Comparison of change in stored body iron and metabolic status after distal gastrectomy according to methods of reconstruction in patients with gastric cancer

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Comparison of change in stored body iron and metabolic status after distal gastrectomy according to methods of reconstruction in patients with gastric cancer

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ABSTRACT

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Background: Anemia after gastrectomy is commonly neglected by clinicians despite being an important and frequent long-term metabolic sequela. We hypothesized that the incidence and timing of the occurrence of iron-deficiency after distal gastrectomy is closely associated with the reconstruction method, and determine the optimal reconstruction method after gastrectomy.

Methods: Using a prospective gastric cancer database, we identified 311 patients with early gastric cancer with complete hematologic parameters who underwent distal gastrectomy between January 2004 and May 2008. Kaplan-Meier methods, Cox regression, and logistic regression were used to evaluate the associations of the reconstruction method with iron metabolism.

Results: The prevalence of iron-deficiency 3 years after distal gastrectomy was 64.0%, and iron-deficiency anemia was observed in 26.4% of patients. Iron-deficiency developed in 58.3% and 79.5% of patients after gastroduodenostomy and gastrojejunostomy within 3 years after surgery (P=0.001), respectively. Iron-deficiency was significantly more frequent in women than in men (P=0.0001) and after gastrojejunostomy than after gastroduodenostomy (P=0.0003). Serum ferritin levels were different according to the reconstruction method after distal gastrectomy.

Conclusion: Iron-deficiency occurs in most gastric cancer patients after distal gastrectomy, and its incidence was different according to reconstruction method. To improve iron metabolism after distal gastrectomy, gastroduodenostomy would be the method of reconstruction whenever possible.

Key words: nutrition; iron-deficiency; stomach neoplasms

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I. INTRODUCTION

Gastric cancer remains a major health issue and one of the leading causes of cancer death worldwide even though the incidence and mortality of gastric cancer have gradually decreased.[1] In East Asia, especially in Korea and Japan, nationwide mass screening programs have improved the survival of gastric cancer patients through early detection.[2-4] The improved survival of gastric cancer patients has increased the interest of highly motivated surgeons in the quality of life of patients after surgical treatment.

Anemia is highly associated with impaired quality of life and performance status in cancer patients.[5,6] Anemia also has the potential to adversely affect the therapeutic efficacy and survival of cancer patients because it compromises the efficacy of radiotherapy and the response to chemotherapy.[7] Anemia after gastrectomy is commonly neglected by clinicians despite being an important

long-term metabolic sequela with high prevalence.[8-12] Anemia after gastrectomy is caused by various mechanisms and most cases of anemia in gastrectomized patients are due to iron-deficiency, abnormal vitamin B12 metabolism, or both.[12,13] Iron-deficiency anemia is more common than vitamin B12 deficiency anemia in patients after gastrectomy. Iron-deficiency after gastrectomy is primarily caused by decreased iron absorption due to reduced food intake and bypass of the duodenum in some methods of reconstruction.[9,10]

However, identifying individuals with iron-deficiency or iron-deficiency anemia after gastrectomy is difficult because the symptoms are vague and non-specific and physicians focus only on improving the survival of these cancer patients. Previous studies of iron-deficiency after gastrectomy were performed a half-century ago with small study populations. Moreover, most studies did not regularly examine hematologic and nutritional profiles related to iron-deficiency. To our knowledge, the influence of the extent of gastrectomy and method of reconstruction on iron metabolism has never been explored thoroughly.

We hypothesized that the incidence of iron-deficiency, based on physiological changes after gastrectomy, is closely associated with the method of reconstruction. To assess the influence of the method of reconstruction and determine the optimal reconstruction method after gastrectomy, we compared the iron and nutritional profiles of patients who underwent distal gastrectomy in a database of gastric cancer patients.

II. MATERIALS AND METHODS

1. Patients

A review of a prospective database of gastric cancer patients at Severance Hospital, Yonsei University Health System, Seoul, Korea identified 456 patients who underwent curative distal gastrectomy for early-stage (stage IA/IB, AJCC 7th edition) gastric cancer between January 2004 and May 2008 and for whom complete hematologic data were available. Among these 456 patients, a total of 145 patients were excluded from the analyses because of anemia according to World Health Organization (WHO) criteria[14] before surgery (n=112), history of other organ cancer or chemotherapy (n=16), and the need for intraoperative or immediately postoperative transfusion (n=11). Patients with recurrence during the follow-up period, undernourished, anemia due to other causes such as vitamin B12 deficiency anemia and anemia due to other chronic diseases were not included. The inclusion and exclusion criteria was shown in Figure 1. Finally, 311 patients were included in this study.

