Surg Endosc (2016) 30:3673–3683
DOI 10.1007/s00464-015-4681-0

REVIEW

Comparison of endoscopic resection and gastrectomy for the treatment of early gastric cancer: a meta-analysis

Fan-Sheng Meng[1] · Zhao-Hong Zhang[2] · Ya-Mei Wang[1] · Lin Lu[3] · Jin-Zhou Zhu[1] · Feng Ji[1]

Received: 11 June 2015 / Accepted: 14 November 2015 / Published online: 10 December 2015
© Springer Science+Business Media New York 2015

Abstract
Background Endoscopic resection methods, including endoscopic mucosal resection and endoscopic submucosal dissection, have become standard treatment modalities for patients with early gastric cancer (EGC) and absolute indications, with en bloc resection being more frequent with the latter. Endoscopic resection, however, has been associated with higher recurrence and metachronous cancer rates than gastrectomy. This meta-analysis compared the efficacy and safety of endoscopic resection and gastrectomy for EGC.
Methods PubMed, EMBASE and Web of Science were electronically searched for relevant studies comparing endoscopic resection and gastrectomy for EGC from 1976 through March 2015. The primary endpoints were en bloc resection and histologically complete resection rates. The secondary endpoints were duration of hospital stay and rates of complications, recurrence, metachronous cancer and overall survival.
Results This meta-analysis enrolled 10 studies with 2070 patients: 993 patients who underwent endoscopic resection and 1077 who underwent gastrectomy. Endoscopic resection was associated with shorter hospital stay (standardized mean difference −2.02; 95 % confidence interval [CI] −2.64 to −1.39) and lower complication rate (relative risk [RR] 0.41; 95 % CI 0.22–0.76) than gastrectomy. However, endoscopic resection was associated with lower rates of en bloc resection (odds ratio [OR] 0.05; 95 % CI 0.02–0.16) and histologically complete resection (OR 0.04; 95 % CI 0.01–0.11) and higher rates of recurrence (RR 5.23; 95 % CI 2.43–11.27) and metachronous cancer (RR 5.22; 95 % CI 2.40–11.34) than gastrectomy. Overall survival rate (OR 1.18; 95 % CI 0.76–1.82) was similar.
Conclusions Endoscopic resection is minimally invasive and as effective as surgery, suggesting that the former be considered standard treatment for EGC. It should be recommended as standard treatment for EGC with indications. Additional randomized controlled trials from more countries are required.

Keywords Early gastric cancer · Endoscopic mucosal resection · Endoscopic resection · Endoscopic submucosal dissection · Gastrectomy · Surgery

Fan-Sheng Meng and Zhao-Hong Zhang have contributed equally to this work.

✉ Lin Lu
linlu2043@163.com

✉ Feng Ji
jifeng1126@sina.com

[1] Department of Gastroenterology, The First Affiliated Hospital, School of Medicine, Zhejiang University, Qingchun Road No. 79, Hangzhou 310000, China

[2] Department of Hematology, Linyi People's Hospital, Jiefang Road No. 27, Linyi 276300, China

[3] Department of Gastroenterology, Linyi People's Hospital, Jiefang Road No. 27, Linyi 276300, China

Early gastric cancer (EGC) is defined as a gastric cancer confined to the mucosa or submucosa, regardless of the occurrence of regional lymph node metastases [1]. Improvements in imaging and other diagnostic techniques and greater public awareness of the importance of early detection have increased the diagnosis of EGC worldwide.

Previously, the standard treatment of EGC was open gastrectomy, but open surgery is associated with high morbidity and mortality rates as well as significantly

impairing quality of life. Although laparoscopy-assisted gastrectomy is less invasive, it may be difficult to determine the precise location of the lesion, resulting in the removal of excess normal tissue. Furthermore, abdominal wound metastasis may be a rare complication of this procedure [2].

These issues have been addressed by the development of endoscopic resection (ER) methods for the treatment of EGC without any risk of lymph node involvement [3]. ER can be broadly categorized as endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD). EMR is currently regarded as the standard treatment for EGCs that meet the absolute indications of Japanese gastric cancer treatment guidelines [4]. These absolute indications, however, are so strict that unnecessary surgeries may be performed. This has resulted in the use of ESD which has been shown to be feasible and effective for EGC with the expanded indications [5–7].

Although several studies have compared ER with gastrectomy for EGC, their results have been somewhat inconsistent. To date, no meta-analysis of greater statistical power has compared the clinical outcomes of ER and gastrectomy. This meta-analysis of eligible studies evaluated the efficacy and safety of ER and gastrectomy for EGC.

Methods

Search strategy

The PubMed, EMBASE, and Web of Science databases were searched systematically for all relevant articles published between 1976 and March 31, 2015, that compared ER with gastrectomy. The following key words were used in these literature searches: "endoscopic submucosal dissection" OR "endoscopic mucosal resection" OR "EMR" OR "endoscopic resection" and "gastrectomy" OR "surgery" and "early gastric cancer" OR "early gastric neoplasm" OR "early stomach cancer" OR "early stomach neoplasm." There were no language restrictions. A recursive manual search of cited references in published studies was performed to identify other studies. The abstracts of important GI meetings, such as Digestive Disease Week, were also searched manually.

Inclusion criteria and exclusion criteria

Studies were included if: (1) patients had been pathologically diagnosed with EGC, (2) ER was compared with gastrectomy, (3) their quality scores were five points or higher, and (4) studies analyzed at least two of the following endpoints including length of hospital stay, rates of en bloc resection, complete resection, complication, recurrence, metachronous cancer and overall survival. Comments, reviews, case reports and guideline articles were excluded, as were studies of patients without EGC or with tumors of other organs and studies with insufficient data.

Data extraction

Two reviewers (YM Wang and JZ Zhu) investigated the data of included studies independently and reached consensus on all items. The following information was extracted: name of first author, year of publication; number, age and sex of patients, length of hospital stay; and rates of en bloc resection, complete resection, complications, recurrence, metachronous cancer and overall survival. Length of hospital stay was defined as the time from the date of ER or gastrectomy to the discharge date; en bloc resection as the—resection of tumors in one piece; and histologically complete resection as—en bloc resection with negative tumor margins. Complications related to the procedure as—major bleeding, perforation, dehiscence and infection during or after the operation; recurrence as—local recurrence of cancer lesions; and metachronous cancer as—a newly developed cancer after at least 1 year after surgery. Overall survival rate was defined as the percentages of patients who remained alive after ER or gastrectomy. The quality of the included nonrandomized studies was assess using the Newcastle–Ottawa Scale (NOS); only articles with quality scores greater than five points were enrolled in this meta-analysis.

