

Figure 2 Reconstruction methods after proximal gastrectomy. A: Esophagogastrostomy; B: Jejunum interposition; C: Double tract.

Table 3 Comparison of the reconstruction methods after proximal gastrectomy

	PG-EG	PG-JI	PG-DT
Advantage	Short operation time	Low incidence of reflux esophagitis	Low incidence of reflux esophagitis Low incidence of DGE
Disadvantage	High incidence of reflux esophagitis High incidence of anastomotic stenosis	Long operation time High incidence of DGE	Long operation time Sometimes difficult for endoscopic evaluation of remnant stomach

PG: Proximal gastrectomy; EG: Esophagogastrostomy reconstruction; JI: Jejunal interposition reconstruction; DT: Double tract reconstruction; DGE: Delayed gastric emptying.

used to treat U-EGC in Japan (Figure 2, Table 3)<sup>[37]</sup>. Double tract (DT) reconstruction and jejunal pouch reconstruction have also been used in a small number of patients. A survey of Japanese institutions regarding reconstruction methods after PG showed that the most frequently used method was EG (48%), followed by JI (28%), DT (13%), and pouch reconstruction (7%)<sup>[35]</sup>.

PG-EG is the simplest procedure since there is a single anastomotic site, but it is associated with a high incidence of reflux esophagitis<sup>[46,47]</sup>. PG-JI may prevent regurgitation of the gastric contents, resulting in a lower incidence of reflux esophagitis, but the procedure is slightly complicated. Several studies have compared the postoperative outcomes of PG-EG and PG-JI. The incidence of esophageal reflux as evaluated by endoscopic findings and symptoms was reported to be lower after PG-JI compared to PG-EG<sup>[41,45]</sup>. However, the questionnaire conducted by Tokunaga *et al.*<sup>[50]</sup> showed that abdominal fullness was more frequently observed after PG-JI than after PG-EG, because the interposed jejunum may prevent the smooth passage of food. The length of interposed jejunum is important in preventing esophageal reflux, but a longer length may induce abdominal fullness.

The other important problem after PG is remnant GC (RGC). Ohyama *et al.*<sup>[51]</sup> reported that RGC was observed in 5% of 316 patients after PG. They also showed that advanced RGC was more likely in patients after PG-JI with a longer length of interposed jejunum (> 15 cm) or PG-DT, and cancer-related death was only observed

in patients who underwent these reconstruction methods. Tokunaga *et al.*<sup>[45]</sup> reported that endoscopic evaluation of the remnant stomach could not be performed in 50% of patients after PG-JI with interposed jejunum > 10 cm, compared to 22% in patients after PG-JI with interposed jejunum ≤ 10 cm. They concluded that a length of 10 cm or shorter is preferable for endoscopic evaluation of the remnant stomach. The type of reconstruction chosen after PG should facilitate postoperative endoscopic examinations for early detection and treatment of RGC.

PG-DT has been attempted to improve postoperative outcomes after PG. PG-DT has three anastomotic sites; esophagojejunostomy, jejunogastrostomy and jejunojejunostomy. The length of interposed jejunum is from 10 to 20 cm between esophagojejunostomy and jejunogastrostomy, and about 20 cm between jejunogastrostomy and jejunojejunostomy. Food passes through the remnant stomach or the jejunum by two routes in PG-DT. PG-DT is thought to offer the same advantages as PG-JI, including the prevention of esophageal reflux, but it is expected to be better than PG-JI with regards to DGE, because an alternative route for food exists if DGE occurs. Only a few studies have analyzed postoperative outcomes after PG-DT. Ahn *et al.*<sup>[52]</sup> evaluated postoperative complications after PG-DT compared to PG-EG; they concluded that PG-DT is a feasible, simple, and novel method. They showed that the incidence of anastomotic stenosis and reflux symptoms was lower after PG-DT than PG-EG and BW was better maintained. Nomura *et al.*<sup>[53]</sup> evaluated

postoperative outcomes after PG-DT vs PG-JI. Although their study had a small sample size, they showed that the BW ratio was significantly higher in the PG-JI group than in the PG-DT group. The incidence of esophageal reflux was 10% in both groups. Further studies are needed to assess the clinical utility of PG-DT.

## CONCLUSION

Function-preserving surgery has already been performed in some of the high volume institutions in Japan and South Korea, and it seems to be useful in terms of postoperative quality of life and oncologic safety. However, indications should be carefully considered, because function-preserving surgery usually involves less extensive procedures, resulting in the possibility of inadequate treatment for more deeply invasive tumors. Preoperative evaluation is very important in selecting the appropriate candidates for function-preserving surgery.

Laparoscopy-assisted PPG and PG has several advantages over conventional PPG and PG in terms of reduced intraoperative blood loss, postoperative pain and fast recovery from invasive surgery<sup>[54,55]</sup>. Since some studies reported that the oncological curability was assured<sup>[33,56,57]</sup>, laparoscopic function-preserving gastrectomy is considered to be feasible by surgeons with sufficient experience in laparoscopic gastrectomy.

Many retrospective studies have shown the usefulness of function-preserving surgery, but there has been no consensus to adopt function-preserving surgery as the standard of surgery. To establish function-preserving surgery as the gold standard for patients with EGC, prospective randomized controlled trials that compare PPG or PG with conventional gastrectomy and evaluate survival and postoperative quality of life are necessary.

## REFERENCES

- Sano T, Hollowood A. Early gastric cancer: diagnosis and less invasive treatments. *Scand J Surg* 2006; 95: 249-255 [PMID: 17249273]
- Isobe Y, Nashimoto A, Akazawa K, Oda I, Hayashi K, Miyashiro I, Katai H, Tsujitani S, Kodera Y, Seto Y, Kaminishi M. Gastric cancer treatment in Japan: 2008 annual report of the JGCA nationwide registry. *Gastric Cancer* 2011; 14: 301-316 [PMID: 21894577 DOI: 10.1007/s10120-011-0085-6]
- Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2010 (ver. 3). *Gastric Cancer* 2011; 14: 113-123 [PMID: 21573742 DOI: 10.1007/s10120-011-0042-4]
- Maki T, Shiratori T, Hatafuku T, Sugawara K. Pylorus-preserving gastrectomy as an improved operation for gastric ulcer. *Surgery* 1967; 61: 838-845 [PMID: 5338114]
- Sawai K, Takahashi T, Suzuki H. New trends in surgery for gastric cancer in Japan. *J Surg Oncol* 1994; 56: 221-226 [PMID: 8057646]
- Hiki N, Nunobe S, Kubota T, Jiang X. Function-preserving gastrectomy for early gastric cancer. *Ann Surg Oncol* 2013; 20: 2683-2692 [PMID: 23504120 DOI: 10.1245/s10434-013-2931-8]
- Katai H. Function-preserving surgery for gastric cancer. *Int J Clin Oncol* 2006; 11: 357-366 [PMID: 17058133 DOI: 10.1007/s10147-006-0613-2]
- Shibata C, Saijo F, Kakyō M, Kinouchi M, Tanaka N, Sasaki I, Aikou T. Current status of pylorus-preserving gastrectomy for the treatment of gastric cancer: a questionnaire survey and review of literatures. *World J Surg* 2012; 36: 858-863 [PMID: 22350486 DOI: 10.1007/s00268-012-1491-6]
- Jiang X, Hiki N, Nunobe S, Fukunaga T, Kumagai K, Nohara K, Sano T, Yamaguchi T. Postoperative outcomes and complications after laparoscopy-assisted pylorus-preserving gastrectomy for early gastric cancer. *Ann Surg* 2011; 253: 928-933 [PMID: 21358534 DOI: 10.1097/SLA.0b013e3182117b24]
- Hiki N, Sano T, Fukunaga T, Ohyama S, Tokunaga M, Yamaguchi T. Survival benefit of pylorus-preserving gastrectomy in early gastric cancer. *J Am Coll Surg* 2009; 209: 297-301 [PMID: 19717032 DOI: 10.1016/j.jamcollsurg.2009.05.027]
- Morita S, Katai H, Saka M, Fukagawa T, Sano T, Sasako M. Outcome of pylorus-preserving gastrectomy for early gastric cancer. *Br J Surg* 2008; 95: 1131-1135 [PMID: 18690631 DOI: 10.1002/bjs.6295]
- Hiki N, Kaminishi M. Pylorus-preserving gastrectomy in gastric cancer surgery--open and laparoscopic approaches. *Langenbecks Arch Surg* 2005; 390: 442-447 [PMID: 16096761 DOI: 10.1007/s00423-005-0573-4]
- Kodama M, Koyama K. Indications for pylorus preserving gastrectomy for early gastric cancer located in the middle third of the stomach. *World J Surg* 1991; 15: 628-633; discussion 633-634 [PMID: 1949863]
- Shimoyama S, Mafune K, Kaminishi M. Indications for a pylorus-preserving gastrectomy for gastric cancer with proper muscle invasion. *Arch Surg* 2003; 138: 1235-1239 [PMID: 14609873 DOI: 10.1001/archsurg.138.11.1235]
- Shimoyama S, Seto Y, Yasuda H, Mafune K, Kaminishi M. Concepts, rationale, and current outcomes of less invasive surgical strategies for early gastric cancer: data from a quarter-century of experience in a single institution. *World J Surg* 2005; 29: 58-65 [PMID: 15599744 DOI: 10.1007/s00268-004-7427-z]
- Kodera Y, Yamamura Y, Kanemitsu Y, Shimizu Y, Hirai T, Yasui K, Morimoto T, Kato T. Lymph node metastasis in cancer of the middle-third stomach: criteria for treatment with a pylorus-preserving gastrectomy. *Surg Today* 2001; 31: 196-203 [PMID: 11318120]
- Kim BH, Hong SW, Kim JW, Choi SH, Yoon SO. Oncologic safety of pylorus-preserving gastrectomy in the aspect of micrometastasis in lymph nodes at stations 5 and 6. *Ann Surg Oncol* 2014; 21: 533-538 [PMID: 24008556 DOI: 10.1245/s10434-013-3252-7]
- Kong SH, Kim JW, Lee HJ, Kim WH, Lee KU, Yang HK. The safety of the dissection of lymph node stations 5 and 6 in pylorus-preserving gastrectomy. *Ann Surg Oncol* 2009; 16: 3252-3258 [PMID: 19639365 DOI: 10.1245/s10434-009-0646-7]
- Ikeguchi M, Hatada T, Yamamoto M, Miyake T, Matsunaga T, Fukuda K, Saito H, Tatebe S. Evaluation of a pylorus-preserving gastrectomy for patients preoperatively diagnosed with early gastric cancer located in the middle third of the stomach. *Surg Today* 2010; 40: 228-233 [PMID: 20180075 DOI: 10.1007/s00595-009-4043-4]
- Jiang X, Hiki N, Nunobe S, Fukunaga T, Kumagai K, Nohara K, Katayama H, Ohyama S, Sano T, Yamaguchi T. Long-term outcome and survival with laparoscopy-assisted pylorus-preserving gastrectomy for early gastric cancer. *Surg Endosc* 2011; 25: 1182-1186 [PMID: 20844895 DOI: 10.1007/s00464-010-1336-z]
- Matsuki A, Nashimoto A, Yabusaki H, Nakagawa S. Long-term clinical outcome and survival after pylorus-preserving gastrectomy. *Hepatogastroenterology* 2012; 59: 2012-2015 [PMID: 22193434 DOI: 10.5754/hge11785]
- Sano T, Sasako M, Kinoshita T, Maruyama K. Recurrence of early gastric cancer. Follow-up of 1475 patients and review of the Japanese literature. *Cancer* 1993; 72: 3174-3178 [PMID: 8242540]
- Sue-Ling HM, Johnston D, Martin IG, Dixon MF, Lansdown

