

Survival benefits of gastrectomy in patients with metastatic gastric cancer: A meta-analysis

Lifan Chen^{1,A,D–F}, Yu Chen^{2,A–C,F}

¹ Medical Department, Shantou Central Hospital, Guangdong, China

² Department of Cardiology, Longgang District People's Hospital of Shenzhen, Guangdong, China

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Advances in Clinical and Experimental Medicine, ISSN 1899–5276 (print), ISSN 2451–2680 (online)

Adv Clin Exp Med. 2025;34(1):9–23

Address for correspondence

Yu Chen

E-mail: yuchenlgdr@outlook.com

Funding sources

None declared

Conflict of interest

None declared

Received on June 21, 2023

Reviewed on September 1, 2023

Accepted on February 19, 2024

Published online on June 11, 2024

Abstract

Background. Individuals with metastatic gastric cancer (MGC) are incurable and have a poor prognosis. To date, surgical resection with curative intent is the only treatment providing hope for a cure, but the role of surgical resection is still controversial.

Objectives. To assess the effects of gastrectomy compared to non-resection on MGC patient survival.

Materials and methods. PubMed, Embase, Cochrane Library, and Web of Science databases were searched up to October 10, 2023. Primary outcomes were 1-, 2-, 3-, and 5-year overall survival (OS), OS, and OS time.

Results. Forty-six studies with 7,152 MGC patients were included. Compared to MGC patients receiving no resection, MGC patients with gastrectomy had significantly improved 1-year OS (pooled relative risk (RR): 1.90, 95% confidence intervals (95% CI): 1.50, 2.41), 2-year OS (pooled RR: 2.23, 95% CI: 1.40, 3.53), 3-year OS (pooled RR: 6.09, 95% CI: 3.12, 11.87), 5-year OS (pooled RR: 4.30, 95% CI: 1.35, 13.74), and reduced risk of death (pooled hazard ratio (HR): 0.49, 95% CI: 0.37, 0.65). Gastrectomy combined with metastasectomy or not also revealed similar results regarding OS and risk of death. Additionally, OS time was significantly longer in patients receiving gastrectomy than patients not receiving resection (pooled weighted mean difference (WMD): 6.06, 95% CI: 1.36, 10.760). No significant difference in postoperative morbidity was detected between the patients receiving gastrectomy and patients not receiving resection (pooled RR: 2.54, 95% CI: 0.13, 51.39).

Conclusions. Gastrectomy, with or metastasectomy, may provide MGC patients with survival benefits.

Key words: survival, meta-analysis, gastrectomy, metastatic gastric cancer

Cite as

Chen L, Chen Y. Survival benefits of gastrectomy for patients with metastatic gastric cancer: A meta-analysis.

Adv Clin Exp Med. 2025;34(1):9–23.

doi:10.17219/acem/184268

DOI

10.17219/acem/184268

Copyright

Copyright by Author(s)

This is an article distributed under the terms of the Creative Commons Attribution 3.0 Unported (CC BY 3.0) (<https://creativecommons.org/licenses/by/3.0/>)

Introduction

Gastric cancer (GC) is the 5th most prevalent cancer and the 4th most common cause of cancer-related death worldwide. Since GC is often diagnosed at an advanced stage, it leads to high mortality, with 769,000 deaths globally in 2020.^{1,2} Over half of GC patients in the USA have regional or distant metastases at the time of diagnosis.³ Individuals with metastatic GC (MGC) are incurable and have a poor prognosis, with a median overall survival (OS) of less than 1 year.^{4–6} Currently, MGC remains a primary global health problem, and timely and effective therapies are of great significance.

Chemotherapy is the gold standard MGC treatment.^{7,8} At present, trastuzumab is the only molecularly targeted drug accepted in first-line treatment, combined with cisplatin and fluoropyrimidine, for patients with MGC with human epidermal growth factor receptor 2 (*HER2*) overexpression who have not received anti-cancer therapy.⁹ However, only around 20% of MGC patients have overexpressed *HER2*.¹⁰

The National Comprehensive Cancer Network (NCCN) guidelines indicate gastrectomy for the relief of GC-related symptoms, such as bleeding or obstruction, in patients with incurable diseases.¹¹ The Japanese Gastric Cancer Association (JGCA) guidelines recommend that patients with MGC but no substantial symptoms can receive gastrectomy.¹² Dittmar et al.¹³ showed that primary non-curative gastrectomy could lower the incidence of serious tumor-related complications and extend OS in patients with advanced GC, as confirmed by Kulig et al.¹⁴ in multicenter settings. In contrast, the REGATTA trial in 2016 showed that advanced GC patients with a single incurable factor did not obtain survival benefit from gastrectomy followed by chemotherapy compared with those undergoing chemotherapy alone.¹⁵ Moreover, selected patients with MGC who underwent surgical resection for therapeutic purposes were shown to have a relatively poor prognosis,¹⁶ and MGC patient prognosis was only moderately improved after palliative gastrectomy based on Surveillance, Epidemiology, and End Results (SEER).¹⁷ Due to these debatable findings, the effect of gastrectomy in patients with MGC requires clarification.

Objectives

This meta-analysis systematically evaluated the influence of gastrectomy on MGC patient survival and included subgroup analysis of metastatic sites.

Methods

Study search and selection

PubMed, Embase, Cochrane Library, and Web of Science databases were comprehensively searched for studies

on gastrectomy in MGC patients up to October 10, 2023, using the following terms: “gastric neoplasms” OR “gastric neoplasm” OR “neoplasm, gastric” OR “neoplasms” OR “gastric” OR “gastric cancer” OR “cancer, gastric” OR “cancers, gastric” OR “gastric cancers” AND “neoplasm metastasis” OR “neoplasm metastases” OR “metastases, neoplasm” OR “metastasis, neoplasm” OR “metastases” OR “metastasis” OR “metastatic” AND “gastrectomy” OR “gastrectomies” OR “metastasectomy” OR “metastasectomies” OR “surgery” OR “surgical resection.” As an example, Supplementary Table 1 outlines the search strategy for PubMed. The full texts and their references were also thoroughly reviewed for eligible studies. Afterward, Endnote X9 (Clarivate Analytics, London, UK) was used to remove duplicates. The search was completed by 2 reviewers independently, and the study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Supplementary Table 2).

Eligibility criteria

Inclusion criteria (PICOS) were: 1) population (P): patients who suffered from MGC; 2) intervention (I): patients in the intervention group who underwent gastrectomy, comparator (C): patients in the control group who did not receive resection for MGC treatment; 3) outcome (O): at least 1 of the following outcomes were included: 1-, 2-, 3-, and 5-year OS, OS, OS time, postoperative morbidity, perioperative mortality, and hospital stay; and 4) study design (S): studies were cohort in design.

Exclusion criteria were: 1) studies on animals; 2) studies with incomplete or invalid data; 3) reviews, meta-analyses, case reports, conference reports, editorial materials, letters, errata, notes, and protocols; 4) studies with data from public databases, such as the SEER and National Cancer Database (NCDB); 5) non-English literature; and 6) studies without available full texts.

Outcome measures

Primary outcomes were 1-, 2-, 3-, and 5-year OS, OS, and OS time. Secondary outcomes were postoperative morbidity, perioperative mortality and hospital stay. Postoperative morbidity mainly included bleeding, intestinal obstruction, anastomotic leakage, and wound infection. Perioperative mortality was defined as death within 30 days after surgery or during postoperative hospitalization.

Data extraction and quality assessment

Two independent authors extracted the data from the eligible studies, including first author, year of publication, country, study design, group, surgery, number of patients (n), sex (male/female), age [years], chemotherapy, Eastern Cooperative Oncology Group Performance Status (ECOG PS), histology, timing of metastases, T-grade, N-grade,

tumor location, metastatic site, follow-up time [months], median survival time [months], and outcomes.

The Newcastle–Ottawa scale (NOS)¹⁸ evaluated the quality of cohort studies, with a maximum score of 9 points indicating low (0–3), medium (4–6) or high (7–9) quality. Two reviewers conducted the assessments independently and settled disagreements through discussion.

Statistical analyses

Statistical analyses employed Stata v. 15.1 (StataCorp, College Station, USA), with relative risk (RR) values used for enumeration data, hazard ratio (HR) for survival data and weighted mean difference (WMD) for measurement data (all included 95% confidence intervals (95 CIs)). The effect size of each outcome was tested for heterogeneity, with funnel plots used to present the results. A random-effects model was selected for use a priori, with a random-effects meta-analysis conducted to assess the effects of gastrectomy compared to non-resection treatment in MGC. When the heterogeneity statistic (I^2) was greater than 50% and the difference was statistically significant ($p < 0.05$), subgroup analysis was performed based on metastatic sites (liver, peritoneum, lymph node, and mixed sites), and meta-regression analysis was used to explore the source of the heterogeneity. Forest plots were drawn, and sensitivity analysis was carried out for outcomes when analyzing more than 2 studies. For outcomes with more than 2 studies, other outcomes were

subject to sensitivity analysis by deleting a single study at a time and comprehensively analyzing the remaining studies, and each paper underwent deletion.

Begg's test was employed to assess publication bias. For publication bias assessment, meta-analyses should include at least 10 studies for the outcome evaluated.^{19,20} The trim-and-fill method was performed using the funnel plot, which formalized the qualitative approach. In brief, the asymmetric outer part was trimmed after estimating the number of studies in the asymmetric part of the funnel, and the symmetric residual was used to assess the real center of the funnel and replace the trimmed studies and their missing equivalents around the center. The filled funnel plot was then used to calculate the true mean and its variance.²¹ Differences were statistically significant when $p < 0.05$.