Statistical analysis

Data were analyzed using STATA software (version 12.0, StataCorp LP, College Station, TX). Standardized mean difference (SMD) and 95 % confidence interval (CI) were calculated for continuous data, odds ratio (OR) or risk ratio (RR) with 95 % CI calculated for dichotomous data. If a study reported a range rather than a standard deviation (SD), SD was estimated using the formula: range/$4(15 < n \leq 70)$ or range/$6(n > 70)$ [8]. Heterogeneity among studies was assessed by the Chi-square test with P value <0.05 considered significant. Heterogeneity was also assessed by calculating I^2, I^2 over 50 % considered statistically heterogeneous. A fixed-effects model was used for calculations when no heterogeneity was observed. If a high degree of heterogeneity was detected, subgroup and sensitivity analyses were performed to explore the sources of heterogeneity; if this source of heterogeneity could not be identified, a random-effects model was used. Funnel plots and Egger's linear regression test were used to evaluate the publication bias.

Results

Study selection and quality assessment

Our search strategy yielded a total of 3813 articles. After scanning their titles and abstracts, 1348 identical articles retrieved from multiple databases were excluded. An additional 2446 articles were excluded: 1182 because they did not compare ER and gastrectomy; 667 because they were reviews, case reports and comments; 458 because they were not studies of ER or gastrectomy; 106 because they were not about EGC. In addition, 19 animal studies and 14 duplicate publications were excluded. Of the remaining 19 articles, nine articles were excluded: three because each assessed only one predetermined endpoint [9, 10], two written in Chinese with low quality scores [11, 12], two meeting abstracts, one that did not assess any predetermined endpoint [13] and one that assessed patients with EGC accompanied by esophageal cancer [14]. The remaining 10 studies included a total of 2070 patients: 993 who underwent ER and 1077 who underwent gastrectomy. All of the articles were full texts of retrospective case–control studies (Fig. 1). The main characteristics and quality assessments of the studies are listed in Table 1.

Comparison of effects

En bloc resection rate

Six studies reported en bloc resection rate [15–20]. No heterogeneity was observed among studies, so a fixed-effects model was applied. The pooled analysis demonstrated that the en bloc resection rate was lower with ER than with gastrectomy (OR 0.05; 95 % CI 0.02–0.16) (Fig. 2). Funnel plots and Egger's test showed no evidence of publication bias ($P = 0.538$).

Histologically complete resection rate

Six studies reported complete resection rates [15–20]. There is no heterogeneity among studies, so a fixed-effects model was applied. The pooled analysis showed that the

