Original Article

Evaluation of postgastrectomy symptoms and daily lives of small remnant distal gastrectomy for upper-third gastric cancer using a large-scale questionnaire survey

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Abstract

Aim: Total gastrectomy (TG) is often performed for proximal gastric cancer. Small remnant distal gastrectomy (SRDG) can also be used in cases where surgical margins can be secured. The impact of preserving proximal small remnant stomach on postoperative quality of life (QOL) has not been fully elucidated. In the present study, we compared postgastrectomy symptoms and daily lives between patients undergoing SDRG and those undergoing TG for proximal gastric cancer using the developed Postgastrectomy Syndrome Assessment Scale (PGSAS)-45.

Methods: Of the 1909 patients enrolled in the PGSAS NEXT study, univariate analysis of 19 main outcomes measures (MOMs) of PGSAS-45 was performed in patients undergoing TG (n = 1020) or SDRG (n = 54). Multiple regression analysis was performed with several clinical factors as explanatory variables.

Results: There was no difference in age and sex between TG and SDRG groups. In SDRG group, postoperative period was shorter, the rates of laparoscopic approach and preservation of the celiac branch of the vagus nerve were higher, and the rates of clinical stage III/IV disease, ≥D2 dissection, and combined resection with other organs were lower than in the TG group significantly (P < .05). SDRG was associated with...
**1 | INTRODUCTION**

Gastric cancer, which is a common cancer and the second most common cause of cancer-related deaths globally, is also the most prevalent cancer in Japan and East Asia. The treatment of gastric cancer with curative intent requires gastrectomy with adequate lymph node dissection. The 5-year survival rate of early-stage gastric cancer is over 90%, and postoperative quality of life (QOL) remains an important issue in these patients. The incidence of gastric cancer in the upper-third of the stomach has been increasing in Asia in recent years. Although total gastrectomy (TG) is often indicated in early-stage proximal gastric cancer, this approach is a technical hindrance to esophageal–jejunal reconstruction and postoperative maintenance of nutritional status is more difficult due to the loss of storage capacity. Considering these issues, small remnant distal gastrectomy (SRDG) has been also performed in patients with upper-third early-stage cancer, with several studies demonstrating its surgical and nutritional benefits compared to TG. Although one study compared conventional distal gastrectomy with TG, optimal approaches to evaluate patient burdens following SRDG and TG have not yet been established.

The Japan Postgastrectomy Syndrome Working Party was founded to investigate symptoms and lifestyle changes in patients undergoing gastrectomy. The group collaboratively developed the Postgastrectomy Syndrome Assessment Scale-45 (PGSAS-45), a questionnaire which evaluates the general features, including symptoms, living status, and QOL, of patients in the postoperative period. The questionnaire has been used for patient-reported outcomes, postgastrectomy symptoms, proximal gastric cancer, small remnant distal gastrectomy, total gastrectomy.

**2 | PATIENTS AND METHODS**

2.1 | Patients

This cross-sectional study included 70 participating institutions. The PGSAS-45 was distributed to 2364 patients between July 2018 and December 2019. Among a total of 1950 (82.5%) completed questionnaires retrieved from the patients, 41 (1.7%) were deemed ineligible due to chemotherapy treatment within the preceding 6 months, failed R0 resection, ineligible operative procedure, ineligible disease, cancer recurrence, second gastrectomy, postoperative period of shorter than 6 months, and consent withdrawal in 22, 6, 5, 2, 2, 2, 1, and 1 patient, respectively. Among the remaining 1909 questionnaires (80.8%), 1685 patients were diagnosed with gastric cancer affecting the upper-third of the stomach. Of these, 1020 patients who underwent conventional TG and 54 patients who underwent SRDG, where the remnant proximal stomach size was equal to or less than one fifth, were included in the present study (Figure 1). Reconstruction procedures were not regulated by study-specific protocols and were chosen based on the principles or discretion of the treating surgeon or institution.

