Review Article

Complications of Minimally Invasive Surgery in the Management of Gastric Cancer: A Systematic Review of Retrospective Cohort Studies

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ABSTRACT

Minimally invasive surgery (MIS), including laparoscopic and robotic approaches, has become established for gastric cancer management, yet postoperative complications remain a critical concern affecting patient recovery and long-term outcomes. This systematic review consolidates retrospective evidence on complications following MIS for gastric cancer. A comprehensive search was conducted across PubMed, Embase, Cochrane Library, Scopus, and Web of Science for studies published from 2022 to 2026. Eligible studies included retrospective cohort or comparative studies involving adult gastric cancer patients undergoing laparoscopic or robotic gastrectomy that reported postoperative complications. Studies comparing MIS with open surgery or different MIS techniques were included. Quality assessment used the ROBINS-I tool. Due to heterogeneity, narrative synthesis was performed. Forty-eight studies were included, predominantly from East Asia. MIS demonstrated reduced intraoperative blood loss, shorter hospital stays, and lower overall morbidity compared to open gastrectomy, with comparable long-term oncologic outcomes. Robotic gastrectomy showed lower severe intra-abdominal infectious complications in visceral obesity (1.4% vs. 15.4%). Anastomotic leakage remained concerning, particularly in remnant gastric cancer MIS (9.8% vs. 6.3%). Patient factors including male sex, low muscle mass, high visceral fat, and older age were significant predictors of morbidity. MIS offers significant short-term benefits over open gastrectomy while maintaining oncologic safety. Robotic approaches may reduce specific complications but require consideration of learning curves and costs. Standardized outcomes and long-term follow-up studies are needed.

Keyword: Gastric cancer, Minimally invasive surgery, Laparoscopic gastrectomy, Robotic gastrectomy, Postoperative complications.

Introduction

Gastric cancer remains a major global health burden, with an estimated 968,000 new cases and 660,000 deaths in 2022; it is the fifth most commonly diagnosed cancer and the fifth leading cause of cancer-related mortality worldwide [1]. Curative-intent treatment still depends on surgical resection with adequate lymphadenectomy, and minimally invasive surgery (MIS)—including laparoscopic and robotic approaches—has become an established option, supported by randomized evidence showing oncologic outcomes comparable to open surgery [2].

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Despite this adoption, postoperative complications remain a critical concern affecting recovery, quality of life, and long-term survival. Anastomotic leakage, pancreatic fistula, intra-abdominal abscess, and pulmonary and wound infections continue to occur in a clinically meaningful proportion of patients. Their incidence reflects interactions among patient-specific factors, such as visceral obesity, nutritional status, and age, and technical factors, including surgical technique and provider experience [3]. In patients with visceral obesity, robotic gastrectomy has been associated with a significantly lower rate of severe intra-abdominal infectious complications than laparoscopic gastrectomy (1.4% vs. 15.4%, $p = 0.004$), suggesting a potential advantage in anatomically complex cases [4]. Assessment of surgical quality has moved beyond individual complication rates toward composite measures such as Textbook Outcome (TO), which integrates multiple perioperative metrics. A scoping review of 45 studies including 139,972 patients found that common TO components include adequate lymphadenectomy (at least 15 nodes) and absence of 30-day readmission and Clavien–Dindo grade $\geq$ II complications, with a median TO rate of 58.6% [5]. Postoperative complications are the most important barrier to achieving TO in gastric cancer surgery, underscoring the need to identify modifiable risk factors and optimize perioperative care [6]. As MIS is adopted more widely, safe delivery and consistent quality depend on patient selection, surgeon skill, learning curves, hospital volume, and standardized protocols [2]. Most current evidence on MIS complications comes from retrospective cohorts and institutional series, which are valuable for reflecting real-world practice but are susceptible to selection bias and confounding. Heterogeneity in populations, surgical approaches, anastomotic techniques, and outcome definitions also limits evidence synthesis. This review therefore synthesizes retrospective evidence on complications after MIS for gastric cancer, focusing on comparisons with open surgery, comparisons among MIS techniques, and patient- and procedure-related factors associated with postoperative morbidity.

Methods

This systematic review was conducted and reported according to PRISMA guidelines [7]. Five electronic databases—PubMed, Embase, Cochrane Library, Scopus, and Web of Science—were searched for studies published from 2022 to December 2026 using MeSH and free-text terms including “gastric cancer,” “stomach neoplasms,” “minimally invasive surgery,” “laparoscopic,” “robotic,” “complications,” “postoperative morbidity,” and “gastrectomy.” Reference lists of included studies and relevant reviews were also hand-searched. Records were imported into Rayyan for deduplication and screening [8]. Eligible studies were retrospective cohort or comparative studies of adults with gastric cancer undergoing laparoscopic or robotic gastrectomy that reported at least one outcome related to complications, morbidity, or mortality and compared MIS with open surgery or compared different MIS techniques. Exclusion criteria were reviews, systematic reviews, meta-analyses, editorials, case reports, conference abstracts, non-English publications, studies not specifically related to gastric cancer, studies not reporting complications, and studies with insufficient data for extraction. Two independent reviewers screened titles and abstracts in Rayyan [8], with disagreements resolved by discussion or a third reviewer. Full texts of potentially eligible studies were assessed against eligibility criteria, and the final selection was summarized using a PRISMA flow diagram. Data were extracted independently by two reviewers using a pilot-tested standardized form. Extracted variables included first author, year, country and setting, study design, sample size, population characteristics (age, sex, stage), surgical technique (laparoscopic, robotic, or open), neoadjuvant therapy, complications assessed, perioperative outcomes (operative time, blood loss, hospital stay), and oncologic outcomes (lymph node yield, survival). Disagreements were resolved by consensus or a third reviewer. Risk of bias was assessed using the ROBINS-I tool [9], covering confounding, participant selection, intervention classification, departures from intended interventions, missing data, outcome measurement, and selection of reported results. Each domain was graded as low, moderate, serious, critical, or no information, and a global risk-of-bias rating was assigned. Because of substantial heterogeneity in populations, surgical techniques, anastomotic approaches, and outcome definitions, meta-analysis was not performed. Findings were therefore synthesized narratively and presented thematically in tables, focusing on overall and severe complications, anastomotic leakage, pancreatic fistula, intra-abdominal infections, other procedure-specific complications, and perioperative and oncologic outcomes.

