Feasibility of central gastrectomy for gastric cancer

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Background. *Central gastrectomy (CG) for gastric cancer was developed to preserve pyloric function and maintain a large gastric volume. Whether this procedure is feasible for limited cases of gastric cancer is unclear.*
Methods. *On the basis of Union Internationale Contre le Cancer TNM classification, pathologic characteristics, perioperative parameters, and long-term results, we analyzed 100 patients who underwent CG.*
Results. *Pathologic findings included T1 (tumor depth, mucosal or submucosal) in 82 patients and T2 (muscularis propria or subserosal) in 18 patients. Mean number of dissected lymph nodes was 17.3, and pathologic N1 (node metastasis, 6 or less) was found in 14 patients. There were no operative deaths, but 5 patients had postoperative complications: anastomotic leakage in 1, severe gastric stasis in 2, ischemic gastric ulcer in 1, and intra-abdominal bleeding in 1. No patient had a cancer recurrence in a mean follow-up of 49 months. New early gastric cancer was detected in 3 patients during follow-up endoscopic examination. The 5-year cumulative survival was 0.97. One year after CG, 63 patients had early satiety after food intake. Mean ratio of 1-year postoperative/preoperative body weight was 95%.*
Conclusions. *Central gastrectomy with sufficient node dissection resulted in good long-term survival and minimal postoperative weight loss. CG is a safe and useful procedure for selected patients with gastric cancer, although close follow-up for recurrence and a more precise analysis on physiologic states is needed. (Surgery 2003;133:68-73.)*

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CONVENTIONAL DISTAL GASTRECTOMY (DG) with regional node dissection, a standard operation for gastric cancer, has excellent outcomes, especially for early gastric cancer.[1,2] However, wide resection of the stomach with loss of pyloric function sometimes leads to postoperative conditions such as dumping syndrome or severe weight loss.[3] Pylorus-preserving gastrectomy for gastric cancer, in which a 1.5-cm prepyloric area remains with preservation of the pyloric branch of the vagal nerve, maintains a more physiologic state than conventional DG.[4-6] Although some authors report suprapyloric nodes can also be dissected during a pylorus-preserving gastrectomy,[7,8] indications for pylorus-preserving gastrectomy are limited to small-sized T1 gastric cancer (Union Internationale Contre le Cancer [UICC] TNM classification).[9]

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In an attempt to preserve more gastric volume and improve quality of life, segmental gastrectomy with node dissection has recently been adopted for small gastric cancers.[10-14] Because the stomach is transected at 2- or 3-cm intervals from the cancer edge and the middle portion of the stomach is usually resected, we call this operation a central gastrectomy (CG).[12] Although there are reports on segmental gastrectomy for benign ulcer,[15,16] studies on CG for gastric cancer are more recent. In this study we retrospectively analyzed clinicopathologic characteristics and follow-up data in 100 patients who underwent CG and briefly compared them with a histologic group of 100 patients who underwent DG and had indications for CG.

PATIENTS AND METHODS

Included in the current study were 100 patients with gastric cancer who underwent CG at Shizuoka General Hospital from July 1992 to September 1996. Informed consent was obtained from all patients. For comparison, we also reviewed the hospital records of 100 patients who underwent conventional DG (including subtotal gastrectomy) from January 1986 to June 1992 and had indications for CG. This study was completed in