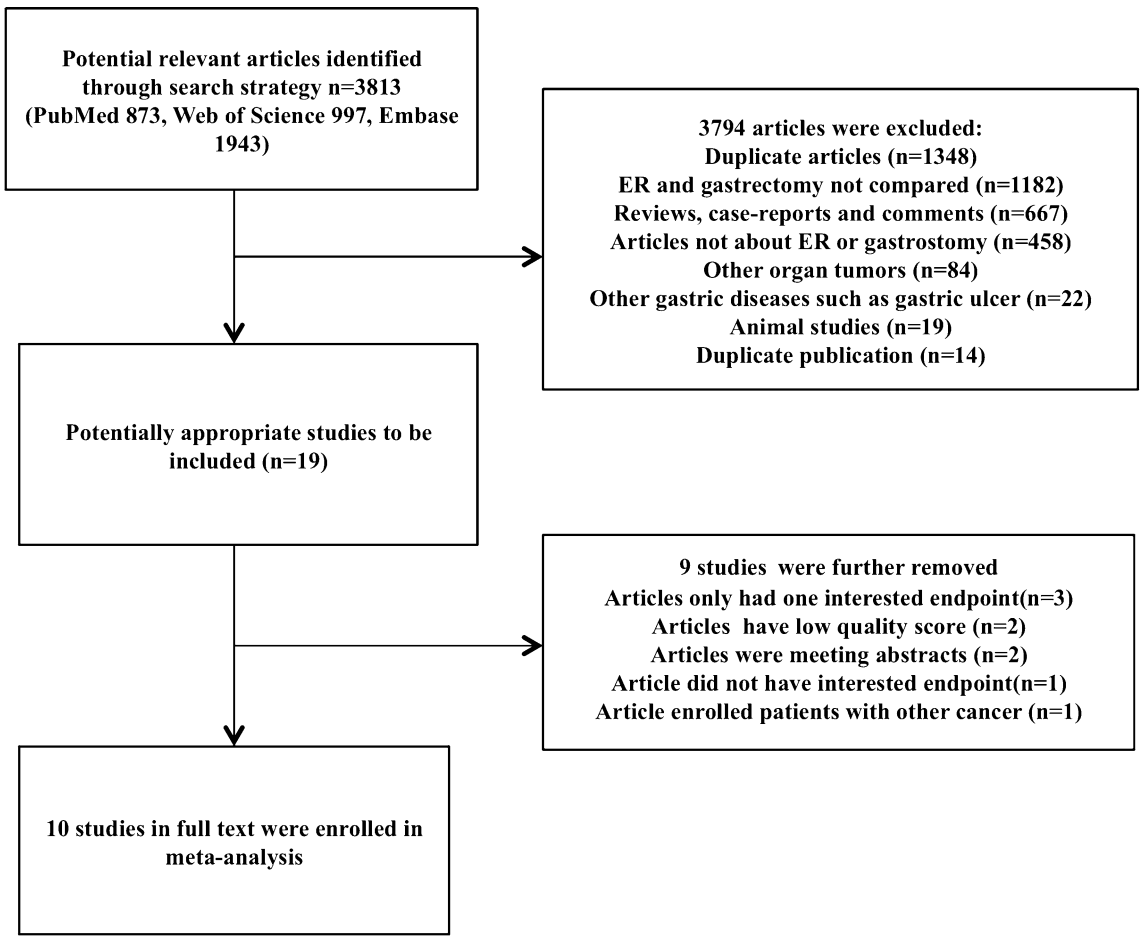


Fig. 1 Flowchart of the search strategy

Table 1 Characteristics of included studies

References	Country	Study design	Article type	Patients	Baseline consistency	Follow-up (months)	Quality score	Endpoints
Kim et al. [16]	South Korea	Retrospective	Full text	EMR 20 GTC 35	No	EMR 36.5 (range 18–66) GTC 29.3 (range 18–66)	6	Complete resection, 5-year survival
Etoh T et al. [17]	Japan	Retrospective	Full text	EMR 49 GTC 44	Yes	N/A	7	Complete resection, complication morbidity, mortality, recurrence, 5-year survival
Choi et al. [22]	South Korea	Retrospective	Full text	EMR 172 GTC 379	Yes	EMR 81 (IQR 56–94) GTC 88 (IQR 63–117)	7	Complete resection, complication hospital stay, mortality, recurrence, metachronous cancer, mortality, 5-year survival, cost
Chiu et al. [18]	HK, China	Retrospective	Full text	ESD 74 GTC 40	Yes	ESD 27 (range 1–65) GTC 77.6 (range 1–180)	8	Operation time, blood loss, hospital stay, en bloc resection, complication, 3-year survival
Zhang et al. [24]	China	Retrospective	Full text	ER 25 GTC 100	N/A	N/A	6	Hospital stay, recurrence, cost
Chung et al. [20]	South Korea	Retrospective	Full text	ESD 76 GTC 149	Yes	42.2 ± 19.2 (SD)	7	En bloc resection, complete resection, recurrence, metachronous cancer, complication
Park et al. [23]	South Korea	Retrospective	Full text	ESD 132 GTC 132	Yes	ESD 17.6 (IQR 9.9–25.7) GTC 24.2 (IQR 12.5–36.7)	7	Hospital stay, complication, recurrence, metachronous cancer, 5-year survival
Kim et al. [19]	South Korea	Retrospective	Full text	ESD 142 GTC 71	No	ESD 76.7 ± 16.5 (SD) GTC 65.5 ± 16.5 (SD)	7	Hospital stay, complication, recurrence, metachronous cancer, overall survival
Choi et al. [21]	South Korea	Retrospective	Full text	ER 261 GTC 114	Yes	ER 74.9 (IQR 59.5–92.2) GTC 78.1 (IQR 64.2–94.0)	7	Complete resection, complication, recurrence, metachronous cancer, 5-year survival
Yamashina et al. [25]	Japan	Retrospective	Full text	ER 42 GTC 13	Yes	43.5 (range 6–159)	7	Operation time, hospital stay, mortality, complication, overall survival

ER endoscopic resection, *EMR* endoscopic mucosal resection, *ESD* endoscopic submucosal dissection, *GTC* gastrectomy, *SD* standard deviation, *IQR* interquartile range, *N/A* not available

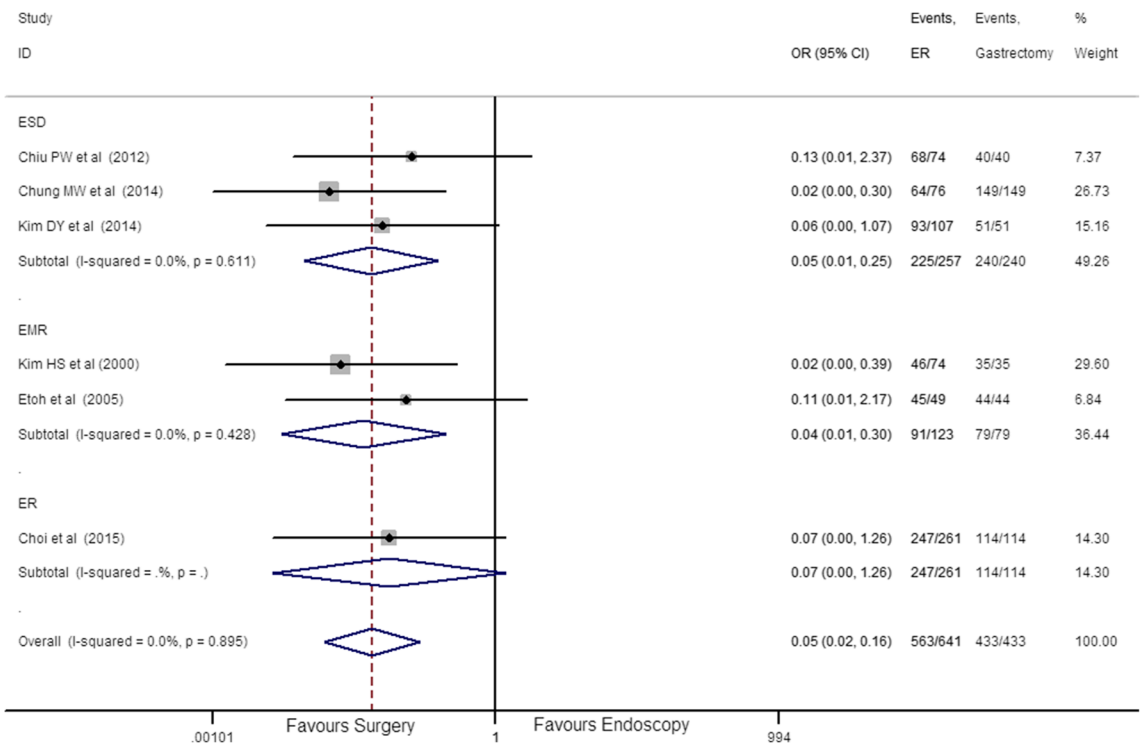


Fig. 2 Forest plot of en bloc resection rate comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection, *EMR* endoscopic mucosal resection, *ER* endoscopic resection

