

# Is splenic hilar lymph node dissection necessary for proximal gastric cancer surgery?

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## Abstract

Advanced proximal gastric cancer sometimes metastasizes to the splenic hilar lymph nodes (No. 10 LN). Total gastrectomy combined with splenectomy is performed for complete removal of the No. 10 LN and was historically a standard procedure in Japan. However, splenectomy is associated with several disadvantages for patients, such as increased postoperative morbidity, risk of thrombotic disease, fatal infection from encapsulated bacteria, and the development of other types of cancer in the long term because of loss of immune function. Therefore, splenectomy should only be performed when its estimated oncological effect exceeds such disadvantages. A Japanese randomized controlled trial (JCOG0110) clearly demonstrated that prophylactic splenectomy is not necessary unless the tumor has invaded the greater curvature; thus, splenectomy is no longer routinely performed in Japan. However, several retrospective studies have shown a comparatively high incidence of No. 10 LN metastasis and therapeutic value from LN dissection at that station in the tumors invading the greater curvature. Similar tendencies have also been reported in type 4 or remnant gastric cancer involving the greater curvature. In view of these facts, No. 10 LN dissection is presently recommended for such patients; however, robust evidence is lacking. In recent years, laparoscopic/robotic spleen-preserving splenic hilar dissection utilizing augmented visualization without pancreatic mobilization has been developed. This procedure is expected to replace prophylactic splenectomy and provide an equal oncological effect with lower morbidity. In Japan, a prospective phase-II study (JCOG1809) is currently ongoing to investigate the safety and feasibility of this procedure.

## KEYWORDS

gastric cancer, lymph node dissection, proximal gastric cancer, splenectomy, splenic hilar lymph node

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## 1 | INTRODUCTION

A standard surgical treatment for advanced proximal gastric cancer is total gastrectomy with an adequate range of lymph node (LN) dissection. The intention of this treatment is local disease control. Gastric cancer in the upper third of the stomach sometimes metastasizes to the splenic hilar LN, which is defined as the No. 10 LN station according to the Japanese Gastric Cancer Classification.<sup>1</sup> The underlying mechanism is thought to involve lymphatic drainage from the proximal stomach through the splenogastric ligament along the left gastroepiploic or short gastric vessels. Thus, the No. 10 LN have been regarded as among those regional LN<sup>1</sup> that should be resected to maximize survival benefits. The anatomy of the splenic hilum is unquestionably complicated because of the variety of splenic vessel branching patterns among individual patients. Therefore, splenectomy was long considered to be an effective and simple way to remove the No. 10 LN together with the anatomically complex splenic hilar vessels. Most physicians were historically certain of the therapeutic effects of No. 10 LN dissection, and long-term survival was, indeed, seen in patients with pathologically positive No. 10 LN who underwent splenectomy. However, splenectomy is well recognized to have several disadvantages for patients, especially a high incidence of postoperative morbidity. Although splenectomy should be performed to achieve R0 resection when the tumor is directly infiltrating the splenogastric ligament or the spleen, it seems unreasonable to uniformly perform splenectomy even with a prophylactic intention considering the potential disadvantages of this procedure. Therefore, it seems important to identify an appropriate population of patients who require No. 10 LN dissection. In addition, a new surgical procedure with the same oncological effect should be developed as a substitute for splenectomy. Such attempts may lead to a more individualized and beneficial treatment strategy for patients. In this review, we summarize the current landscape regarding these topics.

This paper aims at the following three goals. First, we review the existing literature from an epidemiological perspective on the risk of No. 10 LN metastasis. Second, we summarize the results of studies comparing with or without splenectomy, followed by the disadvantages of splenectomy. Third, we describe the prospects for research and development of new surgical techniques in terms of this issue with showing global trends as well as our ongoing research. This review will provide useful information for all surgeons engaged in gastric cancer surgery. The nomenclature or numbering of the LN station used in this review follows the latest Japanese Gastric Cancer Classification.<sup>1</sup>

