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Pedro Felgueiras Loureiro

Laparoscopic versus Robotic gastric cancer surgery: Short-term Outcomes. Systematic Review and Meta-analysis of 25 521 patients

Março, 2023

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Laparoscopic versus Robotic gastric cancer surgery: Short-term Outcomes. Systematic Review and Meta-analysis of 25 521 patients

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Dr. José Pedro Coimbra de Vargas Lobarinhas Barbosa

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Faculdade de Medicina da Universidade do Porto, 23/03/2023

Assinatura conforme cartão de identificação:

Pedro Felgueiras Loureiro

UC Dissertação/Projeto (6º Ano) – DECLARAÇÃO DE REPRODUÇÃO

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DESIGNAÇÃO DA ÁREA DO PROJECTO

Ciências médicas e da saúde

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Laparoscopic versus Robotic gastric cancer surgery: Short-term Outcomes. Systematic Review and Meta-analysis of 25 521 patients.

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COORIENTADOR (se aplicável)

José Pedro Coimbra de Vargas Lobarinhas Barbosa

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Faculdade de Medicina da Universidade do Porto, 23/03/2023

Assinatura conforme cartão de identificação: Pedro Felgueiras Loureiro

INDEX

Laparoscopic versus Robotic gastric cancer surgery: Short-term Outcomes. Systematic Review and Meta-analysis of 25 521 patients

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Laparoscopic versus Robotic gastric cancer surgery

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Keywords: Gastrectomy; Gastric Cancer; Robotic surgery; Laparoscopy; Short-term outcomes

Abstract

Background: Gastric cancer has the third highest cancer-related mortality worldwide. There is no consensus regarding the optimal surgical technique to perform curative resection surgery.

Objective: Compare laparoscopic and robotic gastrectomy regarding short-term outcomes in patients with gastric cancer.

Materials and Methods: This systematic review was conducted according to the PRISMA guidelines. We searched the following topics: “Gastrectomy”, “Laparoscopic” and “Robotic Surgical Procedures”. The included studies compared short-term outcomes between laparoscopic and robotic gastrectomy. Individual risk of bias was assessed with the MINORS scale.

Results: There were no significant differences between robotic gastrectomy (RG) and laparoscopic gastrectomy (LG) regarding conversion rate, reoperation rate, mortality, overall complications, anastomotic leakage, distal and proximal resection margin distances, and recurrence rate. However, mean blood loss (mean difference – MD – -19.43 mL, p<0.00001), length of hospital stay (MD -0.50 days, p=0.0007), time to first flatus (MD -0.52 days, p<0.00001), time to oral intake (MD -0.17 days, p=0.0001), surgical complications with a Clavien-Dindo grade ≥ III (relative risk – RR – 0.68, p<0.0001), and pancreatic complications (RR 0.51, p=0.007) were significatively lower in the RG group. Furthermore, the number of retrieved lymph nodes was significantly higher in the RG group. Nevertheless, the RG group showed a significantly higher operation time (MD 41.19 min, p<0.00001) and cost (MD 3684.27 US Dollars, p<0.00001).

Conclusion: This meta-analysis supports the choice of robotic surgery over laparoscopy concerning relevant surgical complications. However, longer operation time and higher cost remain crucial limitations. Randomized clinical trials are required to clarify the advantages and disadvantages of RG.

Introduction

Nowadays, gastric cancer is the fifth most common cancer worldwide, with its highest prevalence being in Mongolia, Japan, and South Korea. Moreover, WCRF International, in 2020, demonstrated that gastric cancer has the third highest cancer-related mortality rate (7.7/100 000) and it is the fifth most incident tumour in the entire world (11.1/100 000).[1,2]

Despite the development of new surgical techniques and medical devices, prognosis remains poor.[3] Therefore, it is necessary to improve screening methods to achieve earlier diagnosis and improve the odds of finding a resectable tumour, so as to reduce its burden.[4,5]

There are two approaches to treat localized gastric cancer: endoscopic resection or radical gastrectomy. The first one is used for gastric cancer classified as stage IA (T1 N0 M0), according to the TNM classification. On the other hand, radical gastrectomy is used for stage IB-III gastric cancers (>T1 and/or ≥N0 M0), and is associated with a simultaneous D2 lymphadenectomy. To increase the probability of a curative resection, this treatment requires neoadjuvant and adjuvant chemotherapy, in order to reduce pre-operative tumour size and probability of recurrence, respectively.[6]

Currently, the main surgical approaches are minimally invasive, including laparoscopic surgery and robotic surgery.[5]

The largely used conventional laparoscopic gastrectomy (LG) has shown several advantages, when compared with open gastrectomy, such as better surgical safety, less trauma, lower operative morbidity and faster recovery, with similar overall survival, oncologic outcomes and relapse-free survival.[6,7]

On the other hand, robotic gastrectomy (RG) yields high-resolution three-dimensional images, wrist instruments that offer freedom, tremor filtering technology and less fatigue. These features are expected to overcome some drawbacks of laparoscopic surgery.[5]

There are several studies which reported the advantages of the RG, when compared with LG, on the following short-term outcomes in patients with gastric cancer: less blood loss, higher number of harvested lymph nodes, less time to first flatus, shorter length of hospital stay and less post-operative complications.[8] However, the cost and the operative time related to the expensive instruments and the low experience in performing robotic surgery are still relevant limitations to its current utilization.[5,9]

Therefore, our systematic review includes the most recent observational studies and the current literature about the comparison of the short-term outcomes between LG and RG for gastric cancer patients in order to clarify the feasibility and efficiency of robotic surgery, as it is predicted to be more prevalent in the coming years.[10]

Materials and methods

2.1 Search strategy / Information sources

We conducted our meta-analysis according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Literature search was performed independently by two reviewers, on the following databases: PubMed, Web of Science and Cochrane Library. The query used in PubMed was: “Search (((laparoscopic gastrectomy) OR ((“” Gastrectomy”” [Majr:NoExp]) AND “” Laparoscopy “”[Mesh]))) OR ((((“” Gastrectomy “” [Majr:NoExp]) AND “” Robotic Surgical Procedures “” [Mesh])) OR robotic gastrectomy)”. In the Web of Science and Cochrane Library, we used the following query: “(("Gastrectomy" AND "Laparoscopy") OR ("Laparoscopic Gastrectomy")) AND ("Robotic Surgery" OR "Robotic Surgical Procedures" OR "Robotic Gastrectomy")”. Existing systematic reviews were also consulted for additional papers.

2.2 Study selection and eligibility criteria

The researchers screened the literature and selected articles based on their titles and abstracts. In accordance with previous reviews, we included observational clinical studies that compared short-term outcomes between the two surgical approaches (RG and LG), in patients with gastric cancer who underwent curative-intent surgery. [8,11,12]

Then, the authors reviewed the full texts and excluded articles which met the following exclusion criteria: (1) articles which also reported comparison of two robotic systems, (2) proximal gastrectomy comparison only and (3) D1 lymphadenectomy only. One article was excluded due to the impossibility of obtaining an English version.

2.3 Data extraction

Two reviewers independently read and interpreted every original study. Data extraction comprised: study information (author, region, published year, study period, study design, sample size, surgical extension, level of lymphadenectomy and reconstruction options), patients’ characteristics (age and gender) and short-term outcomes, which included three groups: surgical outcomes (operating time, blood loss, conversion rate, reoperation rate and mortality rate), postoperative outcomes (length of hospital stay, time to first flatus, time to oral intake, overall complications, surgical complications according to Clavien-Dindo Grade, anastomotic leakage, pancreatic complication and cost of operation) and oncological outcomes (distal resection margin distance, proximal resection margin distance, recurrence rate and number of retrieved lymph nodes). These variables were chosen in accordance with previous systematic reviews. [8,9,11,12] (Table 1)(Table 2)

2.4 Quality assessment

In our meta-analysis, we used the MINORS (Methodological Index for Non-Randomized Studies) scale to assess the quality and individual risk of bias of our non-randomized studies. The final version of the MINORS scale comprises 12 items, which identify whether the included studies contained a clearly stated aim, included all potentially fit patients, involved prospective collection data, had appropriate endpoints according to the aim of the study, had blind evaluation of objectives and subjective end-points, had an appropriate follow-up period, loss of follow-up under 5% and prospective calculation of the study size. Furthermore, the MINORS scale also evaluates additional criteria for comparative studies such as the control group, the time period of both groups, their baseline equivalence and an adequate statistical analysis. Each item is scored as 0 (not reported), 1 (reported but inadequate) or 2 (report and adequate). The total score, in comparative studies, is 24 points.[13]

2.5 Statistical analysis

We performed our meta-analysis using Review Manager (Version 5.4.1).

For dichotomous outcomes, we presented the results as risk ratios (RR) with 95% confidence intervals (CI), by using the Mantel-Haenszel method. For continuous outcomes, we presented the results as mean differences with 95% CI, by using the generic inverse variance method. Some studies presented their outcomes as median and range. Therefore, we applied a method described by Hozo et al.[14] in order to estimate the mean and standard deviation. We used an alpha (α) level of 0.05 for statistical significance. The Chi-squared (χ^2) test and the I-squared (I^2) measure were used to assess heterogeneity. We applied a random effects model because of the clinical heterogeneity of the included studies. We assessed the existence of publication bias among included studies using funnel plots, provided as supplemental file no.1.

2.6 Subgroup analysis

In our systematic review, 22 studies used Propensity Score-Matching (PSM) in order to minimize baseline differences that usually contribute to bias in the interpretation of the results. The remaining 31 studies did not perform PSM. Hence, we conducted a subgroup analysis to understand whether PSM had any effect in the association between the surgical approach and the studied outcomes.

Results

3.1 Studies selected and characteristics

We selected 2848 articles from our research on PubMed, Web of Science and Cochrane Library. After reading their titles and abstracts, we selected 82 full-text articles to assess for eligibility. No additional studies from other sources were deemed relevant. From these articles, we excluded 29 because they did not fulfil the inclusion criteria. Then, for our systematic review, we included 53 studies in the quality assessment and quantitative analysis (Figure 1). These studies include a total of 25 521 participants, of which 8154 underwent RG and 17367 underwent LG. All studies were retrospective observational studies.[15-67]

3.2 Quality assessment

The median score in the MINORS scale was 22, with a range of 19 to 23. Therefore, all included studies were considered adequate to be included in the quantitative analysis.

3.3 Meta-analysis

A synthesis of every meta-analytical measure is presented in figure 2. (Figure 2) We provide the results of each individual meta-analysis as forest plots in supplemental file no.2.

Surgical outcomes:

Operative time

Our meta-analysis included fifty studies which reported the operation time. It was significantly shorter in laparoscopic gastrectomy group, when compared with the robotic surgery group [MD 41.19, $p<0.00001$ (95%CI: 33.47, 48.92), I^2=98%, $p<0.00001$]. Mean operation time was 269.22 minutes in the robotic surgery group and 225.65 in the laparoscopic surgery group. (Figure 3)

Blood loss

Blood loss was reported in forty-six studies. The mean blood loss was 90.72 mL in the RG group and 108.2 mL in the LG group. This difference was statistically significant [MD -19.43, $p<0.00001$ (95%CI: -25.23, -13.62), I^2 =92% $p<0.00001$].

Conversion

This outcome was included in thirty-three studies and demonstrated no statistically significant difference between the two groups [RR 0.68, p=0.09 (95% CI: 0.43, 1.07), I^2=0%, p=0.50]. Conversion rate to open surgery was 0.59% (26/4390) in the RG group and 0.89% (69/7730) in the LG group.

Reoperation

Eighteen studies reported reoperation rate. There was no statistically significant difference between both surgical approaches, regarding reoperation [RR 0.89, p=0.57 (95% CI: 0.59, 1.34), I^2=0%, p=0.72]. Reoperation rate was 1.38% (37/2677) in the RG group and 1.56% (68/4366) in the LG group.

Mortality

Thirty-nine studies were included, and mortality was comparable between both groups [RR 1.20, p=0.37 (95% CI: 0.81, 1.77), I^2=0%, p=0.98]. Mortality rate was 0,6% (40/6708) in the RG group and 0,59% (64/10776) in the LG group. (Figure 4)

Postoperative outcomes:

Length of Hospital Stay

This outcome was reported in fifty-two studies. The mean length of hospital stay was 8.74 days in the robotic surgery group and 9.38 days in the laparoscopic surgery group.

The robotic surgery group displayed a significantly shorter hospital stay [MD -0,50, p=0.0007 (95% CI -0,79, -0,21), I^2 =85% p<0.00001].

Time to first flatus

There were twenty-five studies which reported time to first flatus. The robotic surgery group showed a significantly shorter time to first flatus [MD -0.52, p<0.00001 (95%CI -0.55, -0.50), I^2 =98% p<0.00001].

Time to oral intake

Twenty-seven studies included this outcome. Time to oral intake was significantly shorter in the robotic surgery group [MD -0.17, p=0.0001 (95%CI -0.25, -0.08), I^2 =53% p=0.0008].

Overall complications

The overall complication rate was 12.97% (873/6732) in the RG group and 13.11% (1504/11469) in the LG group. There were fifty-one studies reporting this outcome, and the meta-analysis did not demonstrate a statistically significant difference [RR 0.93, p= 0.15 (95% CI 0.85, 1.03), I^2=18%, p = 0.14].

Surgical complications (Grade ≥ III in the Clavien-Dindo Classification)

Thirty-one studies reported this outcome. Our study showed that the robotic surgery group had a significantly lower number of surgical complications [RR 0.68, p<0.0001 (95% CI 0.57, 0.82), I^2=7%, p=0.35], with a rate of 3.88% (212/5464) in the RG group and 6.4% (467/7303) in the LG group. (Figure 5)

Anastomotic leakage

Thirty-three studies included this outcome. The rate of anastomotic leakage was 1.72% (91/5289) in the RG group and 1.93% (168/8721) in the LG group. This difference was not significant [RR 1.06, p= 0.71 (95% CI 0.78, 1.45), I^2=16%, p =0.21].

Pancreatic complications

This outcome was included in twenty-one studies. The rate of pancreatic complications was 0.64% (22/3445) in the RG group and 1.42% (78/5497) in the LG group. This difference was statistically significant [RR 0.51, p=0.007 (95% CI 0.31, 0.83), I^2=0%, p =0.60]. (Figure 6)

Cost

Cost was reported in eight studies. On average, the total cost of robotic surgery was 3684.27 US dollars (3442.99 Euros), significantly higher than that of laparoscopic surgery [MD 3684.27, p<0.00001 (95%CI 2986.11, 4382.44), I^2 =90% p < 0.00001]. (Figure 7)

Oncological outcomes:

Distal resection margin distance

Fourteen studies reported this outcome. The mean distal resection margin distance was 6.9 cm in the robotic surgery group and 6.82 cm in the laparoscopic surgery group. The difference was not statistically significant [MD 0.16, p=0.37 (95%CI -0.19, 0.51), I^2=76% p<0.00001].

Proximal resection margin distance

Fifteen studies reported this outcome. The mean proximal resection margin distance was 4.35 cm in RG and 4.24 cm in LG. The difference was not statistically significant [MD 0.06, p=0.29 (95%CI -0.05, 0.18), I^2=0% p=0.52].

Recurrence

Eleven studies reported this outcome. The recurrence rate was 9.9% (134/1358) in the RG group and 10.6% (215/2024) in the LG group. There were no statistically significant differences [RR 0.95, p=0.61 (95% CI 0.77, 1.17), I^2=0%, p=0.91].

Number of retrieved lymph nodes

The number of retrieved lymph nodes was reported in forty-nine studies. The mean number of retrieved lymph nodes was 36.7 in the RG group and 35.61 in the LG group. The robotic surgery group had a significantly higher number of retrieved lymph nodes [MD 1.69, p=0.001 (95%CI 0.68, 2.70), I^2=93% p<0.00001]. (Figure 8)

3.4 Subgroup analysis:

Surgical outcomes:

Operative Time

Both subgroups demonstrated a significantly longer operative time in the robotic surgery group. Heterogeneity was high and statistically significant. Additionally, regarding subgroup differences, I^2=73.5% and p= 0.05. (Figure 3)

Blood Loss

There was a significantly lower blood loss in the robotic surgery group in studies with and without PSM. This difference was more evident in the PSM subgroup. There were no significant differences between groups (I^2=0%, p=0.76) and heterogeneity was similar.

Conversion

The PSM subgroup presented a stronger association between surgical approach and conversion rate, with the robotic surgery group being lower in both subgroups. However, neither subgroup had a statistically significant result (p=0.06 for studies with PSM and p=0.61 for studies without PSM). There were no significant differences between subgroups (I^2=0%, p=0.63) and no significant heterogeneity in either.

Reoperation

The subgroups showed opposite results, both without statistical significance. Inside each subgroup, heterogeneity was not significant. There were no significant differences between subgroups either (I^2=68.4%, p=0.08).

Mortality

There were no significant differences between subgroups (I^2=0%, p=0.98) and neither displayed significant heterogeneity. Both favour the laparoscopic surgery group, although these results are not statistically significant. (Figure 4)

Postoperative complications:

Length of Hospital Stay

The PSM subgroup displayed a significantly lower length of hospital stay in the robotic surgery group, whereas there was no significant difference in studies without PSM, despite both favouring the robotic surgery group. Heterogeneity in both subgroups was significantly high. Between subgroups, there were no significant differences, with I^2= 0%, p=0.84.

Time to first flatus

Both subgroups showed a significantly shorter time to first flatus in the robotic surgery group, although there was significant heterogeneity. There was a significant difference between subgroups (I^2=99.8%, p<0.00001). The PSM subgroup displayed lower heterogeneity.

Time to oral intake

The robotic surgery group had a significantly lower time to oral intake in both subgroups. Heterogeneity was significant in the non-PSM subgroup (I^2=71%, p=0.0008) There were no significant differences between subgroups (I^2=0%, p=0.32).

Overall complications

There was no significant difference in either subgroup. The PSM subgroup favoured the robotic surgery group, but p=0.06. Differences between subgroups were not statistically significant (I^2=56%, p=0.13).

Surgical complications (Grade ≥ III in the Clavien-Dindo Classification)

The PSM subgroup demonstrated a significantly lower rate of surgical complications in the robotic surgery group when compared to the laparoscopic surgery group (3.9% and 5.76%, respectively; RR = 0.66, p<0.0001). Additionally, both subgroups revealed low heterogeneity and there were no significant differences between them (I^2=0%, p=0.97). (Figure 5)

Anastomotic Leakage

In the PSM subgroup, anastomotic leakage was lower in the robotic surgery group. However, the results were not statistically significant (RR=0.73; p=0.11). In both subgroups, heterogeneity was not significant. The differences between them were statistically significant (I^2=80.8%, p=0.02), as they showed opposite results.

Pancreatic Complications

Both subgroups favoured the robotic surgery group, but the results were not statistically significant. There was no significant heterogeneity. Moreover, the two subgroups were similar (I^2=0%, p=0.64). (Figure 6)

Cost

Both subgroups significantly favoured laparoscopic surgery. Heterogeneity was high and significant in both subgroups. There were no significant differences between subgroups (I^2=4.4%, p=0.31). (Figure 7)

Oncological outcomes:

Distal and proximal resection margin distances

Regarding distal resection margin, both subgroups were similar (I^2=0%, p=0.73). In studies without PSM, there was significant heterogeneity (I^2=85%, p<0.00001). For the proximal resection margin, there were no significant differences between subgroups (I^2=23.6%, p=0.25) and neither subgroup displayed significant heterogeneity.

Recurrence

None of the subgroups showed a significant difference in recurrence rate between the two approaches, and heterogeneity was not significant. There were no significant differences between subgroups (I^2=0%, p=0.36).

Number of harvested lymph nodes

The two subgroups showed a significantly higher number of retrieved lymph nodes in the robotic surgery group. They appeared to be similar concerning subgroup differences (I^2=0%, p=1.00), and they both showed high values of heterogeneity, individually. (Figure 8)

Discussion

This meta-analysis, which, as far as we know, is the largest one on the subject so far, provides insights into the comparison of short-term outcomes between robotic and laparoscopic gastrectomies in patients with gastric cancer. *Marano L. et al.*[9] aggregated fourteen meta-analyses published until December 2019 and showed better results in favour of robotic surgery, regarding blood loss, length of hospital stay, recovery of bowel function, distal resection margin distance and number of retrieved lymph nodes. However, not all represented an acceptable level of evidence, concerning the high percentage of heterogeneity of some outcomes. Hence, it is still unclear if robotic gastrectomy is more feasible and safer than laparoscopic gastrectomy.

Our results demonstrated that both surgical techniques are similarly effective in term of conversion rate, reoperation rate, mortality, overall complications, anastomotic leakage, distal and proximal resection margin distances, and recurrence rate.

Operative time and cost favour the laparoscopic approach, while blood loss, length of hospital stay, time to first flatus, time to oral intake, surgical complications (Clavien-Dindo grade ≥ III), pancreatic complications and the number of retrieved lymph nodes favour the robotic approach.

Surgical outcomes:

- **Operative Time**

This meta-analysis shows a similar result to previous studies, which demonstrated that operative time is significantly longer in robotic gastrectomy when compared with laparoscopic gastrectomy.[9,11,12]

Some studies have suggested that the learning curve associated with the use of robotic technology and the need for instrument exchange during the procedure may contribute to the longer operative time seen in the robotic surgery group.[68]

As *Gong S. et al*.[8] refer, the majority of studies did not discriminate the several steps of the surgery, regarding the operative time. *Nishi*[40] and *Ye*[65] divided the operative time into different steps of the surgery, which demonstrated that robotic surgery is not inferior regarding the effective operative time. However, the total operative time, which includes the effective time and "junk time" (setup, docking, and adjustment of surgical instruments), remains longer in robotic surgery due to the latter.[65,69]

There were two studies demonstrating a shorter operative time in the robotic surgery group. One of them (*Omori*) with a statistically significant difference.[40,45] *Omori et al.*[45] applied relevant techniques to shorten the "junk" time, such as the standardization of the setup and the use of MBS and SPIDER techniques which reduce pancreatic manipulation during lymphadenectomy.

So, the early standardization of the setup as well as the surgical team's experience could contribute to similar results between both technical approaches.[26,40] On the other hand, there appear to be more possible factors that influence the operative time, rather than the docking time[46], such as the more accurate and delicate lymphadenectomy provided by the robotic platform.[15,45]

- **Blood Loss**

The mean blood loss was significantly lower in the robotic surgery group, compared to the laparoscopic surgery group. This result was also observed in previous systematic reviews.[9] The majority of studies included in our meta-analysis demonstrate a tendency to a lower blood loss in robotic surgery. However, there were some studies that showed the opposite and stated that robotic surgery still has some instrumental limitations.[22,55]

The reasons for the significant difference in intraoperative blood loss could be due to reduction of the physiologic tremor, increased surgical field with 3D view, which provides greater instrument dexterity and more precise and less damaging dissection. These allow for a more accurate lymphadenectomy, less blood loss, less pancreatic damage, and less muscle trauma.[65,70]

- **Conversion/ Reoperation/Mortality**

Conversion, reoperation, and mortality were found to be comparable between the two groups. There was a tendency to favour the robotic surgery group, regarding conversion and reoperation, and previous studies also presented similar results with no statistically significant difference.[8,11,12] There were four studies that demonstrated more cases of conversion to open gastrectomy in the robotic surgery group, with the following causes: intraabdominal bleeding, serosa involvement, massive abdominal adhesion, damage to adjacent organs with the insertion of trocars, inadequate surgical margins and anatomical and dissection difficulties.[20,33,47,48] Some studies reported the causes of reoperation, such as anastomotic or intra-abdominal bleeding, pancreatic complications (post-operative pancreatic fistula) and intestinal obstruction.[34,65]

The mortality rate was also found to be similar between the two groups. This holds true in this study, with the laparoscopic surgery group displaying a mortality of 0.59%, and the robotic surgery group displaying a value of 0.60%. These findings are consistent with previous studies.[9]

Perioperative outcomes:

- **Length of Hospital Stay/Time to first flatus/Time to oral intake**

The length of hospital stay, time to first flatus and time to oral intake are outcomes associated with a faster recovery as well as lower probability of intrahospital complications and better patient well-being.

This study showed significant results favouring robotic surgery, which appears to cause less damage to adjacent organs, less blood loss and fewer postoperative complications. This finding supports the intrinsic advantages of the robotic platform, resulting in less trauma and, therefore, shorter time to recovery.

The mean of length of hospital stay was 8.74 days in the robotic surgery group and 9.38 days in the laparoscopic surgery group. Similar results can be seen in *Hu LD et al.,* without significant heterogeneity.[71]

In fact, *Liu et al.* correlate the shorter hospital stay in the robotic surgery group with a better bowel function recovery and a faster shift from liquid to soft diet. Additionally, the surgical operation area and the inflammatory response can influence gastrointestinal recovery, due to surgical manipulation of internal organs.[37,65] Moreover, *Guerrini et al.* referred the importance of early oral feeding in accelerating the recuperation process.[12]

- **Overall complications**

Regarding overall complications, they did not differ considerably between both surgical approaches, despite a tendency for lower overall complications in the robotic surgery group. These results were also observed in other meta-analyses.[8,12] However, *Jin T. et al.* claimed to be the first meta-analysis to demonstrate fewer overall complications in the robotic surgery group with statistically significance.[11] Nevertheless, it remains unclear the possible cause of this observation. They still add that this could be related with the statistically significant result in pancreatic complications.[11]

Omori et al. demonstrated, by multivariate analysis, that laparoscopic surgery is an independent risk factor for postoperative complications.[45]

- **Surgical complications (Grade ≥ III in the Clavien-Dindo Classification)**

Several studies applied the Clavien-Dindo (CD) classification to highlight the most severe complications, which have the most impact in postoperative morbidity and mortality**.** In fact, *Guerrini et al.* emphasized the importance of separate medical and surgical complications, because of a direct relation between surgical complications and post operative recovery and prognosis.[12] *Tian et al.* showed that surgical complications CD grade III-IV are independent prognostic factors for both overall survival and relapse-free survival.[59]

Furthermore, *Hikage et al.* established, according to their multivariate analysis, that laparoscopic surgery is an independent risk factor for postoperative complications with a CD grade of III or higher.[22] In this article, these surgical complications were significantly lower in the robotic surgery group, with only 7% heterogeneity (p value=0.35). The rates of the surgical complications were 3.88% in the robotic surgery group and 6.39% in the laparoscopic surgery group. These observations are consistent with those of *Guerrini's* meta-analysis. However, our results presented slightly lower rates of surgical complications.[12] Hence, robotic gastrectomy results in less relevant morbidity.

- **Anastomotic Leakage**

This study did not show a statistically significant difference in anastomotic leakage, which is congruent with previous studies.[12]

- **Pancreatic complications**

Pancreatic morbidity is relatively rare. Nevertheless, it represents a real threat to the patient.[72] One of the main concerns of gastrectomy is pancreatic manipulation during lymphadenectomy.[58]

Jin T. et al. and *Gong S. et al.* showed that pancreatic complications were significantly lower in the robotic surgery group.[8,11] These results are consistent with our meta-analysis. Additionally, *Jin T. et al.* discuss the influence of the extension of lymphadenectomy on pancreatic complications as an unexpected inverse relationship between the number of harvested lymph nodes and pancreatic morbidity.[11] In fact, these results support the efficacy and efficiency of the abovementioned characteristics of the robotic surgery, which lead to minimization of the pressure on the pancreas as well as reduction on parenchymal injury.[16,58,72]

Omori et al. used the SPIDER and MBS techniques to optimize the removal of the suprapancreatic lymph nodes with an internal organ retractor, which held the pancreas, and a bipolar soft-coagulation forceps which minimizes thermal damage.[45]

- **Cost**

The cost of robotic surgery remains an important drawback to this technique. On average, the total cost of robotic surgery was 3684.27 US dollars (3442,99 Euros) significantly higher than that of laparoscopic surgery. Our meta-analysis includes 8 studies that reach the same conclusion: that the cost of the laparoscopic surgery is significantly lower, compared to that of robotic surgery.[9,12]

Some studies suggest that the fewer postoperative complications and the faster recovery and hospital stay can compensate for the higher costs associated with robotic surgery.[9,59] Moreover, other studies predict a reduction in the cost of robotic surgery over time with an increase in competition and technological improvement.[12,19,34]

Oncological outcomes:

- **Distal and proximal resection margin distances**

Our systematic review mainly includes studies on short-term outcomes. Therefore, it becomes difficult to analyse oncological variables, which demand a longer follow-up. To overcome this problem, we used distal and proximal resection margin distances as predictors for oncologic prognosis.[12]

This article did not show a significant difference in either resection margin distance, but there was a small tendency to favour the robotic approach. The mean distal resection margin distance was 6.9 cm in the robotic surgery group and 6.82 cm in the laparoscopic surgery group. Regarding the proximal resection margin distance RG had a mean of 4.35 cm and LG had a mean of 4.24 cm.

