The optimal extent of lymph node dissection in gastroesophageal junctional cancer: retrospective case control study

Won Ho Han¹, Bang Wool Eom¹, Hong Man Yoon¹, Daniel Reim², Young-Woo Kim¹, Moon Soo Kim³, Jong Mog Lee³ and Keun Won Ryu¹*

Abstract

Background: Recently, the incidence of gastroesophageal junction (GEJ) cancer has been increasing in Eastern countries. Mediastinal lymph node (MLN) metastasis rates among patients with GEJ cancer are reported to be 5–25%. However, survival benefits associated with MLN dissection in GEJ cancer has been a controversial issue, especially in Eastern countries, due to its rarity and potential morbidity.

Methods: We retrospectively reviewed 290 patients who underwent surgery for GEJ cancer at the National Cancer Center in Korea from June 2001 to December 2015. Clinicopathologic characteristics and surgical outcomes were compared between patients without MLN dissection (Group A) and patients with MLN dissection (Group B). Prognostic factors associated with the survival rate were identified in a multivariate analysis.

Results: Twenty-nine (10%) patients underwent MLN dissection (Group B). Three of 29 patients (10.3%) showed a metastatic MLN in Group B. The 5-year disease-free survival rate was 79.5% in Group A and 33.9% in Group B (P < 0.001). The multivariate analysis revealed that abdominal LN dissection, pT category, and pN category were statistically significant prognostic factors. LNs were the most common site for recurrence in both groups.

Conclusion: Abdominal LN dissection and pathologic stage are the important prognostic factors for type II and III GEJ cancer rather than mediastinal lymph node dissection.

Keywords: Gastroesophageal junction cancer, Gastric cancer, Lymphadenectomy, Mediastinal lymph node dissection, Siewert type

Background

While gastroesophageal junction (GEJ) cancer has been commonly observed in Western countries, the incidence of GEJ cancer is still rare but has been increasing in Eastern countries in recent years [1, 2]. The Siewert classification system is widely used to classify GEJ cancer according to the distance from the tumor epicenter to the GE junction [3]. However, there is a controversy regarding whether GEJ cancer should be classified as gastric or esophageal cancer [4]. The American Joint Committee on Cancer/Union for International Cancer Control (AJCC/UICC) staging (7th edition, published in 2010) classifies Siewert type I and II as esophageal cancer and type III involving the GEJ as esophageal cancer [4]. However, the 8th edition (published in 2017) classifies Siewert type II as esophageal cancer, and Siewert type III was changed to gastric cancer [5].

Due to the vague anatomical location of GEJ cancer, the range of esophagogastric resection, the staging system, and the extent of lymph node dissection, including mediastinal lymph nodes (MLNs) for this disease entity have been controversial [3, 4]. MLN metastasis rates among patients with GEJ junction type II and III adenocarcinoma are reported to be 5–25% [6–9]. However, MLN dissection is rarely performed in Eastern countries due to the rarity of type I and its invasiveness and associated morbidity. Furthermore, whether MLN dissection has survival benefits has been a debatable issue. [6, 10–13]
In this study, we investigated the optimal extent of LN dissection in GEJ cancer via the analysis of the distribution of lymph node metastasis, prognostic factors and recurrence patterns in GEJ cancer.

**Methods**

A total of 290 patients who were diagnosed with GEJ adenocarcinoma at the National Cancer Center in Korea between June 2001 and December 2015 and underwent curative gastric resection were included. Multiple primary gastric cancer at initial diagnosis, recurrent gastric cancer after curative gastrectomy patients, and those with a history of preoperative chemotherapy were excluded.

Clinicopathologic factors and surgical outcomes of enrolled patients were retrospectively analyzed. Included in the analysis were the patient’s age, sex, preoperative BMI, co-morbidity represented by the American Society of Anesthesiologist (ASA) score, tumor size, location, extent of LN dissection, number of harvested and metastatic LNs, differentiation, Lauren’s classification, surgical procedures, stage, postoperative complications, adjuvant chemotherapy, recurrence status and location.

