








Robotic-assisted minimally invasive surgery for rectal cancer. Experience at the National Cancer Institute – Colombia

Cirugía mínimamente invasiva asistida por robot para el cáncer de recto.
Experiencia en el Instituto Nacional de Cancerología – Colombia

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Abstract

Introduction. The treatment of colorectal tumors requires a comprehensive approach, with surgical resection as the primary focus, usually accompanied by neoadjuvant chemo-radiotherapy. The advantages of the robotic approach have allowed to gain an important place in rectal surgery, considering it a safe and reliable approach for these patients.

Methods. This is an observational, retrospective study that included patients diagnosed with rectal cancer who underwent robotic assisted surgery at the National Institute of Cancerology between 2017 and 2023. Surgeries were performed by a single console surgeon and various surgeons-in-training as assistants.

Results. A total of 43 patients were included in the study. 69.7% of patients had a tumor in the lower rectum, 20.9% in the middle rectum, and only 7.2% in the upper rectum. Low anterior or ultra-low anterior rectal resection was performed in 58.1% of patients and TaTME in 34.9%. The quality of the mesorectum was complete in 79%, almost complete in 18.6% and no patients had an incomplete mesorectum. Postoperative complications: 20.9%; 6.9% (n=3) had Clavien-Dindo complications >IIIa. Anastomotic leak rate: 9.3%.

Conclusion. Robotic surgery for rectal cancer may be technically advantageous compared to other techniques. It is a safe and feasible technique in Latin American countries, achieving optimal oncological results. In this report

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we highlight the results in the most important component of disease-free survival (negative CRM), which has determined its incorporation as the technique of choice in patients with rectal cancer in our institution.

Keywords: colorectal neoplasms; colorectal surgery; minimally invasive surgical procedures; robotic surgical procedures; Latin America.

Resumen

Introducción. El tratamiento de los tumores colorrectales requiere un abordaje integral, con la resección quirúrgica como foco principal, acompañada habitualmente de quimio-radioterapia neoadyuvante. Las ventajas del abordaje robótico han ganado un lugar importante en la cirugía rectal, considerándola un abordaje seguro y confiable para estos pacientes.

Métodos. Se realizó un estudio observacional retrospectivo, que incluyó pacientes diagnosticados con cáncer de recto que se sometieron a cirugía asistida por robot en el Instituto Nacional de Cancerología, en Bogotá, D.C., Colombia, entre 2017 y 2023. Las cirugías fueron realizadas por un único cirujano de consola y varios cirujanos en formación actuaron como asistentes.

Resultados. Se incluyeron en el estudio un total de 43 pacientes. El 69,7 % de los pacientes tenía un tumor en el recto inferior, 20,9 % en recto medio y solo el 7,2 % en recto superior. Se realizó resección rectal anterior baja o anterior ultrabaja en el 58,1 % de los pacientes y TaTME en el 34,9 %. La calidad del mesorrecto fue completa en 79 %, casi completa en 18,6 % y ningún paciente presentó mesorrecto incompleto. Hubo complicaciones postoperatorias en el 20,9 %; 6,9 % (n=3) de las complicaciones fueron clasificadas Clavien-Dindo >IIIa. La tasa de fuga anastomótica fue del 9,3 %.

Conclusión. La cirugía robótica para el cáncer de recto puede ser técnicamente ventajosa en comparación con otras técnicas. Es una opción segura y factible en países latinoamericanos, con resultados oncológicos óptimos. En este informe destacamos los resultados en el componente más importante de la supervivencia libre de enfermedad (MRC negativo), lo que ha determinado su incorporación como técnica de elección en pacientes con cáncer de recto en nuestra institución.

Palabras clave: neoplasias colorrectales; cirugía colorrectal; procedimientos quirúrgicos mínimamente invasivos; procedimientos quirúrgicos robotizados; América Latina.

Introduction

Colorectal cancer is the second leading cause of cancer death worldwide¹. The highest incidence rate is seen in higher income countries, reflecting highly processed and low-fiber diets and high rates of obesity^{1,2}. In Latin America, the literature is very limited, but in our local environment, a study from Cali, Colombia, with a cohort from 1962 to 2007 showed a progressive increase in the incidence of colorectal cancer in our country³, and according to Globocan data for Colombia, it is the third leading cause of cancer-related mortality⁴.