## 2 | EPIDEMIOLOGICAL CONSIDERATION OF NO. 10 LN METASTASIS

### 2.1 | General perspectives

As mentioned above, gastric cancer located in the upper third of the stomach can sometimes metastasize to the No. 10 LN. The

incidence of No. 10 LN metastasis regardless of the transactional circumferential tumor location ranges from 7.3% to 18.3% in previous reports,<sup>2-8</sup> and the 5-year survival rate of these patients reportedly ranges from 11.04% to 22.2%.<sup>2-8</sup> Hence, No. 10 LN metastasis is generally regarded as an unfavorable prognostic indicator or, as indicated by some investigators, a sign of systemic cancer spread.<sup>3</sup> Several risk factors for No. 10 LN metastasis have been identified in retrospective studies, including a circumferential tumor location (Gre, Post, or Circ),<sup>2,5,7,9</sup> type 4 appearance,<sup>6,10</sup> deep tissue invasion,<sup>11</sup> a large tumor ( $\geq 5$  cm),<sup>6,7</sup> advanced stage,<sup>7,12</sup> metastasis to the No. 4sa/4sb LN,<sup>13</sup> or multiple LN metastases to other stations.<sup>12</sup> A Chinese group recently performed a large cohort study of 1068 surgically treated patients with advanced proximal gastric cancer.<sup>14</sup> They proposed that the following two populations are at high risk of No. 10 LN metastasis: patients with greater curvature invasion regardless of cN disease status or tumor size and patients with no greater curvature invasion but a cN(+) disease status and tumor size of  $>5$  cm. Although different opinions exist, the presence of greater curvature invasion is generally regarded as a reasonable and clear-cut clinical predictor of No. 10 LN metastasis. Therefore, many investigators apply the criterion of greater curvature invasion to discriminate high-risk patients, particularly in Japan.

### 2.2 | No. 10 LN metastasis in proximal gastric cancer invading the greater curvature

The management of tumors invading the greater curvature remains controversial. Several investigators have examined the incidence of No. 10 LN metastasis in tumors invading the greater curvature as well as the therapeutic index (obtained by multiplying the metastatic incidence and 5-year survival rate) (Table 1).<sup>7,10,14-19</sup> All such reports were retrospective studies, and the patients underwent splenectomy. The incidence of No. 10 LN metastasis ranged from 13.4% to 24.1%, and the 5-year survival rate ranged from 18.0% to 71.4%. The therapeutic index ranged from 3.82 to 19.4. In most of the studies, the therapeutic index of No. 10 LN dissection was lower than that of Nos. 3, 4sa, 4sb, and 7 LN dissection but was almost equivalent to that of Nos. 8a, 9, and 11 LN dissection. Although we cannot overestimate these results because the retrospective nature of the studies introduces potentially confounding selection bias, these results indicate that No. 10 LN dissection has a local control effect in some patients with proximal gastric cancer.

### 2.3 | No. 10 LN metastasis in remnant gastric cancer

When considering treatment of remnant gastric cancer after distal or subtotal gastrectomy, the necessity of No. 10 LN dissection is a critical point. In particular, when the initial surgery involved radical LN dissection, the lymphatic drainage route is likely to

**TABLE 1** No. 10 LN metastasis in tumors with or without greater curvature invasion

Author	Tumor location	Patients (n)	No. 10 LN metastasis (%)	5-year overall survival (%)	Therapeutic index
Watanabe et al <sup>16</sup>	Gre	132	15.9	41.9	5.6
	Non-Gre	289	6.2	64.5	2.0
Yura et al <sup>17</sup>	Gre	212	15.1	46.9	7.1
	Non-Gre	381	4.2	55.6	2.3
Maezawa et al <sup>18</sup>	Gre	82	13.4	30.0	4.02
Jeong et al <sup>7</sup>	Gre	145	24.1	18.0	4.4
	Non-Gre	520	5.4	36.0	2.0
Kosuga et al <sup>10</sup>	Gre	31	19.4	100.0	19.4
	Non-Gre	181	7.2	64.6	4.64
	Circ	68	16.2	10.0	1.62
Ohkura et al <sup>15</sup>	Gre	63	6.0	63.7	3.822
Kano et al <sup>19</sup>	Gre	60	16.7	40.0	6.7
Zhong et al <sup>14</sup>	High priority <sup>a</sup>	43	16.3	71.4	11.6

Abbreviations: Circ, invading circularly; Gre, invading the greater curvature; LN, lymph node; Non-Gre, not invading the greater curvature.

