

WJG 20th Anniversary Special Issues (8): Gastric cancer

Minimally invasive surgery in gastric cancer

Sang-Yong Son, Hyung-Ho Kim

Sang-Yong Son, Hyung-Ho Kim, Department of Surgery, Seoul National University Bundang Hospital, Seongnam 463-707, South Korea

Author contributions: Son SY performed the research and wrote the paper; Kim HH designed and supervised the research.

Correspondence to: Hyung-Ho Kim, MD, PhD, Department of Surgery, Seoul National University Bundang Hospital, 166 Gumi-ro, Bundang-gu, Seongnam 463-707, South Korea. hkim@snubh.org

Telephone: +82-31-7877095 Fax: +82-31-7874078

Received: November 15, 2013 Revised: January 17, 2014

Accepted: May 12, 2014

Published online: October 21, 2014

i39.14132

Abstract

Minimally invasive surgery for gastric cancer has rapidly gained popularity due to the early detection of early gastric cancer. As advances in instruments and the accumulation of laparoscopic experience increase, laparoscopic techniques are being used for less invasive but highly technical procedures. Recent evidence suggests that the short- and long-term outcomes of minimally invasive surgery for early gastric cancer and advanced gastric cancer are comparable to those of conventional open surgery. However, these results should be confirmed by large-scale multicenter prospective randomized controlled clinical trials.

© 2014 Baishideng Publishing Group Inc. All rights reserved.

Key words: Gastric cancer; Minimally invasive surgery; Laparoscopic gastrectomy

Core tip: Minimally invasive surgery has become an alternative modality for the treatment of gastric cancer.

Son SY, Kim HH. Minimally invasive surgery in gastric cancer. *World J Gastroenterol* 2014; 20(39): 14132-14141 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v20/i39/14132.htm> DOI: <http://dx.doi.org/10.3748/wjg.v20>

INTRODUCTION

Gastric cancer is the second leading cause of cancer-related death and the fourth most common cancer worldwide; nevertheless, its incidence has decreased substantially in most parts of the world. A total of 989600 new cases and 738000 deaths are estimated to have occurred in 2008, accounting for 8% of the total cancer cases and 10% of total cancer deaths. Nearly 70% of new cases and deaths occur in developing countries, and about 40% occur in Eastern Asia^[1,2]. The highest incidence of gastric cancer is found in South Korea at 41.4 per 100000, including both sexes^[3]. Due to health screening programs and improved diagnostic techniques, diagnoses of early gastric cancer (EGC) have steadily increased, accounting for nearly 50% of all gastric cancers in Japan and South Korea^[4,5].

As the incidence of EGC has increased in Eastern Asia, so has minimally invasive surgery (MIS), including laparoscopy- or robot-assisted surgery. According to the tenth national survey by the Japan Society of Endoscopic Surgery, 7341 laparoscopic gastrectomies were performed during 2009, which was an approximately ten-fold increase over a decade and accounted for approximately 25% of gastric cancer surgeries that year^[6]. In South Korea, 3083 laparoscopic gastrectomies (26% of gastric cancer surgeries) were performed in 2009, which was an almost five-fold increase over a 5-year period^[4]. Recently, laparoscopic gastric surgery has spread rapidly and has been adopted in China (fourth-highest prevalence of gastric cancer and the largest population in the world). Furthermore, the publication of Chinese studies on the topic is rapidly increasing^[7].

Laparoscopic surgery, a type of MIS, has been used for the treatment of gastric cancer since the 1990s. Ohgami *et al*^[8] first developed laparoscopic wedge resection of the stomach using a lesion-lifting method in 1991. Ki-

tano *et al*^[9] and Nagai *et al*^[10] reported the success of laparoscopy-assisted distal gastrectomy (LADG) for EGC in 1994 and 1995. In the early 2000s, robot-assisted surgery emerged as one of the treatment modalities for EGC, and the first robot-assisted gastrectomy (RAG) for EGC was reported by Hashizume *et al*^[11] in 2003. In 2011, single-incision laparoscopic surgery was described for EGC^[12]. MIS has revolutionized the surgical approach to gastric cancer for the past two decades, leading to improvements in patients' quality of life by producing less pain, less blood loss, earlier postoperative recovery, and a shorter hospital stay^[13-19].

Currently, MIS is evolving in two major directions^[20]. First, MIS techniques are being used in more radical but less invasive procedures, such as totally laparoscopic distal gastrectomy or laparoscopic total gastrectomy with D1+ or D2 lymphadenectomy. These procedures are comparable to conventional open surgery and can be performed even in patients with advanced gastric cancer (AGC)^[21-23]. Second, MIS is being employed for function-preserving surgery, including pylorus-preserving gastrectomy (PPG), proximal gastrectomy, and limited gastrectomy with sentinel node navigation surgery. These procedures can assist in improving patients' late postoperative function and quality of life^[20,24-26].

RECENT ADVANCES IN LAPAROSCOPIC GASTRECTOMY

As advances in instruments and the accumulation of laparoscopic experience increase, laparoscopic techniques are being used for less invasive but highly technical procedures. Totally laparoscopic gastrectomy (TLG) is one example. TLG has gained popularity since Kanaya *et al*^[27] reported the first delta-shaped anastomosis. A recent meta-analysis (five studies, 652 patients) showed that totally laparoscopic distal gastrectomy has less bleeding, shorter time to first flatus, and lower rates of postoperative complications than LADG. Various intracorporeal anastomoses have been introduced for TLG, such as the Billroth II anastomosis using linear staplers, the beta-shaped Roux-en-Y reconstruction, the semi-loop and overlap method after total gastrectomy, and the inverted T-shaped anastomosis using linear staplers^[28-32].

Laparoscopic surgery is now also being used even for advanced cancers or remnant gastric cancer. Son *et al*^[33] reported three cases of laparoscopic para-aortic lymphadenectomy after palliative chemotherapy for AGC with isolated para-aortic lymph node metastasis. The mean operation time was 365 min, and the mean estimated blood loss was 158 mL. The mean number of retrieved para-aortic lymph nodes was nine. Shinohara *et al*^[34] reported the first series of successful totally laparoscopic completion total gastrectomy (TLCG) for remnant gastric cancer. The mean operation time of the five TLCGs was 360 min, and the mean blood loss was 20 mL. The mean number of retrieved lymph nodes was 19.

Single port surgery is increasingly being used to treat EGC. Omori *et al*^[12] first reported single-incision laparoscopic distal gastrectomy in seven patients with EGC: the median operation time was 344 min, the median estimated blood loss was 25 mL, and the median number of retrieved lymph nodes was 67. Recently, Ahn *et al*^[35] reported the first case of single-incision laparoscopic total gastrectomy for proximal EGC.

CURRENT STATUS OF ONCOLOGICAL SAFETY IN LAPAROSCOPIC GASTRECTOMY

Laparoscopic surgery for EGC has gained popularity based on evidence from six prospective randomized controlled trials (RCTs) that it can achieve comparable oncological outcomes to open surgery^[13,14,17,36-38]. However, the majority of these trials were limited by a small sample size, using patients from a single center, and having a short-term follow-up period.