The study population was classified into patients without MLN dissection (Group A) and those with MLN dissection (Group B). Siewert’s classification was based on the distance from the tumor epicenter to the GEJ measured by preoperative endoscopic examination or the pathologic report obtained after surgery [14]. The dissected LN station and status of lymph node metastasis were investigated in both groups. The LN classification was determined according to Japanese gastric cancer treatment guidelines. [15] Complications were classified and graded according to the Clavien-Dindo classification [16]. The initial recurrence site was defined as the location where the first recurrence was found on the first follow-up examination. To evaluate the risk factors for the disease-free survival rate, extent of lymph node dissection, age, sex, Siewert type, tumor size, histology, proximal margin, stage, and adjuvant chemotherapy were included in the multivariate analysis.

Endoscopy and abdominopelvic CT were performed every 6 months for 5 years post-surgery, and an endoscopy was performed annually for 5 years post-surgery. Recurrence patterns were classified as locoregional, peritoneal, and hematogenous metastasis. This study was approved by the Institutional Review Board of the National Cancer Center (No.NCC2017–0224).

Clinical and pathological variables were analyzed using the χ² test (or Fisher’s exact test) and Student’s t-test for normally distributed continuous data. Univariable analyses of the survival rate were conducted using the log-rank test. All variables with a univariable P-value < 0.05 were included in the multivariable analysis using a Cox proportional hazards model. Variables with a P-value < 0.05 were considered statistically significant. All analyses were performed using SAS® version 9.1.3 for Windows® (SAS Institute, Cary, North Carolina, USA).

**Results**

**Patient demographics and surgical outcomes**

Of the 290 total patients, 29 (10%) patients underwent MLN dissection (group B) (Table 1). The proportion of patients classified as Siewert type II was higher in group B (39.5% for Group A vs. 62.1% for Group B, p = 0.019). In Group B, the tumor size was larger (4.4 ± 2.5 for Group A vs. 5.7 ± 2.9 for Group B, p = 0.025), and more invasive (pT category p = 0.035), and more commonly involved LN metastasis (pN category p = 0.006). While 12 patients (41.4%) underwent esophagectomy (Ivor Lewis) in group B, none of the group A patients underwent esophagectomy. The proximal margin was significantly longer in group B (1.9 ± 1.1 in Group A vs. 4.6 ± 4.9 in Group B, p < 0.001). Abdominal D2 or additional LN dissection was performed more frequently in Group A patients. The number of patients who underwent adjuvant chemotherapy was also higher for group B.

**LN dissection and metastasis**

Distribution of metastatic lymph nodes among the dissected lymph nodes in each LN station was compared between the groups (Table 2). Of the 261 patients in group A, the lymph node stations were not classified in 54 patients. Three patients in group B (10.3%) showed metastatic MLNs. All these patients were Siewert type II patients, and one patient had metastasis of the lower and upper mediastinum simultaneously.

In group A, the rate of abdominal LN metastasis of LN #1 (17.43%), #2 (15.81%), #3 (14.97%) and #7 (9.94%) was high, whereas group B had a higher rate of LN metastasis in all areas except the distal stomach (LN #5 and #6), splenic region (LN #10 and #11d) and LN #12a.

**Postoperative complications**

Surgical complication rates were 37.9% in group B and 30.3% in group A (Table 3). Severe complications (>Clavien-Dindo grade II) were detected in 4 (13.8%) and 31 (11.9%) cases (p = 0.397). Respiratory complications were significantly higher in group B (24.1%) compared to those in group A (7.3%) (p = 0.003). Postoperative mortality was 3.4 and 1.1%, respectively (p = 0.345).