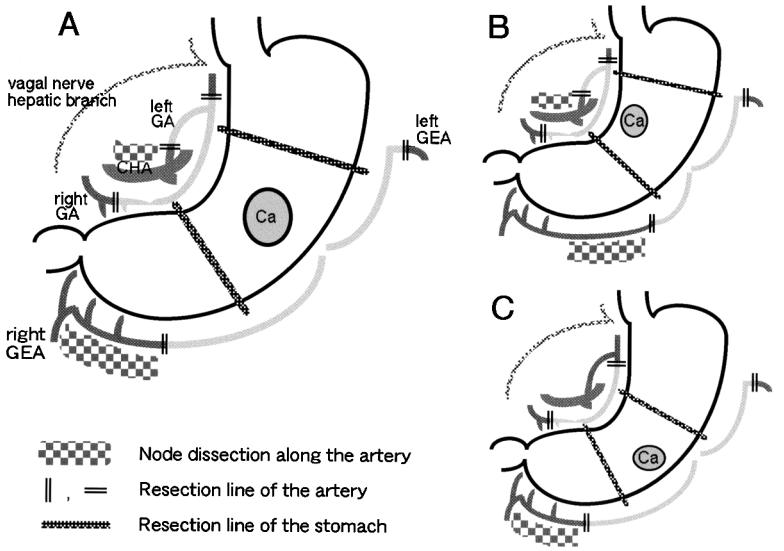

Figure. Schematic illustration of CG. **A**, Basic procedure. **B**, Less invasive procedure, locating on the lesser curvature. **C**, Less invasive procedure, locating on the greater curvature. *GA*, Gastric artery; *GEA*, gastroepiploic artery; *CHA*, common hepatic artery; *Ca*, cancer.

September 1998; the CG group was followed-up for 24 to 76 months (median, 49 months) and the DG group was followed-up for 24 to 99 months (median, 55 months). At least 1 surgeon from a team of 6 members participated in all operations either as an operator or as the first assistant.

Table I shows indications and exclusion criteria for CG. The vertical location of the stomach was recorded as the upper, middle, or lower third of the stomach defined by the 2 lines dividing each curvature into 3 equal parts. When a tumor was spread over 2 portions, the main involved portion was described as the tumor location. When a tumor was located in the distal half of the upper third of the stomach, CG was offered to limited patients with a distance of more than 3 or 4 cm from the esophagogastric junction to the edge of the cancer. When an apparent nodal metastasis was found at the root of the gastric or gastroepiploic artery during operation, conventional DG was used to achieve more exhaustive lymphadenectomy.

When a cancer was detected by routine endoscopic examination, longitudinal and horizontal step biopsies were done to map the precise extent of the cancer during a second endoscopic examination. Depth of tumor invasion was judged by either barium radiograph or endoscopic examination. Endoscopic ultrasonography was not used. When an accurate assessment of the site of the lesion could not be detected during operation, intraoperative endoscopic localization or direct visualization by gastrotomy was done early during the procedure (37 patients), and preoperative endoscopic clipping, 1 cm from the cancer edge, was usually done later (40 patients).

Table I. Indications and exclusion criteria for central gastrectomy (CG)

Indications
1) Tumor invasion restricted to T1 or limited T2 (muscularis propria and macroscopically localized type)
2) Tumor size ≤ 5 cm
3) Tumor in the middle third, distal half of upper third, or proximal half and greater curvature side of lower third of the stomach
Exclusion criteria
4) Macroscopic tumor size < 2 cm and depth limited to mucosa → Endoscopic mucosal resection or wedge gastrectomy indicated
5) Apparent node metastasis noted at the root of the gastric or gastroepiploic artery → Distal gastrectomy (DG) indicated

As shown in the Figure, *A*, the operative strategies for CG were: (1) excision more than 2 cm from the edge of T1 cancer and 3 cm from a T2 cancer; (2) preservation of hepatic and pyloric branches of the vagal nerve to maintain pyloric function; (3) the area around the right gastric artery was not disturbed to preserve the neurovascular supply to the distal antrum and pylorus, and lymph nodes at the proximal short part of the right gastroepiploic artery were dissected with preservation of the vessels to maintain the blood supply of the distal greater curvature of the stomach; (4) excluding the area around the right gastric artery, lymph nodes were principally dissected

Table II. Histopathologic characteristics of patients undergoing CG

Tumor location		Node metastasis	
Upper third	15	pN0	86
Middle third	67	pN1	14
Lower third	18	Pathologic stage	
Tumor size		stage Ia	75
2 cm	31	stage Ib	18
≥2 cm, ≤5 cm	59	stage II	7
>5 cm	10	Proximal margin	
Histologic typing		Mean (cm)	2.9 ± 0.2
Well-differentiated	24	<1 cm	10
Moderately differentiated	23	≥1 cm, <3 cm	47
Poorly differentiated	28	≥3 cm	43
Signet-ring cell	25	Distal margin	
Tumor invasion (depth)		Mean (cm)	2.6 ± 0.2
pT1 (mucosal)	50	<1 cm	7
pT1 (submucosal)	32	≥1 cm, <3 cm	62
pT2	18	≥3 cm	31

to near the same level as that in conventional DG; however, in lesser curvature mucosal cancers less than 3 cm in size, we occasionally omitted lymph node dissection along the proximal right gastroepiploic artery (Fig, *B*). In contrast, for greater curvature mucosal cancers less than 3 cm in size, we occasionally excised the descending branch of the left gastric artery but preserved the main vessel (Fig, *C*); and (5) the proximal and distal ends of the excised stomach specimens were subjected to frozen section examination. When the pathologist detected cancer at the margin, further gastrectomy was carried out.