Recently, several long-term outcome studies of laparoscopic gastrectomy were published (Table 1). Zeng *et al*^[39] conducted a meta-analysis using five RCTs and 17 non-RCTs with 3411 patients, and reported that LADG may reduce intraoperative blood loss, postoperative analgesic consumption, and hospital duration, without increasing the total hospitalization costs and cancer recurrence rate. In relation to oncological safety, they reported that the mean number of retrieved lymph nodes in LADG was similar to that in open distal gastrectomy (ODG), and the long-term survival rate of patients was similar between both groups. Viñuela *et al*^[40] and Jiang *et al*^[41] also conducted meta-analyses and reported the superiority of laparoscopic gastrectomy in postoperative recovery. Kim *et al*^[42] reported the long-term outcomes of a prospective RCT (COACT 0301) with 164 patients and median follow-up period of 74.3 mo. They reported that the LADG and ODG groups showed similar survival (5-year disease-free survival: 98.8% in LADG *vs* 97.6% in ODG, $P = 0.514$; 5-year overall survival: 97.6% in LADG *vs* 96.3% in ODG, $P = 0.721$) with reductions in mild complications observed with LADG (23.2% in LADG *vs* 41.5% in ODG, $P = 0.012$). In relation to patient quality of life, LADG showed better short-term functional and symptom scores, but no long-term advantages.

Currently, two large-scale multicenter RCTs are underway to elucidate the long-term oncological results of laparoscopic gastrectomy: The Korean Laparoscopic Gastrointestinal Surgery Study (KLASS)-01 and Japanese Clinical Oncology Group (JCOG) 0912 trials (Table 2). KLASS trial is the first multicenter (13 institutions) randomized controlled clinical trial to compare open and laparoscopic surgery in patients with clinical stage I gastric cancer. The primary endpoint is overall survival, and secondary endpoints are disease-free survival, morbidity and mortality, quality of life, inflammatory and immune responses, and cost-effectiveness. From 2006 to 2010,

Table 1 Long-term outcomes of laparoscopic gastrectomy for gastric cancer *n* (%)

Ref.	Year	Patients (<i>n</i>)		Follow-up period	Inclusion	Lymphadenectomy	5-yr survival		<i>P</i> value	Recurrence	
		LG	OG				LG	OG		LG	OG
Lee <i>et al</i> ^[118]	2009	106	105	55.0	cT1	D2	95.9%	94.9%	NS	1 (0.94)	1 (0.95)
An <i>et al</i> ^[108]	2010	42	162	35.0	pT1N+	D1 + β, D2	89.7%	89.9%	NS	4 (9.5)	14 (8.6)
Jeong <i>et al</i> ^[109]	2011	138	261	36.8	≤ cT3N1	D1 + β, D2	Median OS: 30 mo			35 (13.4)	30 (21.7)
MacLellan <i>et al</i> ^[110]	2012	21	182	21.3	Stage I-IV	-	69.5% (3YSR)	65.6% (3YSR)	NS	8 (38.1)	67 (36.8)
Hamabe <i>et al</i> ^[111]	2012	66	101	30.4 (LG) 53.3 (OG)	cT1	D2	94.4%	78.5%	NS	4 (6.0)	22 (21.7)
Moisan <i>et al</i> ^[22]	2012	31	31	50.0	-	D1 + α, D1 + β, D2	74.0% (3YSR)	75.0% (3YSR)	NS	5 (16.1)	4 (12.9)
Shinohara <i>et al</i> ^[46]	2013	186	150	48.8	cT2-4	D2	68.1%	63.7%	NS	53 (28.4)	-
Kim <i>et al</i> ^[42]	2013	82	82	74.3	≤ cT1N1	D2	97.6%	96.3%	NS	1 (1.2)	2 (2.4)

LG: Laparoscopic gastrectomy; OG: Open gastrectomy; OS: Overall survival.

Table 2 Ongoing prospective randomized controlled trials in gastric cancer surgery

Study	Country	Start year	Phase	Study design	Inclusion	Sample size	Primary endpoint
KLASS-01	South Korea	2006	III	LADG <i>vs</i> ODG	cT1-2/N0	1400	Overall survival
JCOG 0912	Japan	2010	III	LADG <i>vs</i> ODG	cT1-2/N0	920	Overall survival
JLSSG 0901	Japan	2010	II / III	LADG <i>vs</i> ODG	cT2-4a/N0-2/M0	II: 180 III: 500	II: Morbidity III: Relapse-free survival
KLASS-02	South Korea	2011	III	LADG <i>vs</i> ODG	cT2-4a/N0-4a/M0	1050	3-yr DFS
CLASS-01	China	2012	III	LADG <i>vs</i> ODG	cT2-4a/N0-4a/M0	1056	3-yr DFS
COACT 1001	South Korea	2010	III	LADG <i>vs</i> ODG	cT2-4a/N0-3a/M0	204	Noncompliance rate
KRGS	South Korea	2011	II	Robot <i>vs</i> Laparoscopy	cT1-3/M0	1700	Surgical outcomes
SENORITA	South Korea	2012	III	Laparoscopic SNNS	cT1-2/N0/size < 4 cm	160	Safety/efficacy

LADG: Laparoscopy-assisted distal gastrectomy; ODG: Open distal gastrectomy; SNNS: Sentinel node navigation surgery; DFS: Disease-free survival.

1416 patients (705 patients in LADG and 711 patients in ODG) were enrolled, and the final results are expected to be reported in 2015^[43]. In 2010, the JCOG also started a multicenter RCT to compare ODG and LADG in 920 patients with stage I gastric cancer accrued from 33 institutions. The primary endpoint of JCOG 0912 is overall survival, and the secondary endpoints are relapse-free survival, proportion of LADG completion and conversion to open surgery, adverse events, short-term clinical outcomes, and postoperative quality of life^[44].

There is also notable interest in the application of MIS for AGC. As the accumulation of laparoscopic experience increases, some experienced surgeons are extending the indication of laparoscopic gastrectomy to locally AGC. There is also evidence that MIS is feasible for AGC. Recently, Choi *et al*^[45] conducted a meta-analysis using one RCT and nine non-RCTs with 1819 patients (960 patients in the open group and 859 patients in the laparoscopy group), and reported that there was no statistical difference in overall survival and disease-free survival between laparoscopic gastrectomy and open gastrectomy. Shinohara *et al*^[46] reported the results of a retrospective cohort study in 336 patients (150 open and 186 laparoscopy) who underwent gastrectomy with D2 lymph node dissection for cT2-T4 cancers. Laparoscopic D2 gastrectomy showed significantly less operative blood loss and shorter hospital stay, but there was no difference

in the morbidity and mortality rates between both groups. The 5-year disease-free and overall survival rate were 65.8% and 68.1% in the laparoscopic group and 62.0% and 63.7% in the open group (*P* = 0.737 and *P* = 0.968, retrospectively). Moreover, there were no differences in the patterns of recurrence between both groups. In the laparoscopic group, 53 patients (28.4%) developed tumor recurrence: 29 (54.7%) peritoneal recurrences, 23 (43.4%) distant or hematogenous recurrences, and 15 (28.3%) locoregional or lymphatic recurrences *vs* 17 (50%), 15 (44.1%), and 11 (32.6%), respectively, in the open group. Park do *et al*^[47] reported the long-term outcomes of 239 laparoscopic gastrectomies for AGC. These patients were preoperatively diagnosed with EGC but diagnosed with AGC on final pathological examination from a multicenter retrospective study. They reported that the overall 5-year survival rates were 90.5% in stage I B, 86.4% in II A, 52.8% in III A, 52.9% in III B, and 37.5% in III C, and the results were comparable to the previous reports for open gastrectomy. Lee *et al*^[23] reported the short-term outcomes of a prospective phase II trial. A total of 157 patients with cT2N0-T4aN2 gastric cancer were finally enrolled in this study. The mean number of retrieved lymph nodes was 52.7 for LADG and 63.8 for laparoscopy-assisted total gastrectomy. The complication rate was 25.5% and local and systemic complication rates (more than grade II on the Clavien-Dindo classification)

were 8.3% and 3.2%. They concluded that laparoscopic gastrectomy with D2 lymph node dissection was safe and technically feasible for the treatment of AGC, with an acceptable rate of morbidity and mortality.