<sup>a</sup>Tumor invading the greater curvature or that not invading the greater curvature with a size of  $\geq 5$  cm and clinical N(+).

**TABLE 2** No. 10 LN metastasis in remnant gastric cancer

Author	Tumor location	Patients (n)	No. 10 LN metastasis (%)	(%)No.10 positive patients	Therapeutic index
Katai et al <sup>20</sup>	Gre	284	31.5 (pT2-T4)	20.0	6.3
	Non-Gre	1006	11.7 (pT2-T4)	32.9	3.8
Watanabe et al <sup>21</sup>	Gre	24	16.7	37.7	6.3
	Non-Gre	50	2.0	0.0	0.0

Abbreviations: Gre, invading the greater curvature; LN, lymph node; Non-Gre, not invading the greater curvature.

be changed. Only two publications to date have addressed this issue (Table 2).<sup>20,21</sup> Katai et al performed a retrospective analysis of more than 1133 patients with advanced remnant gastric cancer.<sup>20</sup> They performed LN metastasis mapping and examined survival outcomes using a nationwide registry database of the Japanese Gastric Cancer Association. The patients were divided into two groups according to whether the initial surgery had been performed for benign or malignant disease. In the malignant group, the incidence of No. 10 LN metastasis was 14.1% and the therapeutic index was 4.4. The index was the highest (10.5) when the tumors invaded the greater curvature. In the benign group, the incidence of No. 10 LN metastasis was 19.2% and the therapeutic index was 4.7. The index was somehow lower (2.4) when the tumors invaded the greater curvature. In a small Japanese study, the incidence of No. 10 LN metastasis and the therapeutic index with versus without greater curvature invasion were 16.7% versus 2.0% and 6.3 versus 0, respectively.<sup>21</sup> Although these are retrospective studies, a survival benefit of No. 10 LN dissection may be expected when the tumor invades the greater curvature in the same way as the primary proximal gastric cancer.

## 2.4 | No. 10 LN metastasis in type 4 gastric cancer

The necessity of splenectomy for type 4 cancer is controversial because most such tumors circumferentially involve the stomach wall together with the greater curvature; they have a fundamentally unfavorable prognosis. Another concern is that the most common site of relapse of type 4 cancer is the peritoneum, and control of peritoneal seeding therefore seems to be the top priority for cure of the disease. Several retrospective studies have specifically examined the incidence of No. 10 LN metastasis and the therapeutic index for type 4 tumors (Table 3).<sup>10,19,22</sup> Interestingly, two Japanese high-volume centers reported relatively high therapeutic indices of No. 10 LN dissection in spite of the unfavorable survival rates.<sup>23,24</sup> Kano et al performed a comparative study of type 4 (n = 50) and non-type 4 (n = 60) cancers, both involving the greater curvature.<sup>19</sup> The incidence of No. 10 LN metastasis and the therapeutic index were 26.0% and 3.7 for type 4 cancers and 31.7% and 15.0 for non-type 4 cancers, respectively. Hayashi et al investigated the same parameters in 137 patients with type 4 cancer and reported an incidence of 15% and therapeutic index of

Author	Patients (n)	No. 10 LN metastasis (%)	5-year overall survival (%)	Therapeutic index
Kano et al <sup>19</sup>	50	26.0	52.7	13.7
Hayashi et al <sup>22</sup>	137	15.3	33.3	5.19
Kosuga et al <sup>10</sup>	72	26.4	48.9	12.9

Abbreviation: LN, lymph node.

5.09, which were the sixth highest values among the 15 regional LN stations.<sup>22</sup> Although definitive conclusions cannot be drawn because of the retrospective nature of the studies, these results indicate that No. 10 LN dissection may have a certain survival benefit for some patients with type 4 tumors.

