TOTALLY LAPAROSCOPIC DISTAL GASTRECTOMY WITH D2 LYMPH NODE DISSECTION BASED ON JAPANESE GASTRIC CANCER TREATMENT GUIDELINES: PRINCIPLES AND METHODS

K. Suda, V. A. Kashchenko, K. Ishikawa, Y. Ishida, M. Uyama
Fujita Health University

INSTITUTIONAL AFFILIATION:
*Division of Upper GI, Department of Surgery, Fujita Health University, 1-98 Dengakugakubo, Kutsukake, Toyoake, Aichi, 470-1192 Japan.
†Department of Surgery, L.G. Sokolov Memorial Hospital №122, 4 Kultury Pr. St. Petersburg 194291, Russia.

ADDRESS CORRESPONDENCE AND REQUESTS FOR REPRINTS TO:
Koichi Suda, MD, PhD
Division of Upper GI, Department of Surgery, Fujita Health University, 1-98 Dengakugakubo, Kutsukake, Toyoake, Aichi, 470-1192 Japan

ABSTRACT: The outcomes of treatment for gastric cancer in Japan have improved markedly as a result of early detection and extensive radical surgery. To date, the Japanese Gastric Cancer Association (JGCA) has recommended that non-early, potentially curable gastric cancers should be treated by D2 lymphadenectomy, and defined standard gastrectomy, which is the principal surgical procedure performed with curative intent, as resection of not less than two-thirds of the stomach with a D2 lymph node dissection.

Laparoscopic surgery was launched in the early ‘90s. At that time, most laparoscopic surgeons applied laparoscopic surgery, using its minimally invasive nature, to less extended surgery. However, we assumed from the beginning that laparoscopic surgery should be suitable for meticulous dissection using the high quality of laparoscopic image with magnified visualization, and since mid-‘90s, we have been doing totally laparoscopic D2 gastrectomy with intracorporeal anastomosis using linear staplers as the standard treatment for operable patients with resectable gastric cancer. In this article, we present technical aspects of totally laparoscopic D2 distal gastrectomy with delta-shaped B-I anastomosis based on our experience.

KEY WORDS: gastric cancer, laparoscopic distal gastrectomy, D2 dissection, outermost layer-oriented medial approach, delta-shaped anastomosis.

1. Introduction
Gastric cancer remains a major public health problem in the world. Gastric cancer is the 4th most common cancer and the 2nd leading cause of cancer-related death[1,2]. The highest incidence of gastric cancer is found not only in East Asia including Japan but also in Russia[3]. In terms of prognosis of gastric cancer, 5-year relative survival was over 60% in Japan, whereas 25% in the Western countries[4]. There are following two major factors which may cause such a great difference in long-term outcomes: early detection of gastric cancer, and the extended D2 lymph node dissection[5].

We introduced laparoscopic assistance into moderate to advanced gastrointestinal surgery in 1995, and developed techniques for laparoscopic distal and total gastrectomy with D2 dissection for advanced gastric cancer, which were published for the first time in the world[1,4,5]. Since then, we have performed more than 1,000 laparoscopic gastrectomies. At present, the standard type of operation for curable gastric cancer at Fujita Health University is totally laparoscopic D2 gastrectomy[6].

We herein present the principles and methods of totally laparoscopic D2 distal gastrectomy with delta-shaped B-I anastomosis[6].

2. Set up

2.1. List of instruments
An operating surgeon basically uses Thunderbeat and “Mancina” with his/her right and left hands, respectively. An assistant surgeon does “Johann” and “Croce” with his/her cranial and caudal-sided hands, individually (Fig.1). All the details were shown in Table 1.