There are presently three large-scale multicenter trials underway for AGC, being conducted in three different countries. The KLASS-02 trial is a phase III study to evaluate the efficacy of LADG with D2 lymph node dissection for AGC. The estimated sample size is 1050 and the primary endpoint is 3-year disease-free survival. For quality control, all surgeons are required to be standardized and are qualified through a review of six unedited videos of their procedures (3 laparoscopic and 3 open procedures) by independent reviewers. The Japanese Laparoscopic Surgery Study Group (JLSSG) launched a multicenter phase II/III study, entitled JLSSG 0901, to compare LADG and ODG in patients with cT2-T4aM0 gastric cancer. After the accrual of 180 patients, the incidence of major complications will be assessed. If an early-stopping rule does not apply due to a high complication rate, the trial will continue accrual until 500 patients are enrolled^[48]. Recently, the Chinese laparoscopic gastrointestinal Surgical Study (CLASS) group started a phase III study, which is entitled “CLASS-01” and the study design is similar to that of the KLASS-02 trial.

LAPAROSCOPIC FUNCTION-PRESERVING SURGERY

PPG was originally used for the treatment of peptic ulcer, and it has been introduced as a surgical therapy for EGC that is designed to preserve function and maintain a better quality of life^[49-53]. By preserving pyloric function, it has several nutritional advantages and has less postgastrectomy-related disorders, such as dumping syndrome and alkaline reflux, a lower incidence of disturbed bowel habits, and a reduced flatus frequency^[26,54,55].

Recently, laparoscopy-assisted PPG (LAPPG) has been attempted as both a function-preserving and minimally invasive technique, with reported benefits over conventional PPG. Jiang *et al*^[56] reported the short-term outcomes of 307 LAPPGs. The mean operation time was 229.4 min, the estimated blood loss was 49.1 mL, and the mean total number of dissected lymph nodes was 31.6. Major complications developed in four patients (1.3%), and gastric stasis was the most common complication, occurring in 19 patients (6.2%). The mean serum total protein and albumin levels did not change significantly after surgery, so the authors concluded that LAPPG is a safe operation with a notable reduction in major complications in patients with EGC in the middle third of the stomach. Recently, Suh *et al*^[26] compared the surgical, oncological, nutritional, and functional benefits between 116 LAPPGs and 176 LADGs. They reported that delayed gastric emptying was less frequent in LADG than in LAPPG (1.7% *vs* 7.8%, $P = 0.015$), but the rate of other complications was significantly higher in LADG

than in LAPPG (17.0% *vs* 7.8%, $P = 0.023$). The 3-year recurrence-free survival was similar between LADG and LAPPG (98.8% *vs* 98.2%, $P = 0.702$), but decrease in serum protein and albumin levels at 1 to 6 mo postoperation and abdominal fat volumes at 1 year postoperation were significantly greater in LADG than in LAPPG. They concluded that for middle-third EGC, LAPPG can be considered a superior treatment option over LADG in terms of nutritional advantage and a lower incidence of gallstone.

As the incidence of proximal gastric cancer has recently increased, proximal gastrectomy (PG) is widely accepted as a function-preserving surgery for proximal EGC^[57-59]. In spite of functional benefits such as improved postoperative nutrition, preventing anemia, and release of gut hormones, PG has not gained in popularity, mainly due to postoperative complications such as esophageal reflux and anastomotic stricture^[60-64]. To overcome these complications, various reconstruction methods and esophagojejunostomies have been developed, including jejunal interposition and double tract reconstruction, which are considered to be superior to esophagogastrotomy in preventing postoperative esophageal reflux. Recently, these procedures have been performed laparoscopically with demonstrated clinical efficacy. Kinoshita *et al*^[24] compared 22 laparoscopic proximal gastrectomies (LPGs) with 68 open proximal gastrectomies, both with jejunal interposition. The operation time was longer in the LPG group, but estimated blood loss was significantly less in the LPG group. The average number of harvested lymph nodes did not differ and there was no difference in complication rates, including leakage of the esophagojejunostomy. Ahn *et al*^[65] reported the short-term outcomes of LPG with double tract reconstruction for proximal EGC in 43 patients from June 2009 to April 2012. The mean surgical time was 180.7 min, and the estimated blood loss was 120.4 mL. During the mean follow-up period of 21.6 mo, two patients had esophagojejunostomy stenosis, but they were successfully treated with fluoroscopic balloon dilatations. In addition, two patients had Visick grade II reflux symptoms (4.6%), but were effectively managed by medication.

LAPAROSCOPIC SENTINEL NODE NAVIGATION SURGERY

Sentinel node (SN) biopsy was widely used in patients with melanoma and breast cancer^[66,67]. The SNs are the lymph nodes associated with the primary site of a tumor that are thought to be the first possible micrometastasis site along the lymphatic drainage pathway from the tumor^[66]. The concept of SN biopsy revolutionized the approach to the surgical treatment in both melanoma and breast cancer.

The clinical application of SN biopsy for EGC has been controversial due to its low sensitivity and accuracy^[68-70]. Recently, however, SN biopsy detection and

accuracy rates of 90% to 100% have been achieved^[71-77]. According to a recent meta-analysis that included 38 studies (2128 patients), the pooled SN identification rate, sensitivity, negative predictive value, and accuracy were 93.7%, 76.9%, 90.3%, and 92.0%, respectively. In a subgroup analysis, early T stage, combined tracers, a submucosal injection method, conventional open surgery, and usage of immuno-histochemistry were associated with a higher SN identification rate and sensitivity. The authors concluded that SN biopsy in gastric cancer is technically feasible, especially in cases with early T stage, and when combined tracers and submucosal injection methods are employed^[78]. A study group in the Japan Society of Sentinel Node Navigation Surgery recently conducted a multicenter, single-arm, phase II study of SN mapping using a standardized dual-tracer method. The inclusion criterion was untreated stage cT1-2 adenocarcinoma with tumor size less than 4 cm in gross diameter. SN biopsy was performed in 397 eligible patients. The SN detection rate was 97.5% and the accuracy of nodal evaluation for metastasis was 99%^[79].

Therefore, a dual-tracer method using radioactive colloids and blue dyes are currently considered the most reliable method for SN biopsy^[74-77]. In recent years, computed tomography lymphangiography, infrared ray electronic endoscopy, and indocyanine green fluorescence imaging are emerging as new tracers for laparoscopic SN biopsy^[71,80-84].

Furthermore, a multicenter prospective phase III trial (SENORITA) started last year with the aim of validating the clinical role of laparoscopic SN biopsy. The inclusion criterion was stage cT1N0 tumor of size less than 3 cm and the estimated sample size was 580. The results of this clinical trial are expected to provide perspectives on the future of laparoscopic SN navigation surgery for EGC.

ROBOTIC SURGERY IN GASTRIC CANCER

Robotic surgical systems were introduced in early 2000 to overcome the shortcomings of conventional laparoscopic surgery. They provide the surgeon with technical features such as three-dimensional vision and the elimination of physiologic tremor using a computerized mechanical interface. Moreover, the articulated arms provide natural movement similar to that of the human hand, thus facilitating straightforward manipulation^[85].

Many studies have reported that RAG for gastric cancer has comparable short-term outcomes and oncological feasibility to laparoscopic gastrectomy, but there is no available long-term oncological or RCT data^[86-88]. Recently, the Korean Robot Gastrectomy Study Group began a multicenter prospective, case-matched clinical trial to compare robotic *vs* laparoscopic gastrectomy for EGC. A total of 400 patients were enrolled and the study was completed in 2012. Surgical complications, quality of

life, immunologic response, and cost-effectiveness will be analyzed^[89].

Recently, a robotic system was introduced that included image-guided assistance. Kim *et al*^[90] performed 12 robotic gastrectomies using intraoperative vascular images, which depicted vasculatures around the stomach. The authors reported that the use of image-guidance during the operation provided a vascular map and enabled the surgeon to avoid bleeding and damage to other organs by preventing vascular injury.