### 3 | PREVIOUS REPORTS ON PRESENCE OR ABSENCE OF SPLENECTOMY AND DISADVANTAGES OF SPLENECTOMY

#### 3.1 | Studies comparing splenectomy and non-splenectomy (without intentional No. 10 dissection)

Many investigators worldwide have conducted clinical studies to compare splenectomy and spleen-preservation surgery for treatment of proximal advanced gastric cancer. When discussing the need for No. 10 LN dissection, we should differentiate between spleen-preservation surgery (without intentional No. 10 LN dissection) and spleen-preserving splenic hilar dissection (with intentional No. 10 LN dissection and skeletonization of the splenic vessels). Unquestionably, the latter procedure is more technically complex and requires high surgical proficiency. Table 4 summarizes the outcomes of previous studies comparing splenectomy and spleen-preservation surgery.<sup>2,8,25-32</sup> Most studies did not discriminate patients by the presence of greater curvature invasion. Among these studies, three RCT have been reported. In a Chilean single-institution RCT<sup>29</sup> involving 187 patients, splenectomy showed a slightly better 5-year overall survival (OS) rate (42% vs 36%), but the difference was not statistically significant. A small Italian single-institution RCT<sup>30</sup> involving 73 patients excluded those with tumors invading the greater curvature and included only patients with LN-positive cancer. The splenectomy group had a higher surgical morbidity rate (48.6% vs 19.4%) and mortality rate (5.4% vs 0.0%); however, the 5-year disease-free survival rates were equivalent (42.1% vs 42.9%). The JCOG0110 was a phase-III multi-institution RCT<sup>28</sup> that included 505 patients and was performed to show non-inferiority of spleen-preservation surgery. Eligibility was limited to patients with tumors that did not invade the greater curvature; patients with type 4/large type 3 tumors or tumors accompanied by swollen No. 10 LN were excluded. The 5-year OS rates were equivalent (75.1% vs 76%), and statistical non-inferiority of spleen-preservation surgery was shown. The results of the JCOG0110 clearly demonstrated that neither prophylactic splenectomy nor intentional No. 10 LN dissection is necessary unless the tumor is invading the greater curvature. Based on the

**TABLE 3** No. 10 LN metastasis in type 4 gastric cancer

results of the JCOG0110, the latest Japanese guidelines state that neither splenectomy nor intensive No. 10 LN dissection is necessary for tumors that are not invading the greater curvature.<sup>33</sup> Most of the retrospective case-control studies also reported higher morbidity rates among patients undergoing splenectomy. Additionally, equivalent or slightly worse survival rates were seen in the splenectomy group, and all studies failed to show a survival benefit of splenectomy. With respect to patients with tumors invading the greater curvature, only one retrospective study in Japan investigated splenectomy versus spleen-preservation surgery.<sup>15</sup> The authors reported that splenectomy was associated with a higher morbidity rate (30.2% vs 13.3%) and that no significant survival benefit was observed in the splenectomy group (5-year relapse-free survival rate of 60.2% vs 67.3% and 5-year OS rate of 63.7% vs 73.6%). These results should be carefully interpreted because of the study's small sample and heterogeneity of No. 10 LN dissection in the spleen-preservation group. An RCT does not seem practical because of the low incidence of the disease condition; therefore, further investigation using a large dataset is warranted.

