

Surgical Treatment of Gastric Cancer

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Introduction

Gastric cancer is the leading cause of cancer-related death in Korea. A number of clinical trials to improve survival of gastric cancer patients have been conducted. Although chemotherapy and radiation therapy have been included in many of treatment programs for gastric cancer, the clinical relevance of those modalities have been controversial so far. In terms of gastric cancer treatment, the basic treatment is primarily surgical and surgical resection is the most effective modality for both early and advanced gastric cancer. Surgery in early stage gastric cancer, especially, provides the best chance of cure. Fortunately, the incidence of early gastric cancer has been increased under favor of endoscopic screening in Korea and, therefore, the cure rate of gastric cancer is high when compared to those of the Western countries (1). For several decades, many descriptions on concepts and techniques for the surgical treatment of gastric cancer have been reported

and there are also many controversies in some surgical topics. For examples, debates continue regarding the value of extended lymph node dissection, the indications for limited surgery, the role of palliation, and so on. This article reviews only the most commonly accepted principles of surgical treatment for gastric cancer.

Preparation for operation

If laparotomy is planned after appropriate evaluation of gastric cancer, preoperative physiologic conditions of a patient should be assessed. The patients with gastric cancer are usually elderly and may have potential problems such as malnutrition, anemia, respiratory insufficiency, cardiac abnormalities, hepatic and renal dysfunction, acid-base disorders, clotting abnormalities, and coexistent chronic debilitating diseases. Poor prognoses in the oldest patients over age 80 years were mainly attributed to the number of deaths due to other disease(2). The laboratory

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check-list should be composed to cover these potential problems. The abnormal laboratory findings should be corrected carefully. The main aims of preoperative correction of abnormalities are to prepare the patient to withstand the stresses of operation and to minimize the operative risks. Preoperative therapy for correction of abnormalities should be initiated as soon as possible. If preoperative corrections of physiologic abnormalities are incomplete, the plans for more complete correction during and after operation should be established preoperatively. Because elective gastric resection is classified as clean-contaminated wound, antibiotic prophylaxis is used to reduce the incidence of postoperative wound

infection(3). Preoperative teaching and practice on deep breathing, coughing, and ambulation are also necessary for all patients.

Selection of operative procedures

Selection of an operative procedure is primarily determined by the extent of disease such as the location of primary tumor, the status of lymph node infiltration, and the presence of direct invasion of primary lesion into the adjacent organs. The surgeon should consider what the best surgical procedure for a selected case is. In selecting an appropriate surgical procedure for a patient, postoperative quality of life has become an important

Table 1. Types of operation for gastric cancer treatment

Gastrectomy
Distal subtotal gastrectomy
Total gastrectomy
Gastrectomy combined with adjacent organ(s) resection
Proximal gastrectomy
Laparoscopy-assisted subtotal gastrectomy
Limited surgery: Pylorus preserving gastrectomy
Laparoscopic gastric wedge resection
Postgastrectomy reconstruction
After subtotal gastrectomy
Gastroduodenostomy (Billroth I procedure)
Gastrojejunostomy (Billroth II procedure)
Roux-en-Y gastrojejunostomy
After total gastrectomy
Loop esophagojejunostomy with/without various types of pouches
Roux-en-Y esophagojejunostomy

variable factor. Various types of surgery for gastric cancer have been introduced and performed (Table 1). Basic principles of gastrectomy for gastric cancer is an en bloc resection of tumor with adequate margins of normal tissue and with regional lymph nodes and omental tissues. To completely achieve these principles, regional lymph node and all omental tissues should be removed altogether during performing various types of gastric resection. The lymph node dissection is a major portion of procedures for gastric cancer to achieve curative resection and will be discussed in detail in a separate section. With increasing incidence of early gastric cancer, a few of techniques of limited surgery or endoscopic procedures have been developed and performed for the high risk group of patients.

Lymph node dissection

Based on the anatomical lymphatic flows of the stomach, sixteen stations of lymph nodes were classified and numbered from lymph node number one to lymph node number sixteen by the Japanese Research Society for Gastric Cancer in 1963 (Table 2) (4). Sixteen stations of lymph nodes were grouped as N1, N2, N3, and N4 according to the location of the tumor (Table 3). D2 dissection means complete resection of the N1 and N2 groups which is also called as systematic lymph node dissection. D2

dissection is minimally required for radical gastric cancer surgery and the standard surgery for gastric cancer. The major effect of radical lymph node dissection is in the reduction of local recurrence and, moreover, the degree of lymph node dissection has been known to be an important prognostic factor and correlated well with the survival rate (5). The systematic lymph node dissection is usually not indicated for patients with metastasis, but some Japanese surgeons recommend gastrectomy with extended lymphadenectomy and/or resection of adjacent organs due to survival benefits, even when the operation is histologically noncurative (6,7).