ENDOSCOPIC SURGERY FOR GASTRIC CANCER

Endoscopic resection has changed the main axis of treatment for patients with intramucosal gastric cancer in the past decade^[91]. Because endoscopic resection provides the maintained volume and function of stomach even after curative resection of the tumor, the patient can avoid postgastrectomy complications and retain a good quality of life^[92].

According to the Japanese gastric cancer guidelines, the indication of endoscopic resection is currently recommended in differentiated adenocarcinoma without ulcerative findings, of which the depth invasion is clinically diagnosed as T1a and the diameter is less than 2 cm^[93]. Recently, many reports showed the superiority of endoscopic submucosal dissection (ESD) compared with endoscopic mucosal resection in terms of higher en bloc and complete resection rate^[94-96], and this new technique and the advance of devices allowed to extend the indication of endoscopic resection, which included mucosal cancer without ulcerative findings regardless of tumor size or mucosal cancer with ulcerative findings less than 3 cm, or submucosal invasive cancer (less than 500 μ m from the muscularis mucosae) less than 3 cm^[97-100].

Several studies reported acceptable results of the ESD in extended indication. Sanomura *et al*^[101] reported that complete resection was achieved for 93.2% of the submucosal cancer (sm1, less than 500 μ m) that met the extended criteria and there was neither lymph node metastasis nor local recurrence. Ahn *et al*^[102] reported that there was no difference in local recurrence rate between the absolute indication group and the extended indication group at a median follow-up of 32 mo (0.9% *vs* 1.1%, $P = 0.006$). Recently, two long-term outcomes of ESD in extended indication were reported and these studies demonstrated that there was no difference in disease-free survival between both indication groups^[103,104].

However, some studies showed positive lymph node metastasis in patients with the extended criteria. Jee *et al*^[105] reviewed 129 gastrectomies indicated for extended indication of endoscopic resection and they reported that there was lymph node metastasis in two patients (4%). An *et al*^[106] reported 1.7% of lymph node metastasis even in submucosal cancer (sm1, less than 500 μ m) less than 2 cm. Recently, Kang *et al*^[107] reported that lymph node me-

tastasis was found in 15% of intestinal-type submucosal cancers (sm1, less than 500 μm) less than 3 cm without lymphovascular invasion.

Therefore, the selection of appropriate lesion for endoscopic resection still remains controversial and more long-term follow-up data are needed to achieve a consensus of endoscopic indication for early gastric cancer.

CONCLUSION

Recent evidence suggests that the short- and long-term outcomes of MIS for EGC and AGC are comparable to those of conventional open surgery. However, further Level 1 evidence is required to confirm the suitability of MIS for gastric cancer, as well as the appropriate indications for its use. The ongoing large-scale multicenter RCTs are expected to clarify the oncologic safety of MIS in the near future.

REFERENCES

- 1 **Jemal A**, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. *CA Cancer J Clin* 2011; **61**: 69-90 [PMID: 21296855 DOI: 10.3322/caac.20107]
- 2 **Bertuccio P**, Chatenoud L, Levi F, Praud D, Ferlay J, Negri E, Malvezzi M, La Vecchia C. Recent patterns in gastric cancer: a global overview. *Int J Cancer* 2009; **125**: 666-673 [PMID: 19382179 DOI: 10.1002/ijc.24290]
- 3 GLOBOCAN 2008: cancer fact sheet. Stomach Cancer Incidence and Mortality Worldwide in 2008 Summary [Internet]. Lyon: IARC, 2010. Available from: URL: <http://globocan.iarc.fr/factsheets/cancers/stomach.asp>
- 4 **Yamaguchi N**, Isomoto H, Fukuda E, Ikeda K, Nishiyama H, Akiyama M, Ozawa E, Ohnita K, Hayashi T, Nakao K, Kohno S, Shikuwa S. Clinical outcomes of endoscopic submucosal dissection for early gastric cancer by indication criteria. *Digestion* 2009; **80**: 173-181 [PMID: 19776581]
- 5 **Jeong O**, Park YK. Clinicopathological features and surgical treatment of gastric cancer in South Korea: the results of 2009 nationwide survey on surgically treated gastric cancer patients. *J Gastric Cancer* 2011; **11**: 69-77 [PMID: 22076206 DOI: 10.5230/jgc.2011.11.2.69]
- 6 **Japan Society for Endoscopic Surgery**. Nationwide survey on endoscopic surgery in Japan. *J Jpn Soc Endosc Surg* 2010; **15**: 557-679
- 7 **Chen XZ**, Li YY, Hu JK, Yang K, Liu J, Zhang B, Chen ZX, Chen JP, Zhou ZG. Spread and development of laparoscopic surgery for gastric tumors in mainland China: initial experiences. *Hepatogastroenterology* 2012; **59**: 654-658 [PMID: 22328265 DOI: 10.5754/hge11902]
- 8 **Ohgami M**, Otani Y, Kumai K, Kubota T, Kitajima M. [Laparoscopic wedge resection of the stomach for early gastric cancer using a lesion-lifting-method: curative and minimally invasive treatment]. *Zentralbl Chir* 1998; **123**: 465-468 [PMID: 22462212]
- 9 **Kitano S**, Iso Y, Moriyama M, Sugimachi K. Laparoscopy-assisted Billroth I gastrectomy. *Surg Laparosc Endosc* 1994; **4**: 146-148 [PMID: 8180768]
- 10 **Nagai Y**, Tanimura H, Takifuji K, Kashiwagi H, Yamoto H, Nakatani Y. Laparoscope-assisted Billroth I gastrectomy. *Surg Laparosc Endosc* 1995; **5**: 281-287 [PMID: 7551280]
- 11 **Hashizume M**, Sugimachi K. Robot-assisted gastric surgery. *Surg Clin North Am* 2003; **83**: 1429-1444 [PMID: 14712877]
- 12 **Omori T**, Oyama T, Akamatsu H, Tori M, Ueshima S, Nishida T. Transumbilical single-incision laparoscopic distal gastrectomy for early gastric cancer. *Surg Endosc* 2011; **25**: 2400-2404 [PMID: 21298524 DOI: 10.1007/s00464-010-1563-3]
- 13 **Kitano S**, Shiraishi N, Fujii K, Yasuda K, Inomata M, Adachi Y. A randomized controlled trial comparing open vs laparoscopy-assisted distal gastrectomy for the treatment of early gastric cancer: an interim report. *Surgery* 2002; **131**: S306-S311 [PMID: 11821829]
- 14 **Lee JH**, Han HS, Lee JH. A prospective randomized study comparing open vs laparoscopy-assisted distal gastrectomy in early gastric cancer: early results. *Surg Endosc* 2005; **19**: 168-173 [PMID: 15580441]
- 15 **Lee SI**, Choi YS, Park DJ, Kim HH, Yang HK, Kim MC. Comparative study of laparoscopy-assisted distal gastrectomy and open distal gastrectomy. *J Am Coll Surg* 2006; **202**: 874-880 [PMID: 16735200]
- 16 **Yasuda K**, Shiraishi N, Etoh T, Shiromizu A, Inomata M, Kitano S. Long-term quality of life after laparoscopy-assisted distal gastrectomy for gastric cancer. *Surg Endosc* 2007; **21**: 2150-2153 [PMID: 17479329]
- 17 **Kim YW**, Baik YH, Yun YH, Nam BH, Kim DH, Choi IJ, Bae JM. Improved quality of life outcomes after laparoscopy-assisted distal gastrectomy for early gastric cancer: results of a prospective randomized clinical trial. *Ann Surg* 2008; **248**: 721-727 [PMID: 18948798 DOI: 10.1097/SLA.0b013e318185e62e]
- 18 **Lee JH**, Yom CK, Han HS. Comparison of long-term outcomes of laparoscopy-assisted and open distal gastrectomy for early gastric cancer. *Surg Endosc* 2009; **23**: 1759-1763 [PMID: 19057958 DOI: 10.1007/s00464-008-0198-0]
- 19 **Kim HH**, Hyung WJ, Cho GS, Kim MC, Han SU, Kim W, Ryu SW, Lee HJ, Song KY. Morbidity and mortality of laparoscopic gastrectomy versus open gastrectomy for gastric cancer: an interim report—a phase III multicenter, prospective, randomized Trial (KLASS Trial). *Ann Surg* 2010; **251**: 417-420 [PMID: 20160637 DOI: 10.1097/SLA.0b013e3181cc8f6b]
- 20 **Takeuchi H**, Kitagawa Y. New sentinel node mapping technologies for early gastric cancer. *Ann Surg Oncol* 2013; **20**: 522-532 [PMID: 22941161 DOI: 10.1245/s10434-012-2602-1]
- 21 **Jun G**, Ping L, Jie C, Qi L, Tang D, Wang D. Totally laparoscopic vs. laparoscopically assisted distal gastrectomy for gastric cancer: a meta-analysis. *Hepatogastroenterology* 2013; **60**: 1530-1534 [PMID: 23933947 DOI: 10.5754/hge121240]
- 22 **Moisan F**, Norero E, Slako M, Varas J, Palominos G, Crovari F, Ibañez L, Pérez G, Pimentel F, Guzmán S, Jarufe N, Boza C, Escalona A, Funke R. Completely laparoscopic versus open gastrectomy for early and advanced gastric cancer: a matched cohort study. *Surg Endosc* 2012; **26**: 661-672 [PMID: 22011940 DOI: 10.1007/s00464-011-1933-5]
- 23 **Lee JH**, Ahn SH, Park do J, Kim HH, Lee HJ, Yang HK. Laparoscopic total gastrectomy with D2 lymphadenectomy for advanced gastric cancer. *World J Surg* 2012; **36**: 2394-2399 [PMID: 22674092 DOI: 10.1007/s00268-012-1669-y]
- 24 **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]
- 25 **Machado MA**, Makdissi FF, Surjan RC, Machado MC. Laparoscopic pylorus-preserving pancreatoduodenectomy with double jejunal loop reconstruction: an old trick for a new dog. *J Laparoendosc Adv Surg Tech A* 2013; **23**: 146-149 [PMID: 23157325 DOI: 10.1089/lap.2012.0338]
- 26 **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]
- 27 **Kanaya S**, Gomi T, Momoi H, Tamaki N, Isobe H, Katayama T, Wada Y, Ohtoshi M. Delta-shaped anastomosis in totally laparoscopic Billroth I gastrectomy: new technique of intraabdominal gastroduodenostomy. *J Am Coll Surg* 2002;