#### 3.2 | Disadvantages of splenectomy

As mentioned above, splenectomy is thought to be the most effective procedure for complete removal of No. 10 LN. Nonetheless, it has several disadvantages for patients, including a high postoperative morbidity rate<sup>2,8,15,25-27</sup> and risks of thrombotic disease,<sup>34</sup> infection,<sup>35</sup> and the development of other metachronous malignancies.<sup>23</sup> Most previous studies reported high incidences of post-splenectomy pancreatic fistula or abdominal abscess formation (clinical differentiation of the two conditions is sometimes difficult). In the 1990s, randomized controlled trials (RCT) of D1 versus D2 LN dissection conducted in European countries showed high mortality rates of >10% in the D2 splenectomy group.<sup>36,37</sup> These results were probably affected by low surgical quality, low surgeon experience or surgery volume, or patients' more obese habitus compared with non-European countries; however, since these studies, splenectomy has become uncommonly carried out in Western countries because of its surgical risk. Mobilization of the pancreas from the retroperitoneal bed, pancreatic ischemia or congestion, and mechanical damage to the pancreas appear to be associated with complications. The complication rate has decreased with the development of surgical devices and techniques as well as strengthening of surgeons' efforts, such as preservation of the pancreatic caudal artery and vein to the greatest extent possible; nonetheless, the incidence of complications remains high. An elevated risk of infection and the risk of other

**TABLE 4** Studies comparing splenectomy and spleen-preservation surgery without intentional No. 10 LN dissection

Author	Splenectomy spleen preservation (n)	Mortality (%)	No. 10 LN metastasis (%)	5-year overall survival (%)	Statistical difference	Effectiveness of splenectomy	Pancreatic fistula (%)	Peritoneal abscess (%)
<b>RCT</b>								
Csendes et al <sup>29</sup>	90	4.4	9	42	NS	None	NA	11.0
	97	3.1	-	36				4.0
Galizia et al <sup>30</sup>	37	5.4	-	42.1 (DFS)	NS	None	16.2	10.8
	36	0.0	-	42.9 (DFS)			0.0	2.7
Sano et al <sup>28</sup>	254	0.4	2.4	75.1	Non-inferiority $P = 0.025$	None	12.6	7.9
	251	0.8	-	76.4			2.4	4.0
<b>Retrospective studies</b>								
Sasada et al <sup>2</sup>	201	0.5		57 (Stage II)	NS	None	8.5	5.0
	148	0.0		60 (Stage II)			0.0	2.0
Nashimoto et al <sup>8</sup>	241	NA	22.2	73.3 (Stage II)	NS	None	12.9	NA
	264		18.3	62.6 (Stage II)			6.0	
Lee et al <sup>26</sup>	492	0.6	NA	52.9	$P < 0.001$	None	NA	NA
	173	0.0		64.8				
Zhang et al <sup>25</sup>	100	NA	NA	28.8	$P = 0.013$	None	NA	7.0
	114			33.8				2.0
Wang et al <sup>32</sup>	172	4.1	NA	47	NS	None	NA	4.7
	291	4.8		51				5.2
Otsuji et al <sup>27</sup>	154	NA	NA	46	NS	None	9.1	NA
	91			47			4.4	
Erturk et al <sup>31</sup>	38	NA	NA	NA	NS	None	2.63	NA
	23						0.0	

Abbreviations: DFS, disease-free survival; LN, lymph node; NA, not available; NS, not significant; RCT, randomized controlled trial.

metachronous malignancies are correlated with hampered immune function due to deficiency of splenic function. The spleen is an important site of lymphocyte interaction. After splenectomy, patients are likely to be vulnerable to infection by encapsulated pathogens such as *Streptococcus pneumoniae*. A severe, rapidly developing infectious condition called overwhelming post-splenectomy infection may occur, and high mortality rates of 36% to 69% have been reported<sup>24</sup> in association with this condition. Therefore, all patients who have undergone splenectomy are recommended to receive appropriate vaccination. The immune function of the spleen against cancer is unclear. A large-scale cohort study (mostly involving patients undergoing splenectomy for treatment of trauma)<sup>23</sup> demonstrated a high risk of cancer development in the long-term follow up. However, the relationship of splenectomy with cancer recurrence has not been clearly shown. The immune function of the spleen should be more thoroughly investigated because immune environments are crucial issues for the progression of modern immunotherapy.