All patients included in this study underwent a standard distal subtotal gastrectomy with lymph node dissection using either an open or minimally invasive technique. Minimally invasive approaches for gastrectomy include laparoscopic and robotic approaches. Reconstruction was performed using either gastroduodenostomy (n=234) or gastrojejunostomy (n=84) for distal gastrectomy depending on the location of tumor and the preference of the

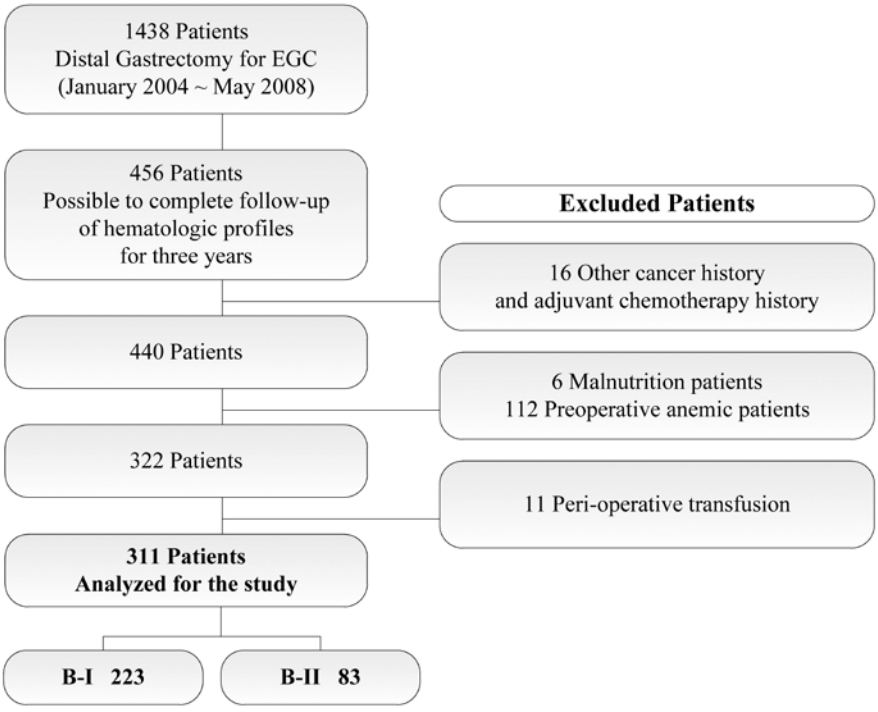

Figure 1. Inclusion and exclusion criteria

surgeons. The patients characteristics was shown in Table 1. This study was approved by the institutional review board of Severance Hospital, Yonsei University Health System (4-2011-0294).

2. Data collection

The prospective database of gastric cancer at Severance Hospital contains patient demographics including past medical history, operative details, pathological tumor characteristics, perioperative hematologic and nutritional parameters, and patients outcomes. The hematological data consisted of

Table 1. Patient Characteristics (n=311)

Average Age (years)	56.1±11.1
Sex	
Male	204 (65.6%)
Female	107 (34.4%)
Preoperative Nutritional Status	
BMI (kg/m^2)	23.8±2.7
Prealbumin (mg/L)	285.0±50.7
Albumin (g/dL)	4.6±0.3
Pathologic Stage	
Stage IA	264 (84.9%)
Stage IB	47 (15.1%)
Histologic Differentiate	
Differentiated	162 (52.1%)
Undifferentiated	149 (47.9%)
Types of Reconstruction	
Gastrojeunostomy	228 (73.3%)
Gastroduodenostomy	83 (26.7%)

Abbreviations: BMI, body mass index

complete blood counts, iron profiles [serum iron, ferritin, transferrin, total iron-binding capacity (TIBC)], and serum vitamin B12 and folate levels. The serum ferritin concentration was measured by a competitive immunoassay using direct chemiluminescence (ADVIA Centaur®, Bayer Diagnostics, Tarrytown, NY, USA) and serum transferrin levels were measured using a nephelometer (Dade Behring®, Siemens Healthcare Diagnostics, Liederbach, Germany). Transferrin saturation was calculated as the ratio of the serum iron level to TIBC multiplied by 100. Each hematologic and nutritional parameter was measured preoperatively, every 3 months for 2 years, and every 6 months thereafter during

the follow-up period.