Results

Study characteristics

After searching the 4 databases, 24,998 studies were retrieved, of which 11,379 were removed due to duplication. The flowchart for study screening is shown in Fig. 1. Finally, 46 studies^{22–67} with 7,152 MGC patients were included according to the eligibility criteria. The publication year of the studies ranged from 2000 to 2023. Supplementary Table 3 exhibits the baseline characteristics of the included

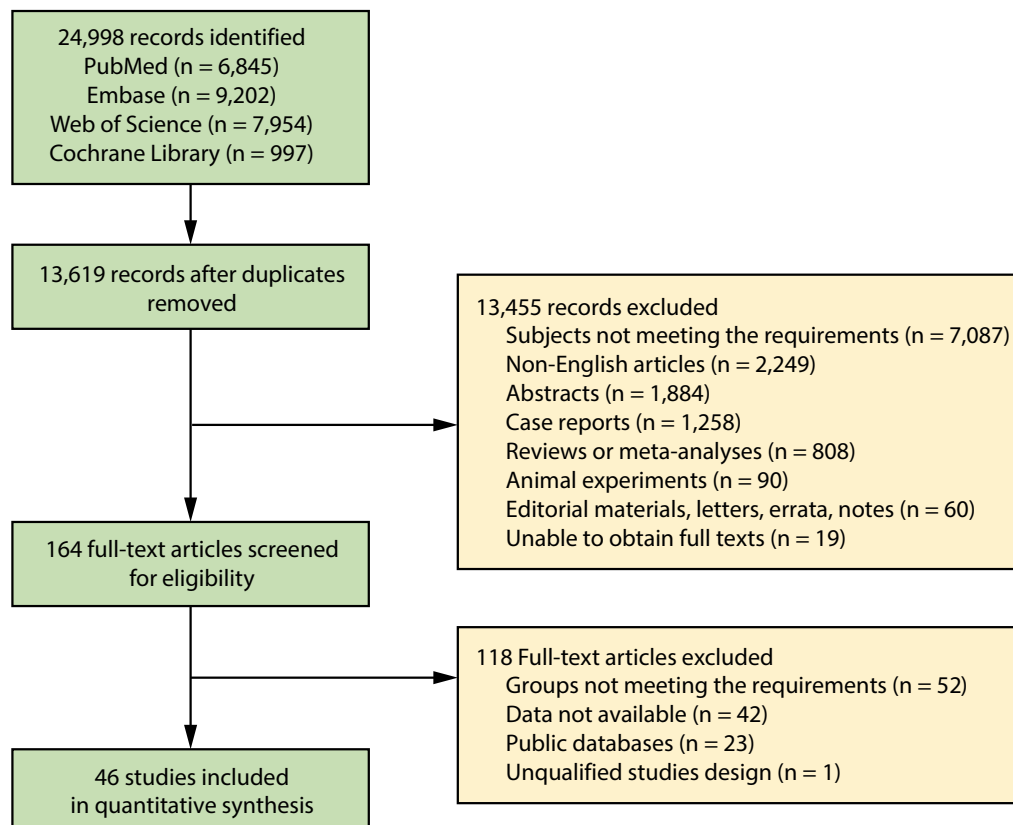


Fig. 1. Flowchart for study screening

studies. In the current study, patients who received gastrectomy were grouped into the gastrectomy group, gastrectomy + metastasectomy group or gastrectomy \pm metastasectomy group, and patients who did not receive resection were classified into the non-resection group. In this regard, 16 studies^{23,28,30,32,37,40,42,44,50,51,53,55,59,61,63,64} made comparisons between the gastrectomy group and the non-resection group, 8 studies^{22,25,34,41,43,54,60,66} compared the gastrectomy + metastasectomy group with the non-resection group, and 22 studies^{24,26,27,29,31,33,35,36,38,39,45–47,48,49,52,56–58,62,65,67} compared the gastrectomy \pm metastasectomy group with the non-resection group. Of 46 cohort studies, 30 were of medium quality and 16 had high quality.

Primary outcomes

One-year overall survival

Gastrectomy vs non-resection

Five studies^{27,28,30,41,42} of 552 patients provided data on the 1-year OS rate of the gastrectomy and non-resection groups. The overall analysis demonstrated that the 1-year OS rate was significantly higher after gastrectomy than after non-resection treatment (pooled RR: 1.90, 95% CI: 1.50, 2.41, $p < 0.001$) (Table 1, Fig. 2A, Supplementary Fig. 1A).

Gastrectomy + metastasectomy vs non-resection

Comparison of the 1-year OS rate between gastrectomy + metastasectomy and non-resection was presented in 3 studies^{25,41,54} with 156 subjects. Metastatic gastric cancer patients undergoing gastrectomy and metastasectomy had significantly greater 1-year OS than those receiving no resection (pooled RR: 1.63, 95% CI: 1.18, 2.26, $p = 0.003$) (Table 1, Fig. 2B, Supplementary Fig. 1B).

Gastrectomy \pm metastasectomy vs non-resection

Twelve studies,^{24,27,29,31,35,38,39,45,46,52,58,65} including 2,475 individuals, compared the 1-year OS rate of the gastrectomy \pm metastasectomy and non-resection groups. After the combined analysis, the gastrectomy \pm metastasectomy group was found to have a significantly increased 1-year OS rate than the non-resection group (pooled RR: 2.65, 95% CI: 1.95, 3.61, $p < 0.001$) (Fig. 2C, Supplementary Fig. 1C). Since the heterogeneity was non-negligible ($I^2 = 78.0\%$, $p < 0.05$), subgroup analysis based on metastatic sites was carried out. When the metastatic site was the liver (pooled RR: 2.54, 95% CI: 1.73, 3.74, $p < 0.001$), the peritoneum (pooled RR: 4.15, 95% CI: 2.94, 5.85, $p < 0.001$) or lymph node (pooled RR: 3.50, 95% CI: 1.79, 6.83, $p < 0.001$), the 1-year OS rate of the gastrectomy \pm metastasectomy group was significantly higher than non-resection (Table 1). To explore the source of heterogeneity, meta-regression analysis

was performed with metastatic sites, and the results suggested that metastatic sites had nothing to do with inter-study heterogeneity ($p > 0.05$) (Supplementary Table 5).

Two-year overall survival

Gastrectomy vs non-resection

Information on the 2-year OS rate of the gastrectomy and non-resection groups was reported in 5 studies^{28,30,32,42,61} with 726 patients. The pooled analysis revealed that the gastrectomy group had a significantly higher 2-year OS rate than the non-resection group (pooled RR: 2.23, 95% CI: 1.40, 3.53, $p = 0.001$) (Table 1, Fig. 3A, Supplementary Fig. 1D).

Gastrectomy + metastasectomy vs non-resection

Two studies^{25,54} investigated the 2-year OS rate in 119 subjects undergoing gastrectomy plus metastasectomy or no resection. Patients undergoing gastrectomy and metastasectomy had a significantly elevated 2-year OS rate compared to those not treated with resection (pooled RR: 2.48, 95% CI: 1.23, 5.00, $p = 0.011$) (Table 1, Fig. 3B, Supplementary Fig. 1E).

Gastrectomy \pm metastasectomy vs non-resection

Data on the 2-year OS rate for 1,877 patients were given in 12 studies.^{24,29,31,35,38,39,45,46,48,52,56,65} A significantly higher 2-year OS rate was observed through combined analysis in the gastrectomy \pm metastasectomy group in contrast to the corresponding rate in the non-resection group (pooled RR: 4.77, 95% CI: 3.12, 7.27, $p < 0.001$) (Table 1, Fig. 3C, Supplementary Fig. 1F).

Three-year overall survival

Gastrectomy vs non-resection

Seven studies^{22,23,28,34,40,41,43} with 625 patients included a 3-year OS analysis of the gastrectomy and non-resection groups. The gastrectomy group had a significantly greater 3-year OS rate than the non-resection group (pooled RR: 6.09, 95% CI: 3.12, 11.87, $p < 0.001$) (Table 1, Fig. 4A, Supplementary Fig. 1G).

Gastrectomy + metastasectomy vs non-resection

Three-year OS was compared between gastrectomy + metastasectomy and non-resection in 420 patients across 5 studies.^{22,34,41,43,54} Overall analysis illustrated that the 3-year OS rate of patients with gastrectomy and metastasectomy was significantly higher than that of patients without resection (pooled RR: 11.40, 95% CI: 5.73, 22.66, $p < 0.001$) (Table 1, Fig. 4B, Supplementary Fig. 1H).

Table 1. Overall analysis for the impact of gastrectomy on different outcomes in MGC patients

Outcome	Indicators	Group	Studies	RR/HR/WMD (95% CI) random-effects model	p-value	I ²
1-year OS	G vs 0	overall	5	1.90 (1.50, 2.41)	<0.001	3.4
	G + M vs 0	overall	3	1.63 (1.18, 2.26)	0.003	0.0
	G ± M vs 0	overall	12	2.65 (1.95, 3.61)	<0.001	78.0
	metastatic sites	liver	5	2.54 (1.73, 3.74)	<0.001	42.1
		peritoneum	3	4.15 (2.94, 5.85)	<0.001	0.0
		lymph node	1	3.50 (1.79, 6.83)	<0.001	N/A
		mixed	5	2.53 (1.35, 4.72)	0.004	90.3
2-year OS	G vs 0	overall	5	2.23 (1.40, 3.53)	0.001	24.3
	G + M vs 0	overall	2	2.48 (1.23, 5.00)	0.011	0.0
	G ± M vs 0	overall	12	4.77 (3.12, 7.27)	<0.001	32.6
3-year OS	G vs 0	overall	7	6.09 (3.12, 11.87)	<0.001	0.0
	G + M vs 0	overall	5	11.40 (5.73, 22.66)	<0.001	0.0
	G ± M vs 0	overall	8	4.95 (2.49, 9.85)	<0.001	43.2
5-year OS	G vs 0	overall	3	4.30 (1.35, 13.74)	0.014	0.0
	G + M vs 0	overall	3	7.68 (1.50, 39.15)	0.014	0.0
	G ± M vs 0	overall	9	4.20 (2.20, 8.01)	<0.001	0.0
OS	G vs 0	overall	8	0.49 (0.37, 0.65)	<0.001	75.5
	metastatic sites	peritoneum	5	0.48 (0.32, 0.71)	<0.001	76.4
		mixed	3	0.49 (0.30, 0.81)	0.005	80.8
	G + M vs 0	overall	3	0.31 (0.24, 0.40)	<0.001	0.0
	G ± M vs 0	overall	2	0.46 (0.34, 0.64)	<0.001	0.0
OS time	G vs 0	overall	2	6.06 (1.36, 10.76)	0.012	96.1
Postoperative morbidity	G vs 0	overall	2	2.54 (0.13, 51.39)	0.544	86.9
	G ± M vs 0	overall	3	1.35 (0.72, 2.54)	0.356	51.5
Perioperative mortality	G ± M vs 0	overall	5	0.63 (0.33, 1.19)	0.153	0.0
Hospital stay	G ± M vs 0	overall	2	1.04 (−0.25, 2.33)	0.114	0.0

MGC – metastatic gastric cancer; RR – relative risk; HR – hazard ratio; WMD – weighted mean difference; 95% CI – 95% confidence interval; OS – overall survival; G – gastrectomy; M – metastasectomy; 0 – non-resection; N/A – not applicable.

Gastrectomy ± metastasectomy vs non-resection

The 3-year OS rate was assessed by 8 studies^{26,31,35,39,46,49,52,62} with 1,707 subjects in the gastrectomy ± metastasectomy and non-resection groups. Compared to patients receiving gastrectomy ± metastasectomy, those not treated with resection had a significantly elevated 3-year OS rate (pooled RR: 4.95, 95% CI: 2.49, 9.85, $p < 0.001$) (Table 1, Fig. 4C, Supplementary Fig. 1I).