Clinical, surgical, and pathologic findings were described on the basis of UICC TNM classification for gastric cancer.[9] The pathologic N classification in the new UICC TNM staging system is defined according to number of metastases to the regional lymph nodes. The TNM classification recommends examination of 15 or more lymph nodes; in this study, we included patients in whom fewer than 15 nodes were excised. Three patients satisfying CG indications (T factor, tumor size, and location) were converted from CG to DG because of macroscopic findings with apparent lymph node metastasis at the root of the left gastric or the right gastroepiploic artery.

The data are expressed as mean ± SEM. Statistical analysis should be considered as descriptive because of the retrospective nature of our study and because the 2 groups of patients were from different time eras. We used a Statview software package (SAS Institute, Inc, Cary, NC). A P value of less than .05 was considered significant. Relative comparability of the CG and DG groups was analyzed using Student t test and chi-square statistics. Survival was estimated using the Kaplan-Meier method.

RESULTS

Pathologic characteristics. Table II shows pathologic characteristics of patients who underwent CG. Transverse tumor sizes greater than 5 cm were seen in 10 patients, whereas longitudinal tumor sizes greater than 5 cm occurred in only 2 patients. Pathologic depth of invasion of tumors less than 2 cm in size (n = 31) was confined to mucosal (n = 22), submucosal (n = 8), and muscularis propria (n = 1). Of 18 patients with pT2 tumors, 15 showed invasion to muscularis propria, whereas 3 showed invasion to the subserosal layer. Numbers of dissected lymph nodes along the left gastric artery, left gastroepiploic artery, and right gastroepiploic artery were 7.2 ± 0.5, 1.3 ± 0.2, and 7.8 ± 0.6, respectively. Number of dissected lymph nodes along the common hepatic artery (n = 69) was 1.2 ± 0.2. Total number of dissected nodes per patient was 17.3 ± 1.0. The 14 patients with lymph node metastasis included 11 with 1 positive node, 2 with 2 positive nodes, and 1 with 5 positive nodes. Metastatic nodal sites were along the lesser curvature (n = 4), the greater curvature (n = 9), and both areas (n = 1). The 14 patients who were lymph node positive showed histologic typing from well to moderately well-differentiated cancers (n = 6), and poorly differentiated or signet-ring cell cancers (n = 8); depth of tumor invasions were pT1 (mucosal, n = 1; submucosal, n = 6) and pT2 (n = 7). The size of mucosal cancer with lymph node metastasis was 3.0 × 2.0 cm. Pathologic features in relation to extent of lymph node dissections are shown in

Table III. Pathologic features in relation to extent of node dissection in patients undergoing CG

		Tumor size		*pT*			*pN*	
	No. of patients	*<3 cm*	*≥3 cm*	*pT1 (m)*	*pT1 (sm)*	*pT2*	*pN0*	*pN1*
(A) Basic LN dissection	59	28 (2)	31 (10)	24 (1)	20 (5)	15 (6)	47	12
(B) LN along the proximal right GEA; not dissected	19	16	3 (1)	10	7 (1)	2	18	1
(C) LN along the left GA trunk; not dissected	22	19 (1)	3	16	5	1 (1)	21	1

Parentheses indicate number of patients with positive LN metastasis. *LN*, Lymph node; *GA*, gastric artery; *GEA*, gastroepiploic artery; *m*, mucosa; *sm*, submucosa.

Table III. Of 59 patients who underwent basic lymph node dissection (Fig, *A*), 17 patients received lymph node dissections along the trunk of the left gastric artery with excision of the descending branch of the artery.

The patients undergoing DG (including subtotal gastrectomy) had tumor locations in the upper third (n = 12), middle third (n = 79), and lower third (n = 9); tumor sizes of < 2 cm (n = 19), ≥ 2cm-≤ 5 cm (n = 73), and > 5 cm (n = 8); histologic differentiated (n = 44) and undifferentiated lesions (n = 56); pT1 (n = 82) and pT2 (n = 18); lymph node metastases of pN0 (n = 93) and pN1 (n = 7); and final pathologic stage Ia (n = 80), stage Ib (n = 15) and stage II (n = 5). No important differences were observed between DG and CG groups. Patients undergoing CG compared with DG had lesser proximal margins (2.9 ± 0.2 vs 3.7 ± 0.2 cm) and distal margins (2.6 ± 0.2 vs 8.4 ± 0.2 cm). Number of dissected lymph nodes per patient undergoing DG was 21.6 ± 1.0.