3. Definitions of anemia and iron-deficiency

According to WHO criteria,[14] anemia was defined as a hemoglobin level less than 13 g/dL in men and 12 g/dL in women. Iron-deficiency was defined by a serum ferritin level <30 ng/mL in the absence of inflammation and transferrin saturations <20% irrespective of the hemoglobin level. Iron-deficiency with anemia was defined as iron-deficiency with a hemoglobin level less than 13 g/dL in men and 12 g/dL in women.[15,16]

4. Treatment of iron-deficiency anemia

To treat anemia among patients with iron-deficiency anemia, those with serum hemoglobin levels <11 g/dL and/or with symptoms of anemia received oral ferrous (Fe^{2+}) sulfate 256 mg (80 mg as iron) twice a day for 12 weeks or until the serum hemoglobin level had returned to normal. Some patients were administrated 200 mg of iron/day ferric hydroxide intravascularly for 3 days. Patients with iron-deficiency without symptoms or anemia were observed without treatment.

5. Data analysis

All statistical analyses were performed using SPSS software, version 18.0 (IBM

Corp., Armonk, NY, USA). Correlations between the body iron status and reconstruction method as well as demographic characteristics of the patients were determined using the Chi-square and Fisher exact tests for statistical analysis as appropriate. To identify the independent risk factors for iron-deficiency after gastrectomy, binary logistic regression analysis was used. To compare of incidence of iron-deficiency according to the method of reconstruction, Kaplan-Meier methods and Cox proportional hazards model were applied. $P<0.05$ was the upper limit for statistical significance.

III. RESULTS

1. Changes of hematologic parameters

The changes of the hematologic profiles of patients according to the method of reconstruction are shown in Figure 2. The body mass index (BMI) became stable 3 months after surgery in all patient groups. Serum ferritin levels decreased continuously regardless of the method of reconstruction, whereas transferrin levels continuously increased. TIBC levels stabilized 3 months after surgery in the gastroduodenostomy group, whereas these levels increased continuously in the gastrojejunostomy groups even with iron supplementation among patients with anemia.

2. Incidence and trends of iron-deficiency

The cumulative incidence of iron-deficiency was 46.0% (n=143) 1 year after surgery, 58.5% (n=182) 2 years after surgery, and 64.0% (n=199) 3 years after surgery. The cumulative incidence of iron-deficiency with anemia was 26.4% (n=82) 3 years after surgery.

Of the 311 patients who underwent distal gastrectomy, iron-deficiency was more frequent in the gastrojejunostomy group than in the gastroduodenostomy group 2 (gastrojejunostomy vs. gastroduodenostomy; 54.8% vs. 68.7%; P=0.037) and 3 years after surgery (gastrojejunostomy vs. gastroduodenostomy;

79.5% vs. 58.3%; P=0.001).