Five-year overall survival

Gastrectomy vs non-resection

Three studies^{37,41,67} containing 366 patients evaluated 5-year OS in the gastrectomy and non-resection groups. Pooled analysis indicated that the 5-year OS rate of patients receiving gastrectomy was significantly higher than that of patients not receiving resection (pooled RR: 4.30,

95% CI: 1.35, 13.74, $p = 0.014$) (Table 1, Fig. 5A, Supplementary Fig. 1J).

Gastrectomy + metastasectomy vs non-resection

The 5-year OS rate of the gastrectomy + metastasectomy and non-resection groups were compared in 3 studies^{25,41,54} of 156 patients. The gastrectomy + metastasectomy group had a significantly increased 5-year OS rate relative to the non-resection group (pooled RR: 7.68, 95% CI: 1.50, 39.15, $p = 0.014$) (Table 1, Fig. 5B, Supplementary Fig. 1K).

Gastrectomy ± metastasectomy vs non-resection

Nine studies^{24,31,36,39,45,46,48,52,67} presented data on 5-year OS in 1,680 patients of the gastrectomy ± metastasectomy and non-resection groups. The 5-year OS rate was significantly greater in patients treated with

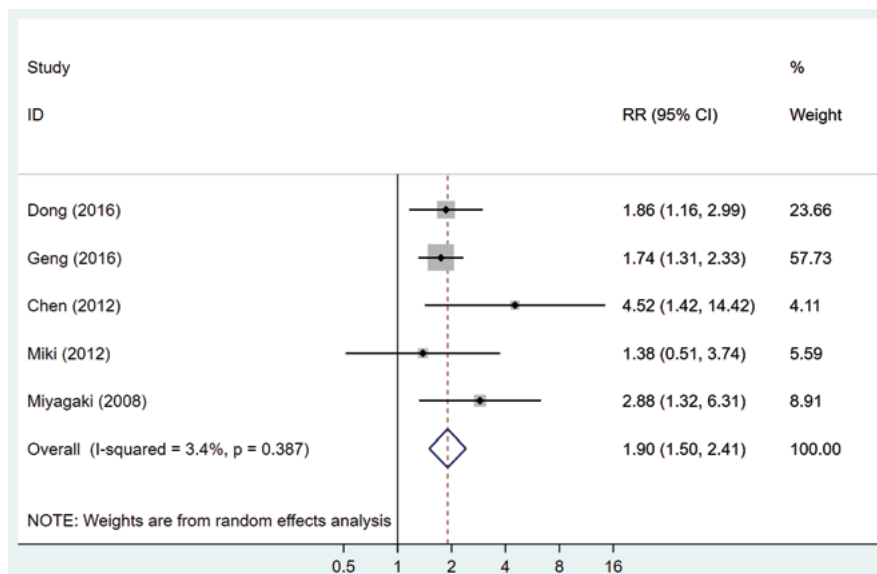
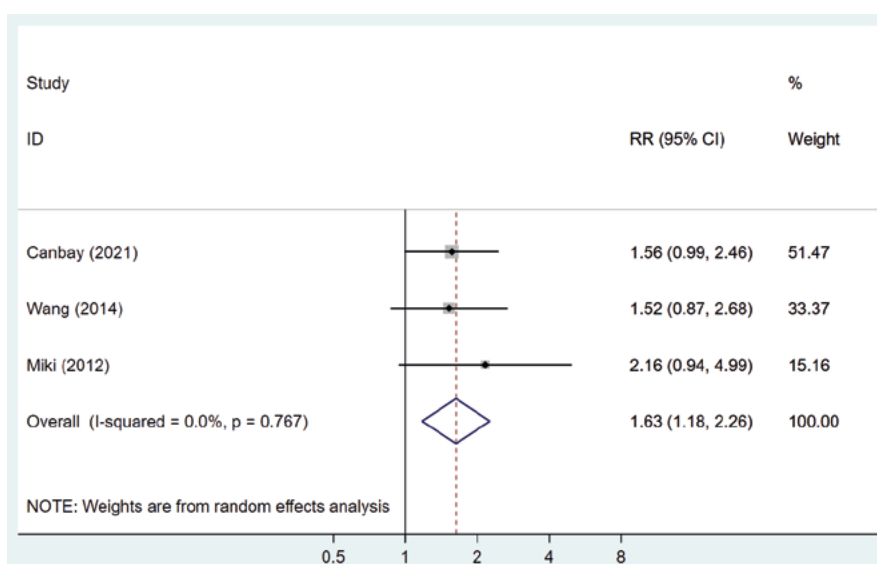
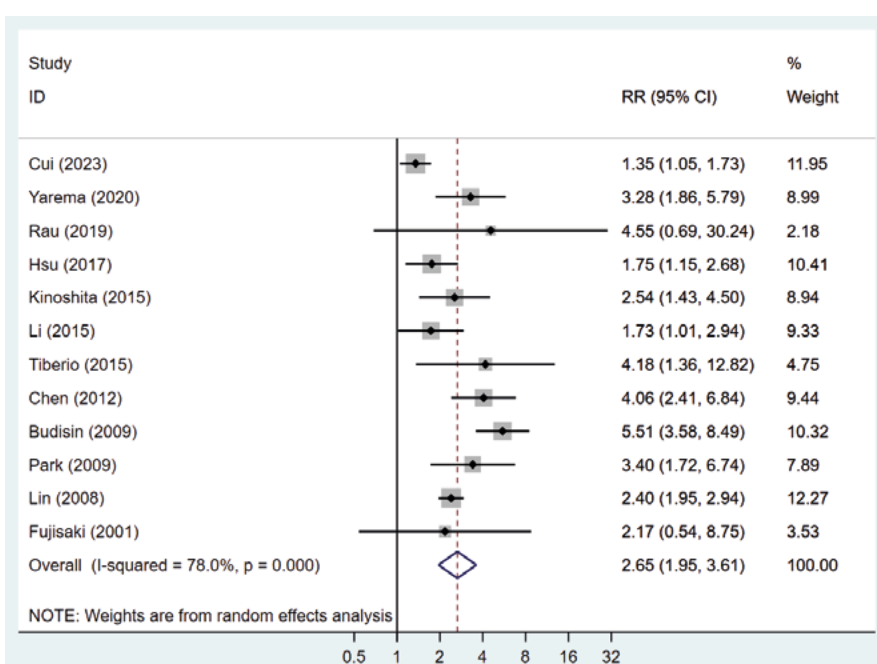
A

Fig. 2. Forest plot for 1-year OS in MGC patients. A. Gastrectomy vs non-resection; B. Gastrectomy + metastasectomy vs non-resection; C. Gastrectomy ± metastasectomy vs non-resection

MGC – metastatic gastric cancer;
OS – overall survival; RR – relative risk;
95% CI – 95% confidence interval.

B**C**

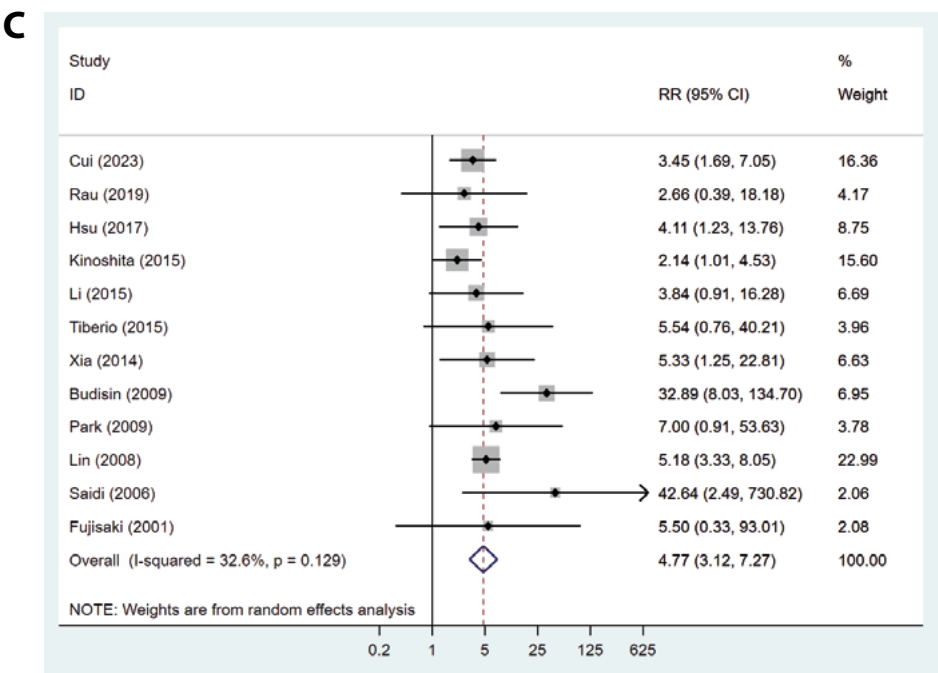
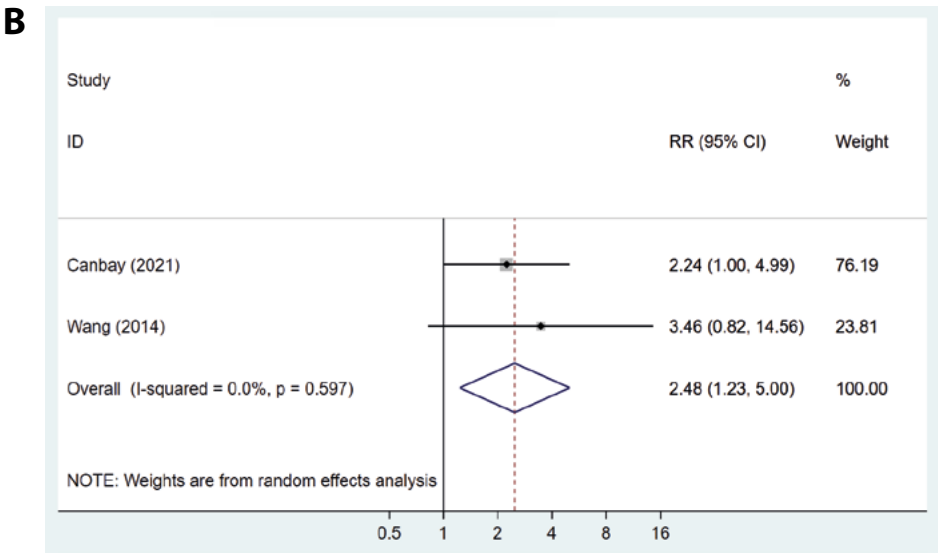
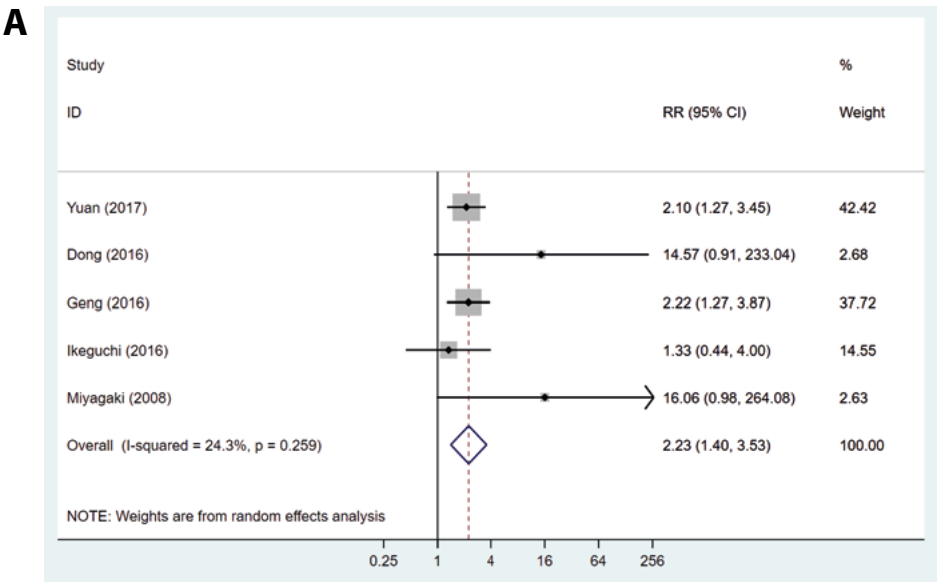