2.2. Patients
The stage of the cancer is classified according to the 14th edition of the Japanese Classification of Gastric Carcinoma (JCGC) [7]. Cancer staging...
is performed based on the findings of contrast-enhanced computed tomography, gastrography, endoscopic study, and endosonography before the beginning of any treatment and, when applicable, after the completion of chemotherapy. The patients with clinical $T \geq 2$ cancer over 5 cm in size and/or a swollen locoregional lymph node over 1.5 cm in size undergo staging laparoscopy. Clinical Stage $\leq$ IIIC is determined to be resectable. Neoadjuvant chemotherapy (S-1 80 mg/m² Day 1-21 + CDDP 60 mg/m² Day 8) is used for those with clinical $T \geq 2$ as well as tumor $\geq$ 5.0 cm in size and/or a swollen locoregional lymph node $\geq$ 1.5 cm in size, unless the patients refuse it. Induction chemotherapy (S-1 80 mg/m² Day 1-14 + CDDP 35 mg/m² Day 8, or Docetaxel 30 mg/m² Day 1, 15 + CDDP 30 mg/m² Day 1, 15 + S-1 80 mg/m² Day 1-14) is used for clinical Stage IV disease, and radical gastrectomy is conducted when downstaging is achieved.
Distal gastrectomy is used for the tumor localized to M and/or L area. D1+ lymphadenectomy is done for preoperative Stage IA disease, whereas D2 is done for preoperative Stage IB, II, and III diseases in accordance with the 3rd edition of the JGCA Guidelines.

2.3. OR setup

Basically, the operator stands on the patient’s right side, except for #6 lymph node dissection (Fig.2). When the operator stands on the left side, the scrub nurse with the table should move from the caudal to the cranial side of the patient (Fig.2) just to avoid the cables connecting between the forceps and generators from getting tangled.

2.4. Patient’s position

The patient is placed in a supine position with legs apart, left arm extended, and 15-degree head-up tilt.

2.5. Trocar arrangement (Fig. 3)

- Camera: navel or mid-line below the navel
- RUP: one-finger caudally from the right subcostal line, top of the right subphrenic “dome”, affecting the comfortableness in grasping adipose tissue including #11p
  
  Note: The distance between Camera and RUP should be longer than eight fingers.
- RLP: Caudally on the median line between Camera and RUP
- LUP: more than two-finger caudally from the left subcostal line, affecting the comfortableness in #6 dissection
  
  Note: The distance between Camera and LUP should also be longer than eight fingers.
- LLP: Caudally on the median line between Camera and LUP
- Additional port: Cranially on the median line between Camera and RUP, suitable for deeply dissecting suprapancreatic lymph nodes over the pancreas

Fig. 4 Outermost layer of the autonomic nerve
3. D2 lymph node dissection

3.1. Outermost layer-oriented medial approach

D2 dissection entails removal of the lymph nodes in the suprapancreatic area in distal gastrectomy. Dissection of this area is technically demanding due to the serious risk of bleeding and/or pancreatic leakage derived from a major vessel or organ injury. To improve the safety, efficacy, and reproducibility of suprapancreatic nodal dissection, we developed our original methodology called outermost layer-oriented medial approach. In this approach, the layer between the autonomic nerve sheaths of the major arteries and the adipose tissue bearing lymphatic tissue is dissected. We termed this layer as the outermost layer of the autonomic nerve. To identify this layer throughout the dissection process, we developed an original surgical theory, “XYZ-axis” theory.

theory (Fig.5), consisting of the following three steps—
(1) cut the serosal membrane on the suprapancreatic
border; (2) dissect suprapancreatic adipose tissue
caudocranially towards the junction of the three
arteries (zero point) to find the outermost layer; (3)
dissect the target adipose tissue mediolaterally along
the layer spreading on the XZ and YZ axes.

