ORIGINAL ARTICLE

Laparoscopic vs Robotic Approach for Rectal Cancer: A Meta-analysis

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Abstract

Technology is evolving constantly today, and among the plethora of innovations, the one with the most potential to look forward to, in surgery, is the introduction and evolution of Robotics. Demand, as well as a pursuit of minimally invasive surgery, has increased exponentially particularly in the last decade, with Robotics being at the leading edge of this evolution. It has shown a potential to provide outcomes that were comparable to those achieved with the laparoscopic approach, with some evidence suggesting even better outcomes than laparoscopy in high-risk groups such as patients with obesity, those treated by extended procedures, and male patients. Despite all its benefits, there is still no sturdy evidence established yet about the overall superiority of robotic surgery over the laparoscopic approach. This lack of concrete evidence warranted the need for a meta-analysis that would help reveal any significant differences between the two approaches (robotics vs laparoscopic). Our study aimed to understand and establish the differences between the two approaches of rectal cancer resections, as well as to ascertain the positive efficacy and benefits of robotic surgery, if any, over the conventional laparoscopic approach. The results of this study found that the rates of sphincter preservation, intersphincteric resection (ISR), and conversion were lower with the robotic total mesorectal excision (TME) compared to laparoscopic TMEs, while no significant difference was found in the rate of major (grade ≥III) complications between the two groups.

Keywords: Minimal access surgery, Open and laparoscopic surgery, Rectal cancer, Robotic surgery.

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Introduction

Technology is evolving constantly today, and among the plethora of innovations, the one with the most potential to look forward to, in surgery is the introduction and evolution of robotics. Demand, as well as a pursuit of minimally invasive surgery, has increased exponentially particularly in the last decade, with Robotics being at the leading edge of this evolution. It has shown a potential to provide outcomes that were comparable to those achieved with the laparoscopic approach, with some evidence suggesting even better outcomes than laparoscopy in high-risk groups such as patients with obesity, those treated by extended procedures, and male patients.

Robotic surgery, however, is not new. It has been around for over three decades, with the first documented robot-assisted surgical procedure done as early as 1985.[1] However, in the year 2000, the introduction of the da Vinci Robotic Surgical System, which became the first robotic surgery system to get the US Food and Drug Administration (FDA) approval, revolutionized the field of robotic surgery, and it has only found evermore wider applications in various surgical procedures ever since.[2]

Despite all these benefits, there is still no sturdy evidence established yet about the overall superiority of robotic surgery over the laparoscopic approach. This lack of concrete evidence warranted the need for a meta-analysis that would help reveal any significant differences between the two approaches (robotics vs laparoscopic).

Our study aimed to understand and establish the differences between the two approaches of rectal cancer resections, as well as to ascertain the positive efficacy and benefits of robotic surgery, if any, over the conventional laparoscopic approach.

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Materials and Methods

The study is a meta-analysis conducted by the first author by doing a preliminary search in the PubMed and Cochrane databases to identify the literature on this topic. A systematic search of the PubMed and Cochrane Library databases was conducted in August 2020. The keywords used were (laparoscopic surgery or

laparoscopy) vs (robotics or robotic, soft or remote operation). Only those articles published after the year 2010 were included. Filters for cancer and systematic reviews were applied while conducting the search, after which 737 articles were obtained. After identification, the duplicates were removed, and the remaining records were screened to select. After applying the inclusion and exclusion criteria, seven articles were selected for this study.

Inclusion Criteria: Population, Interventions, Controls, Outcomes (PICO)

The inclusion criteria consisted of the following:

- **Participants:** All patients were the age of 19 years and above, undergoing surgery for rectal cancer;
- **Intervention:** Robotic or laparoscopic rectal cancer resection;
- **Comparison:** Robotic surgery vs laparoscopic surgery for rectal cancer;
- **Outcome:** The primary outcome of this study was the rate of sphincter preservation (RSP). The secondary outcomes looked into were rates of ISR, and surgical site infections (SSI) which were graded as per the Clavien–Dindo criteria and divided into two groups, namely, minor (grades I–II) and major (≥III).

