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Extended Surgery—Left Upper Abdominal Exenteration Plus Appleby's Method—for Type 4 Gastric Carcinoma

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Background: The prognosis after surgical treatment for type 4 gastric cancer, including linitis plastica, remains poor. The most frequent recurrence mode is retroperitoneal involvement. To remove the tumor and microinvasion surrounding the stomach, extended surgery, left upper abdominal exenteration plus the Appleby's method (LUAE + Apl), has been performed for type 4 cancers since 1983.

Patients and Methods: A total of 54 patients with type 4 cancer underwent extended surgery (LUAE + Apl) over the past 11 years. In the LUAE + Apl surgical procedure, the whole stomach, pancreas body and tail, spleen, gallbladder, transverse colon, and left adrenal were removed en bloc. The results of this treatment are reported and the most beneficial application of this procedure (group A) is evaluated and compared with findings in similar patients who underwent common surgery between 1973 and 1983 (group B).

Results: As postoperative complications, pancreatic fistula (30%; control 19%), liver dysfunction (15%; 14%), anastomosis failure (6%; 9%), and infection (4%; 1%) were observed (NS). In group A, one patient died of liver dysfunction and another of multiple organ failure due to major pancreatic fistula. In stage III, the 5-year survival rate of group A (40%) was better than that of group B (20%; $p < 0.05$). In stage IV, the 5-year survival rate of group A (5%; 3% in group B) was not improved.

Conclusion: LUAE + Apl improved the survival of patients with scirrhous cancer in stage III, but it was not effective for those in stage IV. To improve the survival of patients in stage IV, a new concept of treatment and supportive therapy needs to be used.

Key Words: Scirrhous gastric cancer—Extended surgery—Left upper abdominal exenteration—Appleby's method.

The prognosis after surgical treatment for scirrhous gastric cancer, including linitis plastica, remains poor (1). Because scirrhous cancer cannot be diagnosed in its early stage, almost all tumors are large (>10 cm) and involve the serosa when finally detected (2,3). Some investigators have proposed that scirrhous cancer should not be treated surgically (4). The most frequent recurrence mode is retroperitoneal involvement (5), which may occur due to a small focus remaining at the peritoneum near the stomach. To remove the tumor, microinvasion and lymph node metastasis surrounding the stomach, extended surgery involving left upper abdominal exenteration (LUAE) plus celiac axis resection (the Appleby's method) has been performed for scirrhous cancers since 1983. Appleby's procedure is suitable for dissecting lymph nodes located near the celiac axis and the common hepatic artery, and it must be beneficial for scirrhous cancer to remove these lymph nodes, which have high risk of metastasis. We encountered severe complications with this extended surgical pro-

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cedure in the early period. Some modifications in surgical methods led to safer results. Because the longest survivor has now survived for >10 years, the LUAE + Appleby's method should be evaluated with regard to the surgical procedure and results.

PATIENTS AND METHODS

Before extended operation, a total of 36 patients with type 4 gastric cancer between 1973 and 1978 (group I) and 44 patients between 1978 and 1983 (group II) underwent total gastrectomy with pancreatosplenectomy, curatively. In group II, patients also underwent adjuvant chemotherapy with mitomycin C 20 mg plus 5-fluorouracil (5-FU) 250 mg administered intravenously six times for 3 weeks postoperatively (MF).

Between 1983 and 1986, a total of 28 patients with type 4 cancer underwent a curative extended surgery (LUAE + Appleby's method) and also received adjuvant MF chemotherapy (group III). Between 1987 and 1991, 26 patients with type 4 gastric cancer underwent curative extended surgery and adjuvant MF chemotherapy plus intraperitoneal mitomycin C (MMC) (40 mg) administration (group IV). The survival rates of these four groups were compared. The results of the extended procedure (group A = groups III and IV) and the most beneficial application of this procedure were evaluated in comparison with those in patients who had undergone common surgery (group B = groups I and II).

In group A, gender, age, tumor size, and depth of invasion were similar to those in group B. Stage IV was more frequent in group A than in group B (Table 1).