Subtotal gastrectomy

Although there is a well-documented transition of gastric cancer from distal to proximal lesions, the gastric antrum or distal third of the stomach is still the most frequent site of primary lesion (8). Distal subtotal gastrectomy including radical regional lymph node dissection is the most commonly used procedure for gastric cancer and the operation of choice for distal gastric cancer. The upper midline skin incision is usually placed for distal gastrectomy. To accomplish curative surgery for distal gastric cancer, a resection of 75% to 80% gastric volume including the all length of lesser curvature will be usually required. The proximal resection margin is placed 6 cm proximal to

Table 2. Sixteen stations of gastric regional lymph nodes

1-6: Perigastric lymph nodes

- 1: Right pericardial
- 2: Left pericardial
- 3: Lesser curvature
- 4: Greater curvature
- 5: Suprapyloric
- 6: Infrapyloric

7-16: Extragastric lymph nodes

- 7: Left gastric artery
- 8: Common hepatic artery
- 9: Celiac artery
- 10: Splenic hilum
- 11: Splenic artery
- 12: Hepatic pedicle (hepatoduodenal ligament)
- 13: Retropancreatic (behind the pancreas head)
- 14: Mesenteric root
- 15: Middle colic artery
- 16: Paraaortic
 - 16a: Above the renal vein
 - 16a1: Lymph nodes in the aortic hiatus
 - 16a2: Lymph nodes from the upper margin of celiac trunk to the lower margin of the left renal vein
 - 16b: Below the renal vein
 - 16b1: Lymph nodes from the lower margin of the left renal vein to the upper margin of the inferior mesenteric artery
 - 16b2: Lymph nodes from the upper margin of the inferior mesenteric artery to the aortic bifurcation

Table 3. Four groups of lymph node according to the location of tumor

Group\tumor location	Distal third	Middle third	Proximal third
N1	3-6	3-6, 1	1-3, 4s
N2	7-9, 1	2, 7-11	4d, 7-11, 5, 6
N3	2, 10-14	12-14	12-14, 110, 111
N4	16(a2, b1)	16(a2, b1)	16(a2, b1)

N: group of lymph nodes

gross tumor and the duodenum is divided 4-5 cm distal to the pyloric ring in western countries. However, most Korean and Japanese surgeons may not fix the distance from the lesion to resection margins as long as they can confirm the absence of tumor cells at resection margins through intraoperative frozen biopsy. The proximal resection margin can be shortened to 2-3 cm according to the conditions of primary lesion(9). Frozen-resection histologic examination is basically recommended to evaluate the surgical margins before alimentary reconstruction. The lymph nodes in the pyloric area, hepatoduodenal ligaments, along common hepatic artery and celiac axis are commonly excised with the stomach. The lymph node groups to be removed can be changed on the location of primary lesion(9). The left gastric artery, right gastric artery, and right and left gastroepiploic arteries are divided at their origins. Greater omentum is dissected from the transverse colon combined with separation of the anterior sheet of transverse mesocolon from the posterior sheet. Postgastrectomy reconstruction for alimentary continuity is commonly established by gastrojejunostomy known as Billroth II anastomosis. Billroth I gastroduodenostomy is an attractive alternative for early lesions because of its good physiologic outcome and lesser likelihood of complications. A few surgeons prefer to practice total gastrectomy rather than subtotal gastrectomy in all cases of

gastric cancer because they believe in the risks from the gastric remnant such as, the increased chance of recurrence, hidden multicentric lesion, and a second, metachronous carcinoma. Several studies on the postoperative quality of life revealed the benefits of distal gastrectomy and the operative mortality and morbidity were greater and long-term survival was no better after total gastrectomy than after subtotal gastrectomy(10-12).

Total gastrectomy

Based on the previously described surgical principles for gastric cancer, total gastrectomy is usually indicated in cases of cancer in which the lesion is located on upper part of the stomach. Common indications of total gastrectomy for gastric cancer are as follows, proximal gastric cancer, diffuse extension of the lesion to the stomach, multiple lesions involving whole stomach, distal cancer with metastasis to pericardial lymph nodes, proximal cancer with metastasis to peripyloric lymph nodes, or gastrectomy with combined resection of the spleen and/or distal pancreas. After wide exposure of upper abdomen through the upper midline or transverse incision, the abdominal contents are explored, with emphasis on detecting metastatic disease. Surgical procedures for dissection of the greater omentum, duodenum, and perigastric lymph node are managed in the same way as described above. The proximal resection