## 4 | NEW TRENDS AND FUTURE PROSPECTS

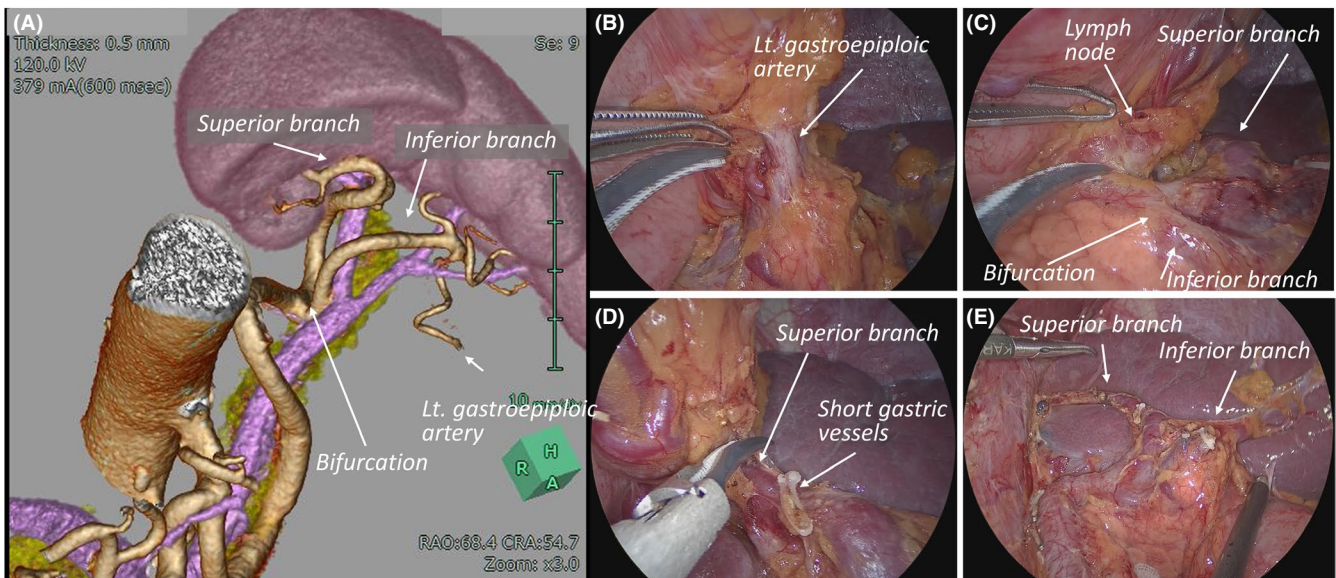
### 4.1 | Concept of spleen-preserving splenic hilar dissection

Even when No. 10 LN dissection is required for tumors invading the greater curvature, either splenectomy or spleen-preserving splenic hilar dissection should be performed. Spleen-preserving splenic hilar dissection, in which the splenic vessels at the hilum are skeletonized to remove the No. 10 LN, has been attempted in open surgery as an alternative to splenectomy. However, such a maneuver at the deeply

located original position of the spleen (in situ method) was technically challenging because of poor visualization, especially in obese patients. An ex situ method after mobilization of the spleen and pancreas has also been reported, but this method is associated with a risk of pancreatic fistula. Since the emergence of laparoscopic surgery, the development of an augmented view is expected in which meticulous and precise skeletonization of the complex vascular structures is performed without mobilization from the retroperitoneal bed and independent of the patient's body habitus (Figure 1). Hence, reduction of postoperative morbidity, particularly that of pancreatic fistula, is anticipated. Several advanced institutions in East Asia have reported their outcomes of this procedure (Table 5).<sup>38-45</sup> Most reported acceptable morbidity rates, but potential selection bias should be considered. The CLASS-04 was a prospective multicenter study conducted in China.<sup>45</sup> The study involved 251 patients with proximal gastric cancer (cT2-4, N $\neq$ , M0) regardless of circumferential tumor location. The average number of retrieved No. 10 LNs was 2.4, and metastasis was recognized in 7.4% of patients. Severe morbidity and mortality were recorded in 3.3% and 0.4% of the patients. The authors concluded that the safety and feasibility of this method were adequate.