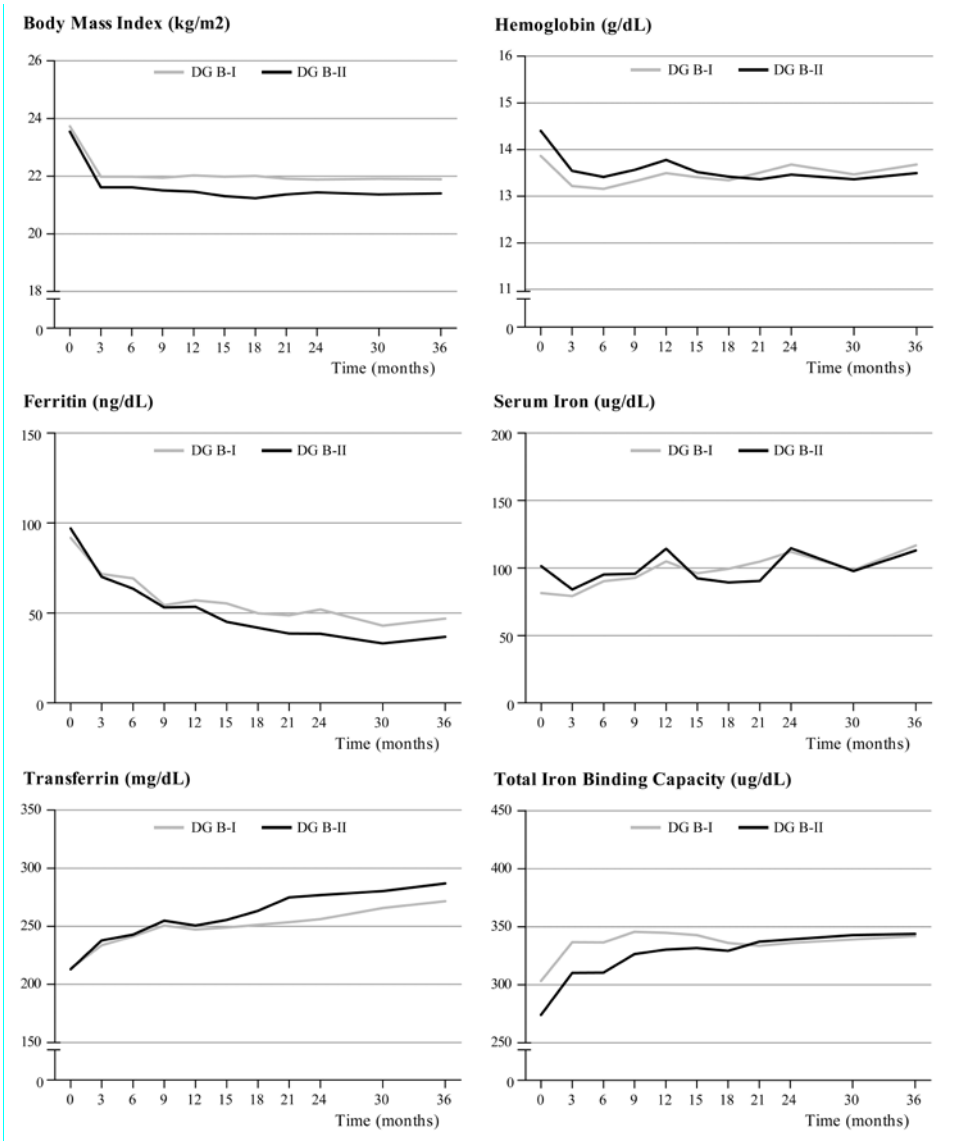

Figure 2. Patterns of the changes in hematologic and nutritional parameters. Abbreviations: DG B-I, distal gastrectomy with gastroduodenostomy; DG B-II, distal gastrectomy with gastrojejunostomy

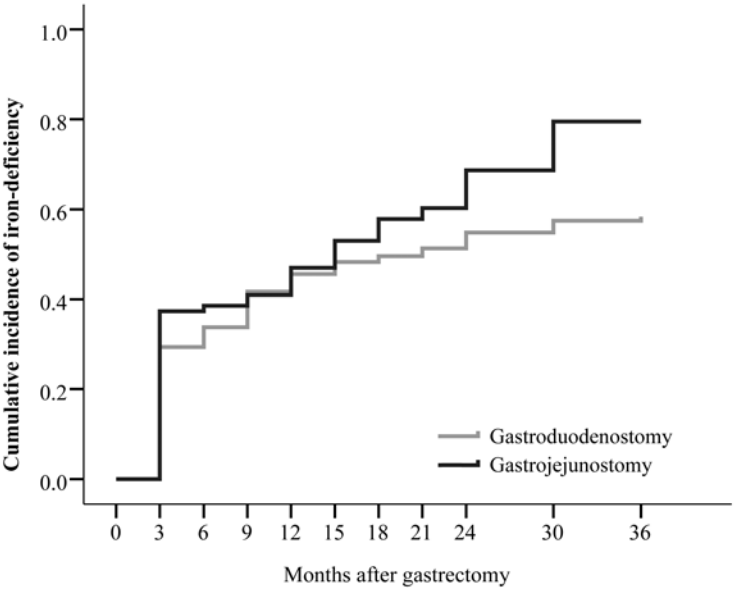

Figure 3. Cumulative incidence of iron-deficiency according to the method of reconstruction for 3 years after distal gastrectomy

Figure 3 shows that the cumulative incidence of iron-deficiency was different between the gastrojejunostomy and gastroduodenostomy groups (P=0.005).