2.2 | Patient eligibility criteria

The patient inclusion criteria were (1) female or male aged 20 years or older; (2) cancer located in the upper-third of the stomach or around the esophagogastric junction (any stage or histologic type); (3) successful R0 resection; (4) no recurrence or metastasis; (5) postoperative period of more than 6 months; (6) previous chemotherapy allowed in cases with more than 6 months since treatment termination; (7) only one gastrectomy; (8) Eastern Cooperative Oncology Group Scale performance status of 0 or 1; (9) capability of understanding the questionnaire; (10) absence of other diseases or previous surgeries that could mask the effect of gastrectomy results in the questionnaire; (11) no organ failure or mental disease; (12) and willingness to participate in the study. The exclusion criteria were (1) active dual malignancy and (2) synchronous another surgery with exception of the resection or the extraction of the perigastric organs to accomplish gastrectomy or lymph node dissection, and ones equivalent to cholecystectomy.
2.3 | QOL assessment

In the present study, PGSAS-45, a multidimensional QOL questionnaire based on the 8-Item Short Form Health Survey (SF-8) and Gastrointestinal Symptoms Rating Scale (GSRS), was used to assess post-gastrectomy symptoms and daily lives. The questionnaire comprises 45 questions, with 8 and 15 items from the SF-8 and GSRS, respectively, and 22 clinically important items selected by the Japan Postgastrectomy Syndrome Working Party (Table 1). Specifically, the PGSAS-45 comprises 23 items pertaining to postoperative symptoms (items 9-33, except for items 29 and 32), including 15 items from the GSRS and 8 newly selected items. In addition, 12 items are related to dietary intake, work, and level of satisfaction with daily life. Five dietary intake items are related to the amount of food ingested (items 34-37 and 41), and three dietary intake items are related to the quality of ingestion (items 38-40). One questionnaire item pertains to work (item 42), whereas three items address the level of satisfaction with daily life (items 43-45). A seven-grade Likert scale is used for 23 symptom-related items, whereas a five-grade Likert scale is used for all other items, except for items 1, 4, 29, 32, and 34-37. For items 1-8, 34, 35, and 38-40, higher scores indicate better outcomes. For items 9-28, 30, 31, 33, and 41-45, higher scores indicate worse outcomes. A total of 19 main outcome measures (MOMs) have been refined through consolidation and selection and classified into three domains: symptoms, living status, and QOL (Table 2). The details of PGSAS-45 have been reported previously.10–12

2.4 | Study design

The present study utilized continuous sampling from a central registration system for participant enrollment. The questionnaire was distributed to all eligible patients, who were instructed to return the completed forms to the data center. All QOL data from the questionnaires were matched with individual patient data collected via case report forms. The study was registered with the University Hospital Medical Information Network Clinical Trials Registry (registration number 000032221) and approved by the ethics committees of all participating institutions. Written informed consent was obtained from all enrolled patients.

2.5 | Statistical analysis

Patient characteristics and MOMs were compared using Student’s t or Fisher’s exact test, as appropriate. All outcome measures were further analyzed using multiple regression analysis (MRA). Ten factors, including type of gastrectomy, age, sex, postoperative period, operative approach, preservation of the celiac branch of the vagus nerve, chemotherapy, clinical stage, extent of lymph node dissection, and combined resection with other organs, were included as explanatory variables in MRA. These factors were selected according to their clinical importance and based on the results of previous PGSAS studies. Statistical significance was set at a P value of <.05. For factors with a P < .1 in univariate analyses, Cohen’s d was calculated. In MRA with a P < .1, the standardization coefficient of regression (β) and the p value were shown in a table. Cohen’s d, β, and R² were used to measure effect sizes. Interpretation of effect sizes were as follows: small, Cohen’s d > 0.2, β > 0.1, R² > 0.02; medium, Cohen’s d > 0.5, β > 0.3, R² > 0.13; large, Cohen’s d > 0.8, β > 0.5, R² > 0.26. All statistical analyses were performed using JMP 12.0.1 software (SAS Institute, Cary, NC, USA).

