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## Function-preserving surgery for gastric cancer

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**Abstract** Early gastric cancer (EGC) with 5-year survival rates exceeding 90% now accounts for nearly 50% of all gastric cancers treated at major institutions in Japan. D2 lymphadenectomy with resection of at least two-thirds of the stomach has been the mainstay of treatment for every stage of gastric cancer, including EGC. Post-gastrectomy syndrome is inevitable after surgery. Most of the symptoms resolve with time, though some patients suffer immensely for prolonged periods. Mucosal cancers rarely metastasize (3% or less). Surgeons have altered the traditional strategy for treatment which focused only on highly radical operations. The new strategy preserves patients' quality of life, while at the same time maintaining a high level of radicality, by employing a function-preserving operation which prevents post-gastrectomy syndrome. The Japanese gastric cancer treatment guidelines have standardized indications for the function-preserving surgery that is widely performed in Japan. There are various kinds of function-preserving operations, such as those reducing the extent of gastrectomy, and those providing nerve preservation, sphincter preservation, and formation of a neostomach. Evaluation of preserved function is not satisfactory, because there is no gold standard for measuring gastrointestinal motor function and patients' quality of life.

**Key words** gastric cancer · function preserving · quality of life · gastrectomy

### Introduction

Early gastric cancer (EGC) now accounts for nearly 50% of all gastric cancers treated at major institutions in Japan.<sup>1</sup>

Distant metastasis of EGC is extremely rare, and peritoneal seeding is unlikely, because the tumor is completely confined to the gastric wall. The only possible route for spread is the lymphatic route. The incidence and extent of nodal metastasis by EGC are closely related to the depth of tumor invasion.<sup>2</sup> Mucosal cancers rarely metastasize (3% or less), whereas nearly 20% of EGCs that have invaded the submucosa metastasize to regional nodes. EGC is recognized as a disease entity with a favorable prognosis after surgical treatment, with 5-year survival rates of more than 90% being reported by both Western<sup>3</sup> and Japanese investigators.<sup>4</sup>

Japanese surgeons were therefore required to move away from the old strategy focusing only on highly radical operations. The new approach preserves patient quality of life (QOL), while at the same time maintaining a high level of radicality, by introducing a function-preserving operation which prevents post-gastrectomy syndrome. D2 lymphadenectomy with resection of at least two-thirds of the stomach has been the mainstay of treatment for every stage of gastric cancer, including EGC.<sup>5,6</sup> However, the use of conventional D2 nodal dissection for EGC is now being challenged.

Recent trends in the management of EGC show the differences between Japan and the West. Despite the discouraging results of the D1/D2 trials in Britain and the Netherlands,<sup>7,8</sup> European surgeons have gradually been performing more aggressive surgery to treat curable gastric cancer.<sup>9–11</sup> Japanese surgeons, on the other hand, have increasingly been adopting more conservative methods, such as endoscopic mucosal resection (EMR) or function-preserving gastrectomies for EGC. These different trends appear to have arisen from different treatment experiences and the use of different diagnostic techniques.

### Function of the stomach and postgastrectomy sequelae

The stomach has two main functions. Firstly, the proximal stomach acts as a temporary reservoir for the food we in-

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gest, with two or three meals a day providing all our energy needs. Some vagal fibers stimulate proximal gastric contractions while others inhibit contractions, thereby allowing relaxation and storage. Secondly, the distal stomach acts as a mixer and grinder for solids during the digestive process. The food mixes with gastric juice inside the stomach and is turned into a semi-liquid substance from which nutrients can be absorbed after it moves into the small intestine, the site of digestion and nutrient absorption. This grinding process is under the control of a pacemaker, a group of muscle cells located in the mid-body along the greater curvature. The pylorus helps to control the size of particles gradually passing into the duodenum. The stomach is also important in the absorption of vitamin B12, iron, and calcium.