The original surgical procedure for LUAE combined with Appleby's method is as follows: the whole stomach, pancreas body and tail, spleen, transverse colon, gallbladder, and left adrenal are removed en bloc. According to Appleby's method, the celiac artery is resected at the root to remove the common hepatic, left gastric, and splenic arteries. The blood supply to the liver is routed from the supramesenteric artery to the pancreatoduodenal artery to the gastroduodenal artery to the hepatic artery (Fig. 1).

Before Appleby's procedure was performed, an angiographic study was obtained in every patient. Through the angiographic studies of the patients, three major variations of the branching of the hepatic artery were classified (Fig. 2). Type I shows the route from the celiac axis–common hepatic artery (CHA) to the right and left hepatic artery, this is the most

TABLE 1. *Patient characteristics*

	Group I (%)	Group II (%)	Group III (%)	Group IV (%)	p
Sex					
M	20(55)	24(55)	12(43)	12(46)	NS
F	16(45)	20(45)	16(57)	14(54)	
Age					
≤40	8(22)	8(18)	4(14)	4(15)	
41–59	16(44)	16(36)	14(50)	14(54)	NS
≥60	12(33)	20(45)	10(36)	8(31)	
Size (cm)					
≤10	9(25)	10(23)	7(25)	6(23)	
11–15	20(55)	16(36)	15(54)	14(54)	NS
≥16	7(19)	18(41)	6(21)	6(23)	
Location					
Upper	12(33)	9(20)	10(36)	9(35)	
Middle	16(44)	24(55)	13(46)	12(46)	NS
Lower	8(22)	11(25)	5(18)	6(23)	
Stage					
I–III	31(86)	28(64)	9(32)	8(31)	<0.01
IV	5(14)	16(36)	19(68)	18(69)	

Group I, patients who underwent common surgery between 1973 and 1977; group II, patients who underwent common surgery and postoperative chemotherapy using mitomycin C and 5-fluorouracil (MF) between 1978 and 1982; group III, patients who underwent extended surgery and MF between 1983 and 1987; group IV, patients who underwent extended surgery and intraperitoneal administration of mitomycin C between 1988 and 1992; NS, no significant difference among the groups.

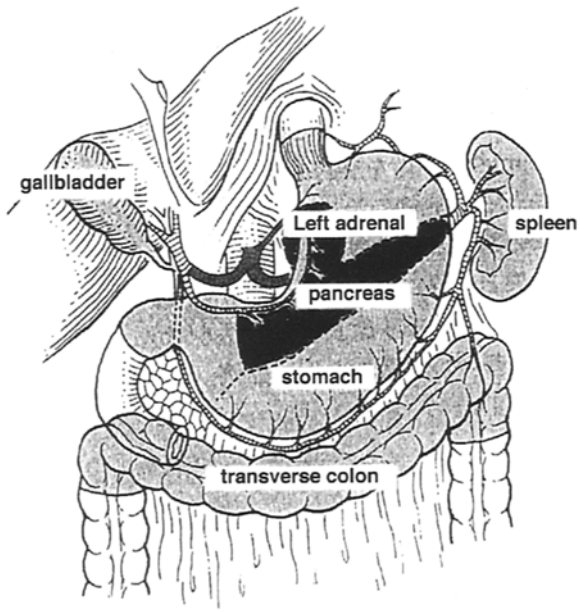

FIG. 1. Extended operation—left upper abdominal exenteration plus Appleby's method. The whole stomach, pancreas body and tail, spleen, transverse colon, gallbladder, and left adrenal are removed en bloc. The celiac artery is resected at the root.

