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HOW-I-DO-IT ARTICLE

Laparoscopic modified lymphadenectomy in gastric cancer surgery using systematic mesogastric excision: a novel technique based on a concept

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Abstract

Purpose Radical surgery for gastrointestinal cancer involves en bloc removal of the primary tumor and organ-specific mesenteries. However, the surgical concept and technique for lymphadenectomy during gastric cancer surgery remain unclear. We examined a novel technique for laparoscopic modified lymphadenectomy during gastric cancer surgery involving systematic mesogastric excision (SME) and focused on the topographic anatomy, surgical technique, and specimens.

Methods Our surgical technique involved the following: mesenterization by dissociating embryological planes, separating fat tissue containing lymph nodes from the pancreas and its associated vessels by tracing the intramesenteric dissectable layers, and dissecting the lymph node that is dependent on the D1+ criteria.

Results Between October 2011 and September 2016, 227 patients underwent laparoscopic D1+ gastrectomy using SME. Of these, total gastrectomy was performed in 47 cases and distal gastrectomy was performed in 180 cases. The median operative time was 303 min (range, 201–722 min), and estimated blood loss was 50 mL (range, 0–550 mL). The median number of harvested lymph nodes was 54 (range, 18–163). There was no conversion to open surgery.

Conclusions SME was adapted for modified gastrectomy and is considered safe. Modified lymphadenectomy during gastrectomy is determined by the resection margin of the mesogastrium.

Keywords Dissectable layer · Gastric cancer · Messogastric excision · Modified lymphadenectomy

Introduction

Radical surgery for gastrointestinal cancer involves en bloc removal of the primary tumor and lymphovascular drainage by excision of organ-specific mesenteries [1, 2]. Although this method of radical surgery involves either total mesorectal excision or complete mesocolic excision, it is widely accepted and applied for colorectal cancer surgery [3–6]; however, it has not yet been applied for gastric cancer surgery probably because of the morphological complexity of the mesenteries of the stomach [7]. Currently, D2 gastrectomy is the recommended procedure for curable, locally advanced gastric cancer [8–10]. The surgical concept and technique for D2 lymph node dissection with gastrectomy have been reported [11]. However, the surgical concept and technique for modified lymphadenectomy for early gastric cancer remain unclear, requiring extensive investigation. Therefore, we aimed to clarify the novel concept and technique of laparoscopic modified lymphadenectomy using systematic mesogastric excision (SME) during gastric cancer surgery. Furthermore, we focused on the topographic anatomy, surgical technique, and specimens.

Tsutomu Kumamoto and Yasunori Kurahashi contributed equally to this work.

