

IMPACT OF ROBOTIC SURGERY ON GASTROINTESTINAL PROCEDURES: INTEGRATIVE REVIEW OF COMPLICATIONS AND SAFETY

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Abstract: Objective: To analyze the complications and safety associated with the use of robotic surgery in gastrointestinal procedures and comparing these results with traditional surgical methods. Methodology: Integrative review using the PubMed database, with the keywords “robotic surgery”, “gastrointestinal” and “complications”. 603 studies were found, of which 8 were selected. Results: The studies reviewed indicated that robotic surgery offers significant advantages such as better anatomical visualization, improved surgical precision, and the potential to reduce patient recovery time. However, challenges such as prolonged operational time and high costs were consistently reported. Furthermore, its application in emergency procedures was limited, being more common in elective surgeries. Final Considerations: The integrative review demonstrates that robotic surgery has the potential to improve clinical results in gastrointestinal procedures, although there are still challenges to be overcome, such as high costs and prolonged operating time.

Keywords: Robotic surgery; Surgical complications; Gastrointestinal procedures; Surgical safety.

INTRODUCTION

Robotic surgery has emerged as a significant innovation in the field of gastrointestinal surgery, offering advantages such as improved anatomical visualization, refined motor control, and an expanded range of motion of surgical instruments. These characteristics potentially improve clinical outcomes and reduce complications associated with traditional procedures (Luo et al., 2017). Despite technological advances, it is essential to fully understand the risks and benefits inherent to this surgical modality, highlighting the complexity of gastrointestinal surgeries (Nakauchi et al., 2017).

The adoption of robotic surgery has expanded globally, with more than 4000 da Vinci surgical systems installed. Although widely used in urology and gynecology, the benefits of robotics in upper gastrointestinal tract surgery are still not clear enough compared to conventional minimally invasive techniques. Despite the potential advantages in reducing local postoperative complications, robotic surgery faces challenges such as prolonged operating time and high costs (Nakauchi et al., 2017).

Robotic surgery is increasingly used in gastrointestinal procedures due to its precision and potential to reduce recovery time. The need for comprehensive assessment of complications associated with this method is crucial to ensure that the benefits outweigh the risks, guiding future surgical practices and promoting better patient outcomes (Biebl et al., 2018). Additionally, the application of robotic surgery in gastrointestinal emergency scenarios is not common, especially in frequent pathological conditions, such as acute appendicitis and cholecystitis, being predominant for elective procedures (Reinisch et al., 2023).

Therefore, the objective of the present study is to analyze the complications and safety associated with the use of robotic surgery in gastrointestinal procedures, considering their frequency, severity, causes, and comparing them with traditional surgical methods.

METHODOLOGY

To carry out this integrative review, a comprehensive search was conducted in the PubMed database using the following keywords: “robotic surgery”, “gastrointestinal” and “complications”. The initial search resulted in a total of 603 relevant studies. The inclusion criteria for selecting the studies were: studies published in English; Studies that specifically addressed robotic surgery

in gastrointestinal procedures; Studies that discussed complications associated with these procedures. The exclusion criteria were: Studies that did not focus on complications or that did not directly involve robotic surgery; Review studies, letters to the editor, editorials and conference abstracts.

Titles and abstracts were reviewed to eliminate studies that did not meet the inclusion criteria, resulting in a reduced list. The remaining articles were fully evaluated to verify whether they really met the established criteria. After this step, 8 studies were selected for detailed review (Figure 1.0).

RESULTS

Results were synthesized to identify patterns in complications associated with robotic surgery in gastrointestinal procedures.

DISCUSSION

Robotic surgery in gastrointestinal procedures has also shown significant advantages compared to the laparoscopic technique, as highlighted in the study by Iacovazzo et al. (2023). The meta-analysis of 18 randomized controlled trials revealed that the robotic approach has a lower rate of conversion to open surgery and a faster recovery from bowel movement, demonstrated by the shorter time to first postoperative flatus. Despite these advantages, there were no significant differences in the rates of anastomotic leak, cardiovascular complications, estimated blood loss, readmissions, deep vein thrombosis, duration of hospitalization, mortality, and postoperative pain between the two techniques.