Results

The PRISMA flow diagram (Figure 1) outlines the study selection process. A total of 731 records were

identified from databases; after removal of 392 duplicates, 339 records were screened. Of these, 125 were excluded, leaving 214 reports sought for retrieval. Thirty-two reports could not be retrieved, and 182 were assessed for eligibility. After excluding 63 studies for wrong outcome, 61 for wrong population, and 24 abstracts, 34 studies were included in the final synthesis [10- 47]. (Table 1) illustrated included studies as, study [10] was conducted in Japan multi-institutional PSM, 327 RGC; [11] Italy two-center retrospective, 781; [12] Japan single-center retrospective, 1,476; [13] Japan single-center retrospective, 152 male; [14] China/USA two-center retrospective, 105; [15] Brazil retrospective; [16] China PSM, 193; [17] China PSM, 726; [18] Japan single-center PSM, 403; [19] Korea retrospective, 4,505; [20] Korea nationwide PSM, 14,076; [21] Japan; retrospective PSM, 614; [22] Japan; single-center retrospective cohort, 302; [23] Japan; retrospective, 150; [24] Turkey retrospective, 20; [25] China high-volume retrospective, 527; [26] Europe GASTRODATA PSM, 2,430; [27] Japan multicenter PSM, 688; [28] Spain EURECCA PSM, 1,333; [29] Japan four-arm retrospective, 174; [30] Japan single-center retrospective, 1,353; [31] Japan nationwide PSM, 3,337; [32] Japan single-center PSM, 217; [33] Japan single-center PSM, 359; [34] Japan single-center retrospective, 54; [35] Japan single-center PSM, 464; [36] Japan single-center retrospective, 82; [37] Japan retrospective, 23; [38] USA single-surgeon retrospective, 26; [39] single-center retrospective comparative, 68; [40] Japan single-center retrospective, 42; [41] Japan multicenter PSM, 988; [42] Japan multicenter PSM, 988; [43] Japan single-center PSM, 169; [44] Japan multicenter PSM, 237; [45] Japan single-center 2:1 PSM, 62; [46] Japan single-center PSM, 61; [47] Korea PSM, 1,319. A wide array of complications was assessed, including overall and severe morbidity, anastomotic leakage, pancreatic fistula, intra-abdominal infections, and postoperative diarrhea [12,18,21,30,33]. Findings were heterogeneous; several studies reported that MIS was associated with lower overall morbidity and reduced blood loss compared with open surgery, particularly for subtotal gastrectomy [20,26,35]. However, specific complications such as anastomotic leakage were sometimes higher with MIS for complex procedures such as completion total gastrectomy for RGC [31]. Table 1 also captures important perioperative metrics, with many studies confirming that MIS leads to shorter hospital stays and less blood loss, while operative times are often longer [10,18,27,46]. Long-term oncologic outcomes, including overall and relapse-free survival, were also summarized, with many studies demonstrating equivalent survival rates between MIS and open procedures. A combined analysis of the included studies reveals a complex but generally favorable profile for MIS in gastric cancer management. The evidence, derived from a substantial amount of retrospective data, consistently shows that MIS provides notable short-term advantages without sacrificing long-term oncologic safety in many contexts, such as decreased surgical trauma (less blood loss) and quicker recovery (shorter hospital stay) [10,15,20,44]. The risk of specific complications varies depending on procedure complexity and patient population, with some research pointing to a higher risk of anastomotic leakage with MIS for total gastrectomy or remnant gastric cancer [31,47]. (Figure 2, 3) risk of bias assessment shows that the included studies' methodological quality varies. Confounding and participant selection were the most frequent possible causes of bias, which are inherent challenges in retrospective cohort designs where randomization is not possible. Overall, while several studies demonstrated a low to moderate risk of bias, a notable proportion had serious methodological concerns, which should be considered when interpreting the synthesized evidence.

Discussion

The overall complication rates observed in our included studies ranged widely, from 7.4% for Clavien-Dindo grade ≥IIIa complications in a large single-institution series of 1,476 patients [12] to 31.6% for perioperative complications in the open surgery arm of the GASTRODATA registry [26]. In comparison to open total gastrectomy, completely laparoscopic total gastrectomy (RR 0.82; 95% CrI 0.73–0.92) and robotic total gastrectomy (RR 0.75; 95% CrI 0.59–0.95) were linked to lower rates of overall postoperative complications, according to a network meta-analysis of 68 studies comprising 44,689 participants [5]. Similarly, a meta- analysis of robot-assisted minimally invasive gastrectomy found that IDEAL-3 randomized controlled trials demonstrated lower overall complications with robotic surgery (8.5–9.2%) compared to laparoscopic total/subtotal gastrectomy (17.6–19.3%) [6]. Anastomotic leakage remains one of the most feared complications following gastrectomy, and our review identified several important patterns. In a nationwide propensity score-matched analysis of 540 patient pairs, According to Nakazawa et al., compared to open