The treatment of rectal tumors requires a comprehensive approach⁵. Historically, surgical

management has been the mainstay of management even though the anatomical situation of the rectum poses a scenario with different approaches according to the level of involvement and regional extension⁶. The goal in the rectal cancer surgery, is to ensure complete mesorectal excision (TME) and to address circumferential and distal margins, as these directly impact in loco-regional recurrence^{7,8}.

However, recent advances in chemotherapy, immunotherapy and radiotherapy for rectal tumors, achieving excellent survival rates, generate controversy about the possible additional benefit of surgical management⁹.

Over the years, laparoscopic and robotic-assisted minimally invasive surgery has emerged as a feasible and safe approach to the surgical management of rectal cancer. In 2003, the first robotic-assisted anterior rectal resection was performed¹⁰. The COREAN and COLOR II studies reported no difference in survival rates between laparotomy and laparoscopic surgery for rectal cancer^{11,12}; however, a recent meta-analysis suggested an increased risk of incomplete total mesorectal excision and positive circumferential margin with the laparoscopic approach¹³. Kim and Yamaguchi reported that robotic surgery can decrease surgical trauma to pelvic vessels and nerves, help to significantly reduce bleeding, preserve sexual and urinary function, and even decrease local recurrence compared to open surgery for rectal cancer^{14,15}.

The advantages of the robotic approach have allowed it to gain an important place in rectal surgery. The three-dimensional vision, the maneuverability of the instruments, and their flexibility in approaching the lower pelvis, especially for tumors of the lower rectum, allow a safer resection plane and less morbidity for the patient^{16,17}. Liao *et al.* published one of the first comparative meta-analyses between laparoscopic and robotic approaches for colorectal cancer, concluded that the robotic approach may be safer and may reduce operative time. However, they did not find any statistically significant differences. The most notable findings were lower conversion rates and lower blood loss compared to the laparoscopic approach¹⁸.

Currently, the only study in Latin America that analyzes the experience of robotic-assisted surgical approach to the colon and rectum is a Mexican retrospective study published in 2016. The study analyzed 5 cases and reported good results in terms of quality of life, with a conversion rate to open surgery of 0%¹⁹. As part of the Latin American collaboration to report the experience of the robotic approach, we aimed to evaluate the short-term outcomes following robotic surgery for rectal cancer in our institution.

Methods

This is an observational, retrospective, descriptive study that included patients diagnosed with rectal cancer who underwent robotic-assisted surgery using the Da Vinci Si® robotic system at the National Institute of Cancerology between 2017 and 2023.

Technical procedure

Surgeries were performed by a single console surgeon and various surgeons-in-training as assistants. In the last cases of ultra-low anterior resection, where we have ensured the distal resection margin through the transanal route, after obtaining the maximum dissection through the transabdominal route in the usual way, the use of a transanal monoportal platform (Gel Point Path) has been performed to achieve precise identification of the distal resection margin using conventional laparoscopic instruments and after distal marking. The extraction of the piece is performed through the transabdominal route, except in selected cases of small specimens where it can be performed through the transanal route. The purse stringing of the distal rectum is performed through the transabdominal route with robotic assistance. This maneuver is performed in an adequate way with the advantages of the robotic platform, mainly for the possibility of stable vision at pelvic level with 180 degrees rotation of the lens and the use of articulated instruments that allow maneuvering in this narrow site. The anastomosis is performed with a single stapling by inserting a circular stapler anvil with a tubular drain at its tip (Figure 1).

Data collection

A database was constructed using the Research Electronic Data Capture (REDCap) platform from the various medical history reports, endoscopic reports, surgical description, surgical pathology report, and postoperative follow-up; patients with loss to follow-up before 3 years were not included in the analysis.