**Multivariable analysis of prognostic factors**

The five-year disease-free survival rate was 79.5% in group A and 33.9% in group B (P < 0.001) (Fig. 1). The five-year overall survival rate was 80.9% in group A and 31.9% in group B (P < 0.001) (Fig. 2). Two hundred eighty-seven patients were included in the survival analysis.
analyses, excepting 3 patients who were included in the analysis for postoperative mortality within 30 days. The five-year disease-free survival rate was 94.3% in group A and 42.5% in group B ($P < 0.001$) (Fig. 3). However there was no difference in survival between the two groups in pStage III,IV (37% vs 20% $p = 0.433$) (Fig. 4).

In the univariate analysis, MLN dissection, D1 + dissection of abdominal LNs, longer tumor size, higher pT category, pN category and pM category, undifferentiated histology, and treatment with chemotherapy were associated with statistically worse survival (Table 4). A Cox proportional hazards model indicated that the extent of abdominal LN dissection was an independent prognostic factor (HR = 3.174, CI95% 1.302–7.738 $p = 0.011$) along with pT category (HR = 2.807, CI95% 1.309–6.017 $p = 0.008$) and pN category (HR = 3.815, CI95% 1.722–8.455 $p < 0.001$).

**Recurrence pattern**

The recurrence pattern was classified according to the site of initial recurrence (Table 5). A total of 40 patients (33.3%) in group A and 15 patients (51.7%) in group B revealed recurrences during the follow-up period. Multiple recurrences detected simultaneously were also

### Table 1 Demographics of gastroesophageal junction cancer patients

|                                     | Patients without MLND Group A ($N = 261$) | Patients with MLND Group B ($N = 29$) | Value     |
|-------------------------------------|------------------------------------------|---------------------------------------|-----------|
| Age                                 | 60.6 ± 12.1                              | 61.4 ± 11.0                           | 0.751     |
| Sex                                 |                                          |                                       | 0.641     |
| Male                                | 200 (76.6%)                              | 24 (82.8%)                            |           |
| Female                              | 61 (23.4%)                               | 5 (17.2%)                             |           |
| BMI*                                | 23.6 ± 3.5                               | 23.0 ± 3.5                            | 0.492     |
| ASA score**                         |                                          |                                       | 0.809     |
| 0                                   | 82 (31.4%)                               | 10 (34.4%)                            |           |
| 1                                   | 162 (62.0%)                              | 17 (58.6%)                            |           |
| 2 or more                           | 17 (6.5%)                                | 2 (6.8%)                              |           |
| Siewert Type                         |                                          |                                       | 0.019     |
| Type II                             | 103 (39.5%)                              | 18 (62.1%)                            |           |
| Type III                            | 158 (60.5%)                              | 11 (37.9%)                            |           |
| Tumor size                          | 44 ± 2.5                                 | 5.7 ± 2.9                             | 0.025     |
| Surgical procedure                  |                                          |                                       | < 0.001   |
| Total gastrectomy                   | 238 (91.2%)                              | 16 (55.2%)                            |           |
| Proximal gastrectomy                | 23 (8.8%)                                | 1 (3.4%)                              |           |
| Esophagectomy (Ivor Lewis)          | 0 (0%)                                   | 12 (41.4%)                            |           |
| Splenectomy                         | 17 (6.5%)                                | 1 (3.4%)                              | 1.000     |
| Yes                                 | 244 (93.5%)                              | 28 (96.6%)                            |           |
| Histopathological type              |                                          |                                       | 0.064     |
| Differentiated                      | 103 (39.8%)                              | 16 (56.2%)                            |           |
| Undifferentiated                    | 142 (54.8%)                              | 13 (44.8%)                            |           |
| Others                              | 14 (5.4%)                                | 0 (0%)                                |           |
| Lauren classification               |                                          |                                       | 0.006     |
| Intestinal                          | 144 (55.2%)                              | 12 (41.4%)                            |           |
| Diffuse                             | 79 (30.3%)                               | 8 (27.6%)                             |           |
| Mixed                               | 24 (9.2%)                                | 2 (6.9%)                              |           |
| Unknown                             | 14 (5.4%)                                | 7 (24.1%)                             |           |
| Proximal margin                     | 1.9 ± 1.1                                | 4.6 ± 4.9                             | < 0.001   |
| Extent of Abdominal                 |                                          |                                       | < 0.001   |
| LN dissection                       |                                          |                                       |           |
| D1+                                 | 36 (13.8%)                               | 15 (51.7%)                            |           |
| D2 or more                          | 225 (86.2%)                              | 14 (48.3%)                            |           |
| Harvested LNs                       | 42.4 ± 16.7                              | 43.1 ± 14.6                           | 0.827     |
| Metastatic LNs                      | 3.0 ± 6.4                                | 5.8 ± 6.7                             | 0.043     |
| T category                          |                                          |                                       | 0.035     |
| pT1                                 | 107 (41.0%)                              | 6 (20.7%)                             |           |
| pT2                                 | 45 (17.2%)                               | 5 (17.2%)                             |           |