- 195: 284-287 [PMID: 12168979]
- 28 **Du J**, Shuang J, Li J, Zhao Q, Hong L, Du X, Wen J, Hua J. Totally laparoscopic Billroth II gastrectomy with a novel, safe, simple, and time-saving anastomosis by only stapling devices. *J Gastrointest Surg* 2012; **16**: 738-743 [PMID: 22160781 DOI: 10.1007/s11605-011-1796-z]
 - 29 **Motoyama K**, Kojima K, Hayashi M, Kato K, Inokuchi M, Sugihara K. β -Shaped intracorporeal Roux-en-Y reconstruction after totally laparoscopic distal gastrectomy. *Gastric Cancer* 2014; **17**: 588-593 [PMID: 24178920]
 - 30 **Okabe H**, Obama K, Tanaka E, Nomura A, Kawamura J, Nagayama S, Itami A, Watanabe G, Kanaya S, Sakai Y. Intracorporeal esophagojejunal anastomosis after laparoscopic total gastrectomy for patients with gastric cancer. *Surg Endosc* 2009; **23**: 2167-2171 [PMID: 18553203 DOI: 10.1007/s00464-008-9987-8]
 - 31 **Inaba K**, Satoh S, Ishida Y, Taniguchi K, Isogaki J, Kanaya S, Uyama I. Overlap method: novel intracorporeal esophagojejunostomy after laparoscopic total gastrectomy. *J Am Coll Surg* 2010; **211**: e25-e29 [PMID: 21036074 DOI: 10.1016/j.jamcollsurg.2010.09.005]
 - 32 **Nagai E**, Ohuchida K, Nakata K, Miyasaka Y, Maeyama R, Toma H, Shimizu S, Tanaka M. Feasibility and safety of intracorporeal esophagojejunostomy after laparoscopic total gastrectomy: inverted T-shaped anastomosis using linear staplers. *Surgery* 2013; **153**: 732-738 [PMID: 23305598 DOI: 10.1016/j.surg.2012.10.012]
 - 33 **Son SY**, Lee CM, Lee JH, Ahn SH, Kim JW, Lee KU, Park do J, Kim HH. Laparoscopy-assisted gastrectomy with para-aortic lymphadenectomy after palliative chemotherapy for advanced gastric cancer with isolated para-aortic lymph node metastasis. *J Korean Surg Soc* 2013; **84**: 304-308 [PMID: 23646317 DOI: 10.4174/jkss.2013.84.5.304]
 - 34 **Shinohara T**, Hanyu N, Tanaka Y, Murakami K, Watanabe A, Yanaga K. Totally laparoscopic complete resection of the remnant stomach for gastric cancer. *Langenbecks Arch Surg* 2013; **398**: 341-345 [PMID: 22777535 DOI: 10.1007/s00423-012-0979-8]
 - 35 **Ahn SH**, Park do J, Son SY, Lee CM, Kim HH. Single-incision laparoscopic total gastrectomy with D1+beta lymph node dissection for proximal early gastric cancer. *Gastric Cancer* 2014; **17**: 392-396 [PMID: 23681260]
 - 36 **Fujii K**, Sonoda K, Izumi K, Shiraishi N, Adachi Y, Kitano S. T lymphocyte subsets and Th1/Th2 balance after laparoscopy-assisted distal gastrectomy. *Surg Endosc* 2003; **17**: 1440-1444 [PMID: 12820059]
 - 37 **Hayashi H**, Ochiai T, Shimada H, Gunji Y. Prospective randomized study of open versus laparoscopy-assisted distal gastrectomy with extraperigastric lymph node dissection for early gastric cancer. *Surg Endosc* 2005; **19**: 1172-1176 [PMID: 16132323]
 - 38 **Huscher CG**, Mingoli A, Sgarzini G, Sansonetti A, Di Paola M, Recher A, Ponzano C. Laparoscopic versus open subtotal gastrectomy for distal gastric cancer: five-year results of a randomized prospective trial. *Ann Surg* 2005; **241**: 232-237 [PMID: 15650632]
 - 39 **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 [PMID: 22664559 DOI: 10.1097/SLA.0b013e3182583e2e]
 - 40 **Viñuela 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**: 446-456 [PMID: 22330034 DOI: 10.1097/SLA.0b013e31824682f4]
 - 41 **Jiang L**, Yang KH, Guan QL, Cao N, Chen Y, Zhao P, Chen YL, Yao L. Laparoscopy-assisted gastrectomy versus open gastrectomy for resectable gastric cancer: an update meta-analysis based on randomized controlled trials. *Surg Endosc* 2013; **27**: 2466-2480 [PMID: 23361259 DOI: 10.1007/s00464-012-2758-6]
 - 42 **Kim YW**, Yoon HM, Yun YH, Nam BH, Eom BW, Baik YH, Lee SE, Lee Y, Kim YA, Park JY, Ryu KW. Long-term outcomes of laparoscopy-assisted distal gastrectomy for early gastric cancer: result of a randomized controlled trial (CO-ACT 0301). *Surg Endosc* 2013; **27**: 4267-4276 [PMID: 23793805 DOI: 10.1007/s00464-013-3037-x]
 - 43 **Kim HH**, Han SU, Kim MC, Hyung WJ, Kim W, Lee HJ, Ryu SW, Cho GS, Kim CY, Yang HK, Park do J, Song KY, Lee SI, Ryu SY, Lee JH. Prospective randomized controlled trial (phase III) to comparing laparoscopic distal gastrectomy with open distal gastrectomy for gastric adenocarcinoma (KLASS 01). *J Korean Surg Soc* 2013; **84**: 123-130 [PMID: 23396494 DOI: 10.4174/jkss.2013.84.2.123]
 - 44 **Nakamura K**, Katai H, Mizusawa J, Yoshikawa T, Ando M, Terashima M, Ito S, Takagi M, Takagane A, Ninomiya M, Fukushima N, Sasako M. A phase III study of laparoscopy-assisted versus open distal gastrectomy with nodal dissection for clinical stage IA/IB gastric Cancer (JCOG0912). *Jpn J Clin Oncol* 2013; **43**: 324-327 [PMID: 23275644 DOI: 10.1093/jjco/hys220]
 - 45 **Choi YY**, Bae JM, An JY, Hyung WJ, Noh SH. Laparoscopic gastrectomy for advanced gastric cancer: are the long-term results comparable with conventional open gastrectomy? A systematic review and meta-analysis. *J Surg Oncol* 2013; **108**: 550-556 [PMID: 24115104 DOI: 10.1002/jso.23438]
 - 46 **Shinohara T**, Satoh S, Kanaya S, Ishida Y, Taniguchi K, Isogaki J, Inaba K, Yanaga K, Uyama I. Laparoscopic versus open D2 gastrectomy for advanced gastric cancer: a retrospective cohort study. *Surg Endosc* 2013; **27**: 286-294 [PMID: 22733201 DOI: 10.1007/s00464-012-2442-x]
 - 47 **Park do J**, Han SU, Hyung WJ, Kim MC, Kim W, Ryu SY, Ryu SW, Song KY, Lee HJ, Cho GS, Kim HH. Long-term outcomes after laparoscopy-assisted gastrectomy for advanced gastric cancer: a large-scale multicenter retrospective study. *Surg Endosc* 2012; **26**: 1548-1553 [PMID: 22170319 DOI: 10.1007/s00464-011-2065-7]
 - 48 **Kodera Y**, Fujiwara M, Ohashi N, Nakayama G, Koike M, Morita S, Nakao A. Laparoscopic surgery for gastric cancer: a collective review with meta-analysis of randomized trials. *J Am Coll Surg* 2010; **211**: 677-686 [PMID: 20869270 DOI: 10.1016/j.jamcollsurg.2010.07.013]
 - 49 **Nishikawa K**, Kawahara H, Yumiba T, Nishida T, Inoue Y, Ito T, Matsuda H. Functional characteristics of the pylorus in patients undergoing pylorus-preserving gastrectomy for early gastric cancer. *Surgery* 2002; **131**: 613-624 [PMID: 12075173]
 - 50 **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]
 - 51 **Hiki N**, Kaminishi M. Pylorus-preserving gastrectomy in gastric cancer surgery--open and laparoscopic approaches. *Langenbecks Arch Surg* 2005; **390**: 442-447 [PMID: 16096761]
 - 52 **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]
 - 53 **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]
 - 54 **Shibata C**, Shiiba KI, Funayama Y, Ishii S, Fukushima K, Mizoi T, Koyama K, Miura K, Matsuno S, Naito H, Kato E, Honda T, Momono S, Ouchi A, Ashino Y, Takahashi Y, Fujiya T, Iwatsuki A, Sasaki I. Outcomes after pylorus-