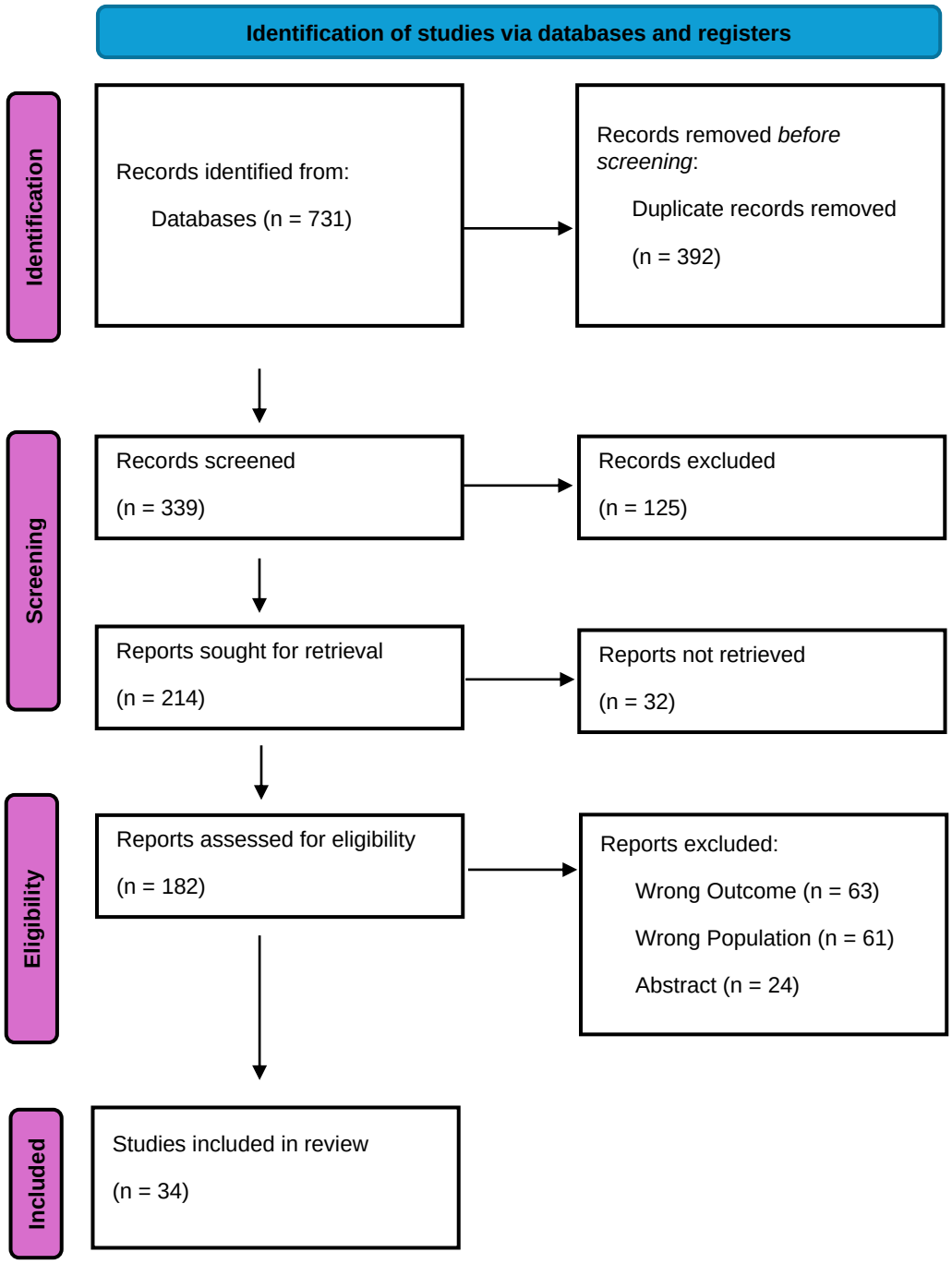

Figure 1: PRISMA flow diagram of the study selection process.

Table 1: Characteristics of included studies**.**

Study [Ref]	**Setting and design**	**Sample and population**	**Intervention / comparison (neoadjuvant)**	**Complications and key results**	**Perioperative outcomes (mortality, blood loss/time, stay)**	**Oncologic outcomes (LN, survival)**
Aoyam, *et al.* 2023 [10]	17 institutions, Japan; multi-institutional retrospective cohort with PSM	327 included; 186 analyzed after matching; RGC radical resection, 2005–2020	MIS vs open surgery	Overall RR 0.76 (95% CI 0.45–1.27); severe RR 0.65 (0.32–1.29)	Blood loss MD −409 mL (−538 to −281); hospital stay MD −6.5 days (−13.1 to 0.1); mortality NM	3-y OS 77.9% vs 76.2%, HR 0.78; 3-y RFS 71.9% vs 62.2%, HR 0.71; LN NM
Elmore, *et al.* 2023 [11]	Two high-referral gastric surgery departments, Italy; multicentre retrospective chart review	781 elective gastrectomies; 51 reinterventions; post-op complications after laparoscopic gastrectomy, 1996–2020	Laparoscopic gastrectomy; relaparoscopy	51 reinterventions; 11/32 laparoscopic reinterventions (34.3%) converted to open; recovery better if completed laparoscopically	NM	NM
Fujita, *et al.* 2023 [12]	Single institution, Japan; retrospective	1,476; gastric cancer laparoscopic or robotic gastrectomy, 2009–2019	Laparoscopic 1,072 (72.6%); robotic 404 (27.4%)	CD ≥IIIa 108 (7.4%); PD 89 (6.0%); C. difficile 24/89 (27.0%), EPEC 16/89 (33.3%), MRSA 7/89 (14.6%); risk age ≥75 OR 1.62; postoperative	NM	NM