Fig. 3. Forest plot for 2-year OS in MGC patients. A. Gastrrectomy vs non-resection; B. Gastrrectomy + metastasectomy vs non-resection; C. Gastrrectomy ± metastasectomy vs non-resection

MGC – metastatic gastric cancer; OS – overall survival; RR – relative risk; 95% CI – 95% confidence interval.

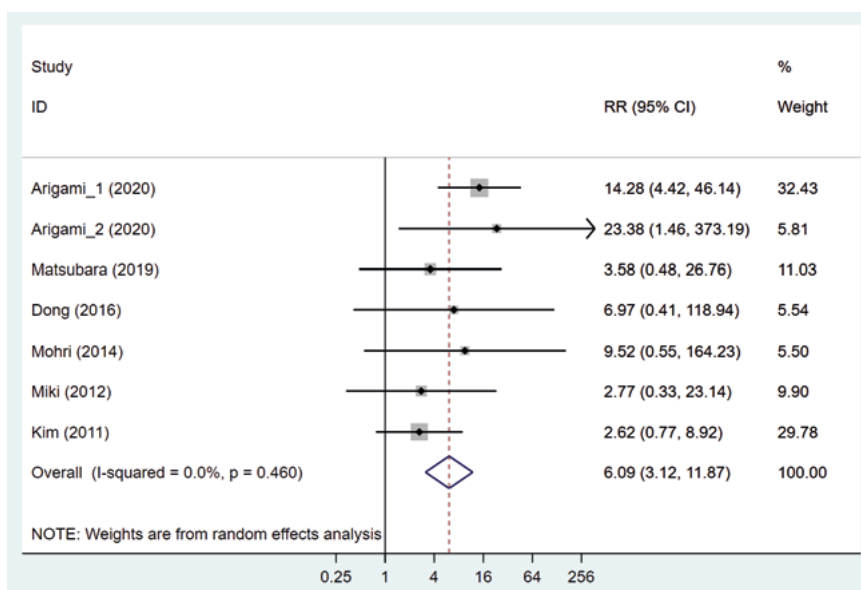
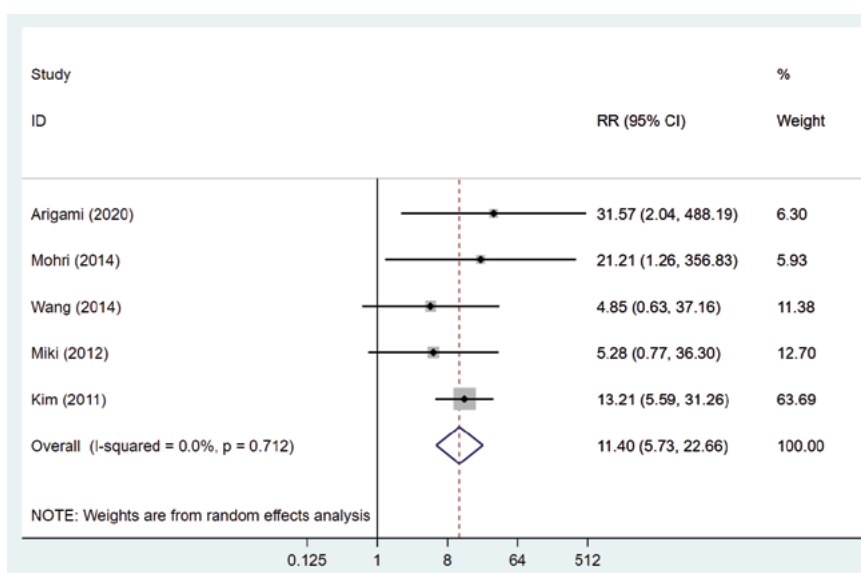
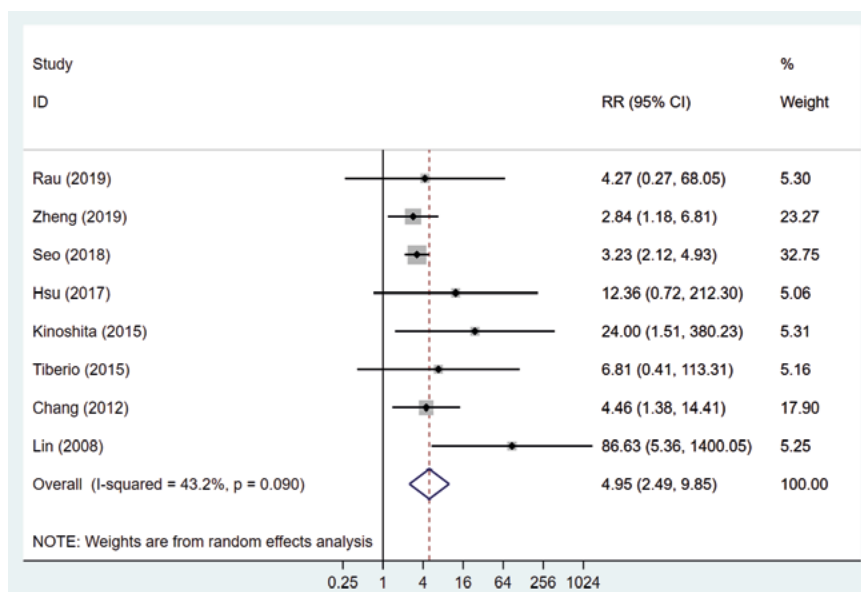
A

Fig. 4. Forest plot for 3-year OS in MGC patients. A. Gastrectomy vs non-resection; B. Gastrectomy + metastasectomy vs non-resection; C. Gastrectomy ± metastasectomy vs non-resection

MGC – metastatic gastric cancer;
OS – overall survival; RR – relative risk;
95% CI – 95% confidence interval.

B**C**

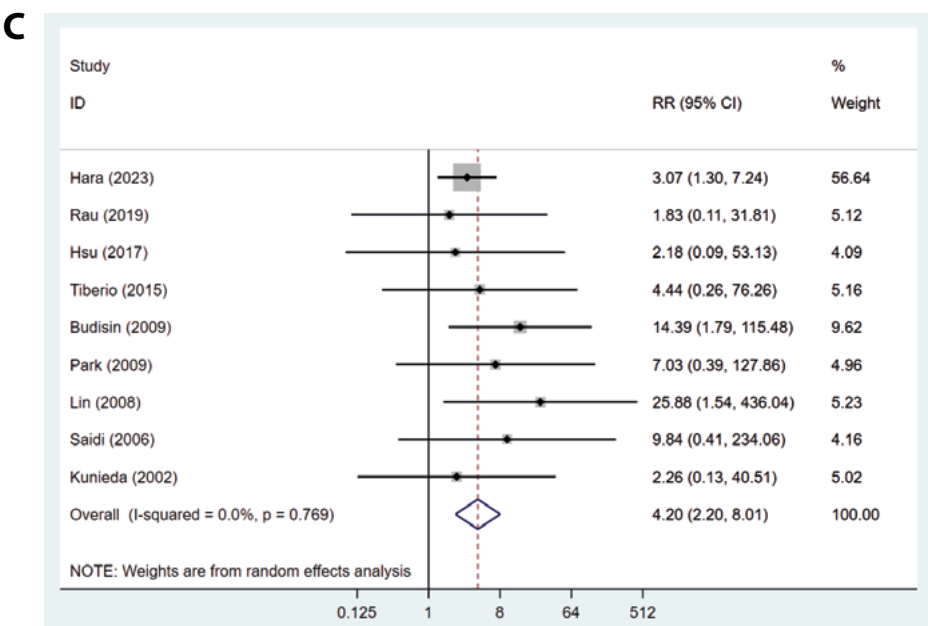
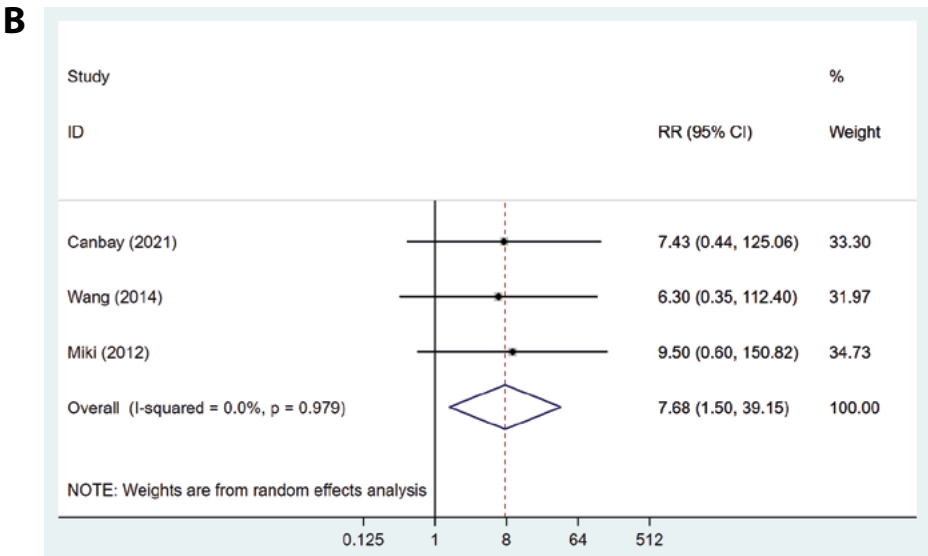
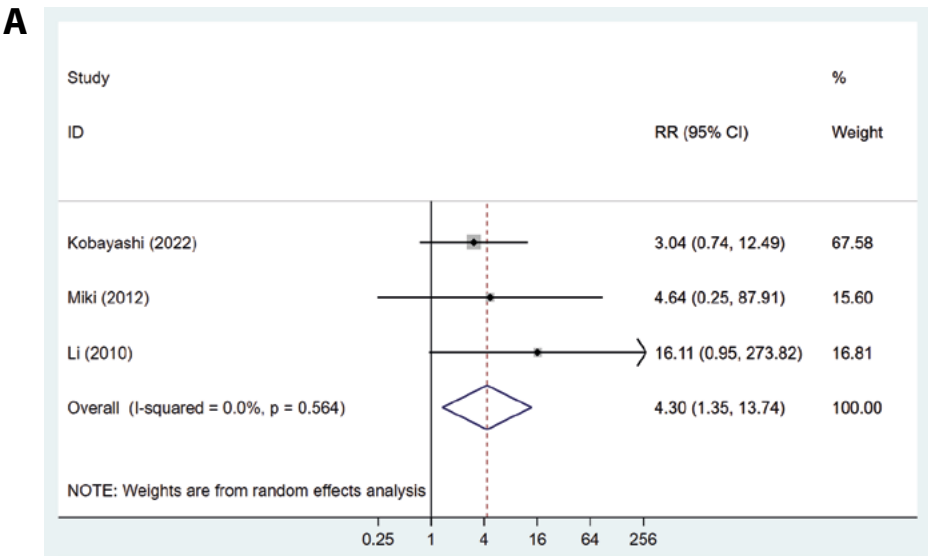