3.2. Details of D2 dissection in distal gastrectomy

3.2.1. #4d dissection
The operating surgeon stands to the right of the
patient. The assistant surgeon holds the greater
curvature on the “watershed” dividing between the
right and left gastroepiploic arteries (RGEA and
LGEA) and raise it cranioventrally with his/her right
hand. Subsequently, the assistant surgeon grasps
the greater omentum near the transverse colon.
Then, the operating surgeon gently holds the pedicle
of the right gastroepiploic artery and vein (RGEA and
RGEV) to create a triangle. The operating surgeon
starts opening the bursa at a thin part of the greater
omentum (Fig.6), and transects it along the border
between adipose tissue belonging to the stomach
and that belonging to the transverse colon referring to
the “line” created by physiological adhesion (Fig.7a).
Adhesion between the posterior aspect of the stomach
and the pancreatic body should be detached as much
as possible just to recover the original anatomy.

3.2.2. #4sb dissection
The assistant surgeon holds the posterior aspect
of the upper area of the stomach and determine the pedicle including the LGEA/V originating from the
pancreatic tail (Fig.7a). By dividing the bursa along
the physiological adhesion line mentioned above,
the root of the gastric branch of LGEA is easily
exposed preserving the omental branch (Fig.7b).
Then, adipose tissue including #4sb is removed out
of the greater curvature from the “watershed” upto
the avascular area between LGEA and short gastric
arteries (SGAs) (Fig.7c).

3.2.3. #6 dissection
The operating surgeon moves to the left of the
patient. Transverse colon is mobilized by dissecting
fusion fascia and pancreatic head is widely exposed.
The left aspect of the adipose tissue including #14v
and 6 is dissected along the inferior border of the
pancreas (Fig.8a). Subsequently by exposing the
edge of the pancreatic head behind the duodenal
bulb, RGEA and the autonomic nerve on the right of
RGEA is exposed on the anterior and inferior aspect
of the pancreatic head, respectively (Fig.8b). At
this site, right gastroepiploic vein (RGEV) is running
along the nerve, and the outermost layer of RGEA
is widely exposed by dividing between the vein
and nerve to facilitate #6v dissection (Fig.8b).
Prepancreatic fascia is dissected along anterior

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Fig. 8 #6v dissection
superior pancreatoduodenal vein (ASPDV) (Fig. 8c). RGEV is transected right above ASPDV (Fig. 8d). Then, the right aspect of the adipose tissue including #6 (#6v) is dissected on the outermost layer of this autonomic nerve (Fig. 8c). As a next step, the anterior superior aspect of the fat tissue including station #6i and #6a is removed from the greater curvature side of the duodenum (“C-loop”) (Fig. 9a). Finally, RGEA and infrapyloric artery (IPA) is transected (Fig. 9b).

3.2.4. Transection of duodenum
The avascular area between the lesser curvature side of the duodenal bulb and the adipose tissue bearing #5 is opened from the posterior aspect of the stomach (Fig. 10a). Then, duodenal bulb is transected in the posteroanterior direction (Fig. 10b).

3.2.5. Lesser omentum, top of #1
The operating surgeon moves back to the right of the patient. The lesser omentum is transected (“reversed-L shape”) (Fig. 11a). The anterior aspect of the subretroperitoneal fascia is exposed in front of the right diaphragmatic crus (Fig. 11b). The top of the #1 dissection is determined confirming the final ascending branch of the left gastric artery (LGA).
3.2.6. Rolling up the stomach
To facilitate suprapancreatic lymph node dissection, the stomach is rolled up (Fig.12).

3.2.7. Probing the outermost layer of CHA and SPA
The assistant surgeon retracts the caudal edge of the pancreatic body and stretches the gastropancreatic fold. The operating surgeon stretches the adipose tissue containing #8a and #11p carefully and dissected along the stably visualized outermost layer of the common hepatic artery (CHA) (Fig.13a) and the proximal part of the splenic artery (SPA) (Fig.13b). This dissection was continued along the outermost layer of the left lateral aspect of the proper hepatic artery (PHA) and the dorsal area of the right gastric artery (RGA).

3.2.8. #5 dissection
The outermost layer of the nerve along PHA and the cranial aspect of RGA is exposed (Fig.14a). The origin of RGA was divided by clips (Fig.14b).

