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Review Article

Minimally Invasive Surgery Techniques in the Treatment of Gastric Cancer

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Abstract

Gastric adenocarcinoma is one of the most common causes of cancer-related deaths worldwide. Minimally invasive surgery used in the treatment of gastric cancer has shown to offer similar oncologic outcomes to standard open operations with decreased morbidity and better quality of life. A number of minimally invasive surgery techniques have been developed to surgically treat both early and locally advanced gastric cancer. These techniques include both endoscopic and laparoscopic resection methods, the use of which is highly dependent on the oncologic stage of the tumor. This manuscript is designed to review the most recent evidence surrounding minimally invasive surgical therapies in the treatment of gastric cancer.

ABBREVIATIONS

ESD: Endoscopic Submucosal Dissection; EMR: Endoscopic Mucosal Resection; JSGE: The Japanese Society of Gastroenterological Endsocopy; RCT: Randomized Control Trial

INTRODUCTION

Surgical resection is the only potentially curative therapy for patients who suffer from gastric cancer. The development of minimally invasive surgical techniques has led to decreased morbidity and to improve quality of life following resection [1-3]. The term "minimally invasive" has been applied to describe both endoscopic and laparoscopic surgical interventions. Endoscopic therapies are primarily used to treat early gastric cancer limited to the gastric mucosa and include endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD) [4,5]. Laparoscopic total or partial gastrectomies are generally reserved for more advanced lesions, which carry a higher risk for lymph node metastases. Since the first laparoscopic-assisted distal gastrectomy with lymph node dissection was described in 1991, the development of new surgical technologies has led to an increase in the use of laparoscopy in the surgical management of gastric cancer [6]. It is imperative for practitioners who treat this disease to educate patients on the different surgical options that are available, especially since they have been shown to offer similar oncologic success with less morbidity compared to standard open operations

ENDOSCOPIC SURGICAL RESECTION

Endoscopic resection of early gastric cancers has been largely pioneered in Japan. The Japanese Society of Gastroenterological Endsocopy (JSGE) originally developed an early classification system to accurately describe early lesions that has since been re categorized at a consensus meeting in Paris in 2003, as detailed in Table 1 [7,8]. This classification system describes early gastric cancer by endoscopic appearance, which is beneficial when deciding which therapeutic intervention will most likely be successful. The incidence of lymph node metastasis in large series of early gastric cancers range from 1-3% for tumors confined to the mucosa and 11-20% for tumors invading the submucosa [9-11]. Therefore, endoscopic resection is generally recommended for lesions confined to the mucosa, where the risk of lymph node metastasis is low.

There are two prominent ways currently utilized to endoscopically resect early gastric cancer, EMR and ESD. EMR utilizes a snare technique to remove dysplastic lesions, similar to a colon polypectomy. There are two ways that EMR is performed, either utilizing suction (suck-and-cut) or a non suction (lift-and-cut) method. Both techniques utilize a submucosal injection to separate the mucosal and submucosal lesions from the muscularis propria. Compared to surgery, EMR is widely accepted to treat early gastric cancers that have virtually no risk of lymph node metastases. The benefits of this procedure include its minimally invasive nature, low cost, good patient tolerance, and better quality to life [12]. Because larger size lesions cannot be resected using this technique, indications for EMR have been developed and are shown in Table 2 [13].

Since EMR is limited in its scope to smaller lesions, ESD was developed to help expand the range for lesions amenable to endoscopic resection. ESD utilizes flexible endoscopy to dissect along the submucosal space of the gastrointestinal tract (Figure 1). Compared to EMR, ESD has the following advantages: higher en bloc resection rate, higher histological complete resection

Table 1: Classification for Lesions Amenable to Endoscopic Resection.
Type I Lesions Polypoid
1. Type 0-Ip → Protruded, Peduculated
2. Type 0-Is → Protruded, Sessile
Type II Lesions Non-polypoid
1. Type 0-IIa → Slightly Elevated
2. Type 0-IIb → Flat
3. Type 0-IIc → Slightly Depressed
Type III Lesions Excavated

Table 2: Indications for EMR in Gastric Cancer
Indications for EMR in Gastric Cancer
1. Type I lesions <2cm
2. Type II b and c lesions < 1cm
3. Cancers that is limited to the mucosa.

rate, and decreased local recurrence [14]. Long term outcomes with ESD are excellent with reported local recurrence rates as low as 0.2% [15]. Although there is more flexibility and excellent outcomes using ESD, it is also associated with higher rates of perforation and longer operative times compared to EMR [16-18]. The indications for ESD are shown in Table 3.