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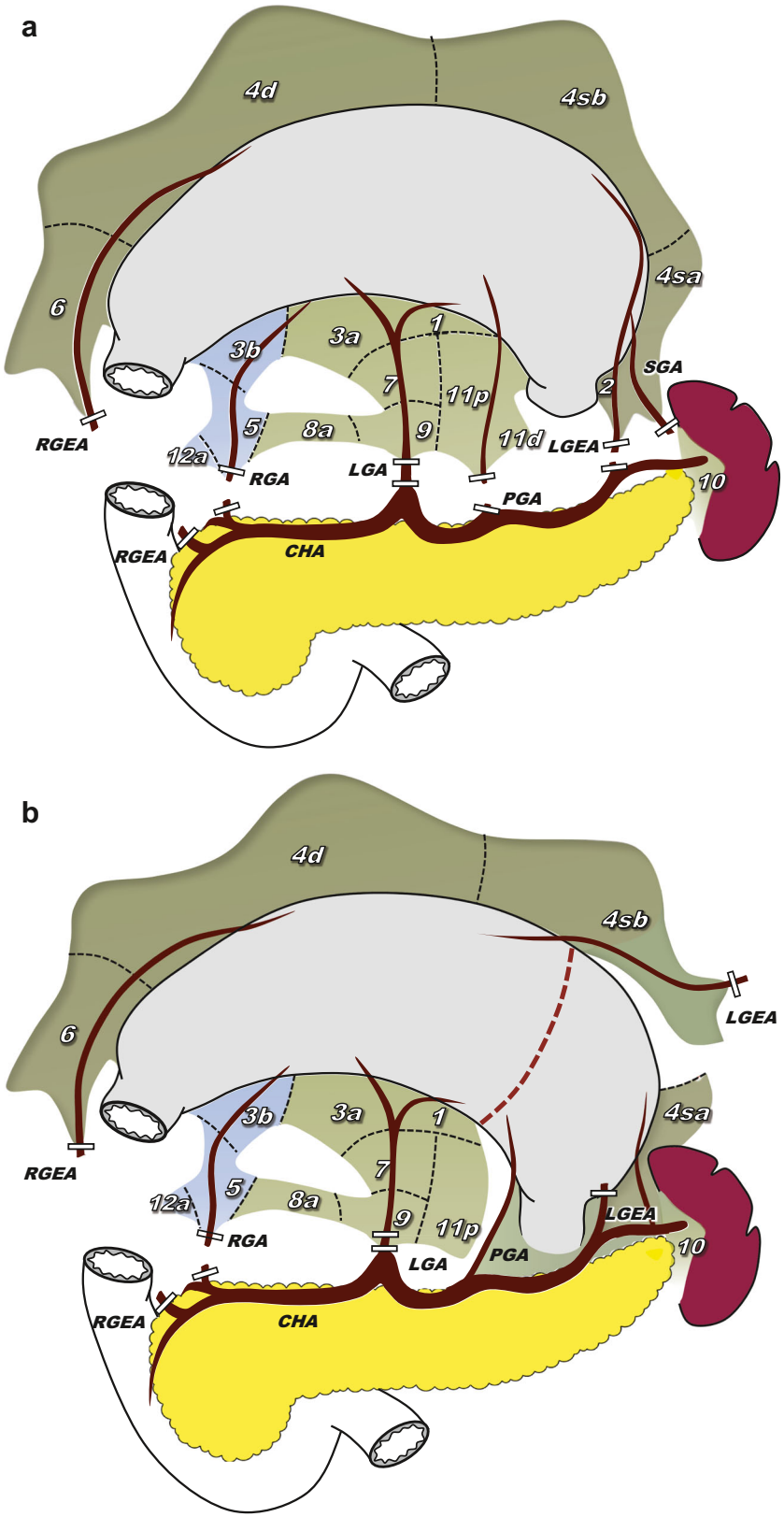


Fig. 1 Schema of the mesogastrium with all lymph nodes (numbered), and a surgical outline of total (**a**) and distal (**b**) D2 gastrectomy under systematic mesogastric excision. LGA, left gastric artery; LGEA, left gastroepiploic artery; PGA, posterior gastric artery; RGA, right gastric artery; RGEA, right gastroepiploic artery; RGEV, right gastroepiploic vein; SGA, short gastric artery

Material and methods

Systematic mesogastric excision

SME consists of three logical steps. First, fixation of the mesogastrium to adjacent mesenteries or the parietal wall is released by dissociating the embryological planes. Second, fat tissues containing lymph nodes are separated from the pancreas and its associated vessels by tracing the intramesenteric dissectable layers. Finally, the tumor-specific mesenteries defined as standard D2 lymphadenectomy are adequately dissected. Therefore, D2 gastrectomy is completed as an en bloc resection of the primary tumor and the tumor-specific mesenteries. Fig. 1 shows the mesogastrium, all the lymph nodes, and a surgical outline of SME during D2 lymph node dissection. Figure 2a, b present the D2 gastrectomy specimen with the attached lymphatic soft tissue that was removed by SME.

How we perform laparoscopic modified lymphadenectomy

D1+ lymph node dissection during gastric cancer surgery is divided into four major parts. In the first segment (great curvature segment), the greater omentum is divided to open the bursa approximately 3 cm away from the gastroepiploic vessels and toward the lower lobe of the spleen. The left gastroepiploic artery and the left gastroepiploic vein are ligated at their roots. During total gastrectomy, the short gastric artery and the short gastric vein are dissected until the left cardiac part of the stomach. In the second segment (infrapyloric segment), fixation of the mesoduodenum is released from the greater omentum and transverse mesocolon. Subsequently, the infrapyloric lymph nodes in the mesoduodenum are removed from the pancreas by tracing the intramesenteric dissectable layers, as described previously [12]. In the third segment (suprapancreatic and lesser curvature segment), the lesser curvatures are transected from the hepatoduodenal ligament toward the right cardiac parts of the stomach. Then, the tissue including the lymph node is traced along the intramesenteric dissectable layers and separated from the pancreas, proper hepatic artery, common hepatic artery, and splenic artery (Fig. 3a). Next, the remaining right gastric artery, right gastric vein, left gastric artery, and left gastric vein are ligated at their roots. Finally, the extent of excision of the mesogastrium is determined using transection lines and the D1+ criteria (Fig. 3b). Figure 2c, d present the D1+ gastrectomy specimen with the attached lymphatic soft tissue removed by SME.