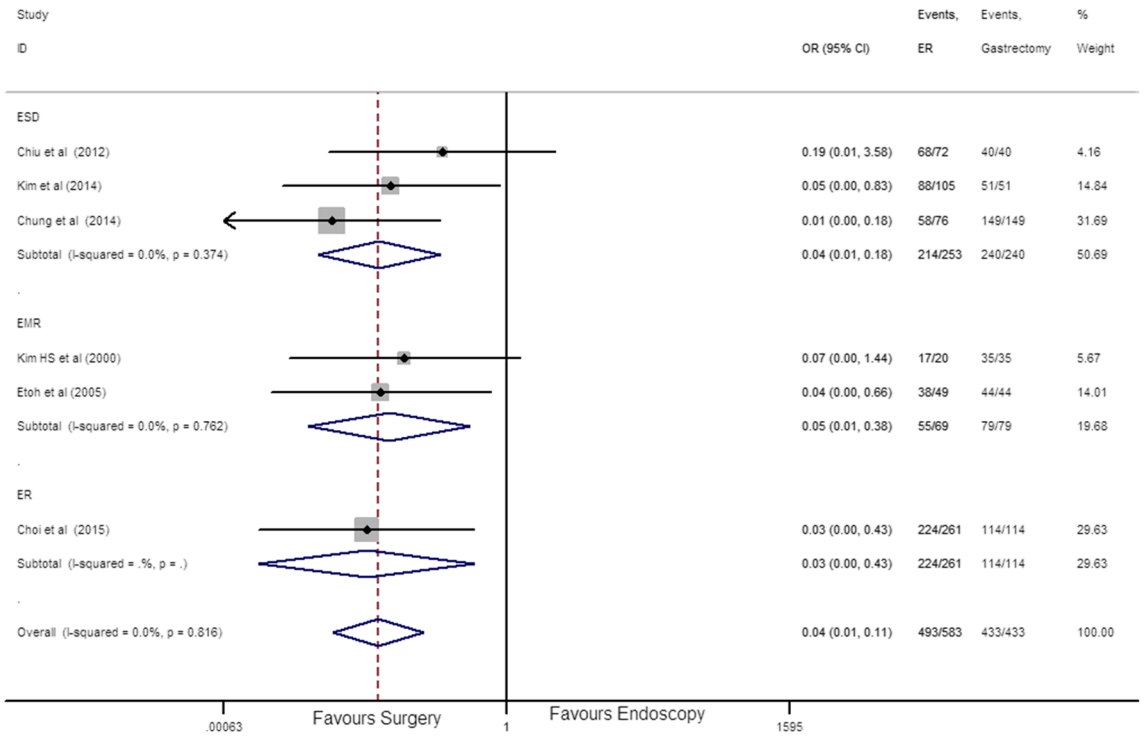


Fig. 3 Forest plot of histologically complete resection rate comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection *EMR* endoscopic mucosal resection, *ER,* endoscopic resection

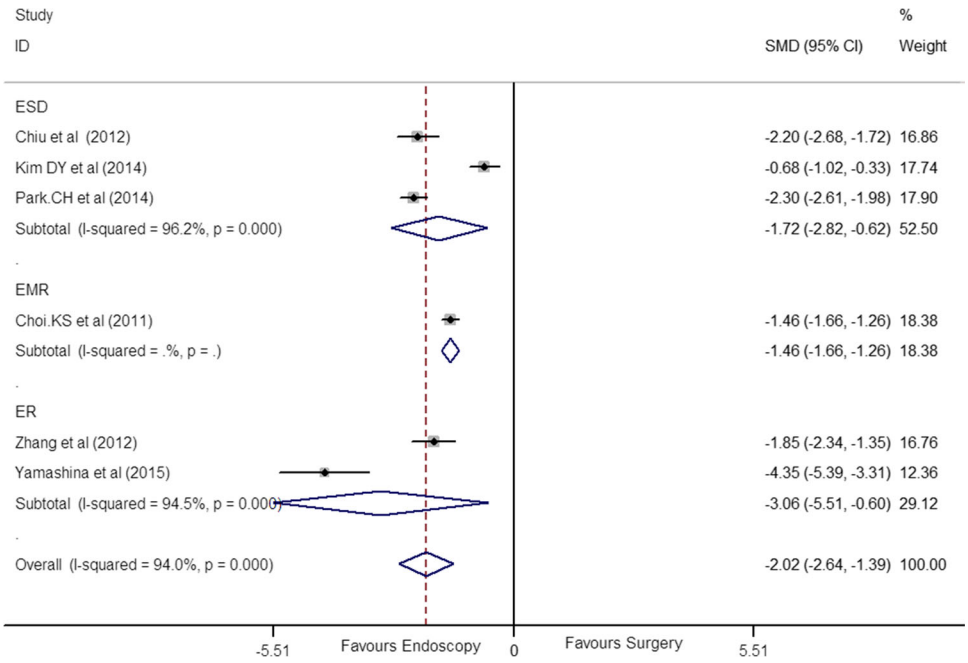


Fig. 4 Forest plot of hospital stay comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection, *EMR* endoscopic mucosal resection, *ER* endoscopic resection

complete resection rate was significantly lower in the ER than in the gastrectomy group (OR 0.04; 95 % CI 0.01–0.11) (Fig. 3). Funnel plots and Egger's test showed no evidence of publication bias ($P = 0.130$).

Hospital stay

Six studies compared hospital stay in patients who underwent ER and gastrectomy [17, 18, 21–24]. These studies were highly heterogeneous ($P = 0.000$; $I^2 = 94.0$ %). Although three studies could be excluded by sensitivity analysis, heterogeneity remained high ($P = 0.000$; $I^2 = 89.1$ %). Thus a random-effects model was applied. Pooled analysis showed that hospital stay was shorter in ER than in the gastrectomy group (SMD −2.02; 95 % CI −2.64 to −1.39) (Fig. 4). No evidence of publication bias was observed ($P = 0.259$).

Complication rate

Seven studies compared complication rates [16–18, 20–22, 24]. Heterogeneity was detected ($P = 0.015$; $I^2 = 61.9$ %), so a random-effects model was used. A pooled analysis showed that the overall complication rate was lower in the ER than in the gastrectomy group (RR 0.41; 95 % CI 0.22–0.76) (Fig. 5). No publication bias was detected ($P = 0.400$).

Recurrence rate

Seven studies reported recurrence rates [16, 18–23], which were significantly higher in the ER than in the gastrectomy group (RR 5.23; 95 % CI 2.43–11.27) (Fig. 6). No heterogeneity was observed ($P = 0.311$, $I^2 = 16$ %), and no evidence of publication bias was found ($P = 0.891$).

Metachronous cancer rate

Six studies reported metachronous cancer rate [18–22, 24]. The pooled analysis revealed that metachronous cancer rate was higher in the ER than in the gastrectomy group (RR 5.22; 95 % CI 2.40–11.34) (Fig. 7). There was no evidence of heterogeneity ($P = 0.998$, $I^2 = 0$ %) or publication bias ($P = 0.229$).

Overall survival rate

Six studies reported overall survival rates [15, 16, 20–22, 24]. A pooled analysis showed that the overall survival rate was similar in the ER and gastrectomy groups (OR 1.18; 95 % CI 0.76–1.82) (Fig. 8). No heterogeneity was observed ($P = 0.800$, $I^2 = 0$ %), and there was no evidence of publication bias ($P = 0.495$).

Discussion

This meta-analysis showed that ER was associated with shorter hospital stay and lower complication rate than gastrectomy for the treatment of EGC. However, ER was associated with lower rates of en bloc resection, histologically complete resection and higher rates of recurrence and metachronous cancer than gastrectomy. The overall survival rates following these two procedures were similar.