The study by Liu C et al. (2023) offers a comparative analysis between laparoscopic and robotic procedures in gastrointestinal surgeries, specifically Heller myotomy (HM) and Nissen fundoplication (NF). The research revealed that although the operative time was

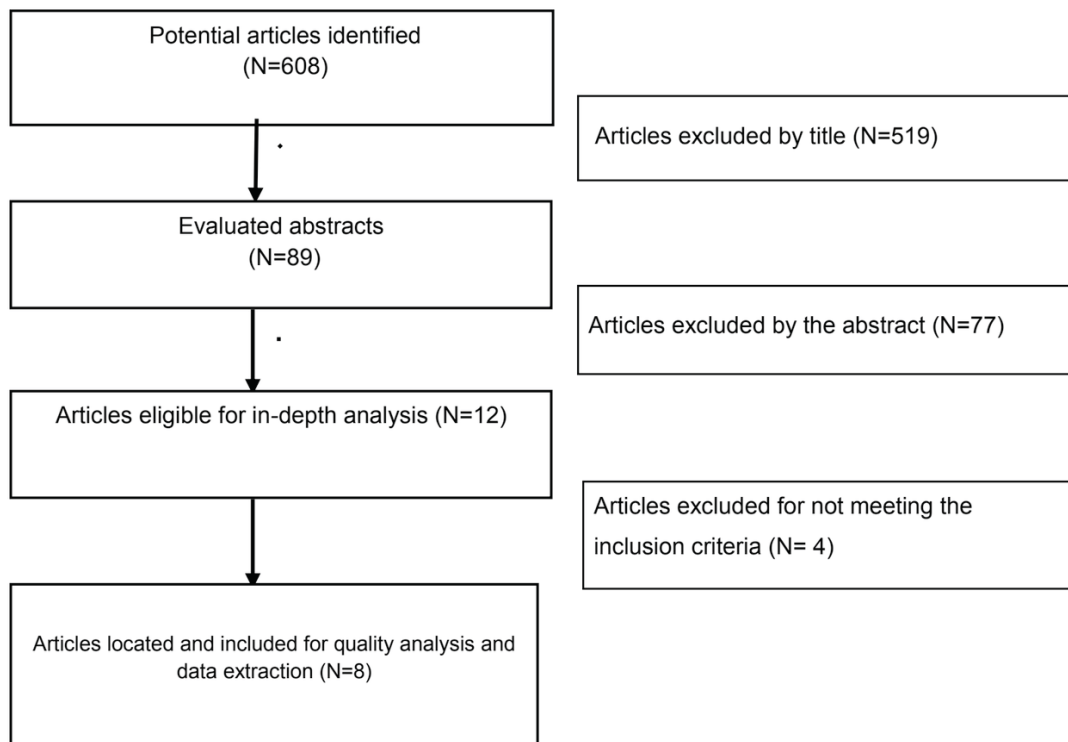


Figure 1.0 Flowchart of the distribution of articles found and selected.

Source: Aguiar RJR et al. (2024)

Study	Kind of study	Surgical procedure	Main results
Banapour et al. (2021)	Prospective Study	Not specified	Zero conversion rate for robotic surgery; acceptable postoperative complications and readmission; prolonged age and operating time associated with complications and readmission.
Iacovazzo et al. (2023)	Clinical Trial	Laparoscopic vs. Robotics	Robotic vs. robotic surgery laparoscopic: no significant differences in postoperative complications; higher costs in robotics.
Liu et al. (2023)	Cohort Study	Robotic Colectomy for Colon Cancer with Anterior Abdominal Surgery	Safe and Feasible Robotic Surgery for Colon Cancer Patients with Previous Abdominal Surgery; similar results between groups with and without SBP.
Liu et al. (2023)	Clinical Trial	Heller myotomy and Nissen fundoplication	Robotic surgery for Heller myotomy and Nissen fundoplication associated with shorter hospital stay and lower complication rate.
Liu et al. (2021)	Cohort Study	Rectal Cancer Resection	Robotic and laparoscopic surgery equally effective for treating rectal cancer; similar postoperative complications.
Ali et al. (2022)	Clinical Trial	Robotic Rectal Resection	Robotic rectal surgery associated with lower rate of serious postoperative complications; higher costs compared to laparoscopy.
Lan et al. (2017)	Cohort Study	Gastrectomy for Gastric Cancer	Comparable postoperative complications between open, laparoscopic and robotic gastrectomy for gastric cancer.
Maggioni et al. (2019)	Cohort Study	Robotic Resection of Gastric GIST	Robotic surgery for resection of gastric GIST: safety profile and encouraging oncological results.