- MR, McMahon MJ, Axon AT. Gastric cancer: a curable disease in Britain. *BMJ* 1993; 307: 591-596 [PMID: 8401015]
- 24 Morita S, Sasako M, Saka M, Fukagawa T, Sano T, Katai H. Correlation between the length of the pyloric cuff and postoperative evaluation after pylorus-preserving gastrectomy. *Gastric Cancer* 2010; 13: 109-116 [PMID: 20602198 DOI: 10.1007/s10120-010-0549-0]
- 25 Ikeguchi M, Kuroda H, Kihara K, Hatata T, Matsunaga T, Fukuda K, Saito H, Tatebe S. Nutritional assessment of patients after pylorus-preserving gastrectomy for early gastric cancer. *Indian J Surg* 2010; 72: 453-457 [PMID: 22131654 DOI: 10.1007/s12262-010-0167-4]
- 26 Park do J, Lee HJ, Jung HC, Kim WH, Lee KU, Yang HK. Clinical outcome of pylorus-preserving gastrectomy in gastric cancer in comparison with conventional distal gastrectomy with Billroth I anastomosis. *World J Surg* 2008; 32: 1029-1036 [PMID: 18256877 DOI: 10.1007/s00268-007-9441-4]
- 27 Nunobe S, Sasako M, Saka M, Fukagawa T, Katai H, Sano T. Symptom evaluation of long-term postoperative outcomes after pylorus-preserving gastrectomy for early gastric cancer. *Gastric Cancer* 2007; 10: 167-172 [PMID: 17922094 DOI: 10.1007/s10120-007-0434-7]
- 28 Tomita R, Fujisaki S, Tanjoh K. Pathophysiological studies on the relationship between postgastrectomy syndrome and gastric emptying function at 5 years after pylorus-preserving distal gastrectomy for early gastric cancer. *World J Surg* 2003; 27: 725-733 [PMID: 12734683 DOI: 10.1007/s00268-003-6906-y]
- 29 Yamaguchi T, Ichikawa D, Kurioka H, Ikoma H, Koike H, Otsuji E, Ueshima Y, Shioaki Y, Lee CJ, Hamashima T, Deguchi E, Ikeda E, Mutoh F, Yamagishi H. Postoperative clinical evaluation following pylorus-preserving gastrectomy. *Hepatogastroenterology* 2004; 51: 883-886 [PMID: 15143939]
- 30 Nakane Y, Akehira K, Inoue K, Iiyama H, Sato M, Masuya Y, Okumura S, Yamamichi K, Hioki K. Postoperative evaluation of pylorus-preserving gastrectomy for early gastric cancer. *Hepatogastroenterology* 2000; 47: 590-595 [PMID: 10791245]
- 31 Michiura T, Nakane Y, Kanbara T, Nakai K, Inoue K, Yamamichi K, Kamiyama Y. Assessment of the preserved function of the remnant stomach in pylorus-preserving gastrectomy by gastric emptying scintigraphy. *World J Surg* 2006; 30: 1277-1283 [PMID: 16794905 DOI: 10.1007/s00268-005-7983-x]
- 32 Sawai K, Takahashi T, Fujioka T, Minato H, Taniguchi H, Yamaguchi T. Pylorus-preserving gastrectomy with radical lymph node dissection based on anatomical variations of the infrapyloric artery. *Am J Surg* 1995; 170: 285-288 [PMID: 7661298]
- 33 Nunobe S, Hiki N, Fukunaga T, Tokunaga M, Ohyama S, Seto Y, Yamaguchi T. Laparoscopy-assisted pylorus-preserving gastrectomy: preservation of vagus nerve and infrapyloric blood flow induces less stasis. *World J Surg* 2007; 31: 2335-2340 [PMID: 17952497 DOI: 10.1007/s00268-007-9262-5]
- 34 Nakane Y, Michiura T, Inoue K, Sato M, Nakai K, Yamamichi K. Length of the antral segment in pylorus-preserving gastrectomy. *Br J Surg* 2002; 89: 220-224 [PMID: 11856138 DOI: 10.1046/j.0007-1323.2001.01984.x]
- 35 Kumagai K, Shimizu K, Yokoyama N, Aida S, Arima S, Aikou T. Questionnaire survey regarding the current status and controversial issues concerning reconstruction after gastrectomy in Japan. *Surg Today* 2012; 42: 411-418 [PMID: 22391980 DOI: 10.1007/s00595-012-0159-z]
- 36 Salvon-Harman JC, Cady B, Nikulasson S, Khettry U, Stone MD, Lavin P. Shifting proportions of gastric adenocarcinomas. *Arch Surg* 1994; 129: 381-388; discussion 388-389 [PMID: 7512326]
- 37 Takiguchi S, Masuzawa T, Hirao M, Imamura H, Kimura Y, Fujita J, Tamura S, Fujiwara Y, Mori M, Doki Y. Pattern of surgical treatment for early gastric cancers in upper third of the stomach. *Hepatogastroenterology* 2011; 58: 1823-1827 [PMID: 21940352 DOI: 10.5754/hge11161]
- 38 Ikeguchi M, Kader A, Takaya S, Fukumoto Y, Osaki T, Saito H, Tatebe S, Wakatsuki T. Prognosis of patients with gastric cancer who underwent proximal gastrectomy. *Int Surg* 2012; 97: 275-279 [PMID: 23113860 DOI: 10.9738/CC150.1]
- 39 Ooki A, Yamashita K, Kikuchi S, Sakuramoto S, Katada N, Hutawatari N, Watanabe M. Clinical significance of total gastrectomy for proximal gastric cancer. *Anticancer Res* 2008; 28: 2875-2883 [PMID: 19031928]
- 40 Sasako M, McCulloch P, Kinoshita T, Maruyama K. New method to evaluate the therapeutic value of lymph node dissection for gastric cancer. *Br J Surg* 1995; 82: 346-351 [PMID: 7796005]
- 41 Masuzawa T, Takiguchi S, Hirao M, Imamura H, Kimura Y, Fujita J, Miyashiro I, Tamura S, Hiratsuka M, Kobayashi K, Fujiwara Y, Mori M, Doki Y. Comparison of perioperative and long-term outcomes of total and proximal gastrectomy for early gastric cancer: a multi-institutional retrospective study. *World J Surg* 2014; 38: 1100-1106 [PMID: 24310733 DOI: 10.1007/s00268-013-2370-5]
- 42 Nozaki I, Hato S, Kobatake T, Ohta K, Kubo Y, Kurita A. Long-term outcome after proximal gastrectomy with jejunal interposition for gastric cancer compared with total gastrectomy. *World J Surg* 2013; 37: 558-564 [PMID: 23254949 DOI: 10.1007/s00268-012-1894-4]
- 43 Katai H, Morita S, Saka M, Taniguchi H, Fukagawa T. Long-term outcome after proximal gastrectomy with jejunal interposition for suspected early cancer in the upper third of the stomach. *Br J Surg* 2010; 97: 558-562 [PMID: 20169569 DOI: 10.1002/bjs.6944]
- 44 Katai H, Sano T, Fukagawa T, Shinohara H, Sasako M. Prospective study of proximal gastrectomy for early gastric cancer in the upper third of the stomach. *Br J Surg* 2003; 90: 850-853 [PMID: 12854112 DOI: 10.1002/bjs.4106]
- 45 Tokunaga M, Ohyama S, Hiki N, Hoshino E, Nunobe S, Fukunaga T, Seto Y, Yamaguchi T. Endoscopic evaluation of reflux esophagitis after proximal gastrectomy: comparison between esophagogastric anastomosis and jejunal interposition. *World J Surg* 2008; 32: 1473-1477 [PMID: 18264827 DOI: 10.1007/s00268-007-9459-7]
- 46 Ahn SH, Lee JH, Park do J, Kim HH. Comparative study of clinical outcomes between laparoscopy-assisted proximal gastrectomy (LAPG) and laparoscopy-assisted total gastrectomy (LATG) for proximal gastric cancer. *Gastric Cancer* 2013; 16: 282-289 [PMID: 22821182 DOI: 10.1007/s10120-012-0178-x]
- 47 An JY, Youn HG, Choi MG, Noh JH, Sohn TS, Kim S. The difficult choice between total and proximal gastrectomy in proximal early gastric cancer. *Am J Surg* 2008; 196: 587-591 [PMID: 18519129 DOI: 10.1016/j.amjsurg.2007.09.040]
- 48 Yoo CH, Sohn BH, Han WK, Pae WK. Long-term results of proximal and total gastrectomy for adenocarcinoma of the upper third of the stomach. *Cancer Res Treat* 2004; 36: 50-55 [PMID: 20396565 DOI: 10.4143/crt.2004.36.1.50]
- 49 Ichikawa D, Ueshima Y, Shirono K, Kan K, Shioaki Y, Lee CJ, Hamashima T, Deguchi E, Ikeda E, Mutoh F, Oka T, Kurioka H. Esophagogastric reconstruction after limited proximal gastrectomy. *Hepatogastroenterology* 2001; 48: 1797-1801 [PMID: 11813627]
- 50 Tokunaga M, Hiki N, Ohyama S, Nunobe S, Miki A, Fukunaga T, Seto Y, Sano T, Yamaguchi T. Effects of reconstruction methods on a patient's quality of life after a proximal gastrectomy: subjective symptoms evaluation using questionnaire survey. *Langenbecks Arch Surg* 2009; 394: 637-641 [PMID: 19066939 DOI: 10.1007/s00423-008-0442-z]
- 51 Ohyama S, Tokunaga M, Hiki N, Fukunaga T, Fujisaki J, Seto Y, Yamaguchi T. A clinicopathological study of gastric stump carcinoma following proximal gastrectomy. *Gastric Cancer* 2009; 12: 88-94 [PMID: 19562462 DOI: 10.1007/s10120-009-0502-2]
- 52 Ahn SH, Jung do H, Son SY, Lee CM, Park do J, Kim HH.