3. Nutritional and hematologic change according to reconstruction methods

Patient demographics, pathology, and preoperative nutritional parameters were compared between patients with gastroduodenostomy and gastrojejunostomy after distal gastrectomy (Table 2). As shown in Table 3, among the nutritional parameters mean prealbumin and albumin levels were higher in gastroduodenostomy group than gastrojejunostomy group at third year after gastrectomy. The significant difference in prealbumin levels was shown form 2

years after surgery. Serum iron profiles including ferritin level and transferrin level also higher in gastroduodenostomy group since 2 years after surgery and these differences has statistical significance. The incidence of iron-deficiency was higher in gastrojejunostomy group, and statistical significance was showed in second and third year after surgery. Iron-deficiency developed in 58.3% and 79.5% of patients after gastroduodenostomy and gastrojejunostomy within 3 years after surgery (P=0.001), respectively.

Table 2. Comparison of demographic, pathologic and preoperative nutritional parameter according to reconstruction methods after distal gastrectomy for early gastric cancer

Variable	**DG B-I (n=228, 73.3%)**	**DG B-II (n=83, 26.7%)**	**P value**
Age (Years)	56.5±10.8	55.3±12.0	0.410
Sex			0.219
Male	145 (63.6%)	59 (71.1%)	
Female	83 (36.4%)	24 (28.9%)	
Pathologic Stage			0.216
Stage IA	197 (86.4%)	67 (80.7%)	
Stage IB	31 (13.6%)	16 (19.3%)	
Histology			0.651
Differentiated	117 (51.3%)	45 (54.2%)	
Undifferentiated	111 (48.7%)	38 (45.8%)	
Retrived lymph node (n)	38.7±14.5	35.6±12.4	0.077
Preoperative Nutritional Status			
BMI (kg/m^2)	23.9±2.6	23.6±2.9	0.382
Prealbumin (mg/L)	289.1±43.7	282.4±55.0	0.518
Albumin (g/dL)	4.5±0.3	4.6±0.3	0.267

Abbreviations: BMI, body mass index; DG B-I, distal gastrectomy with gastroduodenostomy; DG B-II, distal gastrectomy with gastrojejunostomy

Table 3. Comparison of incidence of iron-deficiency and change in nutritional parameters between gastroduodenostomy and gastrojejunostomy group within the 3 years follow-up period after distal gastrectomy

Variable	1st year			2nd year			3rd year		
	DG B-I	**DG B-II**	**P**	**DG B-I**	**DG B-II**	**P**	**DG B-I**	**DG B-II**	**P**
Nutritional Status									
BMI (kg/m^2)	22.2±2.5	21.5±2.5	0.046	22.0±2.4	21.5±2.5	0.093	22.1±2.4	21.4±2.3	0.055
delta BMI (kg/m^2)	1.7±1.3	2.1±1.4	0.059	1.9±1.4	2.2±2.0	0.222	1.9±1.5	2.2±1.4	0.102
Prealbumin (mg/L)	274.7±59.0	257.7±50.1	0.065	272.0±45.8	249.6±51.0	0.001	270.2±62.6	242.1±39.6	<0.001
Albumin (g/dL)	4.6±0.3	4.6±0.3	0.740	4.6±0.3	4.6±0.3	0.342	4.6±0.3	4.4±0.3	<0.001
Serum Iron Profiles									
Hemoglobin (g/dL)	13.6±1.4	13.8±1.2	0.172	13.7±1.3	13.5±1.3	0.154	13.7±1.4	13.5±1.3	0.265
Iron (μg/dL)	105.2±41.2	114.4±50.6	0.109	112.3±45.5	114.9±48.7	0.662	117.7±52.4	113.5±52.9	0.540
Ferritin (ng/dL)	58.4±50.8	54.1±54.6	0.523	52.5±47.4	38.8±41.5	0.023	47.5±50.1	37.2±61.4	0.150
Transferrin (mg/dL)	245.4±41.6	250.4±40.5	0.367	255.2±43.9	276.3±46.7	<0.001	270.8±47.8	286.4±45.7	0.015
TIBC (μg/dL)	341.9±64.2	330.1±50.8	0.141	334.2±57.0	338.4±52.7	0.563	340.6±55.2	343.3±51.6	0.716
Iron Deficiency			0.898			0.037			0.001
Normal	124 (54.4%)	44 (53.0%)		103 (45.2%)	26 (31.3%)		95 (41.7%)	17 (20.5%)	
Iron deficiency	104 (45.6%)	39 (47.0%)		125 (54.8%)	57 (68.7%)		133 (58.3%)	66 (79.5%)	

Abbreviations: BMI, body mass index; delta BMI, Preoperative BMI – BMI at 36 months after surgery; DG B-I, distal gastrectomy with gastroduodenostomy; DG B-II, distal gastrectomy with gastrojejunostomy

4. Factors related to iron-deficiency

Patient demographics, pathology, and preoperative nutritional parameters were compared between normal patients and patients who experienced iron-deficiency during 3 years of follow-up period after distal gastrectomy (Table 4).