- preserving gastrectomy for early gastric cancer: a prospective multicenter trial. *World J Surg* 2004; **28**: 857-861 [PMID: 15593456]
- 55 **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]
- 56 **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]
- 57 **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]
- 58 **Ekström AM**, Signorello LB, Hansson LE, Bergström R, Lindgren A, Nyrén O. Evaluating gastric cancer misclassification: a potential explanation for the rise in cardia cancer incidence. *J Natl Cancer Inst* 1999; **91**: 786-790 [PMID: 10328109]
- 59 **Ahn HS**, Lee HJ, Yoo MW, Jeong SH, Park DJ, Kim HH, Kim WH, Lee KU, Yang HK. Changes in clinicopathological features and survival after gastrectomy for gastric cancer over a 20-year period. *Br J Surg* 2011; **98**: 255-260 [PMID: 21082693 DOI: 10.1002/bjs.7310]
- 60 **Shiraishi N**, Hirose R, Morimoto A, Kawano K, Adachi Y, Kitano S. Gastric tube reconstruction prevented esophageal reflux after proximal gastrectomy. *Gastric Cancer* 1998; **1**: 78-79 [PMID: 11957047]
- 61 **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]
- 62 **Takehita K**, Saito N, Saeki I, Honda T, Tani M, Kando F, Endo M. Proximal gastrectomy and jejunal pouch interposition for the treatment of early cancer in the upper third of the stomach: surgical techniques and evaluation of postoperative function. *Surgery* 1997; **121**: 278-286 [PMID: 9092128]
- 63 **Adachi Y**, Inoue T, Hagino Y, Shiraishi N, Shimoda K, Kitano S. Surgical results of proximal gastrectomy for early-stage gastric cancer: jejunal interposition and gastric tube reconstruction. *Gastric Cancer* 1999; **2**: 40-45 [PMID: 11957069]
- 64 **Furukawa H**, Hiratsuka M, Imaoka S, Ishikawa O, Kabuto T, Sasaki Y, Kameyama M, Ohigashi H, Nakano H, Yasuda T. Limited surgery for early gastric cancer in cardia. *Ann Surg Oncol* 1998; **5**: 338-341 [PMID: 9641455]
- 65 **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]
- 66 **Morton DL**, Wen DR, Wong JH, Economou JS, Cagle LA, Storm FK, Foshag LJ, Cochran AJ. Technical details of intraoperative lymphatic mapping for early stage melanoma. *Arch Surg* 1992; **127**: 392-399 [PMID: 1558490]
- 67 **Giuliano AE**, Kirgan DM, Guenther JM, Morton DL. Lymphatic mapping and sentinel lymphadenectomy for breast cancer. *Ann Surg* 1994; **220**: 391-398; discussion 398-401 [PMID: 8092905]
- 68 **Isozaki H**, Kimura T, Tanaka N, Satoh K, Matsumoto S, Ninomiya M, Ohsaki T, Mori M. An assessment of the feasibility of sentinel lymph node-guided surgery for gastric cancer. *Gastric Cancer* 2004; **7**: 149-153 [PMID: 15449202]
- 69 **Uenosono Y**, Natsugoe S, Ehi K, Arigami T, Hokita S, Aikou T. Detection of sentinel nodes and micrometastases using radioisotope navigation and immunohistochemistry in patients with gastric cancer. *Br J Surg* 2005; **92**: 886-889 [PMID: 15892159]
- 70 **Miyashiro I**, Hiratsuka M, Sasako M, Sano T, Mizusawa J, Nakamura K, Nashimoto A, Tsuburaya A, Fukushima N. High false-negative proportion of intraoperative histological examination as a serious problem for clinical application of sentinel node biopsy for early gastric cancer: final results of the Japan Clinical Oncology Group multicenter trial JCOG0302. *Gastric Cancer* 2014; **17**: 316-323 [PMID: 23933782]
- 71 **Ohdaira H**, Nimura H, Mitsumori N, Takahashi N, Kashiwagi H, Yanaga K. Validity of modified gastrectomy combined with sentinel node navigation surgery for early gastric cancer. *Gastric Cancer* 2007; **10**: 117-122 [PMID: 17577622]
- 72 **Gretschel S**, Bembenek A, Hünerbein M, Dresel S, Schneider W, Schlag PM. Efficacy of different technical procedures for sentinel lymph node biopsy in gastric cancer staging. *Ann Surg Oncol* 2007; **14**: 2028-2035 [PMID: 17453300]
- 73 **Ichikura T**, Sugawara H, Sakamoto N, Yaguchi Y, Tsujimoto H, Ono S. Limited gastrectomy with dissection of sentinel node stations for early gastric cancer with negative sentinel node biopsy. *Ann Surg* 2009; **249**: 942-947 [PMID: 19474686 DOI: 10.1097/SLA.0b013e3181a77e7e]
- 74 **Tajima Y**, Yamazaki K, Masuda Y, Kato M, Yasuda D, Aoki T, Kato T, Murakami M, Miwa M, Kusano M. Sentinel node mapping guided by indocyanine green fluorescence imaging in gastric cancer. *Ann Surg* 2009; **249**: 58-62 [PMID: 19106676 DOI: 10.1097/SLA.0b013e3181927267]
- 75 **Kelder W**, Nimura H, Takahashi N, Mitsumori N, van Dam GM, Yanaga K. Sentinel node mapping with indocyanine green (ICG) and infrared ray detection in early gastric cancer: an accurate method that enables a limited lymphadenectomy. *Eur J Surg Oncol* 2010; **36**: 552-558 [PMID: 20452171 DOI: 10.1016/j.ejso.2010.04.007]
- 76 **Park do J**, Kim HH, Park YS, Lee HS, Lee WW, Lee HJ, Yang HK. Simultaneous indocyanine green and (99m)Tc-antimony sulfur colloid-guided laparoscopic sentinel basin dissection for gastric cancer. *Ann Surg Oncol* 2011; **18**: 160-165 [PMID: 20652640 DOI: 10.1245/s10434-010-1221-y]
- 77 **Takeuchi H**, Oyama T, Kamiya S, Nakamura R, Takahashi T, Wada N, Saikawa Y, Kitagawa Y. Laparoscopy-assisted proximal gastrectomy with sentinel node mapping for early gastric cancer. *World J Surg* 2011; **35**: 2463-2471 [PMID: 21882026 DOI: 10.1007/s00268-011-1223-3]
- 78 **Wang Z**, Dong ZY, Chen JQ, Liu JL. Diagnostic value of sentinel lymph node biopsy in gastric cancer: a meta-analysis. *Ann Surg Oncol* 2012; **19**: 1541-1550 [PMID: 22048632 DOI: 10.1245/s10434-011-2124-2]
- 79 **Kitagawa Y**, Takeuchi H, Takagi Y, Natsugoe S, Terashima M, Murakami N, Fujimura T, Tsujimoto H, Hayashi H, Yoshimizu N, Takagane A, Mohri Y, Nabeshima K, Uenosono Y, Kinami S, Sakamoto J, Morita S, Aikou T, Miwa K, Kitajima M. Sentinel node mapping for gastric cancer: a prospective multicenter trial in Japan. *J Clin Oncol* 2013; **31**: 3704-3710 [PMID: 24019550 DOI: 10.1200/JCO.2013.50.3789]
- 80 **Ishikawa K**, Yasuda K, Shiromizu A, Etoh T, Shiraishi N, Kitano S. Laparoscopic sentinel node navigation achieved by infrared ray electronic endoscopy system in patients with gastric cancer. *Surg Endosc* 2007; **21**: 1131-1134 [PMID: 17180275]
- 81 **Miyashiro I**, Miyoshi N, Hiratsuka M, Kishi K, Yamada T, Ohue M, Ohigashi H, Yano M, Ishikawa O, Imaoka S. Detection of sentinel node in gastric cancer surgery by indocyanine green fluorescence imaging: comparison with infrared imaging. *Ann Surg Oncol* 2008; **15**: 1640-1643 [PMID: 18379850 DOI: 10.1245/s10434-008-9872-7]
- 82 **Kim YH**, Lee YJ, Park JH, Lee KH, Lee HS, Park YS, Park do J, Kim HH. Early gastric cancer: feasibility of CT lymphography with ethiodized oil for sentinel node mapping. *Radiology* 2013; **267**: 414-421 [PMID: 23382288 DOI: 10.1148/radiol.12121527]
- 83 **Yoshida M**, Kubota K, Kuroda J, Ohta K, Nakamura T, Saito