- Laparoscopic double-tract proximal gastrectomy for proximal early gastric cancer. *Gastric Cancer* 2014; 17: 562-570 [PMID: 24052482 DOI: 10.1007/s10120-013-0303-5]
- 53 **Nomura E**, Lee SW, Kawai M, Yamazaki M, Nabeshima K, Nakamura K, Uchiyama K. Functional outcomes by reconstruction technique following laparoscopic proximal gastrectomy for gastric cancer: double tract versus jejunal interposition. *World J Surg Oncol* 2014; 12: 20 [PMID: 24468278 DOI: 10.1186/1477-7819-12-20]
- 54 **Tanaka N**, Katai H, Saka M, Morita S, Fukagawa T. Laparoscopy-assisted pylorus-preserving gastrectomy: a matched case-control study. *Surg Endosc* 2011; 25: 114-118 [PMID: 20526619 DOI: 10.1007/s00464-010-1142-7]
- 55 **Kinoshita T**, Gotohda N, Kato Y, Takahashi S, Konishi M, Kinoshita T. Laparoscopic proximal gastrectomy with jejunal interposition for gastric cancer in the proximal third of the stomach: a retrospective comparison with open surgery. *Surg Endosc* 2013; 27: 146-153 [PMID: 22736285 DOI: 10.1007/s00464-012-2401-6]
- 56 **Hiki N**, Shimoyama S, Yamaguchi H, Kubota K, Kaminishi M. Laparoscopy-assisted pylorus-preserving gastrectomy with quality controlled lymph node dissection in gastric cancer operation. *J Am Coll Surg* 2006; 203: 162-169 [PMID: 16864028 DOI: 10.1016/j.jamcollsurg.2006.05.003]
- 57 **Suh YS**, Han DS, Kong SH, Kwon S, Shin CI, Kim WH, Kim HH, Lee HJ, Yang HK. Laparoscopy-assisted pylorus-preserving gastrectomy is better than laparoscopy-assisted distal gastrectomy for middle-third early gastric cancer. *Ann Surg* 2014; 259: 485-493 [PMID: 23652333 DOI: 10.1097/SLA.0b013e318294d142]

P- Reviewer: Kakushima N, Lim JB, Teoh AYB, Yamamoto H  
S- Editor: Ma YJ L- Editor: Webster JR E- Editor: Zhang DN





Published by **Baishideng Publishing Group Inc**  
8226 Regency Drive, Pleasanton, CA 94588, USA  
Telephone: +1-925-223-8242  
Fax: +1-925-223-8243  
E-mail: [bpgoffice@wjgnet.com](mailto:bpgoffice@wjgnet.com)  
Help Desk: <http://www.wjgnet.com/esps/helpdesk.aspx>  
<http://www.wjgnet.com>



ISSN 1007-9327



© 2014 Baishideng Publishing Group Inc. All rights reserved.

## Feasibility of laparoscopy-assisted total gastrectomy in patients with clinical stage I gastric cancer

Noriko Wada · Yukinori Kurokawa · Shuji Takiguchi · Tsuyoshi Takahashi · Makoto Yamasaki · Hiroshi Miyata · Kiyokazu Nakajima · Masaki Mori · Yuichiro Doki

Received: 25 October 2012 / Accepted: 15 January 2013 / Published online: 22 February 2013  
© The International Gastric Cancer Association and The Japanese Gastric Cancer Association 2013

### Abstract

**Background** Laparoscopy-assisted total gastrectomy (LATG) for gastric cancer is not yet widespread because of the technical difficulty of reconstruction. We have performed LATG on 100 patients with clinical stage I gastric cancer. This study investigated the short-term outcomes of LATG.

**Methods** Between September 2001 and September 2012, 100 patients with clinical stage I gastric cancer underwent LATG with D1 plus beta or D2 lymphadenectomy. Roux-en-Y esophagojejunostomy was performed intracorporeally using end-to-side anastomosis with a circular stapler (the purse-string suture method). The primary endpoint was the proportion of postoperative complications during hospitalization.

**Results** Mean operation time was 249 min; mean blood loss was 182 ml. There were no conversions to open surgery. According to the Clavien–Dindo classification, there were 8 grade II (8 %) and 10 grade IIIa/b (10 %) complications. There were no treatment-related deaths or grade IV complications. The most frequent complication was anastomotic or stump leakage (6 %), followed by pancreatic fistula (5 %). Reoperations were required in two patients with leakage.

**Conclusions** The short-term outcomes of LATG in our study involving 100 patients were outlined. LATG for gastric cancer patients should be attempted preferably in a clinical trial setting by surgeons with sufficient experience in laparoscopic gastrectomy.

**Keywords** LATG · LTG · Laparoscopic · Purse-string suture

### Introduction

The feasibility of laparoscopy-assisted distal gastrectomy (LADG) has been assessed in many studies [1–3]. A multicenter phase II study has demonstrated that LADG can be performed safely by surgeons with sufficient experience [4]. Large-scale phase III trials of LADG versus open distal gastrectomy for clinical stage I gastric cancer are now ongoing in Japan and Korea. Although long-term outcomes have not yet been evaluated, LADG has recently become a common surgical procedure in both countries.

Nevertheless, laparoscopy-assisted total gastrectomy (LATG) is not yet widespread. The reconstruction required in LATG is technically much more difficult than that in LADG. Only a few Korean studies have evaluated the feasibility of LATG with more than 100 patients [5, 6], so the safety of LATG is still controversial. We have performed LATG with the purse-string suture anastomosis on 100 patients with clinical stage I gastric cancer. This is the first Japanese study involving 100 patients to evaluate short-term outcomes after LATG.

### Methods

#### Patients

Between September 2001 and September 2012, 110 consecutive patients with clinical stage I (T1N0M0, T1N1M0,

N. Wada · Y. Kurokawa (✉) · S. Takiguchi · T. Takahashi · M. Yamasaki · H. Miyata · K. Nakajima · M. Mori · Y. Doki  
Department of Gastroenterological Surgery, Osaka University  
Graduate School of Medicine, Osaka, Japan  
e-mail: ykurokawa@gesurg.med.osaka-u.ac.jp

and T2N0M0) gastric cancer underwent LATG at the Osaka University Hospital. Cases of stump carcinoma were excluded from this study. Because 10 of 110 cases underwent the OrVil method or the overlap method (side-to-side anastomosis with a linear stapler) anastomosis, we analyzed only 100 cases with the purse-string suture anastomosis in this study. Clinical evaluation of tumor depth (cT) and lymph node metastasis (cN) were determined by preoperative evaluations with both endoscopy and computed tomography. The details of the methods for preoperative T staging have been reported elsewhere [7]. All tumors were histologically diagnosed as adenocarcinoma of the stomach. Clinical stage was classified according to the Japanese Classification of Gastric Carcinoma, second English edition [8]. Informed consent for LATG was obtained from all patients before surgery.

### Surgery

Surgeons performed LATG and lymph node dissection according to the Japanese Gastric Cancer Treatment Guidelines in principle [9]. Patients with cT1 carcinoma underwent D1 plus beta dissection, including station nos. 7, 8a, and 9. Patients with cT2 disease underwent D2 or D2 minus splenic hilum node (station no. 10). D2 minus station no. 10 was treated as D1 plus beta in this study.

For reconstruction, Roux-en-Y esophagojejunostomy was performed with the purse-string suture method as previously reported [10]. In brief, the esophageal stump was sewn over with interrupted sutures laparoscopically or by using a device called the Endostich, and the anvil of a circular stapler was inserted into the esophageal stump. The purse-string suture was tied and reinforced with a monofilament pre-tied loop. A circular stapler inserted into the distal side of the jejunum was introduced into the abdominal cavity through the mini-laparotomy site, and esophagojejunostomy was performed. Anastomotic leaks were evaluated using air insufflation.

All operations were performed or supervised by surgeons with sufficient experience with laparoscopic gastrectomies and who were certified by the Japan Society for Endoscopic Surgery.

### Statistical analysis

The primary endpoint of this study was the incidence of postoperative complications during hospitalization. The grading of complications was based on the Clavien–Dindo classification system [11]. All statistical analyses were performed using SPSS Statistics software, version 20 (Chicago, IL, USA).

### Results

The background characteristics of the 100 patients in this study are shown in Table 1. Ninety percent of patients were diagnosed as cT1. Only 6 patients (6 %) had clinically positive lymph nodes.

Surgical results are shown in Table 2. D1 plus beta dissection was performed in 95 cases (95 %) and D2 in 5 cases (5 %). All patients received Roux-en-Y reconstruction. Mean operation time was 249 min and mean blood loss was 182 ml. No patients required conversion to open surgery. Two of 7 patients who received splenectomy did so because of either preoperative comorbidity of thrombocytopenia or intraoperative bleeding from the splenic vein.

Table 3 lists the postoperative complications that occurred during hospitalization. Clavien–Dindo grade II complications occurred in eight patients (8 %) whereas those of grade IIIa/b occurred in ten patients (10 %). There were no treatment-related deaths or grade IV complications. The most frequent complication was anastomotic or stump leakage (6 %), followed by pancreatic fistula (5 %). Among the six leakage cases, four occurred in the esophagojejunal anastomosis, one in the duodenum stump, and one in the duodenum stump and the distal side of the jejunum stump. No patients suffered from anastomotic stricture. Reoperations were required in two patients with leakage.

**Table 1** Clinical characteristics

	<i>n</i> = 100
Age (years)	
Median	63
Range	29–85
Gender	
Male	75 (75 %)
Female	25 (25 %)
Body mass index (kg/m <sup>2</sup> )	
Median	22.5
Range	16.2–28.0
Clinical T	
T1	90 (90 %)
T2	10 (10 %)
Clinical N	
N0	94 (94 %)
N1	6 (6 %)
Clinical stage	
IA	84 (84 %)
IB	16 (16 %)

Clinical TNM stages were classified according to the Japanese Classification of Gastric Carcinoma, second English edition

**Table 2** Surgical results

	<i>n</i> = 100
Lymph node dissection	
D1 plus beta <sup>a</sup>	95 (95 %)
D2	5 (5 %)
Combined resection	
Spleen	7 (7 %)
Gallbladder	6 (6 %)
Operation time (min)	
Mean ± SD	249 ± 47
Blood loss (ml)	
Mean ± SD	182 ± 183
Number of dissected lymph nodes	
Mean ± SD	38 ± 16

<sup>a</sup> D2 minus station no. 10 was treated as D1 plus beta in this study

**Table 3** Postoperative complications

	<i>n</i> = 100
Any complications	
Grade II	8 (8 %)
Grade IIIa/b	10 (10 %)
Leakage	
Grade II	0
Grade IIIa/b	6 (6 %)
Pancreatic fistula	
Grade II	1 (1 %)
Grade IIIa/b	5 (5 %)
Bleeding	
Grade II	4 (4 %)
Grade IIIa/b	0
Pneumonia	
Grade II	4 (4 %)
Grade IIIa/b	0
Bowel obstruction	
Grade II	2 (2 %)
Grade IIIa/b	0
Reoperation	2 (2 %)

Grading of complications was based on the Clavien–Dindo classification

## Discussion

Laparoscopy-assisted total gastrectomy is still not widespread because of the technical difficulty of the reconstruction. Several reports have been issued on the feasibility of LATG, but only a few Korean studies have evaluated the feasibility of LATG in populations of more than 100 patients [5, 6]. We have performed LATG with the purse-string suture anastomosis in 100 patients with

clinical stage I gastric cancer. Compared with the previous Korean studies and a small-scale Japanese study evaluating the safety of LATG [5, 6, 12, 13], we were able to perform LATG with more favorable surgical results in terms of operation time. Regarding the incidence of postoperative complications, our study showed better or similar results compared to previous studies of LATG. The incidence of anastomotic leakage in our study was 6 % (6/100), including 1 case of duodenum stump leakage and 1 case of leakage of the duodenum stump and the distal side of the jejunum stump. Previous randomized controlled studies have reported that incidence rates of anastomotic leakage after open total gastrectomy ranged from 3.8 % to 6.8 % [14–16]. Nomura et al. [17] reported the result of a retrospective large-scale study of open total gastrectomy. Although they reported the esophagojejunal leakage rate after stapled anastomosis as 1.0 % using only the data of the recent 6 years, the overall incidence of esophagojejunal anastomosis leakage was 2.9 % (27/943). Indeed, our result of the incidence of esophagojejunal anastomosis leakage (4.0 %) was slightly higher than their result, so we think we should continue to make efforts for reducing the complication rate.

In this study we used only the purse-string suture anastomosis method. The purse-string suture method is simple and is similar to the anastomosis method in open total gastrectomy. The safety of this method has been already reported by other institutions [18, 19]. It requires fewer devices and costs less, and has the advantage of only rarely causing stenosis. Besides the purse-string suture method, two anastomosis methods (the OrVil method and the overlap method) have been reported as useful anastomosis procedures in LATG [20–23]. Although we have performed LATG with the OrVil method or the overlap method for ten cases outside this study, the incidence of anastomotic leakage of grade IIIa/b was 30 % (3/10). The reason for this high incidence was considered to be the inexperience of the surgeons with these methods. These methods might be safer if they were performed more frequently, thus increasing our overall level of expertise.