3.2.9. Medial approach
The avascular space of the left gastric artery (LGA) is dissected bilaterally along the outermost layer (Fig.15a,b).

3.2.10. #12a dissection
The fat tissue containing #8a, 9(R), and 12a is lifted ventrally and laterally. To create a good surgical field, the operating surgeon stretches the thick nerve fibers along the PHA laterally, the assistant surgeon stretches the nerve fibers on the cranial side of the CHA caudally, and the assistant also retracts the target tissue medially (Fig.16a). Under this good surgical field, #12a lymph-nodes are dissected along the portal vein (PV) safely (Fig.16b).
3.2.11. #9(R) dissection

The target fat tissue is completely dissected on the outermost layer of the nerve plexus of the celiac artery, leading to complete mobilization of the target fat tissue containing #8a, 9(R), and 12a. Finally, the lymphatic connection between the target fat tissue and #16a2-inter is divided, and the fat tissue containing #8a, 9(R), and 12a is dissected along the right diaphragmatic crus (Fig. 17). Left gastric vein (LGV) is transected on the way (Fig. 18a).
3.2.12. #7 dissection
The origin of LGA is exposed and divided by clips (Fig.18b).

3.2.13. #11p dissection
The massive area of the target fat tissue bearing suprapancreatic lymph nodes is retracted laterally to the left by the assistant surgeon. #11p lymph nodes are freed from subretroperitoneal (Gerota’s) fascia, delineating the dorsal aspect of #11p (Fig.19a). The lateral aspect of the targeted fat tissue is dissected along the outermost layer of SPA (Fig.19b). To get a good surgical view around the dorsal area of SPA, the assistant surgeon caudally retracts the thick nerve fibers along the cranial edge of SPA (Fig.19b). Under this good surgical field, the lateral bottom aspect of the target fat tissue including #11p and 9(L) lymph-nodes is dissected along the splenic vein (SPV) safely (Fig.19c).

3.2.14. #9(L) dissection
The fat tissue containing #11p and 9(L) is lifted, and lymphatic connection between #9(L) and 16a2-lat is divided (Fig.20).

3.2.15. #1 and 3 dissection
The adipose tissue bearing #1 and 3 is lifted by the assistant surgeon’s right hand and the operating surgeon’s left hand (Fig.21a). The other hand of the assistant surgeon retracts the posterior aspect of the stomach ventrally (Fig.21a). Using this surgical field, #1 and 3 are dissected in the caudocranial direction (Fig.21b).
3.2.16. **Transection of the stomach**

Stomach is transected from the greater to lesser curvature on the line between the prefinal branch of LGEA and final ascending branch of LGA irrespective of the location of the tumor (Fig. 22).

4. **Intracorporeal B-I reconstruction: delta-shaped anastomosis\(^6\)**

4.1. **Intracorporeal anastomosis using linear staplers\(^13\)** (Fig. 23)

Intracorporeal anastomosis is essential for totally laparoscopic gastrectomy, which is characterized by smaller wounds, less invasiveness, and better feasibility of a secure ablation in comparison with laparoscopy-assisted gastrectomy\(^14\). We have preferred...
intracorporeal anastomosis using linear staplers because of its handy, quick visible and reproducible natures. It could reduce anastomotic stenosis and wound infection without increasing anastomotic leakage in comparison with that using circular stapler15). Theoretically, intracorporeal anastomosis using linear staplers should create latero-lateral anastomosis in anti-peristaltic or normo-peristaltic manners. It could reduce Functional end-to-end anastomosis (FEEA)16) and Delta-shaped B-I anastomosis6) are categorized into the anti-peristaltic method. In this type of anastomosis, common stab incision is created at the afferent side, so that the common stab incision could be closed without concern of postoperative stricture using a linear stapler. In contrast, “overlap” method17) is categorized into the Normo-peristaltic method. In this type of anastomosism common stab incision is created at the efferent side, so that the common stab incision should be closed with hand-sewn technique just to prevent postoperative stricture.