Results

Primary Outcome

Rate of Sphincter Preservation

The meta-analysis evaluated the RSP using six studies that provided sufficient data regarding RSP.

As depicted in the forest plot in Figure 1, considering data from various studies plotted against the risk ratio of RSP, gave a pooled estimate of 0.049 (0.28, 0.85), with a statistically significant difference favoring the robotic approach ($p = 0.01$).

Secondary Outcomes

Surgical Site Infections (Major)

The meta-analysis evaluated the rate of SSI, which was graded as per the Clavien–Dindo criteria and divided into two groups, namely, minor (grades I–II) and major (≥III).

The forest plot shown in Figure 2 depicts results for the SSI (major) using 10 studies that published data regarding SSI as per the Clavien–Dindo criteria.

As depicted in the forest plot in Figure 3, considering data from various studies plotted against the risk ratio of SSI (major), gave us a pooled estimate of 1.14 (0.80, 1.62), which was not statistically significant ($p = 0.48$).

Surgical Site Infections (Minor)

The meta-analysis evaluated the rate of SSI, which was graded as per the Clavien–Dindo criteria and divided into two groups, namely, minor (grades I–II) and major (≥III).

The forest plot shown in Figure 3 depicts results for the SSI (minor) using 10 studies that provided data for SSI graded as per the Clavien–Dindo criteria.

As depicted in the forest plot shown in Figure 3, considering data from various studies plotted against the risk ratio of SSI (minor), gave us a pooled estimate of 0.84 (0.83, 0.97), and there was a