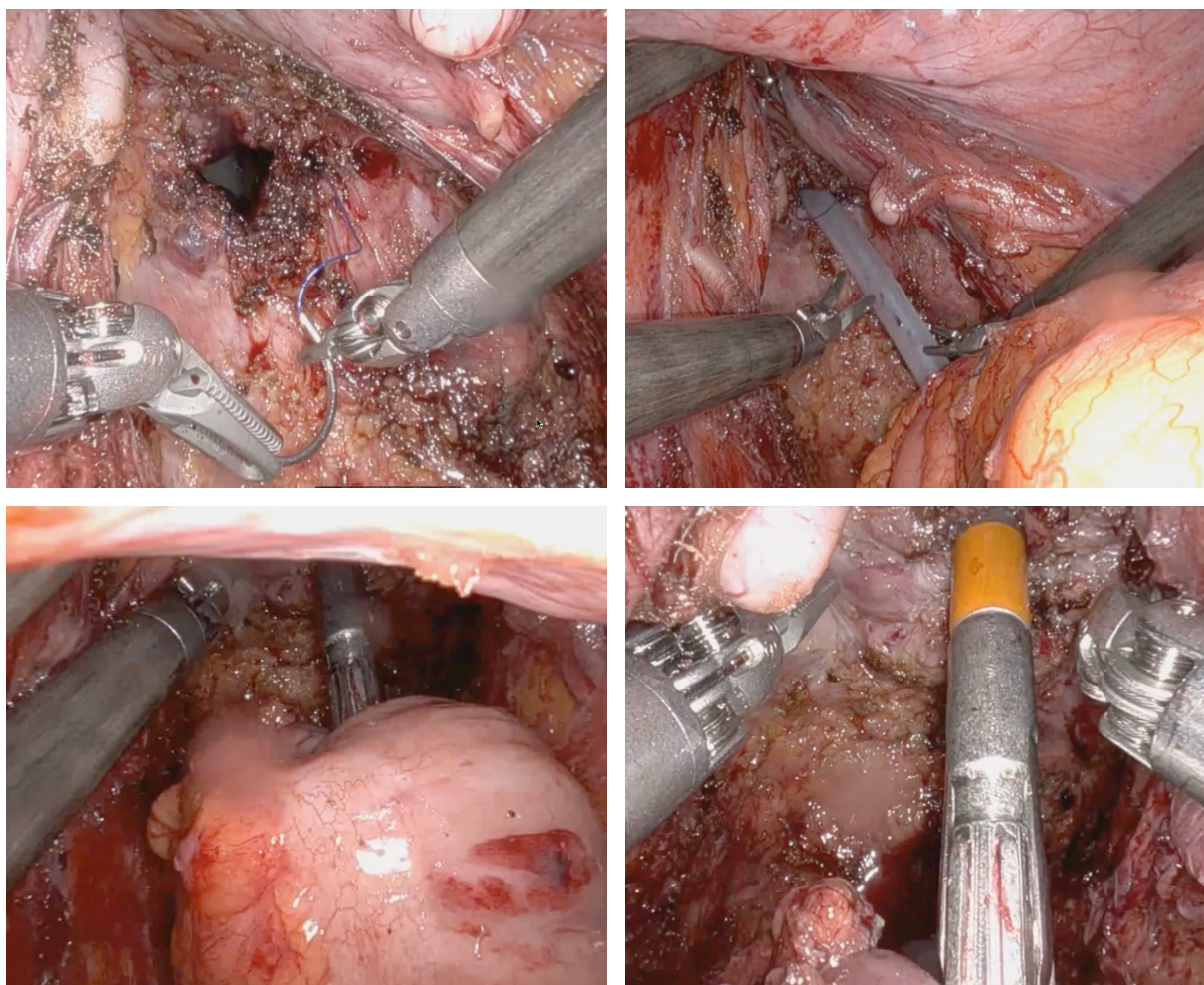


Figure 1. Transabdominal rectal purse-string. In the sequence we can see the trans-abdominal purse-string, then the passage of the suture stem protected by the probe, and finally with the camera at 30 degrees upwards we can see the suture assembled. Source: The authors.

Statistical analysis

Data were analyzed using SPSS Vr. 17. Descriptive statistics were used to report median and inter-quartile range (IQR) of continuous variables (with 25th and 75th percentiles reported as IQR). All statistical analyses were performed in R - Project v3.6.2 software (free license).

Results

Clinical characteristics

A total of 43 patients were included in the study, 53% men and 47% women. The mean age was

61.5 years (RIQ: 70-55.5). The mean body mass index (BMI) was 23.39 kg/m² with a DV of 4.06. Detailed characteristics of the entire cohort are shown in table 1.

