Int Surg 2016;**101:**194–200
DOI: 10.9738/INTSURG-D-15-00137.1

Afferent Loop Syndrome After Subtotal Gastrectomy With Billroth-II Reconstruction: Etiology and Treatment

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The aim of this study was to evaluate the clinical characteristics, treatment, and prognosis of afferent loop syndrome (ALS) following radical subtotal gastrectomy with B-II reconstruction in gastric cancer patients. ALS is an infrequent mechanical complication, which occurs after reconstruction of Billroth-II (B-II) gastrojejunostomy or Roux-en-Y esophagojejunosotomy. From 2002 through 2010, 672 patients who had undergone subtotal gastrectomy with B-II reconstruction for gastric cancer were enrolled. Clinical data, symptom interval, cause, and treatment of 13 ALS patients were reviewed. The body mass index (BMI) of patients who suffered ALS was significantly less than that of patients who did not ($P = 0.0244$). And, there were significant differences in rates of recurrence ($P = 0.0032$) and follow-up duration ($P = 0.0119$) between the two groups. Acute ALS within 1 month occurred in 5 patients (38.5%). Obstructive jaundice or acute pancreatitis occurred in 4 patients (30.1%). The most frequent cause was anastomosis inflammation (6 patients). Only 2 patients required surgery. Most patients with ALS were treated conservatively with or without percutaneous transhepatic biliary drainage (PTBD). Clinical suspicion is of significant importance because ALS is not common and the symptoms are nonspecific. ALS occurs more frequently in low BMI patients than high. PTBD can be considered as a primary treatment option for ALS if rupture of the afferent loop is not present.

Key words: Afferent loop syndrome – Gastrectomy – Billroth-II – Surgery – PTBD

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Afferent loop syndrome (ALS) is an infrequent mechanical complication that occurs after reconstruction of Billroth-II (B-II) gastrojejunostomy or Roux-en-Y esophagojejunostomy.[1] Moreover, ALS can occur in any surgical procedure that includes anastomosis of the jejunum and stomach or esophagus, such as B-II gastrojejunostomy, Roux-en-Y gastrojejunostomy, Roux-en-Y esophagojejunostomy, and the Whipple procedure.[2] ALS is defined by dilatation of the afferent loop with accumulation of bile acid and pancreatic fluid on an abdominal CT scan.[3] Common causes of ALS are adhesions, recurrent cancer, inflammatory thickening of the anastomosis, kinking at the anastomosis, internal hernia, stoma stenosis, or inflammation surrounding the anastomosis.[4,5]

ALS can be divided into 2 types, according to the time of occurrence. Most cases of acute ALS occur during the first few postoperative days, while chronic ALS occurs weeks, months, or even years after surgery.[6] In some patients, acute ALS occurs within hours or days after surgery. Some cases progress rapidly and complications such as peritonitis develop, which can be fatal. Mortality from these complications has been reported to be 30% to 60%.[7,8] Therefore, early diagnosis is important and proper surgical treatment is strongly recommended to prevent exacerbation of the patients' condition.[9,10] Traditionally, surgery has been the treatment of choice for ALS. In acute ALS, emergency surgery may be necessary to prevent rupture of the loop. The surgical procedure is dependent on the cause of the obstruction. In some cases, the anastomosis may need to be taken down and redone. If the afferent loop has become scarred and narrowed, it may need to be excised.

To date, no reports of ALS following open or laparoscopic subtotal gastrectomy for gastric cancer have been published. Moreover, nonsurgical treatment for ALS is not currently recommended. The aim of this study was to evaluate the clinical characteristics, treatment, and prognosis of ALS following radical subtotal gastrectomy with B-II reconstruction in gastric cancer patients.