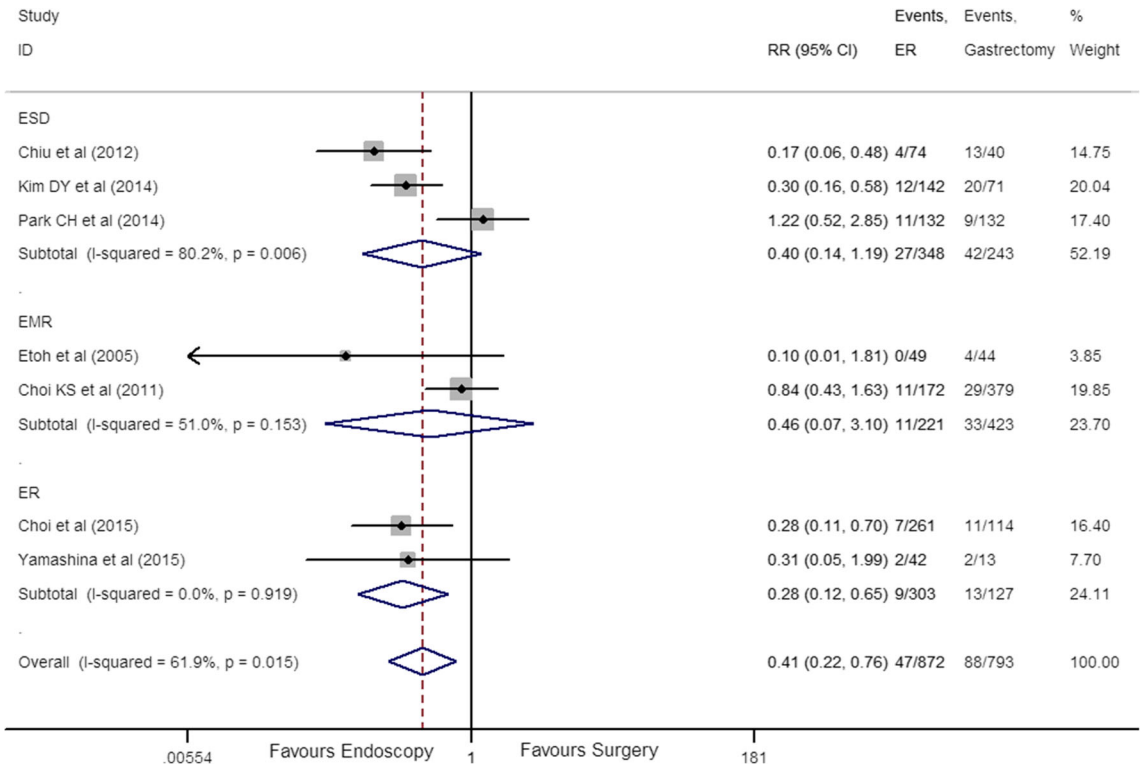


Fig. 5 Forest plot of complication rate comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection, *EMR* endoscopic mucosal resection, *ER* endoscopic resection

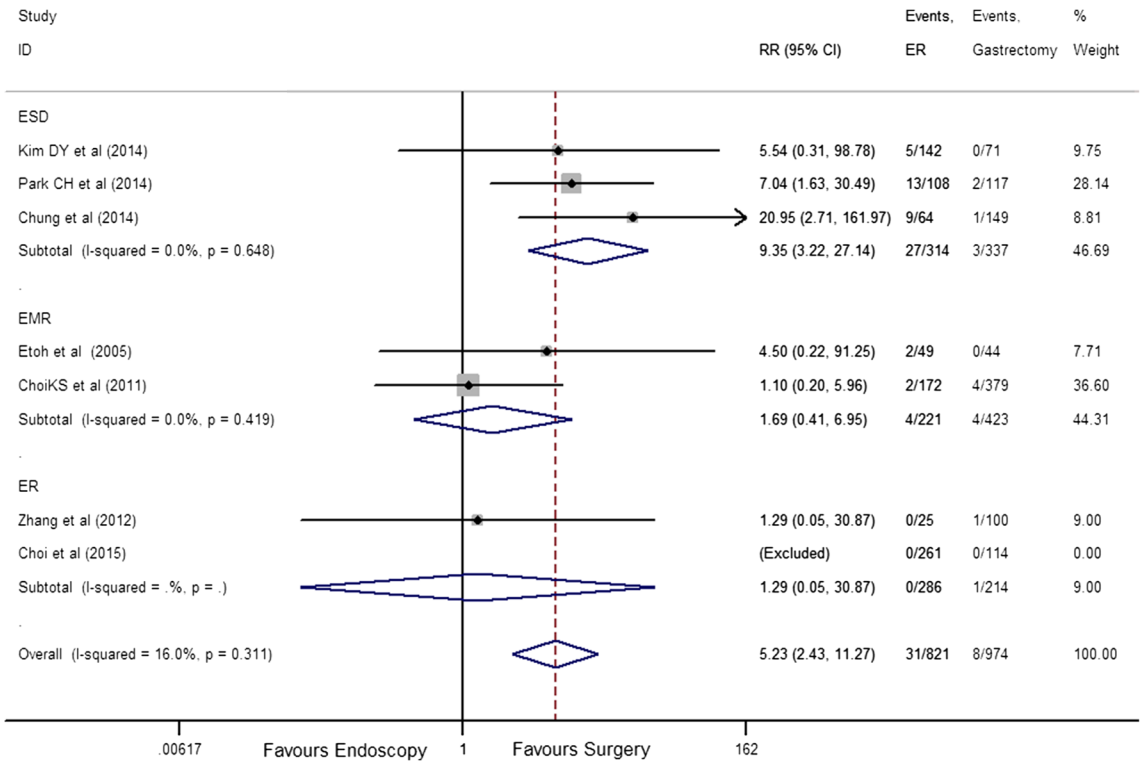


Fig. 6 Forest plot of recurrence rate comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection, *EMR* endoscopic mucosal resection, *ER* endoscopic resection