Resection of the stomach and various vagotomies affect gastric function. Surgical removal of the proximal stomach reduces gastric reservoir capacity, so that the emptying rate of liquids is increased. Resection of the distal stomach and pylorus impairs gastric grinding, so that solids are emptied from the stomach before maceration is completed. Complete gastric vagotomy impairs the gastric emptying of solids.

Some possible side effects (post-gastrectomy syndrome) following surgery include:

Early satiety, or feeling full with a smaller amount of food

Weight loss – this is related to early satiety

Diarrhea – in the initial period

Anemia – due to iron or, more commonly, vitamin B12 deficiency. This will be monitored and replacement given if necessary

“Dumping” syndrome – occasional “fainting spells” after meals due to rapid emptying of the stomach

These sequelae are inevitable for all gastrectomized patients in the early period after surgery. Most of the side effects resolve with time and diet modification. Patients are taught to manage their diets to reduce discomfort. However, some patients suffer post-gastrectomy sequelae for long periods and symptoms are usually quite severe.

## Evaluation of function-preserving surgery (Table 1)

### Tools for evaluation

Because the history of function-preserving surgery is short, there are very few reports describing long-term results.

To compare the functional results obtained with these techniques, common criteria for the evaluation of post-gastrectomy conditions are necessary. However, scientific assessment of this condition is not easy. Anthropometric data, food intake, serum nutritional parameters, hematological surveys, gastric emptying tests, blood glucose, insulin, cholecystokinin, motilin, secretin, body weight, and quality of life (QOL) have been used to assess preserved function. Many randomized clinical trials and experimental studies have been performed comparing different operative procedures, but occasionally they arrive at different conclusions.

### Evaluation based on data

Data-based evaluation is very simple, but not specific, and it is usually difficult to detect differences in functional outcome. Nutritional parameters include serum protein, serum albumin, and serum cholinesterase. Body weight (BW),

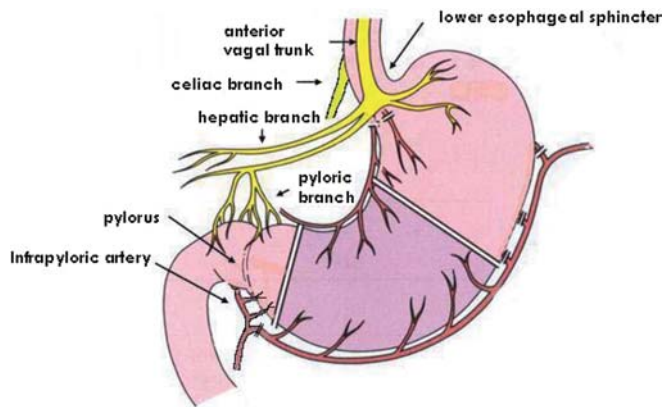
**Table 1.** Methods of evaluating function-preserving surgery

Evaluation based on data	Nutritional parameters	Serum protein, albumin, cholinesterase Body weight, Body Mass Index Food intake
Endoscopic examination	Esophagus	Los Angeles classification <sup>19</sup> Criteria of the Japanese Society of Esophageal Disease <sup>20</sup>
	Remnant stomach	RGB classification <sup>21</sup>
Activity scores	Visick score <sup>22</sup> Karnofsky performance status scale <sup>23</sup> ECOG performance status scale	
QOL questionnaires	Cancer-specific instrument	Spitzer QOL Index <sup>24</sup> EORTC QLQ-C30 <sup>25</sup> EORTC QLQ-STO 22 <sup>28</sup> Troidl questionnaire <sup>26</sup> Korenaga Questionnaire <sup>27</sup>
	Disease-specific instruments	
	Symptom-specific instruments	Reflux esophagitis Dumping syndrome
		Pellegrini, et al. scores <sup>29</sup> Johnson, et al. scores <sup>30</sup> Sigstad's index <sup>31</sup>

body mass index (BMI), and food intake are frequently used. BW change is expressed as a percentage of the pre-illness level (% BW). Food intake is also expressed as a percentage of the pre-illness level (% food intake). Gastrointestinal hormones such as gastrin, secretin, insulin, and cholecystokinin (CCK) are measured.