The risk of postoperative complications is affected by the skill of each individual surgeon. In our case series, six surgeons performed LATG. There was no clear difference among them in the incidence of postoperative complications. Furthermore, all operations were performed or supervised by surgeons with sufficient experience with laparoscopic gastrectomy and who were certified by the Japan Society for Endoscopic Surgery. Also, all surgeons had abundant experience with open gastrectomy. With regard to the learning curve, the incidence of postoperative complications did not show a clear decrease despite the surgeons' increasing expertise. However, in the recent 2 years (after January 2011), there was only one pancreatic



fistula and no anastomotic leakage. During this period, a fixed team of two surgeons (S.T. and Y.K.) have performed LATG in most cases. Even if the learning curves of individual surgeons do not affect the incidence of complications, a fixed team consisting of the same surgeons could perform LATG more safely.

At this point there are insufficient data concerning long-term outcomes after LATG. Several ongoing randomized control trials are comparing long-term survival between laparoscopic and open distal gastrectomy. Long-term outcomes after LATG should be also evaluated by randomized control trials to establish the possibility of a new standard for the surgical treatment of clinical stage I gastric cancer.

In conclusion, the short-term outcomes of LATG in our study involving 100 patients have been outlined. LATG for gastric cancer patients should be attempted preferably in the clinical trial setting by surgeons with sufficient experience in laparoscopic gastrectomy.

## References

1. Yoshikawa T, Cho H, Rino Y, Yamamoto Y, Kimura M, Fukunaga T, et al. A prospective feasibility and safety study of laparoscopy-assisted distal gastrectomy for clinical stage I gastric cancer initiated by surgeons with much experience of open gastrectomy and laparoscopic surgery. *Gastric Cancer* 2012; [Epub ahead of print].
2. Zeng YK, Yang ZL, Peng JS, Lin HS, Cai L. Laparoscopy-assisted versus open distal gastrectomy for early gastric cancer: evidence from randomized and nonrandomized clinical trials. *Ann Surg.* 2012;256:39–52.
3. Vinuela EF, Gonen M, Brennan MF, Coit DG, Strong VE. Laparoscopic versus open distal gastrectomy for gastric cancer: a meta-analysis of randomized controlled trials and high-quality nonrandomized studies. *Ann Surg.* 2012;255:446–56.
4. Katai H, Sasako M, Fukuda H, Nakamura K, Hiki N, Saka M, et al. Safety and feasibility of laparoscopy-assisted distal gastrectomy with suprapancreatic nodal dissection for clinical stage I gastric cancer: a multicenter phase II trial (JCOG0703). *Gastric Cancer.* 2010;13:238–44.
5. Jeong GA, Cho GS, Kim HH, Lee HJ, Ryu SW, Song KY. Laparoscopy-assisted total gastrectomy for gastric cancer: a multicenter retrospective analysis. *Surgery (St. Louis).* 2009;146:469–74.
6. Jeong O, Ryu SY, Zhao XF, Jung MR, Kim KY, Park YK. Short-term surgical outcomes and operative risks of laparoscopic total gastrectomy (LTG) for gastric carcinoma: experience at a large-volume center. *Surg Endosc* 2012; [Epub ahead of print].
7. Makino T, Fujiwara Y, Takiguchi S, Tsuboyama T, Kim T, Nushijima Y, et al. Preoperative T staging of gastric cancer by multi-detector row computed tomography. *Surgery (St. Louis).* 2011;149:672–9.
8. Japanese Gastric Cancer Association. Japanese classification of gastric carcinoma, 2nd English edition. *Gastric Cancer* 1998;1: 10–24.
9. Japanese Gastric Cancer Association. Gastric cancer treatment guidelines. Tokyo: Kanehara; 2004. (in Japanese).
10. Takiguchi S, Sekimoto M, Fujiwara Y, Miyata H, Yasuda T, Doki Y, et al. A simple technique for performing laparoscopic purse-string suturing during circular stapling anastomosis. *Surg Today.* 2005;35:896–9.
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240: 205–13.
12. Eom BW, Kim YW, Lee SE, Ryu KW, Lee JH, Yoon HM, et al. Survival and surgical outcomes after laparoscopy-assisted total gastrectomy for gastric cancer: case-control study. *Surg Endosc* 2012; [Epub ahead of print].
13. Sakuramoto S, Kikuchi S, Futawatari N, Katada N, Moriya H, Hirai K, et al. Laparoscopy-assisted pancreas- and spleen-preserving total gastrectomy for gastric cancer as compared with open total gastrectomy. *Surg Endosc.* 2009;23:2416–23.
14. Schardey HM, Joosten U, Finke U, Staubach KH, Schauer R, Heiss A, et al. The prevention of anastomotic leakage after total gastrectomy with local decontamination. A prospective, randomized, double-blind, placebo-controlled multicenter trial. *Ann Surg.* 1997;225:172–80.
15. Bozzetti F, Marubini E, Bonfanti G, Miceli R, Piano C, Crose N, et al. Total versus subtotal gastrectomy: surgical morbidity and mortality rates in a multicenter Italian randomized trial. The Italian Gastrointestinal Tumor Study Group. *Ann Surg.* 1997;226: 613–20.
16. Sano T, Sasako M, Shibata M, Yamamoto S, Tsuburaya A, Nishimoto A, et al. Randomized controlled trial to evaluate splenectomy in total gastrectomy for proximal gastric carcinoma (JCOG0110): analyses of operative morbidity, operation time, and blood loss. *J Clin Oncol* 2010;28(suppl):15 (abstr 4020).
17. Nomura S, Sasako M, Katai H, Sano T, Maruyama K. Decreasing complication rates with stapled esophagojejunostomy following a learning curve. *Gastric Cancer.* 2000;3:97–101.
18. Kinoshita T, Oshiro T, Ito K, Shibasaki H, Okazumi S, Katoh R. Intracorporeal circular-stapled esophagojejunostomy using hand-sewn purse-string suture after laparoscopic total gastrectomy. *Surg Endosc.* 2010;24:2908–12.
19. So KO, Park JM. Totally laparoscopic total gastrectomy using intracorporeally hand-sewn esophagojejunostomy. *J Gastric Cancer.* 2011;11:206–11.
20. Inaba K, Satoh S, Ishida Y, Taniguchi K, Isogaki J, Kanaya S, et al. Overlap method: novel intracorporeal esophagojejunostomy after laparoscopic total gastrectomy. *J Am Coll Surg.* 2010;211: e25–9.
21. Tsujimoto H, Uyama I, Yaguchi Y, Kumano I, Takahata R, Matsumoto Y, et al. Outcome of overlap anastomosis using a linear stapler after laparoscopic total and proximal gastrectomy. *Langenbecks Arch Surg.* 2012;397:833–40.
22. Jeong O, Park YK. Intracorporeal circular stapling esophagojejunostomy using the transorally inserted anvil (OrVil) after laparoscopic total gastrectomy. *Surg Endosc.* 2009;23:2624–30.
23. Omori T, Oyama T, Mizutani S, Tori M, Nakajima K, Akamatsu H, et al. A simple and safe technique for esophagojejunostomy using the hemidouble stapling technique in laparoscopy-assisted total gastrectomy. *Am J Surg.* 2009;197:e13–7.

## Efficacy of Endoscopic Gastroduodenal Stenting for Gastric Outlet Obstruction due to Unresectable Advanced Gastric Cancer: A Prospective Multicenter Study

SHUNJI ENDO, MD,<sup>1</sup> SHUJI TAKIGUCHI, MD,<sup>2\*</sup> YASUHIRO MIYAZAKI, MD,<sup>2</sup> KAZUHIRO NISHIKAWA, MD,<sup>3</sup> HIROSHI IMAMURA, MD,<sup>4</sup> KO TAKACHI, MD,<sup>5</sup> YUTAKA KIMURA, MD,<sup>6</sup> ATSUSHI TAKENO, MD,<sup>7</sup> SHIGEYUKI TAMURA, MD,<sup>7</sup> MASAKI MORI, MD,<sup>2</sup> AND YUICHIRO DOKI, MD,<sup>2</sup> on behalf of the CLINICAL STUDY GROUP OF OSAKA UNIVERSITY (CSGO), UPPER GI GROUP

<sup>1</sup>Department of Gastroenterological Surgery, Higashiosaka City General Hospital, Osaka, Japan

<sup>2</sup>Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine, Osaka, Japan

<sup>3</sup>Department of Surgery, Osaka General Medical Center, Osaka, Japan

<sup>4</sup>Department of Surgery, Sakai City Hospital, Osaka, Japan

<sup>5</sup>Department of Surgery, Kinki Central Hospital, Hyogo, Japan

<sup>6</sup>Department of Surgery, NTT West Osaka Hospital, Osaka, Japan

<sup>7</sup>Department of Surgery, Kansai Rosai Hospital, Hyogo, Japan

**Background and Objectives:** Gastroduodenal stents for gastric outlet obstruction due to unresectable advanced gastric cancer are increasingly used; however, their effects have not been fully evaluated.

**Methods:** A multicenter prospective observational study was performed. Patients were eligible if they had stage IV gastric cancer with a gastric outlet obstruction scoring system (GOOSS) score of 0 (no oral intake) or 1 (liquids only). Self-expandable metallic stents were delivered endoscopically. The effects of stents were evaluated.

**Results:** Twenty patients were enrolled and 18 were eligible (15 men, three women; median age, 70 years). Stent placement was successfully performed in all patients, with no complications. After stenting, a GOOSS score of 2 (soft solids only) or 3 (low-residue or full diet) was achieved in 13 (72%) patients. An improvement in the GOOSS score by one or more points was obtained in 16 (94%) patients. The median duration of fasting and hospital stay was 3 (range, 0–9) days and 18 (6–168) days, respectively. Chemotherapy was performed after stenting in 13 (72%) patients.

**Conclusions:** Gastroduodenal stents are thought to be feasible, safe, and effective for gastric outlet obstruction due to unresectable advanced gastric cancer, with rapid clinical relief and a short hospital stay.

*J. Surg. Oncol.* 2014;109:208–212. © 2013 Wiley Periodicals, Inc.

**KEY WORDS:** gastric outlet obstruction; stomach neoplasms; stent

### INTRODUCTION

Gastric cancer is one of the most common cancers worldwide and leads to a poor prognosis. In Japan, early detection has increased the number of curative resections and diminished the number of cancer deaths. However, many cases are still detected in the unresectable advanced stage. Advanced gastric cancer often results in gastric outlet obstruction (GOO). GOO causes vomiting, nausea, weight loss, and intolerance to oral feeding, and diminishes the quality of life in these patients who have limited life expectancies. Chemotherapy is indicated for patients with unresectable advanced gastric cancer. However, it is difficult for patients with GOO to orally take S-1, which is included in the first-line regimen for unresectable gastric cancer recommended in Japanese gastric cancer treatment guidelines 2010 [1].

The treatment for GOO has traditionally been surgical gastrojejunostomy. Previously, we have reported the clinical outcome for palliative gastrojejunostomy in unresectable advanced gastric cancer, resulting in good improvement of oral food intake with acceptable morbidity and mortality [2]. However, invasiveness of surgery with general anesthesia is problematic because most of those with GOO have a poor general condition.