A second lesion was found in pathologic specimens from 5 patients undergoing CG and 3 undergoing DG. In 2 of these 8 patients, the second lesion was detected preoperatively during the endoscopic examination.

Perioperative data and morbidity. Operating time for CG was 207 ± 5 minutes, operative blood loss was 294 ± 21 mL, and postoperative hospital stay was 17.3 ± 0.7 days. There was no hospital mortality. Five patients had major postoperative complications (Table IV). Two patients of the 100 undergoing CG had a prolonged postoperative hospital stay (54 and 50 days) as a result of severe gastric stasis. As their food intake gradually increased, additional surgical or endoscopic treatment was not required.

Follow-up. Table IV summarizes follow-up data. No cancer recurrence was found in the CG group, whereas 1 patient undergoing DG (histologic tumor size, 3.5 × 2.0 cm; tumor depth, submucosal; and lymph node metastasis, pN0) died of liver metastasis 43 months postoperatively. New, early gastric cancer was detected in 3 patients undergoing CG (distal stomach in 2, 40 and 48 months postoperatively; and proximal stomach in 1, 8 months postoperatively) and in 1 patient undergoing DG (56 months postoperatively). Endoscopic mucosal resection was carried out in 1 of the 2 patients with the new distal stomach cancer and curative DG was undertaken in other patient. The new proximal stomach cancer after CG was resected by a proximal gastrectomy.

Cumulative 5-year survival in CG was 97%. When compared with the preoperative state, the quantity of food intake 1 year after CG was 90% to 100% (n = 31), 80% to 89% (n = 56), 70% to 79%, (n = 12), and 50% (n = 1). A total of 63 patients had early satiety 1 year after the operation; whereas, 1-year postoperative/preoperative body weight rates in CG and DG were 95 ± 1% and 91 ± 1%, respectively.

DISCUSSION

Recently, pylorus-preserving gastrectomy has been used for small gastric cancer in Japan to preserve pyloric function. Although it can reportedly alleviate postgastrectomy symptoms such as dumping syndrome or duodenogastric reflux, the resected gastric volume is similar to that by conventional DG.[5,6] In pylorus-preserving gastrectomy, the suprapyloric node dissection is excluded because the right gastric artery must be preserved to supply blood to the prepyloric stomach and to maintain the pyloric vagal nerve branch.[4-6] The suprapyloric node can be excluded because the metastasis to suprapyloric nodes is only rarely observed in early gastric cancer in the middle third of the stomach.[4,17,18]

On the basis of the finding that lymph nodes along the proximal right gastroepiploic artery can be sufficiently dissected without excising the artery,

Table IV. Morbidity and follow-up

	CG (n = 100)	*DG (n = 100)*
Morbidity		
Anastomotic leakage	1	3
Gastric stasis	2	
Anastomotic stenosis		2
Ischemic gastric ulcer	1	
Intra-abdominal bleeding	1	
Late result		
Cancer recurrence		1
Death	3	7
Lost to follow-up		3
Cause of death		
Cancer recurrence		1
Other diseases	3	6
Occurrence of new gastric cancer	3	1

we suggest that the level of node dissection in CG is similar to that in conventional DG with the exception of suprapyloric node dissection. This reasoning led us to develop the CG procedure.[12] Because CG appears to afford sufficient node dissection, we extended its indications to T1 and limited T2 cancers of 5 cm or less in size. This concept was on the basis of the fact that a gastric resection of maximum 9 to 11 cm (5-cm tumor size plus 2- to 3-cm oral and anal margins) maintains an adequate residual gastric volume. Ohwada et al[10] proposed that CG is indicated for patients with any mucosal cancers and submucosal cancers less than 5 cm in size with differentiated types. Although, with cancers less than 3 cm and invasion confined to the mucosa, nodal metastasis is extremely rare.[19] Thus, we devised less invasive options for mucosal cancers less than 3 cm in size, in which lymph node dissection along the trunk of the left gastric artery or the proximal right gastroepiploic artery is omitted (Fig, *B* and *C*). Furukawa et al[14] recommended segmental gastrectomy with limited perigastric node dissection for mucosal cancer of any protruded type or depressed type less than 2 cm in the midstomach.