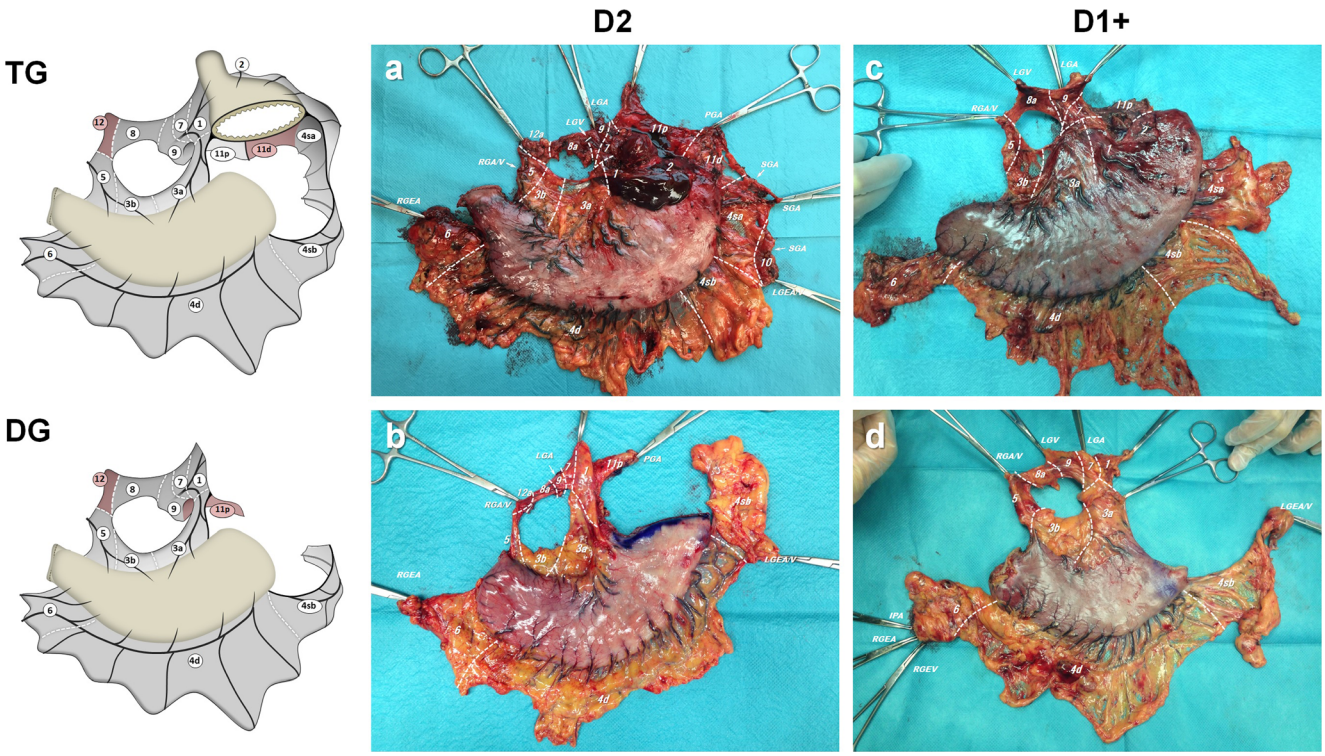


Fig. 2 Diagrams and real surgical specimens obtained after systematic mesogastric excision. The upper panel shows total gastrectomy with D2 (**a**) and D1+ (**c**) lymphadenectomy. The lower panel shows distal gastrectomy with D2 (**b**) and D1+ (**d**) lymphadenectomy. Red areas in diagrams denote different points between the two lymphadenectomies. IPA, infrapyloric artery; LGA, left gastric artery; LGEA, left gastroepiploic artery; LGV, left gastric vein; PGA, posterior gastric artery; RGA, right gastric artery; RGEA, right gastroepiploic artery; RGEV, right gastroepiploic vein; RGV, right gastroepiploic vein; SGA, short gastric artery