3 | RESULTS

3.1 | Patient characteristics

The characteristics of the study participants are summarized in Table 3. TG and SRDG were performed in 1020 and 54 patients, respectively. Compared with the TG group, the SRDG group had
| Domains | Items | Subscales (SS) |
|---------|-------|----------------|
| SF-8    |       | Five or six-point Likert scale |
|         | 1     | Physical functioning* |
|         | 2     | Role physical* |
|         | 3     | Bodily pain* |
|         | 4     | General health* |
|         | 5     | Vitality* |
|         | 6     | Social functioning* |
|         | 7     | Role emotional* |
|         | 8     | Mental health* |
|         | 9     | Abdominal pains |
|         | 10    | Heartburn |
|         | 11    | Acid regurgitation |
|         | 12    | Sucking sensations in the epigastrium |
|         | 13    | Nausea and vomiting |
|         | 14    | Borborygmus |
|         | 15    | Abdominal distension |
|         | 16    | Eructation |
|         | 17    | Increased flatus |
|         | 18    | Decreased passage of stools |
|         | 19    | Increased passage of stools |
|         | 20    | Loose stools |
|         | 21    | Hard stools |
|         | 22    | Urgent need for defecation |
|         | 23    | Feeling of incomplete evacuation |
|         | 24    | Bile regurgitation |
|         | 25    | Sense of foods sticking |
|         | 26    | Postprandial fullness |
|         | 27    | Early satiation |
|         | 28    | Lower abdominal pains |
|         | 29    | Number and type of early dumping symptoms |
|         | 30    | Early dumping general symptoms |
|         | 31    | Early dumping abdominal symptoms |
|         | 32    | Number and type of late dumping symptoms |
|         | 33    | Late dumping symptoms |
|         | 34    | Ingested amount of food per meal* |
|         | 35    | Ingested amount of food per day* |
|         | 36    | Frequency of main meals |
|         | 37    | Frequency of additional meals |
significantly higher postoperative body mass index (SRDG vs. TG; 20.4 ± 2.8 vs 19.7 ± 2.5 kg/m², P = .042), significantly shorter postoperative period (38.8 ± 23.6 vs 52.9 ± 36.5 months, P = .005), and significantly higher rates of laparoscopic utilization (85.2% vs 40.1%, P < .001) and preservation of the celiac branch of the vagus nerve (7.7% [4/52] vs 1.9% [19/993], P = .024; and 27 cases missing in the SRDG and TG groups, respectively). Additionally, the SRDG group had significantly lower rates of advanced clinical stage (P < .001), adjuvant chemotherapy (P = .007), extended lymph node dissection (P = .019), and combined resection (P < .001) and a significantly higher rate of U area in tumor location than the TG group (P < .001).

### 3.2 QOL assessment

The results of the MOMs following TG and SRDG are presented in Table 4. Compared with the TG group, the SRDG group showed significantly lower scores (indicating better condition) in esophageal reflux subscale (SRDG vs TG; 1.5 vs 2.1, P < .001, Cohen’s d = 0.55), meal-related distress subscale (2.1 vs 2.6, P < .001, Cohen’s d = 0.46), total symptom score (2.0 vs 2.2, P = .031, Cohen’s d = 0.32), ability for working (1.8 vs 2.2, P = .004, Cohen’s d = 0.41), dissatisfaction with symptoms (1.7 vs 2.0, P = .015, Cohen’s d = 0.34), dissatisfaction at the meal (2.1 vs 2.7, P = .001, Cohen’s d = 0.49), dissatisfaction at working (1.6 vs 2.1, P < .001, Cohen’s d = 0.50), and dissatisfaction for daily life subscale (1.8 vs 2.3, P < .001, Cohen’s d = 0.52) than the TG group. Additionally, compared with the TG group, the SRDG group had significantly higher scores (indicating better condition) in change in body weight (SRDG vs TG; −10.9% vs −14.3%, P = .007, Cohen’s d = 0.38), ingested amount of food per meal (7.6 vs 6.1, P < .001, Cohen’s d = 0.78), physical component summary of SF-8 (51.6 vs 48.7, P < .001, Cohen’s d = 0.50), and mental component summary of SF-8 (51.1 vs 49.4, P = .048, Cohen’s d = 0.28). Furthermore, the SRDG group exhibited better tendency in several MOMs, including abdominal pain subscale (P = .084, Cohen’s d = 0.24), dumping subscale (P = .061, Cohen’s d = 0.28), and necessity for additional meals (P = .087, Cohen’s d = 0.24) than the TG group. Meanwhile, there were no significant adverse effects in any of the 19 MOMs in the SRDG group compared with the TG group.