- **Recurrence**

Overall, the recurrence rate was comparable between the robotic and laparoscopic techniques (9.9% and 10.6%, respectively), although it appears to be lower in the robotic surgery group. Only one of the recent included studies analyses recurrence, particularly within 5 years after surgery, and it reported 7 cases of recurrence in 58 patients who underwent LG and 3 cases in 36 patients who underwent RG, with no locoregional recurrence in the robotic surgery group.[22] *Han et al.*[21] did not report any case of recurrence and the mean follow-up for both surgical groups were less than 2 years, when recurrence is more common.[73] In fact, recurrence rate can happen in more than half of gastric cancer patients after surgical treatment.[74,75] Furthermore, lymphovascular invasion, lymph node metastases, and tumour stage are independent risk factors of early recurrence (≤12 months) after curative resection.[76]

- **Number of harvested lymph nodes**

Lymphadenectomy is part of the standard treatment, and it is one of the main steps of the surgery, regarding the difficulty on managing and dissecting around critical organs, such as the pancreas, and an important predictor of the oncological prognosis, as they determine the extent of the tumour, according the TNM classification.

In our meta-analysis, the number of retrieved lymph nodes was significantly higher in the robotic surgery group, when compared with the laparoscopic surgery group, as demonstrated in previous meta-analysis.[8,11,12] All of these studies, including ours, showed a significant heterogeneity, which puts the external validity of their results into question.

In fact, some studies[40,59] revealed a significantly higher number of harvested lymph nodes in the robotic surgery group, particularly caused by the retrieval of the supra-pancreatic lymph nodes.[59] They attribute these results to the better surgical field, with 3D vision and endowrist movements, and the reduction of the surgeon's physiologic tremor that the robotic platform provides.[40,59] Moreover, these differences were more evident in advanced gastric cancer[59] and *Jin T. et al.* demonstrated a preference for performing robotic surgery in patients whose BMI was under 25 kg/m^2, whose age was under 65, and who had a tumour with a longest diameter above 5 cm.[11]

Several studies defined that an adequate number of retrieved lymph nodes was more than 15.[34,49-51] *Roh C. 2020.* [49] showed that there was an inadequate number of retrieved lymph nodes (<16) in the laparoscopic surgery group and the surgical success, which included this outcome, was significantly higher in the robotic surgery group. Nevertheless, it remained unclear what the real cause of these results was. This robotic surgery had a firefly system that was used for achieving a real time fluorescence image, during lymphadenectomy, to detect lymphatic drainage and optimise the dissection and retrieval of the lymph nodes with more accuracy. On the other hand, despite the good results of the SPIDER and MBS techniques in reducing pancreatic damage, *Omori et al.*[45] found that laparoscopic and robotic surgeries are comparable concerning the number of retrieved lymph nodes, as shown in a randomized control trial.[77] In opposition, another RCT described a significantly higher number of harvested lymph nodes.[78]

Subgroup Analysis

There were significant subgroup differences in the following outcomes: operative time, time to first flatus and anastomotic leakage. Regarding operative time, while both subgroups favoured robotic surgery, studies without PSM showed more pronounced differences.

The mean difference of time to first flatus was higher in the non-PSM subgroup, when compared to that of the PSM subgroup. However, the first subgroup showed higher heterogeneity. These findings demonstrated that propensity score-matching reduced both heterogeneity and difference between the robotic and laparoscopic surgery groups. The same happened in the following outcomes: conversion, time to oral intake, surgical complications (Clavien-Dindo Grade ≥III), cost, and distal resection margin distance. Therefore, this method allows for a better understanding of each comparison and a more accurate approximation of reality.

Concerning anastomotic leakage, the significant subgroup differences appear to be due to opposite results. The meta-analysis showed that, in the PSM subgroup, there is a tendency for lower anastomotic leakage when performing robotic surgery. There were other outcomes which also showed results favouring robotic surgery in the PSM subgroup, in comparison with those in the non-PSM subgroup, such as blood loss, reoperation, overall complications, proximal resection margin distance and recurrence. However, none of these outcomes demonstrated any significant difference between subgroups.

There were also outcomes where the PSM method did not reduce the heterogeneity of the included studies. In fact, there were higher values of heterogeneity in the PSM subgroup regarding operative time, length of hospital stay, overall complications, pancreatic complications and number of retrieved lymph nodes.

Additionally, length of hospital stay and surgical complications with a Clavien-Dindo Grade ≥III showed a significant difference only in the PSM subgroup.

On the one hand, PSM subgroups were more consistent and did not emphasize the differences between both surgical approaches. On the other hand, in certain outcomes, these subgroups demonstrated results that were more supportive of robotic surgery, highlighting its advantages when compared with laparoscopic surgery.

The demographic characteristics of the people that underwent propensity score-matching were not equal in every study. Therefore, it is still possible that there are variables that did not undergo PSM and are affecting the validity of the results, in terms of heterogeneity.

Limitations

The present study also has some limitations: first, we included non-randomized comparative studies; second, several outcomes demonstrated a high percentage of heterogeneity, which may put the validity of the results into question. These differences between studies could be explained by discrepancies in the surgical team's experience in performing robotic surgery; third, about half of the studies included did not perform propensity score-matching, contributing to the influence of confounding factors on the results and conclusions about the outcomes in study; fourth, there was one article which we could not access, resulting in a slight reporting bias; fifth, the majority of the included studies are from Southeast Asia (Japan, China and Korea), which may not be representative of the global reality; sixth, postoperative inflammatory reaction and drain amylase levels, which could improve the assessment of pancreatic damage, were not included.

Conclusion

In conclusion, we believe that our results demonstrate that robotic gastrectomy is a safe and feasible procedure, when compared with laparoscopic gastrectomy.

Overall, robotic surgery presented better results regarding blood loss, length of hospital stay, time to first flatus, time to oral intake, relevant surgical complications, pancreatic complications and the number of retrieved lymph nodes. However, operative time and financial cost remain the main drawbacks to its widespread use. Further studies are needed to understand mechanisms to minimize these downsides, aiming for a more efficient use of the robotic platform in gastric cancer curative-intent surgery.

Moreover, randomized clinical trials are also desired in contemplation of a better comprehension of the advantages in performing robotic gastrectomy.

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Authorship confirmation/contribution statement

Pedro Loureiro: Conceptualization (equal); Data curation (equal); Formal analysis (equal); Investigation (Lead); Validation (equal); Visualization (Lead); Writing – original draft (Lead); Writing – review & editing (equal)

José Pedro Barbosa: Data curation (equal); Formal analysis (equal); Investigation (Supporting); Resources (Lead); Supervision (Supporting); Validation (equal); Visualization (Supporting); Writing – original draft (Supporting); Writing – review & editing (equal)

José Barbosa: Conceptualization (equal); Investigation (Supporting); Supervision (Lead); Visualization (Supporting); Writing – review & editing (Supporting)

Conflicts of interest

The authors have no conflicts of interest to disclose.

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References

1. World Cancer Research Fund. Stomach cancer statistics. 2020. Available from: https://www.wcrf.org/cancer-trends/stomach-cancer-statistics/ [Last Accessed; February 20, 2023].
2. Ferlay J EM, Colombet M, et al. Global Cancer Observatory: Cancer Today. Lyon, France: International Agency for Research on Cancer. 2020. Available from: https://gco.iarc.fr/today [Last Accessed; February 20, 2023].
3. Chandra R, Balachandar N, Wang S, et al. The changing face of gastric cancer: epidemiologic trends and advances in novel therapies. Cancer Gene Ther 2021;28(5):390-399, doi:10.1038/s41417-020-00234-z
4. Thrift AP, Nguyen TH. Gastric Cancer Epidemiology. Gastrointest Endosc Clin N Am 2021;31(3):425-439, doi:10.1016/j.giec.2021.03.001
5. Wang Y, Zhang L, Yang Y, et al. Progress of Gastric Cancer Surgery in the era of Precision Medicine. Int J Biol Sci 2021;17(4):1041-1049, doi:10.7150/ijbs.56735
6. Lordick F, Carneiro F, Cascinu S, et al. Gastric cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up. Ann Oncol 2022;33(10):1005-1020, doi:10.1016/j.annonc.2022.07.004
7. Zhang CD, Yamashita H, Zhang S, et al. Reevaluation of laparoscopic versus open distal gastrectomy for early gastric cancer in Asia: A meta-analysis of randomized controlled trials. Int J Surg 2018;56(31-43, doi:10.1016/j.ijsu.2018.05.733
8. Gong S, Li X, Tian H, et al. Clinical efficacy and safety of robotic distal gastrectomy for gastric cancer: a systematic review and meta-analysis. Surg Endosc 2022;36(5):2734-2748, doi:10.1007/s00464-021-08994-x
9. Marano L, Fusario D, Savelli V, et al. Robotic versus laparoscopic gastrectomy for gastric cancer: an umbrella review of systematic reviews and meta-analyses. Updates Surg 2021;73(5):1673-1689, doi:10.1007/s13304-021-01059-7
10. Smyth EC, Nilsson M, Grabsch HI, et al. Gastric cancer. Lancet 2020;396(10251):635-648, doi:10.1016/s0140-6736(20)31288-5
11. Jin T, Liu HD, Yang K, et al. Effectiveness and safety of robotic gastrectomy versus laparoscopic gastrectomy for gastric cancer: a meta-analysis of 12,401 gastric cancer patients. Updates Surg 2022;74(1):267-281, doi:10.1007/s13304-021-01176-3
12. Guerrini GP, Esposito G, Magistri P, et al. Robotic versus laparoscopic gastrectomy for gastric cancer: The largest meta-analysis. Int J Surg 2020;82(210-228, doi:10.1016/j.ijsu.2020.07.053
13. Slim K, Nini E, Forestier D, et al. Methodological index for non-randomized studies (minors): development and validation of a new instrument. ANZ J Surg 2003;73(9):712-6, doi:10.1046/j.1445-2197.2003.02748.x
14. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol 2005;5(13, doi:10.1186/1471-2288-5-13
15. Aktas A, Aytac E, Bas M, et al. Totally minimally invasive radical gastrectomy with the da Vinci Xi((R)) robotic system versus straight laparoscopy for gastric adenocarcinoma. Int J Med Robot 2020;16(6):1-9, doi:10.1002/rcs.2146
16. Alhossaini RM, Altamran AA, Cho M, et al. Lower rate of conversion using robotic-assisted surgery compared to laparoscopy in completion total gastrectomy for remnant gastric cancer. Surg Endosc 2020;34(2):847-852, doi:10.1007/s00464-019-06838-3
17. Cianchi F, Indennitate G, Trallori G, et al. Robotic vs laparoscopic distal gastrectomy with D2 lymphadenectomy for gastric cancer: a retrospective comparative mono-institutional study. BMC Surg 2016;16(1):65, doi:10.1186/s12893-016-0180-z

18. Eom BW, Yoon HM, Ryu KW, et al. Comparison of surgical performance and short-term clinical outcomes between laparoscopic and robotic surgery in distal gastric cancer. Eur J Surg Oncol 2012;38(1):57-63, doi:10.1016/j.ejso.2011.09.006
19. Gao G, Liao H, Jiang Q, et al. Surgical and oncological outcomes of robotic- versus laparoscopic-assisted distal gastrectomy with D2 lymphadenectomy for advanced gastric cancer: a propensity score-matched analysis of 1164 patients. World J Surg Oncol 2022;20(1):315, doi:10.1186/s12957-022-02778-w
20. Gao Y, Xi H, Qiao Z, et al. Comparison of robotic- and laparoscopic-assisted gastrectomy in advanced gastric cancer: updated short- and long-term results. Surg Endosc 2019;33(2):528-534, doi:10.1007/s00464-018-6327-5
21. Han DS, Suh YS, Ahn HS, et al. Comparison of Surgical Outcomes of Robot-Assisted and Laparoscopy-Assisted Pylorus-Preserving Gastrectomy for Gastric Cancer: A Propensity Score Matching Analysis. Ann Surg Oncol 2015;22(7):2323-8, doi:10.1245/s10434-014-4204-6
22. Hikage M, Fujiya K, Kamiya S, et al. Comparisons of surgical outcomes between robotic and laparoscopic total gastrectomy in patients with clinical stage I/IIA gastric cancer. Surg Endosc 2022;36(7):5257-5266, doi:10.1007/s00464-021-08903-2
23. Hong SS, Son SY, Shin HJ, et al. Can Robotic Gastrectomy Surpass Laparoscopic Gastrectomy by Acquiring Long-Term Experience? A Propensity Score Analysis of a 7-Year Experience at a Single Institution. J Gastric Cancer 2016;16(4):240-246, doi:10.5230/jgc.2016.16.4.240
24. Huang KH, Lan YT, Fang WL, et al. Comparison of the operative outcomes and learning curves between laparoscopic and robotic gastrectomy for gastric cancer. PLoS One 2014;9(10):e111499, doi:10.1371/journal.pone.0111499
25. Hyun MH, Lee CH, Kwon YJ, et al. Robot versus laparoscopic gastrectomy for cancer by an experienced surgeon: comparisons of surgery, complications, and surgical stress. Ann Surg Oncol 2013;20(4):1258-65, doi:10.1245/s10434-012-2679-6
26. Isobe T, Murakami N, Minami T, et al. Robotic versus laparoscopic distal gastrectomy in patients with gastric cancer: a propensity score-matched analysis. BMC Surg 2021;21(1):203, doi:10.1186/s12893-021-01212-4
27. Junfeng Z, Yan S, Bo T, et al. Robotic gastrectomy versus laparoscopic gastrectomy for gastric cancer: comparison of surgical performance and short-term outcomes. Surg Endosc 2014;28(6):1779-87, doi:10.1007/s00464-013-3385-6
28. Kang BH, Xuan Y, Hur H, et al. Comparison of Surgical Outcomes between Robotic and Laparoscopic Gastrectomy for Gastric Cancer: The Learning Curve of Robotic Surgery. J Gastric Cancer 2012;12(3):156-63, doi:10.5230/jgc.2012.12.3.156
29. Kim HI, Han SU, Yang HK, et al. Multicenter Prospective Comparative Study of Robotic Versus Laparoscopic Gastrectomy for Gastric Adenocarcinoma. Ann Surg 2016;263(1):103-9, doi:10.1097/sla.0000000000001249
30. Kim HI, Park MS, Song KJ, et al. Rapid and safe learning of robotic gastrectomy for gastric cancer: multidimensional analysis in a comparison with laparoscopic gastrectomy. Eur J Surg Oncol 2014;40(10):1346-54, doi:10.1016/j.ejso.2013.09.011
31. Kim KM, An JY, Kim HI, et al. Major early complications following open, laparoscopic and robotic gastrectomy. Br J Surg 2012;99(12):1681-7, doi:10.1002/bjs.8924
32. Kim MC, Heo GU, Jung GJ. Robotic gastrectomy for gastric cancer: surgical techniques and clinical merits. Surg Endosc 2010;24(3):610-5, doi:10.1007/s00464-009-0618-9
33. Kim YW, Reim D, Park JY, et al. Role of robot-assisted distal gastrectomy compared to laparoscopy-assisted distal gastrectomy in suprapancreatic nodal dissection for gastric cancer. Surg Endosc 2016;30(4):1547-52, doi:10.1007/s00464-015-4372-x
34. Kong Y, Cao S, Liu X, et al. Short-Term Clinical Outcomes After Laparoscopic and Robotic Gastrectomy for Gastric Cancer: a Propensity Score Matching Analysis. J Gastrointest Surg 2020;24(3):531-539, doi:10.1007/s11605-019-04158-4

35. Lee J, Kim YM, Woo Y, et al. Robotic distal subtotal gastrectomy with D2 lymphadenectomy for gastric cancer patients with high body mass index: comparison with conventional laparoscopic distal subtotal gastrectomy with D2 lymphadenectomy. Surg Endosc 2015;29(11):3251-60, doi:10.1007/s00464-015-4069-1
36. Li Z, Li J, Li B, et al. Robotic versus laparoscopic gastrectomy with D2 lymph node dissection for advanced gastric cancer: a propensity score-matched analysis. Cancer Manag Res 2018;10(705-714, doi:10.2147/cmar.S161007
37. Liu HB, Wang WJ, Li HT, et al. Robotic versus conventional laparoscopic gastrectomy for gastric cancer: A retrospective cohort study. Int J Surg 2018;55(15-23, doi:10.1016/j.ijsu.2018.05.015
38. Lu J, Zheng HL, Li P, et al. A Propensity Score-Matched Comparison of Robotic Versus Laparoscopic Gastrectomy for Gastric Cancer: Oncological, Cost, and Surgical Stress Analysis. J Gastrointest Surg 2018;22(7):1152-1162, doi:10.1007/s11605-018-3785-y
39. Nakauchi M, Suda K, Susumu S, et al. Comparison of the long-term outcomes of robotic radical gastrectomy for gastric cancer and conventional laparoscopic approach: a single institutional retrospective cohort study. Surg Endosc 2016;30(12):5444-5452, doi:10.1007/s00464-016-4904-z
40. Nishi M, Shimada M, Yoshikawa K, et al. Propensity Score-Matched Analysis of the Short- and Long-Term Outcomes of Robotic Versus Laparoscopic Gastrectomy for Gastric Cancer. Ann Surg Oncol 2022;29(6):3887-3895, doi:10.1245/s10434-021-11203-7
41. Noshiro H, Ikeda O, Urata M. Robotically-enhanced surgical anatomy enables surgeons to perform distal gastrectomy for gastric cancer using electric cautery devices alone. Surg Endosc 2014;28(4):1180-7, doi:10.1007/s00464-013-3304-x
42. Obama K, Kim YM, Kang DR, et al. Long-term oncologic outcomes of robotic gastrectomy for gastric cancer compared with laparoscopic gastrectomy. Gastric Cancer 2018;21(2):285-295, doi:10.1007/s10120-017-0740-7
43. Okabe H, Sunagawa H, Saji M, et al. Comparison of short-term outcomes between robotic and laparoscopic gastrectomy for gastric cancer: a propensity score-matching analysis. J Robot Surg 2021;15(5):803-811, doi:10.1007/s11701-020-01182-4
44. Okumura N, Son T, Kim YM, et al. Robotic gastrectomy for elderly gastric cancer patients: comparisons with robotic gastrectomy in younger patients and laparoscopic gastrectomy in the elderly. Gastric Cancer 2016;19(4):1125-1134, doi:10.1007/s10120-015-0560-6
45. Omori T, Yamamoto K, Hara H, et al. Comparison of robotic gastrectomy and laparoscopic gastrectomy for gastric cancer: a propensity score-matched analysis. Surg Endosc 2022;36(8):6223-6234, doi:10.1007/s00464-022-09125-w
46. Parisi A, Reim D, Borghi F, et al. Minimally invasive surgery for gastric cancer: A comparison between robotic, laparoscopic and open surgery. World J Gastroenterol 2017;23(13):2376-2384, doi:10.3748/wjg.v23.i13.2376
47. Park JY, Ryu KW, Reim D, et al. Robot-assisted gastrectomy for early gastric cancer: is it beneficial in viscerally obese patients compared to laparoscopic gastrectomy? World J Surg 2015;39(7):1789-97, doi:10.1007/s00268-015-2998-4
48. Pugliese R, Maggioni D, Sansonna F, et al. Subtotal gastrectomy with D2 dissection by minimally invasive surgery for distal adenocarcinoma of the stomach: results and 5-year survival. Surg Endosc 2010;24(10):2594-602, doi:10.1007/s00464-010-1014-1
49. Roh CK, Choi S, Seo WJ, et al. Comparison of surgical outcomes between integrated robotic and conventional laparoscopic surgery for distal gastrectomy: a propensity score matching analysis. Sci Rep 2020;10(1):485, doi:10.1038/s41598-020-57413-z
50. Roh CK, Lee S, Son SY, et al. Textbook outcome and survival of robotic versus laparoscopic total gastrectomy for gastric cancer: a propensity score matched cohort study. Sci Rep 2021;11(1):15394, doi:10.1038/s41598-021-95017-3

51. Ryan S, Tameron A, Murphy A, et al. Robotic Versus Laparoscopic Gastrectomy for Gastric Adenocarcinoma: Propensity-Matched Analysis. Surg Innov 2020;27(1):26-31, doi:10.1177/1553350619868113
52. Seo HS, Shim JH, Jeon HM, et al. Postoperative pancreatic fistula after robot distal gastrectomy. J Surg Res 2015;194(2):361-366, doi:10.1016/j.jss.2014.10.022
53. Shen W, Xi H, Wei B, et al. Robotic versus laparoscopic gastrectomy for gastric cancer: comparison of short-term surgical outcomes. Surg Endosc 2016;30(2):574-580, doi:10.1007/s00464-015-4241-7
54. Shibasaki S, Suda K, Nakauchi M, et al. Non-robotic minimally invasive gastrectomy as an independent risk factor for postoperative intra-abdominal infectious complications: A single-center, retrospective and propensity score-matched analysis. World J Gastroenterol 2020;26(11):1172-1184, doi:10.3748/wjg.v26.i11.1172
55. Son S-Y, LEE C-M, Ahn S-H, et al. Clinical outcome of robotic gastrectomy in gastric cancer in comparison with laparoscopic gastrectomy: a case-control study. Journal of Minimally Invasive Surgery 2012;27-31
56. Son T, Lee JH, Kim YM, et al. Robotic spleen-preserving total gastrectomy for gastric cancer: comparison with conventional laparoscopic procedure. Surg Endosc 2014;28(9):2606-15, doi:10.1007/s00464-014-3511-0
57. Song J, Kang WH, Oh SJ, et al. Role of robotic gastrectomy using da Vinci system compared with laparoscopic gastrectomy: initial experience of 20 consecutive cases. Surg Endosc 2009;23(6):1204-11, doi:10.1007/s00464-009-0351-4
58. Suda K, Man IM, Ishida Y, et al. Potential advantages of robotic radical gastrectomy for gastric adenocarcinoma in comparison with conventional laparoscopic approach: a single institutional retrospective comparative cohort study. Surg Endosc 2015;29(3):673-85, doi:10.1007/s00464-014-3718-0
59. Tian Y, Cao S, Kong Y, et al. Short- and long-term comparison of robotic and laparoscopic gastrectomy for gastric cancer by the same surgical team: a propensity score matching analysis. Surg Endosc 2022;36(1):185-195, doi:10.1007/s00464-020-08253-5
60. Uyama I, Kanaya S, Ishida Y, et al. Novel integrated robotic approach for suprapancreatic D2 nodal dissection for treating gastric cancer: technique and initial experience. World J Surg 2012;36(2):331-7, doi:10.1007/s00268-011-1352-8
61. Wang WJ, Li HT, Yu JP, et al. Severity and incidence of complications assessed by the Clavien-Dindo classification following robotic and laparoscopic gastrectomy for advanced gastric cancer: a retrospective and propensity score-matched study. Surg Endosc 2019;33(10):3341-3354, doi:10.1007/s00464-018-06624-7
62. Woo Y, Hyung WJ, Pak KH, et al. Robotic gastrectomy as an oncologically sound alternative to laparoscopic resections for the treatment of early-stage gastric cancers. Arch Surg 2011;146(9):1086-92, doi:10.1001/archsurg.2011.114
63. Yang C, Shi Y, Xie S, et al. Short-term outcomes of robotic- versus laparoscopic-assisted Total Gastrectomy for advanced gastric Cancer: a propensity score matching study. BMC Cancer 2020;20(1):669, doi:10.1186/s12885-020-07160-1
64. Yang SY, Roh KH, Kim YN, et al. Surgical Outcomes After Open, Laparoscopic, and Robotic Gastrectomy for Gastric Cancer. Ann Surg Oncol 2017;24(7):1770-1777, doi:10.1245/s10434-017-5851-1
65. Ye SP, Shi J, Liu DN, et al. Robotic- versus laparoscopic-assisted distal gastrectomy with D2 lymphadenectomy for advanced gastric cancer based on propensity score matching: short-term outcomes at a high-capacity center. Sci Rep 2020;10(1):6502, doi:10.1038/s41598-020-63616-1
66. Yoon HM, Kim YW, Lee JH, et al. Robot-assisted total gastrectomy is comparable with laparoscopically assisted total gastrectomy for early gastric cancer. Surg Endosc 2012;26(5):1377-81, doi:10.1007/s00464-011-2043-0

67. Zheng-Yan L, Yong-Liang Z, Feng Q, et al. Morbidity and short-term surgical outcomes of robotic versus laparoscopic distal gastrectomy for gastric cancer: a large cohort study. Surg Endosc 2021;35(7):3572-3583, doi:10.1007/s00464-020-07820-0
68. Kim MS, Kim WJ, Hyung WJ, et al. Comprehensive Learning Curve of Robotic Surgery: Discovery From a Multicenter Prospective Trial of Robotic Gastrectomy. Ann Surg 2021;273(5):949-956, doi:10.1097/sla.0000000000003583
69. Liu H, Kinoshita T, Tonouchi A, et al. What are the reasons for a longer operative time in robotic gastrectomy than in laparoscopic gastrectomy for stomach cancer? Surg Endosc 2019;33(1):192-198, doi:10.1007/s00464-018-6294-x
70. Ye SP, Shi J, Liu DN, et al. Robotic-assisted versus conventional laparoscopic-assisted total gastrectomy with D2 lymphadenectomy for advanced gastric cancer: short-term outcomes at a mono-institution. BMC Surg 2019;19(1):86, doi:10.1186/s12893-019-0549-x
71. Hu LD, Li XF, Wang XY, et al. Robotic versus Laparoscopic Gastrectomy for Gastric Carcinoma: a Meta-Analysis of Efficacy and Safety. Asian Pac J Cancer Prev 2016;17(9):4327-4333
72. van Boxel GI, Ruurda JP, van Hillegersberg R. Robotic-assisted gastrectomy for gastric cancer: a European perspective. Gastric Cancer 2019;22(5):909-919, doi:10.1007/s10120-019-00979-z
73. Kang WM, Meng QB, Yu JC, et al. Factors associated with early recurrence after curative surgery for gastric cancer. World J Gastroenterol 2015;21(19):5934-40, doi:10.3748/wjg.v21.i19.5934
74. D'Angelica M, Gonen M, Brennan MF, et al. Patterns of initial recurrence in completely resected gastric adenocarcinoma. Ann Surg 2004;240(5):808-16, doi:10.1097/01.sla.0000143245.28656.15
75. Spolverato G, Capelli G, Mari V, et al. Very Early Recurrence After Curative-Intent Surgery for Gastric Adenocarcinoma. Ann Surg Oncol 2022;29(13):8653-8661, doi:10.1245/s10434-022-12434-y
76. Xu J, Shen L, Shui Y, et al. Patterns of recurrence after curative D2 resection for gastric cancer: Implications for postoperative radiotherapy. Cancer Med 2020;9(13):4724-4735, doi:10.1002/cam4.3085
77. Ojima T, Nakamura M, Hayata K, et al. Short-term Outcomes of Robotic Gastrectomy vs Laparoscopic Gastrectomy for Patients With Gastric Cancer: A Randomized Clinical Trial. JAMA Surg 2021;156(10):954-963, doi:10.1001/jamasurg.2021.3182
78. Lu J, Zheng CH, Xu BB, et al. Assessment of Robotic Versus Laparoscopic Distal Gastrectomy for Gastric Cancer: A Randomized Controlled Trial. Ann Surg 2021;273(5):858-867, doi:10.1097/sla.0000000000004466