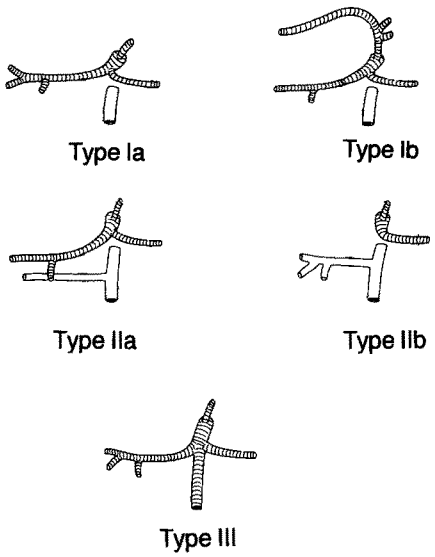

FIG. 2. Angiographic study on hepatic artery. Three major variations of the branching of the hepatic artery are classified as follows: type 1, in which the hepatic artery branches from the celiac artery; type 2, in which the hepatic blood is supplied from the supramesenteric artery partially or totally; and type 3, having a unified trunk of celiac artery and supramesenteric artery.

common type (Ia; 70%). A minor variation was detected on a left hepatic artery. The left hepatic artery branches from the celiac axis or the aorta (Ib; 9%) instead of the CHA. In type II, the right hepatic artery (IIa) or the right and left hepatic artery (IIb) branches from the supramesenteric artery (SMA) (15%). In IIa the common hepatic artery is observed at the common position, and the bypass route from the SMA is consistent in all cases. The right hepatic artery in IIa or the right and left hepatic artery in IIb is located at the posterior side of the hepatoduodenal ligament. In type III cases, the celiac artery and the supramesenteric artery unify to form one trunk (3%). The remaining cases (3%) had variations that were difficult to be classified. Appleby's procedure was performed in patients with type Ia and in one third of those with type Ib or type IIa without liver dysfunction.

For the staging system, the general rules for the Gastric Cancer Study of 1993 (10) was used.

For statistical analysis, χ^2 test or Student's t test was used. The Kaplan-Meier method was used to calculate and compare survival rates.

RESULTS

Surgical Time and Volume of Blood Loss

Surgical time in group A was 301 ± 84 min, whereas that in group B was 299 ± 83 min. The volume of blood loss in group A was 1,329 ± 519 ml, whereas that in group B was 1,379 ± 754 ml. There was no significant difference in surgical time or volume of blood loss between groups A and B.

Morbidity and Mortality

The extended operation, including its many surgical components, induced several kinds of postoperative complications. Liver dysfunction, pancreatic fistula, anastomosis failure, cardiovascular disorder, respiratory disease, and infection were observed, and two patients in group A died of liver dysfunction and multiple organ failure due to major pancreatic fistula. At the autopsy, a major variation that the left hepatic artery branched from the left gastric artery, which we resected during surgery, was found. And an atrophic change on the left lobe of the liver due to decreasing arterial blood flow was found on the patient. Before this major fistula case, the cut end of the pancreas was sutured by a single suture or by mattress suturing using silk. After the cut end of the pancreas was sutured by continuous suturing using proline, no major fistula was experienced. There was no difference in the incidence of postoperative complications between groups A and B, whereas severe complications were encountered in group A (Table 2).

Survival

The 5-year survival rates of groups I and II were 20% and 18% in stage III, and 20% and 0% in stage IV (Fig. 3), respectively. There was no difference between the two groups. The 5-year survival rates in groups III and IV were 40% and 44% in stage III, and 0% and 5% in stage IV, respectively (Fig. 3). In group A (groups III and IV), the 5-year survival rate in stage III (45.0%) was significantly better than that in group B (groups I and II) (20.0%) (Fig. 4). In stage IV, there was no difference in the survival rate between groups A and B, whereas two patients in group A survived for >5 years with cancer recurrence. In group A patients, cancer involvements were diag-

TABLE 2. *Postoperative complications*

	Group A (54) (%)	Group B (80) (%)
Pancreatic fistula	16 (30)	15 (19)
Liver dysfunction	8(15)	11(14)
Anastomosis failure	3(6)	7(9)
Infection	2(4)	1(1)
Others[a]	2(4)	3(4)

[a] Others includes cardiac failure (3), thyroid crisis (1), and ileus (1).