MRA was performed to eliminate confounding factors such as age, sex (male or female), postoperative period, surgical approach (laparoscopic or open), intervention for the celiac branch of vagus nerve (preserved or divided), chemotherapy (yes or no), clinical stage (I/II or III/IV), lymph node dissection (D0/D1, D1+, or D2/D2+), and combined resection (yes, no) as explanatory variables (Table 5). Although the effect sizes of the advantages in the SRDG group were relatively small, esophageal reflux subscale (β = −0.138, P < .001), meal-related distress subscale (β = −0.119, P < .001), dumping subscale (β = −0.078, P = .016), total symptom score (β = −0.090, P = .008), change in body weight (β = 0.096, P = .003), ingested amount of food per meal (β = 0.178, P < .001), necessity for additional meals (β = −0.078, P = .016), ability for working (β = −0.080, P = .011), dissatisfaction

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**Table 1** (Continued)

| Domains       | Items   | Subscales (SS) | Notes          |
|---------------|---------|----------------|----------------|
| Meals (quality) | 38 Appetite* | Five-point Likert scale | Quality of ingestion SS* (item 38-40) |
|               | 39 Hunger feeling* | | |
|               | 40 Satiety feeling* | | |
| Meals (amount) | 41 Necessity for additional meals | | |
| Work          | 42 Ability for working | | |
| Dissatisfaction | 43 Dissatisfaction with symptoms | Dissatisfaction for daily life SS (item 43-45) |
|               | 44 Dissatisfaction at the meal | | |
|               | 45 Dissatisfaction at working | | |

Note: In items or subscales with *; higher score indicating better condition. In items or subscales without *; higher score indicating worse.

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**Table 2** Main outcomes measures in PGSAS

| Domains       | Main outcomes measures                                                                 |
|---------------|----------------------------------------------------------------------------------------|
| Symptoms      | Seven symptom subscales: Esophageal reflux (10, 11, 13, 24), Abdominal pain (9, 12, 28), Meal-related distress (25-27), Indigestion (14-17), Diarrhea (19, 20, 22), Constipation (18, 21, 23), Dumping (30, 31, 33) Total symptom score |
| Living status | Change in body weight (%)*: Ingested amount of food per meal* (34), Necessity for additional meals (41), Quality of ingestion subscale* (38-40) Ability for working (42) |
| QOL           | Dissatisfaction with symptoms (43), at the meal (44), at working (45) Dissatisfaction for daily life subscale (43-45) Physical component summary* (1-8) Mental component summary* (1-8) |

Note: “In items or subscales with *; higher score indicating better condition. In items or subscales without *; higher score indicating worse.”
with symptoms ($\beta = -0.086, P = .007$), dissatisfaction at the meal ($\beta = -0.119, P < .001$), dissatisfaction at working ($\beta = -0.111, P = .001$), dissatisfaction for daily life subscale ($\beta = -0.123, P < .001$), and physical component summary of SF-8 ($\beta = 0.112, P = .001$) were significantly better in the SRDG group than in the TG group. Abdominal pain subscale ($\beta = -0.061, P = .061$) showed a better tendency in the SRDG group than in the TG group. Age, sex, postoperative period, surgical approach, clinical stage, lymph node dissection, and combined resection of other organs also had a significant effect on numerous MOMs, whereas celiac branch preservation, and chemotherapy had no significant effect on the MOMs.

### DISCUSSION

The present study provides important insights into the potential benefits of leaving a small remnant stomach and esophagogastric junction in patients undergoing surgery for gastric cancer, an enduring uncertainty. In this cross-sectional study including 70 participating institutions across Japan, we found that the patients who underwent SRDG experienced a better QOL compared to those who underwent TG, based on improvements in 12 of the 19 MOMs of the PGSAS-45 by univariate analysis. Moreover, MRA indicated that the type of gastrectomy, ie, SRDG, was a significant
independent factor which improved postoperative QOL in 13 of the 19 MOMs even after adjusting for various clinical factors. Our analyses also revealed that nonoperative factors including age, sex, and postoperative period had a considerable effect on postoperative QOL and that factors related to cancer progression had a relatively small effect.