Fig. 5. Forest plot for 5-year OS in MGC patients. A. Gastric Cancer vs non-resection; B. Gastric Cancer + metastasectomy vs non-resection; C. Gastric Cancer ± metastasectomy vs non-resection

MGC – metastatic gastric cancer;
OS – overall survival; RR – relative risk;
95% CI – 95% confidence interval.

gastrectomy \pm metastasectomy than in patients not undergoing resection (pooled RR: 4.20, 95% CI: 2.20, 8.01, $p < 0.001$) (Table 1, Fig. 5C, Supplementary Fig. 1L).

Overall survival

Gastrectomy vs non-resection

Regarding OS, 8 studies^{23,30,34,44,50,55,61,63} made comparisons between gastrectomy and non-resection. The overall analysis demonstrated that patients undergoing gastrectomy had a significantly lower risk of death than those not receiving resection (pooled HR: 0.49, 95% CI: 0.37, 0.65, $p < 0.001$) (Fig. 6A, Supplementary Fig. 1M). Due to relatively large heterogeneity ($I^2 = 75.5\%$, $p < 0.05$), subgroup analysis of metastatic sites was conducted. As the tumor metastasized to the peritoneum, the OS of the gastrectomy group was significantly better than that of the non-resection group (pooled HR: 0.48, 95% CI: 0.32, 0.71, $p < 0.001$) (Table 1). Furthermore, metastatic sites were not the source of the heterogeneity between studies, as found through meta-regression analysis ($p > 0.05$) (Supplementary Table 6).

Gastrectomy + metastasectomy vs non-resection

Three studies^{34,60,66} evaluated OS in patients undergoing gastrectomy plus metastasectomy and not receiving resection. In comparison with the non-resection group, the gastrectomy + metastasectomy group had a significantly reduced risk of death (pooled HR: 0.31, 95% CI: 0.24, 0.40, $p < 0.001$) (Table 1, Fig. 6B, Supplementary Fig. 1N).

Gastrectomy \pm metastasectomy vs non-resection

The OS of the gastrectomy \pm metastasectomy and non-resection groups was explored in 2 studies.^{33,47} The pooled results showed that the risk of death in patients with gastrectomy \pm metastasectomy was significantly decreased by 53.6% compared to those without resection (pooled HR: 0.46, 95% CI: 0.34, 0.64, $p < 0.001$) (Table 1, Fig. 6C, Supplementary Fig. 1O).

Overall survival time

Gastrectomy vs non-resection

Overall survival time for patients who received gastrectomy and no resection was reported in 2 studies.^{51,53} The OS time of the gastrectomy group was significantly longer than that of the non-resection group (pooled WMD: 6.06, 95% CI: 1.36, 10.76, $p = 0.012$) (Table 1, Fig. 7, Supplementary Fig. 1P).

Secondary outcomes

Postoperative morbidity

Gastrectomy vs non-resection

Two studies^{44,59} with 382 subjects assessed the postoperative morbidity of gastrectomy and non-resection groups. The gastrectomy group had comparable postoperative morbidity to the non-resection group (pooled RR: 2.54, 95% CI: 0.13, 51.39, $p = 0.544$) (Table 1).

Gastrectomy \pm metastasectomy vs non-resection

Postoperative morbidity in the gastrectomy \pm metastasectomy and non-resection groups was compared in 3 studies^{47,52,57} of 574 patients. The postoperative morbidity of subjects receiving gastrectomy and metastasectomy did not significantly differ from that of those without resection (pooled RR: 1.35, 95% CI: 0.72, 2.54, $p = 0.36$) (Table 1).

Perioperative mortality

Gastrectomy \pm metastasectomy vs non-resection

Five studies^{36,47,48,56,57} compared perioperative mortality between 304 patients undergoing gastrectomy \pm metastasectomy and 296 not undergoing resection. No significant difference was detected between the gastrectomy \pm metastasectomy and non-resection groups in perioperative mortality (pooled RR: 0.63, 95% CI: 0.33, 1.19, $p = 0.153$; Table 1).

Hospital stay

Gastrectomy \pm metastasectomy vs non-resection

The hospital stays of 395 patients in the gastrectomy \pm metastasectomy and non-resection groups were analyzed in 2 studies.^{45,57} The gastrectomy \pm metastasectomy group and the non-resection group had equivalent hospital stays according to overall analysis (pooled WMD: 1.04, 95% CI: -0.25, 2.33, $p = 0.114$) (Table 1).

Publication bias

Begg's test evaluated publication bias in 1- and 2-year OS outcomes. Other outcomes did not meet the requirement for publication bias assessment, and at least 10 studies were included in the outcome evaluation. The results suggested that publication bias existed when the 2-year OS ($Z = 2.54$, $p = 0.011$) rather than the 1-year OS ($Z = 0.75$, $p = 0.451$) was the outcome. Using the trim-and-fill method, the point estimate for 2-year OS was adjusted slightly from 5.570 (95% CI: 3.966, 6.966) to 5.492 (95% CI: 5.205, 5.779),

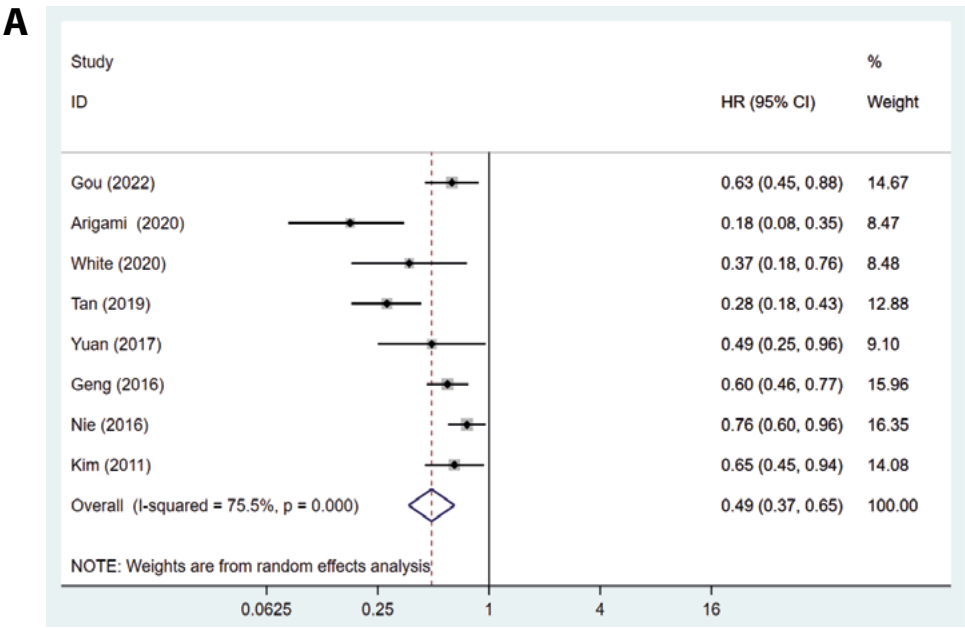
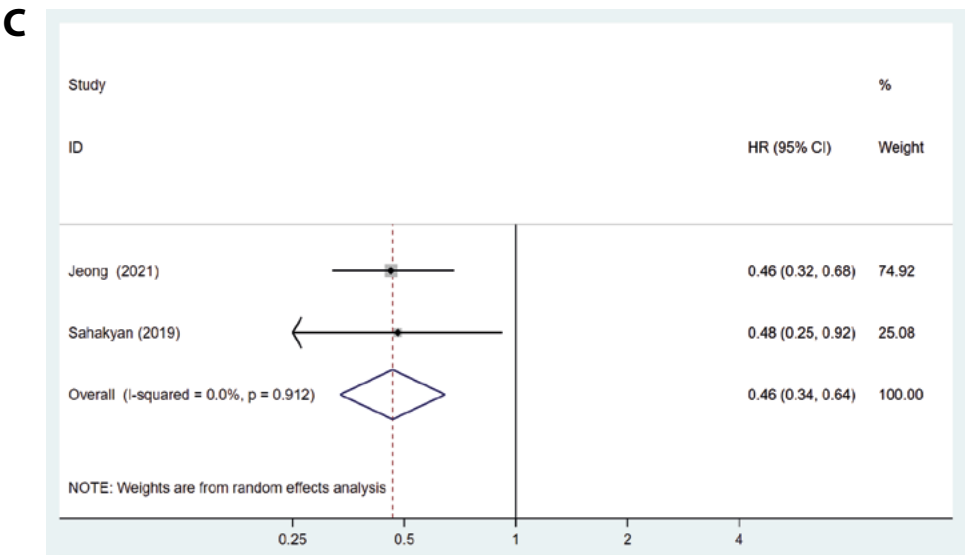
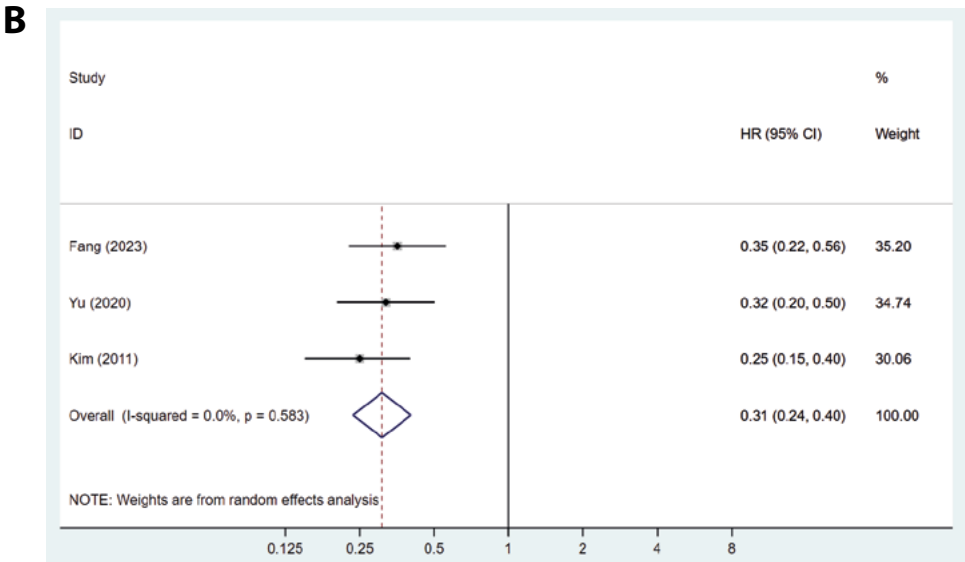