#### *Evaluation of gastric motor function*

Methods of evaluating gastric motor function include the measurement of gastric emptying, gastric contractile activity, and gastric electrical activity. Gastric emptying tests are most frequently used for evaluation. These tests include gastric emptying scintigraphy,<sup>12</sup> a gastric emptying test using



**Fig. 1.** Anatomy of stomach

ultrasonography,<sup>13</sup> magnetic resonance (MR) imaging,<sup>14</sup> and digital X-ray imaging.<sup>15</sup>

Acetaminophen has occasionally been used for pharmacodynamic measurement.<sup>16</sup> The recently developed <sup>13</sup>C-acetate breath test offers an attractive alternative for measuring gastric emptying, as it is nonradioactive.<sup>17</sup>

Each method has advantages and disadvantages.<sup>18</sup> Gastric emptying tests are useful for evaluating gastric function. However, we must also confirm the results of the gastric emptying test, as these results do not tell us whether food stays in the stomach with or without sufficient digestion.

#### *Assessment by endoscope*

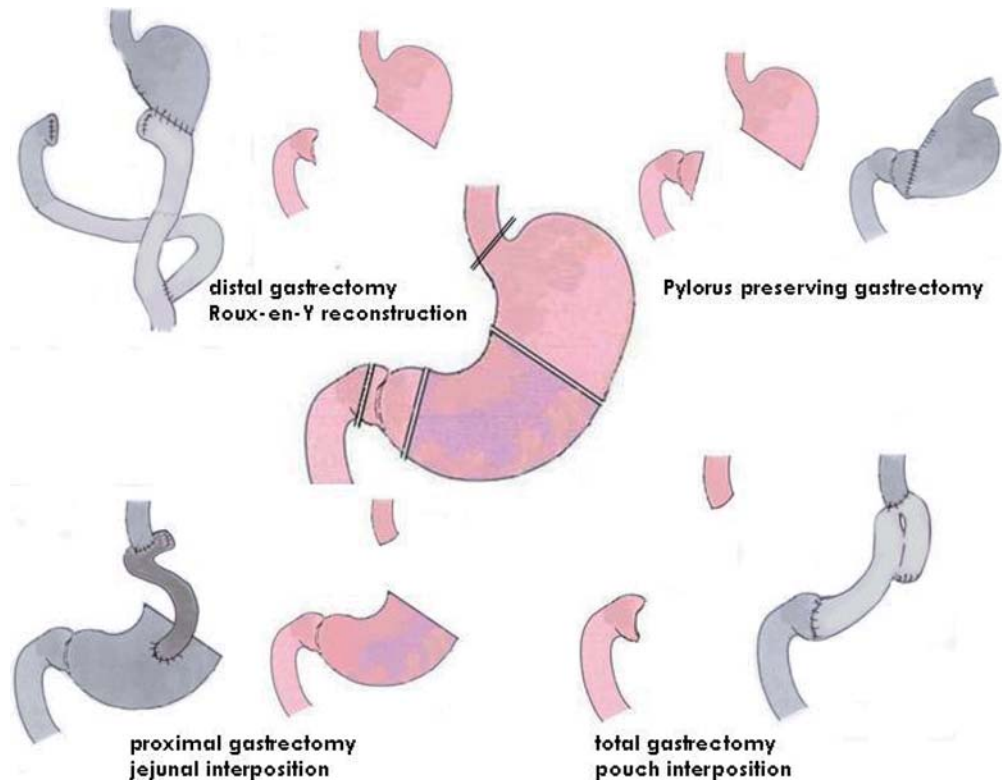
The Los Angeles classification for endoscopy<sup>19</sup> is useful to evaluate the grade of reflux esophagitis after gastrectomy. Endoscopic esophagitis has also been assessed by the criteria of the Japanese Society of Esophageal Disease.<sup>20</sup>