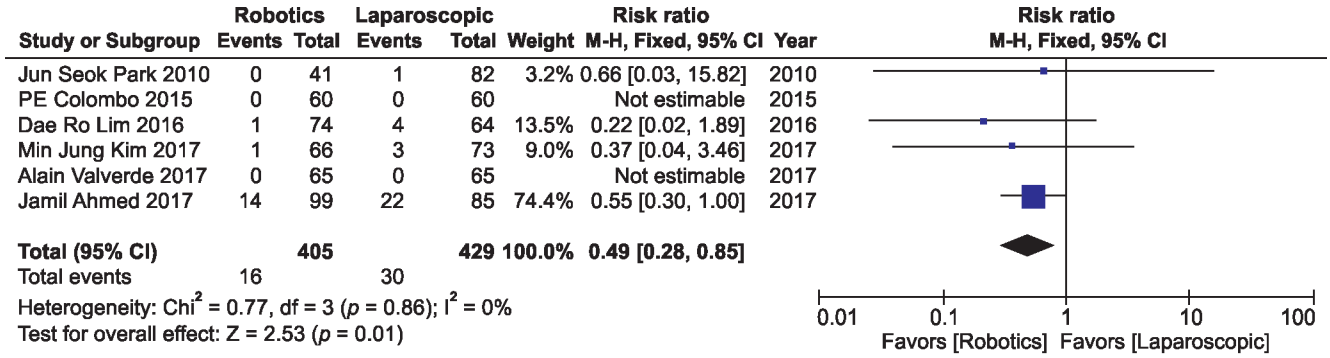

Fig. 1: Forest plot – RSP

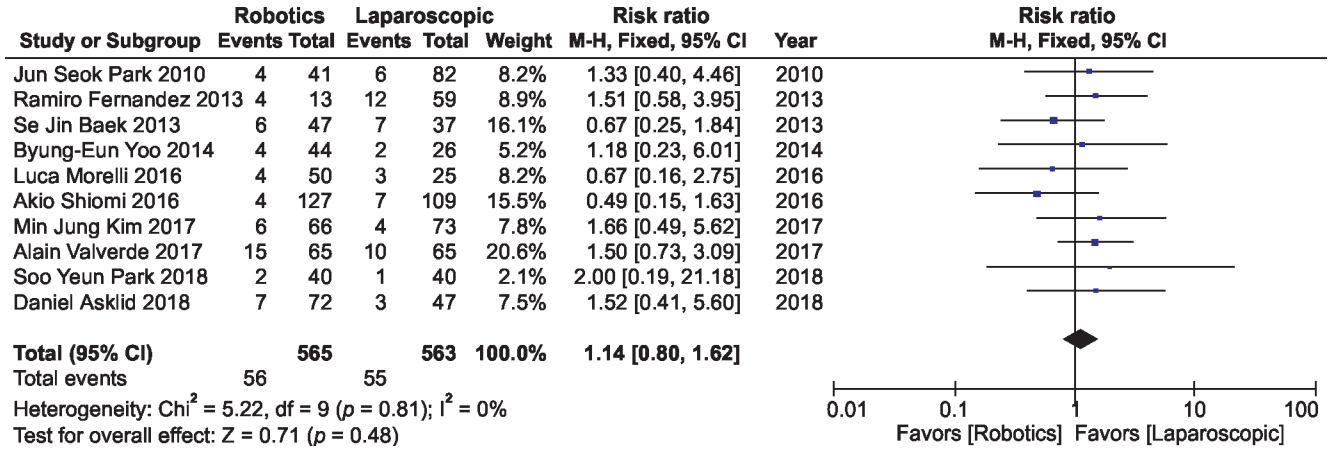

Fig. 2: Forest plot – SSI (major)

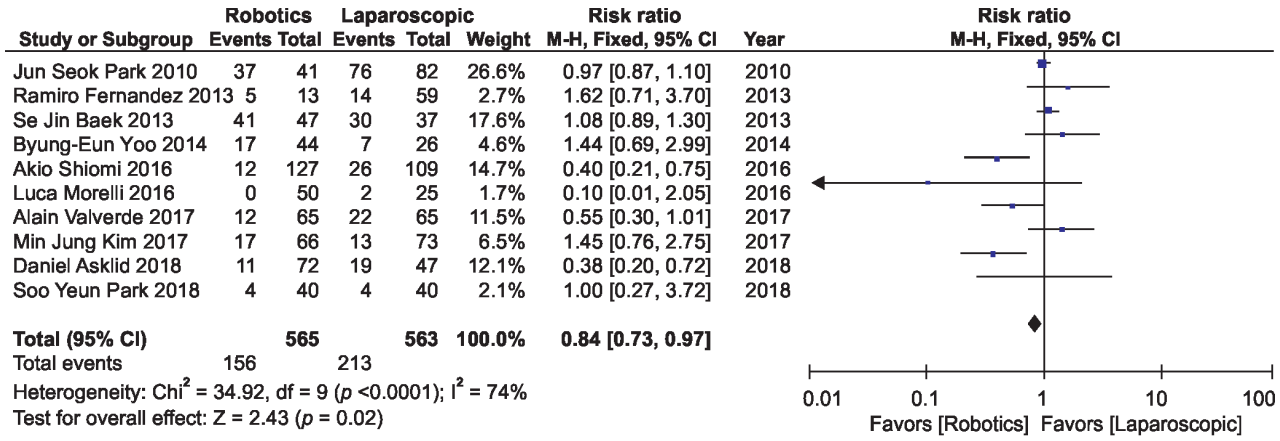

Fig. 3: Forest plot – SSI (minor)