Patients and Methods

From 2002 through 2010, 672 patients who had undergone subtotal gastrectomy with B-II reconstruction for gastric cancer at Dong-A University Medical Center, Korea, were enrolled. Data were prospectively retrieved from operative and pathology reports, with follow-up data obtained from the outpatient clinical database, which included the following: age; sex; body mass index (BMI); comorbidity disease; early gastric cancer (EGC) or advanced gastric cancer (AGC); tumor location; resection margin; TNM stage; retrieved lymph nodes; postoperative outcomes; and recurrences. The clinicopathologic characteristics and postoperative outcomes were retrospectively compared between the 2 groups. Clinical data, symptom interval, cause, and treatment of 13 ALS patients were reviewed. Gastric cancer stage was classified according to the 7th edition of the American Joint Committee on Cancer (AJCC) staging criteria.[11] Lymph node dissection was performed according to the standard D2 lymphadenectomy, based on 2010 Japanese gastric cancer treatment guidelines (ver.3).[12]

Surgical procedure of B-II reconstruction in open or laparoscopic surgery

After gastric resection, a stoma was made in the proximal jejunum 10 to 15 cm from the ligament of Treitz. Then, another stoma was made in the greater curvature of the gastric remnant 1 to 1.5 cm from the stapling line of the artificial lesser curvature. When making stomata, care should be taken to minimize thermal injuries to the intestines and limit stoma size. The side-to-side gastrojejunostomy is done via the antecolic and anisoperistaltic method, using the endoscopic linear stapler on the stomata. We usually used a 45- or 60-mm stapler (Blue color) for anastomosis. After stapling, the entry site is closed by the hand-sewn method: 2 layers of a continuous simple running suture with 1 absorbable monofilament. At the beginning of the first layer of the running suture, the common entry stoma is closed with full-thickness continuous running sutures (usually 5 sutures). Then, the second layer of a seromuscular running suture is placed from 1 end of the incision to the other with the same suture material (Fig. 1).

Diagnosis of ALS using abdominal CT

All 672 patients underwent abdominal computed tomography (CT) during postoperative follow-up. CT is an extremely useful tool for the evaluation of ALS.[13] Two radiologists reviewed the CT scan of 672 patients, and diagnosed ALS and its cause as follows: the afferent loop appears as a fluid-filled, dilated, U-shaped, transversely oriented cystic mass, located in the middle of the abdomen, anterior

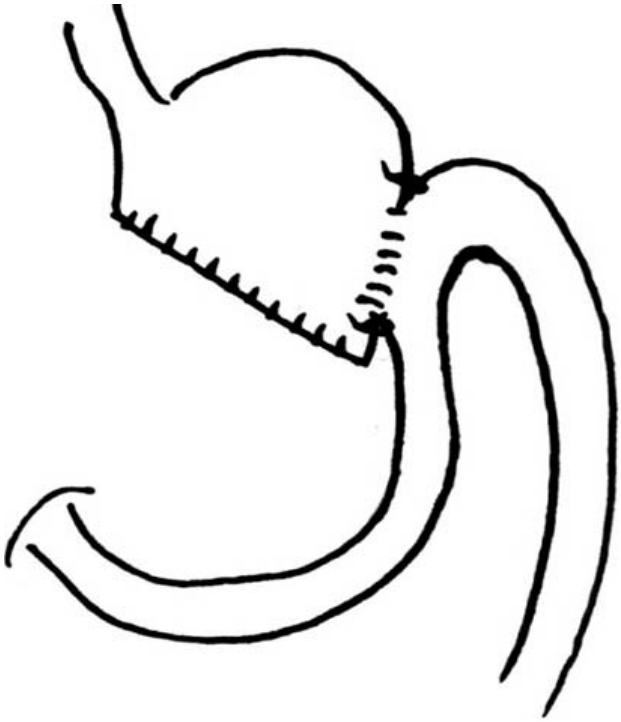

Fig. 1 B-II reconstruction after subtotal gastrectomy. Side-to-side gastrojejunostomy was performed between the greater curvature of the remnant stomach and proximal jejunum.

to the spine. This mass is located behind the superior mesenteric artery and is contiguous with the biliary system.[14,15]

Standardized postoperative follow-up study

All patients who received follow-up were monitored postoperatively with routine blood tests, tumor markers, chest radiography, endoscopy, and computed tomography. In patients with early gastric cancer, follow-up studies were performed every 6 months for 2 years and annually for 3 years. For patients with advanced gastric cancer, follow-up studies were performed every 3 months for the first year, every 6 months for the second year, and annually for the following 3 years.