Previous PGSAS study comparing postoperative QOL between conventional distal gastrectomy (n = 475) with Roux-en-Y reconstruction and TG (n = 393) for stage I gastric cancer reported that distal gastrectomy with Roux-en-Y reconstruction maintained a better QOL in 15 of the 19 MOMs in the PGSAS-45 compared with TG based on MRA. Similarly, in the present study we utilized MRA to demonstrate that the QOL was better with SRDG than TG based on 13 of the 19 MOMs in the PGSAS-45, despite the more limited reservoir capacity with SRDG compared with conventional distal gastrectomy and the insufficient detection power due to the small number of cases in the SRDG group (n = 54). We also compared the effect sizes of these MOMs to identify specific MOMs that were most sustained by the rather small gastric remnant created by SRDG. Our analyses revealed that the MOMs that were favorably affected were (in decreasing order) ingested amount of food per meal, esophageal reflux subscale, dissatisfaction for daily life subscale, meal-related distress subscale, dissatisfaction at the meals, physical component summary of SF-8, dissatisfaction for working, change in body weight, total symptom score, dissatisfaction with symptoms, ability for working, necessity for additional meals, and dumping subscale. Nakada et al reported that total symptom score, ability for working, and necessity for additional meals were crucial clinical factors associated with worse postgastrectomy QOL and that the meal-related distress and dumping subscales were strongly associated with deterioration in most of the MOMs belonging to the living status and QOL domains among the seven symptom subscales of the PGSAS-45. Since SRDG maintained these important MOMs, the QOL after SRDG might also be well preserved.

Patient-reported outcome measures are often used to compare QOL between various gastrectomy procedures. A combination of the 36-Item Short Form Health Survey (SF-36) and GSRS is one such questionnaire, but GSRS tends to overlook certain important symptoms, such as meal-related distress and dumping, which are specific to patients who undergo gastrectomy. Questionnaires such as the EORTC QLQ-C30 and STO-22 have been developed to assess the QOL of patients with cancer undergoing treatment; however, these scales cannot adequately assess several important symptoms of postgastrectomy syndrome. The PGSAS-45 is a self-reported questionnaire that provides a comprehensive assessment of outcomes in patients undergoing surgery for gastric cancer. This questionnaire contains questions on well-known symptoms that considerably affect the QOL of patients and are adequate for

| Domain            | Main outcome measures                      | TG (n = 1020) | SRDG (n = 54) | t-test | P-value | Cohen’s d |
|-------------------|--------------------------------------------|---------------|--------------|--------|---------|-----------|
| Symptoms          | Esophageal reflux SS                        | 2.1 ± 1.0     | 1.5 ± 0.6    | <.001  | 0.55    |           |
|                   | Abdominal pain SS                           | 1.7 ± 0.8     | 1.5 ± 0.7    | .084   | 0.24    |           |
|                   | Meal-related distress SS                    | 2.6 ± 1.1     | 2.1 ± 0.9    | .001   | 0.46    |           |
|                   | Indigestion SS                              | 2.2 ± 1.0     | 2.1 ± 0.8    | .519   |         |           |
|                   | Diarrhea SS                                 | 2.4 ± 1.2     | 2.4 ± 1.3    | .843   |         |           |
|                   | Constipation SS                             | 2.2 ± 1.1     | 2.1 ± 0.9    | .502   |         |           |
|                   | Dumping SS                                  | 2.2 ± 1.2     | 1.9 ± 1.0    | .061   | 0.28    |           |
|                   | Total symptom score                         | 2.2 ± 0.8     | 2.0 ± 0.6    | .031   | 0.32    |           |
| Living status     | Change in BW                                | -14.3% ± 8.9% | -10.9% ± 7.1%| .007   | 0.38    |           |
|                   | Ingested amount of food per meal            | 6.1 ± 1.9     | 7.6 ± 1.6    | <.001  | 0.78    |           |
|                   | Necessity for additional meals              | 2.4 ± 0.9     | 2.2 ± 0.9    | .087   | 0.24    |           |
|                   | Quality of ingestion SS                     | 3.6 ± 1.0     | 3.8 ± 1.0    | .202   |         |           |
|                   | Ability for working                         | 2.2 ± 1.0     | 1.8 ± 0.8    | .004   | 0.41    |           |
| QOL               | Dissatisfaction with symptoms               | 2.0 ± 1.0     | 1.7 ± 0.8    | .015   | 0.34    |           |
|                   | Dissatisfaction at the meal                 | 2.7 ± 1.2     | 2.1 ± 1.0    | .001   | 0.49    |           |
|                   | Dissatisfaction at working                  | 2.1 ± 1.1     | 1.6 ± 0.8    | <.001  | 0.50    |           |
|                   | Dissatisfaction for daily life SS           | 2.3 ± 1.0     | 1.8 ± 0.7    | <.001  | 0.52    |           |
|                   | PCS of SF-8                                 | 48.7 ± 5.7    | 51.6 ± 4.4   | <.001  | 0.50    |           |
|                   | MCS of SF-8                                 | 49.4 ± 6.2    | 51.1 ± 4.7   | .048   | 0.28    |           |