Currently, endoscopic placement of self-expandable metallic stents (SEMSs) is increasingly used as a less invasive method for palliative treatment of GOO caused by biliary-pancreatic malignancies. The efficacy and safety of SEMSs have been reported with an early food

intake, short hospital stay, and low total hospital costs [3,4]. However, the effects of SEMSs for GOO with gastric cancer have not been fully evaluated.

In Japan, SEMSs were not common because this procedure was not included in the Japanese health insurance system. In April 2010, the Japanese payment system for medical services was revised, and endoscopic gastroduodenal stent placement for GOO due to malignancies was approved by the Japanese health insurance system.

**Abbreviations:** GOO, gastric outlet obstruction; SEMS, self-expandable metallic stent; OS, overall survival; UICC, the International Union Against Cancer; PS, Eastern Cooperative Oncology Group Performance Status; GOOSS, gastric outlet obstruction scoring system; BW, body weight; T, depth of tumor invasion; N, lymph node metastasis; M, distant metastasis; MST, median survival time.

\*Correspondence to: Shuji Takiguchi, Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine, 2-2 Yamadaoka, Suita, 565-0871 Osaka, Japan. Fax: 81-6-6789-3259. E-mail: stakiguchi@gesurg.med.osaka-u.ac.jp

Received 30 August 2013; Accepted 14 October 2013

DOI 10.1002/jso.23486

Published online 6 November 2013 in Wiley Online Library (wileyonlinelibrary.com).

In this study, we aimed to prospectively evaluate the effect of SEMs on the rate of improvement of clinical symptoms in patients with GOO due to unresectable advanced gastric cancer. Additional aims were to study the feasibility, complications, duration of fasting after stenting, duration of the hospital stay, feasibility of chemotherapy after stenting, need for re-intervention, and overall survival (OS). This is the first prospective multicenter study to evaluate the effects of SEMs for GOO due to advanced gastric cancer.

## MATERIALS AND METHODS

### Patients and Data Retrieval

This prospective multicenter clinical trial was carried out at 11 institutions belonging to the Clinical Study Group of Osaka University, Upper GI Group between February 2011 and January 2013. Eligibility criteria for participation included the following: non-surgically treated patients with histologically diagnosed primary gastric adenocarcinoma, which was not estimated to be curatively resectable by clinical examinations, with clinical cancer stage IV according to the International Union Against Cancer (UICC) TNM classification (7th edition) [5]; aged equal to or older than 20 years; aged equal to or younger than 90 years; with an Eastern Cooperative Oncology Group Performance Status (PS) score of 0–2 [6]; with a GOO scoring system (GOOSS) score of 0 or 1 [7]; and considered to be alive for more than 3 months. Patients with GOO due to recurrent cancer, with active bleeding from the tumor, who could not receive an endoscopic examination, with additional obstruction of the oral side of the stomach, with additional obstruction of the small or large intestine, who had already undergone SEMS placement, who could not answer the questionnaire about quality of life, or who were considered inappropriate for participants, were excluded. The presence of duodenal invasion was not excluded.

The institutional review board of each hospital approved the protocol. All participants provided written informed consent. This study was performed by the Clinical Study Group of Osaka University, Upper GI Group, which conducted investigator-initiated trials and was composed of hospitals affiliated from the Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine. The data center, located at the Multicenter Clinical Study Group at the Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine, was responsible for central monitoring and statistical analyses under supervision of the statistician in charge.

### Procedures

Endoscopic stent placement was performed using the Wallflex™ duodenal stent (Boston Scientific, Natick, MA) under conscious sedation. It is an uncovered-SEMS with a diameter of 22 mm at the mid-body, and 60, 90, or 120 mm long depending on the case. After a guidewire was correctly positioned distal to the stricture, a stent catheter was advanced over the wire through the working channel of a therapeutic endoscope and the stent was released under fluoroscopic control.

### Outcomes and Definitions

The primary outcome was an improvement in the ability to tolerate an oral solid diet after stenting as assessed by the GOOSS score. Secondary outcomes included the technical success rate, complications, the duration of post-interventional fasting, the duration of the post-interventional hospital stay, the feasibility of chemotherapy after stenting, the need for re-intervention, and OS.

Food intake was assessed by the standardized GOOSS score as follows: 0=no oral intake, 1=liquids only, 2=soft solids, and 3=almost complete or full diet [7]. The ability to take a solid diet was indicated by a GOOSS score of 2 or 3. Technical success was defined as deployment of the SEMS across the stricture, with patency visualized both fluoroscopically and endoscopically. Complications were defined as any adverse event related to SEMS placement, such as bleeding, perforation, and jaundice.

### Sample Size and Data Analysis

A sample size of 20 patients had been planned when the trial was designed, considering that the number of GOO cases due to gastric cancer in the institutions of the Clinical Study Group of Osaka University, Upper GI Group was approximately 60 per year. The projected accrual period was 2 years.

The following parameters were collected and analyzed: sex, age, GOOSS score, body weight (BW), height, PS, albumin levels, total lymphocyte count, hemoglobin levels, previous chemotherapy, tumor location, macroscopic tumor type, depth of tumor invasion (T), lymph node metastasis (N), and distant metastasis (M) according to the Japanese classification of gastric carcinoma (3rd English edition) [8]. Interventional outcomes and complications were collected. GOOSS scores, BW, PS, albumin levels, lymphocyte count, and hemoglobin levels, at 1, 2, and 4 weeks, and every other 4 weeks after stenting, were recorded until the 24th week. The date of the start of oral intake, the date of hospital discharge, post-interventional therapy, including re-stenting, surgery, and chemotherapy, and the date and causes of death were also recorded. The survival time was defined as the duration from the date of stenting to death.

### Statistical Analysis

Differences in parameters after stenting were compared with baseline (pre-interventional) values by the Wilcoxon signed-ranks test. *P* values were derived from two-tailed tests, and differences were considered significant at *P* < 0.05. Analyses were performed using StatView® software (version 5.0 for Macintosh; SAS Institute Inc., Cary, NC).

## RESULTS

### Patients' Characteristics

Twenty patients from six institutions were enrolled between March 2011 and July 2012. One patient with a GOOSS score of 2 and one patient with cancer stage IIIB were excluded. Therefore, the clinical data of 18 patients were retrieved and analyzed in this study. The clinical characteristics of the 18 patients are summarized in Table I.

### Outcome of Stent Placement

SEMS placement was technically successful in all cases, and no complications were encountered. The ability to take solid food orally was achieved by 13 (72%) patients, in whom six had a GOO score of 2 and seven had a GOOSS score of 3. The remaining five patients who could not take solid food included three patients whose GOOSS score improved from 0 to 1, one patient whose GOOSS score remained as 0, and one patient who died within 1 week after stenting. A total of 16 (94%) out of 17 patients showed an improvement of the GOOSS score. The mean GOOSS scores were 1.7, 1.9, 1.8, 1.8, 1.8, 2.1, 2.3, and 2.2, at 1, 2, 4, 8, 12, 16, 20, and 24 weeks after stenting, respectively. The change in GOOSS scores by the post-stenting week is shown in Figure 1. The median duration of post-stenting fasting was 3 (range, 0–9 days) days. The median duration of hospitalization was 18 (6–168 days) days.

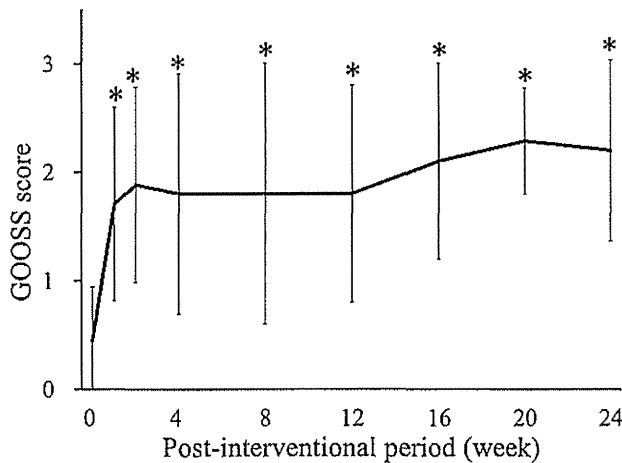
**TABLE I.** Clinical Features of Patients Who Underwent Endoscopic Gastroduodenal Stent Placement for Gastric Outlet Obstruction Due to Unresectable Advanced Gastric Cancer

Variables		
Sex	Male/female	15/3
Age	(Year)	70 (48-90)*
GOOSS score	0/1	10/8
Body weight	(kg)	48 (29-71)*
Body mass index	(kg/m <sup>2</sup> )	18.8 (13.1-22.9)*
PS	0/1/2	5/6/7
Albumin	(g/dl)	2.7 (1.7-3.8)*
Lymphocyte	(/mm <sup>3</sup> )	1068 (602-1,657)*
Hemoglobin	(g/dl)	9.1 (6.6-13.5)*
Pre-interventional chemotherapy	+/-	8/10
Tumor location	L/ML/UML	14/3/1
Tumor type	2/3/4	4/8/6
Depth of tumor invasion (T)	3/4a/4b	3/10/5
Lymph node metastasis (N)	1/2/3a/3b/X	3/4/9/1/1

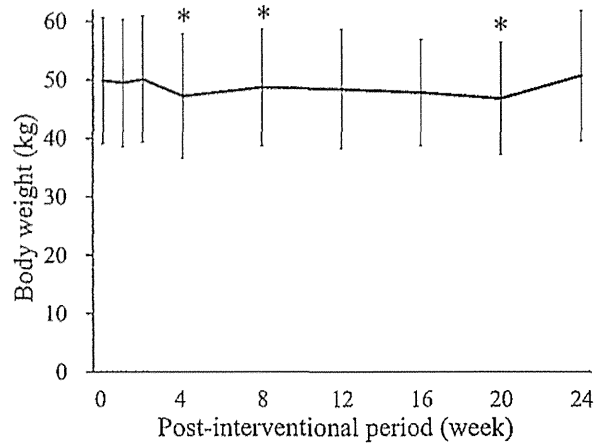
PS, Eastern Cooperative Oncology Group Performance Status score; GOOSS, gastric outlet obstruction scoring system; Tumor location, Tumor type, T, and N are written according to the Japanese Classification of Gastric Carcinoma the 3rd English edition; \*, median (range).

after stenting. Post-stenting chemotherapy was provided to 13 (72%) patients, including 10 patients with an S-1-containing regimen.

Additional therapy included re-stenting in two patients, surgical gastrojejunostomy in three patients, and gastrectomy in one patient. Two patients who could eat solid food after stenting, but then returned to no oral intake because of re-obstruction, received additional SEMS placement on the 105th and 126th post-stenting day, which resulted in good oral intake of solid food. One patient with development of re-obstruction after stenting could take solid food after gastrojejunostomy on the 69th post-stenting day. One patient with inadequate improvement of GOO after stenting could not eat solid food after gastrojejunostomy on the 45th post-stenting day. The other patient who could take solid food after stenting and developed tumor perforation after chemotherapy underwent surgery for peritonitis and gastrojejunostomy on the 165th postoperative day. A patient who had GOO and peritoneal metastasis



**Fig. 1.** Changes in the mean gastric outlet obstruction scoring system (GOOSS) score at baseline (0) and during follow-up after stenting. GOOSS scores after re-intervention were not included. Bars represent the standard deviation. Asterisks represent significant differences ( $P < 0.05$ ) compared with baseline values using the Wilcoxon signed-ranks tests.