Table 4. Comparisons between normal patients and patients who developed iron-deficiency within the 3 years follow-up period after distal gastrectomy

Variable	Normal (n=112, 36.0%)	Iron-deficiency (n=199, 64.0%)	P value
Age (years)	57.7±10.1	55.2±11.6	0.050
Sex			0.0001
Male	89 (43.6%)	115 (56.4%)	
Female	23 (21.5%)	84 (78.5%)	
Preoperative Nutritional Status			
BMI (kg/m^2)	24.4±2.6	23.5±2.7	0.010
Prealbumin (mg/L)	299.3±49.7	279.1±50.3	0.066
Albumin (g/dL)	4.6±0.3	4.5±0.3	0.235
Pathologic Stage			0.335
Stage IA	98 (37.1%)	166 (62.9%)	
Stage IB	14 (29.8%)	33 (70.2%)	
Nutritional Status (at 36 month)			
delta BMI (kg/m^2)	2.1±1.4	1.9±1.5	0.342
Prealbumin (mg/L)	278.7±55.8	249.1±55.0	0.0003
Albumin (g/dL)	4.6±0.3	4.5±0.3	0.009
Types of Reconstruction			0.001
Gastroduodenostomy	95 (41.7%)	133 (58.3%)	
Gastrojejunostomy	17 (20.5%)	66 (79.5%)	

Abbreviations: BMI, body mass index; delta BMI, Preoperative BMI – BMI at 36 months after surgery

The age of patients at the time of operation, sex, pre-operative BMI, and method of reconstruction were significantly different according to body iron storage status 3 years after surgery. Serum prealbumin and albumin concentrations 3 years after surgery were significantly higher in the normal group than in iron-deficiency group. The details of iron-deficiency at third year after distal gastrectomy were show in Table 5. Sex and reconstruction method were independent risk factors for iron-deficiency after gastrectomy (Table 6).

Table 5. Details of iron-deficiency at third year after distal gastrectomy

Variable	Iron-Deficiency without anemia (n=117, 58.8%)	Iron-Deficiency with anemia (n=82, 41.2%)	P value
Age (years)	55.2±10.5	55.3±13.1	0.950
Sex			0.006
Male	77 (67.0%)	38 (33.0%)	
Female	40 (47.6%)	44 (52.4%)	
Preoperative Nutritional Status			
BMI (kg/m^2)	23.9±2.6	23.0±2.6	0.011
Prealbumin (mg/L)	280.8±49.2	276.4±52.6	0.721
Albumin (g/dL)	4.5±0.3	4.5±0.3	0.945
Nutritional Status (at 36 month)			
delta BMI (kg/m^2)	2.0±1.6	1.8±1.4	0.523
Prealbumin (mg/L)	255.8±53.4	237.5±56.4	0.073
Albumin (g/dL)	4.5±0.3	4.4±0.3	0.018
Types of Reconstruction			0.328
Gastroduodenostomy	75 (56.4%)	58 (43.6%)	
Gastrojejunostomy	42 (63.6%)	24 (36.4%)	

Abbreviations: BMI, body mass index; delta BMI, Preoperative BMI – BMI at 36 months after surgery

Table 6. Multiple logistic regression analysis of risk factors for post-gastrectomy iron-deficiency (n=311)

Variable	Odd Ratio	95% Wald Confidence Limits	P value
Age (Year)	0.986	0.964 - 1.009	0.222
Sex (Female vs. Male)	2.975	1.704 - 5.196	0.0001
Preoperative BMI (kg/m^2)	0.914	0.831 - 1.004	0.060
DG B-II vs. DG B-II	3.102	1.674 - 5.746	0.0003

Abbreviations: BMI, body mass index; DG B-I, distal gastrectomy with gastroduodenostomy; DG B-II, distal gastrectomy with gastrojejunostomy

IV. DISCUSSION

We observed iron-deficiency in the majority of patients after gastrectomy, and its incidence was different according method of reconstruction. The number of patients who developed iron-deficiency gradually increased with time from their gastrectomy.