### 4.2 | Studies comparing splenectomy and spleen-preserving splenic hilar dissection

Table 6 shows previous studies that have compared splenectomy and spleen-preserving splenic hilar dissection,<sup>46-52</sup> including both open and laparoscopic procedures. None of them showed survival benefits of splenectomy, but all studies enrolled patients regardless of circumferential tumor location. Among them, one RCT from



**FIGURE 1** Spleen-preserving splenic hilar dissection. A, Preoperative anatomical reconstruction using three-dimensional computed tomography images. B, Technical step 1: dissection around the inferior branch of the splenic vessels. C, Technical step 2: dissection along the main trunk of the splenic artery from proximal to distal. D, Technical step 3: dissection around the superior branch of the splenic vessels. E, Completion view after laparoscopic splenic hilar dissection

**TABLE 5** Short-term outcomes of laparoscopic/robotic spleen-preserving splenic hilar dissection

Author	Surgical procedure	Patients (n)	No. harvested No. 10 LN	Morbidity (%)	Mortality (%)
Hyung et al <sup>38</sup>	Laparoscopic	15	2.7	13.0	0.0
Guan et al <sup>39</sup>	Laparoscopic	41	1.1	4.9	0.0
Huang et al <sup>40</sup>	Laparoscopic	54	3.0	9.3	0.0
Son et al <sup>41</sup>	Robotic	58	0.8	8.6	0.0
Kinoshita et al <sup>42</sup>	Laparoscopic	20	2.0	0.0	0.0
Wang et al <sup>43</sup>	Laparoscopic	16	4.3	6.0	0.0
Chen et al <sup>44</sup>	Robotic	40	3.3	15.0	0.0
Zheng et al <sup>45</sup>	Laparoscopic	242	2.4	3.3	0.4

Abbreviation: LN, lymph node.

Korea randomized 207 patients to either splenectomy or spleen-preserving splenic hilar dissection with open surgery.<sup>46</sup> The 5-year survival rates were 54.8% and 48.8%, respectively, with no statistically significant difference. Most of the studies showed higher incidences of postoperative complications in the splenectomy group. Unfortunately, however, no studies focused on tumors invading the greater curvature. Considering the current indication for No. 10 LN dissection, a prospective study focusing on tumors invading the greater curvature has been required.

### 4.3 | Future perspectives of spleen-preserving splenic hilar dissection

Although laparoscopic spleen-preserving splenic hilar dissection is a promising method to achieve an adequate oncological effect as well as function preservation, it is still regarded as a technically demanding procedure. At present, it can probably only be carried out by expert surgeons at specialized centers. Several means of facilitating the procedure are being attempted. Anatomical reconstruction using three-dimensional computed tomography images enables preoperative planning or real-time navigation according to the individual patient's anatomical structure<sup>42</sup> (Figure 1A). Articulating robotic surgical instruments may help to overcome the movement limitations of straight laparoscopic instruments, leading to more precise dissection<sup>41,44</sup> (Figure 2A). Indocyanine green fluorescence lymphography may help to prevent LN residue (Figure 2B,C). In Japan, the JCOG1809 (UMIN000037580), a single-arm phase-II trial, is being performed to investigate the safety and feasibility of laparoscopic/robotic spleen-preserving splenic hilar dissection for proximal gastric cancer invading the greater curvature (cT2-4a, N $\neq$ , M0 except type 4 or large type 3). In the JCOG1809, the primary endpoint is the incidence of pancreatic fistula and/or intra-abdominal abscess, and the secondary endpoints include retrieved number of No. 10 LN, 5-year survival, and conversion to open surgery or splenectomy. Differing points from the Chinese trial (CLASS-04) are limiting the target to tumors invading the greater curvature and inclusion of robotic surgery.

When the feasibility of this procedure is confirmed by JCOG1809, ideally, a randomized phase-III trial comparing splenectomy should be conducted; however, this seems unrealistic due to the scarcity of the target population. In this type of situation, some analyses using a large database may be an alternative. If the feasibility and efficacy of this procedure are fully proven in the future, it will replace prophylactic splenectomy even for tumors invading the greater curvature.