				complications OR 6.04		
Inaguma, *et al.* 2023 [13]	Single institution, Japan; retrospective	152; male gastric cancer, clinical stage ≤III, MIDG, 2017–2020	MIDG	MMR-L total complications 24.6% vs MMR-H 7.2%, P=0.005; MMR-L independent risk factor	NM	NM
Yan, *et al.* 2023 [14]	Two high-volume centers, China and USA; retrospective review	105; gastric cancer MITG, 2015–2020	IEJ n=60 vs EEJ n=45; linear vs circular stapler	EEJ higher wound infection 13.3% vs 8.3%, P=0.044; pneumonia 40.0% vs 21.7%, P=0.042; LS vs CS: reflux 50.0 vs 44.4, P=0.041; diarrhea 33.3 vs 0.0, P=0.045; dysphagia 22.2 vs 11.1, P=0.049; eating restrictions 33.3 vs 41.7, P=0.029	NM	OS and DFS did not differ significantly between LS and CS
Araruna, *et al.* 2024 [15]	Brazil; retrospective cohort with PSM	NM; clinical stage II–III gastric adenocarcinoma, neoadjuvant chemotherapy then MIS or OG, 2007–2020	MIS vs OG; neoadjuvant yes	No significant differences in global, clinical, or surgical complications or mortality; MIS increased D2, curative intent, complete	Shorter hospital stay with MIS; mortality no significant difference	MIS did not independently affect survival; extended resection and higher ASA predicted reduced survival

				neoadjuvant therapy; reduced transfusion and shorter stay		
Cui, *et al.* 2024 [16]	Chinese PLA General Hospital First Medical Center, Beijing, China; retrospective PSM	193 included; after matching 49 NICT-MIG and 86 NCT-MIG; LAGC, 2020–2023	NICT-MIG vs NCT-MIG; neoadjuvant yes	Overall adverse events, bleeding, operation time, LN, flatus, hospital stay, overall and severe morbidity comparable; risk POCs: EBL >200 mL P=0.010; PNI <45 P=0.003	Intraoperative bleeding comparable; hospital stay comparable	Objective and pathologic complete response higher with NICT-MIG
Cui, *et al.* 2024 [17]	Chinese PLA General Hospital First Medical Center, Beijing, China; retrospective PSM	726 older patients; after matching 61 NICT-MIG and 114 MIG; >65 y, 2020–2023	NICT-MIG vs upfront MIG; neoadjuvant yes	MPR 44.2%; pCR 21.3% in NICT-MIG; no significant difference in overall POC or severe POC; risk EBL >200 mL P=0.010; LMR ≥3.25 P=0.006	Intraoperative bleeding comparable; NICT-MIG longer postoperative days P=0.030	No significant difference in 2-y OS or RFS
Kubo, *et al.* 2024 [18]	Single institution, Japan; retrospective PSM	403 enrolled; 197 RG and 206 LG; high VFA matched 71+71; low VFA 77; MIS, 2015–2022	RG vs LG; visceral obesity by VFA	High VFA: RG 1.4% vs LG 15.4%, P=0.004; low VFA: RG 1.1% vs LG 2.6%, P=1.00	RG operative time longer 420 vs 365 min, P<0.001	NM
Oh, *et al.* 2024 [19]	Korea; retrospective	4,902 reviewed; 4,505 included; MIDG with delta-shaped	Delta-shaped anastomosis	Textbook outcome 3,736/4,505 (82.9%); post-op	NM	NM

		anastomosis, 2009–2020		complications affected TO most (91.9%); POC within 30 days 8.7%; major CD ≥3 2.4%		
Park, *et al.* 2024 [20]	Korea, 68 institutions; nationwide survey with PSM	14,076 underwent surgery; 4,953 stage IB–III included; 1,689 MIS vs 1,689 open matched; 2019	MIS vs open	Overall morbidity MIS 17.5% vs open 21.9%, P=0.001; MIS protective OR 0.799, P=0.006; lower wound complications, intra-abdominal abscess, cardiac problems	Mortality no significant difference; less blood loss MIS; shorter stay MIS	Higher harvested LNs in MIS
Ri, *et al.* 2024 [21]	Cancer Institute Hospital, Tokyo, Japan; retrospective PSM	834 initially; 614 after matching (307 each); minimally invasive R0 gastrectomy, 2019–2023	PGA mesh vs non-PGA	Pancreas-related CD ≥2: PGA 2.9% vs non-PGA 6.8%, P=0.025; drain amylase similar POD 1 and 3	NM	NM
Serizawa, *et al.* 2024 [22]	Single center, Japan; single-center retrospective cohort	302; laparoscopic or robotic total gastrectomy, 2009–2019	MITG; Period-I vs Period-II after standardization	Late overall 19/302 (6.3%); 14/24 (58.3%) late intestinal complications required reoperation; Period-II 2.9% vs Period-I 9.0%, P=0.030; 3-y	NM	Period-I independent risk factor for late intestinal complications

				cumulative incidence 0.03 vs 0.10, P=0.035		
Tanaka, *et al.* 2024 [23]	Single institution, Japan; retrospective	150; highly advanced gastric cancer with preoperative chemotherapy followed by R0 gastrectomy, 2009–2022	Robotic 62; laparoscopic 88; neoadjuvant yes	Morbidity grade ≥3a 12%; local complication 10.7%; total/proximal + splenectomy 29.8% vs distal 3.2% vs total/proximal 4.9%, P<0.001; splenectomy independent OR 8.574	Operative time 475 min; blood loss 72 g; hospital stay 14 days (IQR 11–18)	50 (33.3%) grade ≥2 histological response
Ustuner, *et al.* 2024 [24]	Turkey; retrospective	20; curative laparoscopic total or subtotal gastrectomy, 2021–2023	LTG or LSG	One LSG stump leakage CD 3a; one atelectasis CD 2	LTG 290 ± 52.3 min; LSG 310 ± 39.4 min; LTG 9.3 days; LSG 12.3 days	NM
Xue, *et al.* 2024 [25]	High-volume center, China; retrospective cohort	527; robotic gastrectomy, 2016–2021	Robotic gastrectomy	Complication rate and recovery time decreased with phase advancement, P<0.05; LN noncompliance decreased; learning phase independent for textbook outcome, P<0.05	NM	Extraperigastric LN phase III 17.40±7.05 vs phase I 15.12±6.90, P=0.005
Benciveng a, *et al.* 2025 [26]	24 high-volume European centers, GASTRODA	2,430; 1,800 OG and 630 MIG; curative-intent	MIG vs OG; total vs subtotal; neoadjuvant less frequent in MIG	MIG perioperative complications 23.0% vs OG 31.6%,	30-day 1.6% vs 3.3%, P=0.026; 90-day	MIG higher R0 96.5% vs 92.4%