Regarding the location of the tumors, 69.7% of patients had it in the lower rectum, 20.9% in the middle rectum, and only 7.2% in the upper rectum, with a median distance to the anal verge of 6 cm (RIQ: 3-10). Thirty-two (74.4%) patients received neoadjuvant chemoradiotherapy, with a median time from consolidation to surgery of 2 months. Thirty-nine percent of patients received adjuvant therapy.

Table 1. Demographic and medical characteristics of rectal cancer patients undergoing robotic surgery.

Characteristics	Total (n=43)
Demographic	
Mean age (years)	61.5 (55.5-70)
Gender, n (%)	
Male	23 (53%)
Female	20 (47%)
Body mass index, kg/m ²	
Median ± SD	23.39 ± 4.06
Tumor location, n (%)	
Upper rectum	4 (7.2%)
Middle rectum	9 (20.9%)
Lower rectum	30 (69.7%)
Median distance to the anal verge (cm)	5.8 (3-10)
Surgical	
Type of intervention, n (%)	
Low or ultra-low anterior rectal resection	25 (58.1%)
TaTME	15 (34.9%)
Abdominoperineal resection	3 (6.9%)
Mean surgical time (minutes)	
General	306.6
Low or ultra-low anterior rectal resection	326
TaTME	409.8
Conversion, n (%)	2 (4.6%)
Neoadjuvant and adjuvant management	
Adjuvant management, n (%)	17 (39%)
Neoadjuvant management, n (%)	32 (74.4%)

SD: Standard deviation; RIQ: Rank interquartile.

Source: The authors.

The quality of the mesorectum was complete in 81.4% (Figure 1), almost complete in 18.6% and no patient had an incomplete mesorectum. Of the patients with almost complete mesorectal quality (n=8), 75% (n=6) were patients with the TaTME approach.

Surgical management

Low anterior or ultra-low anterior rectal resection was performed in 58.1% of patients, TaTME in 34.9%, and abdominoperineal resection in only 6.9%. A protective ileostomy was performed in

the 86% of the cases. The mean operative time was 306.6 minutes, being longer for TaTME (409.8 minutes) and 326 minutes for anterior rectal resection. The conversion rate was 4.6%.

Pathologic results

Most patients had pathologic tumor stage T3 (n=33.9%), followed by stage T1 (25.6%). The 20.9% of patients had a complete pathologic response. The degree of histologic differentiation was moderate in 45.5% of patients. A positive surgical margin was present in 4.6% (n=2): proximal or distal margin (n=0), circumferential (n=2). The mean number of nodes resected was 15.6 (RIQ: 11-19). 27.9% (n=12) of patients underwent lymphadenectomy of less than 12 nodes.

Short-term outcomes

There were no intraoperative complications. Intensive care unit was required in 2.3% (n=1) with a stay of 2 days. The median length of hospital stay was 6 days (RIQ: 5-9) (Table 2). Hospital readmission rate was 18.6% (n=8), with 15% of patients hospitalized for common medical complications (urinary tract infection, SARS Cov-19).

Postoperative complications occurred in 20.9% (n=9) of the patients, but only 6.9% (n=3) had Clavien-Dindo complications >IIIa and 66.6% (n=6) had Clavien-Dindo complications I and II. The anastomotic leak rate was 9.3% (n=4), with no differences between the types of approaches performed (LRR vs. TaTME), 90% of these patients were managed endoscopically. Mortality at 90 days was 2.3% (n=1) (Table 3).

Discussion

Minimally invasive surgery has emerged as a feasible and safe option for treating various gastrointestinal neoplasms, including colorectal tumors. Initially, laparoscopic techniques were used, and now robotic technology is also being employed. Several studies in the literature have demonstrated that minimally invasive surgery is non-inferior to traditional surgery in terms of oncological safety, complications, and postoperative recovery for patients with

Table 2. Short-term and pathologic outcomes in patients with rectal cancer treated with robotic surgery.