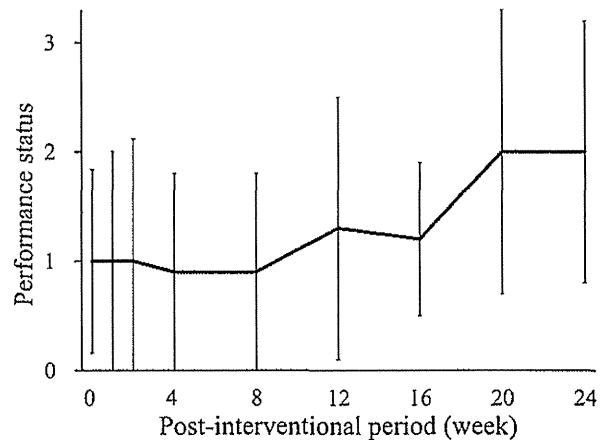


**Fig. 2.** Changes in the mean body weight at baseline (0) and during follow-up after stenting. Body weight after re-intervention was not included. Bars represent the standard deviation. Asterisks represent significant differences ( $P < 0.05$ ) compared with baseline values using the Wilcoxon signed-ranks tests.

due to gastric cancer underwent SEMS placement and received chemotherapy with S-1, cisplatin, and trastuzumab. Curative gastrectomy could be performed on the 76th post-stenting day because the peritoneal metastasis disappeared after two cycles of the regimen. The cancer stage was ypT4aN3bM0 stage IIIB.

**Changes in Nutritional Values and Performance Status**

BW, PS, albumin levels, total lymphocyte count, and hemoglobin levels, at 1, 2, and 4 weeks, and every other 4 weeks after stenting, were recorded until the 24th week and compared with baseline values. BW was significantly decreased at 4, 8, and 20 weeks after stenting compared with baseline, however, no significant increase in BW compared with the baseline value was observed during follow-up (Fig. 2). There were no significant changes in PS (Fig. 3), albumin levels (Fig. 4), lymphocyte count, and hemoglobin levels during the follow-up.



**Fig. 3.** Changes in the mean Eastern Cooperative Oncology Group Performance Status (PS) score at baseline (0) and during follow-up after stenting. PS scores after re-intervention were not included. Bars represent the standard deviation. There were no significant differences between baseline and post-interventional values by the Wilcoxon signed-ranks tests.

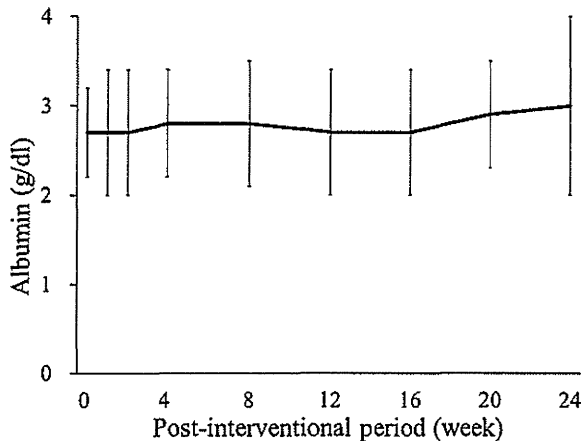


Fig. 4. Changes in the mean albumin levels at baseline (0) and during follow-up after stenting. Albumin levels after re-intervention were not included. Bars represent the standard deviation. There were no significant differences between baseline and post-interventional values by the Wilcoxon signed-ranks tests.

#### Overall Survival

At the time of analysis, 17 patients had died. The cause of death was gastric cancer in every case. The median survival time (MST) was 186 days and the 1-year survival rate was 11%.

#### DISCUSSION

The SEMS has been increasingly used for the palliation of malignant GOO, mainly due to biliary-pancreatic cancer. Some studies have reported the effects of SEMSs for GOO [3,4,9–11]. However, for the first time, we evaluated the effects of SEMSs for GOO due to advanced gastric cancer by a prospective multicenter study. We found that SEMSs in gastric cancer resulted in an acceptable improvement in oral intake with excellent technical success, without any complications.

Previous retrospective analyses concerning the effects of SEMSs for malignant GOO have reported similar clinical outcomes. Chandrasegaram et al. [4] reported that 69% and 77% patients could eat solids or puree on the 5th and 10th post-stenting days, respectively. Canena et al. [9] also reported that solid food intake (GOOSS score of 2–3) was achieved by 72% of patients within 5 days after stenting, which is similar to our study. They reported that the mean GOOSS score was 1.76 at 5 days after stenting, and 1.64 during the follow-up. Compared with these data, our patients maintained a good GOOSS score, ranging from 1.7 to 2.3 during follow-up. Although some other reports have mentioned a remarkably higher rate of clinical success with GOO, the definition of improvement of GOO differs [10–12]. An improvement of the GOOSS score by one or more points was obtained in 94% of patients in our series. However, this improvement in GOO failed to lead to improvement in nutritional parameters and general condition, including BW, PS, albumin levels, lymphocytes, and hemoglobin levels.

In the current study, five patients could not eat solid food after SEMS placement. All of them had a GOOSS score of 0 and a PS of 2. One patient died on the 6th day after stenting, and one died on the 17th day after stenting. One patient needed gastrojejunostomy, one needed central venous port placement, and the other patient did not receive any additional intervention because of a poor general condition. However, among 13 patients who could eat solid food after stenting, only two patients had a PS of 2 and the other 11 patients had a PS of 0 or 1.

Considering these data, the ability to take solid food after stenting might partially depend on PS. Sasaki et al. [10] also showed that a poor PS was a poor predictive factor of solid intake. Patients with a PS of 2 would be more likely to be lying in bed, which makes oral intake difficult because advanced cancer in the stomach results in lost migration activity and patients require the assistance of gravity to let food pass through the stent. In fact, the patient with a PS of 2 who could not eat solid food after stenting could also not eat solid food after gastrojejunostomy.

The change in the GOOSS showed that GOOSS scores were maintained at approximately 2 from the 1st week to the 24th week after stenting. In Figure 1, GOOSS scores after re-intervention were not included. Four patients maintained GOOSS scores of 2–3 for 24 weeks after stenting without re-intervention, while three patients required re-intervention due to re-obstruction on the 69th, 105th, and 126th days. No et al. [12] reported that the median duration between SEMS placement for gastric cancer and the recurrence of obstructive symptoms was 125 days. Some studies, including those on gastric cancer and biliary-pancreatic malignancies, found that stent patency lasted for 4–17 months [4,9,11], although the duration of stent patency is thought to be difficult to evaluate objectively. Recurrent obstruction is caused by tumor ingrowth or overgrowth, and remains an important problem of SEMSs. Additional SEMS placement was performed for two cases in our series with good results. Recent reports have also described the effectiveness of additional SEMS insertion using a stent-in-stent procedure [4,11,12]. Additional SEMS placement may be a feasible choice for recurrent obstruction after stenting.

Chemotherapy is also expected to improve maintenance of stent patency, mainly as a result of reducing tumor ingrowth or overgrowth. In our series, chemotherapy was administered in most patients soon after stenting. Ability of oral intake of S-1 is important for treating patients with unresectable advanced gastric cancer because S-1 is a key drug for unresectable advanced gastric cancer [13]. Notably, one patient in our series with peritoneal metastasis underwent curative resection after SEMS placement and chemotherapy. Less invasiveness of endoscopic SEMS placement enabled the patient to start chemotherapy as soon as the 8th day after stenting. Furthermore, if this patient had undergone surgical gastrojejunostomy instead of SEMS placement, the next surgery of gastrectomy would have been difficult and complicated. In this patient, gastrectomy was performed without difficulty by fully mobilizing the duodenal bulb and resecting the duodenum just distal to the SEMS. This patient showed the advantages of SEMS placement in terms of early administration of chemotherapy and the technical ease of gastrectomy when chemotherapy was effective. This patient is doing well with good oral intake for 16 months after stenting and 13 months after gastrectomy.

The MST after stenting was 186 days, which is compatible with that in a recent Korean report after stenting for gastric cancer (189 days) [12]. For patients who underwent chemotherapy including the S-1 regimen, the MST was 9.1 months, which is similar to the reported MST of patients with advanced gastric cancer who underwent S-1 chemotherapy (11.0 months) [13]. Therefore, the ability of chemotherapy with S-1 after stenting leads to a survival benefit.

#### CONCLUSIONS

We prospectively analyzed the effectiveness of endoscopic gastroduodenal SEMS placement for GOO due to unresectable advanced gastric cancer. This procedure was technically successful in every patient, and 72% of patients could eat solid food. The duration of post-interventional fasting and hospitalization was short. Gastroduodenal SEMSs are thought to be feasible, safe, and effective for GOO due to unresectable advanced gastric cancer. This palliative treatment might become the choice of treatment for GOO. A further study is being planned to compare SEMSs and gastrojejunostomy by a randomized controlled trial in our multicenter group.

## REFERENCES

1. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2010 (ver. 3). *Gastric Cancer* 2011;14:113–123.
2. Takeno A, Takiguchi S, Fujita J, et al.: Clinical outcome and indications for palliative gastrojejunostomy in unresectable advanced gastric cancer: Multi-institutional retrospective analysis. *Ann Surg Oncol* 2013;20:3527–3533.
3. Jeurnink SM, Steyerberg EW, van Hooft JE, et al.: Dutch SUSTENT Study Group. Surgical gastrojejunostomy or endoscopic stent placement for the palliation of malignant gastric outlet obstruction (SUSTENT study): A multicenter randomized trial. *Gastrointest Endosc* 2010;71:490–499.
4. Chandrasegaram MD, Eslick GD, Mansfield CO, et al.: Endoscopic stenting versus operative gastrojejunostomy for malignant gastric outlet obstruction. *Surg Endosc* 2012;26:323–329.
5. Sobin LH, Gospodarowicz MK, Wittekind C: TNM classification of malignant tumors, 7th edition. Oxford: Wiley -Blackwell; 2009;pp 73–77.
6. Oken MM, Creech RH, Tormey DC, et al.: Toxicity and response criteria of the Eastern Cooperative Oncology Group. *Am J Clin Oncol* 1982;5:649–655.
7. Adler DG, Baron TH: Endoscopic palliation of malignant gastric outlet obstruction using self-expanding metal stents: Experience in 36 patients. *Am J Gastroenterol* 2002;97:72–78.
8. Japanese Gastric Cancer Association. Japanese classification of gastric carcinoma: 3rd English edition. *Gastric Cancer* 2011;14:101–112.
9. Canena JM, Lagos AC, Marques IN, et al.: Oral intake throughout the patients' lives after palliative metallic stent placement for malignant gastroduodenal obstruction: A retrospective multicentre study. *Eur J Gastroenterol Hepatol* 2012;24:747–755.
10. Sasaki T, Isayama H, Nakai Y, et al.: Predictive factors of solid food intake in patients with malignant gastric outlet obstruction receiving self-expandable metallic stents for palliation. *Dig Endosc* 2012;24:226–230.
11. Sasaki T, Isayama H, Maetani I, et al.: Japanese multicenter estimation of WallFlex duodenal stent for unresectable malignant gastric outlet obstruction. *Dig Endosc* 2013;25:1–6.
12. No JH, Kim SW, Lim CH, et al.: Long-term outcome of palliative therapy for gastric outlet obstruction caused by unresectable gastric cancer in patients with good performance status: Endoscopic stenting versus surgery. *Gastrointest Endosc* 2013;78:55–62.
13. Koizumi W, Narahara H, Hara T, et al.: S-1 plus cisplatin versus S-1 alone for first-line treatment of advanced gastric cancer (SPIRITS trial): A phase III trial. *Lancet Oncol* 2008;9:215–221.