Note: Outcome measures with*; higher score indicating better condition. Outcome measures without*; higher score indicating worse condition. The interpretation of effect size in Cohen’s d: ≥0.2 as small, ≥0.5 as medium, ≥0.8 as large.

Abbreviations: BW, body weight; MCS, mental component summary; PCS, physical component summary; SRDG, small remnant distal gastrectomy; SS, subscale; TG, total gastrectomy.
### TABLE 5 All outcome measures analyzed using multiple regression analysis

| Domain          | Main outcome measures                  | Type of gastrectomy [SRDG] | Age (years) | Sex [Male] | Postoperative period (Mons) | Approach [Laparoscopic] |
|-----------------|----------------------------------------|-----------------------------|-------------|------------|-----------------------------|-------------------------|
|                 |                                        | β                           | P value     | β          | P value                    | β                      |
| Symptoms        | Esophageal reflux SS                    | −0.138                      | <.001       | −0.084     | .007                         | 0.095                   |
|                 | Abdominal pain SS                      | −0.061                      | .061        | −0.057     | .074                         | −0.101                  |
|                 | Meal-related distress SS               | −0.119                      | <.001       | −0.107     | .001                         | −0.061                  |
|                 | Indigestion SS                         | −0.091                      | .004        | −0.061     | .051                         | −0.073                  |
|                 | Diarrhea SS                            | −0.122                      | <.001       | 0.102      | .001                         | 0.127                  |
|                 | Constipation SS                        | 0.089                       | .005        | 0.136      | <.001                        | 0.111                  |
|                 | Dumping SS                             | −0.078                      | .016        | −0.193     | <.001                        | −0.077                  |
|                 | Total symptom score                    | −0.090                      | .008        | −0.136     | <.001                        | −0.077                  |
| Living status   | Change in BW*                          | 0.096                       | .003        | −0.118     | <.001                        | 0.071                  |
|                 | Ingested amount of food per meal*      | 0.178                       | <.001       | −0.103     | .001                         | 0.078                  |
|                 | Necessity for additional meals         | −0.078                      | .016        | 0.098      | .002                         | −0.062                  |
|                 | Quality of ingestion SS*               | −0.042                      | .035        | −0.099     | .004                         | −0.099                  |
|                 | Ability for working                    | −0.111                      | .001        | −0.122     | .001                         | −0.094                  |
| QOL             | Dissatisfaction with symptoms          | −0.086                      | .007        | −0.091     | .004                         | −0.099                  |
|                 | Dissatisfaction at the meal            | −0.119                      | <.001       | −0.099     | .002                         | −0.094                  |
|                 | Dissatisfaction a working              | −0.111                      | .001        | −0.083     | .008                         | −0.055                  |
|                 | Dissatisfaction for daily life SS      | −0.123                      | <.001       | −0.083     | .008                         | −0.118                  |
|                 | PCS of SF-8*                           | 0.112                       | .001        | −0.096     | .002                         | 0.071                  |
|                 | MCS of SF-8*                           | 0.065                       | .042        | 0.251      | <.001                        | 0.078                  |

Note: Outcome measures with*: higher score indicating better condition.
Outcome measures without*: higher score indicating worse condition.
If β is positive, the score of the outcome measure of the patients belonging to the category in [brackets] is higher in cases when the factor is a nominal scale, and the score of outcome measure of the patients with larger values is higher in cases when the factor is a numerical scale.
The interpretation of effect size in β: ≥0.1 as small, ≥0.3 as medium, ≥0.5 as large.
The interpretation of effect size in R²: ≥0.02 as small, ≥0.13 as medium, ≥0.26 as large.
Abbreviations: [Y], yes; BW, body weight; CTx, chemotherapy; LN, lymphnode; MCS, mental component summary; PCS, physical component summary; SRDG, small remnant distal gastrectomy; SS, subscale.