Fig. 6. Forest plot for OS in MGC patients. A. Gastrectomy vs non-resection; B. Gastrectomy + metastasectomy vs non-resection; C. Gastrectomy ± metastasectomy vs non-resection

MGC – metastatic gastric cancer; OS – overall survival; HR – hazard ratio; 95% CI – 95% confidence interval.



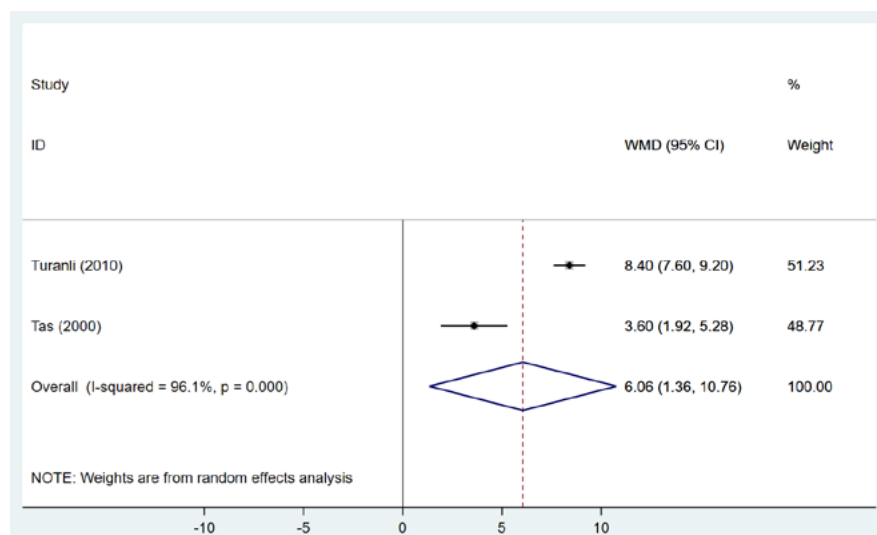


Fig. 7. Forest plot for OS time in gastrectomy vs non-resection

MGC – metastatic gastric cancer; OS – overall survival; WMD – weighted mean difference; 95% CI – 95% confidence interval.

indicating that publication bias did not exert a significant influence on the results for 2-year OS outcome, and the results were relatively robust.

Sensitivity analysis

The results of sensitivity analysis revealed that 1-study removal did not significantly impact the combined results, suggesting that the corresponding findings were stable and robust (Supplementary Table 7, Supplementary Fig. 2A–M).

Discussion

To date, surgical resection with curative intent has been the only treatment providing hope for cure,⁶⁸ but, for MGC, palliative chemotherapy with best supportive care is the best current standard,^{4,69} and the role of surgical resection is still controversial. Hence, this study undertook a meta-analysis to quantitatively and synthetically analyze the survival effect of gastrectomy among MGC patients. Using 46 studies on 7,152 MGC patients, we revealed that gastrectomy, with or without metastasectomy, was beneficial to 1-, 2-, 3-, 4-, and 5-year OS and OS compared to no resection treatment. Moreover, patients undergoing gastrectomy may have longer OS time than those receiving no resection.

Lasithiotakis et al.⁷⁰ conducted a systematic review and meta-analysis to evaluate the impact of gastrectomy for patients with stage IV GC on 1- and 2-year OS, postoperative mortality and morbidity, palliation, and quality of life, though the meta-analysis was only done for 1-year OS. The above evaluation focused on GC patients in stage IV (any T, any N and metastatic (M1) gastric carcinoma), while our analysis paid attention to patients with MGC, including GC with distant metastasis, lymph node metastasis or both. The current study also assessed the role of gastrectomy in 3-year OS, 5-year OS, OS, OS time, postoperative

morbidly, perioperative mortality, and hospital stay, and subgroup analysis by stratification of metastatic sites further explored the effect of gastrectomy. Consequently, gastrectomy provided survival benefits for individuals with MGC, with greater 1-, 2-, 3-, and 5-year OS, better OS, and possibly longer OS time. This may be primarily due to the progress in technology and surgical equipment, advances in anesthesia and nutritional support, effective post-operative care, and timely resolution of medical problems.

As supported by the findings of Li et al.,⁷¹ palliative gastrectomy was related to improved survival of MGC patients. Prominent survival benefits were achieved by non-curative gastrectomy for patients with MGC.¹⁴ Consistently, primary tumor resection combined with chemotherapy was shown to bring better OS and 2-year OS than chemotherapy alone for MGC patients.⁷² Fornaro et al.⁷³ put forward that gastrectomy was a predictor of prolonged OS in asymptomatic metastatic esophagogastric cancer. Thus, gastrectomy may be a promising treatment for improving OS in patients undergoing MGC. Furthermore, mortality risk in MGC patients was comparable following gastrectomy and non-resection treatment. Since MGC is a heterogeneous disease with specific complications and therapeutic outcomes at different metastatic sites, more studies are required to seek the most suitable strategies to treat patient subgroups with distinct metastatic sites.

Of note, the present study also revealed the survival advantage of gastrectomy plus metastasectomy compared with non-resection therapy. Similarly, a study applying the SEER database demonstrated that gastrectomy combined with metastasectomy had better OS than no surgery.⁷⁴ Choi et al.⁷⁵ reported a case of a 53-year-old man suffering from GC with synchronous bone metastasis and concluded that gastrectomy combined with metastasectomy might improve quality of life and OS. Berger et al.⁷⁶ and Choi et al.⁷⁷ believed in the OS benefit of this therapy. On this front, our revelations cast light on the therapeutic role of combined treatment of gastrectomy. As a multi-modality, gastrectomy

plus metastasectomy could be taken into consideration and have a favorable prognosis.

Nevertheless, some researchers have proposed contrasting results. Kokkola et al.⁷⁸ reported that non-curative gastrectomy did not enhance OS for MGC patients, and prophylactic, palliative gastrectomy was not required if no bleeding or obstruction occurred before surgery. A relatively poor prognosis was found after resection among patients with MGC noted before the resection.¹⁶ The discrepancies may be attributed to different study designs, analysis methods, target populations, and sample sizes. Future well-designed studies can help verify our findings and advance clinical decisions in MGC treatment.

The strengths of this study were that it included 7,152 patients with MGC, including distant metastasis, lymph node metastasis or both, and quantitatively analyzed more outcomes, covering a broader range. Furthermore, sensitivity analysis showed most findings were robust and reliable.

Limitations

Some limitations should be considered in the interpretation of results. All studies were retrospective cohort in design, and more prospective studies and randomized controlled trials are needed for analysis. Metastatic gastric cancer grades and gastrectomy types were not analyzed in subgroups, and only articles in English were included.

This meta-analysis assessed the effects of gastrectomy compared to non-resection treatment on the OS of patients with MGC but did not involve comparisons between gastrectomy with different extents of resection or between a range of interventions (e.g., gastrectomy, metastasectomy and non-resection treatment), which can be investigated in future research. Additionally, sensitivity analysis was not conducted for the outcomes with only 2 studies, such as gastrectomy plus metastasectomy compared to non-resection for 2-year OS. The limited number of studies may affect the stability of these results. More studies are needed for validation.

Conclusions

This up-to-date meta-analysis suggests that gastrectomy, with or without metastasectomy, could provide MGC patients with survival benefits, and may be adopted to improve OS among the MGC population. Properly designed prospective research is required to validate our findings.

Supplementary data

The Supplementary materials are available at <https://zenodo.org/uploads/10609032>. The package includes the following files:

Supplementary Table 1. The search strategy for PubMed database.

Supplementary Table 2. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.

Supplementary Table 3. The baseline characteristics of the included studies.

Supplementary Table 4. The quality assessment of the included studies.

Supplementary Table 5. Meta-regression analysis on metastatic sites for 1-year OS in gastrectomy ± metastasectomy vs non-resection groups.

Supplementary Table 6. Meta-regression analysis on metastatic sites for OS in gastrectomy vs non-resection groups.

Supplementary Table 7. Sensitivity analysis for the outcomes with over two studies included.