Characteristics	Total (n=43)
Short-term outcomes	
ICU requirement, n (%)	1 (2.3%)
Median of hospital stay, days (RIQ)	6 (5-9)
Pathological outcomes	
Tumor staging, n (%)	
T1	11 (25.6%)
T3	15 (33.9%)
Complete pathological response, n (%)	9 (20.9%)
Histological differentiation, n (%)	
Moderate	19 (45.5%)
Positive margins, n (%)	
Proximal	0 (0%)
Distal	0 (0%)
Circunferential	2 (4.6%)
Resected nodes, n (%)	
Median (RIQ)	15.6 (11-19)
Quality of the mesorectum, n (%)	
Complete	34 (81.4%)
Almost complete	8 (18.6%)
Incomplete	0 (0%)

SD: Standard deviation; RIQ: Rank interquartile; ICU: Intensive Care Unit.

Source: The authors.

Table 3. Complications in rectal cancer patients treated with robotic surgery.

Characteristics	Total (n=43)
Hospital readmission, n (%)	8 (18.6%)
Postoperative complications, n (%)	
Clavien Dindo ≥III	3 (6.9%)
Clavien Dindo I-II	6 (13.8%)
Anastomotic leak, n (%)	4 (9.3%)
Endoscopic management	3 (90%)
Mortality ≤ 90 days, n (%)	1 (2.3%)

Source: The authors.

colorectal cancer¹⁷⁻¹⁹. It has also been associated with shorter hospital stays. However, there is still some uncertainty regarding the management of rectal cancer, as there is a lack of comprehensive studies to fully validate these findings.

In this scenario, the introduction of new technologies and approaches to surgical management was initially driven by the search for a greater possibility of sphincter preservation, better oncologic quality, and fewer short-term complications^{20,21}. The first approach to overcoming the limitations of laparoscopic surgery in rectal surgery was the ACOSOG study Z6051, which noted that two-dimensional vision and non-articulated instruments could create technical limitations in the dissection of the pelvis²².

Robotic colorectal surgery shows less intraoperative blood loss, shorter time to oral tolerance, lower conversion rate to open surgery, shorter hospital stays, and longer distal margins compared to laparoscopic and open surgery. This approach also shows a shorter learning curve. Some studies suggest that it may reduce perioperative or 30-day mortality, increase overall survival, reduce wound infection, and improve functional outcomes, while others show no significant differences.

In this series, the most common procedure was low anterior or ultra-low anterior rectal resection, performed in 58.1% of patients, followed by TaTME and abdominoperineal resection in 6.9%. These results are striking because 69.7% of the patients had tumors in the lower rectum with a mean distance to the anal verge of 6 cm. Within our institution, we found that the number of procedures involving anal sphincter sacrifice decreased. However, these results are only descriptive and for a different period.

The impact of BMI on complications in robotic colorectal surgery remains debated. To date some studies have found a proportional increase in complications in obese patients^{23,24}. In this series the mean BMI was 23.39 kg/m² (normal), however in a recent publication of our institution, we found that the median BMI was found to be significantly higher in patients who had intraoperative complications compared to those who did not²⁵.

We encountered no intraoperative complications and had a conversion rate of 4.6% in two patients who underwent the TaTME procedure at the beginning of our personal learning curve. Although these results are lower than those reported in other studies (5-8.1%)^{26,27}, the length of hospital stay (6 days) aligns with the findings of a recent meta-analysis. The meta-analysis demonstrated the benefits of robotic surgery over the laparoscopic approach in terms of conversion rates and hospital stay²⁷.

The standardization of total mesorectal excision (TME) from a surgical perspective has significantly improved oncologic outcomes. This procedure involves removing the mesorectum, its associated lymph nodes, and the primary tumor while adhering to embryologic planes. By focusing on achieving a clear circumferential resection margin (CRM)²⁸, TME surgery has shown to have a lower local recurrence (LR) rate (<10%) compared to previous conventional dissection, thus improving long-term survival in patients with rectal cancer²⁹.

Among the surgical parameters of the rectal resections in this series, it is important to highlight that 79% of specimens showed complete or

almost complete integrity of the mesorectum, 18.6% showed partial integrity, 0% had positive proximal or distal margins, and 4.6% had circumferential positive margins. These findings are of great relevance for the oncological prognosis of the patients, and the results are superior to those reported in other studies such as ROLLAR, which had a positive margin rate of 5%^{16,30}. Additionally, the number of nodes dissected (15.6) meets the necessary requirements for adequate staging of patients with colorectal cancer according to the AJCC³¹.