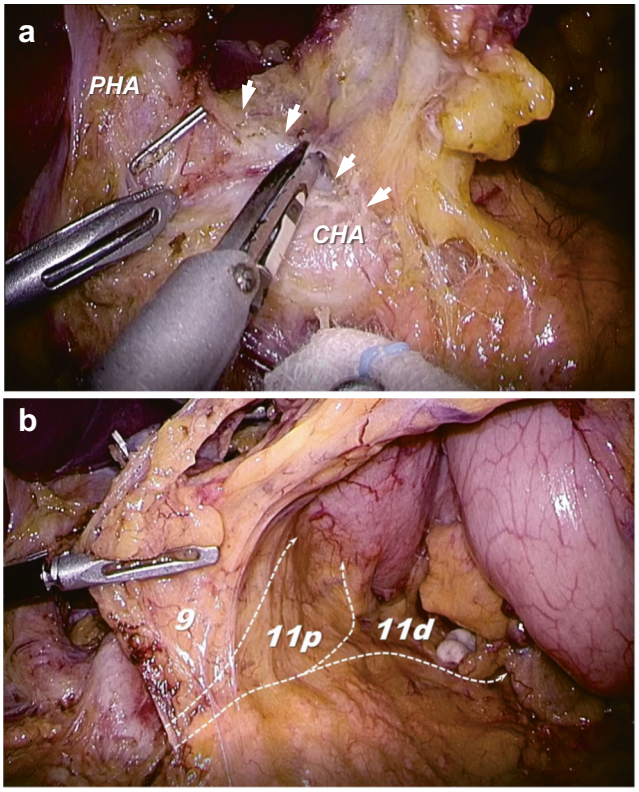


Fig. 3 Intraoperative suprapancreatic segment findings during D1+ lymphadenectomy under systematic mesogastric excision. (**a**) The intramesenteric dissectable layer was traced along the common and proper hepatic artery. The white arrows show the intradissectable layer. CHA; common hepatic artery, PHA; proper hepatic artery. **b** The transection line of the mesogastrium was determined according to the D1+ criteria

Patient selection

This study analyzed the data and specimens of 227 patients with gastric cancer who underwent either laparoscopic total gastrectomy or distal gastrectomy with D1+ lymphadenectomy using SME at Toranomon Hospital or Hyogo College of Medicine Hospital between October 2011 and September 2016. The study was approved by the Ethics Committee of Toranomon Hospital and Hyogo College of Medicine Hospital.

Results

We performed laparoscopic D1+ lymphadenectomy using SME for 227 patients with primary gastric cancer: 151 men and 76 women with a median age of 66 years (range, 35–92 years). The median body mass index was 22.9 (range, 14.6–35). Total gastrectomy was performed in 47 cases, and distal gastrectomy was performed in 180 cases. The median operative time was 304 min (range, 234–656 min) and 303 min (range, 201–722 min), and the estimated blood loss was 50 mL (range, 0–550 mL) and 50 mL (range, 0–487 mL), respectively. None of these patients underwent conversion to open surgery or experienced intraoperative complications. The median number of harvested lymph nodes was 54 (range, 24–163) and 54 (range, 18–119), respectively.