Table 1.0: Characteristics of the studies selected in the integrative review on complications and safety of robotic surgery in gastrointestinal procedures

Source: Aguiar RJR et al. (2024)

significantly longer for robotic-assisted HM compared to laparoscopic (127 minutes vs. 108 minutes, $p < 0.01$), the postoperative benefits were notable. The robotic approach resulted in lower overall complication rates ($p < 0.05$) and shorter hospital stay (1.5 days vs. 2.7 days, $p < 0.001$). For NF, although the operative time did not show significant differences between the approaches, the hospitalization time was again shorter in the robotic group (1.54 days vs. 2.7 days, $p < 0.001$). The resolution of postoperative symptoms and the need for additional interventions were similar between the two techniques for both surgeries.

The incorporation of robotic surgery into gastrointestinal procedures has shown significant progress in comprehensive cancer centers. In the study conducted by Banapour et al. (2021), data reveals that although robotic surgery offers a promising approach with relatively low rates of intraoperative complications (0.4%), gastrointestinal procedures present a range of post-operative challenges. Complications such as ileus (16.3%), anemia (9.6%) and cardiac arrhythmias (6.6%) were the most prevalent. The need for hospital readmissions was observed in 4% of cases, with ileus and urinary tract infection being frequent causes. The study's multivariable analysis highlights the advanced age of patients and prolonged duration of the operation as significant predictors for complications and readmissions, underlining the need for careful planning and close monitoring of these factors in patients undergoing robotic gastrointestinal surgery.

Liu L et al. (2023) highlights the feasibility and safety of robotic surgery in patients with colon cancer who have already undergone previous abdominal surgeries. The findings indicated that there was no significant difference between the two groups in terms of operative time, estimated blood loss, number of lymph nodes recovered, length of hospital

stay and associated costs.

Furthermore, rates of postoperative complications, conversion to open surgery, and mortality were similar between groups.

The meta-analysis carried out by Liu, Li and Wang (2021) also compared postoperative complications between robotic and laparoscopic surgeries for the treatment of rectal cancer, revealing similar results between both techniques. Based on analysis of 22,744 participants, there were no statistically significant differences in the rates of overall complications, wound complications, anastomotic leak, anastomotic bleeding, stoma-related complications, intra-abdominal abscess, urinary tract infection, enterocolitis, reoperations, and mortality. Specifically, the study found that complications such as postoperative ileus, readmission, and urinary retention also had similar incidences between the robotic and laparoscopic groups.

Robotic rectal resection surgery, according to the retrospective study carried out by Ali et al. (2022), demonstrates significant advantages over the laparoscopic approach in the treatment of rectal cancer, particularly with regard to short-term postoperative complications. Analyzing data from 155 treated patients, the study revealed that robotic surgery is associated with a lower incidence of serious complications and a lower rate of sepsis compared to laparoscopic surgery. Additionally, the robotic approach showed superior performance in lymph node harvesting, which is crucial to the oncological efficacy of the procedure. However, despite the observed clinical advantages, robotic surgery is significantly more expensive.

The study conducted by Lan et al. (2017) aimed to compare postoperative complications between open, laparoscopic and robotic gastrectomy for the treatment of gastric cancer. Data were retrospectively analyzed from patients diagnosed with

gastric cancer and undergoing gastrectomy between January 2014 and October 2016. The results indicated that there were no significant differences in the patients' baseline characteristics and in many of the operational or postoperative data between the groups of open, laparoscopic and robotic surgery. There were no significant differences in overall complication rates between surgery groups. However, anastomotic leakage was more common in the laparoscopic and robotic groups compared with the open group.

The study conducted by Maggioni et al. (2019) presented a single-center evaluation of robotic resection of gastric gastrointestinal stromal tumors. Six patients were analyzed focusing on the safe, oncological and viable profile of robot-assisted surgery. The results revealed an average operating time of 173 ± 39 minutes and an average hospital stay of 3 ± 1 days. There was no conversion rate to open or laparoscopic surgery, and no intra- or postoperative complications were recorded during a mean follow-up of 12 months. All resections were classified as R0, indicating a

disease-free margin in all cases. The findings highlighted the utility of robotic surgery for the resection of gastric GISTs, emphasizing that hand-sewn anatomical reconstruction can prevent distortion of the stomach.

FINAL CONSIDERATIONS

Although the application of robotic surgery is widespread in areas such as urology and gynecology, its effectiveness in gastrointestinal surgeries, especially emergency procedures, is not yet completely understood. The review demonstrated an overall reduction in postoperative complications, but benefits vary depending on the type of procedure and complexity of the case. Given the increasing use of robotic surgery, it is crucial to continue investigating its long-term effects and compare them with traditional surgical techniques to establish clear guidelines and optimize clinical outcomes. Responsible, evidence-based adoption of robotic technology can thus significantly improve the quality of surgical care and patient outcomes.

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