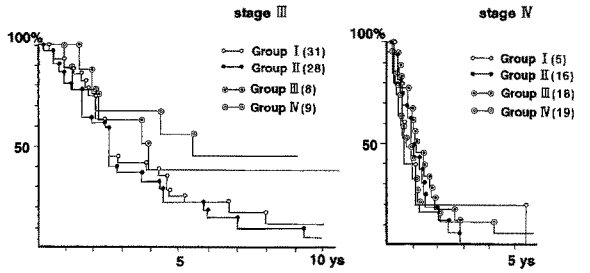

FIG. 3. Survival rates of patients in groups I, II, III, and IV. Group I includes 36 patients with scirrhous cancer who underwent common surgery between 1973 and 1978. In group II, 44 patients underwent common surgery and postoperative chemotherapy using MF between 1978 and 1983. The 5-year survival rates of groups I and II are 20% and 18% in stage III, and 20% and 0% in stage IV, respectively. There in no significant difference between the two groups. In group III, 26 patients with type 4 cancer underwent curative extended surgery (left upper abdominal exenteration [LUAE] plus Appleby's procedure and MF between 1983 and 1986). The 5-year survival rates of group III are 40% and 0% in stages III and IV, respectively. In stage III, the survival rate in group III is better than that of group II, but there is no significant difference between the two groups. In group IV, 28 patients underwent LUAE and intraperitoneal administration of mitomycin C between 1987 and 1991. The 5-year survival rates in group IV are 44% and 5% in stages III and IV, respectively. There is no significant difference between groups III and IV.

nosed postoperatively in the left adrenal (n = 3 cases) and transverse colon (n = 6 cases), which were not detected during surgery. Finally, two stage IV patients who survived for >5 years had cancer involvement, one in the left adrenal, and the other in the transverse colon.

All patients were followed over the long term. The recurrence modes in group A were retroperitoneal (12 patients), peritoneal dissemination (21), lymph node (2), and hematologic metastasis (bone, lung and brain (9) (Table 3). The incidence of retroperitoneal recurrence was decreased in group A, whereas in other types the recurrence rates remained unchanged.

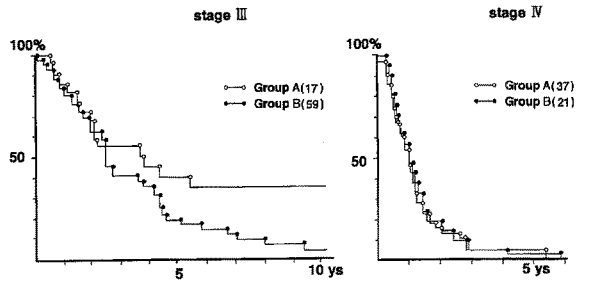

FIG. 4. Survival rates of patients in groups A and B. Group A (groups III and IV) includes 54 patients with type 4 cancer who underwent LUAE. Group B (groups I and II) includes 80 patients with type 4 cancer who underwent common surgery. The 5-year survival rates in groups A and B are 45.0% and 20.0% in stage III, and 5% and 3% in stage IV, respectively. Statistically, there is a significant difference between groups A and B in stage III.

TABLE 3. *Causes of death*

	Group A (%)	Group B (%)
Recurrence		
Retroperitoneal	12(25)*	34(44)[a]
Disseminated peritoneal	21(44)	21(27)
Lymph node	2(4)	3(4)
Liver, lung, bone	9(19)	3(4)
Others	4(8)	16(21)

Others include deaths due to cardiovascular diseases, other cancers, a traffic accident, and un unknown death.
[a] $p < 0.05$.

DISCUSSION

Early diagnosis of scirrhous cancer remains difficult (6,7) because the natural history of scirrhous cancer is unclear. The incidence of type 4 cancer (scirrhous cancer) has not changed in the past 10 years, whereas the incidence of total stomach cancer in Japan is decreasing (8).

In a report by Iwanaga (9), the characteristics of scirrhous cancer included large tumor (>20 cm in diameter) and advanced stage III or IV at detection (70% of patients). The incidence of node-positive patients was >80%. The most frequent route of invasion was retroperitoneal and the second was disseminated peritoneal involvement.

