gastric cancer. Ann Surg Oncol 2009;16:603-608.
PUBMED | CROSSREF

https://doi.org/10.5230/jgc.2023.23.e18

jgc Journal of Gastric Cancer

17. Degiuli M, Sasako M, Calgaro M, Garino M, Rebecchi F, Mineccia M, et al. Morbidity and mortality after D1 and D2 gastrectomy for cancer: interim analysis of the Italian Gastric Cancer Study Group (IGCSG) randomised surgical trial. Eur J Surg Oncol 2004;30:303-308.
PUBMED | CROSSREF

18. Strong VE, Yoon SS. Extended lymphadenectomy in gastric cancer is debatable. World J Surg 2013;37:1773-1777.
PUBMED | CROSSREF

19. Kim MC, Kim HH, Jung GJ. Surgical outcome of laparoscopy-assisted gastrectomy with extraperigastric lymph node dissection for gastric cancer. Eur J Surg Oncol 2005;31:401-405.
PUBMED | CROSSREF

20. Curet MJ. Special problems in laparoscopic surgery. Previous abdominal surgery, obesity, and pregnancy. Surg Clin North Am 2000;80:1093-1110.
PUBMED | CROSSREF

21. Takeuchi D, Koide N, Suzuki A, Ishizone S, Shimizu F, Tsuchiya T, et al. Postoperative complications in elderly patients with gastric cancer. J Surg Res 2015;198:317-326.
PUBMED | CROSSREF

22. Lee H, Park CH, Park SM, Kim W, Chin HM, Kim JJ, et al. Safety of laparoscopic radical gastrectomy in gastric cancer patients with end-stage renal disease. J Gastric Cancer 2018;18:287-295.
PUBMED | CROSSREF

23. Kim DJ, Park CH, Kim W, Jin HM, Kim JJ, Lee HH, et al. Safety of laparoscopic radical gastrectomy in gastric cancer patients with liver cirrhosis. Surg Endosc 2017;31:3898-3904.
PUBMED | CROSSREF