	TA registry; retrospective multicenter with PSM	gastrectomy, 2017–2021		P<0.001; subtotal MIG 17.9% vs OG 25.3%, P=0.005; total MIG 31.5% vs OG 36.1%, P=0.201; after PSM subtotal OR 0.49, P=0.005; total OR 1.15, P=0.645	1.9% vs 4.7%, P=0.001; shorter stay MIG	
Ebihara, *et al.* 2025 [27]	Five institutions, Japan; multicenter retrospective PSM	688 enrolled; 300 matched pairs; curative MIDG, 2018–2024	Billroth-I vs Roux-en-Y reconstruction	CD II P<0.001 and CD III P=0.027 more frequent in R-Y; R-Y longer operation, longer stay, greater blood loss	R-Y longer operation 309 vs 265 min, P<0.001; greater blood loss P=0.047; R-Y longer stay 10 vs 10 days, P=0.042	5-y OS B-I 91.1% vs R-Y 83.4%, P=0.019; RFS no difference, P=0.056; independent prognostic for OS: reconstruction method, POC ≥CD III, LN metastasis
Garsot, *et al.* 2025 [28]	39 centers, EURECCA Spanish Registry; population-based cohort with PSM	1,333 matched-pair; elective gastric cancer resection with curative intent, 2014–2021	MIG vs OG; subtotal vs total	Overall 47.4% vs 44.7%; major 19.1% vs 18.2%; 90-day mortality 4.4% vs 3.2%; failure to rescue 23.1% vs 17.3%; anastomotic leakage after TG ~17%, no difference	90-day mortality 4.4% vs 3.2%; MIG shorter median hospitalization 8 vs 10 days, P<0.001	≥15 nodes: MIG 84.2% vs OG 78.8%, P<0.001; 5-y OS 62% vs 64.6%; DFS 58.5% vs 56.5%

Ikeda, *et al.* 2025 [29]	Kobe University Hospital, Japan; retrospective four-arm comparative	174; LAGC after NAC, 2011–2024	No NAC/open n=63; no NAC/MIS n=49; NAC/open n=20; NAC/MIS n=42; neoadjuvant yes	Severe POC grade ≥III lowest in NAC/MIS, no pancreatic fistula; NAC/open 20%; no NAC/MIS 6.1%	NAC/MIS less blood loss and fewer transfusions; shorter stay with NAC/MIS	R0 highest in NAC/MIS 97.6%; 5-y RFS and OS higher in NAC/MIS but not statistically significant
Inoue, *et al.* 2025 [30]	Single institution, Japan; retrospective	1,353; standard MIS, 2011–2021	MIS including robotic (530 robotic)	POPF 80/1,353 (5.9%); intra-abdominal infectious CD ≥II 145/1,353 (10.7%); median D1Amy 812 U/L; D1Amy AUC 0.888; nomogram AUC 0.8960; validation 0.9259	NM	Significant risk factors: age, tumor location, splenectomy, D1Amy
Nakazawa, *et al.* 2025 [31]	Japan, National Clinical Database; nationwide retrospective PSM	3,337 patients; 540 matched pairs; RGC completion total gastrectomy, 2018–2022	MIS vs open completion total gastrectomy	Anastomotic leakage higher MIS 9.8% vs 6.3%, P=0.034; overall complication, reoperation, mortality comparable	MIS longer operative time 344 vs 248.5 min, P<0.001; reduced blood loss 70 vs 290 mL, P<0.001; median stay 13 vs 14 days, P=0.065	NM
Omori, *et al.* al. 2025 [32]	Single institution, Japan; retrospective PSM	217 eligible; 205 followed 1 year; 42 matched pairs; proximal gastric and EGJ cancer MIPG, 2014–2022	DFT vs UFT	UFT fewer reflux symptoms 0% vs 14.3%, P=0.0011; LA grade B or higher reflux	UFT shorter operative time P=0.044; similar blood loss	NM

				esophagitis 0% vs 14.3%, P=0.0011; similar morbidity		
Ri, *et al.* 2025 [33]	Cancer Institute Hospital, Tokyo, Japan; retrospective PSM	359; after matching 190 (95 each); locally advanced gastric and EGJ cancer, 2017–2024	MTG vs OTG; some subgroups without NAC	MTG CD ≥3 3.2% vs OTG 11.6%, P=0.026; IAIC CD ≥2 7.4% vs 17.9%, P=0.029; CD ≥3 2.1% vs 9.5%, P=0.030	NM	NM
Tanaka, *et al.* 2025 [34]	Single institution, Japan; retrospective	54 (NAC n=26; upfront n=28); advanced gastric cancer with symptomatic GOO, R0 MIS, 2007–2020	LSPGJ + NAC + MIG vs upfront gastrectomy; neoadjuvant yes	GOO score improved P<0.001; no differences in POC, hospital stay, adjuvant chemotherapy; cumulative recurrence lower NAC P=0.041; recurrence and hematogenous metastasis lower NAC P=0.031 and 0.041	No difference in hospital stay	OS and RFS trends favored NAC but not statistically significant
Yamamoto, *et al.* 2025 [35]	Single institution, Japan; retrospective PSM	464; after matching 332 (166 each); gastric cancer aged ≥75 y, open or laparoscopic gastrectomy, 2004–2018	Laparoscopy vs open	Laparoscopy lower complication rate P=0.002	Laparoscopy longer operative time, less blood loss (all P<0.020); shorter stay P<0.020	No significant differences in 3-y OS, RFS, DFS (all P>0.200)
Yokoo, *et al.* 2025 [36]	Kobe University Hospital, Japan;	82; distal gastric cancer, Billroth II or Roux-en-Y,	Gastrectomy including minimally	Duodenal stump fistula 2.7% vs 0%, P=0.27; no	NM	5-y OS 30% vs 30%, P=0.67