Although the mechanisms of negative iron balance following gastrectomy are not fully established, there are several hypotheses to explain body iron depletion in patients after gastric resection. Body iron-deficiency is aggravated by poor nutritional status and decreased dietary iron intake.[12,17] Increased iron depletion can also result from gastrointestinal blood loss, usually at the anastomotic site.[9,18] Bacterial overgrowth in the blind loops can result in iron-losing enteropathy.[19] However, alterations in digestion and impaired iron absorption are considered the leading factors contributing to iron-deficiency after gastrectomy.[8] Malabsorption of dietary iron possibly results from the reduction of gastric acid secretion and bypassing of the duodenum.[12,13] Reduced gastric acidity, a common consequence of gastrectomy, impairs the conversion of non-heme iron (Fe^{3+}) to the ferrous form (Fe^{2+}), which is more absorbable.[20] Moreover, some methods of reconstruction after gastrectomy may lead to decreased iron absorption due to bypass of the major sites of iron absorption: the duodenum and the proximal jejunum. It has been shown that primary absorption of dietary iron occurs at the duodenal mucosa in mammals. Through

the entire small intestine, iron absorption is mediated by proteins on biological membranes; however, majority of the absorption of molecular iron and heme iron occurs across the apical and basolateral membranes of duodenal enterocytes.[21] A transport protein named heme carrier protein 1 was recently identified in the duodenum.[22] Moreover, patients underwent total gastrectomy with preservation of the duodenal passage by a type of jejunal pouch interposition showed significantly higher concentrations of iron and hemoglobin compared to those patients with a Roux-en-Y reconstruction.[23] Thus, duodenal passage is necessary for the absorption of dietary iron. With these mechanisms of negative iron balance following gastrectomy, the incidence of iron-deficiency will be different according to the extent of gastrectomy and reconstruction method.

Our study clearly demonstrated that the incidence of iron-deficiency after distal gastrectomy was closely associated with the method of reconstruction. In this study, the gastrojejunostomy group exhibited a higher incidence of iron-deficiency than did the gastroduodenostomy group during all periods of 12 months after surgery, and the difference was statistically significant beginning 2 years after surgery. Therefore, the timing of the occurrence of iron-deficiency after gastrectomy is related to method of reconstruction. The size difference of the remnant stomach after distal gastrectomy between patients with gastroduodenostomy and patients with gastrojejunostomy would affect iron intake and absorption. However, the affect would be minimal because there was

little difference in body mass index change between gastroduodenostomy and gastrojejunostomy group as shown in Figure 2.

Considering the long-term sequela of iron metabolism, the surgeons' first choice of reconstruction after distal gastrectomy would be gastroduodenostomy rather than gastrojejunostomy, provided it is surgically and oncologically safe. In this context, pylorus-preserving gastrectomy would be an effective alternative of gastroduodenostomy, although its indication is a bit limited. Because pylorus-preserving gastrectomy conserve the pyloric ring and duodenal passage, it may prevent the sequelae of gastroduodenostomy such as reflux gastritis or dumping syndrome associated with rapid gastric emptying and may have better nutritional status and hemoglobin levels than gastroduodenostomy.[24] Thus far, total gastrectomy has been regarded as the standard treatment for gastric cancer located in the upper body. Other types of surgery such as total gastrectomy with jejunal interposition and proximal gastrectomy with preservation of the duodenal passage using various methods of reconstruction may have a theoretical benefit for iron metabolism.[23,24] Thus, a comparative study regarding different degrees of resection and reconstruction methods is needed to clarify iron metabolism after total gastrectomy.

The prophylactic iron supplementation can be considered to prevent the occurrence of iron-deficiency after gastrectomy. Although little has been studied about this idea in patients with gastric cancer, it has been shown in a randomized study that prophylactic supplementation of oral iron successfully

prevented iron-deficiency after Roux-en-Y gastric bypass for morbid obesity.[25] Even with iron supplementation in patients with anemia, serum ferritin levels decreased continuously in all groups according to the method of reconstruction, and these levels were slightly higher in the gastroduodenostomy group than in the gastrojejunostomy group. Ferritin is the cellular storage protein for iron, and serum ferritin is an important parameter for assessing total body iron stores.[20] The measurement of ferritin provides the most useful laboratory marker for body iron stores.[26] Thus, repeated measurement of serum ferritin is a suitable method for estimating changes in iron balance. In addition, transferrin levels continuously increased among our patients. These changes in serum ferritin and transferrin levels were different from those of BMI, which was stabilized 3 months after gastrectomy regardless of the method of reconstruction. Therefore, weight loss and decreased dietary iron absorption may be caused by different mechanisms. Interestingly, TIBC levels reached a plateau 3 months after surgery in the gastroduodenostomy group, whereas these levels increased continuously in the gastrojejunostomy. These differences in TIBC levels are correlated with the incidence of iron-deficiency according to the method of reconstruction; however, further investigation is needed.