margin is placed approximately 2-6 cm proximal to esophagogastric junction according to the status of cancer lesion. If the lesion is involving distal esophagus or esophagogastric junction, making a decision on the extent of resection is difficult and complicated. The management of patients with adenocarcinoma of the esophagogastric junction has been a matter of debate. For a valid comparison of tumors arising at esophagogastric junction, a German group classified adenocarcinomas of this area into three types. Type I is defined as adenocarcinoma of the distal esophagus arising from Barrett esophagus that may infiltrate the esophagogastric junction from above, type II means adenocarcinoma arising at cardia of esophagogastric junction, and type III refers to subcardial gastric carcinoma that infiltrates the esophagogastric junction and distal esophagus from below(13). Based on the collection of data, some distinctions between types were defined(14). Type I tumor is a distinct entity that requires a specific therapeutic approach as distal esophageal cancer. Type III tumors clearly represent a form of gastric cancer and require treatment according to the gastric cancer guidelines. The relation of type II tumors to distal esophageal or proximal gastric cancer, however, remains controversial. Most type II tumors resemble proximal gastric cancer more closely than they do distal esophageal adenocarcinoma. Curative

surgical approach for type II tumor can be achieved by a transabdominal approach with total gastrectomy, resection of the distal esophagus after wide splitting of the esophageal hiatus, and lymphadenectomy in the lower posterior mediastinum, in addition to a D2 lymph node dissection according to the principles of gastric cancer surgery(15). Resection of type II tumors using an abdominal approach only has been shown to be feasible and safe by several groups(14,16-19). This classification from Germany may provide a useful guide for selecting the surgical approach. Alimentary reconstruction is commonly performed by a Roux-en-Y esophagojejunostomy. The isoperistaltic jejunal level should be 45 to 60 cm long to prevent alkaline reflux into the esophagus(3). EEA (end-to-end anastomosis) stapling device is usually used to perform the esophagojejunostomy. End-to-end esophagojejunostomy should be avoided because of an increased incidence of leakage, noted in 16% of patients. This leakage rate is reduced to 2% with an end-to-side anastomosis because of better blood supply(20). The esophageal connection to the jejunum may be accomplished by creating a jejunal pouch as described by Hunt(21) and Lawrence(22). Nadrowski(23) reviewed the physiologic and nutritional effects of various types of pouches after total gastrectomy from literatures and concluded that Roux-en-Y esophagojejunostomy was adequate to reconstruct the alimentary

tract and complicated pouches were not necessary. A few of surgeons, however, prefer the techniques of pouch and Roux-en-Y reconstruction for the postoperative quality of life(24).

Palliative surgery for gastric cancer

Patients requiring palliative surgery are not infrequent in gastric cancer. Curative operation cannot be expected in cases with evidences of dissemination such as, Virchow's metastasis, cancerous ascites, metastasis to the liver or lung, periumbilical metastasis, or other site distant metastasis. In patients with risk factors and/or distant metastases, a palliative surgical procedure may be indicated. A palliative procedure should be performed with reasonable risk that may be decided on the basis of the patient's individual situation. The main purposes of palliative surgery for gastric cancer are to control complications such as, bleeding, obstruction, and intractable pain and to maintain enteral digestion. Procedures for palliation include resection of the main lesion with or without lymphadenectomy or omental resection, bypass surgery, gastrostomy or enterostomy for enteral feeding, and other surgery to relieve urgent conditions associated with gastric cancer (9,25).

New trends in gastric cancer surgery

Although subtotal or total gastrectomy with radical lymph node dissection have been standard procedures for gastric cancer, new trends in gastric cancer surgery recently have been developed. Postoperative quality of life has become a main topic in current surgical field and techniques for more limited surgery have been introduced. With development of endoscopic and laparoscopic techniques, endoscopic therapy and laparoscopy-assisted limited surgery have become more prevalent. Limited surgery for gastric cancer includes wedge resection of stomach, pylorus preserving gastrectomy(PPG), vagus-preserving gastrectomy, proximal gastrectomy, and gastrectomy with limited lymph node dissection. Endoscopic mucosal resection (EMR) or endoscopic laser therapy is a very minimally invasive option for the treatment of mucosal gastric cancer. The indications for endoscopic treatment are limited according to the size, location, histologic type, gross finding of the lesion. Laparoscopic wedge resection can be performed as another minimally invasive method for early gastric cancer(26). Although perigastric lymph nodes can be dissected laparoscopically in an en bloc fashion, complete lymph node dissection by this method is still limited. The absolute indication of laparoscopic wedge resection should be for the lesion which has little possibility of lymph node metastasis as like as that of EMR(27). Recently, laparoscopy assisted Billroth I gastrectomy or Billroth II