We recently reported a new endoscopic classification (RGB classification), assessing the amount of food residue, extent of gastritis, and bile reflux in the remnant stomach, which facilitates a general understanding and description of the problem.<sup>21</sup>

#### *Assessment of QOL*

QOL includes general and specific physical complaints and satisfaction with life, as well as psychosocial burden. As expected, measurement of QOL has seen the use of a variety of instruments and scales by different authors. Hundreds of different scales are available for the measurement

**Fig. 2.** Various function-preserving gastrectomies



of QOL, varying from the seductively simple to the very complex. Commonly used scales include the Visick score, which assesses QOL after gastric operations,<sup>22</sup> and the Karnofsky scale, which evaluates QOL after an intervention.<sup>23</sup>

Cancer-specific instruments include Spitzer's QOL index<sup>24</sup> and the European Organization for Research and Treatment of Cancer Core QOL – questionnaire (EORTC QLQ-C30).<sup>25</sup> Generic cancer questionnaires are not sensitive enough to detect QOL issues of importance to patients within specific treatment groups.

Disease-specific instruments in addition to cancer-specific instruments help to address these problems. These include the Troidl questionnaire,<sup>26</sup> and Korenaga's questionnaire.<sup>27</sup> The EORTC Quality of Life Group has developed a questionnaire module for patients with gastric cancer that assesses QOL issues related to dysphagia, eating restrictions, reflux, and abdominal pain, as well as specific symptoms that may occur after surgery, or during chemotherapy or radiation treatment (EORTC QLQ-STO 22).<sup>28</sup>

Several symptom-specific scores are used for post-gastrectomy evaluation. Postoperative reflux scores are calculated using modifications of the methods of Pellegrini et al.<sup>29</sup> and Johnson et al.<sup>30</sup> Symptoms of early or late dumping have been assessed according to the method of Sigstad.<sup>31</sup>

The EORTC-QLQ-STO 22 is anticipated to become one of the standards for assessing QOL in patients with gastric cancer, though additional questionnaires are needed to answer specific research questions. No gold standard for QOL questionnaires has yet been established. The questionnaires used in studies should be consistently evaluated from the viewpoint of reliability and validity. We must also be reminded that QOL, quantified as a simple sum of item scores, may distort the results, because there can be large differences between global QOL as experienced by patients and the simple summing of scores. Whether assessments are performed by medical or non-medical staff also affects the result.

## Concept of function-preserving surgery in the Japanese Gastric Cancer Treatment Guidelines

The Japanese Gastric Cancer Association (JGCA) issued its gastric cancer treatment guidelines (GLs) in March, 2001, and then a English version in 2002.<sup>32</sup> Patients with EGC are usually classified clinically as stage IA (T1N0), stage IB (T1N1), or stage II (T1N2). Although the GLs advocate resection of at least two-thirds of the stomach with D2 node dissection as the standard treatment for most stages of advanced gastric cancer, the GLs also describe modified procedures as standard or investigational treatments. The GLs provide standardized indications for less extensive gastrectomy, which is widely performed in Japan at present for "presumed mucosal cancers." The GLs advocate less extensive procedures for stage IA and stage IB. Because T2 tumors are associated with a high incidence of nodal metastasis, accurate preoperative diagnosis is key to performing less extensive surgery, because understaged patients will receive inadequate treatment.

The GLs define less extensive resection as modified gastrectomy according to Japanese classification of gastric cancer.<sup>33</sup> The GLs also introduce optional treatment approaches, such as the pylorus-preserving method, the vagus-nerve preserving method, and laparoscopic assistance.