The retrospective nature of our study limited our ability to evaluate the relationship between the timing of the occurrence of iron-deficiency and patients' dietary iron intake. It is crucial to evaluate the development of iron-deficiency in patients with gastric cancer as well as in healthy persons. Limited

information regarding iron supplementation after gastrectomy may have influenced the incidence and occurrence of iron-deficiency among the patients included in the analyses. Additionally, the incidence of iron-deficiency may have been underestimated because some patients may have received iron supplementation outside of our hospital. However, it was impossible to obtain the entire medication histories of the patients retrospectively. Moreover, we did not use the ferritin criteria for iron replacement. The lack of evaluation of the quality of life of patients, including the presence of symptoms related to iron-deficiency, is another limitation of our study. These limitations primarily arose from the retrospective nature of this study, and thus, well-designed prospective studies would supplement our findings and overcome these limitations.

Although the study was performed in a retrospective manner, the hematologic profiles of all of the patients included in the study were evaluated prospectively. These detailed hematologic profiles were serially examined in a large cohort of patients. Moreover, the analyzed patients had early gastric cancer without any evidence of recurrence during the follow-up period, and these patients had no other history of cancer. Therefore, the influence of the myelosuppressive effects of chemotherapy and anemia caused by the chronic disease process associated with malignancy was completely eliminated. Thus, the obtained results regarding the incidence of iron-deficiency and iron-deficiency anemia were relatively objective.

V. CONCLUSION

In conclusion, the results of the present study revealed that the incidence of iron-deficiency is remarkably high in patients who underwent gastrectomy in a relatively early period after surgery. Therefore, frequent routine examination of serum ferritin levels is recommended during the follow-up for gastrectomized patients. Moreover, the incidence of iron-deficiency was different according to the method of reconstruction. To preserve iron metabolism, gastroduodenostomy would be considered the optimal method of reconstruction after distal gastrectomy when it is possible to perform the surgery in an oncologically safe manner.

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ABSTRACT (IN KOREAN)

위암 환자에서 원위부 위절제 수술 후 재건 방법에 따른 영양지표와 체내 저장 철의 변화

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목적: 위 절제술 이후 빈혈은 가장 흔히 발생하는 대사 장애 이지만 임상에서 쉽게 무시되어온 후유증이다. 원위부 위절제술 후 철 결핍증의 발생 및 발생 시기가 수술 후 재건방법과 밀접한 관련이 있다고 가설을 세우고, 원위부 위절제술 이후 철 대사 및 환자의 좋은 영양상태를 위한 재건방법을 찾기 위해 본 연구를 시행하였다.
방법: 전향적으로 축적한 위암 데이터베이스를 사용하여, 2004년 1월부터 2008년 5월 사이에 조기위암으로 근치적 원위부 위절제술을 시행받은 311명의 환자를 대상으로 분석하였다.
결과: 대상환자 중 원위부 위절제수술 후 3년간 추적관찰 기간동안 철결핍증의 전체 발생률은 64.0% 였고, 빈혈을 동반한 철결핍증은 26.4%의 환자에게서 관찰되었다. 철결핍증은 위-십이지장문합술과 위-공장문합술 환자에게서 수술 후 3년 이내에 각각 58.3% 와 79.5% 의 환자에게 발생하였다. (P=0.001) 철결핍증은 남자보다는 여자에게서 (P=0.0001), 위-십이지장문합술 보다는 위-공장문합술 이후에 더 많이 발생하였다. (P=0.0003) 혈청 페리틴 농도 역시 원위부 위절제술 후 재건방법에 따라 차이를 보였다.
결론: 철결핍은 위암으로 원위부 위절제술을 시행받은 대부분의 환자에게서 발생하였고, 그 발생률은 재건방법에 따라 다르게 나타났다. 원위부 위절제수술 이후 보다 나은 철분 대사를 위해서는 그 술기가 종양학적으로 문제가 없다면 가능한 위-공장문합술 보다는 위-십이지장 문합술을 시행하여야 한다.

핵심되는 말: 영양, 철 결핍, 위암, 재건술

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