Clinical evaluation. We used the PGSAS-45 in the present study, which therefore should be considered to have adequately evaluated postgastrectomy syndrome and the QOL in patients undergoing gastrectomy.

It has been well documented that distal gastrectomy is superior to TG in terms of postoperative QOL and nutritional status; however, data demonstrating the superiority of SRDG, in which very small remnant stomach is preserved, are limited. Kosuga et al reported that laparoscopic SRDG exhibited a significant advantage over laparoscopic TG regarding postoperative nutritional status. In the present survey, in addition to several QOL scores of the PGSAS-45, the scores for postoperative dietary intake and weight loss were better after SRDG compared with TG, even though the volume of remnant stomach in SRDG would be extremely small compared with conventional distal gastrectomy. Preservation of other important functions such as maintaining an antireflux mechanism by preserving lower esophageal sphincter or a relatively well-maintained serum ghrelin level in addition to a smaller reservoir function might have contributed to the improved QOL score in SRDG found in the present study.

There are several reasons other than better QOL and nutritional status for the preference of SRDG over TG, including the prevention of reflux and stable short-term results. Kosuga et al reported that 8.2% of the patients who underwent laparoscopic TG experienced severe reflux esophagitis, which was not observed in patients who underwent laparoscopic SRDG. Additionally, the authors reported higher rates of postoperative complications in the laparoscopic TG group than in the laparoscopic SRDG group, especially anastomotic leakage and stricture which are related to technical difficulties of esophagojejunostomy within the narrow space of the esophago gastric junction. Furukawa et al also found that laparoscopic SRDG was associated with favorable endoscopic findings with low-grade remnant gastritis and bile reflux compared with laparoscopic proximal gastrectomy. These findings suggest that the small remnant stomach might be functioning after SRDG.

Preserving a very small remnant stomach in surgery for gastric cancer surgery raises concerns regarding oncological safety. SRDG is recommended if the proximal surgical margin can be secured with the strict confirmation of accurate preoperative diagnosis; however,
it was still unclear. Kano et al reported the oncological feasibility of laparoscopic SRDG compared with laparoscopic proximal gastrectomy or TG for cT1N0 gastric cancer in proximal stomach. In that study, the width of the pathological margin was significantly shorter in patients who underwent laparoscopic SRDG than in those who underwent other procedures and none of the patients who underwent any of the procedures had metastases in no. 2 or 4sa lymph nodes, which were retrieved only during proximal stomach resection. Therefore, great care is warranted to obtain an adequate surgical margin during SRDG in patients with advanced gastric cancer in the proximal stomach.

One of interests on optimal method of surgical resection in the upper-third early gastric cancer will be comparison of SRDG with proximal gastrectomy (PG). When the occupied area of the upper part of the stomach is divided into three equal parts, the proximal part is indicated for PG and the distal part is indicated for SRDG. The intermediate site would be a competing occupied site for PG and SRDG. Therefore, it seems that there are not a few cases where the indications overlap. As an evaluation between surgical procedures of PG and SRDG, it is important to first investigate whether the superiority in each procedure can be shown in comparison with TG, and in which evaluation factors and how large effect it is. Comparing competing SRDG and PG would be the next step. Whether to perform PG or SRDG for patients to whom either procedure is indicated depends on the policy of the institution and the preference of the surgeon. There is a need for future verification.