In the past, lesions of the mucosa required open or laparoscopic resection. However, with the recent advances in EMR/ESD, improvement in local mucosal control via endoscopic interventions has yielded excellent outcomes, making larger surgical resections unnecessary. As these technologies continue to develop, the indications for endoscopic resection could expand.

LAPAROSCOPIC RESECTION

The introduction of laparoscopy into the treatment algorithm for gastric cancer initially had to weigh the potential benefits of a faster recovery time, decreased operative blood loss, and lower morbidity rates against the concern for oncologic safety. The laparoscopic versus open debate has been studied in several randomized control trials (RCT) with many of these studies showing no difference in post-operative morbidity or mortality [19]. Due to low number of patients studied in these RCT, a recent met analysis by Vineula et al., looked at 3055 patients in 25 studies both randomized and nonrandomized trials to determine the effect of laparoscopy in the treatment of gastric cancer [20]. They determined that laparoscopic gastric resections were associated with longer operative times, decreased length in hospital stay and a decreased overall complication rate. The open group did have a higher number of lymph nodes retrieved; however, the proportion of nodes less than 15 was equal in both groups. Other studies have also shown that laparoscopic gastrectomies are associated with lower blood loss and no difference in oncologic outcomes [21].

As experience with the laparoscopic gastrectomy has increased, it has been determined that the learning curve may be as high as 50-60 cases. At this point, several studies have shown that operative times decrease, lymph node harvest increases, and complications decrease as surgeons get closer to these numbers [22,23]. Therefore, extensive laparoscopic resections for advanced tumors may be better performed at high volume centers.

Specific patient populations have also been studied to determine which surgical approach would be most beneficial. In obese patients, laparoscopic gastrectomy has been associated with lower rates of wound and hernia complications [24]. Compared with the open approach, older patients experience a faster return to GI function, fewer post-operative complications and a shorter hospital stay [25]. As results neither obesity nor age should be a contraindication to a laparoscopic resection, as it appears both of these patient populations may in fact does better using a minimally invasive approach.

In addition to resecting the gastric cancer itself, it is important to perform an adequate lymphadenectomy. Debate still exists whether a D1 or D2 lymphadenectomy is most beneficial for patients with advanced gastric cancer. A D1 lymphadenectomy includes nodes along the greater and lesser curvatures of the stomach including perigastric lymph nodes. A D2 lymphadenectomy also includes nodal basins along the left gastric, common hepatic, celiac, splenic hilum, and splenic artery. Proponents of a D1 lymphadenectomy will look to two studies: The Dutch Gastric Cancer Group Trial 711 and UK Medical Research Council Gastric Cancer Surgical Trial (ST01). Both randomized trials showed significant morbidity in the D2 lymphadenectomy group and no difference in mortality compared to the D1 lymphadenectomy group [26,27]. Both studies used a D2 lymphadenectomy that included a distal pancreatectomy and splenectomy to adequately resect lymph node stations 10 and 11. However, it has been shown that multi-visceral resection has the poorest survival in gastric cancer patients and may have contributed to no difference [28]. Recent studies show improved morbidity and mortality with avoidance of routine splenectomy and pancreatectomy compared to traditional D2 lymphadenectomy [29-31]. In addition, there is a

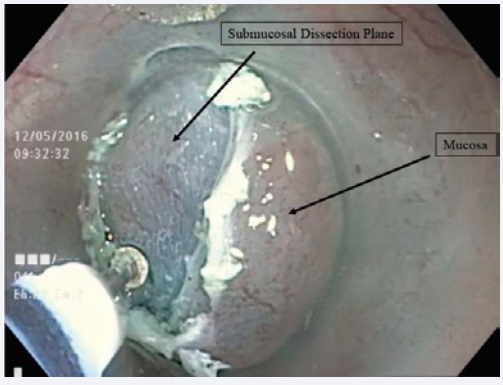

Figure 1 Dissection along the submucosal space during ESD.

Table 3: Indications for ESD in Gastric Cancer.
Indications for ESD in Gastric Cancer
1. Differentiated and Undifferentiated Tumors
2. < 3cm
3. Cancers that is limited to the mucosa.

survival benefit when greater than 15 lymph nodes are harvested at the time of resection and the D2 is associated with a greater number of retrieved nodes [32,33]. As a result, we advocate for a laparoscopic D2 lymphadenectomy in advanced gastric cancer patients. Although the laparoscopic approach has been shown to be associated with longer operating times, it does produce less operative blood loss, shorter hospital stays, and quicker recovery to bowel function [34].