* MLND mediastinal lymph node dissection
* BMI body mass index (kg/m²)
** ASA American Society of Anesthesiologists
*** AJCC 7th edition: Esophagus and Esophagogastric Junction
included. LN recurrence (50%) was the most common
type of recurrence in group B. LN recurrence and
hematogenous metastasis occurred at the same rate
(34.7%) in group A. When comparing patterns of LN
recurrence, the MLN recurrence was more common in
group B (50%, 4/8), whereas the paraaortic LN recur-
rence rate was more common (81%, 13/16) in group A.

Among patients who received adjuvant chemotherapy,
recurrence was significantly increased from 42.9% (12
cases) to 57.1% (16 cases) when the delay of adjuvant
chemotherapy was more than 8 weeks. (\(p = 0.021\)).

**Discussion**
In this study, the pathologic stage (pT category, pN
category) and extent of abdominal LN dissection were
significant prognostic factors rather than MLN dissec-
tion and the Siewert classification type in GEJ cancer.
Even though patients with MLN dissection had more
advanced disease and a poor prognosis, the analysis
of the recurrence pattern showed that MLN dissec-
tion did not reduce MLN recurrence. In addition, the
respiratory complications increased after MLN dissec-
tion. The prognostic significance of MLN dissection
in GEJ cancer was not conclusive in this study.

In this study, none of the patients were diagnosed
with Siewert type I adenocarcinoma. Unlike studies
conducted in Western countries [3], studies in Korea
and Japan reported the rates of Siewert type I cancer
to be very low or close to zero in comparison with
the rates of Siewert type II and III cancers [17, 18].

**Table 2** Comparison of LN metastasis based on lymph node station

| LN station         | Group A (N = 207a) | Group B (N = 29) |
|--------------------|--------------------|------------------|
|                    | No. of Patients with Metastatic LNs | No. of Patients with LN dissection | Percent (%) | No. of Patients with Metastatic LNs | No. of Patients with LN dissection | Percent (%) |
| Upper mediastinum  | 0                   | 0                | 0            | 1                    | 12                | 8.3          |
| Middle mediastinum | 0                   | 0                | 0            | 0                    | 11                | 0            |
| Lower mediastinum  | 0                   | 0                | 0            | 3                    | 29                | 10.3         |
| 1                  | 38                  | 207              | 18.3         | 1                    | 14                | 57.1         |
| 2                  | 31                  | 196              | 15.8         | 5                    | 11                | 45.4         |
| 3                  | 31                  | 207              | 14.9         | 9                    | 14                | 64.2         |
| 4d                 | 4                   | 190              | 2.1          | 1                    | 10                | 100          |
| 4sa                | 4                   | 191              | 2.1          | 2                    | 9                 | 22.2         |
| 4sb                | 5                   | 203              | 2.4          | 1                    | 11                | 9.0          |
| 5                  | 3                   | 196              | 1.5          | 0                    | 9                 | 0            |
| 6                  | 2                   | 197              | 1.0          | 0                    | 12                | 0            |
| 7                  | 19                  | 191              | 9.9          | 4                    | 14                | 28.5         |
| 8                  | 9                   | 119              | 7.5          | 1                    | 8                 | 12.5         |
| 9                  | 15                  | 189              | 7.9          | 4                    | 11                | 36.3         |
| 10                 | 5                   | 95               | 5.2          | 0                    | 4                 | 0            |
| 11p                | 11                  | 171              | 6.4          | 1                    | 7                 | 14.2         |
| 11d                | 4                   | 128              | 3.1          | 0                    | 5                 | 0            |
| 12a                | 4                   | 146              | 2.7          | 0                    | 10                | 0            |
| Para aortic LN     | 3                   | 9                | 33.3         | 0                    | 2                 | 0            |