## Details of function-preserving methods (Table 2, Fig. 1, Fig. 2)

### Reducing the extent of resection

A large remnant stomach can, of course, have greater reservoir capacity, and can slow emptying more effectively than a small remnant stomach. Moreover, a large stomach can preserve the gastric pacemaker. When the pacemaker is included in the resected stomach, the potential for a new gastric pacemaker to appear in the remnant stomach is

**Table 2.** Functions that can be preserved with gastric surgery

Preservation of structure	Stomach	Decrease in extent of resection	Resection of less than two-thirds of the stomach
			This procedure can be applied except to total gastrectomy. Examples, segmental gastrectomy, proximal gastrectomy
	Sphincter	Pylorus	
		Lower esophageal sphincter	
	Nerve	Vagus nerve	Hepatic Pyloric Latarjet Celiac
Sympathetic nerve			
Formation of lost structure	Neostomach	Pouch (jejunum)	
	Neocardia	Colon	

lower and there is a decrease in the movement of the remnant stomach and a delay in emptying after a solid meal.<sup>34</sup>

### Nerve preservation

There are three routes of pyloric innervation in humans.<sup>35</sup> One is the superior region of the pylorus, which is related to the hepatoduodenal ligament, whereby the nerve branches arise from the anterior hepatic plexus containing the branches coming from the hepatic branch of the vagus. The nerves run along the right gastric artery, via the suprapyloric or supraduodenal branch, toward the antro-pyloric region (pyloric branch). The second route is the posterior-lower region of the pylorus, which is related to the gastro-pancreatic ligament. The nerves run along the gastroduodenal or right gastroepiploic artery, to the infrapyloric artery, and reach the antro-pyloric region. The third route is the lower antrum region, which is related to the left gastric artery and the nerves of Latarjet. This route involves the branches of the Latarjet nerves passing through the lesser curvature, and entering the antro-pyloric region.

The pyloric branch is usually spared and the nerve along the infrapyloric artery is also occasionally spared to maintain pyloric function. Preservation of the hepatic branch allows contraction of the gallbladder after meal intake to continue.

The effects of celiac branch preservation have not been clarified in the detail. Nordback and Harju<sup>36</sup> reported that vagal nerve amputation in post-gastrectomy patients with gastric cancer led to a disturbance of insulin secretion.

### Neostomach

#### *Pouch procedures*

Pouch procedures for the formation of a neostomach were developed to provide a reservoir for food and to slow down rapid emptying of food into the small intestine, as both functions are important.<sup>37,38</sup> There is no obvious evidence for the advantage of a pouch. According to Sharma's review article,<sup>39</sup> most studies found that patients with pouch reconstruction fared better, though no significant benefit was demonstrated in some studies. The beneficial effects of having a pouch become apparent with a long-term follow-up.<sup>40-42</sup> A randomized controlled trial found a short pouch to be more effective than a long pouch in maintaining nutrition and preventing reflux symptoms.<sup>43,44</sup>

### Colon

The colon has, on rare occasions, been used for gastric replacement. A segment of the left colon has been used to recreate not only the reservoir but also the angle of His, to prevent reflux.<sup>45</sup> The ileocolon has been used as a reservoir with an anti-reflux mechanism (cecum as a reservoir and ileocecal valve as a substitute for pyloric sphincter).<sup>46,47</sup>

### *Sphincter*

The pylorus is currently preserved as a limited procedure for certain patients with EGC undergoing distal gastrectomy, segmental gastrectomy, or proximal gastrectomy, based on the expected benefits. The lower esophageal sphincter (LES) is usually removed during total gastrectomy to achieve a curative operation. Hirai et al.<sup>48</sup> reported that LES preservation for curative total gastrectomy possibly reduced the reflux.