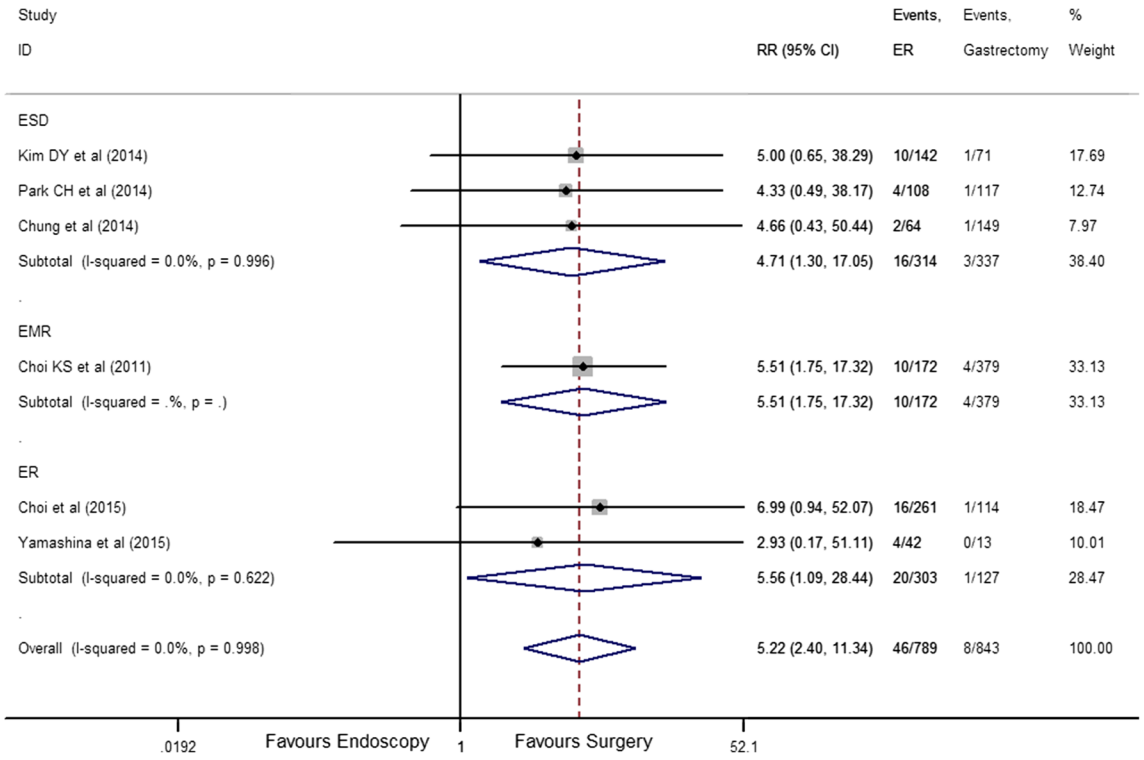


Fig. 7 Forest plot of metachronous cancer rate comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection, *EMR* endoscopic mucosal resection, *ER* endoscopic resection

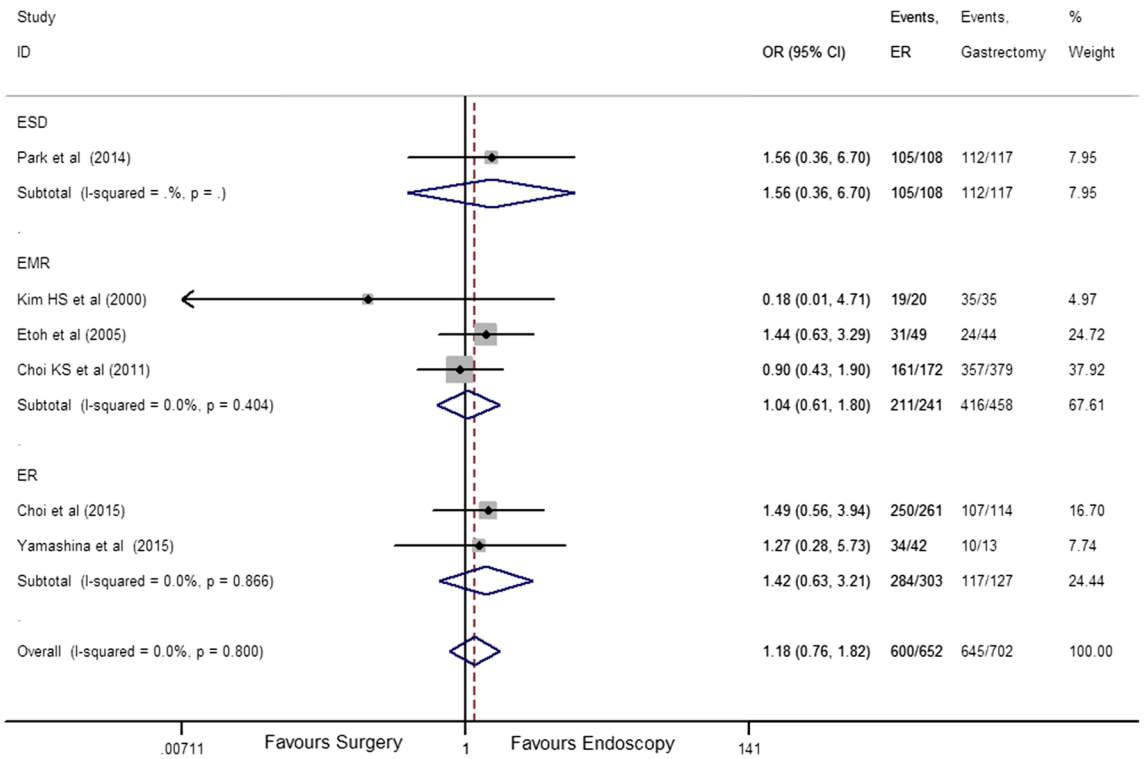


Fig. 8 Forest plot of overall survival comparing ER and gastrectomy. *ESD* endoscopic submucosal dissection, *EMR* endoscopic mucosal resection, *ER* endoscopic resection

ER, developed in Japan, is a promising alternative for the treatment of superficial carcinomas of the gastrointestinal tract that is gaining popularity worldwide. According to Japanese gastric cancer treatment guidelines, EMR is used to remove EGCs with absolute indications, whereas ESD is used for EGCs with expanded indications [4]. Several meta-analyses have demonstrated that ESD is associated with higher rates of en bloc resection and histologically complete resection and a lower recurrence rate than EMR. However, ESD has several drawbacks, including longer operation time and higher complication rate [25–28].

This meta-analysis showed that hospital stay was shorter after ER than after gastrectomy. Shorter hospital stay results in lower costs and fewer complications. ER is less invasive than surgery, while preserving the entire stomach and maintaining the integrity of normal digestive physiology. Thus, patients who undergo ER experience a more rapid recovery of gastrointestinal function and better long-term quality of life.