The rate of postoperative complications was 20.9% (n=9), with only 6.9% (n=3) having Clavien-Dindo complications >IIIa, and 66.6% (n=6) experiencing Clavien Dindo I and II complications. Additionally, the rate of anastomotic leak in the rectal resections was 9.3% (n=4). However, this complication was identified in time to perform endoscopic intervention in 90% of patients, with successful results and no mortality at 90 days related to this complication. Moreover, in recent cases of TaTME, a transabdominal rectal purse-string has been implemented after securing the distal margin through the transanal route (Figure 2).



Figure 2. Complete mesorectum.

Source: The authors.

Conclusion

Robotic surgery for rectal cancer may be technically advantageous compared to other techniques. According to this report and the available literature it is a safe and feasible technique in Latin American countries, achieving optimal oncological results. In this report we highlight the results in the most important component of disease-free survival (negative CRM), which has determined its incorporation as the technique of choice in patients with rectal cancer in our institution.

Compliance with ethical standards

Informed consent: This clinical research follows the principles of the International Committee on Harmonisation's Good Clinical Practice Guidelines and the ethical principles of the Declaration of Helsinki, both in its design and conduct. In accordance with the CIOMS guidelines and Resolution 008430 of 4 October 1993 of the Ministry of Health of the Republic of Colombia. The Research Ethics Committee of the National Cancer Institute, on the basis of Resolution No. 008430 of 1993 of the Ministry of Health, which establishes the technical and administrative scientific standards for health research, determined that the present research is a study without risk, so that informed consent was not required, and after verifying compliance with the required requirements, approved the research work by Resolution CEI-00786-21, according to Law No. 0014-21.

Conflicts of interest: the authors declared that they had no conflicts of interest.

Use of Artificial Intelligence: It is worth noting that no AI-assisted technologies were used in any aspect of the study. All procedures, from data collection to analysis and discussion, were carried out manually by the research team.

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Author's contribution:

- Conception and design of the study: Raúl Pinilla-Morales, Antonio Caycedo-Marulanda, Mario Rey-Ferro.
- Acquisition of data: Jorge Vélez-Bernal, Juliana Rendón-Hernández, Mario Rey-Ferro, Ana Deise Bonilla.
- Data analysis and interpretation: Juliana Rendón-Hernández, Ana Deise Bonilla.
- Drafting the manuscript: Raúl Pinilla-Morales, Silvia Guerrero-Macías, Jorge Vélez-Bernal.

- Critical review and final approval: Raúl Pinilla-Morales, Silvia Guerrero-Macías, Antonio Caycedo-Marulanda.