- J, Kobayashi M, Sato T, Beck Y, Kitagawa Y, Kitajima M. Indocyanine green injection for detecting sentinel nodes using color fluorescence camera in the laparoscopy-assisted gastrectomy. *J Gastroenterol Hepatol* 2012; **27** Suppl 3: 29-33 [PMID: 22486868 DOI: 10.1111/j.1440-1746.2012.07067.x]
- 84 **Yano K**, Nimura H, Mitsumori N, Takahashi N, Kashiwagi H, Yanaga K. The efficiency of micrometastasis by sentinel node navigation surgery using indocyanine green and infrared ray laparoscopy system for gastric cancer. *Gastric Cancer* 2012; **15**: 287-291 [PMID: 22041868 DOI: 10.1007/s10120-011-0105-6]
- 85 **Hur H**, Kim JY, Cho YK, Han SU. Technical feasibility of robot-sewn anastomosis in robotic surgery for gastric cancer. *J Laparoendosc Adv Surg Tech A* 2010; **20**: 693-697 [PMID: 20809816 DOI: 10.1089/lap.2010.0246]
- 86 **Pugliese R**, Maggioni D, Sansonna F, Ferrari GC, Forgiione A, Costanzi A, Magistro C, Pauna J, Di Lernia S, Citterio D, Brambilla C. Outcomes and survival after laparoscopic gastrectomy for adenocarcinoma. Analysis on 65 patients operated on by conventional or robot-assisted minimal access procedures. *Eur J Surg Oncol* 2009; **35**: 281-288 [PMID: 18342480 DOI: 10.1016/j.ejso.2008.02.001]
- 87 **Song J**, Oh SJ, Kang WH, Hyung WJ, Choi SH, Noh SH. Robot-assisted gastrectomy with lymph node dissection for gastric cancer: lessons learned from an initial 100 consecutive procedures. *Ann Surg* 2009; **249**: 927-932 [PMID: 19474671 DOI: 10.1097/01.sla.0000351688.64999.73]
- 88 **Yoon HM**, Kim YW, Lee JH, Ryu KW, Eom BW, Park JY, Choi IJ, Kim CG, Lee JY, Cho SJ, Rho JY. Robot-assisted total gastrectomy is comparable with laparoscopically assisted total gastrectomy for early gastric cancer. *Surg Endosc* 2012; **26**: 1377-1381 [PMID: 22083338 DOI: 10.1007/s00464-011-2043-0]
- 89 **Lee HJ**, Yang HK. Laparoscopic gastrectomy for gastric cancer. *Dig Surg* 2013; **30**: 132-141 [PMID: 23867590 DOI: 10.1159/000350884]
- 90 **Kim YM**, Baek SE, Lim JS, Hyung WJ. Clinical application of image-enhanced minimally invasive robotic surgery for gastric cancer: a prospective observational study. *J Gastrointest Surg* 2013; **17**: 304-312 [PMID: 23207683 DOI: 10.1007/s11605-012-2094-0]
- 91 **Ono H**, Kondo H, Gotoda T, Shirao K, Yamaguchi H, Saito D, Hosokawa K, Shimoda T, Yoshida S. Endoscopic mucosal resection for treatment of early gastric cancer. *Gut* 2001; **48**: 225-229 [PMID: 11156645]
- 92 **Takahashi T**, Saikawa Y, Kitagawa Y. Gastric cancer: current status of diagnosis and treatment. *Cancers (Basel)* 2013; **5**: 48-63 [PMID: 24216698 DOI: 10.3390/cancers5010048]
- 93 **Japanese Gastric Cancer Association**. Japanese classification of gastric carcinoma: 3rd English edition. *Gastric Cancer* 2011; **14**: 101-112 [PMID: 21573743 DOI: 10.1007/s10120-011-0041-5]
- 94 **Oda I**, Saito D, Tada M, Iishi H, Tanabe S, Oyama T, Doi T, Otani Y, Fujisaki J, Ajioka Y, Hamada T, Inoue H, Gotoda T, Yoshida S. A multicenter retrospective study of endoscopic resection for early gastric cancer. *Gastric Cancer* 2006; **9**: 262-270 [PMID: 17235627]
- 95 **Watanabe K**, Ogata S, Kawazoe S, Watanabe K, Koyama T, Kajiwara T, Shimoda Y, Takase Y, Irie K, Mizuguchi M, Tsunada S, Iwakiri R, Fujimoto K. Clinical outcomes of EMR for gastric tumors: historical pilot evaluation between endoscopic submucosal dissection and conventional mucosal resection. *Gastrointest Endosc* 2006; **63**: 776-782 [PMID: 16650537]
- 96 **Min BH**, Lee JH, Kim JJ, Shim SG, Chang DK, Kim YH, Rhee PL, Kim KM, Park CK, Rhee JC. Clinical outcomes of endoscopic submucosal dissection (ESD) for treating early gastric cancer: comparison with endoscopic mucosal resection after circumferential precutting (EMR-P). *Dig Liver Dis* 2009; **41**: 201-209 [PMID: 18571998 DOI: 10.1016/j.dld.2008.05.006]
- 97 **Hirasaki S**, Tanimizu M, Moriwaki T, Hyodo I, Shinji T, Koide N, Shiratori Y. Efficacy of clinical pathway for the management of mucosal gastric carcinoma treated with endoscopic submucosal dissection using an insulated-tip diathermic knife. *Intern Med* 2004; **43**: 1120-1125 [PMID: 15645644]