Statistical analysis

Statistical analysis was performed with commercial software (GraphPad InStat, version 3.06; GraphPad Software, Inc, La Jolla, California). Continuous variables were expressed as mean with SD and compared using the Student's *t*-test or Mann-Whitney test. Category variables were compared using the χ^2 or Fisher's exact test. A value of $P < 0.05$ was considered significant.

Table 1 Clinicopathologic characteristics of the ALS and NALS groups

	ALS (n = 13)	NALS (n = 659)	*P* value
Age, y*	57.2 ± 11.0	58.3 ± 11.6	0.7234
Sex			0.7653
Male	8	447	
Female	5	212	
BMI, kg/m^{2}*	21.4 ± 2.3	23.4 ± 3.2	0.0259
Comorbidity			0.7832
No	6	277	
Yes	7	382	
EGC/AGC	4/9	313/346	0.2723
TNM stage			0.0748
Stage I	5	387	
Stage II	1	116	
Stage III	4	103	
Stage IV	3	53	
Tumor location			0.5659
Middle	3	207	
Lower	10	452	
Resection margin, cm*			
Proximal	5.1 ± 3.0	5.0 ± 3.3	0.8821
Distal	5.5 ± 4.3	5.4 ± 3.8	0.9840
Retrieved lymph nodes, n*	40.2 ± 15.4	34.9 ± 14.8	0.2020

*All values represent the mean and standard deviation.
NALS, nonafferent loop syndrome.

Results

Clinicopathologic characteristics between the ALS and NALS groups

The median age of ALS patients (8 men and 5 women) was 57.2 years (range: 42–77). There were no statistical differences in clinicopathologic characteristics except BMI. The BMI of patients who suffered ALS was significantly less than that of patients who did not ($P = 0.0244$; Table 1).

Postoperative outcomes between the ALS and NALS groups

Table 2 presents postoperative outcomes. There were no differences in surgical procedure, surgery time, or intra-abdominal complications. However, there were significant differences in rates of recurrence ($P = 0.0032$) and follow-up duration ($P = 0.0119$) between the 2 groups.

Clinical data, cause, and treatment of ALS

Among the 672 patients, ALS occurred in 13 (1.9%) patients during 5 years of follow-up. Among the 13

Table 2 Postoperative outcomes of the ALS and NALS groups

	ALS (n = 13)	NALS (n = 659)	*P* value
Operation method			1.0000
Open	9	463	
Laparoscopy	4	196	
Operation time, min*	222.3 ± 57.0	212.9 ± 55.3	0.5471
Intra-abdominal complication			1.0000
No	10	594	
Yes	3	65	
Median follow-up duration, mo (range)	38.3 ± 36.6 (0.1–146)	71.4 ± 41.7 (8.9–125.8)	0.0119
Recurrence			0.0032
No	7	578	
Yes	6	81	

*All values represent the mean and standard deviation.

ALS patients, acute ALS within 1 month occurred in 5 patients (38.5%). Most of the findings were relatively nonspecific gastrointestinal symptoms. Obstructive jaundice or acute pancreatitis occurred in 4 patients (30.1%). The causes were anastomosis inflammation (6 patients); recurrent cancer (4 patients); adhesions (2 patients); and acute pancreatitis (1 patient). All ALS cases were successfully treated; and patients without recurrence fully recovered. Only 2 patients required surgery. Most patients with ALS were treated conservatively with or without percutaneous transhepatic biliary drainage (PTBD; Table 3).

Discussion

There are many late complications following gastrectomy including dumping syndrome, metabolic disturbance, ALS, efferent loop syndrome, alkaline reflux gastritis, retained antrum syndrome, and postvagotomy syndrome. Recently, many investigators in Korea and Japan have focused on not only immediate surgical outcomes, but also long-term outcomes after gastric surgery; the latter is due to the rapidly increasing incidence of early gastric cancer.[16,17] However, the incidence, causes, clinical manifestations, and treatment of these late complications have not been properly investigated to date.