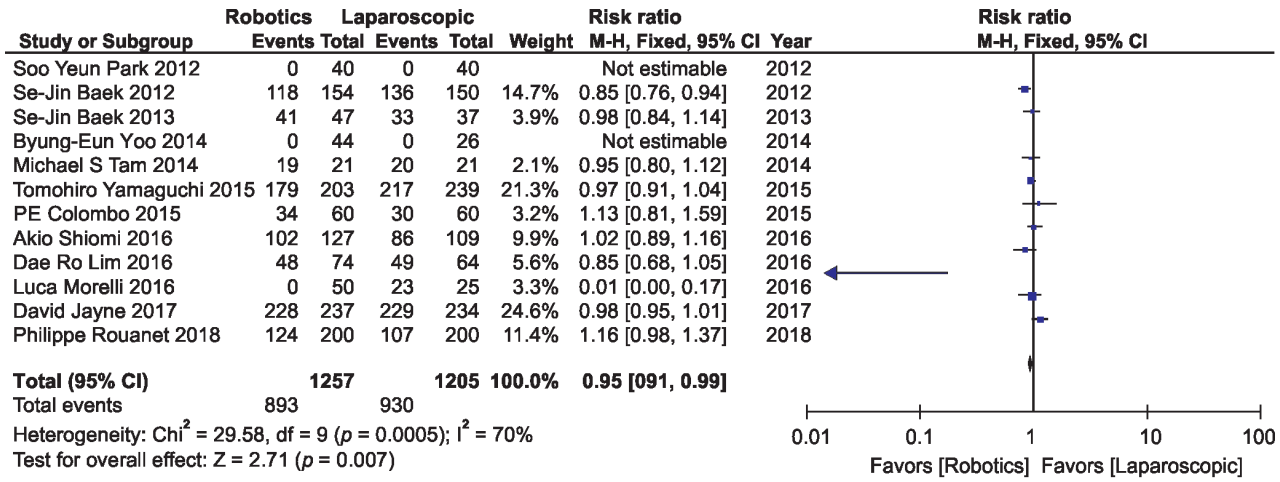

Fig. 4: Forest plot – Rate of intersphincteric resection

statistically significant difference between the two approaches ($p = 0.02$) favoring the robotic approach.

Rate of Intersphincteric Resection (RIR)

The meta-analysis evaluated the RIR, using 12 studies that have published data regarding RIR. As depicted in the forest plot shown in Figure 4, considering data from various studies plotted against the risk ratio of RIR, gave us a pooled estimate of 0.95 (0.91, 0.99), and there was a statistically significant difference between the two groups ($p = 0.007$) favoring the robotic approach.

Discussion

The treatment of cancer over the years has gone through a gradual process of development, particularly from the technical standpoint. Before the development of imaging modalities in the 1970s, an "exploratory laparotomy" would be required just to diagnose cancer. However, thanks to the advancements in modern technology, surgeons are now able to use tools equipped with optical fiber technology and pocket-sized video cameras to look inside the body as well as special surgical instruments such as the laparoscope, to operate via narrow tubes put into small cuts in the skin.[1] The most recent advancement in surgical techniques is the introduction of robotics surgery systems which has also shown the most potential, by allowing small surgical incisions and high precision demanding surgeries in a minimally invasive manner.[2] This has not only revolutionized general surgery but also cancer surgery, where surgeons can now excise tumors with precise and accurate margins, allowing for better outcomes overall. Minimally invasive approaches such as laparoscopic and robotic surgeries have especially played a major role in decreasing the morbidity and mortality in patients with rectal cancer, while also improving their quality of life, by helping avoid colostomies for most patients with rectal cancer.[3,4] After the first robotic colectomy was done in 2002, multiple case series and prospective studies have evidenced the viability and safety of this approach.[5] However, concrete evidence is missing to establish the superiority of one approach over the other.

In this discussion, we shall be comparing the robotic approach vs the laparoscopic approach for rectal cancer surgeries. Both surgical techniques were compared under various parameters. In our study, we mainly focused on three different parameters, namely, RSP, RIR, and the postoperative complications (PoC). The demographics of the patient have been presented in (Table 1). The PoC was graded as per the Clavein–Dindo criteria and divided into two groups, that is, minor complications (grades I–II) and major complications (grade ≥III).

The RSP and RIR have been observed to influence the postoperative quality of life of patients whereas the PoC has been known to influence the postoperative outcomes, length of hospital stays as well as the rate of readmissions.