- 98 **Kodashima S**, Fujishiro M, Yahagi N, Kakushima N, Omata M. Endoscopic submucosal dissection using flexknife. *J Clin Gastroenterol* 2006; **40**: 378-384 [PMID: 16721217]
- 99 **Gotoda T**, Yanagisawa A, Sasako M, Ono H, Nakanishi Y, Shimoda T, Kato Y. Incidence of lymph node metastasis from early gastric cancer: estimation with a large number of cases at two large centers. *Gastric Cancer* 2000; **3**: 219-225 [PMID: 11984739]
- 100 **Soetikno R**, Kaltenbach T, Yeh R, Gotoda T. Endoscopic mucosal resection for early cancers of the upper gastrointestinal tract. *J Clin Oncol* 2005; **23**: 4490-4498 [PMID: 16002839]
- 101 **Sanomura Y**, Oka S, Tanaka S, Noda I, Higashiyama M, Imagawa H, Shishido T, Yoshida S, Hiyama T, Arihiro K, Chayama K. Clinical validity of endoscopic submucosal dissection for submucosal invasive gastric cancer: a single-center study. *Gastric Cancer* 2012; **15**: 97-105 [PMID: 21785925 DOI: 10.1007/s10120-011-0076-7]
- 102 **Ahn JY**, Jung HY, Choi KD, Choi JY, Kim MY, Lee JH, Choi KS, Kim do H, Song HJ, Lee GH, Kim JH, Park YS. Endoscopic and oncologic outcomes after endoscopic resection for early gastric cancer: 1370 cases of absolute and extended indications. *Gastrointest Endosc* 2011; **74**: 485-493 [PMID: 21741645 DOI: 10.1016/j.gie.2011.04.038]
- 103 **Park CH**, Shin S, Park JC, Shin SK, Lee SK, Lee YC, Lee H. Long-term outcome of early gastric cancer after endoscopic submucosal dissection: expanded indication is comparable to absolute indication. *Dig Liver Dis* 2013; **45**: 651-656 [PMID: 23422031 DOI: 10.1016/j.dld.2013.01.014]
- 104 **Choi MK**, Kim GH, Park do Y, Song GA, Kim DU, Ryu DY, Lee BE, Cheong JH, Cho M. Long-term outcomes of endoscopic submucosal dissection for early gastric cancer: a single-center experience. *Surg Endosc* 2013; **27**: 4250-4258 [PMID: 23765426 DOI: 10.1007/s00464-013-3030-4]
- 105 **Jee YS**, Hwang SH, Rao J, Park DJ, Kim HH, Lee HJ, Yang HK, Lee KU. Safety of extended endoscopic mucosal resection and endoscopic submucosal dissection following the Japanese Gastric Cancer Association treatment guidelines. *Br J Surg* 2009; **96**: 1157-1161 [PMID: 19705373 DOI: 10.1002/bjs.6686]
- 106 **An JY**, Baik YH, Choi MG, Noh JH, Sohn TS, Kim S. Predictive factors for lymph node metastasis in early gastric cancer with submucosal invasion: analysis of a single institutional experience. *Ann Surg* 2007; **246**: 749-753 [PMID: 17968165]
- 107 **Kang HJ**, Kim DH, Jeon TY, Lee SH, Shin N, Chae SH, Kim GH, Song GA, Kim DH, Srivastava A, Park do Y, Lauwers GY. Lymph node metastasis from intestinal-type early gastric cancer: experience in a single institution and reassessment of the extended criteria for endoscopic submucosal dissection. *Gastrointest Endosc* 2010; **72**: 508-515 [PMID: 20554277 DOI: 10.1016/j.gie.2010.03.1077]
- 108 **An JY**, Heo GU, Cheong JH, Hyung WJ, Choi SH, Noh SH. Assessment of open versus laparoscopy-assisted gastrectomy in lymph node-positive early gastric cancer: a retrospective cohort analysis. *J Surg Oncol* 2010; **102**: 77-81 [PMID: 20578083 DOI: 10.1002/jso.21554]
- 109 **Jeong SH**, Lee YJ, Park ST, Choi SK, Hong SC, Jung EJ, Joo YT, Jeong CY, Ha WS. Risk of recurrence after laparoscopy-assisted radical gastrectomy for gastric cancer performed by a single surgeon. *Surg Endosc* 2011; **25**: 872-878 [PMID: 21072670 DOI: 10.1007/s00464-010-1286-5]
- 110 **MacLellan SJ**, MacKay HJ, Ringash J, Jacks L, Kassam Z, Conrad T, Khalili I, Okrainec A. Laparoscopic gastrectomy for patients with advanced gastric cancer produces oncolog-

ic outcomes similar to those for open resection. *Surg Endosc* 2012; **26**: 1813-1821 [PMID: 22350227 DOI: 10.1007/s00464-011-2118-y]

111 **Hamabe A**, Omori T, Tanaka K, Nishida T. Comparison of

long-term results between laparoscopy-assisted gastrectomy and open gastrectomy with D2 lymph node dissection for advanced gastric cancer. *Surg Endosc* 2012; **26**: 1702-1709 [PMID: 22207307 DOI: 10.1007/s00464-011-2096-0]

P-Reviewer: Kim GH, Kakushima N, Tong Q **S-Editor:** Gou SX
L-Editor: A **E-Editor:** Ma S





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

Help Desk: <http://www.wjgnet.com/esps/helpdesk.aspx>

<http://www.wjgnet.com>



ISSN 1007-9327