	retrospective review	2011–2021; Duo+ n=37, Duo− n=45	invasive approach	positive distal resection line		
Yoshikawa, *et al.* 2025 [37]	Japan; retrospective	23 consecutive; gastric cancer MILAR with da Vinci SP, 2024	MILAR	One grade II intra-abdominal fluid infection; one grade II enteritis; no anastomotic leakage or pancreatic fistula; no grade III or higher	Median operation 192 min (distal 191; proximal 174; total 308); median blood loss 13 mL; none >250 mL	NM
Ablatt, *et al.* 2026 [38]	Single-surgeon center, USA; retrospective	26; laparoscopic 7, robotic 19; total gastrectomy with extended lymphadenectomy, 2017–2023	Laparoscopic/robotic total gastrectomy with extended lymphadenectomy	Esophageal leak 2/26 (7.7%) managed with stent; no deaths within 30 days	0 deaths within 30 days; median operative time 4 h 45 min; median stay 7 days	Median 19.5 nodes; 3-y survival 71.4%; 5-y survival 58.6%
Alrashidi 2026 [39]	Single center; retrospective comparative	68; FL n=31, non-FL n=37; RGC curative resection, 2014–2024	FL vs non-FL MIS; robotic more in FL	Postoperative complication rates and mortality similar and acceptable in both groups	FL longer operation 275.0 vs 251.7 min, P=0.163; lower EBL 100 vs 120 mL, P=0.098; shorter stay FL 6 vs 7 days, P=0.089	NM
Amada, *et al.* 2026 [40]	Single institution, Japan; retrospective	42; 28 cStage IV; 18 HER2-negative; 14 conversion surgery; 12 MIS; HER2-negative cStage IV, 2022–2024	MIS conversion surgery after ICI-combined chemotherapy; neoadjuvant yes	Grade 2 postoperative complications minimal; no severe events	No severe events; median stay 9 days	High tumor response; 1-y RFS and OS both 100.0%

Ebihara, *et al.* 2026 [41]	Five institutions, Japan; multicenter retrospective PSM	988 enrolled; eligible 186 (D2 74; Non-D2 112); 82 after matching; older ≥75 y, cN+ or ≥cT2, MIDG, 2018–2024	D2 vs Non-D2 lymphadenectomy	POC comparable between groups	Non-D2 shorter operation 285 vs 349 min, P=0.025	5-y OS D2 47.7% vs Non-D2 34.6%, P=0.143; RFS 34.3% vs 27.2%, P=0.578; pN independent for RFS HR 3.553
Ebihara, *et al.* 2026 [42]	Five institutions, Japan; retrospective PSM	988; gastric cancer MIDG, 2018–2024	MIDG	Male 15.4% vs female 9.5%, P=0.037; male independent risk OR 1.727 (95% CI 1.032–2.939), P=0.037	Male longer operation 293 vs 274 min, P<0.001; greater blood loss median 5 vs 0 mL, P<0.001	Male sex independent risk factor for poorer RFS
Ebihara, *et al.* 2026 [43]	Single center, Japan; retrospective PSM	169; 43 prior non-curative ESD; 33 matched pairs; post-ESD laparoscopic n=33, robotic n=10; pT1 gastric cancer MIDG, 2018–2024	Laparoscopic vs robotic MIDG after ESD	ESD vs non-ESD: operative duration, EBL, POC, LOS similar; ESD modest reduction in LN yield; all R0; no recurrences; post-ESD robotic longer operative time; blood loss, LND yield, morbidity, LOS comparable	Robotic longer operative time in post-ESD subgroup; similar LOS	Modest reduction in LN yield after ESD; OS and RFS comparable; no disease recurrence
Fujii, *et al.* 2026 [44]	19 institutions, Japan; multicenter retrospective	237 eligible (MIS 130; open 107); 64 matched pairs; cStage IVb	MIS vs open; neoadjuvant yes (chemotherapy)	MIS 31.2% vs open 46.9%; RR 0.67 (95% CI 0.41–1.08),	MIS longer operation MD 98 min (53–143); reduced	R0 92% vs 78%; 3-y OS 56.5% vs 44.6%; HR

	cohort with PSM	gastric cancer, curative-intent MIS or open after chemotherapy, 2011–2022		not significant	blood loss MD −550 g (−738 to −362)	0.83 (95% CI 0.51–1.36)
Hayami, *et al.* 2026 [45]	Single institution, Japan; retrospective 2:1 PSM	After matching 62 DFT and 31 NFTT; gastric and EGJ cancer MIPG, 2019–2024	DFT vs NFTT	NFTT lower anastomotic stenosis 3.2% vs 29.0%, P=0.003; robotic 2.5% vs 30.8%, P=0.008; no reflux symptoms NFTT 0% vs DFT 6.5%, P=0.30	NFTT shorter reconstruction time 87 vs 108 min, P=0.004	NM
Iwasaki, *et al.* 2026 [46]	Single center, Japan; single-center retrospective cohort with PSM	61 consecutive RGC; 53 open, 8 MIS; open or MIS total gastrectomy, 1999–2025	Open vs MIS total gastrectomy	Pancreatic fistula lower MIS 0% vs 16.7% (not significant)	MIS longer operation 352 vs 297 min, P<0.05; reduced blood loss 39 vs 576 mL, P<0.05; shorter stay MIS 12 vs 17 days, P<0.05	NM
Kim, *et al.* 2026 [47]	Korea; retrospective PSM	1,319 OTG and 348 MITG; locally advanced gastric cancer, 2007–2019	MITG vs OTG	CD ≥III: OTG 12.4% vs MITG 10.6%, P=0.470; anastomotic leakage: OTG 2.9% vs MITG 4.7%, P=0.230	MITG less blood loss but longer operative time	5-y OS 83.0% vs 87.3%, P=0.398; HR death 0.88; 5-y RFS 71.0% vs 72.5%, P=0.895; HR recurrence 1.08