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## Details of function-preserving surgery

### Endoscopic mucosal resection (EMR)

#### *History*

EMR is the ultimate treatment for preserving stomach function. EMR is indicated in patients with a small mucosal cancer and no lymph node metastasis. Vigorous retrospective studies have been conducted in Japan, and databases, containing data for many hundreds and even thousands of EGC patients who have undergone surgery that included lymphadenectomy, have been analyzed to identify the specific features of EGC without lymph node metastasis.<sup>49-51</sup>

Endoscopic treatment of various gastrointestinal mucosal lesions has a long history. Laser therapy once played a leading role in the treatment of malignant gastrointestinal tumors, and was primarily employed as palliative treatment for patients at high operative risk or those with incurable disease.<sup>52</sup> Tada et al.<sup>53</sup> first described the "strip biopsy" technique in 1988 and developed it into a method of curing mucosal gastric cancer. The revolutionary feature of this technique is that depressed as well as polypoid mucosal lesions can be removed along with the surrounding normal mucosa, and it provides sufficient material to histologically examine the lesion for tumor cell infiltration.

EMR has already become an essential therapeutic tool in Japan,<sup>54</sup> although no prospective studies have been published in English. A new section, "Handling of mucosectomy specimens" has been added to the Japanese Classification of Gastric Carcinoma to provide a standard description of EMR. Large series of up to 400 EMRs at a single institution have been reported at congresses.<sup>55</sup> Although the strip biopsy and aspiration methods are common EMR techniques because of their convenience and reliability, both have limitations in regard to tumor size and location. Various techniques, including endoscopic submucosal resection, are being tested for safer and wider resection and expansion of the indications.<sup>54,56-57</sup> Endoscopic submucosal dissection techniques using the insulated-tip diathermic knife or the diathermic needle knife have been introduced to overcome the above limitation, but they entail a high risk of bleeding and perforation.<sup>57,58</sup>



### Indications

EMR is indicated for tumors satisfying all of the following conditions, as promulgated in the GLs: (1) confinement to the mucosal layer; (2) elevated type (I or IIa), or depressed type (IIc) with no ulcer or ulcer scar (no fold convergence endoscopically); (3) well- or moderately differentiated adenocarcinoma; (4) smaller than 2.0 cm.<sup>59</sup> Conditions (2) to (4) are assessed by endoscopy and biopsy. EMR is then performed, and if histological examination of the resected specimen confirms item (1), the procedure is considered to have been curative.

It should be noted that EMR is not considered to be a definitive treatment until histological examination of the resected specimen reveals that the tumor satisfies the previously mentioned criteria. For EMR to be considered potentially curative, two conditions must be met: the primary tumor must be completely removed with a clear margin, and the possibility of lymph node metastasis must be zero, or extremely low.

After successful EMR, however, close endoscopic follow-up is mandatory, because multifocal lesions, either synchronous or metachronous, are not uncommon in the stomach.<sup>60</sup> Second and third lesions are removed by EMR, if they satisfy the above criteria.

Several studies have demonstrated EMR to be feasible for larger lesions outside the GLs.<sup>57,58</sup> Larger lesions can be removed with a high rate of clearance. Expansion of the indications for EMR has been conducted at two large specialized cancer centers, both of which advanced the following indications:<sup>50</sup> (1) differentiated tumors confined to the mucosal layer without ulcer or vessel infiltration; (2) differentiated tumors confined to the mucosal layer with ulceration, with the absence of vessel infiltration, and less than 3 cm in diameter.

EMR also is useful for local resection in elderly patients with various complications, who would be high-risk candidates for conventional surgical operations.<sup>61</sup>

### Pylorus-preserving gastrectomy

#### Indications

Pylorus-preserving gastrectomy (PPG) was used to treat peptic ulcer,<sup>62</sup> but has also been applied to treatment for EGC.<sup>63-67</sup> Pylorus-preserving gastrectomy is indicated for EGC when the distal border of the tumor is located more than 4 cm from the pylorus.