## Postoperative gastrectomy outcomes in octogenarians with gastric cancer

Jota Mikami · Yukinori Kurokawa · Yasuhiro Miyazaki · Tsuyoshi Takahashi · Makoto Yamasaki · Hiroshi Miyata · Kiyokazu Nakajima · Shuji Takiguchi · Masaki Mori · Yuichiro Doki

Received: 11 August 2014 / Accepted: 4 November 2014  
© Springer Japan 2014

### Abstract

**Purpose** It is controversial whether the treatment strategy for gastric cancer should be different for elderly patients. We herein evaluated the feasibility of gastrectomy and the risk factors for postoperative complications in octogenarians with gastric cancer.

**Methods** We retrospectively collected data on 441 consecutive patients who underwent total or subtotal gastrectomy for gastric cancer. We divided all of the patients into two groups: the octogenarian group ( $n = 47$ ), consisting of patients aged 80–89 years, and the younger group ( $n = 394$ ), consisting of patients under 80 years of age.

**Results** The postoperative complication rate was 23.1 % (91/394) in the younger group and 36.2 % (17/47) in the octogenarian group ( $P = 0.049$ ). Octogenarian patients had significantly lower preoperative serum albumin levels ( $P < 0.001$ ) and higher ASA scores ( $P < 0.001$ ). Although the rate of each major complication was similar between the two groups, there was a trend toward a higher rate of other miscellaneous complications, mostly non-surgical complications, in the octogenarian group ( $P = 0.077$ ). A multivariate analysis of the patients in the octogenarian group revealed that only total gastrectomy was a significant risk factor for postoperative complications ( $P = 0.035$ ).

**Conclusion** Octogenarian patients with gastric cancer experienced more complications than younger patients. Therefore, closer monitoring is needed for octogenarian patients who will receive total gastrectomy.

**Keywords** Gastric cancer · Gastrectomy · Elderly patient · Older persons · Oldest-old persons

### Introduction

Gastric cancer is the second most common cancer worldwide [1]. Recent increases in the average human lifespan have resulted in an increased number of elderly patients with gastric cancer, including those who undergo surgery [2]. Surgeons need to minimize the occurrence of severe and potentially fatal complications, especially among elderly patients, most of whom are fragile due to multiple comorbidities. Some studies have reported that elderly cancer patients might not have the same opportunity for curative treatment as younger patients [3, 4]. However, the living conditions and medical care have recently been dramatically improved in many countries [5]. These changes may make it possible to perform invasive surgery safely, even in elderly patients with comorbidities [6]. Therefore, it is necessary to re-evaluate the optimal treatment strategy in elderly patients after considering their medical history and general health status.

Several studies have reported that aging is associated with the occurrence of postoperative complications after gastric cancer surgery [7–9], while other studies have reported that elderly patients can safely undergo gastrectomy [6, 10]. Thus, it is controversial whether the treatment strategy for elderly patients should be the same as that for younger patients. The risk factors for postoperative complications in elderly patients with gastric cancer remain unknown. In this study, we evaluated the feasibility of gastrectomy in octogenarians, and investigated the risk factors for postoperative complications in octogenarians with gastric cancer.

J. Mikami · Y. Kurokawa (✉) · Y. Miyazaki · T. Takahashi · M. Yamasaki · H. Miyata · K. Nakajima · S. Takiguchi · M. Mori · Y. Doki  
Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine, Osaka, Japan  
e-mail: ykurokawa@gesurg.med.osaka-u.ac.jp

## Patients and methods

We retrospectively collected data on 441 consecutive patients who underwent total or subtotal gastrectomy for gastric cancer between January 2008 and December 2011. Patients who were over 90 years old and patients who underwent concurrent surgery for synchronous malignant tumors were excluded. All tumors were histologically diagnosed as adenocarcinoma of the stomach. In principle, all patients were treated according to the Japanese Gastric Cancer Treatment Guidelines [11]. We used the 14th edition of the Japanese classification of gastric carcinoma to determine the pathological stage [12]. Postoperative complications were evaluated according to the Clavien–Dindo classification [13]. We considered complications of Grade II or higher to be postoperative complications in this study.

We divided the patients into two groups: the octogenarian group, consisting of patients aged 80–89 years, and the younger group, consisting of patients under 80 years of age. We compared the clinicopathological factors in the two groups using the Chi-squared test for categorical variables and the Mann–Whitney *U* test for continuous variables. Yates' correction was used for the Chi-squared test when at least one cell of the table was smaller than 5. We also evaluated which clinicopathological factors were associated with postoperative complications in the octogenarian group using a multivariate logistic regression analysis. A value of  $P < 0.05$  was considered to be statistically significant. All statistical analyses were performed using the SPSS Statistics software program, version 20 (IBM Corp., Armonk, NY, USA).

## Results

Of the 441 patients, 47 (10.7 %) were in the octogenarian group (Table 1). The median age was 66 years old in the younger group and 82 years old in the octogenarian group. The male to female ratio was similar between the two groups. Although the body mass index (BMI) was similar between the two groups, the octogenarian group had a significantly lower preoperative serum albumin level (median 3.5 g/dl) than the younger group (median 4.0 g/dl) ( $P < 0.001$ ). The preoperative American Society of Anesthesiologists (ASA) score was also significantly different between the two groups ( $P < 0.001$ ). The laparoscopic approach was used frequently in both groups, and nearly 30 % of patients underwent total gastrectomy in both groups. Regarding the distribution of the pStage, there were significantly more patients with advanced tumors in the octogenarian group ( $P = 0.046$ ).

Table 2 compares the surgical outcomes in the younger and octogenarian groups. The volume of blood loss and

**Table 1** Patient characteristics of the younger and octogenarian groups

Factors	Younger group ( <i>n</i> = 394)	Octogenarian group ( <i>n</i> = 47)	<i>P</i> value
Age (years)			
Median (range)	66 (29–79)	82 (80–89)	<0.001
Sex			
Male	290 (73.6 %)	34 (72.3 %)	0.85
Female	104 (26.4 %)	13 (27.7 %)	
Body mass index (kg/m <sup>2</sup> )			
Median (range)	22.1 (12.9–31.3)	21.6 (13.3–27.4)	0.44
Serum albumin level (g/dl)			
Median (range)	4.0 (2.1–4.9)	3.5 (1.9–4.4)	<0.001
ASA score			
1	130 (33.0 %)	2 (4.3 %)	<0.001
2	237 (60.2 %)	33 (70.2 %)	
3 or 4	27 (6.9 %)	12 (25.5 %)	
Approach			
Open	119 (30.2 %)	18 (38.3 %)	0.26
Laparoscopic	275 (69.8 %)	29 (61.7 %)	
Gastrectomy			
Total	119 (30.2 %)	15 (31.9 %)	0.81
Subtotal	275 (69.8 %)	32 (68.1 %)	
Lymph node dissection			
<D2	253 (64.2 %)	29 (61.7 %)	0.74
≥D2	141 (35.8 %)	18 (38.3 %)	
pStage <sup>a</sup>			
I	266 (67.5 %)	24 (51.1 %)	0.046
II	70 (17.8 %)	9 (19.1 %)	
III	45 (11.4 %)	10 (21.3 %)	
IV	13 (3.3 %)	4 (8.5 %)	

ASA American Society of Anesthesiologists

<sup>a</sup> Pathological stage was according to the 14th edition of Japanese classification of gastric carcinoma

the length of the operation were similar between the two groups. The proportion of patients who experienced postoperative complications was 23.1 % (91/394) in the younger group and 36.2 % (17/47) in the octogenarian group ( $P = 0.049$ ). The most frequent complication was pancreatic fistula formation, followed by anastomotic leakage and abdominal abscess, and the rate of each major complication was similar between the two groups. Other miscellaneous complications included enterocolitis (younger 0.3 %, octogenarian 2.1 %), cholecystitis (octogenarian 2.1 %), liver dysfunction (younger 0.3 %), urinary tract infection (younger 0.3 %), massive ascites (younger 0.3 %), bacteremia (younger 0.5 %, octogenarian 2.1 %), colon perforation (younger 0.5 %), pancreatitis (younger 0.3 %), pulmonary



**Table 2** Surgical outcomes of the younger and octogenarian groups

Outcomes	Younger group (n = 394)	Octogenarian group (n = 47)	P value
Blood loss (ml), median (range)	150 (10–2700)	232 (20–1650)	0.18
Operation time (min), median (range)	215 (105–570)	210 (120–346)	0.27
Postoperative complications <sup>a</sup>	91 (23.1 %)	17 (36.2 %)	0.049
Pancreatic fistula	23 (5.8 %)	4 (8.5 %)	0.69
Anastomotic leakage	16 (4.1 %)	3 (6.4 %)	0.72
Abdominal abscess	17 (4.3 %)	2 (4.3 %)	1.00
Bowel obstruction or ileus	13 (3.3 %)	2 (4.3 %)	1.00
Bleeding	8 (2.0 %)	1 (2.1 %)	1.00
Delayed gastric empty	7 (1.8 %)	1 (2.1 %)	1.00
Pneumonia	6 (1.5 %)	1 (2.1 %)	1.00
Other	10 (2.5 %)	4 (8.5 %)	0.077
Hospital death	1 (0.3 %)	0 (0.0 %)	1.00

<sup>a</sup> Postoperative complications included Grade II or higher according to the Clavien–Dindo classification. Some complications were duplicated in same patient

infarction (younger 0.3 %) and cerebral infarction (octogenarian 2.1 %). The rate of hospital death was 0.3 % (1/394) in the younger group and 0.0 % (0/47) in the octogenarian group. Among the patients who experienced a postoperative complication, the duration of the postoperative hospital stay was similar in the two groups ( $P = 0.96$ ).

A multivariate analysis of the octogenarian group revealed that only total gastrectomy was a significant risk factor for postoperative complications (odds ratio 5.43; 95 % confidence interval 1.12–26.3;  $P = 0.035$ ) (Table 3). There were 15 patients who underwent total gastrectomy in the octogenarian group, with eight (53.3 %) of them experiencing a complication. On the other hand, nine (28.1 %) of the 32 patients who underwent subtotal gastrectomy developed a complication.

## Discussion

In this study, the proportion of patients who experienced postoperative complications in the octogenarian group was significantly higher compared to that in the younger group. The significant difference in the overall complication rate between the two groups was due to the difference in the rates of miscellaneous complications, such as enterocolitis, cholecystitis, pulmonary infarction and cerebral infarction. Indeed, octogenarian patients usually have some comorbidities and a worse nutritional status, which was consistent with the significantly lower preoperative serum albumin levels and higher ASA scores in the octogenarian group in the present study. These high-risk conditions probably contributed to some non-surgical complications after gastrectomy in the octogenarian group.