Another debate that often arises in the surgical management of gastric cancer concerns the optimal method of reconstruction [35,36]. Gastric replacements using a variety of enteric reservoirs have been described in an effort to improve both symptoms and nutrition following gastrectomy. A number of prospective randomized trials comparing different methods of reconstruction and their outcomes have been completed [37-39]. Several trials have shown a strong clinical benefit, both in the short and long term, for patients who receive a Hunt-Lawrence or Roux-en-Y esophago-jejunal pouch [40,41]. This type of reconstruction is associated with greater weight recovery, increased food intake post-operatively, and a decreased incidence of dumping syndrome compared to patients with jejunal pouches [37,40,42]. These studies show us that Hunt-Lawrence pouches improve quality of life post-operatively following a total gastrectomy. The technique on how to do this laparoscopically has been demonstrated (Figure 2) [43].

ROBOTIC RESECTION

Due to the steep learning curve that may be associated with the laparoscopic gastrectomy, some surgeons advocate for the use of robotics to make the operation technically easier [44]. Proponents of robotic surgery in the treatment of gastric cancer state that the 2-D visualization, restricted range of motion, physiologic tremor and decreased tactile sensation hinder the performance of laparoscopy [45]. Some argue that robotics is a better approach for patients with larger BMI in a variety of procedures [46,47]. One study by Lee et al., showed that a robotic approach in patients with high BMI was associated with less blood loss and consistency of a quality D2 lymphadenectomy compared to laparoscopy [48]. The learning curve for robotic gastrectomy has been shown to be around 20 cases, which is significantly less than that for laparoscopy [49]. Robotics may be a good alternative to laparoscopic gastrectomy in low volume centers.

FUTURE DIRECTIONS

Several modifications to the standard total gastrectomy have been created, including the introduction of endoscopic and laparoscopic techniques, in an attempt to minimize morbidity and improve quality of life postoperatively. The sentinel node concept, which involves the identification and surgical removal of the first lymph nodes to receive drainage from the primary tumor, is the standard of care in a number of different tumors, most notably melanoma and breast cancer [50-53]. If the sentinel nodes are negative for tumor, often patients are spared the increased morbidity of additional surgery. In Japan, the sentinel node concept is being applied for early gastric cancer [54,55]. The detection of sentinel nodes range in early studies from 93.5% to 100% and the diagnostic accuracy of the sentinel node biopsy at predicting regional lymph node status ranged from 85% to 100%. Large scale clinical trials have been completed, which shows a false negative rate of 7% and a sensitivity of detecting metastases based on sentinel lymph nodes of 93% [56]. Laparoscopic detection of sentinel nodes has been described using a combination of a radiotracer and blue dye [57]. The adoption of sentinel node concept to gastric cancer has the possibility of limiting the extent of the gastric resection as well as the need for a large lymph node dissection [58-60]. Although initial data is promising, further validation of the sentinel lymph node concept needs to be completed. The combination of both laparoscopy and accurate navigation of gastric sentinel nodes has the promise of improving long term quality of life in patients with gastric cancer.

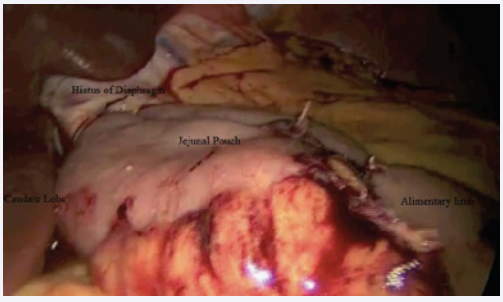

Figure 2 Laparoscopic view of Hunt-Lawrence pouch following total gastrectomy.

CONCLUSION

Minimally invasive approaches to gastric cancer are constantly evolving. The introduction of endoscopic techniques has obviated the need for large scale surgical resections in patients with early gastric cancer limited to the mucosa. Although the learning curve is steep, laparoscopic gastric resection is preferred as it has similar oncologic benefit with significantly less morbidity. It is important for surgeons who treat gastric cancer to be abreast on these techniques in order to maximize short and long term quality of life in these patients throughout the post-operative phase.