4.2. Optimal size and shape of anastomosis created with linear staplers (Fig. 24)

There have been a couple of reports suggesting that the size of an anastomosis created using a 25 mm circular stapler is sufficient18). In the meantime, an isosceles triangular anastomosis is created by using two sets of linear staplers. The size of an isosceles triangle is at least as large as that of an anastomosis using a 25 mm circular stapler when the vertical angle ranges from 50 to 130 degree, maximized when the vertical angle comes to 90 degree. In other words, an isosceles right triangle, in which the sides are in the ratio $1:1:\sqrt{2}$ must be the optimal shape of anastomosis created with linear staplers. Then, the 1st and the 2nd stapling should be created using 45 mm and 60 mm staplers, respectively.

4.3. Process flow diagram of selecting type of intracorporeal anastomosis (Fig. 25)

In practice, following distal gastrectomy, delta-shaped anastomosis is used when B-I anastomosis is technically possible. When B-I could not be used, then B-II anastomosis is applied for patients over 75 year of age or those with high surgical risk, whereas Roux-en Y anastomosis is used for patients under 75 year of age. In both B-II and Roux-en Y, FEEA is used as a standard type of anastomosis, but Overlap method is used for patients with relatively small remnant stomach. Following total gastrectomy, intra-abdominal Roux-en Y anastomosis is done using FEEA, whereas intrathoracic Rouxe-en Y anastomosis is performed using Overlap method.

4.4. Keys for successful intracorporeal anastomosis

- Sufficient blood flow
- No twisting: 4.5.5., 4.5.6.
- Formation of isosceles right triangle: 4.5.4.
- Appropriate tension to the anastomosis: 4.5.2., 4.5.3.

4.5. Delta-shaped B-I anastomosis

Following are the details of delta-shaped anastomosis:

4.5.1. Transection of the duodenal bulb in the posteroanterior direction (Fig. 26)

4.5.2. Transection of the stomach (Fig. 27)

The stomach is transected from the greater to lesser curvature on the line between the prefinal branch of LGEA and final ascending branch of LGA irrespective of the location of the tumor.
4.5.3. "Delta check" (Fig. 28)
It is confirmed whether the remnant stomach and the duodenal stump could be anastomosed without too much tension.

4.5.4. Creation of the entry holes (Fig. 29)
Small incisions are created on the greater curvature side of the gastric stump and the posterior side of the duodenal stump. The size of the entry holes should be as small as 1 cm to create an isosceles right triangle after closure of the common stab incision.

4.5.5. Insertion of the cartridge fork into the remnant stomach, insertion of the anvil fork into the duodenal stump, 1st stapling (Fig. 30)
1st stapling is done putting the posterior walls of the stomach and duodenum together.

4.5.6. Temporary closure of the common stab incision, 2nd stapling, confirmation of complete full-thickness closure of the common stab incision (Fig. 31)
4.5.7. Inversion of the greater curvature end of the 2nd stapling line to avoid fistula formation between the anastomosis and GDA (Fig. 32)

5. Conclusions
It has been clearly shown that laparoscopic gastrectomy has considerable short-term benefits over open approach, even though further investigation would be required to demonstrate oncological safety of laparoscopic gastrectomy especially for advanced gastric cancer\textsuperscript{1,10}. The principles and methods for totally laparoscopic gastrectomy based on our experience demonstrated in this article may help the other surgeons overcome technical difficulties in laparoscopic D2 gastrectomy and intracorporeal anastomosis.

![Fig. 32 Inversion of the greater curvature end of the 2nd stapling line](image)

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White-marked items: Olympus
Yellow-marked items: Covidien
Blue-marked items: Ethicon
Orange-marked items: Storz
6. REFERENCES