#### Method

The distal two-thirds of the stomach is resected, but a pyloric cuff, about 2 cm wide, is preserved. The length of the pyloric cuff may play an important role in the motility of the pyloric ring after PPG. A recent report showed the benefits of a wider cuff for gastric motility.<sup>68</sup> Infrapyloric vessels are occasionally preserved to maintain the blood supply of wider pyloric cuffs and nerves. Infrapyloric node dissection

with preservation of these vessels should be evaluated. The vagus nerves are identified and preserved to maintain pyloric function. Several Japanese surgeons also preserve the celiac branch of the posterior vagal trunk in combination with PPG.

All regional nodes except the suprapyloric nodes (No. 5) should be dissected as in the standard D2 operation. PPG is currently indicated for EGC in the middle of the stomach, from which nodal metastasis to No. 5 is extremely uncommon.<sup>66</sup> Because a pyloric cuff is retained, PPG is not desirable for lesions located in the distal antrum.

#### Evaluation of function

The incidences of postgastrectomy dumping syndrome, bile regurgitation, and gallbladder stone formation are reportedly decreased, and BW recovery is better after PPG than after Billroth I reconstruction.<sup>64-66</sup> However, these benefits have not been corroborated by a prospective randomized trial. Impaired gastric emptying occasionally develops as a sequela.<sup>65,69</sup> Evaluation using gastric emptying scintigraphy revealed no patients with increased gastric emptying, while some patients showed delayed emptying.<sup>12</sup> Nomura et al.<sup>70</sup> reported the results of an emptying test using acetaminophen after PPG. The gastric emptying rates were similar before and after PPG. Urushihara et al.<sup>15</sup> reported that contraction of the remnant stomach was better after PPG than after distal gastrectomy.

### Proximal gastrectomy

#### Indications

Because no benefit of total gastrectomy with splenectomy has been seen, at least for EGC, proximal gastrectomy with or without preservation of the vagus nerves for EGC in the proximal third of the stomach is being tested at some institutions.<sup>71-73</sup> Proximal gastrectomy is currently indicated for EGC only when at least half of the stomach can be preserved to maintain both the curability of the operation and the functional capacity of the remnant stomach.

#### Method

All regional nodes except for those of the splenic hilum (No. 10) and the distal splenic nodes (No. 11d) are dissected as in the standard D2 operation, although the dissection of the distal lesser curvature nodes (No. 3) is incomplete. Anti-reflux procedures, such as jejunal interposition (physiological sphincter), and new gastric fundus formation are routinely added. Pylorus function is also maintained by this method, because the vagus nerves, including the hepatic and pyloric branches, are preserved, as in PPG. Reflux esophagitis develops as a sequela in some cases.

#### Evaluation of function

Proximal gastrectomy was prospectively evaluated in a single-arm study at our institution, and the survival

data were almost the same as those obtained after total gastrectomy, and were satisfactory.<sup>71</sup> Studies have shown improvement of postoperative absorption,<sup>74,75</sup> and BW recovery to be better after proximal than after total gastrectomy.

Simple esophagogastrostomy is associated with a high incidence of reflux esophagitis,<sup>76,77</sup> despite several modifications. It has been necessary to minimize the incidence of esophagitis in patients in whom proximal gastrectomy is performed, and recent efforts, including the jejunal interposition method, with or without a pouch, have yielded good results.<sup>71,78,79</sup>

### Segmental gastrectomy

Segmental gastrectomy (SG) involves more limited resection of the body of the stomach and is indicated for mucosal tumors in the mid to upper portion of the gastric body. The segment of the stomach containing the tumor is resected with<sup>80</sup> or without preservation of the Latarjet branch of the vagus nerve,<sup>81</sup> and the hepatic and pyloric branches are preserved.

Lymphadenectomy used to be limited to the perigastric region close to the resected segment. Recently, segmental gastrectomy with a more than 5-cm-wide pyloric cuff, to cover the same lymph node dissection area as PPG, has been introduced. The results, in terms of function, are generally satisfactory.