A gastrojejunostomy with blind loop such as B-II anastomosis, Roux-en-Y reconstruction, or any anastomosis with small bowel and stomach, might be complicated with afferent loop obstruction. A bowel obstruction should be treated appropriately; if not, further complications can develop such as bowel strangulation, perforation, and panperitoni-

Table 3 Clinical data, cause, and treatment of 13 ALS cases

No	Sex	Age	Stage	Symptom interval, mo	ALS symptom	Cause	Treatment
1	M	42	IIIA	54	None	Recurrent cancer	Completion total gastrectomy
2	M	46	IV	0.2	Abdominal discomfort, nausea, vomiting	Anastomosis inflammation	Conservative treatment
3	M	54	IIIA	8	Nausea, vomiting, jaundice	Recurrent cancer	PTBD
4	F	54	IA	84	Bilious vomiting	Anastomosis inflammation	PTBD
5	M	45	II	28	Abdominal discomfort	Anastomosis inflammation	Conservative treatment
6	F	65	IB	0.1	Abdominal discomfort	Anastomosis inflammation	Conservative treatment
7	F	56	IB	26	Jaundice	Recurrent cancer	Conservative treatment
8	M	63	IA	0.3	Abdominal pain	Acute pancreatitis	PTBD and duodenojejunostomy
9	F	69	IV	2	None	Anastomosis inflammation	None
10	M	77	IA	0.1	Abdominal pain, jaundice	Adhesions	PTBD
11	F	43	IV	0.3	Abdominal distension, jaundice	Anastomosis inflammation	ENBD and PTBD
12	M	65	IIIA	11	Abdominal pain	Adhesions	Adhesiolysis
13	M	64	IIIB	9	Weakness, nausea	Recurrent cancer	Conservative treatment

ENBD, endoscopic nasobiliary drainage.

Fig. 2 Abdominal CT findings of ALS in a 56-year-old woman. Afferent loop dilatation was found on CT during routine follow-up; however, she did not have any symptoms. A markedly dilated afferent loop was filled with fluid.

tis.[18,19] Although the incidence of ALS was 0.3% in another study,[20] in the present study ALS had an incidence of 1.9% in B-II anastomosis after radical subtotal gastrectomy for gastric cancer with long-term follow-up. This is the first report of a large series of patients who underwent radical subtotal gastrectomy and B-II reconstruction with laparoscopic surgery; however, it was a single-center study.

The incidence of ALS could affect an antecolic anastomosis or a long afferent loop. In the present study, the BMI was lower in the ALS group than in the NALS group. Among lower BMI patients, ALS can be associated with a redundant afferent loop because of loss of mesenteric fat and a thin transverse colon and jejunum. However, results are conflicting because, in general, postoperative intra-abdominal adhesions occur more frequently in obese patients. The length of the afferent loop in laparoscopic gastrectomy can be longer than that of open surgery. However, no difference of incidence of ALS between laparoscopic and open gastrectomy was found in the present study. In the ALS group, the incidence of recurrence was higher than that of the NALS group because recurrence is one of the causes of ALS. Furthermore, recurrent malignancy in itself can produce a mass effect: adhesions or thickening of tissue. Consequently, recurrent cancer might cause afferent loop obstruction. The follow-up duration was shorter in the ALS group than in the NALS group because the ALS group had recurrent cancer. Nine patients died of recurrent gastric cancer.