gastrectomy have been performed successfully (28). The long term clinical results should be carefully analyzed for the completeness of these new techniques. Laparoscopy is also diagnostic and highly accurate in detecting occult metastasis including peritoneal dissemination. Laparoscopic examination before laparotomy can prevent patients with advanced gastric cancer from unnecessary laparotomy (29). PPG is different from conventional subtotal gastrectomy in retaining a 1.5 cm length of the pyloric cuff and in neglecting the suprapyloric lymph node dissection, with the remaining pyloric branch of the vagal nerve being uninjured. As PPG is a less radical operation than conventional gastrectomy for gastric cancer, this procedure is usually indicated only for early gastric cancer located in the middle third of the stomach. Through PPG, patients maintain the pyloric function postoperatively which results in a decrease of the dumping syndrome and prevention of alkaline reflux gastritis(30). In terms of surgical stress, gallbladder function, and postoperative quality of life, PPG has been also known to have advantages over conventional distal gastrectomy(31). Moreover, Sawai et al(32) devised a techniques for performing PPG with more radical lymph node dissection without compromising pyloric blood flow. The key point of this method is to keep infrapyloric arterial flow which can permit divisions of the right gastric and right gastroepiploic arteries with adjacent

lymph nodes. Since the rate of lymph node metastasis of early gastric cancers confined to the mucosa is very low and almost all metastases in these cases involve the perigastric nodes or lymph nodes along the left gastric artery, some surgeons prefer modified radical gastrectomy(MRG) which means gastrectomy with D1 lymph node dissection or MRG with left gastric lymph node dissection as a kind of limited surgery.

Summary

Definitely, treatment for gastric cancer is primarily surgical. Detection in early stage of disease and complete surgical resection is the best way to cure gastric cancer. If surgery is planned, careful preoperative evaluation and corrections of physiologic and psychologic abnormalities are essential to reduce perioperative morbidity or mortality. Basic principle of gastrectomy for gastric cancer is an en bloc resection of tumor with adequate margins of normal tissue and with regional lymph nodes and omental tissues. To complete these principles, regional lymph nodes and all omental tissues should be removed altogether during performing various types of gastric resection. The lymph node dissection is one of the most effective procedures for gastric cancer to achieve curative resection. The basic types of gastric resection are distal subtotal gastrectomy and total gastrectomy according to the condition

of primary lesions and the status of lymph node metastases. When the primary lesion is located near the esophagogastric junction, it is sometimes hard for a surgeon to select adequate surgical method. Postoperative quality of life in a patient has become a very important factor to be considered in every step of surgical therapy. With increasing incidence of early gastric cancer, a number of surgical trials for limited surgery or endoscopic procedures have been performed, but the long-term clinical results should be carefully analyzed to define the clinical relevance of these new techniques. For patients with disseminated gastric cancer, a palliative procedure can be performed to improve quality of life of patients and to avoid immediate death due to the cancer-related complications.

-요약-

위암은 한국에서뿐만 아니라 세계적으로도 가장 중요한 암 사망 원인의 한가지로 보고되고 있다. 현재까지 외과적 수술이 위암에 대한 유일한 근치적 치료수단으로 인정되고 있으며, 가능한 한 조기에 발견하여 근치적 절제술을 시행하는 것이 가장 중요하다. 근치적 수술을 위한 술기의 표준화 및 각 수술 술기의 우열에 대한 논란이 현재까지 그치지 않고 있으나, 여기에서는 한국 및 일본에서 가장 보편적으로 인정되고 있는 위암에 대한 수술 치료의 원칙을 기술하고자 한다. 위장 절제술은 위아전절제술과 위전절제술로 대별되며 절제연은 중앙

의 침윤이 없는 충분한 정상조직을 확보하여야 하고 주변 림프절의 동반절제가 포함되어야 한다. 병변의 상태에 따라 주변장기의 동반절제와 광범위한 림프절 광청술이 요구되기도 한다. 소화관의 복구는 구조적 혹은 기능적인 면에서 환자의 삶의 질과 밀접한 관련을 가지므로 상황에 따라 적절한 방법의 선택을 요한다. 술 후 환자의 삶의 질을 향상시키기 위해서 저침습성 혹은 최소한의 절제를 목적으로 하는 새로운 술기들이 소개되기도 하였다. 유문보존 위절제술, 복강경을 이용한 위설상절제 및 위아전절제술, 내시경점막절제술등을 그 예로 들 수 있으며, 이러한 시술의 적응증과 안전성은 향후 임상성적의 분석을 통해 정립되어야 한다. 근치적 절제술이 불가능한 위암환자에서는 환자의 고통감소와 경구적 영양 섭취를 위해서 고식적 수술을 시행할 수 있으며, 특히, 진행성 위암에 의한 합병증으로 인해 생명이 위태로운 경우에는 응급수술이 요구되기도 한다. 진행성 위암은 수술적 치료를 하더라도 예후가 불량하므로 조기에 발견하는 것이 가장 중요하다. 최근, 한국에서는 상부 위장관에 대한 내시경 시술의 보편화로 전체 위암에서 조기위암이 차지하는 비율이 향상되고 있으며, 적절한 근치적 수술을 통해 위암의 생존율이 향상되고 있다.

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