### Wedge resection

An attempt at local wedge resection with regional lymphadenectomy has been reported, by Seto et al.,<sup>82</sup> who describe local resection with lymphadenectomy, for mucosal EGCs 4 cm in diameter or less, to prevent postgastrectomy syndrome. The extent of lymphadenectomy depends on the tumor location. Intraoperative endoscopy and frozen section analysis of the dissected nodes determine the resection line and nodal status. It is important to preserve the pacemaker zone in the proximal corpus along the greater curvature and to preserve the celiac, hepatic, and pyloric branches of the vagus nerve. Several reports have shown the possibility of developing sentinel-node-guided surgery for gastric cancer.<sup>83,84</sup>

### Laparoscopic surgery

#### History

Laparoscopic local gastric resection<sup>85,86</sup> has been performed in Japan for EGC. Because the target of laparoscopic local resection is EGC without lymph node metastasis, expansion of the indications for endoscopic treatment have resulted in a decrease in the number of patients treated by this method. Laparoscopy-assisted Billroth-I gastrectomy for EGC was first described by Kitano et al.<sup>87</sup> in 1994, and Billroth-II

gastrectomy was reported by Goh and Kum<sup>88</sup> in 1992. Laparoscopy assisted gastrectomy is still in the development phase, but the number of EGC patients treated by laparoscopy-assisted distal gastrectomy (LADG) has increased in Japan. The GLs describe LADG as one of the optional forms of modified gastrectomy, because LADG (D2) is still performed at only a few hospitals in Japan.<sup>89</sup>

#### Outcome

A survey by the Japanese Society for Endoscopic Surgery<sup>90</sup> showed low perioperative morbidity, and zero mortality, and possibly a shorter hospital stay after laparoscopic wedge resection.

Laparoscopy-assisted gastrectomy with nodal dissection has been evaluated in some studies. Evaluation of survival is very difficult, because the survival rate with open surgery is quite good. A recent report showed faster recovery, less pain, and shorter hospital stays. However, the only benefit in terms of QOL may be better cosmesis.<sup>91</sup>

A survey of the Japan Society for Endoscopic Surgery found low morbidity and mortality rates for LADG, similar to those for open distal gastrectomy.<sup>90,92</sup> A small randomized study revealed some advantages, including less pain and less impairment of pulmonary function after LADG than after open distal gastrectomy.<sup>93</sup> A multicenter randomized controlled trial is awaited to confirm the clinical advantages of LADG, including the medical expense aspect.

### Sentinel nodes in gastric cancer

The ability to identify a tumor free sentinel node (SN) may enable the surgeon to avoid the morbidity associated with radical lymphadenectomy in patients with gastric cancer and may enable the introduction of function-preserving surgery.

The blue dye method<sup>94</sup> has been used to detect the SN (the first node in the regional lymphatic basin that drains the primary tumor). For the blue-dye technique, the time of injection of the blue dye needs to be carefully monitored, because there is a short window of time during which selective identification of the SN is possible. For this reason, Kitigawa et al.<sup>95</sup> affirm that a combination of intraoperative endoscopic injection of blue dye and gamma-probe inspection facilitates the localizing of SNs in gastric cancer (after the endoscopic submucosal injection of radioactive tracer, subserosal injection is difficult for visualizing small and superficial lesions, which are not palpable from the serosal side). To confirm the complete resection of SNs, a survey of the abdominal cavity with a gamma-detecting probe is essential.

For the time being, solid evidence is needed before we apply SN biopsy for reducing the extent of lymphadenectomy for gastric cancer. This is because of the complicated anatomy of lymphatic streams from the stomach, and because of frequent micrometastasis.

## Conclusion

Function-preserving surgery is already widely performed in Japan for “presumed T1 cancers.” Because function-preserving surgery usually involves less extensive procedures, it must be performed with caution, because more deeply invasive tumors have a high incidence of nodal metastasis, and understaged patients will receive inadequate treatment.

Evaluation of preserved function is very important. However, scientific assessment is not easy, because there is no gold standard for measuring gastrointestinal motor function and the QOL of patients.

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