* Of the 261 patients in group A, lymph node station were not classified in 54 patients

**Table 3** Postoperative Complications

|                      | Group A (N = 261) | Group B (N = 29) | Value |
|----------------------|------------------|------------------|-------|
| All complication     | 79 (30.3%)       | 11 (37.9%)       | 0.397 |
| Severe complication  | 31 (11.9%)       | 4 (13.8%)        | 0.764 |
| above CD grade III   |                  |                  |       |
| Anastomosis related  | 23 (8.8%)        | 5 (17.2%)        | 0.145 |
| complication (leakage, stricture) |
| Respiratory related  |                  |                  |       |
| Complication (pneumonia, pleural effusion, pneumothorax) | 19 (7.3%) | 7 (24.1%) | 0.003 |
| Postoperative mortality | 3 (1.1%) | 1 (3.4%) | 0.345 |

*CD clavien dindo classification
Consequently, concern was focused on the characteristics and treatment of Siewert type II GEJ cancer in Eastern Asian countries.

MLN metastasis rates in GE junction Type II and III adenocarcinomas are reported to be 5–25% [6–9], and postoperative MLN recurrence rates are reported to be 0–11% [6, 10, 11, 19]. In this study, none of the type III patients showed recurrence in the mediastinum. Considering that MLN dissection can increase respiratory complications in this study, MLN dissection seems to be unnecessary for type III GEJ cancer in Eastern Asian patients.

There has been controversy as to whether GEJ cancer should be classified and treated as esophageal cancer or...
gastric cancer [18]. The results of recent studies suggest that type II GEJ cancer should be classified as esophageal cancer including MLN dissection [14, 20]. However, in this study, MLN recurrence rates were higher in patients who underwent MLN dissection, even though more advanced-staged patients had been selected for MLN dissection. This suggests that MLN dissection might not be effective in preventing MLN recurrence in the present study. Similar results of a higher recurrence rate were found in a previous study in which patients underwent MLN dissection [11]. For this reason, further studies are needed to determine the necessity of MLN dissection in GEJ cancer.

Recent studies have reported satisfactory prognoses for early stage GEJ cancer following total gastrectomy and abdominal LN dissection, and some of these studies have reported no mediastinal recurrence after surgery [10, 19]. This suggests that sufficient abdominal

Fig. 3 Five years Disease free survival according to pathologic stage. The five-year disease-free survival rate was 94.3% in group A and 42.5% in group B ($P < 0.001$)

Fig. 4 Five years Disease free survival according to pathologic stage. However there was no difference in survival between the two groups in pStage III/IV (37% vs 20% $P = 0.433$)
LN dissection is more important than MLN dissection in GEJ cancer. However, there have been few studies comparing the prognosis according to the extent of abdominal LN dissection. The necessity of D2 dissection in GEJ adenocarcinoma should be considered based on the results of this study.