## 5 | CONCLUSION

Prophylactic splenectomy is not necessary for tumors that do not invade the greater curvature. A survival impact of No. 10 LN dissection for tumors invading the greater curvature has been suggested by previous retrospective studies; however, this precise survival impact is still unclear. Laparoscopic/robotic spleen-preserving splenic hilar dissection is expected to replace prophylactic splenectomy because of the greater benefits to patients.

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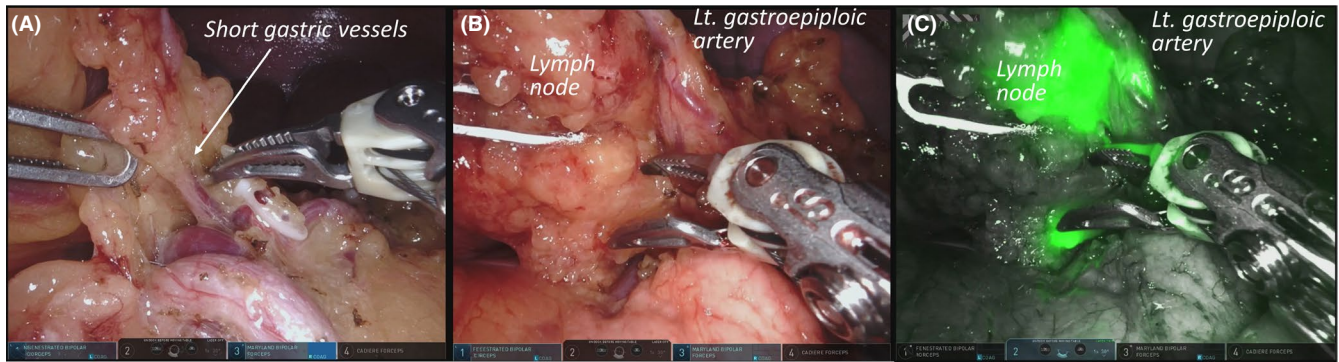
Disclosure outside the scope of the current work: Dr Kinoshita has received an honorarium for lectures from Medtronic, Intuitive

TABLE 6 Studies comparing splenectomy vs SPSHD

Author	Splenectomy SPSHD (n)	Surgical approach	Harvested No. LN (n)	5-year overall survival (%)	Statistical difference	Effectiveness of splenectomy	Pancreatic fistula (%)	Peritoneal abscess (%)	Mortality (%)
<b>RCT</b>									
Yu et al <sup>46</sup>	104	Open	NA	54.8	NS	None	NA	3.8	NA
	103			48.8				2.9	
<b>Retrospective studies</b>									
Ji et al <sup>47</sup>	31	Open	2	23	P = 0.018	None	6.5	22.6	3.2
	118 (SPSHD, ex)		2	50			0.0	6.8	0.8
	68 (SPSHD, in)		1	46			0.0	8.8	0.0
Li et al <sup>48</sup>	62	Open	5.4	55	NS	None	NA	NA	NA
	69		5	66					
Jeong et al <sup>49</sup>	229	Open	NA	55	P < 0.001	None	NA	NA	NA
	845			80					
Zhang et al <sup>50</sup>	38	Open	NA	16.9	P = 0.008	None	NA	2.6	0.0
	70			38.7				0.0	1.4
Son et al <sup>51</sup>	44	Laparoscopic	3.21	65.9	NS	None	4.5	NA	0.0
	68		1.78	77.3			0.0	NA	0.0
Usui et al <sup>52</sup>	19	Laparoscopic	2.4	NA	NA	NA	15.8	NA	0.0
	59		1.3				5.1		0.0

Abbreviations: ex, ex situ; in, in situ; LN, lymph node; NA, not available; NS, not significant; RCT, randomized controlled trial; SPSHD, spleen-preserving splenic hilar dissection.





**FIGURE 2** New techniques for spleen-preserving splenic hilar dissection. A, Splenic hilar dissection using robotic surgical system. (B,C) Indocyanine green lymphography using infra-red fluorescence image

Surgical, Ethicon, and Olympus. Dr Kinoshita has received a consultancy fee from Verb Surgical.

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