Supplementary Fig. 1. Funnel plot for presenting result heterogeneity in different outcomes. 1A. 1-year OS in gastrectomy vs non-resection groups; 1B. 1-year OS in gastrectomy + metastasectomy vs. non-resection groups; 1C. 1-year OS in gastrectomy ± metastasectomy vs non-resection groups; 1D. 2-year OS in gastrectomy vs non-resection groups; 1E. 2-year OS in gastrectomy + metastasectomy vs. non-resection groups; 1F. 2-year OS in gastrectomy ± metastasectomy vs. non-resection groups; 1G. 3-year OS in gastrectomy vs non-resection groups; 1H. 3-year OS in gastrectomy + metastasectomy vs non-resection groups; 1I. 3-year OS in gastrectomy ± metastasectomy vs non-resection groups; 1J. 5-year OS in gastrectomy vs non-resection groups; 1K. 5-year OS in gastrectomy + metastasectomy vs non-resection groups; 1L. 5-year OS in gastrectomy ± metastasectomy vs non-resection groups; 1M. OS in gastrectomy vs non-resection groups; 1N. OS in gastrectomy + metastasectomy vs non-resection groups; 1O. OS in gastrectomy ± metastasectomy vs non-resection groups; 1P. OS time in gastrectomy vs non-resection groups.

Supplementary Fig. 2. Sensitivity analysis for the outcomes with over two studies included. 2A. 1-year OS in gastrectomy vs non-resection groups; 2B. 1-year OS in gastrectomy + metastasectomy vs non-resection groups; 2C. 1-year OS in gastrectomy ± metastasectomy vs non-resection groups; 2D. 2-year OS in gastrectomy vs non-resection groups; 2E. 2-year OS in gastrectomy ± metastasectomy vs non-resection groups; 2F. 3-year OS in gastrectomy vs non-resection groups; 2G. 3-year OS in gastrectomy + metastasectomy vs non-resection groups; 2H. 3-year OS in gastrectomy ± metastasectomy vs non-resection groups; 2I. 5-year OS in gastrectomy vs non-resection groups; 2J. 5-year OS in gastrectomy + metastasectomy vs non-resection groups; 2K. 5-year OS in gastrectomy ± metastasectomy vs non-resection groups; 2L. OS in gastrectomy vs non-resection groups; 2M. OS in gastrectomy + metastasectomy vs non-resection groups.

Supplementary File 1. The reference lists of the included studies for analysis.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

ORCID iDs

Lifan Chen  <https://orcid.org/0000-0002-2271-4448>

Yu Chen  <https://orcid.org/0000-0002-2353-668X>

References

- Jaroenlapnopparat A, Bhatia K, Coban S. Inflammation and gastric cancer. *Diseases*. 2022;10(3):35. doi:10.3390/diseases10030035
- Sung H, Ferlay J, Siegel RL, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2021;71(3):209–249. doi:10.3322/caac.21660
- Chidambaram S, Guiral DC, Markar SR. Novel multi-modal therapies and their prognostic potential in gastric cancer. *Cancers (Basel)*. 2023;15(12):3113. doi:10.3390/cancers15123113
- Patel TH, Cecchini M. Targeted therapies in advanced gastric cancer. *Curr Treat Options Oncol*. 2020;21(9):70. doi:10.1007/s11864-020-00774-4
- Ajani JA, D'Amico TA, Bentrem DJ, et al. Gastric Cancer, Version 2.2022, NCCN Clinical Practice Guidelines in Oncology. *J Natl Compr Canc Netw*. 2022;20(2):167–192. doi:10.6004/jnccn.2022.0008
- Liang X, Zhu J, Li Y, et al. Treatment strategies for metastatic gastric cancer: Chemotherapy, palliative surgery or radiotherapy? *Future Oncol*. 2020;16(5):91–102. doi:10.2217/fon-2019-0495
- Catenacci DVT, Chung HC, Shen L, et al. Safety and efficacy of HER2 blockade by trastuzumab-based chemotherapy-containing combination strategies in HER2+ gastroesophageal adenocarcinoma. *ESMO Open*. 2022;7(1):100360. doi:10.1016/j.esmoop.2021.100360
- Smyth EC, Verheij M, Allum W, Cunningham D, Cervantes A, Arnold D. Gastric cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2016;27:v38–v49. doi:10.1093/annonc/mdw350
- Pellino A, Riello E, Nappo F, et al. Targeted therapies in metastatic gastric cancer: Current knowledge and future perspectives. *World J Gastroenterol*. 2019;25(38):5773–5788. doi:10.3748/wjg.v25.i38.5773
- Janjigian YY, Kawazoe A, Yañez P, et al. The KEYNOTE-811 trial of dual PD-1 and HER2 blockade in HER2-positive gastric cancer. *Nature*. 2021;600(7890):727–730. doi:10.1038/s41586-021-04161-3
- Ajani JA, Bentrem DJ, Besh S, et al. Gastric Cancer, Version 2.2013. *J Natl Compr Canc Netw*. 2013;11(5):531–546. doi:10.6004/jnccn.2013.0070
- Japanese Gastric Cancer Association. Japanese Classification of Gastric Carcinoma: 2nd English Edition. *Gastric Cancer*. 1998;1(1):10–24. doi:10.1007/s101209800016
- Dittmar Y, Rauchfuss F, Goetz M, et al. Non-curative gastric resection for patients with stage 4 gastric cancer: A single center experience and current review of literature. *Langenbecks Arch Surg*. 2012;397(5):745–753. doi:10.1007/s00423-012-0902-3
- Kulig P, Sierzega M, Kowalczyk T, Kolodziejczyk P, Kulig J. Non-curative gastrectomy for metastatic gastric cancer: Rationale and long-term outcome in multicenter settings. *Eur J Surg Oncol*. 2012;38(6):490–496. doi:10.1016/j.ejso.2012.01.013
- Fujitani K, Yang HK, Mizusawa J, et al. Gastrectomy plus chemotherapy versus chemotherapy alone for advanced gastric cancer with a single non-curative factor (REGATTA): A phase 3, randomised controlled trial. *Lancet Oncol*. 2016;17(3):309–318. doi:10.1016/S1470-2045(15)00553-7
- Gold JS, Jaques DP, Bentrem DJ, et al. Outcome of patients with known metastatic gastric cancer undergoing resection with therapeutic intent. *Ann Surg Oncol*. 2007;14(2):365–372. doi:10.1245/s10434-006-9059-z
- Ebinger SM, Warschkow R, Tarantino I, Schmied BM, Güller U, Schiesser M. Modest overall survival improvements from 1998 to 2009 in metastatic gastric cancer patients: A population-based SEER analysis. *Gastric Cancer*. 2016;19(3):723–734. doi:10.1007/s10120-015-0541-9
- Stang A. Critical evaluation of the Newcastle–Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *Eur J Epidemiol*. 2010;25(9):603–605. doi:10.1007/s10654-010-9491-z
- Kicinski M, Springate DA, Kontopantelis E. Publication bias in meta-analyses from the Cochrane Database of Systematic Reviews. *Stat Med*. 2015;34(20):2781–2793. doi:10.1002/sim.6525
- Sterne JAC, Sutton AJ, Ioannidis JPA, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. *BMJ*. 2011;343:d4002. doi:10.1136/bmj.d4002
- Duval S, Tweedie R. Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*. 2000;56(2):455–463. doi:10.1111/j.0006-341X.2000.00455.x
- Arigami T, Matsushita D, Okubo K, et al. Indication and prognostic significance of conversion surgery in patients with liver metastasis from gastric cancer. *Oncology*. 2020;98(5):273–279. doi:10.1159/000505555
- Arigami T, Matsushita D, Okubo K, et al. Clinical significance of conversion surgery for gastric cancer with peritoneal dissemination: A retrospective study. *Oncology*. 2020;98(11):798–806. doi:10.1159/000509530
- Budisin NI, Majdevac IZ, Budisin ES, Manic D, Patrnogic A, Radovanovic Z. Surgery for patients with gastric cancer in the terminal stage of the illness: TNM stage IV. *J BUON*. 2009;14(4):593–603. PMID:20148448.
- Canbay E, Canbay Torun B, Cosarc K, et al. Surgery with hyperthermic intraperitoneal chemotherapy after response to induction chemotherapy in patients with peritoneal metastasis of gastric cancer. *J Gastrointest Oncol*. 2021;12(Suppl 1):S47–S56. doi:10.21037/jgo-20-121
- Chang YR, Han DS, Kong SH, et al. The value of palliative gastrectomy in gastric cancer with distant metastasis. *Ann Surg Oncol*. 2012;19(4):1231–1239. doi:10.1245/s10434-011-2056-x
- Chen S, Li Y, Feng X, Zhou Z, Yuan X, Chen Y. Significance of palliative gastrectomy for late-stage gastric cancer patients. *J Surg Oncol*. 2012;106(7):862–871. doi:10.1002/jso.23158
- Dong Y, Ma S, Yang S, Luo F, Wang Z, Guo F. Non-curative surgery for patients with gastric cancer with local peritoneal metastasis: A retrospective cohort study. *Medicine (Baltimore)*. 2016;95(49):e5607. doi:10.1097/MD.00000000000005607
- Fujisaki S, Tomita R, Nezu T, Kimizuka K, Park E, Fukuzawa M. Prognostic studies on gastric cancer with concomitant liver metastases. *Hepatogastroenterology*. 2001;48(39):892–894. PMID:11462950.
- Geng X, Liu H, Lin T, et al. Survival benefit of gastrectomy for gastric cancer with peritoneal carcinomatosis: A propensity score-matched analysis. *Cancer Med*. 2016;5(10):2781–2791. doi:10.1002/cam4.877
- Hsu JT, Liao JA, Chuang HC, et al. Palliative gastrectomy is beneficial in selected cases of metastatic gastric cancer. *BMC Palliat Care*. 2017;16(1):19. doi:10.1186/s12904-017-0192-1
- Ikeguchi M, Miyatani K, Takaya S, et al. Role of surgery in the management for gastric cancer with synchronous distant metastases. *Indian J Surg Oncol*. 2016;7(1):32–36. doi:10.1007/s13193-015-0428-6
- Jeong O, Jung MR, Kang JH. Treatment modality based survival in gastric carcinoma patients with stand-alone peritoneal metastasis: A case-control study. *J Gastric Cancer*. 2021;21(2):122. doi:10.5230/jgc.2021.21.e12
- Kim KH, Lee KW, Baek SK, et al. Survival benefit of gastrectomy ± metastasectomy in patients with metastatic gastric cancer receiving chemotherapy. *Gastric Cancer*. 2011;14(2):130–138. doi:10.1007/s10120-011-0015-7
- Kinoshita J, Fushida S, Tsukada T, et al. Efficacy of conversion gastrectomy following docetaxel, cisplatin, and S-1 therapy in potentially resectable stage IV gastric cancer. *Eur J Surg Oncol*. 2015;41(10):1354–1360. doi:10.1016/j.ejso.2015.04.021
- Kunieda K, Saji S, Sugiyama Y, et al. Evaluation of treatment for synchronous hepatic metastases from gastric cancer with special reference to long-term survivors. *Surg Today*. 2002;32(7):587–593. doi:10.1007/s005950200106
- Li C, Yan M, Chen J, et al. Survival benefit of non-curative gastrectomy for gastric cancer patients with synchronous distant metastasis. *J Gastrointest Surg*. 2010;14(2):282–288. doi:10.1007/s11605-009-1095-0
- Li Z, Fan B, Shan F, et al. Gastrectomy in comprehensive treatment of advanced gastric cancer with synchronous liver metastasis: A prospectively comparative study. *World J Surg Onc*. 2015;13(1):212. doi:10.1186/s12957-015-0627-1