The present study has several limitations. First, the number of patients in the SRDG and TG groups were not matched due to the retrospective study design. However, the present study included a relatively high number of patients than previous studies analyzing the effect of small remnant stomach on QOL after distal gastrectomy. Of the 70 institutions that participated in the PGSAS NEXT study, only 7 had enrolled cases of SRDG (data not shown). However, the QOL of SRDG would be better than that of TG, and it is expected that SRDG will become widespread in the future. Second, selection bias regarding the type of resection used, SRDG or TG, cannot be ruled out. Since surgeons and institutions are likely to use

| Celiac branch of vagus [Preserved] | CTx [Y] | cStage [III/IV] | LN dissection [D1+] | LN dissection [D2/ D2] | Combined resection [Y] |
|-----------------------------------|---------|----------------|--------------------|------------------------|-----------------------|
| β | P value | β | P value | β | P value | β | P value | β | P value | β | P value | β | P value |
| 0.042 | <.001 | -0.063 | .042 | -0.072 | .021 | 0.065 | .054 | 0.036 | <.001 | 0.035 | <.001 |
| 0.088 | .021 | -0.102 | .002 | -0.100 | .003 | 0.077 | .024 | 0.018 | .067 | 0.078 | <.001 |
| 0.101 | .008 | -0.054 | .083 | 0.097 | .013 | -0.094 | .005 | 0.053 | <.001 | 0.008 | .659 |
| 0.063 | .090 | 0.058 | .080 | 0.082 | <.001 | 0.071 | .036 | 0.040 | <.001 | 0.029 | .002 |
| 0.065 | .096 | 0.058 | .064 | 0.030 | .001 | 0.076 | .025 | 0.038 | <.001 | 0.013 | .253 |

One of interests on optimal method of surgical resection in the upper-third early gastric cancer will be comparison of SRDG with proximal gastrectomy (PG). When the occupied area of the upper part of the stomach is divided into three equal parts, the proximal part is indicated for PG and the distal part is indicated for SRDG. The intermediate site would be a competing occupied site for PG and SRDG. Therefore, it seems that there are not a few cases where the indications overlap. As an evaluation between surgical procedures of PG and SRDG, it is important to first investigate whether the superiority in each procedure can be shown in comparison with TG, and in which evaluation factors and how large effect it is. Comparing competing SRDG and PG would be the next step. Whether to perform PG or SRDG for patients to whom either procedure is indicated depends on the policy of the institution and the preference of the surgeon. There is a need for future verification.

The present study has several limitations. First, the number of patients in the SRDG and TG groups were not matched due to the retrospective study design. However, the present study included a relatively high number of patients than previous studies analyzing the effect of small remnant stomach on QOL after distal gastrectomy. Of the 70 institutions that participated in the PGSAS NEXT study, only 7 had enrolled cases of SRDG (data not shown). However, the QOL of SRDG would be better than that of TG, and it is expected that SRDG will become widespread in the future. Second, selection bias regarding the type of resection used, SRDG or TG, cannot be ruled out. Since surgeons and institutions are likely to use

| Celiac branch of vagus [Preserved] | CTx [Y] | cStage [III/IV] | LN dissection [D1+] | LN dissection [D2/ D2] | Combined resection [Y] |
|-----------------------------------|---------|----------------|--------------------|------------------------|-----------------------|
| β | P value | β | P value | β | P value | β | P value | β | P value | β | P value |
| 0.042 | <.001 | -0.063 | .042 | -0.072 | .021 | 0.065 | .054 | 0.036 | <.001 | 0.035 | <.001 |
| 0.088 | .021 | -0.102 | .002 | -0.100 | .003 | 0.077 | .024 | 0.018 | .067 | 0.078 | <.001 |
| 0.101 | .008 | -0.054 | .083 | 0.097 | .013 | -0.094 | .005 | 0.053 | <.001 | 0.008 | .659 |
| 0.063 | .090 | 0.058 | .080 | 0.082 | <.001 | 0.071 | .036 | 0.040 | <.001 | 0.029 | .002 |
| 0.065 | .096 | 0.058 | .064 | 0.030 | .001 | 0.076 | .025 | 0.038 | <.001 | 0.013 | .253 |
their preferred techniques according to each indication for proximal stomach, a randomized controlled trial is required to eliminate potential biases.

In conclusion, the results of the present study indicated that SRDG might be beneficial in improving postoperative QOL and reducing the symptoms of postgastrectomy syndrome in patients undergoing surgery for early-stage gastric cancer in upper-third of the stomach.

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DISCLOSURE

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