Tables

Table 1:Summary of studies included in the Meta-analysis

No.	Author	Region	Year	Study period	Study design	Sample size RG	LG	Surgical extension	Level of LND	Reconstruction	MINORS
1	Aktas et al. 2020	Turkey	2020	2013-2018	OCS (P)	30	64	D, P, T, EJG	D2	RY	21
2	Alhoassaini et al. 2020	Korea	2019	2005–2017	OCS (R)	25	30	T	NA	BI, BII	23
3	Cianchi et al. 2016	Italy	2016	2008–2015	OCS (P)	30	41	D	D1+a/b, D2	BII, RY	21
4	Eom et al. 2012	Korea	2011	2009–2010	OCS (P)	30	62	D	D1+b, D2	BII	22
5	Gao, G. et al. 2022	China	2022	2015-2021	OCS (R)	441	723	D	D2	BI, BII, RY	21
6	Gao, Y. et al. 2019	China	2018	2011–2014	OCS (P)	163	339	D, P, T	D1+, D2	BI, BII, RY	21
7	Han et al. 2015	Korea	2015	2008–2013	OCS (R)	68	68	PPG	D1 + b	GG	23
8	Hikage et al. 2022	Japan	2022	2013-2020	OCS (P)	36	58	T	D1 +, D2	EJJ	21
9	Hong et al. 2016	Korea	2016	2008–2015	OCS (P)	232	232	D	D1+a/b, D2	BI, BII, RY	22
10	Huang et al. 2014	Taiwan	2014	2008–2014	OCS (P)	72	73	D, T	D1+a/b, D2	BI, RY	22
11	Hyun et al. 2013	Korea	2013	2009–2010	OCS (P)	38	83	D, T	D1+a/b, D2	BI, BII, RY	22
12	Isobe et al. 2021	Japan	2021	2018-2020	OCS (R)	69	88	D	D1, D1+, D2	BI, BII, RY	21
13	Junfeng et al. 2014	China	2014	2010–2013	OCS (R)	120	394	D, P, T	D1, D2	BI, BII, RY	23
14	Kang et al. 2012	Korea	2012	2008–2011	OCS (P)	100	282	D, T	D1+a/b, D2	BI, BII, RY	22
15	Kim, H.I. et al. 2016	Korea	2013	2003–2009	OCS (P)	172	481	D, T	D1+a/b, D2	BI, BII	22
16	Kim, H.I. et al. 2014	Korea	2016	2011–2012	OCS (P)	185	185	D, T	D1+a/b, D2	BI, BII, RY	23
17	Kim, K.M. et al. 2012	Korea	2012	2005–2010	OCS (P)	436	861	D, T	D1+a/b, D2	BI, BII, RY	23
18	Kim, M.C. et al. 2010	Korea	2010	2007–2008	OCS (P)	16	11	D	D1 + b, D2	BI, BII	22
19	Kim, Y.W. et al. 2016	Korea	2015	2009–2001	OCS (P)	87	288	D	D1, D2	NA	20
20	Kong et al. 2020	China	2020	2014-2017	OCS (R)	294	750	D, P, T	D2, D2+	BI, BII, RY	21
21	Lee et al. 2015	Korea	2015	2003–2010	OCS (P)	133	267	D	D2	BI, BII, RY	21
22	Liu et al. 2018	China	2018	2017–2017	OCS (R)	100	135	D, T	D1+a/b, D2	BII, RY	21
23	Li et al. 2018	China	2018	2013–2017	OCS (P)	112	112	D, T	D2	BI, BII, RY	23
24	Lu et al. 2018	China	2018	2016–2017	OCS (P)	101	303	D, T	D1 +, D2	BI, BII, RY	20
25	Nakauchi et al. 2016	Japan	2016	2009–2012	OCS (R)	84	437	D, T	D1+a/b, D2	BI, BII, RY	23
26	Nishi et al. 2022	Japan	2022	2005-2020	OCS (R)	83	368	D, P, T, PPG	D1, D2	BI, RY	21
27	Noshiro et al. 2014	Japan	2014	2010–2012	OCS (P)	21	160	D	D1+a/b, D2	BI, BII, RY	22
28	Obama et al. 2018	Korea	2017	2005–2009	OCS (P)	315	525	D, T	D1+a/b, D2	BI, BII, RY	23
29	Okabe et al. 2021	Japan	2021	2012-2020	OCS (P)	110	256	D, P, T	D1 +, D2	BI, RY	22
30	Okumura et al. 2016	Japan	2016	2003–2010	OCS (P)	370	132	D, T	D1+a/b, D2	BI, BII, RY	22
31	Omori et al. 2022	Japan	2022	2014-2019	OCS (P)	210	979	D, P, T, EJG	D1 +, D2	BI	22
32	Parisi et al. 2017	Italy	2017	2015–2016	OCS (P)	151	151	D, T	D2	BI, BII, RY	21
33	Park et al. 2015	Korea	2015	2009–2011	OCS (P)	145	612	D, T	D1 + a/b	BI, BII, RY	19
34	Pugliese et al. 2010	Italy	2010	2000–2009	OCS (R)	16	48	D	D2	RY	21
35	Roh, C.K. et al. 2020	Korea	2020	2015-2017	OCS (R)	56	152	D	D1 +	BI, BII	21
36	Roh, C.K. et al. 2021	Korea	2021	2009-2018	OCS (P)	74	321	T	D1 +, D2	RY	22
37	Ryan et al. 2020	USA	2020	2010-2014	OCS (P)	631	1262	T, ST	NA	NA	22
38	Seo et al. 2015	Korea	2014	2004–2009	OCS (P)	40	40	D	D1+b, D2	BI, BII, RY	20
39	Shen et al. 2016	China	2016	2011–2014	OCS (R)	93	330	D, T	D1+a/b, D2	BI, BII, RY	21
40	Shibasaki et al 2020	Japan	2020	2009–2019	OCS (P)	359	1042	D, P, T	D1+, D2	BI, BII, RY	22
41	Song et al. 2009	Korea	2008	2005–2006	OCS (P)	20	20	D	D1+a/b, D2	BI	21
42	Son, S-Y. et al. 2012	Korea	2012	2007–2011	OCS (R)	21	42	D, P, T	D1 + b, D2	BI, BII, RY	19
43	Son, T. et al. 2014	Korea	2014	2003–2010	OCS (P)	51	58	T	D2	RY	22
44	Suda et al. 2015	Japan	2015	2009–2012	OCS (R)	88	438	D, T	D1+a/b, D2	BI, BII, RY	22
45	Tian et al 2022	China	2022	2014-2019	OCS (P)	463	877	T, ST	D1 +, D2	BI, BII, RY	22
46	Uyama et al. 2012	Japan	2012	2009–2010	OCS (P)	25	225	D	D2	BI	21
47	Wang et al. 2019	China	2018	2016–2018	OCS (P)	223	223	D, T	D2	BII, RY	23
48	Woo et al. 2011	Japan	2011	2005–2009	OCS (P)	236	591	D, T	D1+a/b, D2	BI, BII, RY	23
49	Yang, S.Y. et al. 2017	Korea	2017	2009–2015	OCS (P)	173	511	D, T	D1+a/b, D2	BI, BII, RY	21
50	Yang, C. et al. 2020	China	2020	2010-2017	OCS (P)	126	257	T	D2	RY	22
51	Ye et al. 2020	China	2020	2014-2019	OCS (R)	325	358	D	D2	BI, BII, RY	21
52	Yoon et al 2012	Korea	2011	2009–2011	OCS (R)	36	65	T	D1+a/b, D2	BI, BII	23
53	Zheng-Yan et al. 2021	China	2020	2010-2019	OCS (P)	519	957	D	D1, D2	BI, BII, RY	22

RG: Robotic Gastrectomy; LG: Laparoscopic Gastrectomy; LND: Lymphadenectomy; MINORS: Methodological Index for Non-Randomized Studies; OCS: Observational Clinical Study; P: prospectively collected data; R: retrospectively collected data; D: Distal; P: Proximal; T: Total; EGJ: Esophagogastric Junction; PPG: Pylorus-preserving Gastrectomy; ST: Sub-Total; BI: Billroth I; BII: Billroth II; RY: Roux-en-Y; GG: GG: gastro-gastro anastomosis; EJJ: Esophagojejunostomy; NA: Not Available

Table 2:Patients' characteristics.

No.	Author	Year	Age (RG)		Age (LG)		Sex (RG)			Sex (LG)		
			Mean	Sd	Mean	Sd	M	F	Pt	M	F	Pt
1	Aktas et al. 2020	2020	55	8	59	10,5	18	12	30	41	23	64
2	Alhoassaini et al. 2020	2019	54	15	60	15	17	8	25	22	8	30
3	Cianchi et al. 2016	2016	73	10,25	74	11,75	14	16	30	19	22	41
4	Eom et al. 2012	2011	52	11,5	57	11	21	9	30	41	21	62
5	Gao, G. et al. 2022	2022	60	11	60	11	284	126	410	301	109	410
6	Gao, Y. et al. 2019	2018	60	10	59	11	121	42	163	201	138	339
7	Han et al. 2015	2015	50	8	49	11	31	37	68	32	36	68
8	Hikage et al. 2022	2022	72	10,25	71	12,5	26	10	36	46	12	58
9	Hong et al. 2016	2016	53	11	55	13	154	78	232	156	76	232
10	Huang et al. 2014	2014	67	15	66	13	40	32	72	42	31	73
11	Hyun et al. 2013	2013	54	12	60	12	25	13	38	55	28	83
12	Isobe et al. 2021	2021	70	1	70	1	31	19	50	34	16	50
13	Junfeng et al. 2014	2014	54	10	55	11	90	30	120	276	118	394
14	Kang et al. 2012	2012	53	12	58	12	63	37	100	191	91	282
15	Kim, H.I. et al. 2016	2013	55	13	61	11	103	69	172	294	187	481
16	Kim, H.I. et al. 2014	2016	53	11	56	11	113	72	185	113	72	185
17	Kim, K.M. et al. 2012	2012	54	12	58	12	265	171	436	550	311	861
18	Kim, M.C. et al. 2010	2010	53	15	57	13	10	6	16	10	1	11
19	Kim, Y.W. et al. 2016	2015	54	12	60	11	46	41	87	170	118	288
20	Kong et al. 2020	2020	58	11	59	10	197	69	266	383	149	532
21	Lee et al. 2015	2015	53	13	59	11	85	48	133	154	113	267
22	Liu et al. 2018	2018	58	2,83	58	2,5	79	21	100	101	34	135
23	Li et al. 2018	2018	55	11	56	11	78	34	112	79	33	112
24	Lu et al. 2018	2018	NA	NA	NA	NA	73	28	101	212	91	303
25	Nakauchi et al. 2016	2016	64	8,67	68	9	48	36	84	307	130	437
26	Nishi et al. 2022	2022	67	12	67	11	62	21	83	243	125	368
27	Noshiro et al. 2014	2014	66	10	69	12	14	7	21	102	58	160
28	Obama et al. 2018	2017	54	12	59	11	189	126	315	327	198	525
29	Okabe et al. 2021	2021	69	8	70	7,83	62	31	93	57	36	93
30	Okumura et al. 2016	2016	NA	NA	NA	NA	227	143	370	83	49	132
31	Omori et al. 2022	2022	66	1	66	1	152	58	210	153	57	210
32	Parisi et al. 2017	2017	68	12	65	14	70	81	151	66	85	151
33	Park et al. 2015	2015	54	11	58	11	75	70	145	369	243	612
34	Pugliese et al. 2010	2010	NA	NA	NA	NA	NA	NA	16	NA	NA	48
35	Roh, C.K. et al 2020	2020	58	11	58	11	27	24	51	27	24	51
36	Roh, C.K. et al 2021	2021	54	12	55	13	42	32	74	42	32	74
37	Ryan et al. 2020	2020	65	12	65	12	449	182	631	906	356	1262
38	Seo et al 2015	2014	51	4	55	5	19	21	40	20	20	40
39	Shen et al 2016	2016	56	10	57	11	75	18	93	249	81	330
40	Shibasaki et al 2020	2020	67	9,83	70	5	233	126	359	740	302	1042
41	Song et al. 2009	2008	51	12	55	5	8	12	20	13	7	20
42	Son, S-Y. et al. 2012	2012	52	13	52	13	14	7	21	26	16	42
43	Son, T. et al. 2014	2014	55	12	58	12	23	28	51	36	22	58
44	Suda et al. 2015	2015	68	9	64	11,5	51	37	88	307	131	438
45	Tian et al 2022	2022	59	11	60	10	330	126	456	310	146	456
46	Uyama et al. 2012	2012	61	11	62	9	14	11	25	156	69	225
47	Wang et al. 2019	2018	57	10	57	11	183	40	223	180	43	223
48	Woo et al. 2011	2011	54	12	58	11	136	100	236	364	227	591
49	Yang, S.Y. et al. 2017	2017	NA	NA	NA	NA	98	75	173	335	176	511
50	Yang, C. et al. 2020	2020	60	9	61	9	105	21	126	100	26	126
51	Ye et al. 2020	2020	57	8	57	9	189	96	285	186	99	285
52	Yoon et al 2012	2011	53	11	56	12	18	18	36	31	34	65
53	Zheng-Yan et al. 2021	2020	55	10	55	12	354	162	516	333	184	516

RG: Robotic Gastrectomy; LG: Laparoscopic Gastrectomy; SD: Standard Deviation; M: Male; F: Female; Pt: Patients; NA: Not Available

Figures

PRISMA 2009 Flow Diagram

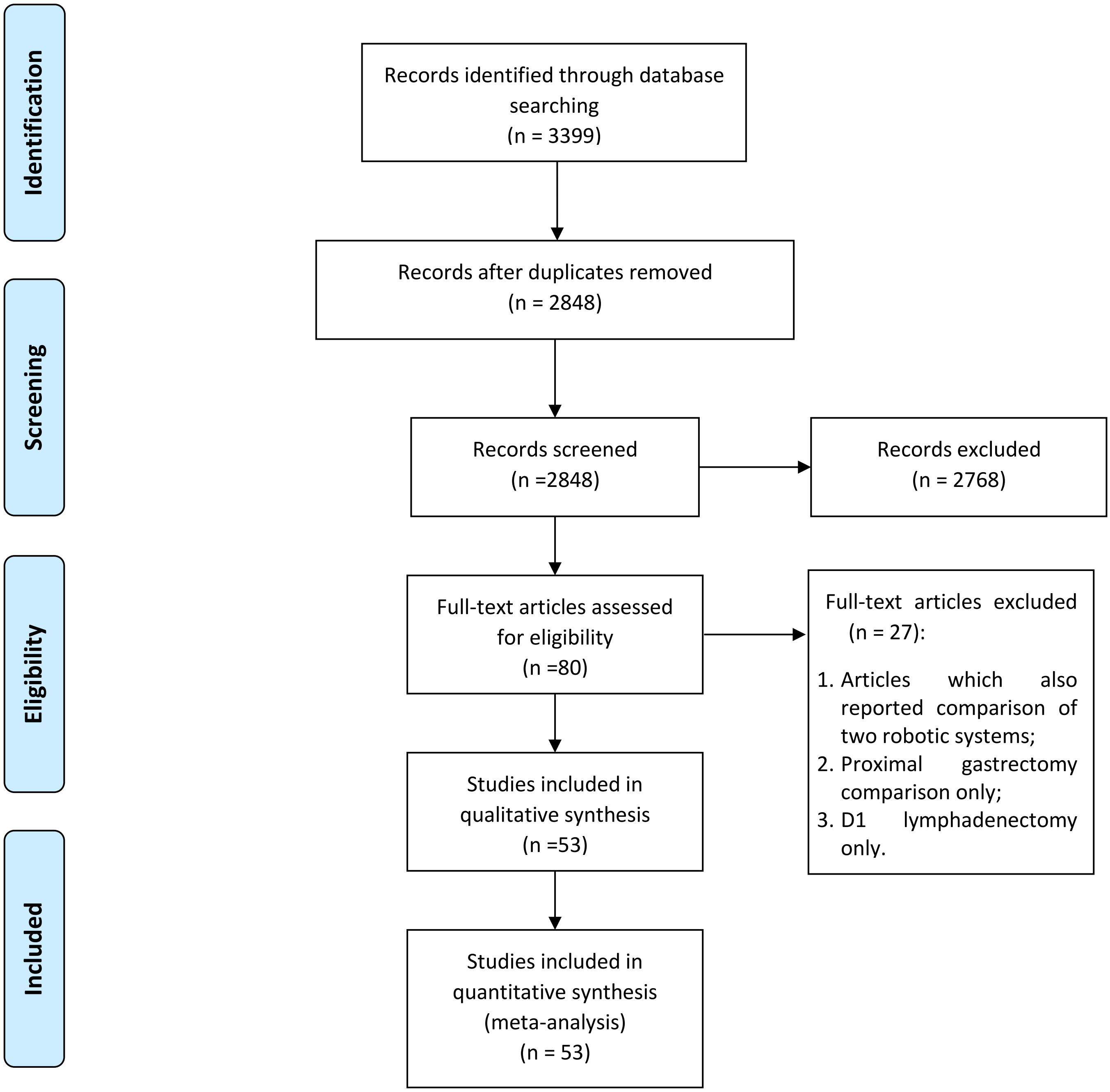


Figure 1: Flow Diagram according to the PRISMA Guidelines

Outcomes	No. of studies	No. patients		Overall effect size (MD1/RR)	95% CI of overall effect	P value	Heterogeneity (I^2, P)
		RG	LG				
Surgical Outcomes:							
Operative Time	50	6950	11651	41.19	33.47, 48.92	p< 0.00001	I^2= 98%, p< 0.00001
Blood Loss	46	6734	11856	-19.43	-25.23, -13.62	p< 0.00001	I^2= 92%, p< 0.00001
Conversion	33	4390	7730	0.68	0.43, 1.07	p= 0.09	I^2= 0%, p= 0.50
Reoperation	18	2677	4366	0.89	0.59, 1.34	p= 0.57	I^2= 0%, p= 0.72
Mortality	39	6708	10776	1.20	0.81, 1.77	p= 0.37	I^2= 0%, p= 0.98
Perioperative Outcomes:							
Length of Hospital Stay	52	7621	12953	-0,50	-0,79, -0,21	p= 0.0007	I^2= 85%, p< 0.00001
Time to First Flatus	25	4002	5623	-0,52	-0.55, -0.50	p< 0.00001	I^2= 98%, p< 0.00001
Time to Oral Intake	27	4602	6296	-0,17	-0.25, -0.08	p= 0.0001	I^2= 53%, p= 0.0008
Overall complications	51	6732	11469	0.93	0.85, 1.03	p= 0.15	I^2= 18%, p= 0.14
Surgical complications	31	5464	7303	0.68	0.57, 0.82	p< 0.0001	I^2= 7%, p= 0.35
Anastomotic leakage	33	5289	8721	1.06	0.78, 1.45	p= 0.71	I^2= 16%, p= 0.21
Pancreatic comp.	21	3445	5497	0.51	0.31, 0.83	p= 0.007	I^2= 0%, p= 0.60
Cost	8	1683	2184	3684.27	2986.11, 4382.44	p< 0.00001	I^2= 90%, p< 0.00001
Oncological Outcomes:							
Distal Resection MD2	14	2184	3973	0.16	-0.19, 0.51	p= 0.37	I^2= 76% p< 0.00001
Proximal Resection MD2	15	2235	4031	0.06	-0.05, 0.18	p= 0.29	I^2= 0%, p= 0.52
Recurrence	11	1358	2024	0.95	0.77, 1.17	p= 0.61	I^2= 0%, p= 0.91
No. retrieved lymph nodes	49	7292	11622	1.69	0.68, 2.70	p= 0.001	I^2= 93% p< 0.00001

Figure 2: Results of the Meta-Analysis: RG. Robotic Gastrectomy; LG: Laparoscopic Gastrectomy; MD1: Mean Difference; RR: Risk Ratio; CI: Confidence Interval; comp.: complications; MD2: Margin Distance

Study or Subgroup	Weight	Mean Difference IV, Random, 95% CI
1.1.1 With PSM		
GAO 2022	2.2%	19.90 [14.02, 25.78]
GAO Y 2019	2.1%	17.29 [3.32, 31.26]
HAN 2015	2.2%	64.40 [52.56, 76.24]
HONG 2016	2.2%	23.70 [15.26, 32.14]
ISOBE 2021	1.9%	79.60 [55.70, 103.50]
KONG 2020	2.2%	19.15 [10.32, 27.98]
LI Z 2018	2.1%	33.90 [19.34, 48.46]
LU 2018	2.2%	44.80 [35.78, 53.82]
NISHI 2022	1.8%	-0.12 [-25.42, 25.18]
OBAMA K 2018	2.2%	69.00 [62.16, 75.84]
OKABE 2021	1.8%	1.00 [-23.79, 25.79]
OMORI 2022	2.3%	-23.00 [-26.19, -19.81]
PARISI 2017	2.0%	145.07 [125.54, 164.60]
ROH 2020	2.1%	27.80 [13.28, 42.32]
ROH 2021	2.1%	32.80 [16.01, 49.59]
SHIBASAKI 2020	2.0%	13.00 [-6.10, 32.10]
TIAN 2022	2.2%	19.91 [14.30, 25.52]
WANG WJ 2019	2.2%	3.90 [-2.73, 10.53]
YANG 2020	2.1%	20.80 [7.02, 34.58]
YE 2020	2.3%	39.00 [37.26, 40.74]
ZHENG-YAN 2020	2.2%	26.20 [20.21, 32.19]
Subtotal (95% CI)	**44.5%**	**32.01 [18.89, 45.13]**
Heterogeneity: Tau² = 891.01; Chi² = 1557.01, df = 20 (P < 0.00001); I² = 99%		
Test for overall effect: Z = 4.78 (P < 0.00001)		
1.1.2 Without PSM		
AKTAS 2020	1.4%	150.00 [109.48, 190.52]
ALHOASSAINI 2020	1.6%	67.00 [32.07, 101.93]
CIANCHI 2016	2.2%	50.00 [43.80, 56.20]
EOM 2012	2.1%	39.70 [24.05, 55.35]
HIKAGE 2022	1.1%	36.50 [-14.46, 87.46]
HUANG 2014	1.5%	38.10 [2.04, 74.16]
HYUN 2013	2.0%	14.40 [-5.67, 34.47]
JUNFENG 2014	2.2%	13.50 [4.72, 22.28]
KANG 2012	2.2%	28.60 [16.73, 40.47]
KIM HI 2014	2.2%	39.30 [31.74, 46.86]
KIM HI 2016	2.1%	43.00 [28.77, 57.23]
KIM KM 2012	2.2%	50.00 [43.41, 56.59]
KIM MC 2010	1.7%	55.30 [26.56, 84.04]
KIM YW 2016	2.2%	18.40 [7.79, 29.01]
LEE 2015	2.2%	46.50 [37.51, 55.49]
LIU 2018	2.3%	5.00 [2.99, 7.01]
NAKAUCHI 2016	1.8%	17.00 [-8.28, 42.28]
NOSHIRO 2014	1.4%	124.00 [84.66, 163.34]
PARK 2015	2.1%	66.00 [51.80, 80.20]
PUGLIESE 2010	1.7%	109.00 [77.93, 140.07]
SHEN 2016	2.1%	30.90 [14.38, 47.42]
SON G 2009	1.9%	95.90 [72.63, 119.17]
SON SY 2012	1.8%	100.50 [74.05, 126.95]
SON T 2014	2.0%	53.80 [33.53, 74.07]
SUDA 2015	1.8%	20.00 [-4.78, 44.78]
UYAMA 2012	1.8%	16.00 [-9.13, 41.13]
WOO 2011	2.2%	48.80 [41.32, 56.28]
YANG 2017	2.2%	27.90 [17.23, 38.57]
YOON 2012	1.4%	95.60 [55.26, 135.94]
Subtotal (95% CI)	**55.5%**	**48.79 [38.11, 59.47]**
Heterogeneity: Tau² = 730.36; Chi² = 775.46, df = 28 (P < 0.00001); I² = 96%		
Test for overall effect: Z = 8.96 (P < 0.00001)		
Total (95% CI)	**100.0%**	**41.19 [33.47, 48.92]**
Heterogeneity: Tau² = 683.61; Chi² = 2367.10, df = 49 (P < 0.00001); I² = 98%		
Test for overall effect: Z = 10.45 (P < 0.00001)		
Test for subgroup differences: Chi² = 3.78, df = 1 (P = 0.05), I² = 73.5%		

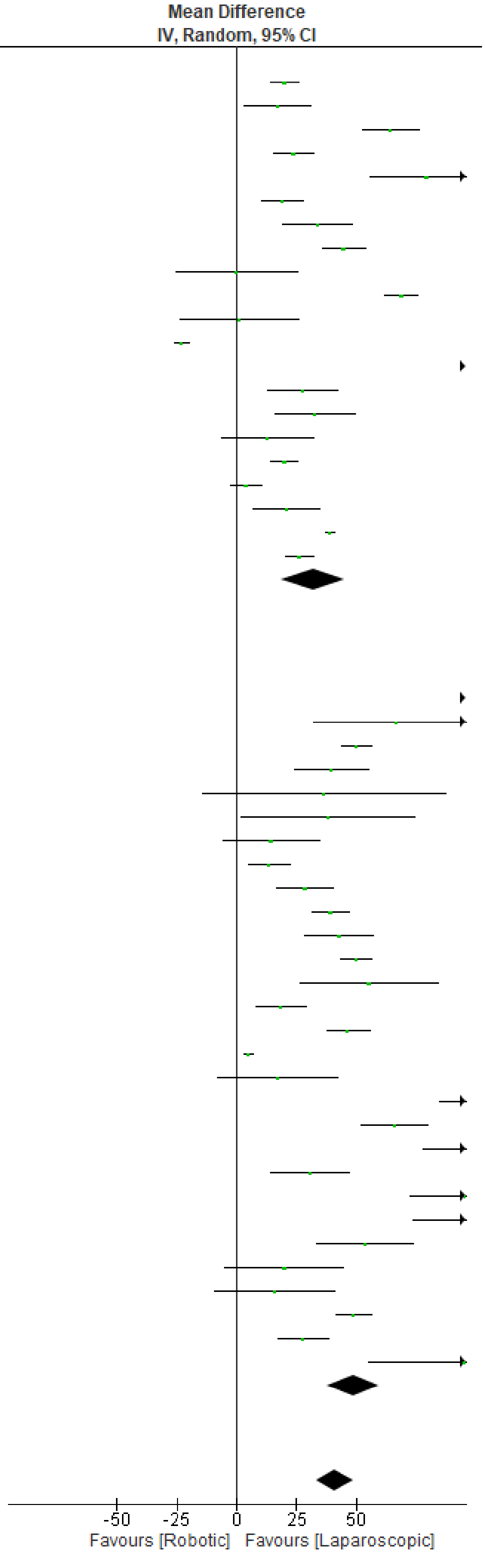


Figure 3: Operative Time

Study or Subgroup	Weight	Risk Ratio M-H, Random, 95% CI
1.5.1 With PSM		
GAO 2022	6.9%	0.75 [0.17, 3.33]
GAO Y 2019		Not estimable
HAN 2015		Not estimable
HONG 2016		Not estimable
ISOBE 2021		Not estimable
KONG 2020	2.7%	1.00 [0.09, 10.98]
LI Z 2018		Not estimable
OBAMA K 2018		Not estimable
OMORI 2022	1.5%	0.33 [0.01, 8.14]
ROH 2021		Not estimable
RYAN 2020	44.8%	1.46 [0.82, 2.62]
SHIBASAKI 2020	2.7%	2.00 [0.18, 21.96]
TIAN 2022	3.0%	0.33 [0.03, 3.19]
YANG 2020	2.0%	1.00 [0.06, 15.81]
YE 2020	4.8%	1.50 [0.25, 8.91]
ZHENG-YAN 2020	1.5%	0.33 [0.01, 8.16]
Subtotal (95% CI)	**69.8%**	**1.19 [0.75, 1.90]**
Total events		
Heterogeneity: Tau² = 0.00; Chi² = 3.58, df = 8 (P = 0.89); I² = 0%		
Test for overall effect: Z = 0.74 (P = 0.46)		
1.5.2 Without PSM		
AKTAS 2020	1.7%	0.42 [0.02, 8.47]
CIANCHI 2016	2.8%	0.68 [0.06, 7.19]
EOM 2012		Not estimable
HUANG 2014	2.0%	1.01 [0.06, 15.90]
KANG 2012		Not estimable
KIM HI 2014	1.7%	0.40 [0.02, 7.67]
KIM HI 2016		Not estimable
KIM KM 2012	4.8%	1.32 [0.22, 7.85]
KIM MC 2010		Not estimable
KIM YW 2016	2.0%	3.31 [0.21, 52.38]
NAKAUCHI 2016	2.0%	5.20 [0.33, 82.36]
NOSHIRO 2014		Not estimable
OKUMURA 2016	1.5%	0.12 [0.00, 2.92]
PARK 2015	1.7%	0.60 [0.03, 11.55]
PUGLIESE 2010	2.1%	3.00 [0.20, 45.24]
SON G 2009		Not estimable
SON SY 2012		Not estimable
SON T 2014	1.5%	3.40 [0.14, 81.76]
SUDA 2015	2.0%	4.98 [0.31, 78.82]
UYAMA 2012		Not estimable
WOO 2011	2.7%	1.10 [0.10, 12.07]
YANG 2017	1.7%	0.59 [0.03, 12.20]
YOON 2012		Not estimable
Subtotal (95% CI)	**30.2%**	**1.20 [0.59, 2.45]**
Total events		
Heterogeneity: Tau² = 0.00; Chi² = 7.26, df = 13 (P = 0.89); I² = 0%		
Test for overall effect: Z = 0.51 (P = 0.61)		
Total (95% CI)	**100.0%**	**1.20 [0.81, 1.77]**
Total events		
Heterogeneity: Tau² = 0.00; Chi² = 10.81, df = 22 (P = 0.98); I² = 0%		
Test for overall effect: Z = 0.89 (P = 0.37)		
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.98), I² = 0%		