Discussion

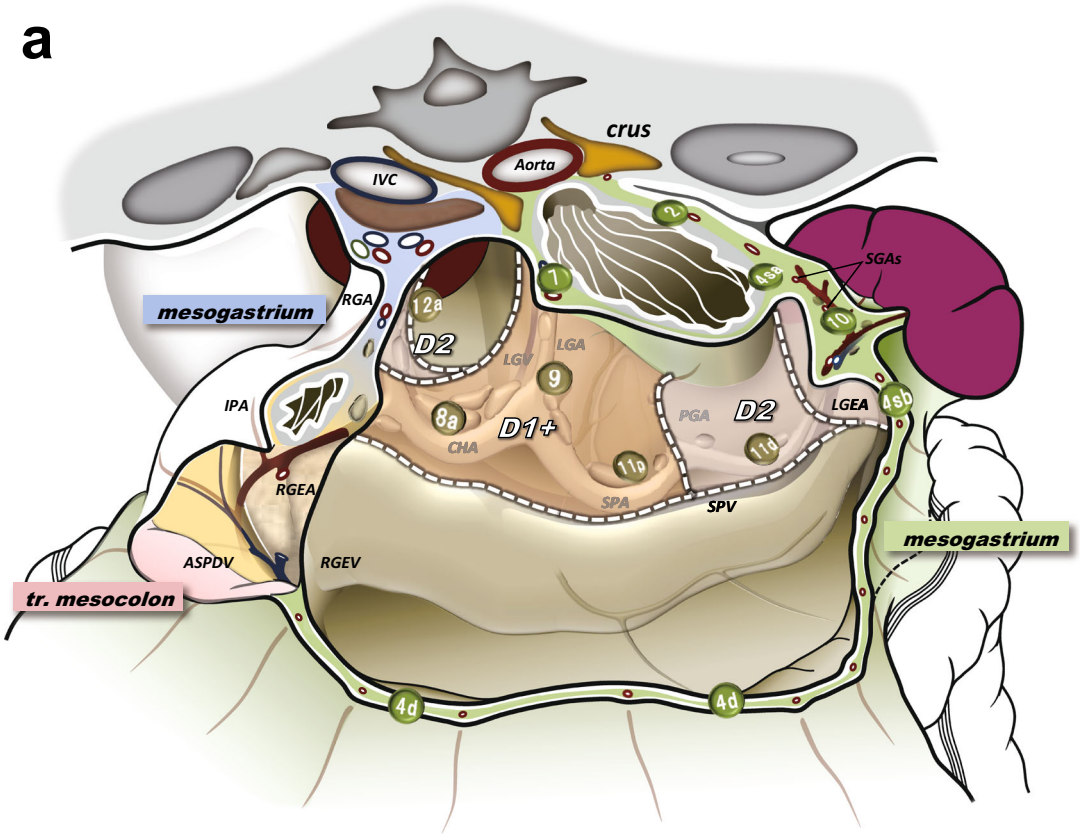
A surgical technique and the concept of modified gastric cancer surgery were determined. SME can also be adapted to modified gastrectomy and standardized D2 gastrectomy. By comparing the specimen of D1+ with that of D2 gastrectomy, we were able to determine the extent of narrowing of the resected margin of the mesogastrium with modified lymphadenectomy.

Radical surgery for gastrointestinal cancer involves en bloc resection of the primary tumor and organ-specific mesentery by dissecting the lymphovascular drainage. This simple surgical technique has been accepted for colorectal cancer surgery, such as during total mesorectal excision or complete mesocolic excision procedures [3–6]. However, the same kind of standardized surgery has not yet been accepted for gastric cancer surgery because the gastric mesentery has some embryological restrictions.

The treatment guidelines of the Japan Gastric Cancer Association define three levels of lymphadenectomy: D1, D1+, and D2 [13]. Total gastrectomy with D1+ lymphadenectomy includes lymph node stations D1+ 8a, 9, and 11p; D2 lymphadenectomy includes lymph node stations D1+ 8a, 9, 11p, and 12a (Fig. 4a). Distal gastrectomy with D1+ lymphadenectomy includes lymph node stations D1+ 8a and 9; D2 lymphadenectomy includes D1+ 8a, 9, 11p, and 12a (Fig. 4b). A surgical technique and a new concept were reported for D2 gastrectomy, which is the standardized surgery used for gastric cancer worldwide [11]. However, whether this novel surgical strategy can be adapted for modified lymphadenectomy is controversial.

In the current study, 227 cases safely underwent laparoscopic D1+ lymphadenectomy using SME. Similarly, during D2 gastrectomy using SME, mesenterization of the mesogastrium is performed by dissociating the embryological planes, and the organ-specific mesenteries containing lymph nodes are separated from the pancreas and its associated vessels by tracing the intramesenteric dissectable layers. However, this surgical procedure is different from D2 lymph node dissection during gastrectomy using SME in the dissection of the gastric mesentery tissue. With total gastrectomy,