The results of this meta-analysis also showed that ER was associated with lower en bloc and complete resection rates than gastrectomy. Although the en bloc resection rate of ESD is high, EMR cannot resect lesions larger than 2 cm en bloc. Major factors that may influence prognosis in patients undergoing ER treatment of EGCs include depth of invasion, lesion size, status of differentiation and lymph node, ulcer presence and submucosal fibrosis. Lymph node metastasis has been reported to start with deep mucosal infiltration [29]. For example, the rate of lymph node metastasis of intramucosal EGC is 2–3 %, but increases to about 20 % in patients with EGCs invading the submucosa [30]. The micrometastasis rate has been reported higher in patients with lesions larger than 2 cm and in those with submucosal and undifferentiated type cancers [30]. Gastrectomy is more effective than ER for submucosal and undifferentiated cancers, reducing the risk of micrometastases. Submucosal fibrosis has been associated with a lower complete resection rate and a higher perforation rate [31]. ER combined with laparoscopic lymph node dissection may be a less invasive method of removing EGCs [32].

This meta-analysis also showed an association between high rates of incomplete resection and tumor recurrence. Standard EMR has been associated with risk of recurrence, especially when lesions are not resected en bloc, or when the resection margins are positive for tumor cells [33]. Positive margins give rise to local recurrence, lymph node metastasis and distant metastasis.

The pooled complication rate for ER was 5.4 %, with bleeding and perforation being the most common complications. Perforation is uncommon during EMR, but is more common during ESD. Most of the bleeding and perforation can be managed conservatively by argon plasma coagulation, insulated-tip knife or metal hemoclips. Uncontrolled bleeding or perforation requires surgical intervention. Complications associated with gastrectomy including dehiscence, major bleeding and infection, which could lead to death.

The pooled incidence of metachronous cancer was much higher in patients who underwent ER (5.8 %) than surgery (0.9 %). Several hypotheses may explain this finding. For example, primary EGCs frequently develop in the middle or lower third of the stomach, with these high-risk areas remaining after ER. Alternatively, atrophic gastritis and intestinal metaplasia persist in the residual mucosa after ER [21]. However, the improved quality of life in patients who undergo ER may outweigh the risk of metachronous lesions and all metachronous EGCs after ER can be successfully re-managed by ER without affecting overall survival.

EGC is associated with an excellent prognosis, with 5-year survival rates over 90 % [18]. In addition, the 5-year cancer-specific survival rates of patients with EGCs limited to the mucosa and submucosa have been reported to be 99 and 96 %, respectively [33]. In this meta-analysis, the pooled 5-year overall survival rates were similar in patients who underwent ER (92.0 %) and gastrectomy (91.9 %). As ER is minimally invasive, resulting in a higher quality of life, ER should be the first-line treatment for EGCs with indications.

Noteworthily, this pooled analysis showed that the rates of procedure-related death were similar in patients who underwent ER and surgery (data not shown). Although surgery is associated with a higher complication rate, most of these complications could be managed successfully during the operation.

This meta-analysis had several limitations. First, all the included studies were retrospective in design, with relatively low quality; moreover, these studies show significant heterogeneity. Second, most of the studies were from Japan and South Korea, countries with advanced endoscopic technology. Thus, it may not be possible to extrapolate the results of this meta-analysis to Western countries. Third, some of the patients in these trials were not selected according to absolute or expanded indications. Finally, some of the definitions and criteria for endpoints differed slightly among these studies which may have influenced the results of this meta-analysis.

In conclusion, this meta-analysis showed that ER was as effective as gastrectomy, while being safer and having lower costs in patients with EGC. A high proportion of patients with EGC may benefit from ER, making ER the first-line treatment for patients meeting indicated criteria. Surgery may be an alternative or second-line treatment when ER is not curative. As ER is technically challenging,

however, it should be performed in tertiary centers. Randomized, controlled trials with large samples from additional countries are required to confirm these findings.

Compliance with ethical standards

Disclosures Drs. Fan-Sheng Meng, Zhao-Hong Zhang, Ya-Mei Wang, Lin Lu, Jin-Zhou Zhu and Feng Ji have no conflicts of interest or financial ties to disclose.