Abbreviations: ASA, American Society of Anesthesiologists; CD, Clavien–Dindo; CI, confidence interval; DFS, disease-free survival; EBL, estimated blood loss; HR, hazard ratio; LAGC, locally advanced gastric cancer; LN, lymph node; MIS, minimally invasive surgery; NAC, neoadjuvant chemotherapy; NM, not mentioned; OG, open gastrectomy; OS, overall survival; PSM, propensity score matching; RGC, remnant gastric cancer; RFS, relapse-free survival; TO, textbook outcome.

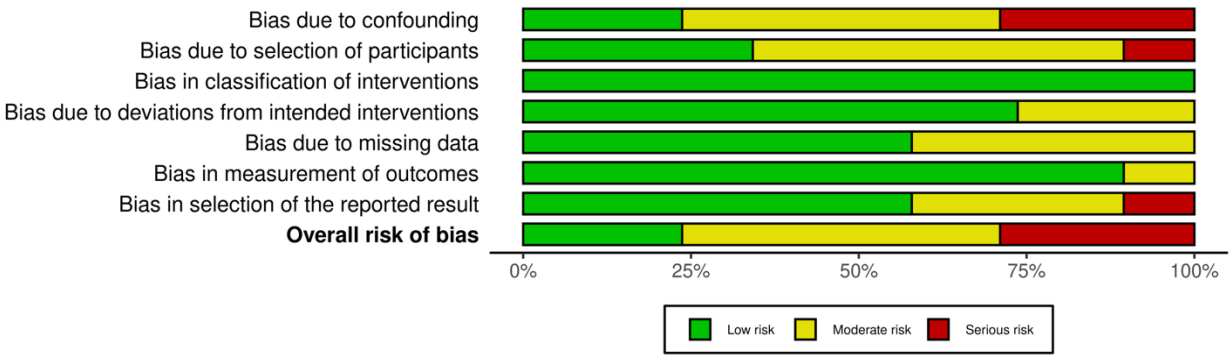

Figure 2: Risk of bias assessment of included retrospective studies (ROBINS-I).

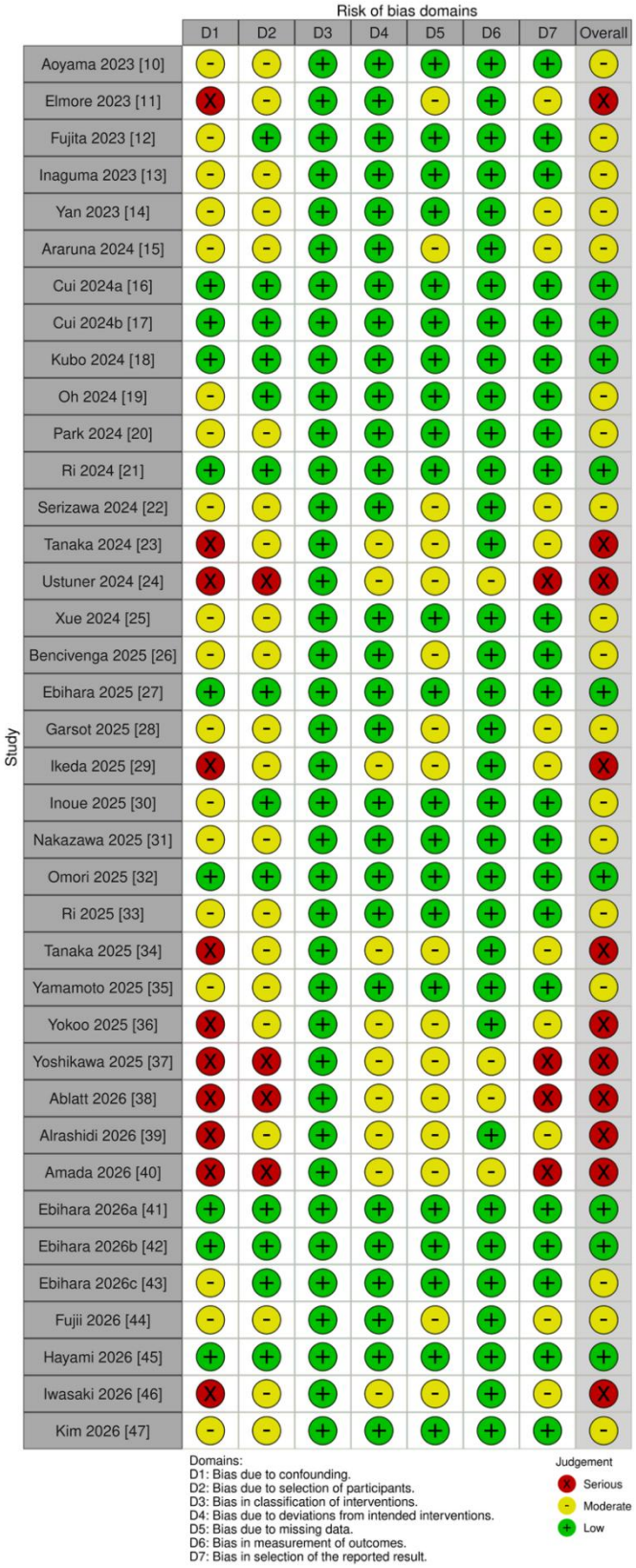

Figure 3: Risk of bias assessment of included retrospective studies (ROBINS-I).