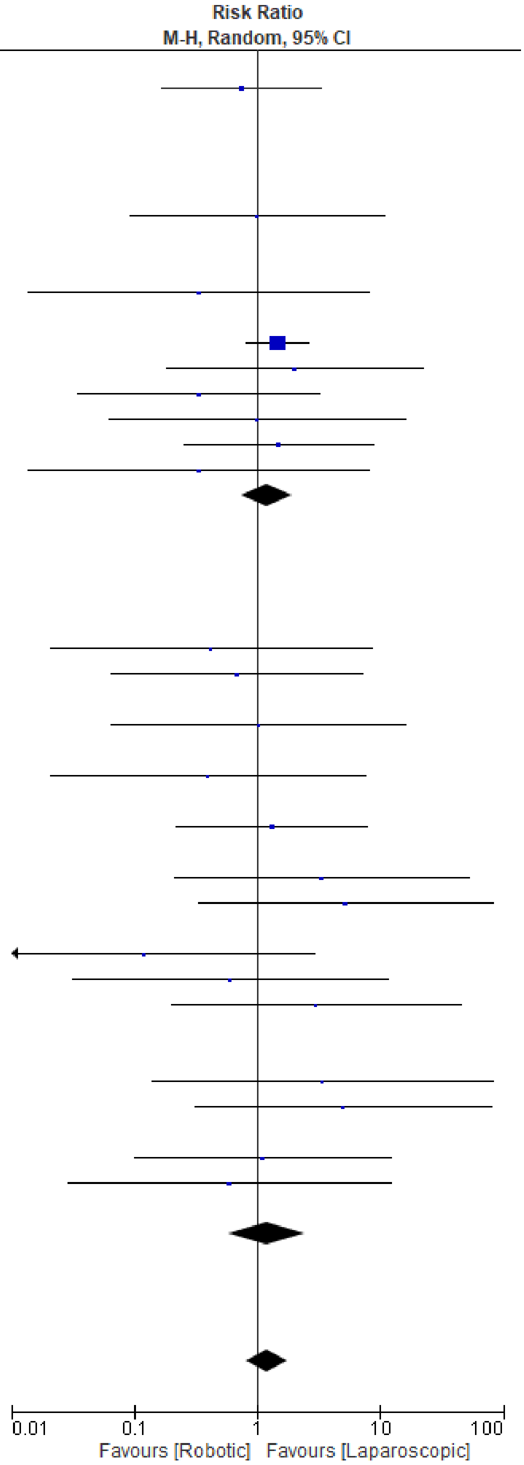


Figure 4: Mortality

Study or Subgroup	Weight	Risk Ratio IV, Random, 95% CI
2.5.1 With PSM		
GAO 2022	8.5%	0.81 [0.46, 1.41]
GAO Y 2019	1.3%	1.00 [0.20, 4.88]
HAN 2015	3.3%	0.88 [0.34, 2.28]
HONG 2016	4.7%	0.85 [0.39, 1.85]
ISOBE 2021	0.8%	0.14 [0.02, 1.12]
KONG 2020	3.7%	0.55 [0.22, 1.33]
LI Z 2018	3.1%	1.14 [0.43, 3.05]
LU 2018	1.4%	2.25 [0.51, 9.88]
NISHI 2022	1.1%	0.50 [0.09, 2.65]
OMORI 2022	1.4%	0.20 [0.04, 0.90]
PARISI 2017	1.3%	0.29 [0.06, 1.35]
ROH 2020	0.6%	0.33 [0.04, 3.10]
ROH 2021	4.1%	0.73 [0.31, 1.70]
SHIBASAKI 2020	6.7%	0.48 [0.25, 0.92]
TIAN 2022	5.1%	0.80 [0.38, 1.69]
WANG WJ 2019	9.0%	0.44 [0.25, 0.75]
YANG 2020	2.9%	1.00 [0.36, 2.77]
YE 2020	6.7%	0.71 [0.38, 1.36]
ZHENG-YAN 2020	6.1%	0.74 [0.37, 1.45]
Subtotal (95% CI)	**71.9%**	**0.66 [0.54, 0.81]**
Total events		
Heterogeneity: Tau² = 0.00; Chi² = 15.93, df = 18 (P = 0.60); I² = 0%		
Test for overall effect: Z = 4.07 (P < 0.0001)		
2.5.2 Without PSM		
AKTAS 2020	2.3%	1.22 [0.39, 3.85]
ALHOASSAINI 2020	1.4%	0.40 [0.09, 1.81]
HYUN 2013	3.4%	0.78 [0.30, 2.01]
KIM HI 2016	0.8%	1.00 [0.14, 7.02]
KIM KM 2012	9.1%	1.10 [0.64, 1.87]
KIM YW 2016	0.8%	0.33 [0.04, 2.55]
LEE 2015	2.1%	0.40 [0.12, 1.36]
NAKAUCHI 2016	1.6%	0.19 [0.05, 0.75]
OKUMURA 2016	3.0%	1.00 [0.37, 2.72]
SON T 2014	1.3%	2.32 [0.50, 10.71]
SUDA 2015	1.6%	0.18 [0.05, 0.74]
YOON 2012	0.7%	0.30 [0.04, 2.40]
Subtotal (95% CI)	**28.1%**	**0.67 [0.43, 1.02]**
Total events		
Heterogeneity: Tau² = 0.16; Chi² = 15.92, df = 11 (P = 0.14); I² = 31%		
Test for overall effect: Z = 1.86 (P = 0.06)		
Total (95% CI)	**100.0%**	**0.68 [0.57, 0.82]**
Total events		
Heterogeneity: Tau² = 0.02; Chi² = 32.30, df = 30 (P = 0.35); I² = 7%		
Test for overall effect: Z = 4.16 (P < 0.0001)		
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.97), I² = 0%		

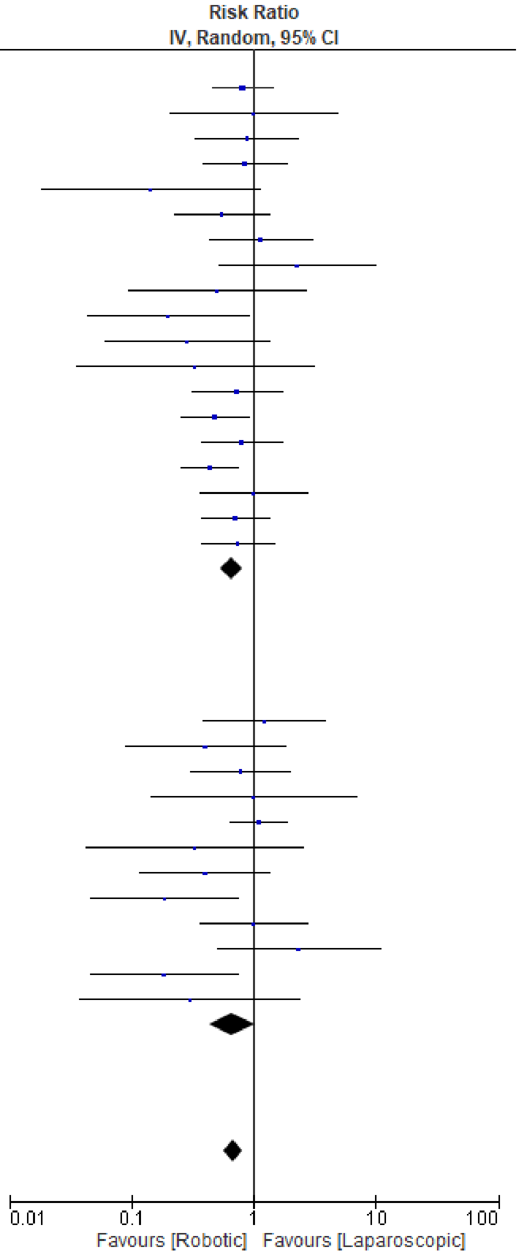


Figure 5: Surgical complications (Grade ≥ III in the Clavien-Dindo Classification)

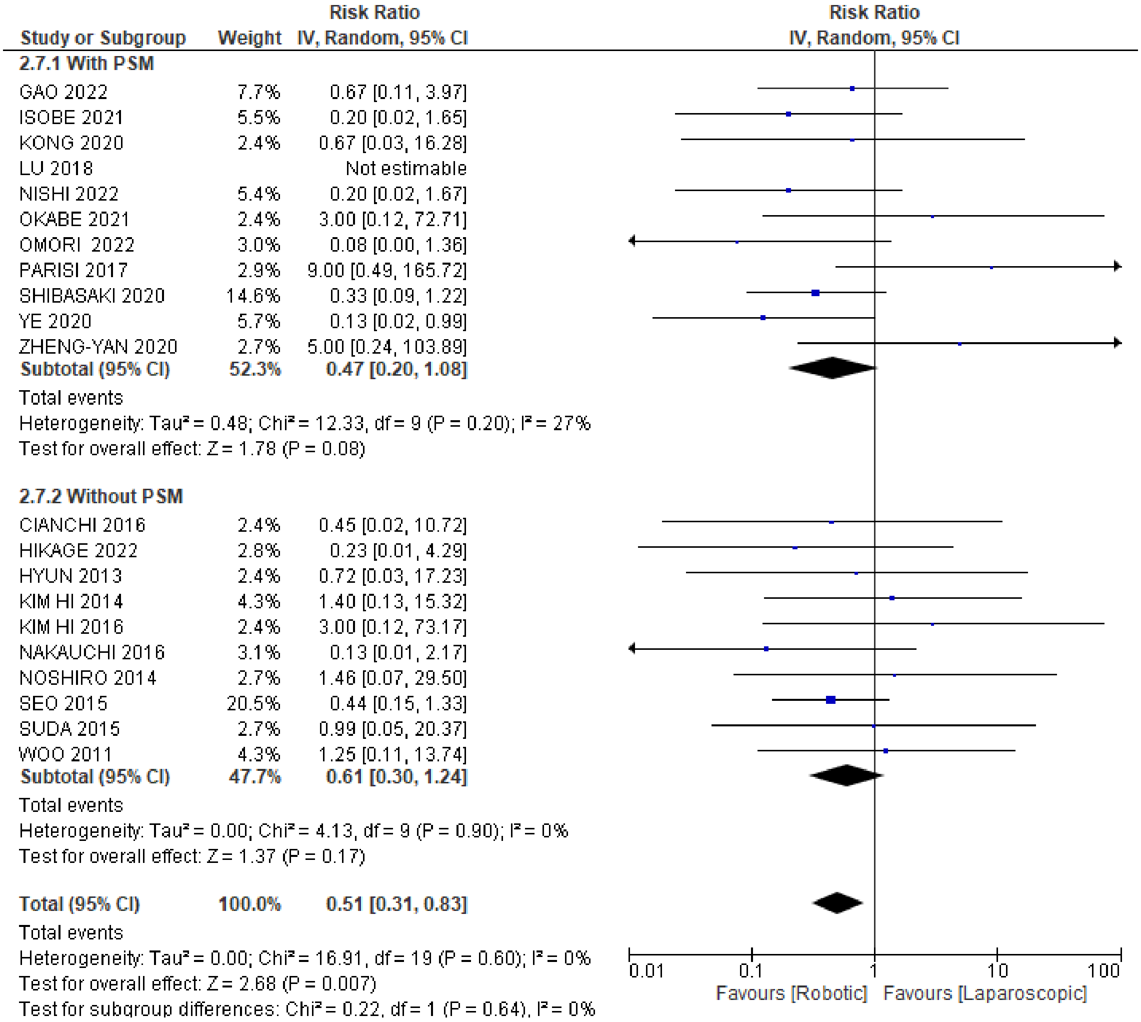


Figure 6: Pancreatic Complications

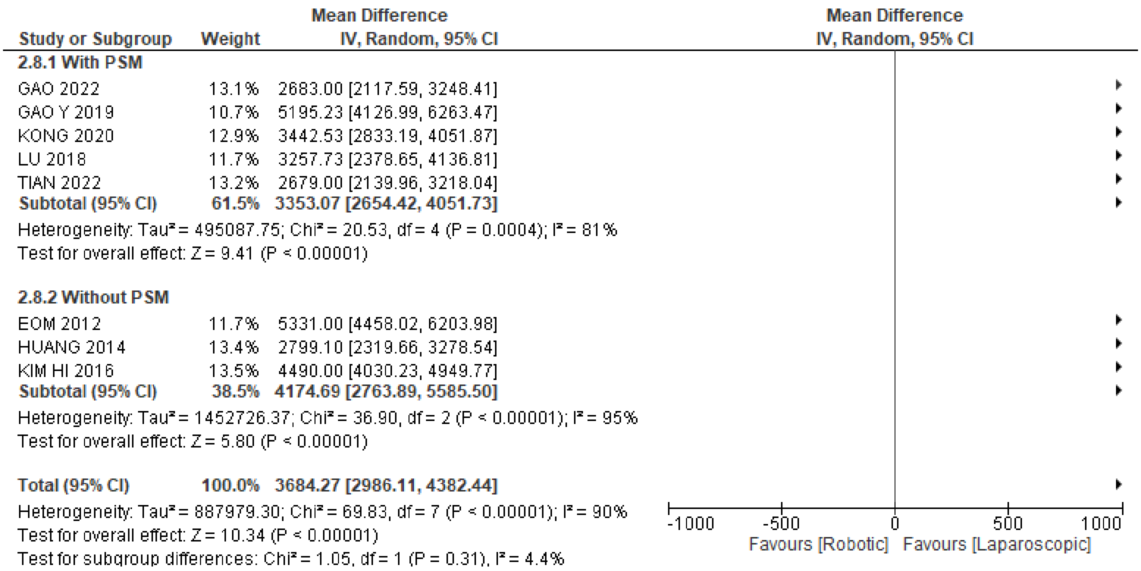


Figure 7: Cost

Study or Subgroup	Weight	Mean Difference IV, Random, 95% CI
3.4.1 With PSM		
GAO 2022	2.6%	2.00 [0.33, 3.67]
GAO Y 2019	2.5%	1.21 [-0.95, 3.37]
HAN 2015	1.9%	-3.10 [-7.17, 0.97]
HONG 2016	2.4%	2.00 [-0.46, 4.46]
ISOBE 2021	1.2%	0.80 [-6.05, 7.65]
KONG 2020	2.5%	2.11 [0.19, 4.03]
LI Z 2018	2.4%	1.80 [-0.60, 4.20]
LU 2018	2.3%	-2.00 [-4.88, 0.88]
NISHI 2022	1.9%	9.74 [5.46, 14.02]
OBAMA K 2018	2.4%	-0.10 [-2.49, 2.29]
OKABE 2021	1.9%	0.00 [-4.19, 4.19]
OMORI 2022	2.8%	-1.30 [-1.51, -1.09]
PARISI 2017	2.3%	3.20 [0.37, 6.03]
ROH 2020	1.1%	8.50 [1.20, 15.80]
ROH 2021	1.7%	-2.90 [-7.62, 1.82]
RYAN 2020	2.7%	2.20 [1.00, 3.40]
SHIBASAKI 2020	2.4%	1.00 [-1.40, 3.40]
TIAN 2022	2.6%	1.33 [-0.44, 3.10]
WANG WJ 2019	2.3%	3.70 [1.03, 6.37]
YANG 2020	2.2%	2.99 [-0.16, 6.14]
YE 2020	2.7%	3.80 [3.18, 4.42]
ZHENG-YAN 2020	2.7%	2.50 [1.38, 3.62]
Subtotal (95% CI)	**49.4%**	**1.68 [0.35, 3.00]**
Heterogeneity: Tau² = 7.88; Chi² = 372.28, df = 21 (P < 0.00001); I² = 94%		
Test for overall effect: Z = 2.48 (P = 0.01)		
3.4.2 Without PSM		
AKTAS 2020	1.9%	-4.00 [-8.25, 0.25]
ALHOASSAINI 2020	1.1%	2.00 [-5.66, 9.66]
CIANCHI 2016	2.6%	8.70 [7.24, 10.16]
EOM 2012	1.5%	-3.20 [-8.68, 2.28]
HIKAGE 2022	0.8%	0.50 [-8.67, 9.67]
HUANG 2014	2.0%	2.50 [-1.35, 6.35]
HYUN 2013	1.6%	0.20 [-5.04, 5.44]
JUNFENG 2014	2.4%	1.90 [-0.34, 4.14]
KIM HI 2014	2.4%	0.50 [-1.84, 2.84]
KIM HI 2016	2.5%	2.00 [-0.17, 4.17]
KIM KM 2012	2.6%	2.60 [0.87, 4.33]
KIM MC 2010	1.0%	3.70 [-4.27, 11.67]
KIM YW 2016	2.2%	3.00 [-0.05, 6.05]
LEE 2015	2.3%	1.30 [-1.44, 4.04]
LIU 2018	2.0%	6.20 [2.50, 9.90]
NOSHIRO 2014	0.9%	4.00 [-4.45, 12.45]
PUGLIESE 2010	2.2%	-6.00 [-9.16, -2.84]
SEO 2015	2.7%	5.00 [3.75, 6.25]
SHEN 2016	2.5%	1.70 [-0.31, 3.71]
SON G 2009	1.0%	-7.40 [-15.39, 0.59]
SON SY 2012	1.4%	-6.80 [-12.74, -0.86]
SON T 2014	1.3%	4.40 [-1.92, 10.72]
SUDA 2015	2.2%	2.00 [-1.14, 5.14]
UYAMA 2012	1.1%	1.10 [-6.37, 8.57]
WOO 2011	2.4%	1.60 [-0.65, 3.85]
YANG 2017	2.3%	5.10 [2.51, 7.69]
YOON 2012	1.6%	3.40 [-1.87, 8.67]
Subtotal (95% CI)	**50.6%**	**1.68 [0.23, 3.12]**
Heterogeneity: Tau² = 10.04; Chi² = 150.49, df = 26 (P < 0.00001); I² = 83%		
Test for overall effect: Z = 2.27 (P = 0.02)		
Total (95% CI)	**100.0%**	**1.69 [0.68, 2.70]**
Heterogeneity: Tau² = 9.59; Chi² = 674.11, df = 48 (P < 0.00001); I² = 93%		
Test for overall effect: Z = 3.27 (P = 0.001)		
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 1.00), I² = 0%		

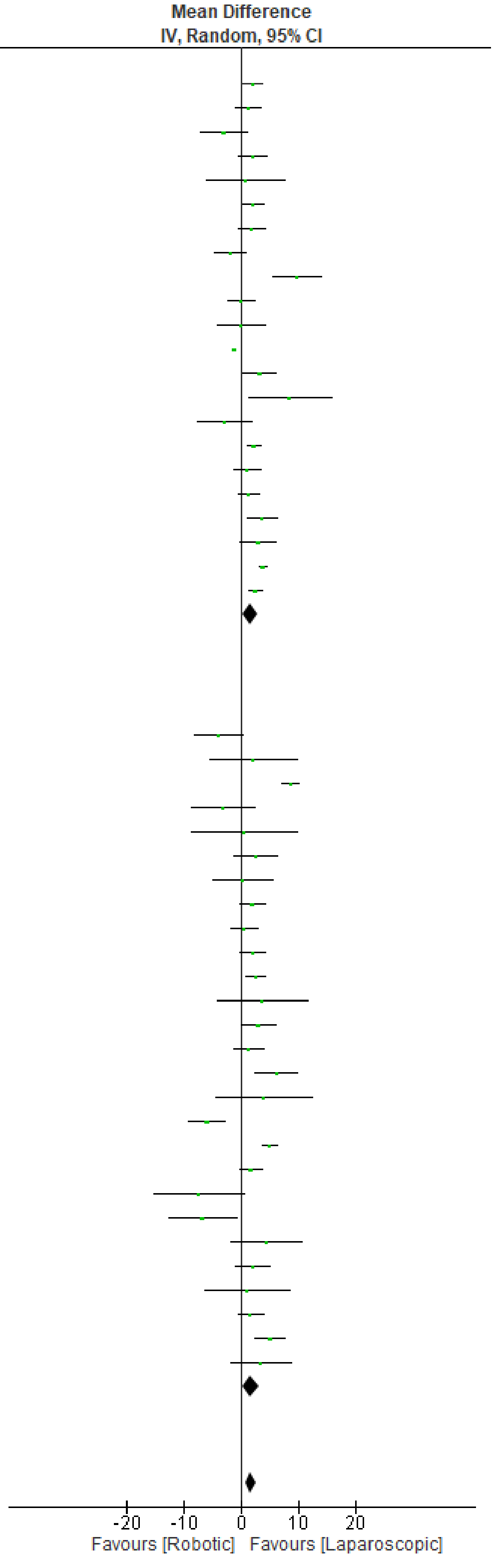
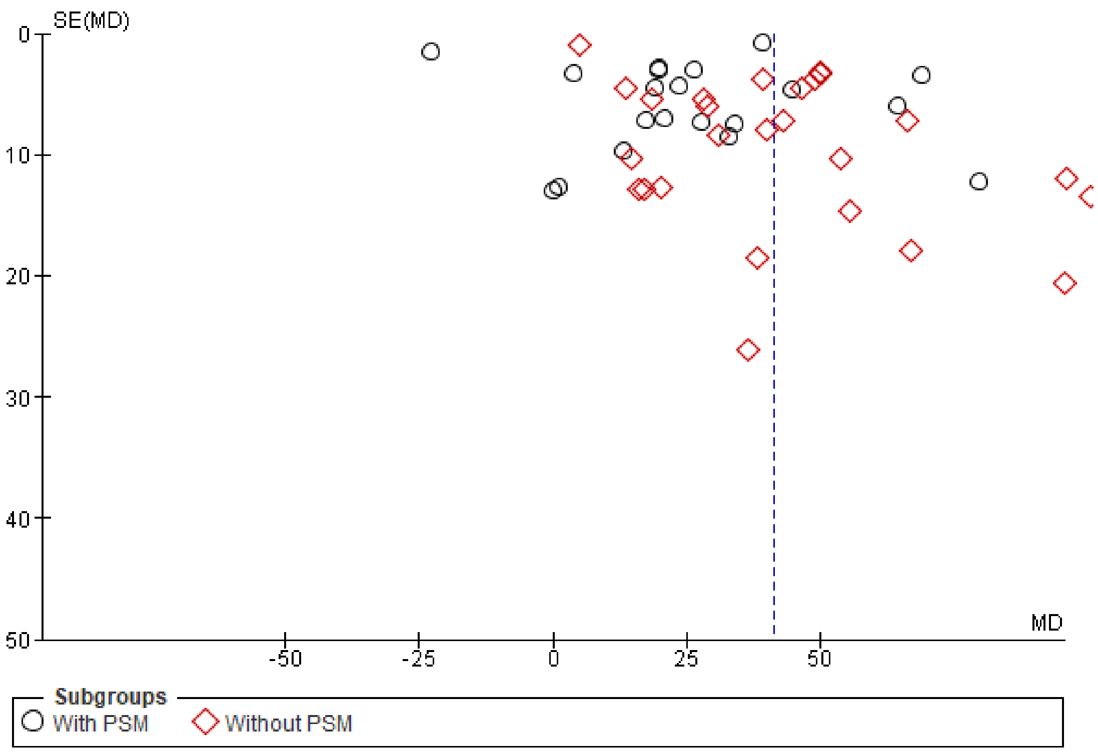