References

- 1 Cui CL, Dornisch AM, Umlauf AE, Cuomo RE, Murphy JD, Lopez NE. International socioeconomic predictors of colon and rectal cancer mortality: Is colorectal cancer a first world problem? *JCO Glob Oncol*. 2021;7:1659-67. <https://doi.org/10.1200/GO.21.00307>
- 2 Argilés G, Taberner J, Labianca R, Hochhauser D, Salazar R, Iveson T, et al. Localised colon cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2020;31:1291-305. <https://doi.org/10.1016/j.annonc.2020.06.022>
- 3 Cortés A, Bravo LE, García LS, Collazos P. Incidencia, mortalidad y supervivencia por cáncer colorrectal en Cali, Colombia, 1962-2012. *Salud Pública Méx*. 2014;56:457-64.
- 4 World Health Organization. International Agency for Research on Cancer. Global Cancer Observatory - GLOBOCAN. Cancer today. Data version: Globocan 2022 (version 1.1) - 08.02.2024. Available from: <https://gco.iarc.who.int/today>.
- 5 Benson AB, Venook AP, Al-Hawary MM, Azad N, Chen Y, Ciombor KK, et al. Rectal Cancer, Version 2.2022, NCCN Clinical Practice Guidelines in Oncology. *J Natl Compr Canc Netw*. 2022;20:1139-67. <https://doi.org/10.6004/jnccn.2022.0051>
- 6 Abbas MA, Chang GJ, Read TE, Rothenberger DA, Garcia-Aguilar J, Peters W, et al. Optimizing rectal cancer management: Analysis of current evidence. *Dis Colon Rectum*. 2014;57:252-9. <https://doi.org/10.1097/DCR.000000000000020>
- 7 Quirke P, Steele R, Monson J, Grieve R, Khanna S, Couture J, et al. Effect of the plane of surgery achieved on local recurrence in patients with operable rectal cancer: a prospective study using data from the MRC CR07 and NCIC-CTG CO16 randomised clinical trial. *Lancet*. 2009;373:821-8. [https://doi.org/10.1016/S0140-6736\(09\)60485-2](https://doi.org/10.1016/S0140-6736(09)60485-2)
- 8 Lam J, Tam MS, Retting RL, McLemore EC. Robotic versus laparoscopic surgery for rectal cancer: A comprehensive review of oncological outcomes. *Perm J*. 2021;25:21.050. <https://doi.org/10.7812/TPP/21.050>
- 9 Mullaney TG, Lightner AL, Johnston M, Keck J, Wattoo D. 'Watch and wait' after chemoradiotherapy for rectal cancer. *ANZ J Surg*. 2018;88:836-41. <https://doi.org/10.1111/ans.14352>
- 10 Giulianotti PC, Coratti A, Angelini M, Sbrana F, Cecconi S, Balestracci T, et al. Robotics in general surgery: Personal experience in a large community hospital. *Arch Surg*. 2003;138:777-84. <https://doi.org/10.1001/archsurg.138.7.777>
- 11 Jeong SY, Park JW, Nam BH, Kim S, Kang SB, Lim SB, et al. Open versus laparoscopic surgery for mid-rectal