Fig. 4 Extent of D1+ and D2 lymphadenectomy during total (**a**) and distal (**b**) gastrectomy. ASPDV, anterior superior pancreaticoduodenal vein; IPA, infrapyloric artery; IVC, inferior vena cava; LGEA, left gastroepiploic artery; PGA, posterior gastric artery; RGA, right gastric artery; RGEA, right gastroepiploic artery; RGEV, right gastroepiploic vein; SGA, short gastric artery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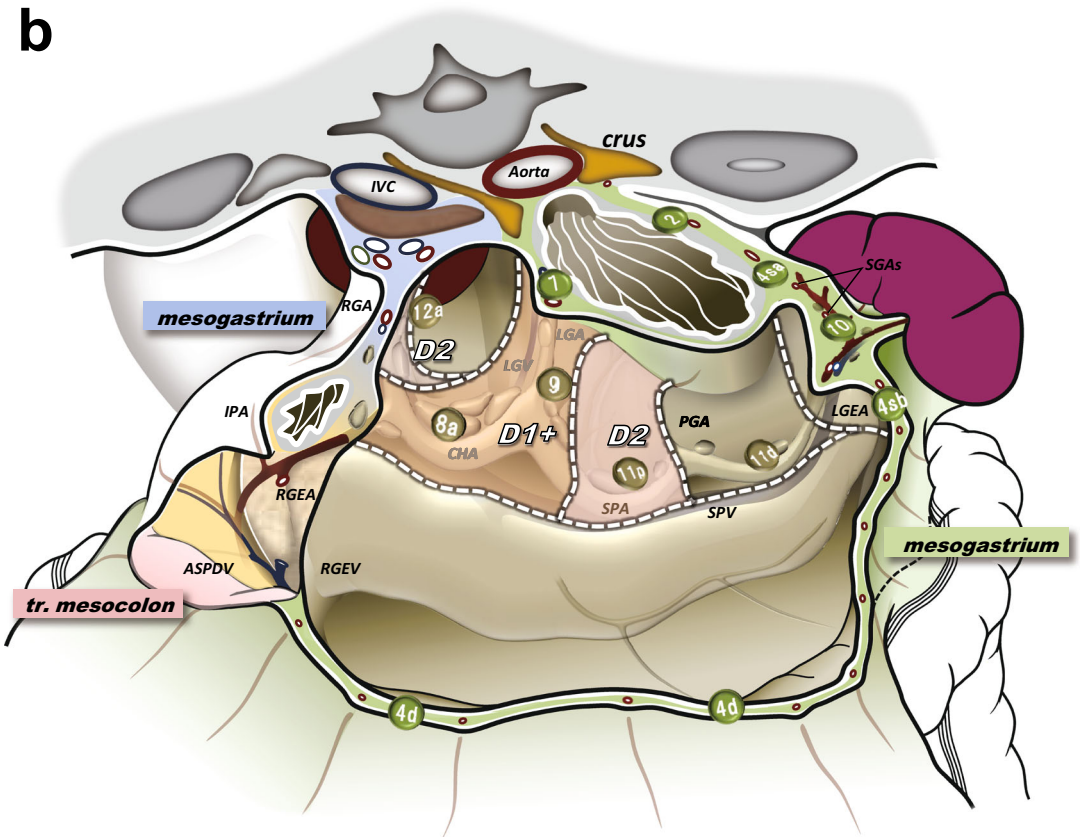
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nodal stations 11d and 12a remain. With distal gastrectomy, nodal stations 11p and 12a remain.

When gastric cancer surgery using SME is performed, en bloc resection of the primary tumor and organ-specific mesenteries becomes possible. The D1+ and D2 gastrectomy specimens were similar (Fig. 2). Interestingly, the difference between D1+ and D2 lymphadenectomy was simply the extent of the narrowed excised portion of the mesogastrium.

Conclusion

Modified lymphadenectomy for gastric cancer surgery can also be performed using SME. We determined the type of modified lymphadenectomy according to the resection margin of the mesogastrium, and the D1+ lymph node dissection method is reasonable and appropriate for lymphadenectomy. Although the concept and novel technique used here were explained by focusing on the topographic anatomy and surgical specimens, the oncological outcomes of gastric cancer surgery performed using SME need to be further investigated.

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Acquisition: All members.
Drafting: Tsutomu Kumamoto and Yasunori Kurahashi.
Critical revision of manuscript: Hisashi Shinohara.

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Compliance with ethical standards

Disclosures of ethical statements The institutional review boards of Toranomon Hospital and Hyogo College of Medicine Hospital approved the research protocol.

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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