Table 1: Demographics

Study	Age-group (years)	Male	Female	Country of origin
Kim (2017)[14]	48–71	52	21	South Korea
Ahmed et al. (2017)[6]	62–74	58	27	Portugal
Colombo (2015)[15]	35–85	42	18	France
Valverde et al. (2017)[9]	55–75	45	20	France
Park (2010)[16]	54–72	39	33	Korea
Lim (2016)[8]	33–86	36	18	Korea

In our study, we found that the RSP for the robotic approach was higher compared to the laparoscopic approach, and the difference was found to be statistically significant [0.49 (0.28, 0.84)] ($p = 0.01$). Similarly, the RIR with the robotic approach was found to be significantly higher than the laparoscopic group [0.95 (0.91, 0.99)] ($p = 0.007$). This could be attributed to various factors such as (1) robotics offers 3D views, which allows for precise dissections in a narrow surgical field such as the pelvis, (2) better freedom of movement due to the EndoWrist instruments which increase dexterity, and (3) Avoidance of physiological tremors and decreased fatigue for the operator compared to the laparoscopic approach.[6]

Baek et al. in their study to determine the advantages of Robotic surgery found albeit no significant difference between the robotic and laparoscopic groups with respect to operative time, operative outcome, and pathological outcome, they did conclude that the robotic surgical approach may help overcome some of the limitations of laparoscopy such as better surgical access to anatomically difficult areas such as the pelvis.[7]

Ahmed et al. also compared the RSP between the two approaches and found that the robotic approach yielded a higher RSP than the laparoscopic approach and the difference was statistically significant ($p = 0.045$) independent of the tumor level. They also reported a significantly lower conversion rate ($p = 0.043$), shorter operating time ($p = 0.013$) and shorter length of hospital stay ($p = 0.001$) favoring the robotic approach. However, there was no significant difference in the short-term (<30 days) PoC between the two groups. Lim et al. found that the RSP with the robotic approach was higher than with the laparoscopy, but the difference was not significant ($p = 0.444$) and although the RIR was also found to be higher with the robotic approach, there was no statistically significant difference between the two.[8]

Valverde et al. in their study of 130 patients found that the robotic proctectomy for sphincter-saving surgeries offered similar quality of TMEs as the laparoscopic counterpart, but with a statistically significant lower conversion rate in the former.[9]

Postoperative complications in our study were assessed as per the Clavein–Dindo criteria[10,11] and were divided into two groups, namely, minor (Clavein–Dindo grades I–II) and major (Clavein–Dindo grade ≥III). We found a significant difference between the rate of minor complications (grades I–II) favoring the robotic approach ($p = 0.02$). No significant difference was found in the rate of major complications ($p = 0.48$) between the two surgical approaches in our study. Asklid et al. supported these results as they reported no significant difference in the more major (grade ≥III) complications ($p = 0.54$); however, a significant difference in the overall complication rate was reported ($p < 0.001$). A significantly lower conversion rate favoring robotics ($p = 0.002$) was also reported in their study.[12]

Shiomi et al. reported similar findings with a difference in the overall complication rate favoring the robotic approach ($p = 0.003$), but no significant difference was found in the major complication rate (grade ≥III) between the two groups ($p = 0.19$).[13]

A systematic review of the other parameters, namely, intraoperative blood loss, readmissions, postoperative 30-day mortality, previous history of abdominal surgery, etc., showed no significant difference.

To sum up everything that has been stated so far, the results of this study suggest that the rates of sphincter preservation, ISR, and conversion were lower with the Robotic TMEs compared to laparoscopic TMEs, while no significant difference was found in the rate of major (grade ≥III) complications between the two groups.

Conclusion

Due to the limited availability of data, a statistical analysis could not be done for the overall survival rate and further investigation in multicenter studies is proposed to gain a better insight into it. Furthermore, we would also like to suggest studies to look into other parameters such as the surgeon's physical and mental stress, tumor spillage, R0 resection rate, and overall patient satisfaction rate between the two groups which could potentially influence the overall outcome of rectal cancer surgeries.

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