Figure 8: Number of Retrieved Lymph Nodes

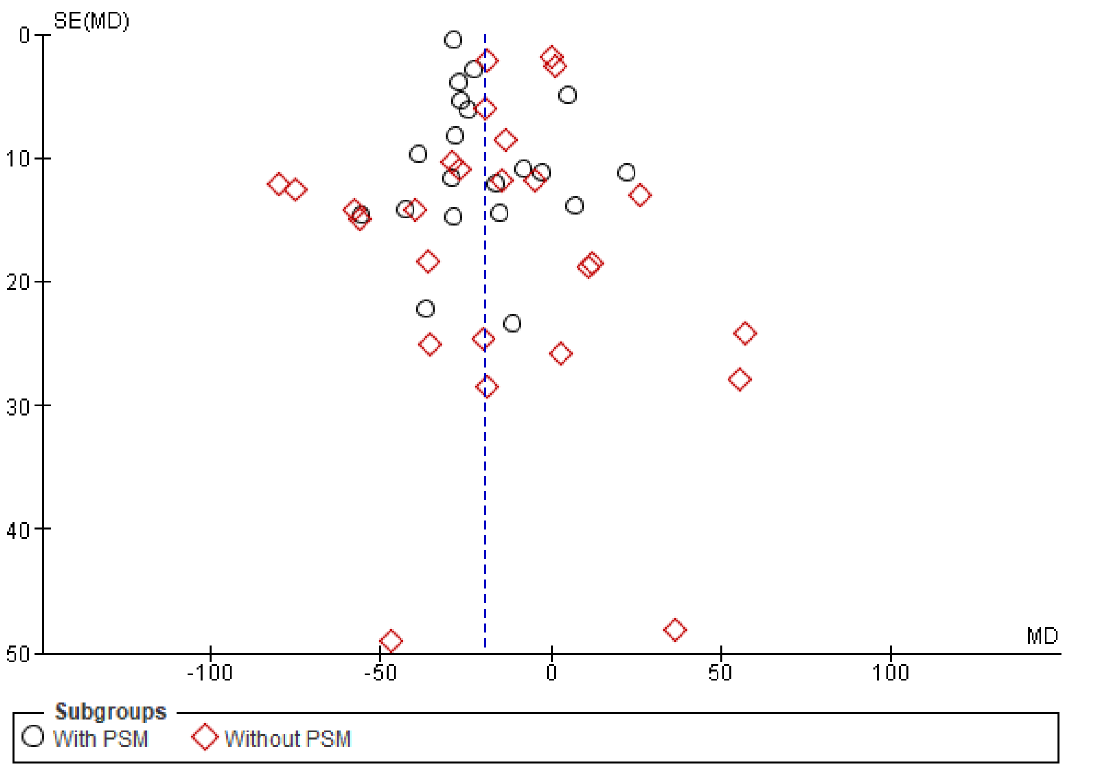
Supplemental Files

Supplemental File no.1 - Funnel Plots

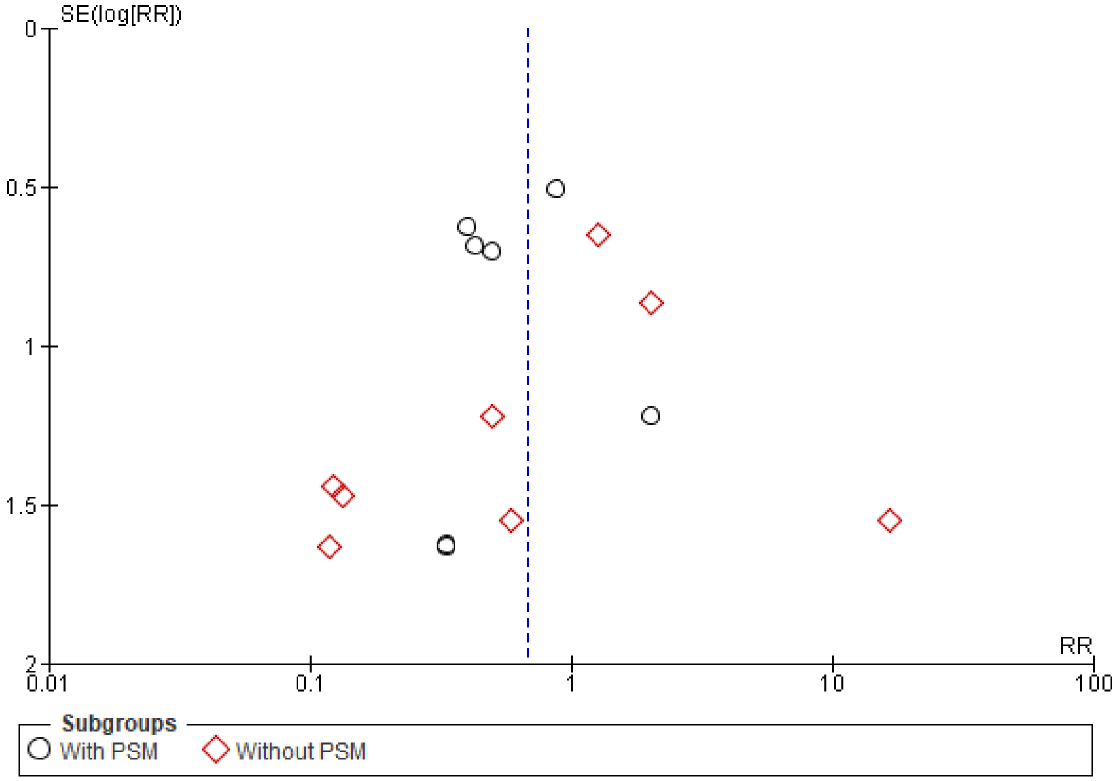
- **Operative Time**



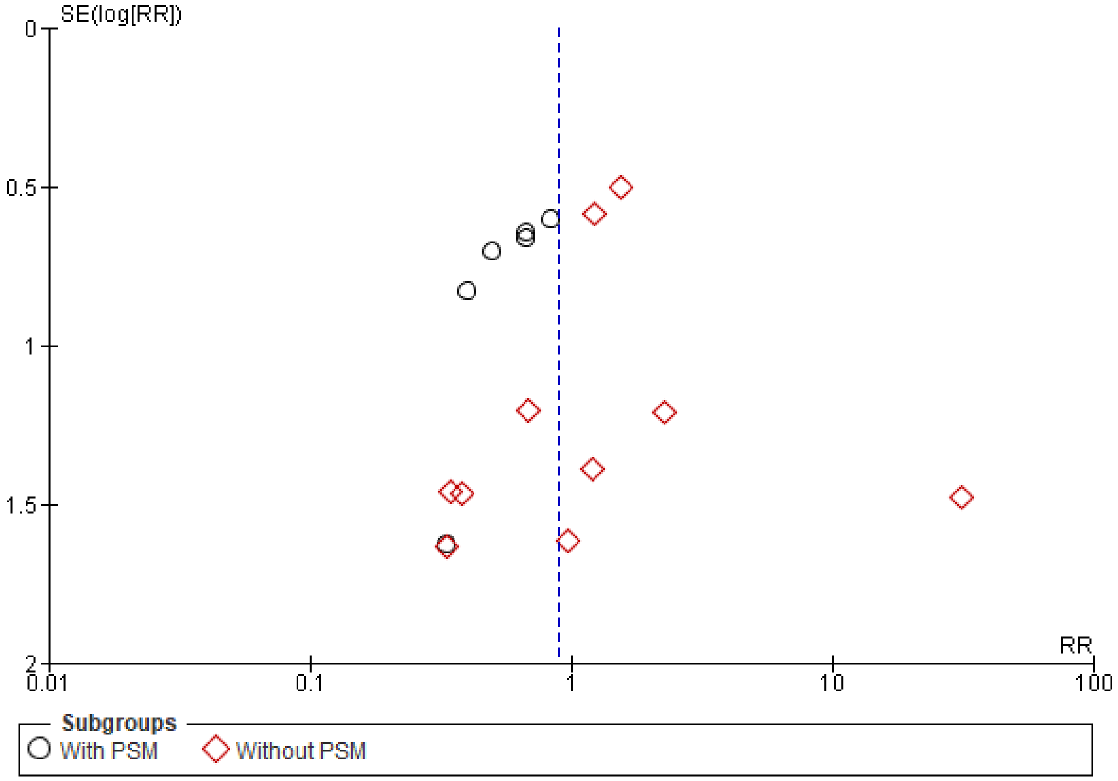
- **Blood Loss**



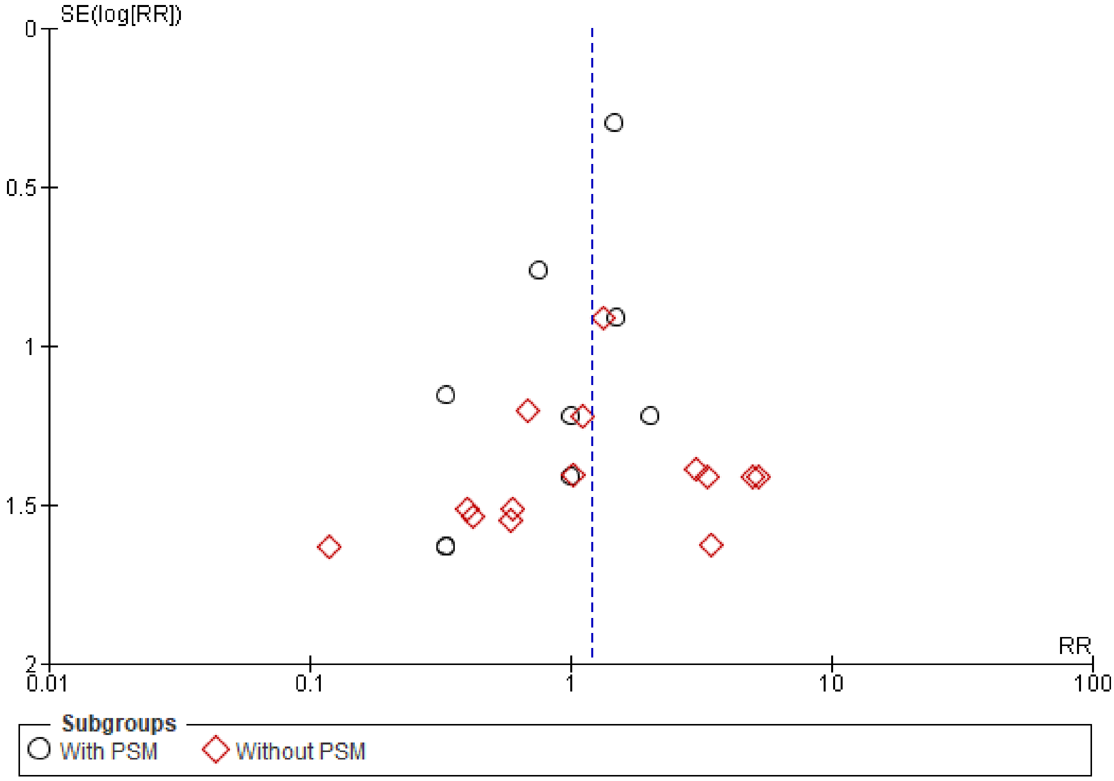
- **Conversion**



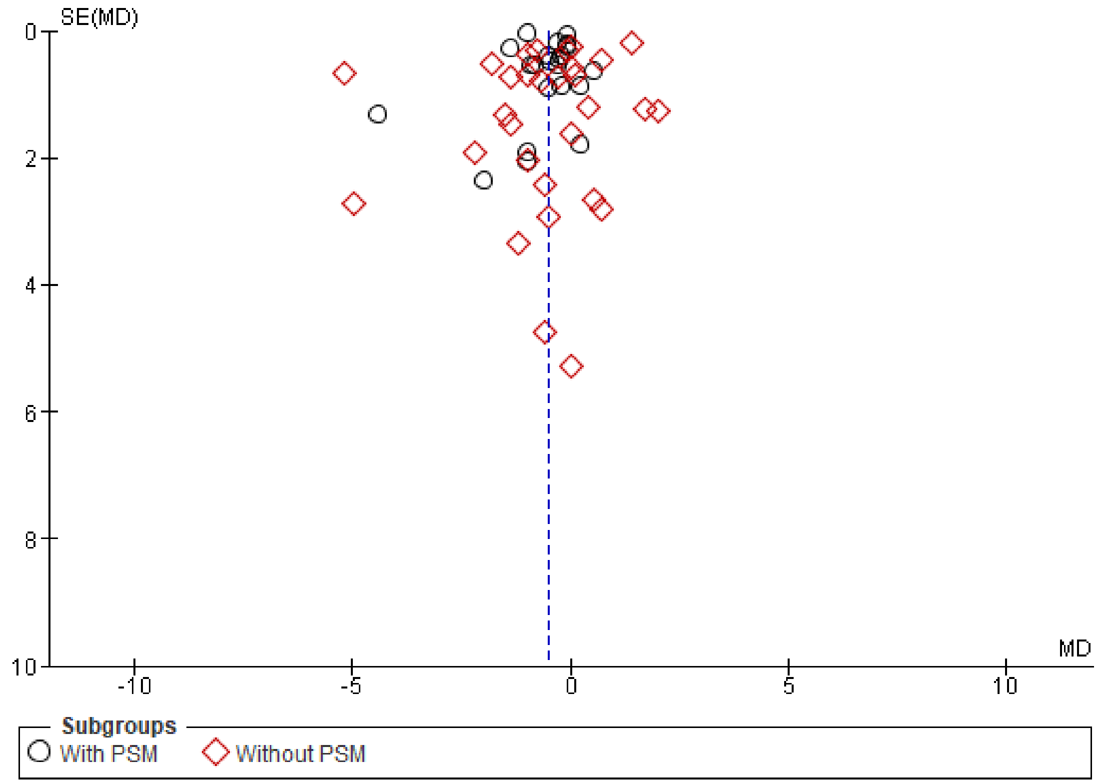
- **Reoperation**



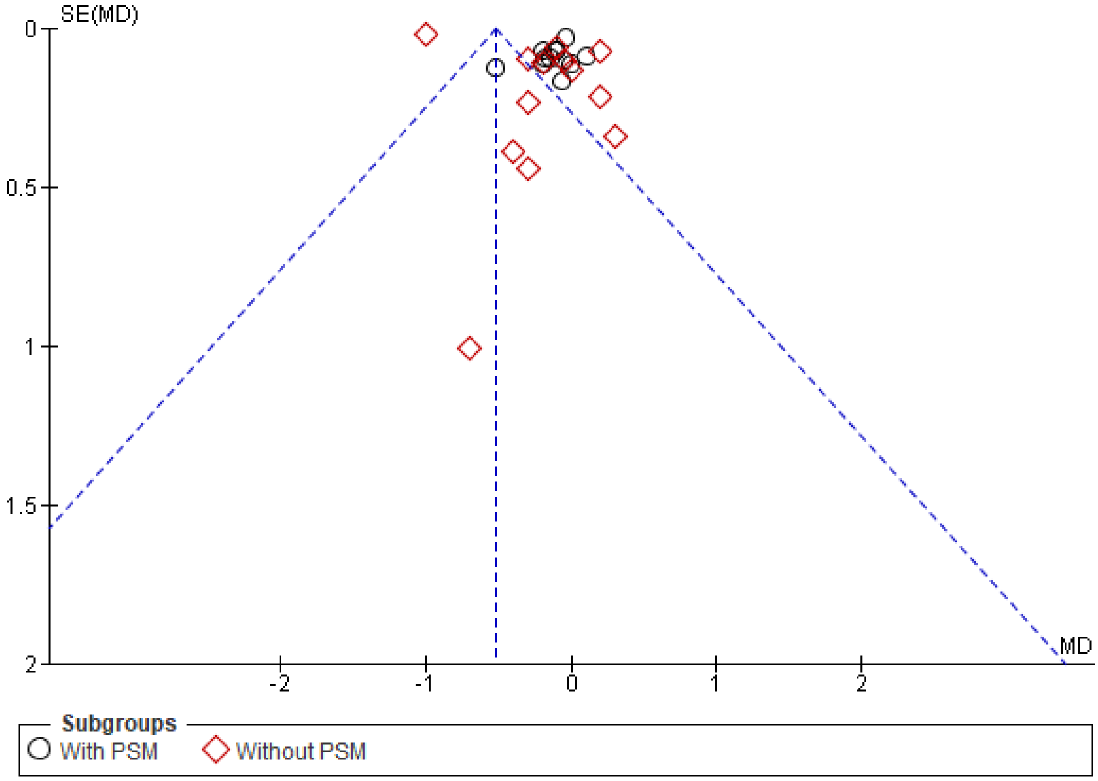
- **Mortality**



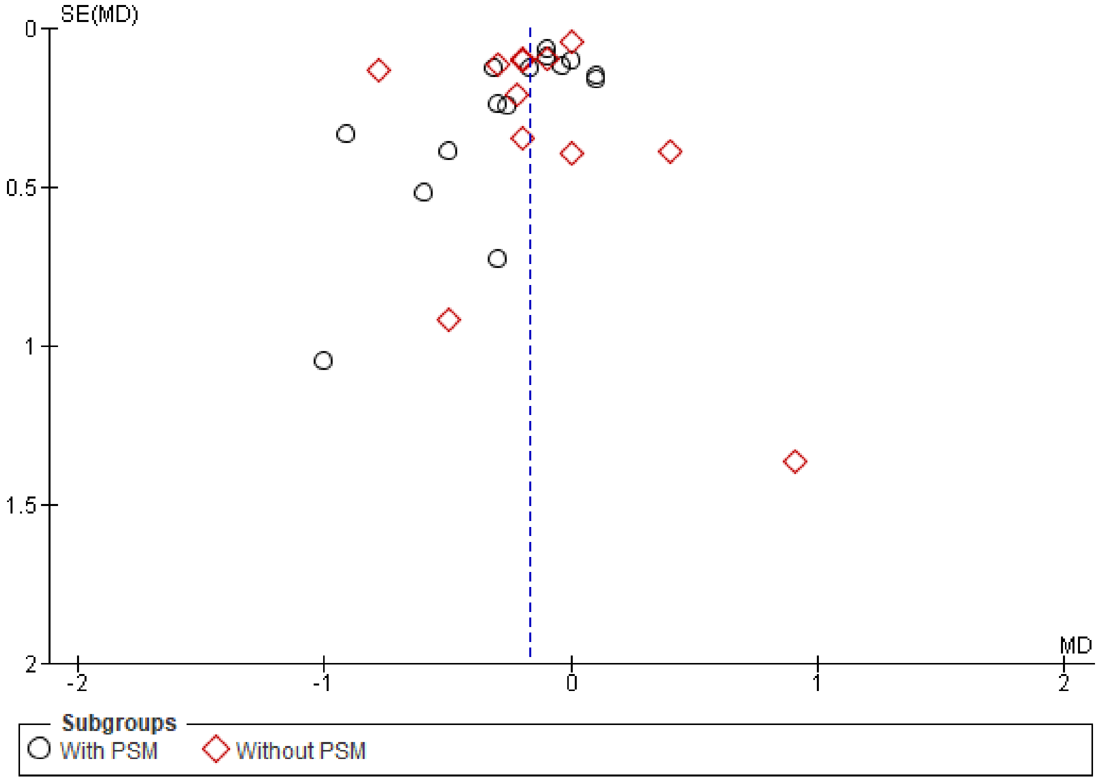
- **Length of Hospital stay**



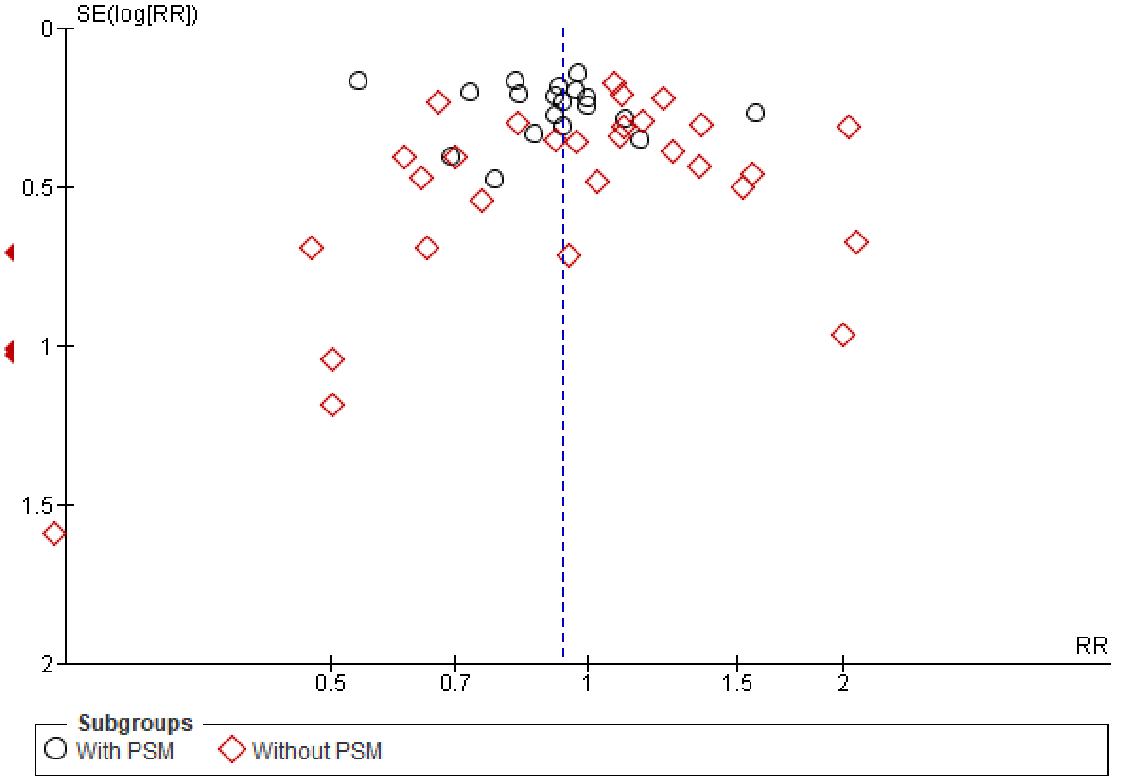
- **Time to First Flatus**



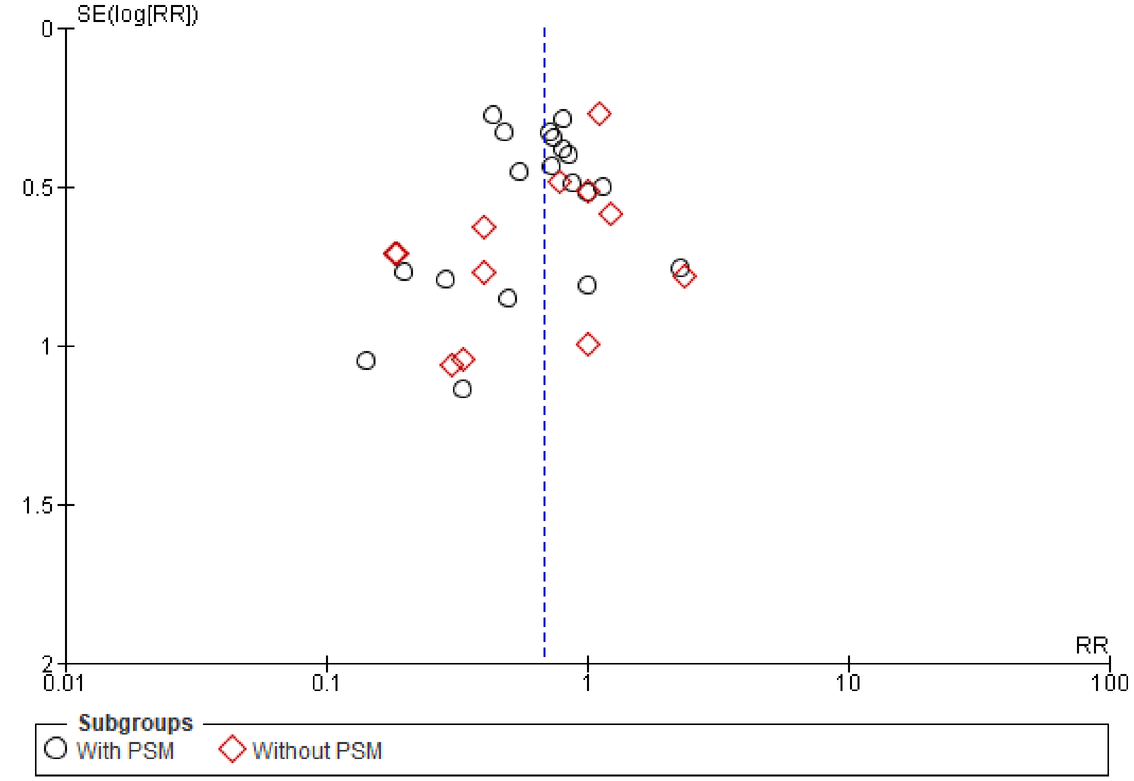
- **Time to oral intake**



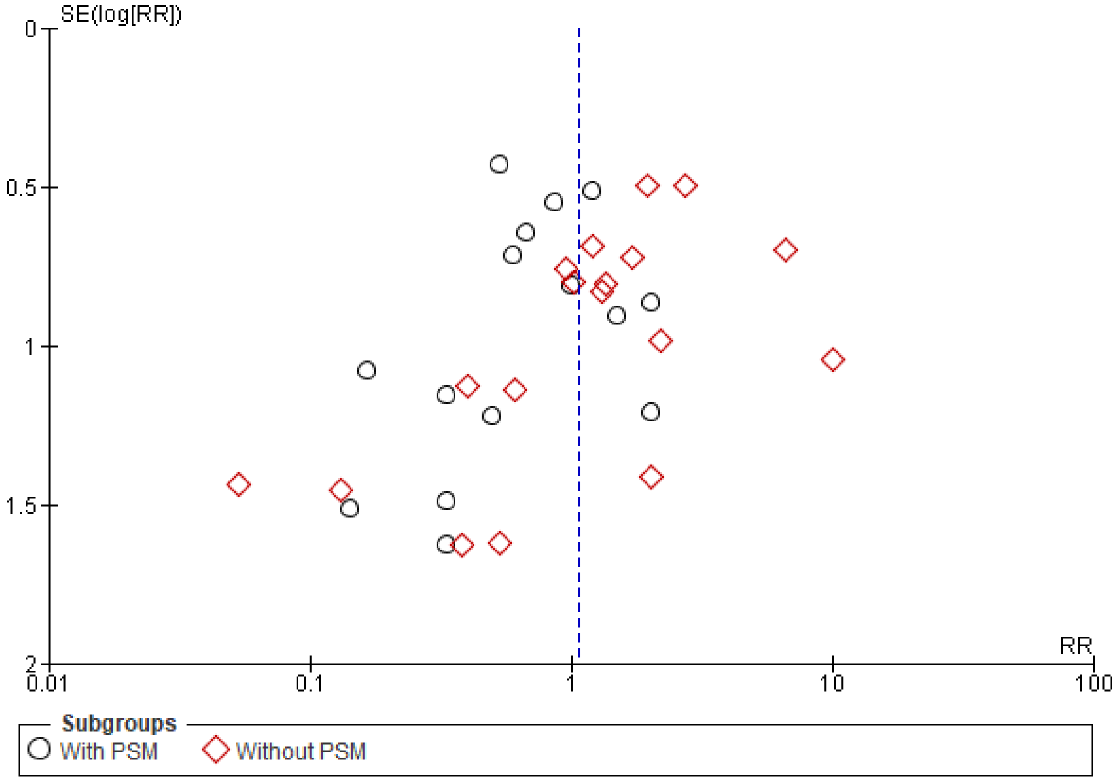
- **Overall Complications**



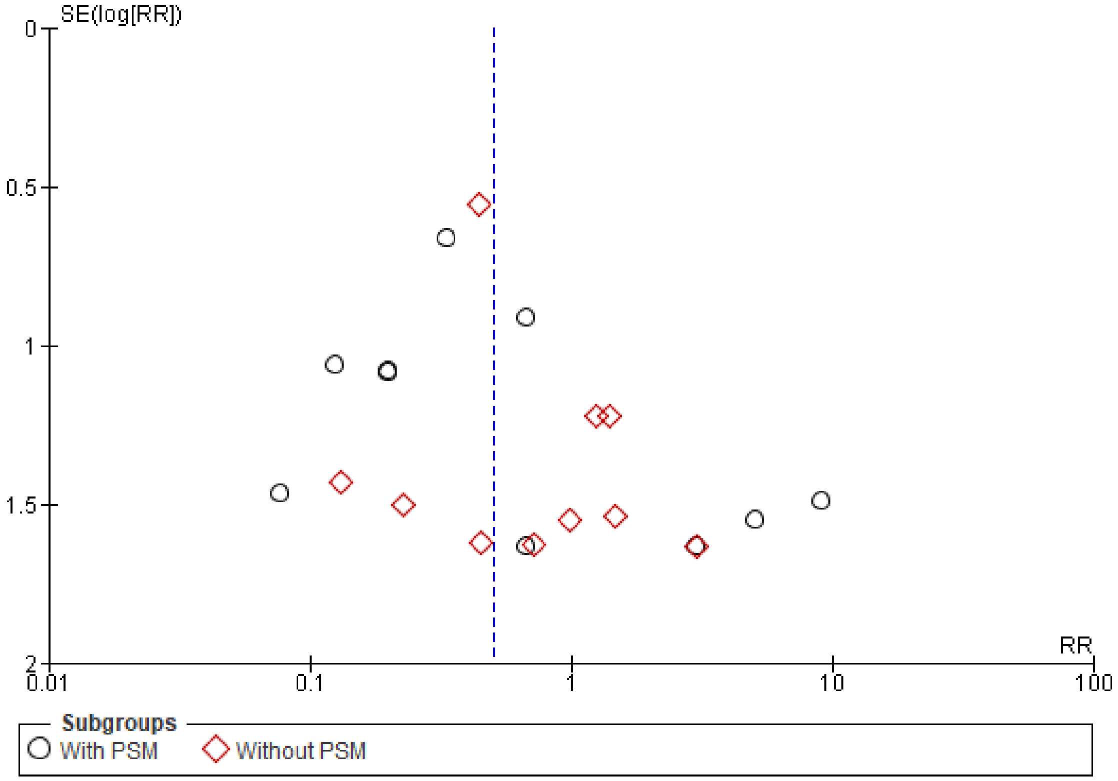
- **Surgical complication according to Clavien-Dindo Grade ≥ III**