Similar to the results of previous studies [9, 16], LN metastasis rates were high for LN stations #1, 2, 3, and 7, and LN metastasis rates were low for distal stomach LNs #5 and #6 in patients with GEJ cancer (0–3.5%). The rate of LN metastasis at the suprapancreatic area (#8a, #9 and #11p) was found to be 12.5–36.3% for the

**Table 4 Multivariable analysis of prognostic factor (Disea fee survival)**

|                      | Number of patients | Disease free survival rates (%) | P value (Log rank test) | Hazard ratio (95% CI) | P value |
|----------------------|--------------------|---------------------------------|-------------------------|-----------------------|---------|
| **Age**              |                    |                                 |                         |                       |         |
| < 60                 | 165                | 77.0                            | 0.383                   |                       |         |
| ≥ 60                 | 122                | 74.6                            |                         |                       |         |
| **Sex**              |                    |                                 |                         |                       |         |
| Male                 | 221                | 75.6                            | 0.815                   |                       |         |
| Female               | 66                 | 77.3                            |                         |                       |         |
| **Mediastinal LN dissection** |                |                                 | < 0.001                 | 0.328                 |         |
| No                   | 259                | 79.5                            |                         |                       |         |
| Yes                  | 28                 | 33.9                            | 1.473 (0.678–3.199)     |                       |         |
| **Abdominal LN dissection** |                |                                 | 0.043                   | 0.011                 |         |
| D2 or more           | 238                | 81.4                            |                         |                       |         |
| D1+                  | 49                 | 65.3                            | 3.174 (1.302–7.738)     |                       |         |
| **Siewert Type**     |                    |                                 | 0.870                   |                       |         |
| Type II              | 120                | 79.2                            |                         |                       |         |
| Type III             | 167                | 73.7                            |                         |                       |         |
| **Tumor size**       |                    |                                 | < 0.001                 | 0.731                 |         |
| < 4 cm               | 151                | 86.8                            |                         |                       |         |
| ≥ 4 cm               | 136                | 64.0                            | 1.113 (0.487–1.656)     |                       |         |
| **pT category**      |                    |                                 | < 0.001                 | 0.008                 |         |
| pT1, T2              | 160                | 90.0                            |                         |                       |         |
| pT3, T4              | 217                | 58.3                            | 2.807 (1.309–6.017)     |                       |         |
| **pN category**      |                    |                                 | < 0.001                 | < 0.001               |         |
| pN0                  | 163                | 93.9                            |                         |                       |         |
| pN+                  | 124                | 52.4                            | 3.815 (1.722–8.455)     |                       |         |
| **pM category**      |                    |                                 | < 0.001                 | 0.070                 |         |
| pM0                  | 282                | 77.3                            |                         |                       |         |
| pM1                  | 5                  | 0.0                             | 2.754 (0.920–8.241)     |                       |         |
| **Histology**        |                    |                                 | 0.025                   | 0.109                 |         |
| Differentiated       | 117                | 82.1                            |                         |                       |         |
| Undifferentiated     | 155                | 74.2                            | 1.469 (0.918–2.350)     |                       |         |
| **Proximal margin**  |                    |                                 | 0.445                   |                       |         |
| ≥ 2 cm               | 140                | 76.4                            |                         |                       |         |
| < 2 cm               | 147                | 75.5                            |                         |                       |         |
| **Chemotherapy**     |                    |                                 | < 0.001                 | 0.096                 |         |
| No                   | 179                | 90.5                            |                         |                       |         |
| Yes                  | 108                | 51.9                            | 1.751 (0.905–3.388)     |                       |         |

*PM category: 3cases were diagnosed with washing cytology positive and 3cases were diagnosed with paraaortic LN metastasis in final pathology*
MLN dissection group (group B) indicating that abdomi-
nal LN dissection is more important for advanced GEJ

cancer. LN#2 is known to be important for LN dissec-
tion of GEJ cancer as it follows the left inferior phrenic
artery and drains into the paraaortic LNs. Approximately
70% of patients who have paraaortic LN recurrence have
been reported to show metastasis at LN#2 in the initial
operation [21]. In this study, of the 15 patients who had
paraaortic LN recurrence, 9 patients (60%) showed LN
#2 metastasis in the initial operation.

In multivariate analysis, the pT category and pN cat-

gory were independent prognostic factors rather than
MLND or the Siewert classification type. In this study,
no significant survival difference was found between
Siewert types. A study compared survival rates and re-
ported that tumor location was associated with cancer
prognosis [22], while others reported that Siewert type
was not associated with cancer prognosis and that
baseline stage had a stronger influence on cancer prog-
nosis [6].