REFERENCES

1. Sasako M, Saka M, Fukagawa T, Katai H, Sano T. Surgical treatment of advanced gastric cancer: Japanese perspective. Dig Surg. 2007; 24: 101-107.
2. 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: 1099-1102.
3. Shchepotin IB, Evans SR, Chorny VA, Shabahang M, Buras RR , Nauta RJ. Postoperative complications requiring relaparotomies after 700 gastretomies performed for gastric cancer. Am J Surg. 1996; 171: 270-273.
4. Nakajima T. Gastric cancer treatment guidelines in Japan. Gastric Cancer. 2002; 5: 1-5.
5. Ono H, Kondo H, Gotoda T, Shirao K, Yamaguchi H, Saito D, et al. Endoscopic mucosal resection for treatment of early gastric cancer. Gut. 2001; 48: 225-229.
6. Kitano S, Iso Y, Moriyama M, ugimachi K. Laparoscopy-assisted Billroth I gastrectomy. Surg Laparosc Endosc. 1994; 4: 146-148.
7. The general rules for the gastric cancer study in surgery. Jpn J Surg. 1973; 3: 61.

8. The Paris endoscopic classification of superficial neoplastic lesions: esophagus, stomach, and colon: November 30 to December 1, 2002. Gastrointest Endosc. 2003; 58: S3-43.

9. Adachi Y, Mori M, Maehara Y, Kitano S, Sugimachi K. Prognostic factors of node-negative gastric carcinoma: Univariate and multivariate analyses. J Am Coll Surg. 1997; 184: 373-377.

10. Gotoda T, Yanagisawa A, Sasako M, Katai H, Sano T, Shimoda T. Evaluation of the necessity for gastrectomy with lymph node dissection for patients with submucosal invasive gastric cancer. Br J Surg. 2001; 88: 444-449.

11. 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.

12. Makuuchi H, Kise Y, Shimada H, Chin O, Tanaka H. Endoscopic mucosal resection for early gastric cancer. Semin Surg Oncol. 1999; 17: 108.

13. Raju GS, Waxman I. High-frequency US probe sonography-assisted endoscopic mucosal resection. Gastrointest Endosc. 2000; 52: 39-49.

14. 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.

15. Tanabe S, Ishido K, Higuchi K, Sasaki T, Katada C, Azuma M, et al. Long-term outcomes of endoscopic submucosal dissection for early gastric cancer: a retrospective comparison with conventional endoscopic resection in a single center. Gastric Cancer. 2014; 17: 130-136.

16. Lian J, Chen S, Zhang Y, Qiu F. A meta-analysis of endoscopic submucosal dissection and EMR for early gastric cancer. Gastrointest endosc. 2012; 76: 763-770.

17. Min BH, Lee JH, Kim JJ, Shim HG, Chang DK, Kim YH, et al. Clinical outcomes of endoscopic submucosal dissection (ESD) for treating early gastric cancer: comparison with endoscopic mucosal resection after circumferential precurring (EMR-P). Digest Liver Dis. 2009; 41: 201-209.

18. Nakamoto S, Sakai Y, kasanuki J, Kondo F, Ooka Y, Kato K, et al. Indication for the use of endoscopic mucosal resection for early gastric cancer in Japan: a comparative study with endoscopic submucosal dissection. Endoscopy. 2009; 41: 746-750.

19. Kim HH, Hyung WJ, Cho GS, Kim MC, Han SU, Kim W, et al. 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.

20. Viñuela EF, Gonen M, Brennan MF, Coit DG, Strong VE. Laparoscopic versus open distal gastrectomy for gastric cancer: a metaanalysis of randomized controlled trials and high-quality nonrandomized studies. Ann Surg. 2012; 255: 446-456.

21. Xiong JJ, Nunes QM, Huang W, Tan CL, Ke NW, Xie SM, et al. Laparoscopic vs open total gastrectomy for gastric cancer: a meta-analysis. World J Gastroenterol. 2013; 19: 8114-8132.

22. Yoo CH, Kim HO, Hwang SI, Byung Ho Son, Jun Ho Shin, Hungdai Kim. Short-term outcomes of laparoscopic-assisted distal gastrectomy for gastric cancer during a surgeon's learning curve period. Surg Endosc. 2009; 23: 2250-2257.

23. Kunisaki C, Makino H, Yamamoto N, Sato T, Oshima T, Nagano Y, et al. Learning curve for laparoscopy-assisted distal gastrectomy with regional lymph node dissection for early gastric cancer. Surg Laparosc Endosc Percutan Tech. 2008; 18: 236-241.