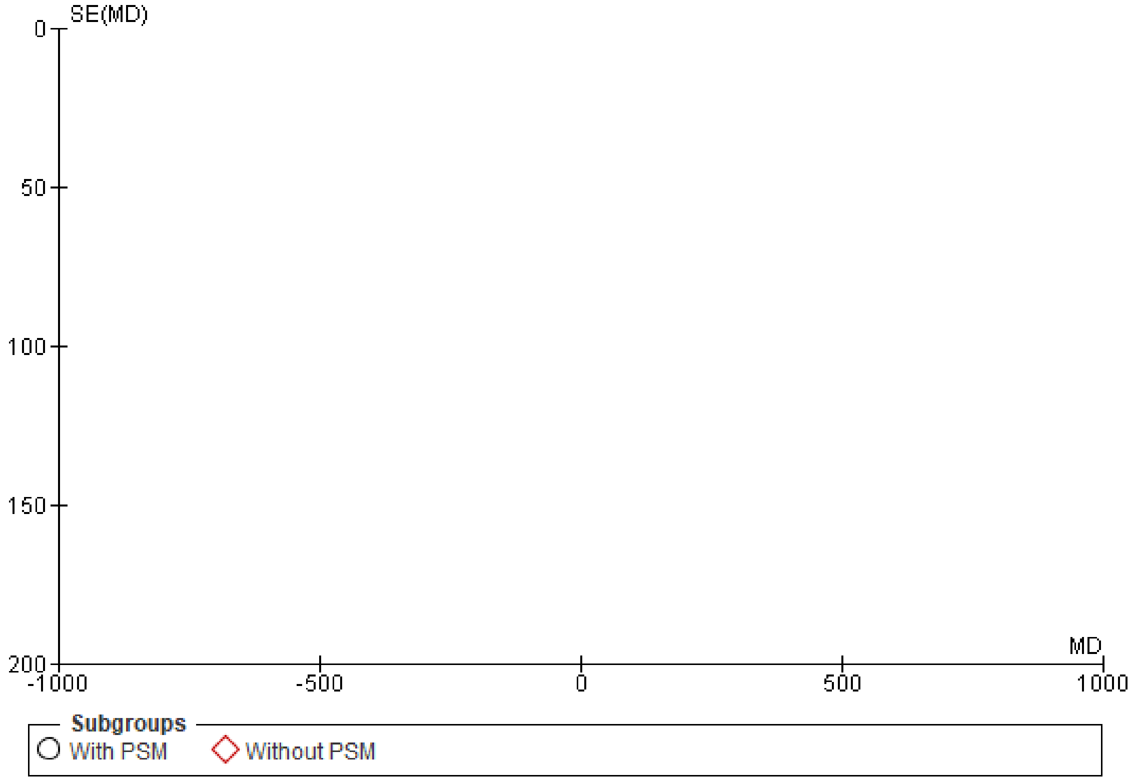
- **Anastomotic Leakage**



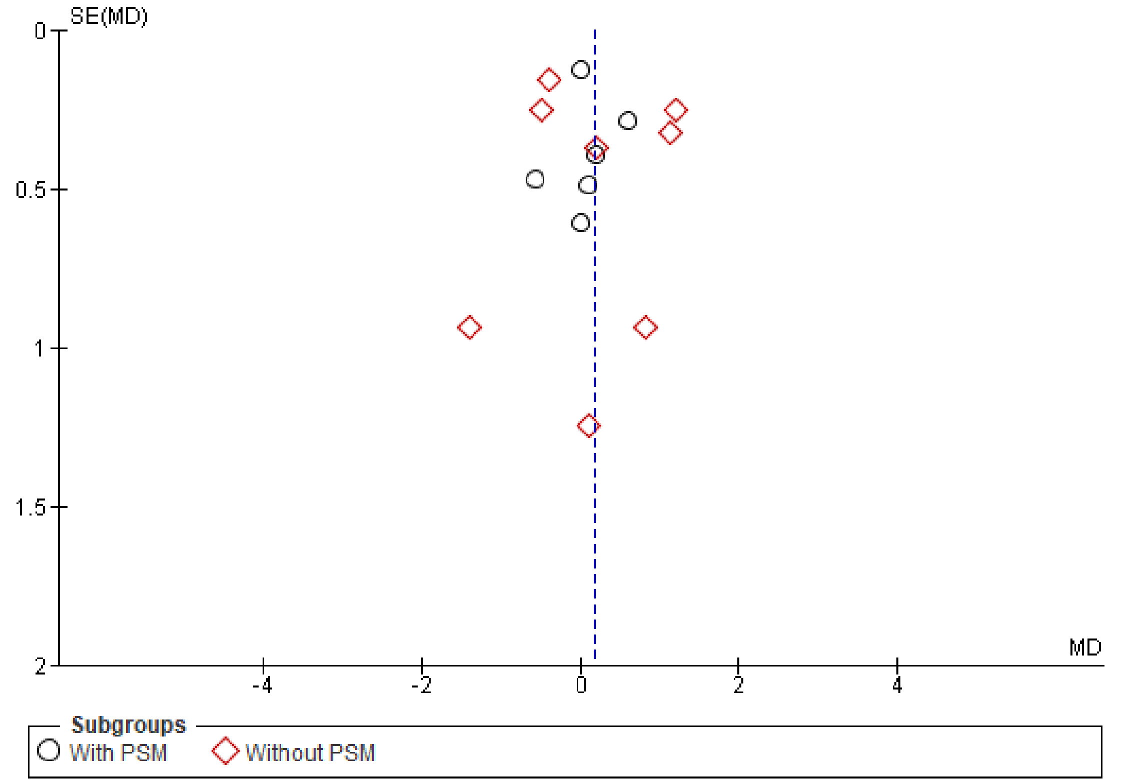
- **Pancreatic Complications**



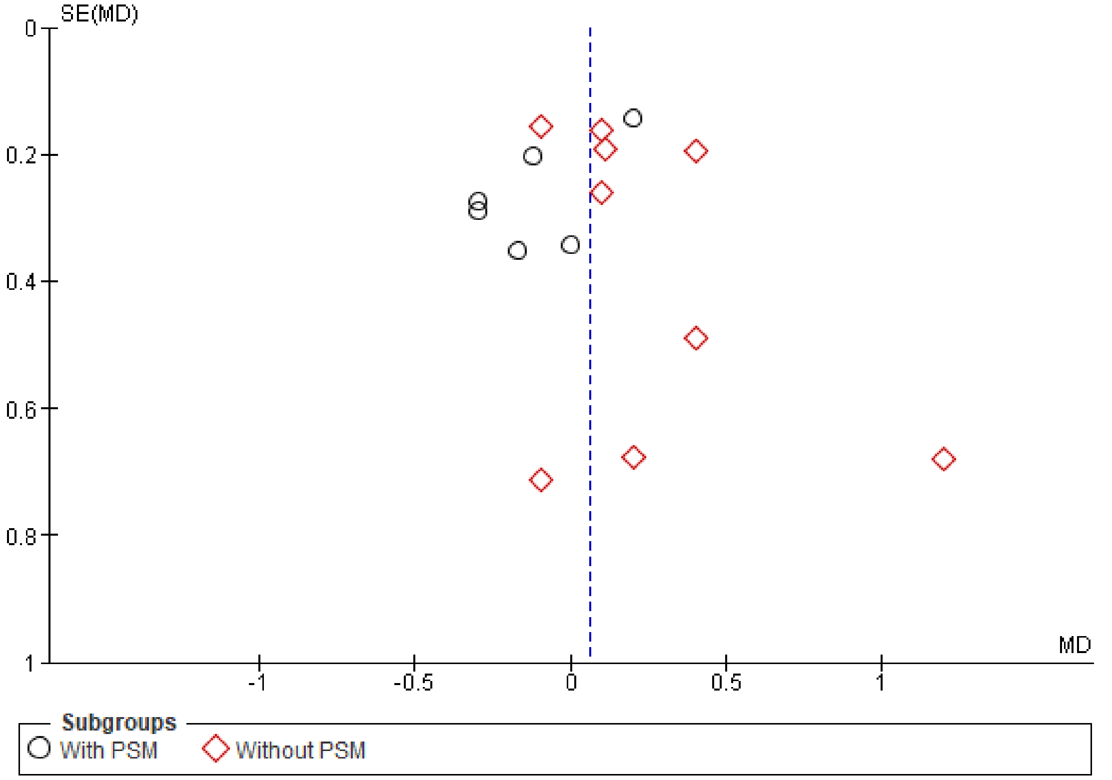
- **Cost**



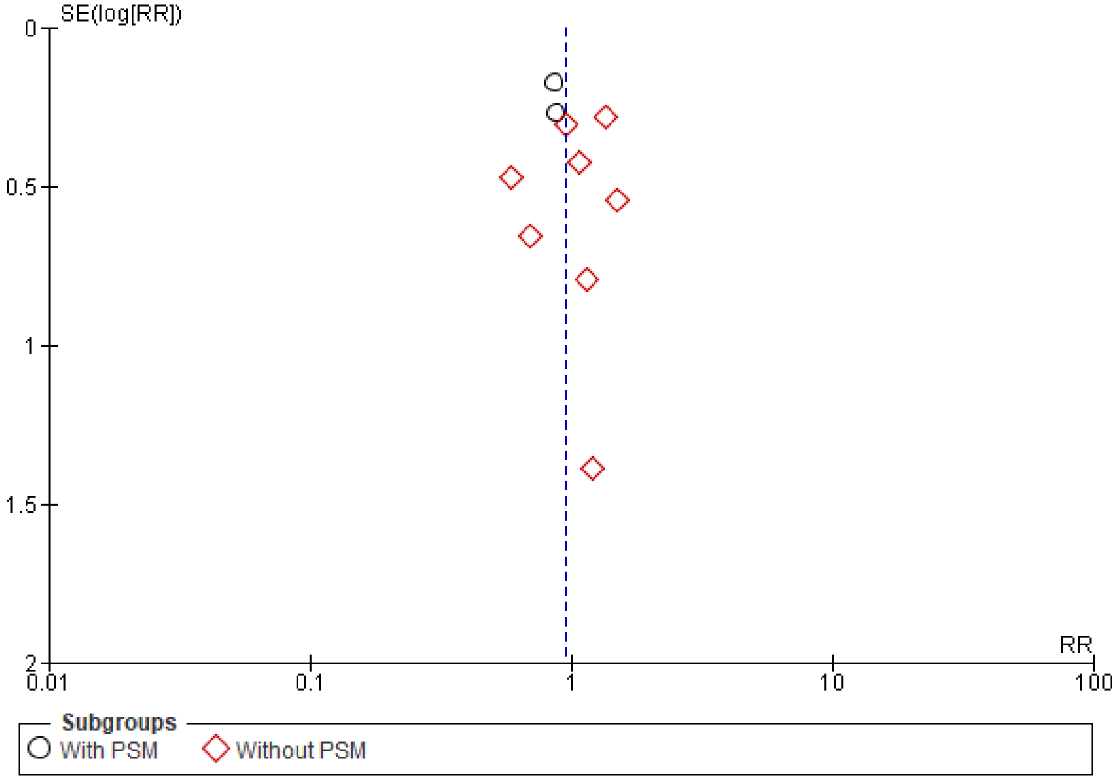
- **Distal resection margin distance**



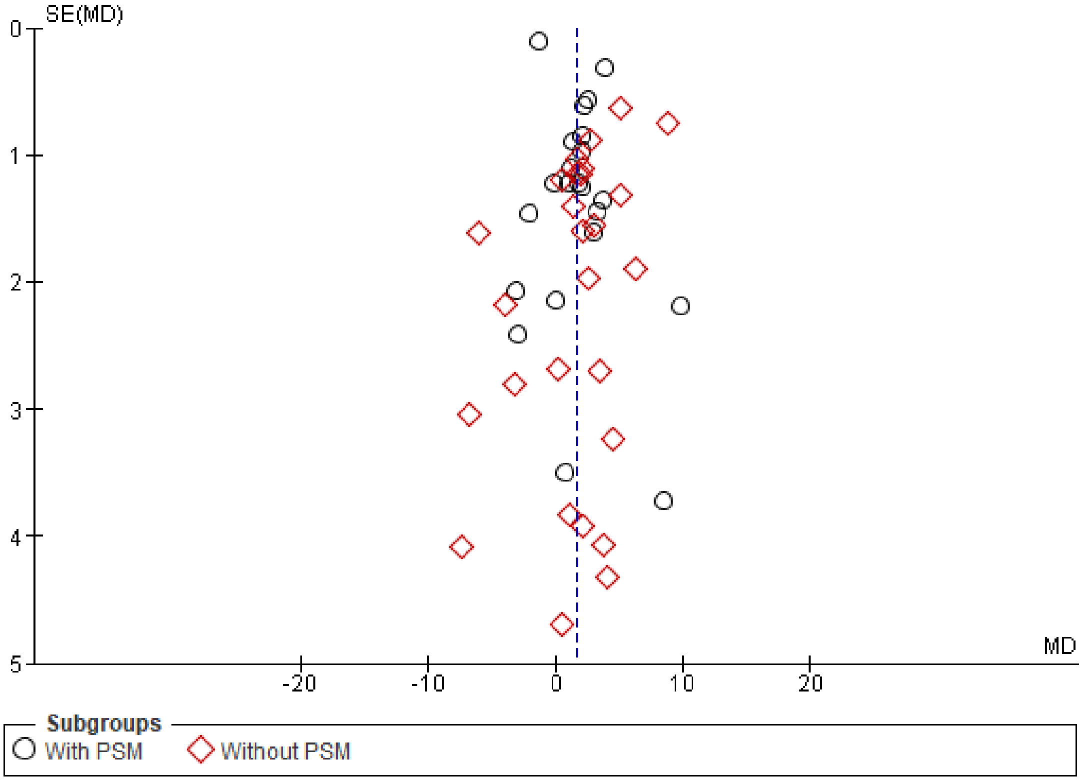
- **Proximal resection margin distance**



- **Recurrence**



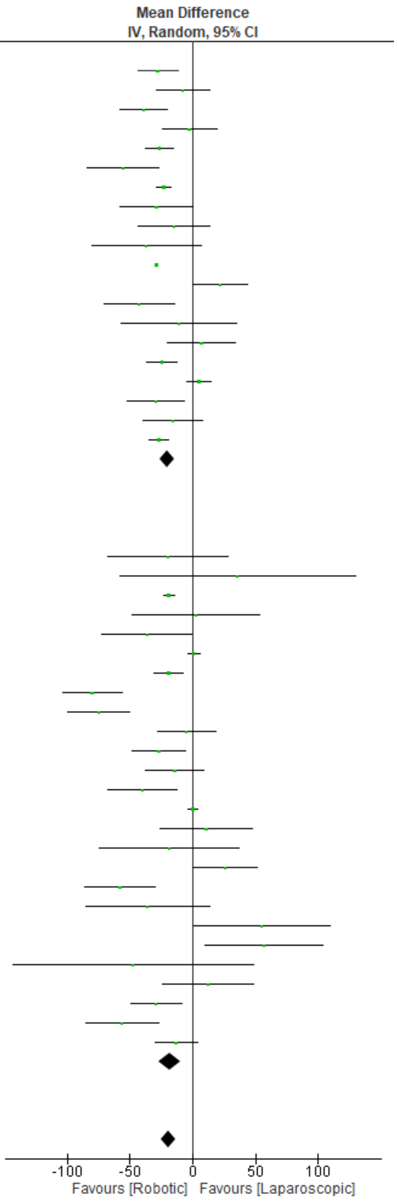
- **Number of retrieved lymph nodes**



Supplemental File no.2 - Forest Plots:

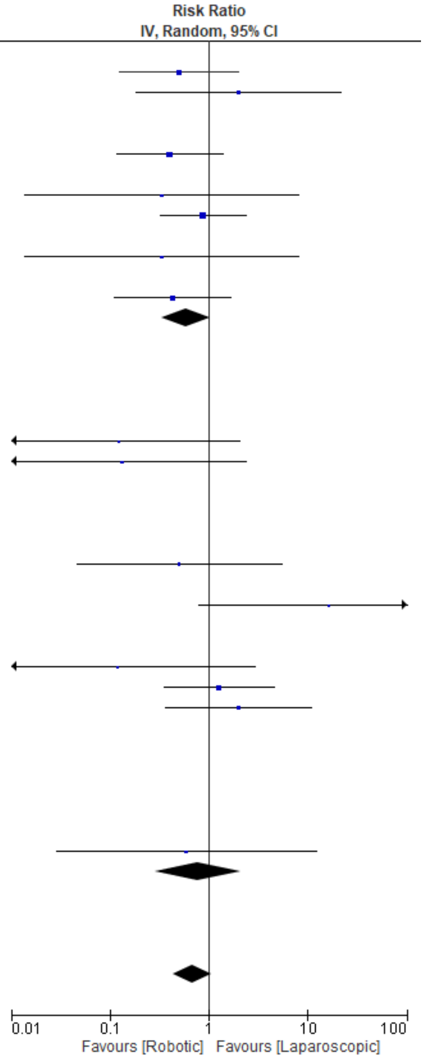
- **Blood Loss**

	Robotic surgery			Laparoscopic surgery				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
1.2.1 With PSM								
GAO 2022	139.3	97.8	410	167.3	134.2	410	2.9%	-28.00 [-44.07, -11.93]
GAO Y 2019	101.47	121.84	163	109.48	69.12	163	2.4%	-8.01 [-29.51, 13.49]
HONG 2016	77.6	80.8	232	116.6	124.8	232	2.6%	-39.00 [-58.13, -19.87]
ISOBE 2021	12.5	70.1	50	15	36.3	50	2.4%	-2.50 [-24.38, 19.38]
KONG 2020	77.07	64.37	266	103.68	86.92	532	3.3%	-26.61 [-37.31, -15.91]
LI Z 2018	179.2	66.8	112	234.8	139.5	112	1.9%	-55.60 [-84.24, -26.96]
LU 2018	26	19	101	49	38	303	3.6%	-23.00 [-28.66, -17.34]
NISHI 2022	38.62	73.06	79	67.53	108.2	79	1.9%	-28.91 [-57.70, -0.12]
OBAMA K 2018	86.9	144	311	101.8	209.8	311	2.0%	-14.90 [-43.18, 13.38]
OKABE 2021	0	189.17	93	37	100	93	1.2%	-37.00 [-80.49, 6.49]
OMORI 2022	13.4	4.7	210	42.1	4.7	210	3.7%	-28.70 [-29.60, -27.80]
PARISI 2017	117.91	68.11	151	95.93	119.22	151	2.4%	21.98 [0.08, 43.88]
ROH 2020	30.7	28.2	51	73.3	97.1	51	2.0%	-42.60 [-70.35, -14.85]
ROH 2021	137.9	155.5	74	149.1	128.3	74	1.1%	-11.20 [-57.13, 34.73]
SHIBASAKI 2020	36	155.8	359	29	358.3	1042	2.0%	7.00 [-20.07, 34.07]
TIAN 2022	73.67	83.15	456	98.08	101.24	456	3.2%	-24.41 [-36.43, -12.39]
WANG WJ 2019	148.6	51.2	223	143.5	54.9	223	3.3%	5.10 [-4.75, 14.95]
YANG 2020	154.37	89.68	126	183.77	95.39	126	2.3%	-29.40 [-52.26, -6.54]
YE 2020	150	151	285	166	139	285	2.3%	-16.00 [-39.83, 7.83]
ZHENG-YAN 2020	112.1	56.7	516	139	69.5	516	3.5%	-26.90 [-34.64, -19.16]
Subtotal (95% CI)			**4268**			**5419**	**50.0%**	**-20.28 [-26.42, -14.14]**
Heterogeneity: Tau² = 102.12; Chi² = 92.49, df = 19 (P < 0.00001); I² = 79%								
Test for overall effect: Z = 6.47 (P < 0.00001)								
1.2.2 Without PSM								
AKTAS 2020	80	17.5	30	100	195	64	1.0%	-20.00 [-68.18, 28.18]
ALHOASSAINI 2020	202	194	25	166	155	30	0.3%	36.00 [-58.12, 130.12]
CIANCHI 2016	99.5	7.6	30	118.7	10.7	41	3.6%	-19.20 [-23.46, -14.94]
HIKAGE 2022	32.5	132.5	36	30	101	58	1.0%	2.50 [-47.99, 52.99]
HUANG 2014	79.6	77.1	72	116	135.3	73	1.5%	-36.40 [-72.18, -0.62]
HYUN 2013	131.3	10.1	38	130.48	17.8	83	3.6%	0.82 [-4.18, 5.82]
JUNFENG 2014	118.3	55.8	120	137.6	61.6	394	3.2%	-19.30 [-30.99, -7.61]
KANG 2012	93.25	84.59	100	173.45	145.19	282	2.3%	-80.20 [-103.91, -56.49]
KIM HI 2014	59.8	71.6	172	134.9	246.7	481	2.2%	-75.10 [-99.61, -50.59]
KIM HI 2016	50	82.5	185	55	137.3	185	2.3%	-5.00 [-28.08, 18.08]
KIM KM 2012	85	160	436	112	229	861	2.4%	-27.00 [-48.44, -5.56]
KIM MC 2010	30.3	15.1	16	44.7	37.1	11	2.3%	-14.40 [-37.54, 8.74]
LEE 2015	47	57.9	133	87.1	216.9	267	2.0%	-40.10 [-67.92, -12.28]
LIU 2018	100	16.6	100	100	8.33	135	3.6%	0.00 [-3.54, 3.54]
NAKAUCHI 2016	44	155.6	84	33	169.5	437	1.5%	11.00 [-25.88, 47.88]
NOSHIRO 2014	96	114	21	115	174	160	0.8%	-19.00 [-74.72, 36.72]
PARK 2015	171.3	141.5	145	145.5	134.5	612	2.2%	25.80 [0.42, 51.18]
PUGLIESE 2010	90	48	16	148	53	48	2.0%	-58.00 [-85.89, -30.11]
SHEN 2016	176.6	217.2	93	212.5	198.8	330	1.0%	-35.90 [-84.98, 13.18]
SON G 2009	94.8	121.5	20	39.5	27.7	20	0.9%	55.30 [0.68, 109.92]
SON SY 2012	173.2	96.3	21	116.6	76.8	42	1.1%	56.60 [9.31, 103.89]
SON T 2014	163.4	255.1	51	210.7	254.9	58	0.3%	-47.30 [-143.24, 48.64]
SUDA 2015	46	155.7	88	34	169.5	438	1.5%	12.00 [-24.20, 48.20]
UYAMA 2012	51.8	38.2	25	81	104.6	225	2.5%	-29.20 [-49.47, -8.93]
WOO 2011	91.6	152.6	236	147.9	269	591	1.9%	-56.30 [-85.44, -27.16]
YANG 2017	52.6	92.2	173	65.9	111.6	511	2.8%	-13.30 [-30.10, 3.50]
Subtotal (95% CI)			**2466**			**6437**	**50.0%**	**-18.65 [-27.27, -10.03]**
Heterogeneity: Tau² = 276.44; Chi² = 188.80, df = 25 (P < 0.00001); I² = 87%								
Test for overall effect: Z = 4.24 (P < 0.0001)								
Total (95% CI)			**6734**			**11856**	**100.0%**	**-19.43 [-25.23, -13.62]**
Heterogeneity: Tau² = 238.44; Chi² = 541.69, df = 45 (P < 0.00001); I² = 92%								
Test for overall effect: Z = 6.56 (P < 0.00001)								
Test for subgroup differences: Chi² = 0.09, df = 1 (P = 0.76), I² = 0%								



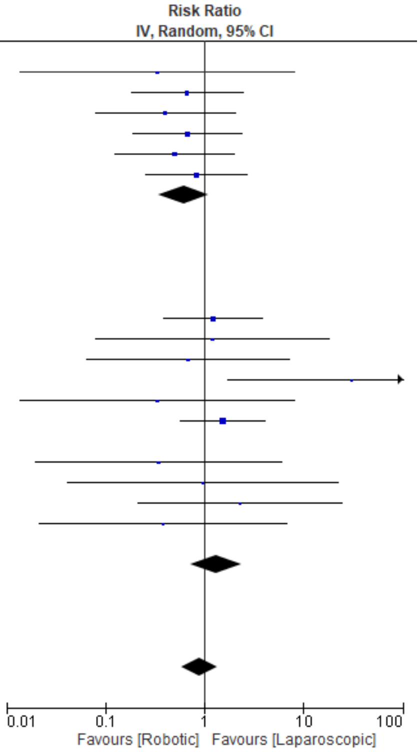
- **Conversion**

Study or Subgroup	Robotic surgery Events	Robotic surgery Total	Laparoscopic surgery Events	Laparoscopic surgery Total	Weight	Risk Ratio IV, Random, 95% CI
1.3.1 With PSM						
GAO 2022	3	410	6	410	10.9%	0.50 [0.13, 1.99]
GAO Y 2019	2	163	1	163	3.6%	2.00 [0.18, 21.84]
HAN 2015	0	68	0	68		Not estimable
ISOBE 2021	0	50	0	50		Not estimable
KONG 2020	3	266	15	532	13.7%	0.40 [0.12, 1.37]
LU 2018	0	101	0	303		Not estimable
OBAMA K 2018	0	311	1	311	2.0%	0.33 [0.01, 8.15]
PARISI 2017	7	151	8	151	21.2%	0.88 [0.33, 2.35]
ROH 2020	0	51	0	51		Not estimable
ROH 2021	0	74	1	74	2.0%	0.33 [0.01, 8.05]
SHIBASAKI 2020	0	354	0	354		Not estimable
TIAN 2022	3	456	7	456	11.4%	0.43 [0.11, 1.65]
Subtotal (95% CI)		**2455**		**2923**	**64.8%**	**0.59 [0.33, 1.03]**
Total events	18		39			
Heterogeneity: Tau² = 0.00; Chi² = 2.51, df = 6 (P = 0.87); I² = 0%						
Test for overall effect: Z = 1.85 (P = 0.06)						
1.3.2 Without PSM						
AKTAS 2020	0	30	8	64	2.6%	0.12 [0.01, 2.07]
ALHOASSAINI 2020	0	25	4	30	2.5%	0.13 [0.01, 2.35]
CIANCHI 2016	0	30	0	41		Not estimable
EOM 2012	0	30	0	62		Not estimable
HYUN 2013	0	38	0	83		Not estimable
KIM HI 2014	0	172	0	481		Not estimable
KIM HI 2016	1	185	2	185	3.6%	0.50 [0.05, 5.47]
KIM MC 2010	0	16	0	11		Not estimable
KIM YW 2016	2	87	0	288	2.3%	16.42 [0.80, 338.83]
NAKAUCHI 2016	0	84	0	437		Not estimable
NOSHIRO 2014	0	21	0	160		Not estimable
OKUMURA 2016	0	370	1	132	2.0%	0.12 [0.00, 2.92]
PARK 2015	3	145	10	612	12.7%	1.27 [0.35, 4.54]
PUGLIESE 2010	2	16	3	48	7.2%	2.00 [0.37, 10.92]
SHEN 2016	0	93	0	330		Not estimable
SON G 2009	0	20	0	20		Not estimable
SON T 2014	0	51	0	58		Not estimable
SUDA 2015	0	88	0	438		Not estimable
UYAMA 2012	0	25	0	225		Not estimable
WOO 2011	0	236	0	591		Not estimable
YANG 2017	0	173	2	511	2.3%	0.59 [0.03, 12.20]
Subtotal (95% CI)		**1935**		**4807**	**35.2%**	**0.77 [0.29, 2.09]**
Total events	8		30			
Heterogeneity: Tau² = 0.60; Chi² = 10.11, df = 7 (P = 0.18); I² = 31%						
Test for overall effect: Z = 0.51 (P = 0.61)						
Total (95% CI)		**4390**		**7730**	**100.0%**	**0.68 [0.43, 1.07]**
Total events	26		69			
Heterogeneity: Tau² = 0.00; Chi² = 13.35, df = 14 (P = 0.50); I² = 0%						
Test for overall effect: Z = 1.67 (P = 0.09)						
Test for subgroup differences: Chi² = 0.23, df = 1 (P = 0.63), I² = 0%						



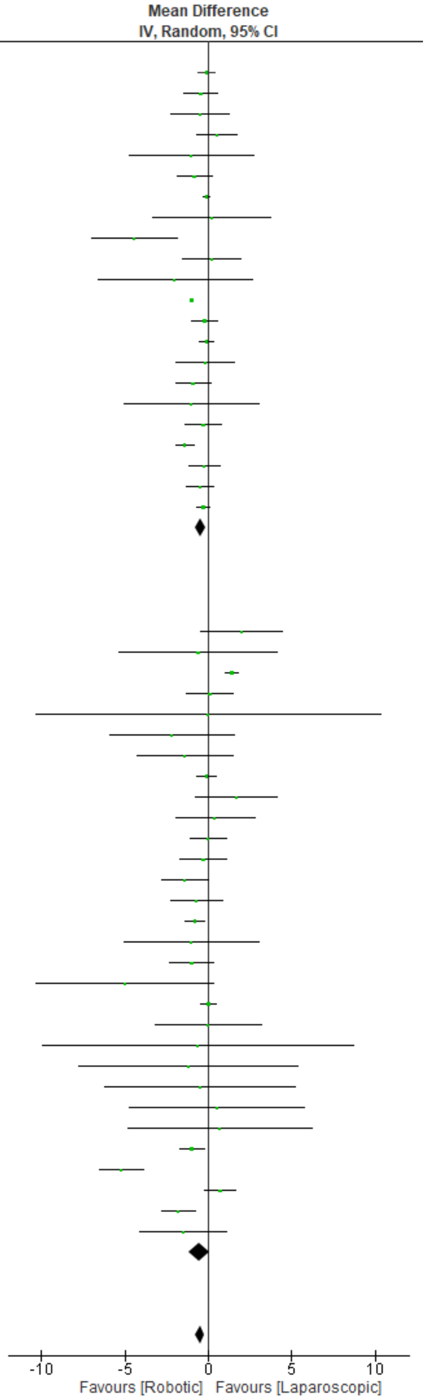
- **Reoperation**

Study or Subgroup	Robotic surgery Events	Robotic surgery Total	Laparoscopic surgery Events	Laparoscopic surgery Total	Weight	Risk Ratio IV, Random, 95% CI
1.4.1 With PSM						
HAN 2015	0	68	1	68	1.7%	0.33 [0.01, 8.04]
KONG 2020	3	266	9	532	10.2%	0.67 [0.18, 2.44]
PARISI 2017	2	151	5	151	6.5%	0.40 [0.08, 2.03]
SHIBASAKI 2020	4	354	6	354	10.9%	0.67 [0.19, 2.34]
TIAN 2022	3	456	6	456	9.0%	0.50 [0.13, 1.99]
YE 2020	5	285	6	285	12.5%	0.83 [0.26, 2.70]
Subtotal (95% CI)		**1580**		**1846**	**50.9%**	**0.61 [0.34, 1.10]**
Total events	17		33			
Heterogeneity: Tau² = 0.00; Chi² = 0.79, df = 5 (P = 0.98); I² = 0%						
Test for overall effect: Z = 1.65 (P = 0.10)						
1.4.2 Without PSM						
AKTAS 2020	4	30	7	64	13.0%	1.22 [0.39, 3.85]
ALHOASSAINI 2020	1	25	1	30	2.3%	1.20 [0.08, 18.23]
CIANCHI 2016	1	30	2	41	3.1%	0.68 [0.06, 7.19]
KANG 2012	5	100	0	282	2.1%	30.82 [1.72, 552.44]
KIM HI 2016	0	185	1	185	1.7%	0.33 [0.01, 8.13]
KIM KM 2012	7	436	9	861	17.9%	1.54 [0.58, 4.10]
KIM MC 2010	0	16	0	11		Not estimable
NAKAUCHI 2016	0	84	7	437	2.1%	0.34 [0.02, 5.96]
PUGLIESE 2010	0	16	1	48	1.7%	0.96 [0.04, 22.48]
SON T 2014	2	51	1	58	3.1%	2.27 [0.21, 24.35]
SUDA 2015	0	88	6	438	2.1%	0.38 [0.02, 6.67]
YOON 2012	0	36	0	65		Not estimable
Subtotal (95% CI)		**1097**		**2520**	**49.1%**	**1.30 [0.72, 2.35]**
Total events	20		35			
Heterogeneity: Tau² = 0.00; Chi² = 7.53, df = 9 (P = 0.58); I² = 0%						
Test for overall effect: Z = 0.87 (P = 0.38)						
Total (95% CI)		**2677**		**4366**	**100.0%**	**0.89 [0.59, 1.34]**
Total events	37		68			
Heterogeneity: Tau² = 0.00; Chi² = 11.47, df = 15 (P = 0.72); I² = 0%						
Test for overall effect: Z = 0.57 (P = 0.57)						
Test for subgroup differences: Chi² = 3.16, df = 1 (P = 0.08), I² = 68.4%						