This type of tumor is difficult to diagnose early due to the limited number of signs of superfacial irregularity (10). Difficulties in treating scirrhous cancer are due to the characteristics and the late diagnosis. In this series the number of patients in stage III is small, and the ratio of stage III decreased as the number of patients with scirrhous cancer increased. We continue to seek improved surgical treatment that fits the characteristics of scirrhous cancer.

Extended surgery involving left upper abdominal evisceration was reported by Kajitani et al. (11) in 1980. In the original method, they resected the whole stomach, pancreas body and tail, spleen, gallbladder, transverse colon, left adrenal, and left lobe of liver. The patients who underwent Kajitani's surgery had advanced cancer, including those with scirrhous tumors. Our left upper abdominal exenteration was modified to exclude the left lobectomy of liver because the incidence of recurrence on the liver surface was low. Lymph node dissection in the deeper layer, including celiac (node station 9), splenic (node station 11), supramesenteric (node station 14), and paraaor-

tic (node station 16) stations, is very easy via the extended approach. We applied this extended surgery for scirrhous gastric cancer. The LUAE procedure is suitable for removing small foci surrounding the stomach, which may recur in the peritoneum. Because the surgical procedure is the accumulation of multiple organ resection, an effort to perform a well-balanced procedure is needed, but there are no special surgical techniques.

Appleby's procedure was originally reported by Appleby (12) in 1953 and was performed widely by Wada et al. (13) in the 1980s. The purpose of this procedure is to dissect the lymph nodes along the celiac (n = 9), common hepatic (n = 8), and splenic (n = 11) arteries by completely resecting these arteries. The blood supply to the liver is reconstructed by a new route using the supramesenteric artery–pancreatoduodenal artery–gastroduodenal artery–hepatic artery.

Iizuka (14) reported some complications after Appleby's method such as necrotic cholecystitis, bleeding, and severe pancreatic fistula. The reason for these complications may be on the decreased blood supply due to Appleby's procedure.

To avoid these disorders, we performed a preoperative angiogram on every patient scheduled for extended surgery. Using the preoperative angiogram, variations in the branching and route of the hepatic artery can be detected. The typical branching described in text books is found in 70% of all cases (15,16). These results indicate two clinical problems. One is the objective selection of patients to receive Appleby's procedure. We performed Appleby's procedure in 50% of patients with typical branching and no liver dysfunctions. The other problem involves the lymphatic system in patients with variations of branching. Most important lymph node stations are located along arteries, such as the celiac, common hepatic, hepatic, and splenic arteries. In patients with variation of branching, lymph nodes were not found at the same sites as those patients without variation. Although Appleby's procedure is a rational method for dissecting lymph node stations along the celiac and common hepatic arteries, surgeons can dissect these lymph nodes without resecting these arteries. To avoid major complications, we are planning to introduce a modified extended surgery without Appleby's method.

Konishi et al. (17) reported the results of adjuvant chemotherapy using methotrexate/5-FU sequential administration. The multicenter study of adjuvant chemotherapy after surgery was favorable, but the surgical procedure was not described clearly. Nakajima (18) reported adjuvant chemotherapy for advanced gastric cancer including scirrhous cancer. In this multicenter study, the results of postoperative chemotherapy using mitomycin C, 5-FU, and adriamycin were not favorable. According to the intraperitoneal chemotherapy using mitomycin C in group IV, the survival rate of group IV showed no improvement in comparison with that of group III, in which MF was administered intravenously. Sautner et al. (19) also reported that intraperitoneal cisplatin monotherapy does not improve survival probability after surgery for stage 3 and 4 gastric cancer.

Although this was not a randomized study, these results showed that the survival rate of the extended operation in the latter two periods was more favorable than that of the common surgery in the former two periods in stage III. To clarify the superiority of the extended operation, a new randomized trial may be necessary.

To improve the survival of patients with stage IV cancer, a new surgical technique or chemotherapy, such as neoadjuvant chemotherapy (20), should be investigated. Other clinical procedures such as stomas for ileus, intraureter intubation for ureteral obstruction, and intravenous alimentation at home are important for maintaining good conditions and to support chemotherapy.

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