We performed CG on the basis of our criteria (Table I), but postoperative histologic findings of tumor size and depth often differed from those diagnosed preoperatively. CG was carried out in 22 patients with mucosal cancers of less than 2 cm in size. Specifically, wedge gastrectomy or endoscopic mucosal resection was undertaken for patients whose histologic diagnosis was expected to coincide with the preoperative diagnosis. Recently, tumor depth was assessed using preoperative endoscopic ultrasonography. However, as its diagnostic accuracy for early gastric cancer is relatively low (44%[20] or 55%[21]), we have not yet adopted this method to aid in preoperative staging.

In 41 patients, we did not use a lymph node dissection along the trunk of the left gastric artery or the proximal right gastroepiploic artery. We believe it is possible to conduct a focused node dissection for mucosal cancers less than 3 cm in size. However, we would emphasize that the basic node dissection shown in Fig, *A,* should usually be done in CG because precise preoperative diagnosis about the depth of tumor invasion remains difficult and remote lymph node metastasis may occur even in submucosal cancer.[22]

Two of our patients had severe gastric stasis develop postoperatively, probably as a result of injury to the hepatic or pyloric branch of the vagal nerve during operation. No cancer recurrence was experienced after CG. In 5 patients undergoing CG and 3 undergoing DG in our series, a second, small cancer lesion was detected by preoperative endoscopic examination or by postoperative pathologic examination. During follow-up after CG, a new cancer was detected in the residual stomach of 3 patients (distal stomach, 2; proximal stomach, 1). As with all localized resections for gastric cancer, this is a serious problem with CG. To prevent overlooking new lesions, postoperative endoscopy should be done once or twice a year. Takeda et al[23] recommend periodic endoscopy to detect early gastric cancer arising from the remnant stomach. Another important concern is the direction of lymph drainage after CG. Strategies for the range of lymph node dissection for patients with a new gastric cancer during the follow-up of CG must be proposed hereafter.

Some studies[15,16] report abnormalities in postoperative gastric emptying and symptomatology after segmental gastrectomy in patients with benign gastric ulcer, though only a few deal with postoperative gastric cancer.[11,12] It is important to evaluate postoperative symptoms and physiologic parameters such as weight change, food intake, and gastric emptying with patients considering CG. Koufuji et al[11] found that early satiety is high (44%) even 6 months after segmental gastrectomy. Ohwada et al[24] reported that emptying of a liquid meal returns to a level similar to healthy individuals but emptying of a solid meal remains prolonged 1 year after segmental gastrectomy. In contrast, the 1-year postoperative/preoperative body weight after pylorus-preserving gastrectomy varies from 91% to 99%.[5,6] Tomita et al[25] found that all patients after pylorus-preserving gastrectomy had early satiety and that gastric emptying of a semisol-

id diet was slower than in healthy control participants. Nakane et al[26] reported that the early satiety after pylorus-preserving gastrectomy decreased from 35% (at 1 year after operation) to 16% (2 years after operation).

In 87% of our patients after CG, food intake 1 year postoperatively was 80% or more of the preoperative food intake. However, 63% of our patients had early satiety at 1 year after operation. The percentage of postoperative to preoperative body weight was 95% in CG group, and 91% in DG group. There are several potential technical variations of CG that would preserve either the perigastric artery or gastric branches of the vagal nerve. A much more limited procedure would be expected to result in a better gastric function postoperatively. One would assume that by using the basic operative procedure shown in Fig, *A*, a larger volume of the remaining proximal or distal stomach would improve postoperative early satiety and decreased food intake quantity. Although postoperative changes in body weight of our patients undergoing CG were minimal, study of the volume of retained stomach to postoperative gastric symptoms would be very interesting to see if this assumption was true.

In summary, CG with a distal margin of 2 to 3 cm from the edge of the cancer makes it possible to dissect almost the same extent of lymph nodes as that by conventional DG. Patients undergoing CG showed excellent postoperative survival and minimal weight loss. We conclude that CG is a useful operative procedure for selected patients with gastric cancer. However, it will be necessary to investigate postoperative gastric emptying and the incidence of new cancer developing in the residual stomach.

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