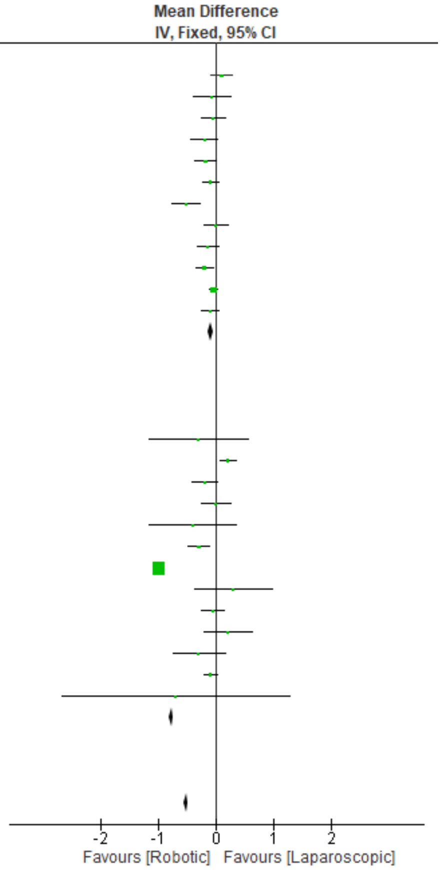
- **Length of Hospital Stay**

Study or Subgroup	Robotic Mean	Robotic SD	Robotic Total	Laparoscopic Mean	Laparoscopic SD	Laparoscopic Total	Weight	Mean Difference IV, Random, 95% CI
2.1.1 With PSM								
GAO 2022	9	3.9	410	9.1	3.5	410	3.6%	-0.10 [-0.61, 0.41]
GAO Y 2019	7.09	4.3	163	7.55	4.79	163	2.8%	-0.46 [-1.45, 0.53]
HAN 2015	8.6	4.2	68	9.1	6.1	68	1.6%	-0.50 [-2.26, 1.26]
HONG 2016	7.6	8.6	232	7.1	4.1	232	2.4%	0.50 [-0.73, 1.73]
ISOBE 2021	12	5.6	50	13	12.3	50	0.5%	-1.00 [-4.75, 2.75]
KONG 2020	9.53	6.29	266	10.35	8.66	532	2.7%	-0.82 [-1.87, 0.23]
LI Z 2018	6.9	0.66	112	7	0.66	112	4.0%	-0.10 [-0.27, 0.07]
LU 2018	11.9	4.83	101	11.69	30	303	0.6%	0.21 [-3.30, 3.72]
NISHI 2022	11.73	4.58	79	16.15	10.7	79	1.0%	-4.42 [-6.99, -1.85]
OBAMA K 2018	7.2	10	311	7	12.1	311	1.7%	0.20 [-1.54, 1.94]
OKABE 2021	10	14	93	12	17.83	93	0.4%	-2.00 [-6.61, 2.61]
OMORI 2022	7	0.33	210	8	0.5	210	4.1%	-1.00 [-1.08, -0.92]
PARISI 2017	8.85	4.1	151	9.07	2.6	151	3.2%	-0.22 [-0.99, 0.55]
ROH 2020	5.1	1.2	51	5.2	0.9	51	3.8%	-0.10 [-0.51, 0.31]
ROH 2021	9	5	74	9.2	5.7	74	1.7%	-0.20 [-1.93, 1.53]
RYAN 2020	10.2	11.1	631	11.1	11.2	1262	2.6%	-0.90 [-1.96, 0.16]
SHIBASAKI 2020	12	32.17	354	13	21.33	354	0.5%	-1.00 [-5.02, 3.02]
TIAN 2022	7.31	7.83	456	7.6	8.97	456	2.6%	-0.29 [-1.38, 0.80]
WANG WJ 2019	10.2	2.6	223	11.6	3.4	223	3.6%	-1.40 [-1.96, -0.84]
YANG 2020	9.62	2.86	126	9.86	4.31	126	2.9%	-0.24 [-1.14, 0.66]
YE 2020	9	4.5	285	9.5	5.3	285	3.1%	-0.50 [-1.31, 0.31]
ZHENG-YAN 2020	7.2	2.7	516	7.5	3.2	516	3.9%	-0.30 [-0.66, 0.06]
Subtotal (95% CI)			**4962**			**6061**	**53.1%**	**-0.48 [-0.80, -0.16]**
Heterogeneity: Tau² = 0.29; Chi² = 135.92, df = 21 (P < 0.00001); I² = 85%								
Test for overall effect: Z = 2.96 (P = 0.003)								
2.1.2 Without PSM								
AKTAS 2020	8	4.75	30	6	7.25	64	1.0%	2.00 [-0.46, 4.46]
ALHOASSAINI 2020	8.9	7.9	25	9.5	10	30	0.3%	-0.60 [-5.33, 4.13]
CIANCHI 2016	9.5	1	30	8.1	0.5	41	3.8%	1.40 [1.01, 1.79]
EOM 2012	7.9	3.2	30	7.8	3.2	62	2.1%	0.10 [-1.29, 1.49]
HIKAGE 2022	9	4	36	9	39.75	58	0.1%	0.00 [-10.31, 10.31]
HUANG 2014	11	11.8	72	13.2	11.1	73	0.5%	-2.20 [-5.93, 1.53]
HYUN 2013	10.5	5.9	38	11.9	10.3	83	0.8%	-1.40 [-4.30, 1.50]
JUNFENG 2014	7.8	3	120	7.9	2.3	394	3.5%	-0.10 [-0.68, 0.48]
KANG 2012	9.8	12.2	100	8.1	4.1	282	1.1%	1.70 [-0.74, 4.14]
KIM HI 2014	7.1	15.5	172	6.7	5.7	481	1.1%	0.40 [-1.97, 2.77]
KIM HI 2016	6	5.2	185	6	5.8	185	2.5%	0.00 [-1.12, 1.12]
KIM KM 2012	7.5	13.7	436	7.8	8.5	861	2.1%	-0.30 [-1.71, 1.11]
KIM MC 2010	5.1	0.3	16	6.5	2.4	11	2.1%	-1.40 [-2.83, 0.03]
KIM YW 2016	6.7	6.09	87	7.4	7.86	288	1.9%	-0.70 [-2.27, 0.87]
LEE 2015	6.2	2.3	133	7	3.8	267	3.5%	-0.80 [-1.40, -0.20]
LIU 2018	11	8.95	100	12	21.33	135	0.5%	-1.00 [-5.00, 3.00]
NAKAUCHI 2016	14	5	84	15	8.7	437	2.2%	-1.00 [-2.34, 0.34]
NOSHIRO 2014	8	12	21	13	9.16	160	0.3%	-5.00 [-10.33, 0.33]
PARK 2015	7.9	3	145	7.9	1.5	612	3.6%	0.00 [-0.50, 0.50]
PUGLIESE 2010	10	1.7	16	10	10.9	48	0.7%	0.00 [-3.19, 3.19]
SEO 2015	6.75	7.5	40	7.37	29	40	0.1%	-0.62 [-9.90, 8.66]
SHEN 2016	9.4	32.2	93	10.6	2.2	330	0.2%	-1.20 [-7.75, 5.35]
SON G 2009	5.7	4.8	20	6.2	12.1	20	0.2%	-0.50 [-6.20, 5.20]
SON SY 2012	6.4	12	21	5.9	3.1	42	0.3%	0.50 [-4.72, 5.72]
SON T 2014	8.6	1	51	7.9	21.3	58	0.3%	0.70 [-4.79, 6.19]
SUDA 2015	14	3.2	88	15	3.2	438	3.3%	-1.00 [-1.73, -0.27]
UYAMA 2012	12.1	2.8	25	17.3	5.7	225	2.2%	-5.20 [-6.53, -3.87]
WOO 2011	7.7	1.9	236	7	10.8	591	2.9%	0.70 [-0.20, 1.60]
YANG 2017	5.9	3.3	173	7.7	10	511	2.8%	-1.80 [-2.80, -0.80]
YOON 2012	8.8	7.9	36	10.3	0.5	65	1.0%	-1.50 [-4.08, 1.08]
Subtotal (95% CI)			**2659**			**6892**	**46.9%**	**-0.55 [-1.15, 0.04]**
Heterogeneity: Tau² = 1.50; Chi² = 156.36, df = 29 (P < 0.00001); I² = 81%								
Test for overall effect: Z = 1.82 (P = 0.07)								
Total (95% CI)			**7621**			**12953**	**100.0%**	**-0.50 [-0.79, -0.21]**
Heterogeneity: Tau² = 0.54; Chi² = 340.57, df = 51 (P < 0.00001); I² = 85%								
Test for overall effect: Z = 3.39 (P = 0.0007)								
Test for subgroup differences: Chi² = 0.04, df = 1 (P = 0.84), I² = 0%								



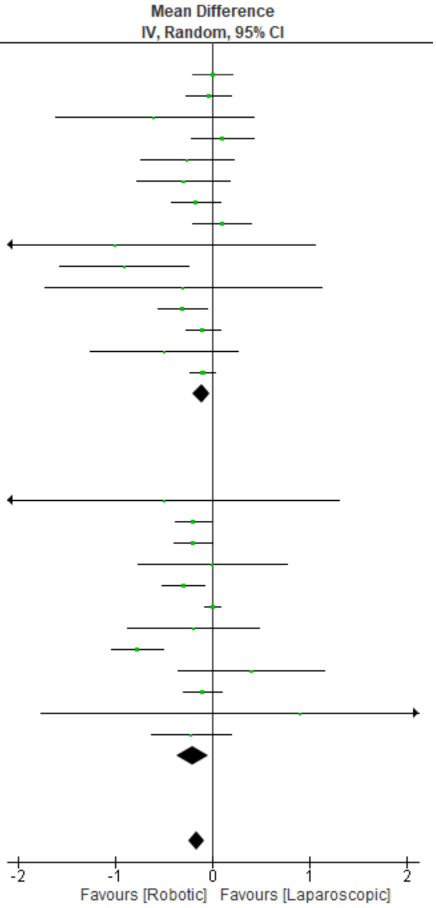
- **Time to First Flatus**

Study or Subgroup	Robotic Mean	Robotic SD	Robotic Total	Laparoscopic Mean	Laparoscopic SD	Laparoscopic Total	Weight	Mean Difference IV, Fixed, 95% CI
2.2.1 With PSM								
GAO 2022	2.8	1.3	410	2.7	1.4	410	2.0%	0.10 [-0.08, 0.28]
GAO Y 2019	2.82	1.48	163	2.89	1.6	163	0.6%	-0.07 [-0.40, 0.26]
KONG 2020	3.36	1.43	266	3.41	1.4	532	1.5%	-0.05 [-0.26, 0.16]
LI Z 2018	2.6	0.6	112	2.8	1.1	112	1.2%	-0.20 [-0.43, 0.03]
LU 2018	3.27	0.8	101	3.45	0.95	303	1.9%	-0.18 [-0.37, 0.01]
OBAMA K 2018	2.8	0.8	311	2.9	1	311	3.3%	-0.10 [-0.24, 0.04]
PARISI 2017	3.23	1.33	151	3.75	0.76	151	1.1%	-0.52 [-0.76, -0.28]
ROH 2020	2.9	0.4	51	2.9	0.7	51	1.4%	0.00 [-0.22, 0.22]
TIAN 2022	2.72	1.49	456	2.86	1.42	456	1.9%	-0.14 [-0.33, 0.05]
WANG WJ 2019	2.7	0.6	223	2.9	0.9	223	3.3%	-0.20 [-0.34, -0.06]
YE 2020	2.31	0.27	285	2.35	0.5	285	15.4%	-0.04 [-0.11, 0.03]
ZHENG-YAN 2020	3.1	1.3	516	3.2	1.1	516	3.1%	-0.10 [-0.25, 0.05]
Subtotal (95% CI)			**3045**			**3513**	**36.8%**	**-0.09 [-0.13, -0.05]**
Heterogeneity: Chi² = 23.29, df = 11 (P = 0.02); I² = 53%								
Test for overall effect: Z = 4.10 (P < 0.0001)								
2.2.2 Without PSM								
ALHOASSAINI 2020	3.2	0.7	25	3.5	2.3	30	0.1%	-0.30 [-1.17, 0.57]
CIANCHI 2016	3.2	0.3	30	3	0.3	41	3.4%	0.20 [0.06, 0.34]
JUNFENG 2014	3.1	1.1	120	3.3	0.9	394	1.4%	-0.20 [-0.42, 0.02]
KIM HI 2016	3	1.5	185	3	1	185	1.0%	0.00 [-0.26, 0.26]
KIM MC 2010	3.2	1.1	16	3.6	0.9	11	0.1%	-0.40 [-1.16, 0.36]
KIM YW 2016	3.5	0.8	87	3.8	0.8	288	1.8%	-0.30 [-0.49, -0.11]
LIU 2018	2	0.16	100	3	0.12	135	48.2%	-1.00 [-1.04, -0.96]
SHEN 2016	3.1	3.1	93	2.8	2.2	330	0.1%	0.30 [-0.37, 0.97]
SON G 2009	3	0.4	20	3.05	0.22	20	1.7%	-0.05 [-0.25, 0.15]
SON SY 2012	3.5	0.8	21	3.3	0.8	42	0.4%	0.20 [-0.22, 0.62]
SON T 2014	2.9	0.7	51	3.2	1.6	58	0.3%	-0.30 [-0.75, 0.15]
YANG 2017	3	0.7	173	3.1	0.7	511	4.6%	-0.10 [-0.22, 0.02]
YOON 2012	4.2	1.4	36	4.9	7.9	65	0.0%	-0.70 [-2.67, 1.27]
Subtotal (95% CI)			**957**			**2110**	**63.2%**	**-0.77 [-0.81, -0.74]**
Heterogeneity: Chi² = 615.06, df = 12 (P < 0.00001); I² = 98%								
Test for overall effect: Z = 46.59 (P < 0.00001)								
Total (95% CI)			**4002**			**5623**	**100.0%**	**-0.52 [-0.55, -0.50]**
Heterogeneity: Chi² = 1263.70, df = 24 (P < 0.00001); I² = 98%								
Test for overall effect: Z = 39.53 (P < 0.00001)								
Test for subgroup differences: Chi² = 625.34, df = 1 (P < 0.00001), I² = 99.8%								



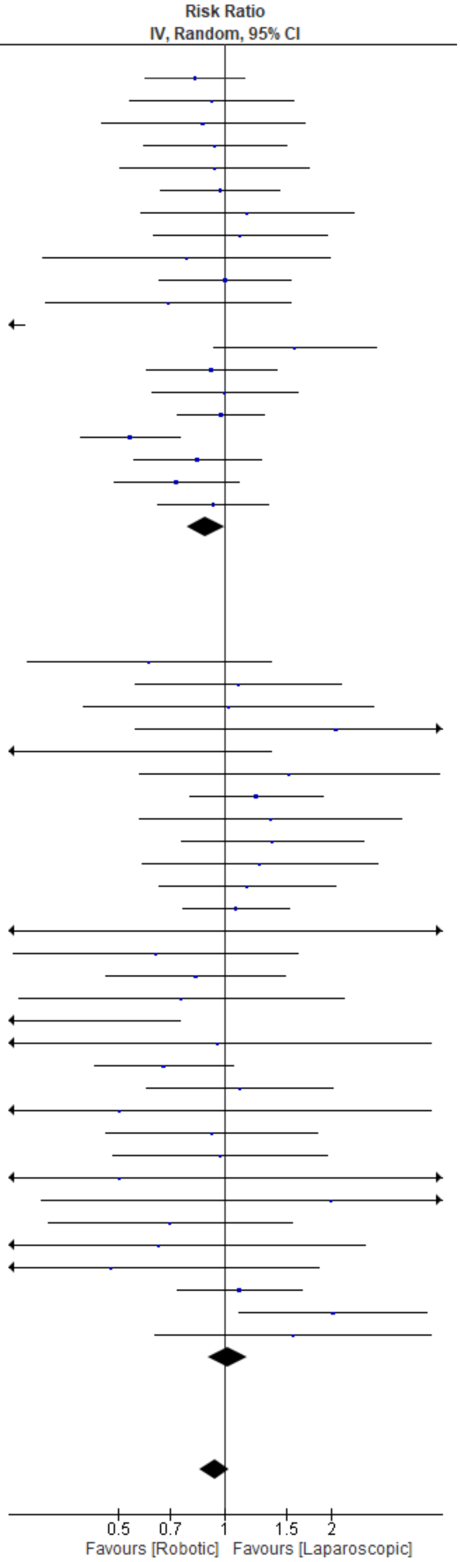
- **Time to Oral Intake**

Study or Subgroup	Robotic Mean	Robotic SD	Robotic Total	Laparoscopic Mean	Laparoscopic SD	Laparoscopic Total	Weight	Mean Difference IV, Random, 95% CI
2.3.1 With PSM								
GAO 2022	3.3	1.3	410	3.3	1.6	410	6.4%	0.00 [-0.20, 0.20]
GAO Y 2019	3.26	0.96	163	3.3	1.19	163	5.6%	-0.04 [-0.27, 0.19]
HAN 2015	4.4	0.9	68	5	4.2	68	0.6%	-0.60 [-1.62, 0.42]
HONG 2016	4.9	2.1	232	4.8	1.4	232	4.0%	0.10 [-0.22, 0.42]
KONG 2020	4.85	2.9	266	5.11	3.87	532	2.4%	-0.26 [-0.74, 0.22]
LI Z 2018	3.6	1.6	112	3.9	2	112	2.4%	-0.30 [-0.77, 0.17]
LU 2018	5.01	0.96	101	5.18	1.44	303	5.3%	-0.17 [-0.42, 0.08]
OBAMA K 2018	4.4	2	311	4.3	1.8	311	4.4%	0.10 [-0.20, 0.40]
OKABE 2021	3	9.33	93	4	3.83	93	0.2%	-1.00 [-3.05, 1.05]
PARISI 2017	3.21	2.41	151	4.12	3.37	151	1.4%	-0.91 [-1.57, -0.25]
ROH 2021	6.1	4	74	6.4	4.8	74	0.3%	-0.30 [-1.72, 1.12]
TIAN 2022	4.43	1.87	456	4.74	2.03	456	5.2%	-0.31 [-0.56, -0.06]
WANG WJ 2019	3.9	0.8	223	4	1.1	223	6.8%	-0.10 [-0.28, 0.08]
YE 2020	5.5	4.1	285	6	5.1	285	1.1%	-0.50 [-1.26, 0.26]
ZHENG-YAN 2020	3.5	1.2	516	3.6	0.9	516	8.0%	-0.10 [-0.23, 0.03]
Subtotal (95% CI)			**3461**			**3929**	**54.1%**	**-0.12 [-0.20, -0.03]**
Heterogeneity: Tau² = 0.00; Chi² = 16.97, df = 14 (P = 0.26); I² = 18%								
Test for overall effect: Z = 2.65 (P = 0.008)								
2.3.2 Without PSM								
ALHOASSAINI 2020	4.9	2.9	25	5.4	3.9	30	0.2%	-0.50 [-2.30, 1.30]
CIANCHI 2016	5.2	0.3	30	5.4	0.5	41	6.6%	-0.20 [-0.39, -0.01]
JUNFENG 2014	3.9	1	120	4.1	0.9	394	6.3%	-0.20 [-0.40, -0.00]
KIM HI 2016	4	5.3	185	4	0.8	185	1.1%	0.00 [-0.77, 0.77]
KIM KM 2012	4.4	1.8	436	4.7	2.2	861	5.8%	-0.30 [-0.52, -0.08]
LIU 2018	4	0.33	100	4	0.33	135	9.0%	0.00 [-0.09, 0.09]
PUGLIESE 2010	4.8	1.3	16	5	0.8	48	1.3%	-0.20 [-0.88, 0.48]
SEO 2015	3.52	0.5	40	4.3	0.7	40	5.0%	-0.78 [-1.05, -0.51]
SHEN 2016	3.8	3.5	93	3.4	2.4	330	1.1%	0.40 [-0.36, 1.16]
SON G 2009	4	0.01	20	4.1	0.45	20	6.4%	-0.10 [-0.30, 0.10]
SON T 2014	5.7	9.5	51	4.8	2.2	58	0.1%	0.90 [-1.77, 3.57]
UYAMA 2012	3.56	1	25	3.78	0.91	225	3.0%	-0.22 [-0.63, 0.19]
Subtotal (95% CI)			**1141**			**2367**	**45.9%**	**-0.21 [-0.36, -0.05]**
Heterogeneity: Tau² = 0.04; Chi² = 37.90, df = 11 (P < 0.0001); I² = 71%								
Test for overall effect: Z = 2.55 (P = 0.01)								
Total (95% CI)			**4602**			**6296**	**100.0%**	**-0.17 [-0.25, -0.08]**
Heterogeneity: Tau² = 0.02; Chi² = 54.93, df = 26 (P = 0.0008); I² = 53%								
Test for overall effect: Z = 3.85 (P = 0.0001)								
Test for subgroup differences: Chi² = 0.97, df = 1 (P = 0.32), I² = 0%								



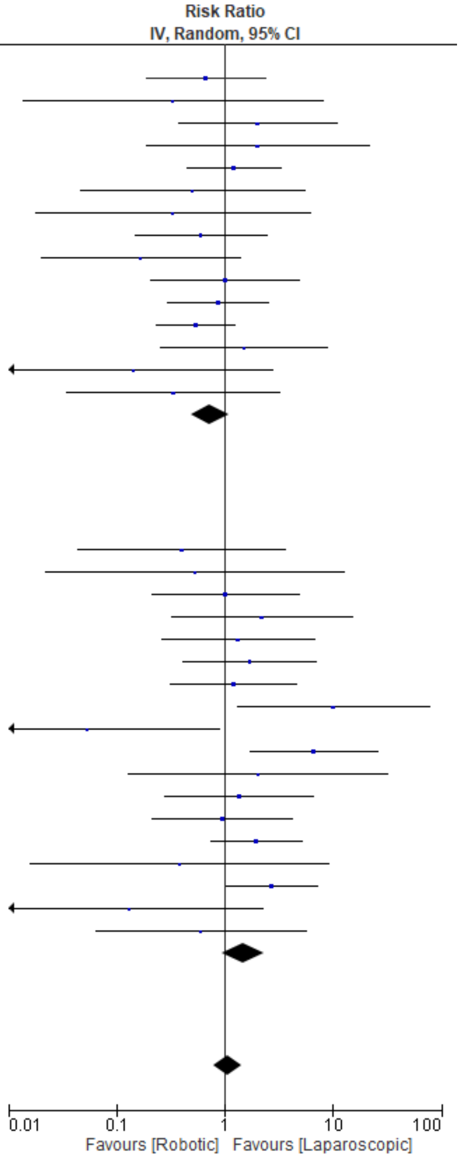
- **Overall Complications**

Study or Subgroup	Robotic Events	Robotic Total	Laparoscopic Events	Laparoscopic Total	Weight	Risk Ratio IV, Random, 95% CI
2.4.1 With PSM						
GAO 2022	56	410	68	410	4.9%	0.82 [0.59, 1.14]
GAO Y 2019	22	163	24	163	2.4%	0.92 [0.54, 1.57]
HAN 2015	13	68	15	68	1.7%	0.87 [0.45, 1.68]
HONG 2016	30	232	32	232	3.0%	0.94 [0.59, 1.49]
ISOBE 2021	14	50	15	50	1.9%	0.93 [0.51, 1.72]
KONG 2020	33	266	68	532	3.9%	0.97 [0.66, 1.43]
LI Z 2018	15	112	13	112	1.6%	1.15 [0.58, 2.31]
LU 2018	14	101	38	303	2.2%	1.11 [0.63, 1.95]
NISHI 2022	7	79	9	79	0.9%	0.78 [0.30, 1.99]
OBAMA K 2018	36	311	36	311	3.3%	1.00 [0.65, 1.54]
OKABE 2021	9	93	13	93	1.2%	0.69 [0.31, 1.54]
OMORI 2022	1	210	27	210	0.2%	0.04 [0.01, 0.27]
PARISI 2017	30	151	19	151	2.5%	1.58 [0.93, 2.68]
ROH 2020	22	51	24	51	3.4%	0.92 [0.60, 1.41]
ROH 2021	23	74	23	74	2.9%	1.00 [0.62, 1.62]
TIAN 2022	78	456	80	456	5.7%	0.97 [0.73, 1.29]
WANG WJ 2019	42	223	78	223	4.9%	0.54 [0.39, 0.75]
YANG 2020	30	126	36	126	3.5%	0.83 [0.55, 1.26]
YE 2020	35	285	48	285	3.7%	0.73 [0.49, 1.09]
ZHENG-YAN 2020	51	516	55	516	4.3%	0.93 [0.65, 1.33]
Subtotal (95% CI)		**3977**		**4445**	**58.1%**	**0.88 [0.78, 1.00]**
Total events	561		721			
Heterogeneity: Tau² = 0.02; Chi² = 27.45, df = 19 (P = 0.09); I² = 31%						
Test for overall effect: Z = 1.90 (P = 0.06)						
2.4.2 Without PSM						
AKTAS 2020	6	30	21	64	1.2%	0.61 [0.27, 1.35]
ALHOASSAINI 2020	10	25	11	30	1.7%	1.09 [0.56, 2.14]
CIANCHI 2016	6	30	8	41	0.9%	1.02 [0.40, 2.65]
EOM 2012	4	30	4	62	0.5%	2.07 [0.55, 7.70]
HIKAGE 2022	1	36	9	58	0.2%	0.18 [0.02, 1.35]
HUANG 2014	9	72	6	73	0.8%	1.52 [0.57, 4.05]
HYUN 2013	18	38	32	83	3.4%	1.23 [0.80, 1.89]
JUNFENG 2014	7	120	17	394	1.1%	1.35 [0.57, 3.18]
KANG 2012	14	100	29	282	2.0%	1.36 [0.75, 2.47]
KIM HI 2014	9	172	20	481	1.3%	1.26 [0.58, 2.71]
KIM HI 2016	22	185	19	185	2.1%	1.16 [0.65, 2.07]
KIM KM 2012	44	436	81	861	4.5%	1.07 [0.76, 1.52]
KIM MC 2010	0	16	1	11	0.1%	0.24 [0.01, 5.30]
KIM YW 2016	5	87	26	288	0.9%	0.64 [0.25, 1.61]
LEE 2015	14	133	34	267	2.1%	0.83 [0.46, 1.49]
LIU 2018	5	100	9	135	0.7%	0.75 [0.26, 2.17]
NAKAUCHI 2016	2	84	56	437	0.4%	0.19 [0.05, 0.75]
NOSHIRO 2014	2	21	16	160	0.4%	0.95 [0.24, 3.85]
OKUMURA 2016	45	370	24	132	3.1%	0.67 [0.42, 1.05]
PARK 2015	12	145	46	612	2.0%	1.10 [0.60, 2.02]
PUGLIESE 2010	1	16	6	48	0.2%	0.50 [0.07, 3.85]
SEO 2015	11	40	12	40	1.6%	0.92 [0.46, 1.83]
SHEN 2016	9	93	33	330	1.5%	0.97 [0.48, 1.95]
SON G 2009	1	20	2	20	0.2%	0.50 [0.05, 5.08]
SON SY 2012	2	21	2	42	0.2%	2.00 [0.30, 13.22]
SON T 2014	8	51	13	58	1.2%	0.70 [0.32, 1.55]
SUDA 2015	2	25	54	438	0.5%	0.65 [0.17, 2.51]
UYAMA 2012	2	25	38	225	0.5%	0.47 [0.12, 1.85]
WOO 2011	26	173	81	591	3.6%	1.10 [0.73, 1.65]
YANG 2017	9	36	63	511	1.9%	2.03 [1.10, 3.74]
YOON 2012	6	25	10	65	1.0%	1.56 [0.63, 3.84]
Subtotal (95% CI)		**2755**		**7024**	**41.9%**	**1.02 [0.89, 1.16]**
Total events	312		783			
Heterogeneity: Tau² = 0.00; Chi² = 30.39, df = 30 (P = 0.45); I² = 1%						
Test for overall effect: Z = 0.25 (P = 0.81)						
Total (95% CI)		**6732**		**11469**	**100.0%**	**0.93 [0.85, 1.03]**
Total events	873		1504			
Heterogeneity: Tau² = 0.02; Chi² = 61.00, df = 50 (P = 0.14); I² = 18%						
Test for overall effect: Z = 1.44 (P = 0.15)						
Test for subgroup differences: Chi² = 2.27, df = 1 (P = 0.13), I² = 56.0%						