24. Noshiro H, Shimizu S, Nagai E, Kenoki Ohuchida, Masao Tanaka. Laparoscopy-assisted distal gastrectomy for early gastric cancer: Is it beneficial for patients of heavier weight? Ann Surg. 2003; 238: 680–685.

25. Yasuda K, Sonoda K, Shiroshita H, Inomata M, Shiraishi N, Kitano S. Laparoscopically assisted distal gastrectomy for early gastric cancer in the elderly. Br J Surg. 2004; 91: 1061-1065.

26. Songun I, Putter H, Kranenbarg EM, Sasako M, van de Velde CJ. Surgical treatment of gastric cancer: 15-year follow-up results of the randomised nationwide Dutch D1D2 trial. Lancet Oncol. 2010; 11: 439-449.

27. Cuschieri A, Fayers P, Fielding J, Craven J, Bancewicz J, Joypaul V, et al. Postoperative morbidity and mortality after D1 and D2 resections for gastric cancer: preliminary results of the MRC randomized controlled surgical trial. The Surgical Cooperative Group. Lancet. 1996; 347: 995-999.

28. Cuschieri A, Weeden S, Fielding J, Bancewicz J, Craven J, Joypaul V, et al. Patient survival after D1 and D2 resections for gastric cancer: long-term results of the MRC randomized surgical trial. Surgical Cooperative Group. Br J Cancer. 1999; 79: 1522-1530.

29. Maruyama K, Sasako M, Kinoshita T, Sano T, Katai H, Okajima K. Pancreas preserving total gastrectomy for proximal gastric cancer. World J Surg. 1995; 19: 532-536.

30. Biffi R, Chiappa A, Luca F, Pozzi S, Faso FL, Andreoni B, et al. Extended lymph node dissection without routine spleno-pancreatectomy for treatment of gastric cancer: low morbidity and mortality rates in a single center series of 250 patients. J Surg Oncol. 2006; 93: 394-400.

31. Yu, W, Choi GS, Chung HY. Randomized clinical trial of splenectomy versus splenic preservation in patients with proximal gastric cancer. Br J Surg. 2006; 93: 559-563.

32. Schwarz RE, Smith DD. Clinical impact of lymphadenectomy extent in resectable gastric cancer of advanced stage. Ann Surg Oncol. 2007; 14: 317-328.

33. Putchakayala K, Difronzo LA. D2 lymph node dissection improves staging in patients with gastric adenocarcinoma. Am Surg. 2011; 77: 1326-1329.

34. Tochihiko S, Satoh S, Kanaya S, Ishida Y, Taniguchi K, Isogaki J, et al. Laparoscopic versus open D2 gastrectomy for advanced gastric cancer: a retrospective cohort study. Surg Endosc. 2013; 27: 286-294.

35. Herrington JL Jr. Various types of pouch replacement following total gastrectomy. Historical data and current thoughts regarding total gastrectomy. Am Surg. 1968; 34: 879-887.

36. Lehnert T, Buhl K. Techniques of reconstruction after total gastrectomy for cancer. Br J Surg. 2004; 91: 528-564.

37. Nakane Y, Okumura S, Akehira K, Okamura S, Boku T, Okusa T, et al. Jejunal pouch reconstruction after total gastrectomy for cancer. A randomized controlled trial. Ann surg. 1995; 222: 27-35.

38. Troidl H, Kusche J, Vestweber KH, Eypasch E, Maul U. Pouch versus esophagojejunostomy after total gastrectomy: a randomized clinical trial. World J Surg. 1987; 11: 699-712.

39. Iivoenen MK, Mattila JJ, Nordback IH, Matikainen MJ. Long-term follow-up of patients with jejunal pouch after total gastrectomy: A randomized prospective study. Scand J Gastroenterol. 2000; 35: 679-685.

40. Fein M, Fuchs KH, Thalheimer A, Freys SM, Heimbucher J, Thiede A. Long-term benefits of Roux-en-Y pouch reconstruction after total gastrectomy: a randomized trial. Ann surg. 2008; 247: 759-765.

41. Endo S, Nishida T, Nishikawa K, Yumiba T, Nakajima K, Yasumasa K, et al. Motility of the pouch correlates with quality of life after total

gastrectomy. Surgery. 2006; 139: 493-500.

42. Zong L, Chen P, Chen YB, Shi G. Pouch Roux-en-Y vs No Pouch Roux-en-Y following total gastrectomy: a meta-analysis based on 12 studies. J Biomed Res. 2011; 25: 90-99.