Total gastrectomy was the only significant risk factor for postoperative complications in the octogenarian group. All of the other clinicopathological factors, including the serum albumin level, extent of lymph node dissection and

**Table 3** Multivariate logistic analysis of risk factors for postoperative complications in the octogenarian group

	Multivariate	
	Odds ratio(95 % CI)	P value
Male	1.03 (0.21–5.19)	0.97
Body mass index $\geq 25$ kg/m <sup>2</sup>	3.65 (0.42–31.8)	0.24
Serum albumin level $< 3$ g/dl	3.56 (0.55–23.3)	0.18
ASA score $\geq 3$	1.56 (0.30–8.13)	0.60
Laparoscopic approach	4.04 (0.60–27.0)	0.15
Total gastrectomy	5.43 (1.12–26.3)	0.035
Lymph node dissection $\geq D2$	1.46 (0.27–7.87)	0.66
pStage II–IV <sup>a</sup>	1.71 (0.27–11.0)	0.57

CI confidential interval. ASA American Society of Anesthesiologists

<sup>a</sup> Pathological stage was according to the 14th edition of Japanese classification of gastric carcinoma

tumor stage did not significantly affect the occurrence of postoperative complications. More than half of the octogenarian patients who underwent total gastrectomy experienced a postoperative complication. Although there were no hospital deaths in the octogenarian group, closer monitoring is needed for octogenarian patients who will undergo total gastrectomy compared to younger patients.

There has been no standard definition of elderly patients in clinical studies involving surgery. In previous studies that have included elderly patients with gastric cancer, various definitions of “elderly” were used [14–17]. The United Nations defines persons aged 80 years or over as the oldest-old [18]. However, patients over 90 years old are extremely rare even in Japan. Indeed, there was only one patient in our institution who was over 90 and treated during the study period. We therefore classified the study patients into two groups, the octogenarian group (80–89 years) and the younger group (under 80 years). Park et al. [8] reported that aging was associated with a higher frequency of surgical

complications and mortality. Takeshita et al. [10] suggested that limited lymph node dissection should be considered for patients between 80 and 84 years of age, since the prognostic significance of radical surgery is uncertain in patients 85 years old or over. However, Orsenigo et al. [19] showed that the rates of postoperative complications and mortality in elderly patients were comparable to those in younger patients despite their comorbidities, and they did not have a worse overall survival.

Since the surgical outcomes in gastric cancer patients sometimes vary by hospital or country, the optimal procedure for elderly patients remains unclear. Furthermore, most of the previous studies did not use a common criterion for evaluating surgical complications [20–22]. Recently, the Clavien–Dindo classification has become a worldwide standard classification system for surgical complications [13]. In our study, we evaluated Grade II or higher complications according to the Clavien–Dindo classification in more than 400 consecutive patients with gastric cancer. To confirm the results obtained in our study, multicenter cohort studies using the same criteria for age and postoperative complications are warranted.

Among the patients who underwent total gastrectomy, 34 (28.6 %) younger patients and one octogenarian patient (6.7 %) underwent splenectomy. This appears to indicate that we tended to avoid extensive lymphadenectomy for the elderly patients compared with the younger patients. Nevertheless, the postoperative complication rate was higher in the octogenarian group than in the younger group. Furthermore, total gastrectomy significantly affected the postoperative complication rate. A previous study reported that the quality of life declines after surgery for gastric cancer, especially total gastrectomy [23, 24]. Since long-term survival can be expected with radical surgery even in elderly patients, radical gastrectomy should not be ruled out as a treatment for gastric cancer. However, in elderly patients, the type of gastrectomy should be determined after a comprehensive evaluation of each individual patient, including his or her performance status and lifestyle.

**Conflict of interest** Jota Mikami and co-authors have no conflicts of interest to declare.

## References

- World health organization. Causes of death. 2004. [http://www.who.int/healthinfo/global\\_burden\\_disease/GBD\\_report\\_2004update\\_part2.pdf](http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_part2.pdf). Accessed Jul 2014.
- Pisanu A, Montisci A, Piu S, Uccheddu A. Curative surgery for gastric cancer in the elderly: treatment decisions, surgical morbidity, mortality, prognosis and quality of life. *Tumori*. 2007;93:478–84.
- Ramesh HS, Pope D, Gennari R, Audisio RA. Optimising surgical management of elderly cancer patients. *World J Surg Oncol*. 2005;3:17.
- Saif MW, Makrilia N, Zalonis A, Merikas M, Syrigos K. Gastric cancer in the elderly: an overview. *Eur J Surg Oncol*. 2010;36:709–17.
- Imano M, Okuno K. Treatment strategies for gastric cancer patients with peritoneal metastasis. *Surg Today*. 2014;44:399–404.
- Matsushita I, Hanai H, Kajimura M, Tamakoshi K, Nakajima T, Matsubayashi Y, et al. Should gastric cancer patients more than 80 years of age undergo surgery? Comparison with patients not treated surgically concerning prognosis and quality of life. *J Clin Gastroenterol*. 2002;35:29–34.
- Sasada S, Ikeda Y, Saito H, Saku M. Characteristics of gastric cancer in patients over 80-years-old. *Hepatogastroenterology*. 2008;55:1931–4.
- Park DJ, Lee HJ, Kim HH, Yang HK, Lee KU, Choe KJ. Predictors of operative morbidity and mortality in gastric cancer surgery. *Br J Surg*. 2005;92:1099–102.
- Liang YX, Deng JY, Guo HH, Ding XW, Wang XN, Wang BG, et al. Characteristics and prognosis of gastric cancer in patients aged  $\geq 70$  years. *World J Gastroenterol*. 2013;19:6568–78.
- Takeshita H, Ichikawa D, Komatsu S, Kubota T, Okamoto K, Shiozaki A, et al. Surgical outcomes of gastrectomy for elderly patients with gastric cancer. *World J Surg*. 2013;37:2891–8.
- Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2010 (ver. 3). *Gastric Cancer*. 2011;14:113–23.
- Japanese Gastric Cancer Association. Japanese classification of gastric carcinoma: 3rd English edition. *Gastric Cancer*. 2011;14:101–12.
- Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg*. 2004;240:205–13.
- Gretschel S, Estevez-Schwarz L, Hunerbein M, Schneider U, Schlag PM. Gastric cancer surgery in elderly patients. *World J Surg*. 2006;30:1468–74.
- Kumagai K, Hiki N, Nunobe S, Jiang X, Kubota T, Aikou S, et al. Potentially fatal complications for elderly patients after laparoscopy-assisted distal gastrectomy. *Gastric Cancer*. 2014;17:548–55.
- Hayashi T, Yoshikawa T, Aoyama T, Ogata T, Cho H, Tsuburaya A. Severity of complications after gastrectomy in elderly patients with gastric cancer. *World J Surg*. 2012;36:2139–45.
- Endo S, Yoshikawa Y, Hatanaka N, Tominaga H, Shimizu Y, Hiraoka K, et al. Treatment for gastric carcinoma in the oldest old patients. *Gastric Cancer*. 2011;14:139–43.
- United Nations. World population ageing. 2009. [http://www.un.org/esa/population/publications/WPA2009/WPA2009\\_WorkingPaper.pdf](http://www.un.org/esa/population/publications/WPA2009/WPA2009_WorkingPaper.pdf). Accessed Jul 2014.
- Orsenigo E, Tomajer V, Palo SD, Carlucci M, Vignali A, Tamburini A, et al. Impact of age on postoperative outcomes in 1118 gastric cancer patients undergoing surgical treatment. *Gastric Cancer*. 2007;10:39–44.
- Katai H, Sasako M, Sano T, Fukagawa T. Gastric cancer surgery in the elderly without operative mortality. *Surg Oncol*. 2004;13:235–8.
- Gunther K, Horbach T, Merkel S, Meyer M, Schnell U, Klein P, et al. D3 lymph node dissection in gastric cancer: evaluation of postoperative mortality and complications. *Surg Today*. 2000;30:700–5.
- Hotta T, Taniguchi K, Kobayashi Y, Johata K, Sahara M, Naka T, et al. Postoperative evaluation of pylorus-preserving procedures compared with conventional distal gastrectomy for early gastric cancer. *Surg Today*. 2001;31:774–9.

23. Kumagai K, Shimizu K, Yokoyama N, Aida S, Arima S, Aikou T. Questionnaire survey regarding the current status and controversial issues concerning reconstruction after gastrectomy in Japan. *Surg Today*. 2012;42:411–8.
24. Takayama T, Matsumoto S, Wakatsuki K, Tanaka T, Migita K, Ito M et al. A novel laparoscopic procedure for treating proximal early gastric cancer: laparoscopy-assisted pylorus-preserving nearly total gastrectomy. *Surg Today* (2014) (in press).

## Accuracy of multidetector-row CT in diagnosing lymph node metastasis in patients with gastric cancer

Takuro Saito · Yukinori Kurokawa · Shuji Takiguchi · Yasuhiro Miyazaki · Tsuyoshi Takahashi · Makoto Yamasaki · Hiroshi Miyata · Kiyokazu Nakajima · Masaki Mori · Yuichiro Doki

Received: 18 April 2014 / Accepted: 22 July 2014 / Published online: 6 August 2014  
© European Society of Radiology 2014

### Abstract

**Objectives** The purpose of this study was to determine the optimal cut-off value of lymph node size for diagnosing metastasis in gastric cancer with multidetector-row computed tomography (MDCT) after categorizing perigastric lymph nodes into three regions.

**Methods** The study included 90 gastric cancer patients who underwent gastrectomy. The long-axis diameter (LAD) and short-axis diameter (SAD) of all visualized lymph nodes were measured with transverse MDCT images. The locations of lymph nodes were categorized into three regions: lesser curvature, greater curvature, and suprapancreatic. The diagnostic value of lymph node metastasis was assessed with receiver operating characteristic (ROC) analysis.

**Results** The area under the curve was larger for SAD than LAD in all groups. The optimal cut-off values of SAD were determined as follows: overall, 9 mm; differentiated type, 9 mm; undifferentiated type, 8 mm; lesser curvature region, 7 mm; greater curvature region, 6 mm; and suprapancreatic region, 9 mm. The diagnostic accuracies for lymph node metastasis using individual cut-off values were 71.1 % based on histological type and 76.6 % based on region of lymph node location.

**Conclusions** The diagnostic accuracy of lymph node metastasis in gastric cancer was improved by using individual cut-off values for each lymph node region.

### Key points

- Multidetector-row computed tomography is widely used to predict pathological nodal status.

- An optimal cut-off value of lymph node size has not been determined.
- Cut-off values were assessed according to histology and nodal location.
- The optimal cut-off values differed based on histology and nodal location.
- Diagnostic accuracy was improved by using individual cut-off values for each region.

**Keywords** Gastric cancer · Stomach · Multidetector-row CT · Lymph node metastasis · Staging accuracy

### Abbreviations

MDCT	multidetector-row computed tomography
LAD	long-axis diameter
SAD	short-axis diameter
ROC	receiver operating characteristics
AUC	area under the curve

### Introduction

Gastric cancer is a major cause of cancer-related deaths worldwide, and it is the most common cause of cancer-related mortality in eastern Asia [1]. Lymph node metastasis is one of the most important factors affecting the prognosis of gastric cancer [2, 3]. Locally advanced tumours usually require preoperative chemotherapy to improve curative resection rates and long-term survival. In European countries, perioperative chemotherapy using a regimen of epirubicin, cisplatin, and fluorouracil is a standard treatment for localized gastric cancer [4, 5]. The National Comprehensive Cancer Network (NCCN) guidelines state that perioperative chemotherapy or preoperative chemoradiation is the preferred approach for T2 or more advanced gastric cancer [6]. Although accurate

T. Saito · Y. Kurokawa (✉) · S. Takiguchi · Y. Miyazaki · T. Takahashi · M. Yamasaki · H. Miyata · K. Nakajima · M. Mori · Y. Doki  
Department of Gastroenterological Surgery, Osaka University, Graduate School of Medicine, 2-2-E2, Yamadaoka, Suita, Osaka 565-0871, Japan  
e-mail: ykurokawa@gesurg.med.osaka-u.ac.jp