In the present study, the patients with ALS had nonspecific gastrointestinal symptoms such as abdominal discomfort, nausea, vomiting, weakness, and abdominal distension. Among 13 ALS patients, only 1 had the classic symptom of chronic ALS, which has been described as bilious vomiting resulting in relief of the abdominal pain. Two patients with afferent loop dilatation on CT scan had no symptoms (Fig. 2). One of the two underwent a completion total gastrectomy because he had recurrent cancer caused by ALS. However, 3 patients with recurrences died of their cancers after resolution of ALS. ALS may be due to internal herniation, adhesions, kinking, a gastrointestinal stone, or stenosis caused by inflammatory change or malignancy.[4,20] The most common cause of ALS in the present study was anastomosis inflammation. Three afferent loop syndromes occurred during the postoperative hospital stay. These acute ALS cases were successfully treated conservatively with or without PTBD. Most acute and chronic ALS cases without recurrent cancer also were successfully treated conservatively with or without PTBD. Only 2 chronic ALS patients underwent surgery.

Surgical management options for ALS after B-II gastrojejunostomy depends on the etiology and acuteness of the ALS as well as patient status. Conversion to a Billroth I anastomosis, Roux-en-Y reconstruction, and construction of a Braun-type enteroenterostomy between the afferent and efferent limbs are commonly used techniques. Other treatment options include resection of the stenotic or ischemic segment with reconstruction of the afferent loop, revision of the gastric stoma, and interposition of a jejunal segment between the gastric pouch and duodenum.[20,21]

In our experience, PTBD is an extremely useful treatment for decompressing an acutely dilated afferent loop.[22] Endoscopic treatment such as ballooning or stent placement after reducing

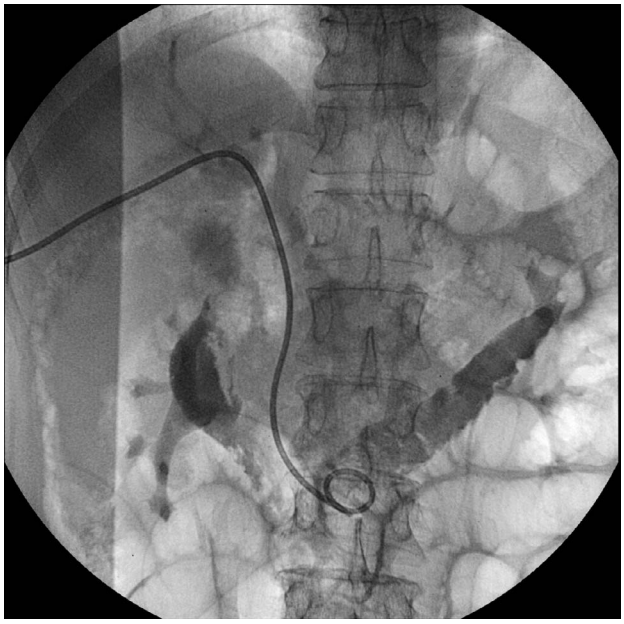

Fig. 3 PTBD for an ALS patient caused by acute pancreatitis. Tip of PTBD catheter is present in the duodenum.

inflammation of a dilated afferent loop by PTBD can be performed. Technically, sufficient aspiration of accumulated fluid in a dilated afferent loop is required for symptom relief by placing the PTBD catheter tip in the duodenum (Fig. 3). Then, the PTBD catheter tip can be placed in the distal common bile duct. Only 1 patient with acute pancreatitis as a cause of ALS required additional surgery, which was a side-to-side duodenojejunostomy after PTBD, 2 weeks after its onset. In the present study, all patients with jaundice or acute pancreatitis first underwent PTBD. ALS can be treated conservatively if neither jaundice nor acute pancreatitis is present. With post-PTBD management, we should pay close attention to metabolic acidosis as well as electrolyte imbalance in patients with complete afferent loop obstruction.

In conclusion, clinical suspicion is of significant importance because ALS is not common and the symptoms are nonspecific. ALS can be related to patients with low rather than high BMI. PTBD can be considered as a primary treatment option for ALS if rupture of afferent loop is not present. Following PTBD, various procedures such as endoscopic, radiologic, or surgical treatment can be performed based on the cause of ALS and patient status.

Acknowledgments

Supported by the Dong-A University Research Fund. All authors disclosed no financial relationships relevant to this publication.

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