43. Ward MA, Ujiki MB. Creation of a Jejunal Pouch during Laparoscopic Total Gastrectomy and Roux-en-Y Esophagojejunostomy. Ann surg oncol. 2017; 24: 184-186.

44. Lanfranco AR, Castellanos AE, Desai JP, Meyers WC. Robotic surgery: a current perspective. Ann Surg. 2004; 239: 14-21.

45. Cadiere GB, Himpens J, Germay O, Izizaw R, Degueldre M, Vandromme J, et al. Feasibility of robotic laparoscopic surgery: 146 cases. World J Surg. 2001; 25: 1467-1477.

46. Gallo T, Kashani S, Patel DA, Elsahwi K, Silasi DA, Azodi M. Robotic-assisted laparoscopic hysterectomy: outcomes in obese and morbidly obese patients. JSLS. 2012; 16: 421-427.

47. Markar SR, Karthikesalingam AP, Venkat-Ramen V, Kinross J, Ziprin P. Robotic vs. laparoscopic Roux-en-Y gastric bypass in morbidly obese patients: systematic review and pooled analysis. Int J Med Robot. 2011; 7: 393–400.

48. Lee J, KimYM, Woo Y, Obama K, Noh SH, Hyung WJ. Robotic distal subtotal gastrectomy with D2 lymphadenectomy for gastric cancer patients with high BMI: comparison with conventional laparoscopic distal subtotal gastrectomy with D2 lymphadenectomy. Surg Endosc. 2015; 29: 3251-3260.

49. Song J, Kang WH, Oh SJ, Hyung WJ, Choi SH, Noh SH. et al. Role of robotic gastrectomy using da Vinci system compared with laparoscopic gastrectomy: Initial experience of 20 consecutive cases. Surg Endosc. 2009; 23: 1204-1211.

50. Morton DL, Wen DR, Wong JH, Economou JS, Cagle LA, Storm FK, et al. Technical details of intraoperative lymphatic mapping for early stage melanoma. Arch Surg. 1992; 127: 392-399.

51. Giuliano AE, Kirgan DM, Guenther JM, Morton DL. Lymphatic mapping and sentinel lymphadenectomy for breast cancer. Ann Surg. 1994; 220: 391-398.

52. Prenzel KL, Monig SP, Sinning JM, Baldus SE, Gutschow CA, Grass G, et al. Role of skip metastasis to mediastinal lymph nodes in non-small cell lung cancer. J Surg Oncol. 2003; 82: 256-260.

53. Merrie AE, van Rij AM, Phillips LV, Rossaak JI, Yun K, Mccall JL. Diagnostic use of the sentinel node in colon cancer. Dis Colon Rectum. 2001; 44: 410-417.

54. Kitagawa Y, Fujii H, Mukai M, Kubota T, Ando N, Watanabe M, et al. The role of the sentinel lymph node in gastrointestinal cancer. Surg Clin North Am. 2000; 80: 1799-1809.

55. Hiratsuka M, Miyashiro I, Ishikawa O, Furukawa H, Motomura K, Ohigashi H, et al. Application of sentinel node biopsy to gastric cancer surgery. Surgery. 2001; 129: 335-340.

56. Kitagawa Y, Takeuchi H, Takagi Y, et al. Prospective multicentertrial of sentinel node mapping for gastric cancer. J Clin Oncol. 2009; 27: 4518.

57. Kitagawa Y, Ohgami M, Fujii H, Mukai M, Kubota T, Ando N, et al. Laparoscopic detection of sentinel lymph nodes in gastrointestinal cancer: A novel and minimally invasive approach. Ann Surg Oncol. 2001; 8: 86S–89S.

58. Orsenigo E, Tomajer V, Di Palo S, Viale E, Masci E, Canevari C, et al. Sentinel node mapping during laparoscopic distal gastrectomy for gastric cancer. Surg Endosc. 2008; 22: 118-121.

59. Saikawa Y, Otani Y, Kitagawa Y, Yoshida M, Wada N, Kubota T, et al. Interim results of sentinel node biopsy during laparoscopic gastrectomy: Possible role in function-preserving surgery for early cancer. World J Surg. 2006; 30: 1962–1968.

60. Takeuchi H, Oyama T, Kamiya S, Nakamura R, Takahashi T, Wada N, et al. Laparoscopy-assisted proximal gastrectomy with sentinel node mapping for early gastric cancer. World J Surg. 2011; 35: 2463-2471.

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