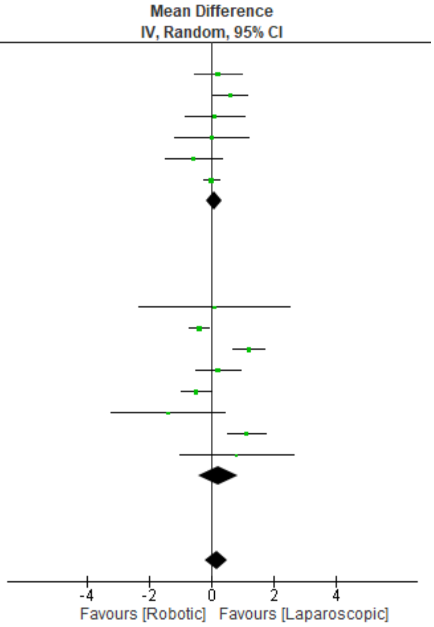
- **Anastomotic Leakage**

Study or Subgroup	Robotic Events	Robotic Total	Laparoscopic Events	Laparoscopic Total	Weight	Risk Ratio IV, Random, 95% CI
2.6.1 With PSM						
GAO 2022	4	410	6	410	4.7%	0.67 [0.19, 2.34]
HAN 2015	0	68	1	68	0.9%	0.33 [0.01, 8.04]
HONG 2016	4	232	2	232	2.9%	2.00 [0.37, 10.81]
ISOBE 2021	2	50	1	50	1.6%	2.00 [0.19, 21.36]
KONG 2020	6	266	10	532	6.5%	1.20 [0.44, 3.27]
LI Z 2018	1	112	2	112	1.6%	0.50 [0.05, 5.44]
LU 2018	0	101	4	303	1.1%	0.33 [0.02, 6.10]
OKABE 2021	3	93	5	93	3.9%	0.60 [0.15, 2.44]
OMORI 2022	1	210	6	210	2.0%	0.17 [0.02, 1.37]
PARISI 2017	3	151	3	151	3.2%	1.00 [0.21, 4.88]
SHIBASAKI 2020	6	354	7	354	5.8%	0.86 [0.29, 2.53]
WANG WJ 2019	8	223	15	223	8.1%	0.53 [0.23, 1.23]
YANG 2020	3	126	2	126	2.7%	1.50 [0.25, 8.82]
YE 2020	0	285	3	285	1.0%	0.14 [0.01, 2.75]
ZHENG-YAN 2020	1	516	3	516	1.7%	0.33 [0.03, 3.19]
Subtotal (95% CI)		**3197**		**3665**	**47.7%**	**0.73 [0.50, 1.08]**
Total events	42		70			
Heterogeneity: Tau² = 0.00; Chi² = 8.65, df = 14 (P = 0.85); I² = 0%						
Test for overall effect: Z = 1.58 (P = 0.11)						
2.6.2 Without PSM						
ALHOASSAINI 2020	1	25	3	30	1.8%	0.40 [0.04, 3.61]
HIKAGE 2022	0	36	1	58	0.9%	0.53 [0.02, 12.71]
HUANG 2014	3	72	3	73	3.3%	1.01 [0.21, 4.86]
HYUN 2013	2	38	2	83	2.3%	2.18 [0.32, 14.93]
JUNFENG 2014	2	120	5	394	3.1%	1.31 [0.26, 6.68]
KANG 2012	3	100	5	282	3.9%	1.69 [0.41, 6.95]
KIM HI 2014	3	172	7	481	4.2%	1.20 [0.31, 4.58]
KIM HI 2016	10	185	1	185	2.1%	10.00 [1.29, 77.33]
KIM KM 2012	0	436	18	861	1.2%	0.05 [0.00, 0.88]
KIM YW 2016	6	87	3	288	4.1%	6.62 [1.69, 25.92]
LEE 2015	1	133	1	267	1.2%	2.01 [0.13, 31.85]
LIU 2018	3	100	3	135	3.2%	1.35 [0.28, 6.55]
NAKAUCHI 2016	2	84	11	437	3.6%	0.95 [0.21, 4.19]
SHEN 2016	6	93	11	330	6.8%	1.94 [0.74, 5.09]
SON T 2014	0	51	1	58	0.9%	0.38 [0.02, 9.08]
SUDA 2015	6	88	11	438	6.8%	2.71 [1.03, 7.15]
WOO 2011	0	236	9	591	1.1%	0.13 [0.01, 2.25]
YOON 2012	1	36	3	65	1.8%	0.60 [0.06, 5.58]
Subtotal (95% CI)		**2092**		**5056**	**52.3%**	**1.47 [0.93, 2.31]**
Total events	49		98			
Heterogeneity: Tau² = 0.20; Chi² = 21.89, df = 17 (P = 0.19); I² = 22%						
Test for overall effect: Z = 1.65 (P = 0.10)						
Total (95% CI)		**5289**		**8721**	**100.0%**	**1.06 [0.78, 1.45]**
Total events	91		168			
Heterogeneity: Tau² = 0.13; Chi² = 38.19, df = 32 (P = 0.21); I² = 16%						
Test for overall effect: Z = 0.37 (P = 0.71)						
Test for subgroup differences: Chi² = 5.20, df = 1 (P = 0.02), I² = 80.8%						



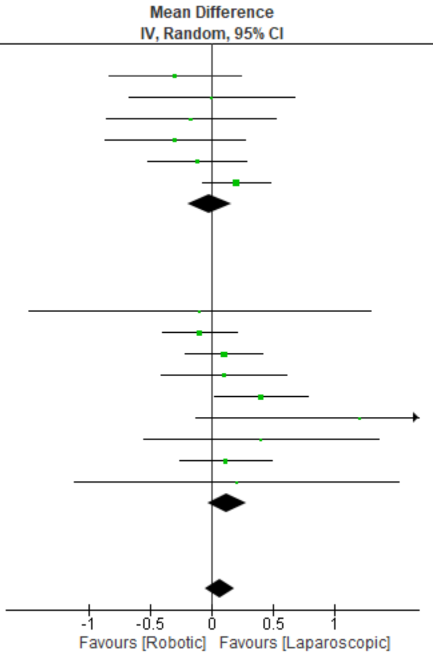
- **Distal resection margin distance**

Study or Subgroup	Robotic surgery Mean	SD	Total	Laparoscopic Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.1.1 With PSM								
HAN 2015	4	2.1	68	3.8	2.5	68	7.6%	0.20 [-0.58, 0.98]
HONG 2016	5.9	3.2	232	5.3	3	232	9.1%	0.60 [0.04, 1.16]
LU 2018	6.24	4.38	101	6.14	3.81	303	6.4%	0.10 [-0.86, 1.06]
ROH 2021	11.9	3.4	74	11.9	4	74	5.0%	0.00 [-1.20, 1.20]
YANG 2020	7.14	3.68	126	7.72	3.83	126	6.5%	-0.58 [-1.51, 0.35]
ZHENG-YAN 2020	4.2	1.9	516	4.2	2.1	516	11.3%	0.00 [-0.24, 0.24]
Subtotal (95% CI)			**1117**			**1319**	**45.8%**	**0.09 [-0.17, 0.34]**
Heterogeneity: Tau² = 0.01; Chi² = 5.71, df = 5 (P = 0.34); I² = 12%								
Test for overall effect: Z = 0.68 (P = 0.50)								
3.1.2 Without PSM								
HYUN 2013	7.3	5.2	38	7.2	8.3	83	1.8%	0.10 [-2.33, 2.53]
JUNFENG 2014	5.2	1.2	120	5.6	2.2	394	10.9%	-0.40 [-0.71, -0.09]
KIM KM 2012	7.4	4.5	436	6.2	3.9	861	9.6%	1.20 [0.70, 1.70]
KIM YW 2016	6.6	3.1	87	6.4	2.8	288	7.9%	0.20 [-0.53, 0.93]
SHEN 2016	5.1	2.3	93	5.6	1.6	330	9.6%	-0.50 [-1.00, -0.00]
SON SY 2012	6.3	3.1	21	7.7	4.2	42	2.8%	-1.40 [-3.24, 0.44]
WOO 2011	7.21	4.33	236	6.08	3.71	591	8.6%	1.13 [0.50, 1.76]
YOON 2012	12.4	4.5	36	11.6	4.5	65	2.8%	0.80 [-1.03, 2.63]
Subtotal (95% CI)			**1067**			**2654**	**54.2%**	**0.21 [-0.44, 0.86]**
Heterogeneity: Tau² = 0.62; Chi² = 48.17, df = 7 (P < 0.00001); I² = 85%								
Test for overall effect: Z = 0.63 (P = 0.53)								
Total (95% CI)			**2184**			**3973**	**100.0%**	**0.16 [-0.19, 0.51]**
Heterogeneity: Tau² = 0.27; Chi² = 53.89, df = 13 (P < 0.00001); I² = 76%								
Test for overall effect: Z = 0.89 (P = 0.37)								
Test for subgroup differences: Chi² = 0.11, df = 1 (P = 0.73), I² = 0%								



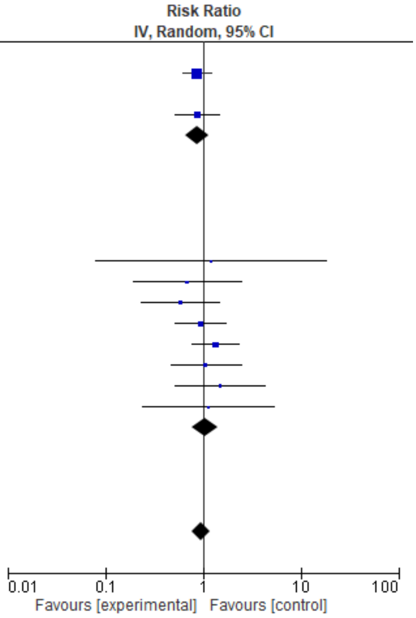
- **Proximal resection margin distance**

Study or Subgroup	Robotic Mean	SD	Total	Laparoscopic Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.2.1 With PSM								
HAN 2015	2.6	1.5	68	2.9	1.7	68	4.8%	-0.30 [-0.84, 0.24]
HONG 2016	4.7	4.4	232	4.7	2.8	232	3.1%	0.00 [-0.67, 0.67]
LU 2018	5.22	3.11	101	5.39	2.94	303	2.9%	-0.17 [-0.86, 0.52]
ROH 2021	2.5	1.5	74	2.8	2	74	4.3%	-0.30 [-0.87, 0.27]
YANG 2017	3.55	1.69	126	3.67	1.53	126	8.9%	-0.12 [-0.52, 0.28]
ZHENG-YAN 2020	5.1	2.4	516	4.9	2.2	516	17.8%	0.20 [-0.08, 0.48]
Subtotal (95% CI)			**1117**			**1319**	**41.9%**	**-0.02 [-0.20, 0.17]**
Heterogeneity: Tau² = 0.00; Chi² = 4.75, df = 5 (P = 0.45); I² = 0%								
Test for overall effect: Z = 0.19 (P = 0.85)								
3.2.2 Without PSM								
HYUN 2013	5.6	3.6	38	5.7	3.7	83	0.7%	-0.10 [-1.49, 1.29]
JUNFENG 2014	5.5	1.2	120	5.6	2.2	394	15.0%	-0.10 [-0.41, 0.21]
KIM KM 2012	3.8	2.8	436	3.7	2.6	861	14.1%	0.10 [-0.22, 0.42]
KIM YW 2016	3.4	2.1	87	3.3	2.2	288	5.4%	0.10 [-0.41, 0.61]
SHEN 2016	5.8	1.6	93	5.4	1.8	330	9.8%	0.40 [0.02, 0.78]
SON SY 2012	5.9	2.9	21	4.7	1.6	42	0.8%	1.20 [-0.13, 2.53]
SON T 2014	3.4	2.5	51	3	2.6	58	1.5%	0.40 [-0.56, 1.36]
WOO 2011	3.72	2.53	236	3.61	2.4	591	9.9%	0.11 [-0.27, 0.49]
YOON 2012	4.5	3.6	36	4.3	2.5	65	0.8%	0.20 [-1.12, 1.52]
Subtotal (95% CI)			**1118**			**2712**	**58.1%**	**0.12 [-0.03, 0.28]**
Heterogeneity: Tau² = 0.00; Chi² = 7.08, df = 8 (P = 0.53); I² = 0%								
Test for overall effect: Z = 1.54 (P = 0.12)								
Total (95% CI)			**2235**			**4031**	**100.0%**	**0.06 [-0.05, 0.18]**
Heterogeneity: Tau² = 0.00; Chi² = 13.14, df = 14 (P = 0.52); I² = 0%								
Test for overall effect: Z = 1.05 (P = 0.29)								
Test for subgroup differences: Chi² = 1.31, df = 1 (P = 0.25), I² = 23.6%								



- **Recurrence**

Study or Subgroup	Robotic surgery Events	Robotic surgery Total	Laparoscopic surgery Events	Laparoscopic surgery Total	Weight	Risk Ratio IV, Random, 95% CI
3.3.1 With PSM						
GAO Y 2019	44	163	51	163	37.7%	0.86 [0.61, 1.21]
HAN 2015	0	68	0	68		Not estimable
LI Z 2018	21	112	24	112	15.9%	0.88 [0.52, 1.48]
Subtotal (95% CI)		**343**		**343**	**53.6%**	**0.87 [0.65, 1.15]**
Total events	65		75			
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.96); I² = 0%						
Test for overall effect: Z = 0.99 (P = 0.32)						
3.3.2 Without PSM						
ALHOASSAINI 2020	1	25	1	30	0.6%	1.20 [0.08, 18.23]
HIKAGE 2022	3	36	7	58	2.6%	0.69 [0.19, 2.50]
JUNFENG 2014	5	120	28	394	5.0%	0.59 [0.23, 1.49]
NAKAUCHI 2016	11	84	60	437	12.1%	0.95 [0.52, 1.74]
OBAMA K 2018	21	313	26	524	14.0%	1.35 [0.77, 2.36]
OKUMURA 2016	21	370	7	132	6.3%	1.07 [0.47, 2.46]
PUGLIESE 2010	4	16	8	48	3.9%	1.50 [0.52, 4.32]
SON T 2014	3	51	3	58	1.8%	1.14 [0.24, 5.39]
Subtotal (95% CI)		**1015**		**1681**	**46.4%**	**1.05 [0.77, 1.43]**
Total events	69		140			
Heterogeneity: Tau² = 0.00; Chi² = 3.26, df = 7 (P = 0.86); I² = 0%						
Test for overall effect: Z = 0.32 (P = 0.75)						
Total (95% CI)		**1358**		**2024**	**100.0%**	**0.95 [0.77, 1.17]**
Total events	134		215			
Heterogeneity: Tau² = 0.00; Chi² = 4.09, df = 9 (P = 0.91); I² = 0%						
Test for overall effect: Z = 0.50 (P = 0.61)						
Test for subgroup differences: Chi² = 0.82, df = 1 (P = 0.36), I² = 0%						



Reporting Guidelines

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page and paragraph/ table #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1 (paragraph 1): “Laparoscopic versus Robotic gastric cancer surgery: Short-term Outcomes. Systematic Review and Meta-analysis of 25 521 patients”
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 2 (paragraph 1-5): “Background: (…) There is no consensus regarding the optimal surgical technique to perform curative resection surgery”; “Objective: Compare laparoscopic and robotic gastrectomy regarding short-term outcomes in patients with gastric cancer.”; “Materials and Methods: (…) We searched the following topics: “Gastrectomy”, “Laparoscopic” and “Robotic Surgical Procedures”. (…)”; “Results: There were no significant differences between robotic gastrectomy (RG) and laparoscopic gastrectomy (LG) regarding conversion rate, reoperation rate, mortality, overall complications, anastomotic leakage, distal and proximal resection margin distances and recurrence rate. (…)“; “Conclusion: This meta-analysis supports the choice of robotic surgery over laparoscopy concerning relevant surgical complications. (…)”
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 3 (paragraph 1; 2 and 8): “Nowadays, gastric cancer is the fifth most common cancer worldwide (…) has third highest cancer-related mortality rate (7.7/100 000) and it is the fifth most

			incident tumour in the entire world (11.1/100 000).” “Currently, the main surgical approaches are minimally invasive, including laparoscopic surgery and robotic surgery”;
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 3 (paragraph 3-8): “Therefore, our systematic review includes the most recent observational studies and the current literature about the comparison of the short-term outcomes between LG and RG for gastric cancer patients in order to clarify the feasibility and efficiency of robotic surgery, as it is predicted to be more prevalent in the coming years.”
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Not reported.
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 4 (paragraph 2 and 3): “(…) we included observational clinical studies that compared short-term outcomes between the two surgical approaches (RG and LG), in patients with gastric cancer who underwent curative-intent surgery.”
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 4 (paragraph 1): “(…), on the following databases: PubMed, Web of Science and Cochrane Library.”

Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Page 4 (paragraph 1): “The query in the PubMed was: “Search (((laparoscopic gastrectomy) OR ((“” Gastrectomy”” [Majr:NoExp]) AND “” Laparoscopy “”[Mesh]))) OR ((((“” Gastrectomy “” [Majr:NoExp]) AND “” Robotic Surgical Procedures “” [Mesh])) OR robotic gastrectomy)”.”
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 4 (paragraph 2 and 3): “The researchers screened the literature and selected articles based on their titles and abstracts”; “Then, the authors reviewed the full texts and excluded articles which met the following exclusion criteria (…)”
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 4 (paragraph 4): “Two reviewers independently read and interpreted every original study.”
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 4 (paragraph 4): “Data extraction comprised: study information (…), patients’ characteristics (…) and short-term outcomes (…)”
Risk of bias in individual studies / Risk of bias across studies	12/ 15	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Page 4 (paragraph 5): “In our meta-analysis, we used the MINORS (Methodological Index for Non-Randomized Studies) scale to assess the quality and individual risk of bias of our non-randomized studies.”
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 5 (paragraph 1 and 2): “For dichotomous outcomes, we presented the results as risk ratios (RR) with 95% confidence intervals (CI), by using the Mantel-Haenszel method. For

			continuous outcomes, we presented the results as mean differences with 95% CI, by using the generic inverse variance method."
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis.	Page 5 (paragraph 1 and 2): "We performed our meta-analysis using Review Manager (Version 5.4.1)."; "The Chi-squared (χ2) test and the I-squared (I2) measure were used to assess heterogeneity. We applied a random effects model because of the clinical heterogeneity of the included studies."
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Page 5 (paragraph 3): "Hence, we conducted a subgroup analysis to understand whether PSM had any effect in the association between the surgical approach and the studied outcomes."
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Page 5 (paragraph 4): "Then, for our systematic review, we included 53 studies in the quality assessment and quantitative analysis (Figure 1)."
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Page 5 (paragraph 4): "These studies include a total of 25 521 participants, of which 8154 underwent RG and 17367 underwent LG. All studies were retrospective observational studies."
Risk of bias within and across studies	19/ 22	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Page 6 (paragraph 1): "The median score in the MINORS scale was 22, with a range of 19 to 23. Therefore, all included studies were considered adequate to be included in the quantitative analysis."

Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Page 6 (paragraphs 3-8); page 7 and 8 (paragraph 1-4): Operation Time: "Our meta-analysis included fifty studies which reported the operative time. It was significantly shorter in laparoscopic gastrectomy group, when compared with the robotic surgery group [MD 41.19, p<0.00001 (95%CI: 33.47, 48.92), I2=98%, p<0.00001]. Mean operation time was 269.22 minutes in the robotic surgery group and 225.65 in the laparoscopic surgery group. (Figure 3)"
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Page 6 (paragraph 2): Operation Time: "Our meta-analysis included fifty studies which reported the operative time. It was significantly shorter in laparoscopic gastrectomy group, when compared with the robotic surgery group [MD 41.19, p<0.00001 (95%CI: 33.47, 48.92), I2=98%, p<0.00001]. Mean operation time was 269.22 minutes in the robotic surgery group and 225.65 in the laparoscopic surgery group. (Figure 3)"
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 8 (paragraph 5-7); page 9 and 10 (paragraph 1-5): Subgroups Analysis – Operation Time: "Both subgroups demonstrated a significative longer operative time in the robotic surgery group. Heterogeneity was high and statistically significant. Additionally, regarding subgroup differences, I2=73.5% and p= 0.05. (Figure 3)"
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 10 (paragraph 6-7); page 11-15 and 16 (paragraph 1): "Operative time and cost favor the laparoscopic approach, while blood loss, length of hospital stays, time to first flatus, time to oral intake, surgical complications (Clavien-Dindo grade ≥ III), pancreatic complications and the number of retrieved lymph nodes favors the robotic approach.";

			Operative Time: "This meta-analysis shows a similar result to previous studies, which demonstrated that operative time is significantly longer in robotic gastrectomy when compared with laparoscopic gastrectomy."
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 16 (paragraph 2): "The present study also has its limitations: first, we included non-randomized comparative studies; second, several outcomes demonstrated a high percentage of heterogeneity, which may put the validity of the results into. These differences between studies could be explained by the discrepancies in the surgical team's experience in performing robotic surgery;(…)"
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Page 16 (paragraph 3-5): "In conclusion, we believe that our results demonstrate that robotic gastrectomy is a safe and feasible procedure, when compared with laparoscopic gastrectomy."; "Moreover, randomized clinical trials are also desired in contemplation of a better comprehension of the advantages in performing robotic gastrectomy."
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	No funding.

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Submission Guidelines

Mary Ann Liebert, Inc. publishers

Manuscript Submission Guidelines and Policies for *Journal of Laparoendoscopic & Advanced Surgical Techniques*

Last updated 7/20/2022 12:31:13 PM

Journal Information

- **Manuscript Submission Site: https://mc.manuscriptcentral.com/lap**
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- Support Contact: prosupport@liebertpub.com
- Journal Model: Hybrid (Open Access option)
- Blinding: Single Blind
- File formatting requirement stage: Upon submission
- Instant Online Option (immediate publication of accepted version): No
- Submission Fee: None
- Average time to initial decision: 15 days

Manuscript Types and Guidelines

Full Reports-Original Research Articles	3,000-word limit Structured abstract of no more than 250 words Maximum total of ten (10) figures and/or tables
Full Reports-Review Articles	8,000-word limit Structured abstract of no more than 250 words Maximum total of ten (10) figures and/or tables
Technical Reports	3,000-word limit Structured abstract of no more than 250 words Maximum total of ten (10) figures and/or tables

Perspectives	1,500-word limit Unstructured abstract of no more than 200 words Maximum total of two (2) figures and/or tables
Research Briefs	1,200-word limit No abstract Section headings are not required Maximum total of two (2) figures and/or tables
Editorials	1,000-word limit No abstract No figures or tables
Letters to the Editor	500-word limit May include one figure OR table Reference citations are identical in style to those of full original articles, but should not exceed five (5).

Word limits do NOT pertain to the abstract, disclosure statements, author contribution statements, funding information,acknowledgments, tables, figure legends, or references.

References

Journal of Laparoendoscopic & Advanced Surgical Techniques uses Mary Ann Liebert's **Vancouver** reference format.Templates are available in **Zotero** and through the CSL Style Repository. An **Endnote template** is also available.

Liebert Vancouver Style: Order of Citation

- Reference List: Prepared in sequential order as cited in text.
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- Include among the references any articles that have been accepted but have not yet published; identify the name of publication and add "In Press." If the reference has been published online, provide the DOI number inplace of the page range.

Style Examples for Reference List:

Type of Reference	Punctuation and Order of Elements in Reference List
Journal article with 1-3 authors	Wang Q, Nambiar K, Wilson JM. Isolating natural adeno-associated viruses from primate tissues with a high-fidelity polymerase. Hum Gene Ther 2021;32(23-24):1439-1449; doi: 10.1089/hum.2021.055 [insert article-specific DOI if available].

Journal article with more than 3authors	Pfister EL, DiNardo N, Mondo E, et al. Artificial miRNAs reduce human mutant Huntington throughout the striatum in a transgenic sheep model of Huntington's disease. Hum Gene Ther2018;29(6):663–673; doi: 10.1089/hum.2017.199 [insert article-specific DOI if available].
Edited Book	Herzog RW, Zolotukhin S, (eds). A Guide to Human Gene Therapy. World Scientific Publishing Co.Pte. Ltd.: Singapore; 2010.
Chapter in an Edited Book	Nicklin SA, Baker AH. Adenoviral Vectors. In: A Guide to Human Gene Therapy. (Herzog RW, Zolotukhin S. eds.) World Scientific Publishing Co. Pte. Ltd.: Singapore; 2010; pp. 21-36.
Authored Book	Isaacson W. The Code Breaker: Jennifer Doudna, Gene Editing, and the Future of the HumanRace. Simon & Schuster: New York, NY; 2021.
Website	Last name, first/middle initial(s) of author(s) [if available]. U.S. Food and Drug Administration. Whatis Gene Therapy? Silver Spring, MD; 2018. Available from: **https://www.fda.gov/vaccines-blood- biologics/cellular-gene-therapy-products/what-gene-therapy** [Last accessed: month/date/year].
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- Videos may be uploaded in the following formats:
  - WMV
  - MPEG
  - AVI

    - MOV
- Video dimensions must be at least 640 x 840 or higher for the best results. The video must also be in the NTSCformat (the European PAL format is not supported).

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- Title each file with the type of content contained in the file (e.g., manuscript.doc, tables.doc, FigureLegends.doc, Fig1.tif, SupplementalData.pdf, etc.).

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- Submission of high resolution .TIFF or .EPS figure files is preferred. Please upload as individual files. Cite figures consecutively in text within parentheses.
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- Title page* with full manuscript title, all contributing authors' names and affiliations, a short running title, a denotation of the corresponding author, and a list of 4-6 keywords/search terms,
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- Funding statement, even when not applicable,
- References,
- Tables included in the text or as a separate document,
- Figure legends at the end of the main text or in a separate Word file,
- Figures uploaded as individual high-resolution files,
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*Double-blinded journals require a separate title page with the title, all contributing authors' names and affiliations, a denotation of the corresponding author, author acknowledgements, disclosures, and related identifying information.

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Author 1: review and editing (equal). **Author 2**: Conceptualization (lead); writing – original draft (lead); formal analysis(lead); writing – review and editing (equal). **Author 3**: Software (lead); writing – review and editing (equal). **Author 4**: Methodology (lead); writing – review and editing (equal). **Author 5**: Conceptualization (supporting); Writing – original draft (supporting); Writing – review and editing (equal).

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