References

1. Japanese Gastric Cancer A (1998) Japanese classification of gastric carcinoma—2nd English edition. Gastric Cancer 1:10–24
2. Mo X, Yang Y, Lai H, Xiao J, He K, Chen J, Lin Y (2014) Does carbon dioxide pneumoperitoneum enhance wound metastases following laparoscopic abdominal tumor surgery? A meta-analysis of 20 randomized control studies. Tumor Biol 35:7351–7359
3. Oka S, Tanaka S, Kaneko I, Mouri R, Hirata M, Kawamura T, Yoshihara M, Chayama K (2006) Advantage of endoscopic submucosal dissection compared with EMR for early gastric cancer. Gastrointest Endosc 64:877–883
4. Assoc JGC (2011) Japanese gastric cancer treatment guidelines 2010 (ver. 3). Gastric Cancer 14:113–123
5. Park CH, Shin S, Park JC, Shin SK, Lee SK, Lee YC, Lee H (2013) Long-term outcome of early gastric cancer after endoscopic submucosal dissection: expanded indication is comparable to absolute indication. Dig Liver Dis 45:651–656
6. 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 (2011) Endoscopic and oncologic outcomes after endoscopic resection for early gastric cancer: 1370 cases of absolute and extended indications. Gastrointest Endosc 74:485–493
7. Lee IS, Yook JH, Park YS, Kim KC, Oh ST, Kim BS (2013) Suitability of endoscopic submucosal dissection for treatment of submucosal gastric cancers. Br J Surg 100:668–673
8. Hozo SP, Djulbegovic B, Hozo I (2005) Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol 5:13
9. Kim Y, Kim YW, Choi IJ, Cho JY, Kim JH, Kwon JW, Lee JY, Lee NR, Seol SY (2015) Cost comparison between surgical treatments and endoscopic submucosal dissection in patients with early gastric cancer in Korea. Gut Liver 9:174–180
10. Fukase K, Oshima S, Hara T, Saito Y, Miura T, Fujishima S, Suzuki Y, Shirahata N, Suzuki K, Takeda H (2012) Comparative evaluation of long-term prognosis between endoscopic treatment and surgery for early gastric cancer. Gastroenterol Endosc 54:1121
11. Zhou P, Peng G, Yang S, Chen D, Li Y, Zhang H, Fang D, Yao L (2014) Effectiveness of endoscopic submucosal dissection vs gastrectomy for early gastric cancer and precancerous lesions. J Third Mil Med Univ 36:1507–1511
12. Zhang HY, Liu HB (2014) Clinical effects of endoscopic submucosal dissection vs surgical treatment for early gastric cancer. World Chin J Digestol 22:5330–5333
13. Choi ES, Park KS, Cho KB, Kim ES, Lee SM (2014) Comparison of quality of life and worry of cancer recurrence between endoscopic and surgical treatment for early gastric cancer: a cross-sectional study. J Gastroenterol Hepatol (Australia) 29:4
14. Park SJ, Ahn JY, Jung HY, Na S, Park SE, Kim MY, Choi KS, Lee JH, Kim do H, Choi KD, Song HJ, Lee GH, Kim JH, Han S (2015) Endoscopic resection for synchronous esophageal squamous cell carcinoma and gastric adenocarcinoma in early stage is a possible alternative to surgery. Gut Liver 9:59–65
15. Kim HS, Lee DK, Baik SK, Kim JM, Kwon SO, Kim DS, Cho MY (2000) Endoscopic mucosal resection with a ligation device for early gastric cancer and precancerous lesions: comparison of its therapeutic efficacy with surgical resection. Yonsei Med J 41:577–583
16. Etoh T, Katai H, Fukagawa T, Sano T, Oda I, Gotoda T, Yoshimura K, Sasako M (2005) Treatment of early gastric cancer in the elderly patient: results of EMR and gastrectomy at a national referral center in Japan. Gastrointest Endosc 62:868–871
17. Chiu PWY, Teoh AYB, To KF, Wong SKH, Liu SYW, Lam CCH, Yung MY, Chan FKL, Lau JYW, Ng EKW (2012) Endoscopic submucosal dissection (ESD) compared with gastrectomy for treatment of early gastric neoplasia: a retrospective cohort study. Surg Endosc Other Interv Tech 26:3584–3591
18. Kim DY, Hong SJ, Cho GS, Jeong GA, Kim HK, Han JP, Lee YN, Ko BM, Lee MS (2014) Long-term efficacy of endoscopic submucosal dissection compared with surgery for early gastric cancer: a retrospective cohort study. Gut Liver 8:519–525
19. Chung MW, Jeong O, Park YK, Lee KH, Lee JH, Lee WS, Joo YE, Choi SK, Cho SB (2014) Comparison on the long term outcome between endoscopic submucosal dissection and surgical treatment for undifferentiated early gastric cancer. Korean J Gastroenterol = Taehan Sohwagi Hakhoe chi 63:90–98
20. Choi IJ, Lee JH, Kim Y-I, Kim CG, Cho S-J, Lee JY, Ryu KW, Nam B-H, Kook M-C, Kim Y-W (2015) Long-term outcome comparison of endoscopic resection and surgery in early gastric cancer meeting the absolute indication for endoscopic resection. Gastrointest Endosc 81:U333–U395
21. Choi KS, Jung HY, Choi KD, Lee GH, Song HJ, Kimdo H, Lee JH, Kim MY, Kim BS, Oh ST, Yook JH, Jang SJ, Yun SC, Kim SO, Kim JH (2011) EMR versus gastrectomy for intramucosal gastric cancer: comparison of long-term outcomes. Gastrointest Endosc 73:942–948
22. Park CH, Lee H, Kim DW, Chung H, Park JC, Shin SK, Hyung WJ, Lee SK, Lee YC, Noh SH (2014) Clinical safety of endoscopic submucosal dissection compared with surgery in elderly patients with early gastric cancer: a propensity-matched analysis. Gastrointest Endosc 80:599–609
23. Zhang WJ, Pan WS, Chen GL (2012) Endoscopic therapy versus surgery for treatment of high-grade intraepithelial neoplasia and early gastric cancer: a comparative study of efficacy and economics. J Pract Oncol 27:264–267
24. Yamashina T, Uedo N, Dainaka K, Aoi K, Matsuura N, Ito T, Fujii M, Kanesaka T, Yamamoto S, Akasaka T, Hanaoka N, Takeuchi Y, Higashino K, Ishihara R, Kishi K, Fujiwara Y, Iishi H (2015) Long-term survival after endoscopic resection for early gastric cancer in the remnant stomach: comparison with radical surgery. Ann Gastroenterol 28:66–71
25. Park YM, Cho E, Kang HY, Kim JM (2011) The effectiveness and safety of endoscopic submucosal dissection compared with endoscopic mucosal resection for early gastric cancer: a systematic review and metaanalysis. Surg Endosc 25:2666–2677
26. Cao Y, Liao C, Tan A, Gao Y, Mo Z, Gao F (2009) Meta-analysis of endoscopic submucosal dissection versus endoscopic mucosal resection for tumors of the gastrointestinal tract. Endoscopy 41:751–757
27. Lian J, Chen S, Zhang Y, Qiu F (2012) A meta-analysis of endoscopic submucosal dissection and EMR for early gastric cancer. Gastrointest Endosc 76:763–770
28. Facciorusso A, Antonino M, Di Maso M, Muscatiello N (2014) Endoscopic submucosal dissection vs endoscopic mucosal resection for early gastric cancer: a meta-analysis. World J Gastrointest Endosc 6:555–563

29. Holscher AH, Drebber U, Monig SP, Schulte C, Vallbohmer D, Bollschweiler E (2009) Early gastric cancer: lymph node metastasis starts with deep mucosal infiltration. Ann Surg 250:791–797
30. Lee H, Yun WK, Min BH, Lee JH, Rhee PL, Kim KM, Rhee JC, Kim JJ (2011) A feasibility study on the expanded indication for endoscopic submucosal dissection of early gastric cancer. Surg Endosc 25:1985–1993
31. Higashimaya M, Oka S, Tanaka S, Sanomura Y, Yoshida S, Hiyama T, Arihiro K, Shimamoto F, Chayama K (2013) Outcome of endoscopic submucosal dissection for gastric neoplasm in relationship to endoscopic classification of submucosal fibrosis. Gastric Cancer 16:404–410
32. Abe N, Takeuchi H, Ohki A, Yanagida O, Masaki T, Mori T, Sugiyama M (2011) Long-term outcomes of combination of endoscopic submucosal dissection and laparoscopic lymph node dissection without gastrectomy for early gastric cancer patients who have a potential risk of lymph node metastasis. Gastrointest Endosc 74:792–797
33. Gotoda T (2007) Endoscopic resection of early gastric cancer. Gastric Cancer 10:1–11