- or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. *Lancet Oncol.* 2014;15:767-74.
[https://doi.org/10.1016/S1470-2045\(14\)70205-0](https://doi.org/10.1016/S1470-2045(14)70205-0)
- 12 Bonjer HJ, Deijen CL, Abis GA, Cuesta MA, van der Pas MHGM, de Lange-de Klerk ESM, et al. A Randomized trial of laparoscopic versus open surgery for rectal cancer. *N Engl J Med.* 2015;372:1324-32.
<https://doi.org/10.1056/NEJMoa1414882>
 - 13 Martínez-Pérez A, Carra MC, Brunetti F, deAngelis N. Pathologic outcomes of laparoscopic vs open mesorectal excision for rectal cancer: A systematic review and meta-analysis. *JAMA Surg.* 2017;152:e165665.
<https://doi.org/10.1001/jamasurg.2016.5665>
 - 14 Kim HJ, Choi GS, Park JS, Park SY, Yang CS, Lee HJ. The impact of robotic surgery on quality of life, urinary and sexual function following total mesorectal excision for rectal cancer: a propensity score-matched analysis with laparoscopic surgery. *Colorectal Dis.* 2018;20:O103-13.
<https://doi.org/10.1111/codi.14051>
 - 15 Yamaguchi T, Kinugasa Y, Shiomi A, Kagawa H, Yamakawa Y, Furutani A, et al. Oncological outcomes of robotic-assisted laparoscopic versus open lateral lymph node dissection for locally advanced low rectal cancer. *Surg Endosc.* 2018;32:4498-505.
<https://doi.org/10.1007/s00464-018-6197-x>
 - 16 Jayne D, Pigazzi A, Marshall H, Croft J, Corrigan N, Copeland J, et al. Effect of robotic-assisted vs conventional laparoscopic surgery on risk of conversion to open laparotomy among patients undergoing resection for rectal cancer: The ROLARR Randomized Clinical Trial. *JAMA.* 2017;318:1569-80.
<https://doi.org/10.1001/jama.2017.7219>
 - 17 Safiejko K, Tarkowski R, Koselak M, Juchimiuk M, Tarasik A, Pruc M, et al. Robotic-assisted vs. standard laparoscopic surgery for rectal cancer resection: A systematic review and meta-analysis of 19,731 patients. *Cancers.* 2021;14:180.
<https://doi.org/10.3390/cancers14010180>
 - 18 Liao G, Zhao Z, Lin S, Li R, Yuan Y, Du S, et al. Robotic-assisted versus laparoscopic colorectal surgery: a meta-analysis of four randomized controlled trials. *World J Surg Oncol.* 2014;12:122.
<https://doi.org/10.1186/1477-7819-12-122>
 - 19 Villanueva-Sáenz E, Ramírez-Ramírez MM, Zubieta-O'Farrill G, García-Hernández L. Experiencia inicial en cirugía colorrectal asistida por robot en México. *Cir Cir.* 2017;85:284-91.
<https://doi.org/10.1016/j.circir.2016.09.007>
 - 20 Hahn SJ, Sylla P. Technological advances in the surgical treatment of colorectal cancer. *Surg Oncol Clin N Am.* 2022;31:183-218.
<https://doi.org/10.1016/j.soc.2022.01.001>
 - 21 Thomas A, Altaf K, Sochorova D, Gur U, Parvaiz A, Ahmed S. Effective implementation and adaptation of structured robotic colorectal programme in a busy tertiary unit. *J Robot Surg.* 2021;15:731-9.
<https://doi.org/10.1007/s11701-020-01169-1>
 - 22 Fleshman J, Branda M, Sargent DJ, et al. Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: The ACOSOG Z6051 Randomized Clinical Trial. *JAMA.* 2015;314:1346-55.
<https://doi.org/10.1001/jama.2015.10529>
 - 23 Massala-Yila EF, Ali M, Yu W, Wang W, Ren J, Wang D. Evaluating body mass index's impact on Da Vinci Robotic rectal cancer surgery, a retrospective study. *J Robot Surg.* 2024;18:22.
<https://doi.org/10.1007/s11701-023-01774-w>
 - 24 Suwa Y, Joshi M, Poynter L, Endo I, Ashrafian H, Darzi A. Obese patients and robotic colorectal surgery: systematic review and meta-analysis. *BJS Open.* 2020;4:1042-53.
<https://doi.org/10.1002/bjs.5.50335>
 - 25 Pinilla-Morales RE, Guerrero-Macías S, Restrepo-López J, Aguirre-Bermúdez G, Guevara-Cruz O, Oliveros-Wilche R. Cirugía asistida por robot en el manejo de las neoplasias gastrointestinales. Resultados de los dos primeros años de implementación en una institución latinoamericana. *Rev Colomb Cancerol.* 2023;27:281-90.
<https://doi.org/10.35509/01239015.934>
 - 26 Zhang X, Wei Z, Bie M, Peng X, Chen C. Robot-assisted versus laparoscopic-assisted surgery for colorectal cancer: a meta-analysis. *Surg Endosc.* 2016;30:5601-14.
<https://doi.org/10.1007/s00464-016-4892-z>
 - 27 Xiong B, Ma L, Huang W, Zhao Q, Cheng Y, Liu J. Robotic versus laparoscopic total mesorectal excision for rectal cancer: a meta-analysis of eight studies. *J Gastrointest Surg.* 2015;19:516-26.
<https://doi.org/10.1007/s11605-014-2697-8>
 - 28 Liu G, Zhang S, Zhang Y, Fu X, Liu X. Robotic surgery in rectal cancer: Potential, challenges, and opportunities. *Curr Treat Options Oncol.* 2022;23:961-79.
<https://doi.org/10.1007/s11864-022-00984-y>
 - 29 Collin A, Dahlbäck C, Folkesson J, Buchwald P. Total mesorectal excision quality in rectal cancer surgery affects local recurrence rate but not distant recurrence and survival: population-based cohort study. *BJS Open.* 2024;8:zrae071.
<https://doi.org/10.1093/bjsopen/zrae071>
 - 30 Grosek J, Ales Kosir J, Sever P, Erculj V, Tomazic A. Robotic versus laparoscopic surgery for colorectal cancer: a case-control study. *Radiol Oncol.* 2021;55:433-8.
<https://doi.org/10.2478/raon-2021-0026>
 - 31 Amin MB, Greene FL, Edge SB, Compton CC, Gershengwald JE, Brookland RK, et al. The Eighth Edition AJCC Cancer Staging Manual: Continuing to build a bridge from a population-based to a more "personalized" approach to cancer staging. *CA Cancer J Clin.* 2017;67:93-9.
<https://doi.org/10.3322/caac.21388>