Postoperative complications were slightly higher in
mediastinal LN dissection group (group B). postopera-
tive complications may lead to delay or omission of ad-
juvant chemotherapy. Recent studies suggest that delay
or omission of adjuvant chemotherapy may have an im-

cact survival in GEJ cancer [23, 24]. Although adjuvant
chemotherapy showed less prognostic relevance, among
patients who received adjuvant chemotherapy, recur-
rence was significantly increased when the delay of
adjuvant chemotherapy was more than 8 weeks in the
present study.

The present study has several limitations. First, it was
conducted retrospectively at a single institution and thus
did not include a high enough number of patients who
underwent MLN dissection. Selection bias may be
present as retrospective studies, and the difference in
clinicopathologic characteristics between the two
groups could have the possibility of affecting the out-
come. Therefore, relatively few patients had MLN recur-
rence in this study; thus, statistical results
should be interpreted with caution. Moreover, the re-
results are not comparable to Western series because
the multimodal treatment concepts, such as neoadju-
vant chemotherapy or chemoradiation, are not applied
in Eastern Asian patients. Furthermore, biologic and
ethnic differences were not considered in this
analysis.

**Conclusion**

Abdominal LN dissection and the pathologic stage are
the more important prognostic factors in type II and III
GEJ cancer rather than MNLD. MLN dissection itself
did not show prognostic significance. Optimal lymphad-
enectomy for the abdomen and mediastinum should be
determined in future studies.

**Abbreviations**

GEJ: gastroesophageal junction; MLN: Mediastinal lymph node

**Acknowledgements**

Not applicable

**Authors’ contributions**

WH and KR carried out acquisition of data, statistical analysis, preparation of
the manuscript and typing. JL, MK, DR participated in interpretation of data
and critical revision. BE, HY, YK participated in study design, interpretation of
data and critical revision. All authors read and approved the final manuscript.

**Funding**

This work was supported by a grant (NCC 1710160–1) from the National
Cancer Center, Republic of Korea. The funding body will not play any role in
the trial.

**Availability of data and materials**

The datasets and/or analysed during the current study are not publicly
available but are available from the corresponding author on reasonable
request.

**Ethics approval and consent to participate**

All procedures followed were in accordance with the ethical standards of
the responsible committee on human experimentation (institutional and
national) and with the Helsinki Declaration of 1964 and later versions. This
study was approved by the Institutional Review Board of the National Cancer
Center (No.NCC2017–0224). The need for and patients’ informed consent
was waived given the retrospective nature of the study.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

| Table 5 Recurrent pattern |
|---------------------------|
| Recurrence site           | Group A (N = 40) | Group B (N = 15) |
|---------------------------|----------------|----------------|
| Locoregional             | 18 (39.1%)     | 10 (62.5%)     |
| LN recurrence            | 16             | 8              |
| Para aortic              | 13             | 3              |
| Mediastinal              | 2              | 4              |
| Perigastric              | 1              | 1              |
| Anastomosis site         | 2              | 2              |
| Peritoneum               | 12 (26.0%)     | 2 (12.5%)      |
| Hematogenous             | 16 (34.7%)     | 4 (25.0%)      |
| Liver                    | 5              | 1              |
| Lung                     | 2              | 2              |
| Bone                     | 3              | 1              |
| Colon                    | 2              | 0              |
| Kidney                   | 1              | 0              |
| Ovary                    | 2              | 0              |
| Brain                    | 1              | 0              |

*In patients without Mediastinal LN dissection group (group A), recurrence was
found concurrently in 6 cases. In 3 cases, paraaortic metastasis and
hematogenous metastasis were present. In 3 cases, peritoneum and
hematogenous metastasis were found.

* In patients with Mediastinal LN dissection group (group B), there was a case
in which paraaortic metastasis and bone metastasis were found concurrently.