39. Lin SZ, Tong HF, You T, et al. Palliative gastrectomy and chemotherapy for stage IV gastric cancer. *J Cancer Res Clin Oncol*. 2007;134(2): 187–192. doi:10.1007/s00432-007-0268-z
40. Matsubara D, Konishi H, Kubota T, et al. Comparison of clinical outcomes of gastrojejunal bypass and gastrectomy in patients with metastatic gastric cancer. *Anticancer Res*. 2019;39(5):2545–2551. doi:10.21873/anticancer.13376
41. Miki Y, Fujitani K, Hirao M, et al. Significance of surgical treatment of liver metastases from gastric cancer. *Anticancer Res*. 2012;32(2): 665–670. PMID:22287760.
42. Miyagaki H, Fujitani K, Tsujinaka T, et al. The significance of gastrectomy in advanced gastric cancer patients with non-curative factors. *Anticancer Res*. 2008;28(4C):2379–2384. PMID:18751422.
43. Mohri Y, Tanaka K, Ohi M, et al. Identification of prognostic factors and surgical indications for metastatic gastric cancer. *BMC Cancer*. 2014;14(1):409. doi:10.1186/1471-2407-14-409
44. Nie RC, Chen S, Yuan SQ, et al. Significant role of palliative gastrectomy in selective gastric cancer patients with peritoneal dissemination: A propensity score matching analysis. *Ann Surg Oncol*. 2016; 23(12):3956–3963. doi:10.1245/s10434-016-5223-2
45. Park S, Kim J, Park J, et al. Value of nonpalliative resection as a therapeutic and pre-emptive operation for metastatic gastric cancer. *World J Surg*. 2009;33(2):303–311. doi:10.1007/s00268-008-9829-9
46. Rau B, Brandl A, Thuss-Patience P, et al. The efficacy of treatment options for patients with gastric cancer and peritoneal metastasis. *Gastric Cancer*. 2019;22(6):1226–1237. doi:10.1007/s10120-019-00969-1
47. Sahakyan MA, Gabrielyan A, Aghayan DL, et al. Gastrectomy for metastatic gastric cancer: A 15-year experience from a developing country. *Indian J Surg Oncol*. 2019;10(3):527–534. doi:10.1007/s13193-019-00943-4
48. Saidi RF, ReMine SG, Dudrick PS, Hanna NN. Is there a role for palliative gastrectomy in patients with stage IV gastric cancer? *World J Surg*. 2006;30(1):21–27. doi:10.1007/s00268-005-0129-3
49. Seo HS, Song KY, Jung YJ, et al. Radical gastrectomy after chemotherapy may prolong survival in stage IV gastric cancer: A Korean multi-institutional analysis. *World J Surg*. 2018;42(10):3286–3293. doi:10.1007/s00268-018-4635-5
50. Tan HL, Chia CS, Tan GHC, et al. Metastatic gastric cancer: Does the site of metastasis make a difference? *Asia Pac J Clin Oncol*. 2019;15(1): 10–17. doi:10.1111/ajco.13025
51. Tas F, Aykan NF, Aydinler A, et al. The roles of chemotherapy and surgery in gastric carcinoma and the influence of prognostic factors on survival. *Am J Clin Oncol*. 2000;23(1):53–57. doi:10.1097/00000421-200002000-00015
52. Tiberio GAM, Baiocchi GL, Morgagni P, et al. Gastric cancer and synchronous hepatic metastases: Is it possible to recognize candidates to R0 resection? *Ann Surg Oncol*. 2015;22(2):589–596. doi:10.1245/s10434-014-4018-6
53. Turanlı S. The value of resection of primary tumor in gastric cancer patients with liver metastasis. *Indian J Surg*. 2010;72(3):200–205. doi:10.1007/s12262-010-0053-0
54. Wang W, Liang H, Zhang H, Wang X, Xue Q, Zhang R. Prognostic significance of radical surgical treatment for gastric cancer patients with synchronous liver metastases. *Med Oncol*. 2014;31(11):258. doi:10.1007/s12032-014-0258-3
55. White MG, Kothari A, Ikoma N, et al. Factors associated with resection and survival after laparoscopic HIPEC for peritoneal gastric cancer metastasis. *Ann Surg Oncol*. 2020;27(13):4963–4969. doi:10.1245/s10434-020-08842-7
56. Xia X, Li C, Yan M, Liu B, Yao X, Zhu Z. Who will benefit from noncurative resection in patients with gastric cancer with single peritoneal metastasis? *Am Surg*. 2014;80(2):124–130. doi:10.1177/000313481408000219
57. Yang K, Liu K, Zhang WH, et al. The value of palliative gastrectomy for gastric cancer patients with intraoperatively proven peritoneal seeding. *Medicine (Baltimore)*. 2015;94(27):e1051. doi:10.1097/MD.0000000000001051
58. Yarema R, Ohorchak M, Hyrya P, et al. Gastric cancer with peritoneal metastases: Efficiency of standard treatment methods. *World J Gastrointest Oncol*. 2020;12(5):569–581. doi:10.4251/wjgo.v12.i5.569
59. Yoshikawa T, Kanari M, Tsuburaya A, et al. Should gastric cancer with peritoneal metastasis be treated surgically? *Hepatogastroenterology*. 2003;50(53):1712–1715. PMID:14571824.
60. Yu P, Zhang Y, Ye Z, et al. Treatment of synchronous liver metastases from gastric cancer: A single-center study. *Cancer Manag Res*. 2020;12:7905–7911. doi:10.2147/CMAR.S261353
61. Yuan SQ, Nie RC, Chen S, et al. Selective gastric cancer patients with peritoneal seeding benefit from gastrectomy after palliative chemotherapy: A propensity score matching analysis. *J Cancer*. 2017; 8(12):2231–2237. doi:10.7150/jca.18932
62. Zheng XH, Zhang W, Yang L, et al. Role of D2 gastrectomy in gastric cancer with clinical para-aortic lymph node metastasis. *World J Gastroenterol*. 2019;25(19):2338–2353. doi:10.3748/wjg.v25.i19.2338
63. Gou M, Qian N, Zhang Y, et al. Construction of a nomogram to predict the survival of metastatic gastric cancer patients that received immunotherapy. *Front Immunol*. 2022;13:950868. doi:10.3389/fimmu.2022.950868
64. Kobayashi H, Honda M, Kawamura H, et al. Clinical impact of gastrectomy for gastric cancer patients with positive lavage cytology without gross peritoneal dissemination. *J Surg Oncol*. 2022;125(4): 615–620. doi:10.1002/jso.26770
65. Cui Y, Yu Y, Zheng S, et al. Does resection after neoadjuvant chemotherapy of docetaxel, oxaliplatin, and S-1 (DOS regimen) benefit for gastric cancer patients with single non-curable factor? A multicenter, prospective cohort study (Neo-REGATTA). *BMC Cancer*. 2023; 23(1):308. doi:10.1186/s12885-023-10773-x
66. Fang J, Huang X, Chen X, et al. Efficacy of chemotherapy combined with surgical resection for gastric cancer with synchronous ovarian metastasis: A propensity score matching analysis. *Cancer Med*. 2023;12(16):17126–17138. doi:10.1002/cam4.6362
67. Hara K, Cho H, Onodera A, et al. Long-term treatment outcomes in gastric cancer with oligometastasis. *Ann Gastroenterol Surg*. 2024; 8(1):60–70. doi:10.1002/ags3.12733
68. Santoro R. Subtotal gastrectomy for gastric cancer. *World J Gastroenterol*. 2014;20(38):13667. doi:10.3748/wjg.v20.i38.13667
69. Choi JH, Choi YW, Kang SY, et al. Combination versus single-agent as palliative chemotherapy for gastric cancer. *BMC Cancer*. 2020; 20(1):167. doi:10.1186/s12885-020-6666-1
70. Lasithiotakis K, Antoniou SA, Antoniou GA, Kaklamani I, Zoras O. Gastrectomy for stage IV gastric cancer: A systematic review and meta-analysis. *Anticancer Res*. 2014;34(5):2079–2085. PMID:24778009.
71. Li Q, Zou J, Jia M, et al. Palliative gastrectomy and survival in patients with metastatic gastric cancer: A propensity score-matched analysis of a large population-based study. *Clin Transl Gastroenterol*. 2019; 10(5):e00048. doi:10.14309/ctg.0000000000000048
72. Warschkow R, Baechtold M, Leung K, et al. Selective survival advantage associated with primary tumor resection for metastatic gastric cancer in a Western population. *Gastric Cancer*. 2018;21(2):324–337. doi:10.1007/s10120-017-0742-5
73. Fornaro L, Fanotto V, Musettini G, et al. Selecting patients for gastrectomy in metastatic esophago-gastric cancer: Clinics and pathology are not enough. *Future Oncol*. 2017;13(25):2265–2275. doi:10.2217/fon-2017-0246
74. Yang LP, Wang ZX, He MM, et al. The survival benefit of palliative gastrectomy and/or metastasectomy in gastric cancer patients with synchronous metastasis: A population-based study using propensity score matching and coarsened exact matching. *J Cancer*. 2019; 10(3):602–610. doi:10.7150/jca.28842
75. Choi YJ, Kim DH, Han HS, et al. Long-term survival after gastrectomy and metastasectomy for gastric cancer with synchronous bone metastasis. *World J Gastroenterol*. 2018;24(1):150–156. doi:10.3748/wjg.v24.i1.150
76. Berger Y, Giurcanu M, Vining CC, et al. Cytoreductive surgery for selected patients whose metastatic gastric cancer was treated with systemic chemotherapy. *Ann Surg Oncol*. 2021;28(8):4433–4443. doi:10.1245/s10434-020-09475-6
77. Choi YW, Ahn MS, Jeong GS, et al. The role of surgical resection before palliative chemotherapy in advanced gastric cancer. *Sci Rep*. 2019; 9(1):4136. doi:10.1038/s41598-019-39432-7
78. Kokkola A, Louhimo J, Puolakkainen P. Does non-curative gastrectomy improve survival in patients with metastatic gastric cancer? *J Surg Oncol*. 2012;106(2):193–196. doi:10.1002/jso.23066