surgery, MIS for leftover gastric cancer was linked to a noticeably greater rate of anastomotic leakage (9.8% vs. 6.3%; P=0.034) [31]. In a retrospective research, Iwasaki et al. found that the MIS group had a decreased incidence of postoperative pancreatic fistula (0% vs. 16.7%), however this difference was not statistically significant [46]. The GastroBenchmark and GASTRODATA databases analysis of 9,356 oncological gastrectomies revealed that anastomotic leakage rates were significantly higher after minimally invasive total gastrectomy (5.2%) compared to distal gastrectomy (1.1%), and that anastomotic technique was an independent predictive factor for leakage, overall morbidity, and major complications [48]. Another significant cause of morbidity after gastric cancer surgery is pancreatic fistula and intra-abdominal infectious problems. According to Kubo et al.'s review, among patients with visceral obesity, robotic gastrectomy was linked to a considerably lower rate of serious intra-abdominal infection sequelae than laparoscopic gastrectomy (1.4% vs. 15.4%; P=0.004) [18]. This conclusion is especially significant because large visceral fat area was found to be an independent risk factor in a recent study on risk factors for infection complications following gastrectomy in older individuals [49]. According to Ri et al., following minimally invasive gastrectomy, the use of polyglycolic acid (PGA) mesh significantly decreased pancreas-related complications of Clavien-Dindo grade ≥2 (2.9% vs. 6.8%; P=0.025) [21]. Inoue et al. developed a predictive nomogram for pancreatic fistula in MIS that incorporated drain amylase levels on postoperative day 1, achieving an area under the curve of 0.896 in the training set and 0.926 in the validation set [30]. The comparison between robotic and laparoscopic approaches was a recurring theme in our review. Xue et al. analyzed the learning curve of robotic gastrectomy in 527 patients and found that postoperative complication rates and recovery times significantly decreased with phase advancement, with the learning phase being an independent factor for textbook outcome attainment [25]. A systematic review of the learning curve in robotic D2 gastrectomy reported that outcomes improved substantially after the learning curve, with 50% less blood loss, 18% increased lymph node yield, and 62% fewer major complications [50]. The management of remnant gastric cancer (RGC) represents a particularly challenging subset of gastric cancer surgery. Our review included several studies specifically addressing MIS for RGC. According to Aoyama et al., MIS for RGC was linked to better short- and long-term results than open surgery, with a risk ratio of 0.65 (95% CI 0.32–1.29) for serious complications [10]. Nakazawa et al. discovered that although the short-term results of MIS for RGC were similar to those of open surgery, the MIS group had a greater frequency of anastomotic leaking [31]. Alrashidi discovered that although the fluorescent group had longer operation times, it showed positive tendencies toward reduced estimated blood loss and shorter hospital stays when comparing fluorescence lymphography-guided MIS with non-fluorescent MIS for RGC [39]. Neoadjuvant therapy has become increasingly important in the management of locally advanced gastric cancer, and our review included several studies examining MIS in this context. According to Cui et al., minimally invasive gastrectomy following neoadjuvant chemo-immunotherapy (NICT-MIG) was as safe and feasible as MIG following chemotherapy alone (NCT-MIG), with the NICT-MIG group exhibiting considerably greater objective and pathologic complete response rates [16]. When compared to upfront MIG, NICT-MIG was linked to longer postoperative days in older patients, but there was no discernible difference in overall or severe postoperative sequelae [17]. Ikeda et al. reported that the NAC/MIS group had the lowest rate of severe postoperative complications (grade ≥III) compared to NAC/open and no NAC/MIS groups, with no incidence of pancreatic fistula [29]. The impact of patient-related factors on postoperative complications was a significant theme in our review. Male sex was found by Ebihara et al. to be an independent risk factor for shorter relapse-free survival after minimally invasive distal gastrectomy and postoperative complications (OR 1.727; 95% CI 1.032–2.939; P=0.037) [42]. Low muscle mass ratio was shown by Inaguma et al. to be a major independent risk factor for both intra-abdominal infectious complications and overall problems following MIDG [13]. Fujita et al. reported that postoperative diarrhea occurred in 6.0% of patients following minimally invasive gastrectomy, with age ≥75 years (OR 1.62) and total gastrectomy being independent risk factors [12]. Textbook outcome (TO) has emerged as a comprehensive composite measure of surgical quality, and several studies in our review assessed TO attainment. Oh et al. reported that TO was achieved in 82.9% of 4,505 patients undergoing minimally invasive distal gastrectomy with delta-shaped anastomosis, with postoperative complications being the most significant factor affecting TO [19].

According to Park et al., MIS was a significant protective factor against overall morbidity (OR 0.799; P=0.006), and the overall morbidity rate was significantly lower in the MIS group than in the open group (17.5% vs. 21.9%; P=0.001) [20]. Limitations: This systematic review highlights several limitations affecting result interpretation: all studies were retrospective, raising selection, confounding, and information bias risks; significant methodological concerns were noted using the ROBINS-I tool; heterogeneity in populations and surgical techniques hindered meta-analysis; inadequate reporting of key demographic variables was common; the predominance of studies from East Asia limits generalizability to Western populations; publication bias may favor minimally invasive surgery; and a lack of long-term follow-up data restricts judgments on MIS's impact on oncologic outcomes.

Conclusion

Minimally invasive gastrectomy for gastric cancer achieves comparable long-term oncologic outcomes with less intraoperative blood loss, shorter hospital stays, and lower morbidity than open surgery, although anastomotic leakage remains a concern in complex cases. Robotic surgery may reduce intra-abdominal infections and improve lymph node yield but is limited by learning curves and cost. Male sex, low muscle mass, high visceral fat, and older age predict postoperative morbidity, highlighting the need for further randomized trials with standardized outcomes and long-term follow-up.

Conflict of Interest

None

Funding

None

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