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Review Article

Laparoscopic versus robotic approach in rectal cancer

Marcus Valadão *, Rodrigo Otavio Araujo, Eduardo Linhares, José Paulo de Jesus

Instituto Nacional de Câncer, Departamento de Cirurgia Abdominal e Pélvica, Rio de Janeiro, RJ, Brazil

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ABSTRACT

The treatment of rectal cancer is complex and responsible for sequelae due to the various therapeutic modalities, especially the surgical resection. The advent of minimally invasive surgery provided a faster postoperative recovery and a lower complication rate when compared to conventional surgery. The implementation of laparoscopic approach in rectal cancer was responsible for these better results, but the limitations of this method added to the development of robotics, raised the question of which minimally invasive method would be more advantageous in the approach of rectal cancer. The present review will address the most recent data regarding the comparison between the laparoscopic and robotic approach in rectal cancer.

Abordagem laparoscópica ou robótica no câncer retal

Palavras-chave:
Câncer retal
Cirurgia minimamente invasiva
Cirurgia robótica
Cirurgia laparoscópica

RESUMO

O tratamento do câncer de reto é complexo e responsável por sequelas causadas pelas diversas modalidades terapêuticas, principalmente a ressecção cirúrgica. O advento da cirurgia minimamente invasiva está associado a uma recuperação pós-operatória mais rápida e uma menor taxa de intercorrências do que as observadas na cirurgia convencional. A implementação da abordagem laparoscópica no câncer de reto foi responsável por esses melhores resultados, mas as limitações do método, bem como o desenvolvimento da cirurgia robótica, levantaram a questão de qual método minimamente invasivo seria mais vantajoso na abordagem desse tipo de câncer. A presente revisão apresenta os dados mais recentes na comparação entre a abordagem laparoscópica e robótica no câncer retal.

* *Corresponding author*.
E-mail: drmarcusvaladao@gmail.com (M. Valadão).
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Introduction

Minimally invasive surgery has revolutionized the treatment of colorectal cancer in the last 20 years. Despite the initial questioning of the safety of the laparoscopic method from a cancer standpoint, several randomized studies have unequivocally demonstrated the short- and long-term benefits of minimally invasive colorectal cancer surgery.[1–4] Laparoscopic surgery in colorectal cancer compared to conventional surgery had several benefits: faster postoperative recovery, lower rate of complications, shorter hospitalization time, and similar cancer outcomes (overall survival rate and disease-free survival).[1–4] It means that laparoscopic surgery offers the same oncologic results of conventional surgery associated with a faster postoperative recovery. However, although laparoscopic treatment of colon cancer has proven to be feasible and oncologically safe, on the other hand, the treatment of laparoscopic rectal cancer has been less adopted for several reasons: need for a long and arduous learning curve, technical difficulties related to the limitations of the method itself and by the anatomical aspects of the rectal surgery.[5–8] The general opinion of the oncologic surgical community is that Laparoscopic Total Mesorectal Excision (TME) is a procedure with a high degree of difficulty and has been associated with a learning curve as extensive as 50 to 150 cases to achieve consistent results.[9] In the United States, laparoscopic rectal resection represents less than 20% of all rectal resections, in addition to high conversion rates (46.2%), and no significant improvements in this conversion rate was achieved in recent years.[10] It is known that the TME as proposed by Heald[11] is per se a technically difficult surgery and that the addition of laparoscopy seems to increase the degree of difficulty of the procedure. For these reasons the use of laparoscopy in rectal cancer has become routine only in highly specialized centers.

Robotic surgery was developed as a new technique capable of overcoming the limitations of laparoscopy in the pelvis and thus making the minimally invasive TME more adoptable and reproducible.

Objectives

Comprehend the potential advantages of the robotic platform in the treatment of rectal cancer and to compare the results between laparoscopic and robotic approach in rectal cancer resection.

Methods

Critical review of medical literature and expert discussion.

Potential advantages of the robotic approach

The robotic system da Vinci® is the first surgical robot approved in the United States by the FDA (Food and Drug Administration) in the year 2000. The da Vinci system is in its third generation (da Vinci® Xi), consisting of the following items: (1) Two surgical consoles capable of combining dual command for training purposes; (2) High-definition 3D camera controlled by the surgeon; (3) Endowrist technology that allows for the articulation of the surgical clamp and reproduces all movements of the hand and (4) Tremor eliminator that prevents the transmission of the tremor from the surgeon's hand and provides a greater dexterity of the movements. Weber et al.[12] and Hashizume et al.[13] were the first to undergo robotic colorectal surgery in 2002. Before that, robotic surgeries had already been successfully performed in the areas of cardiac surgery, urologic surgery and general surgery. The robotic approach has some potential advantages when compared to laparoscopic surgery in rectal cancer: elimination of tremor allowing more precise surgery, high quality 3D image allowing a clearer visualization of the structures, control of the camera by the surgeon that allows the stability of the camera work on the pelvis with more efficiency and comfort, instrument articulation allowing an increase in the freedom of movement and consequent better working condition in the pelvis, as well as better ergonomics for the surgeon and consequently less fatigue in long lasting procedures.

Comparison of laparoscopy versus robotics in rectal cancer

Until 2016 four meta-analysis investigated the role of robotic surgery in rectal cancer compared to the laparoscopic approach.[14–17] These 4 meta-analysis were concordant in some aspects: they showed that the robotic approach presented similar results to laparoscopy regarding morbimortality, oncological outcomes of short and medium term, as well as identifying a significantly lower rate of conversion in the robotic group. These 4 meta-analyses had limitations: the small number of studies published at that time included in the analysis. In 2017, Li and colleagues[18] updated the previous meta-analysis, including 17 case-control studies (3601 patients, 1726 cases operated by robotics and 1875 operated by laparoscopy). In 2018, Prete and colleagues[19] published another meta-analysis comparing the robotic approach with the laparoscopic approach in rectal cancer, including only prospective randomized studies for the analysis. This meta-analysis included 5 randomized studies (671 patients, 334 submitted to robotic ETM and 337 to laparoscopic ETM).[19] A most recent meta-analysis was published in 2019 and included 73 studies (6 randomized trials and 67 observational studies) with 169,236 cases.[20] In the next sub-items we will describe the findings of the meta-analysis mentioned above.[18–20]

Postoperative recovery

There was no difference in the length of hospital stay between robotics and laparoscopy in the 2 meta-analysis cited.[18,19] Regarding the return of the intestinal function, Li et al.[18] did not show any difference between the 2 groups. On the other hand, Prete and co-workers[19] showed an earlier bowel function return in the robotic group (statistically significant different), but the quality of the evidence was considered low. Moreover, Ng and co-workers[20] showed that the robotic group had a significantly shorter duration of hospitalization, time to oral diet and lesser intraoperative blood loss.

Operative time

Three meta-analyses were concordant regarding operative time. Li and colleagues[18] found that robotic surgery was longer than laparoscopic surgery on average 57minutes and this difference was statistically significant ($p < 0.001$). Similarly, Prete and colleagues[19] identified that the robotic group had a significantly longer operative time than laparoscopy (an average of 38 min longer). Ng and co-workers[20] also found longer duration of the operative time in the robotic approach. This increase in total operative time is explained by the additional time required for the robot to be docked to the patient associated with the need to change the position of the robotic arms during the rectal surgery since the second generation robotic platform (da Vinci Si) does not allows the approach of the splenic flexure and the pelvis with the same positioning of the robotic arms. In this way, the inferior mesenteric vein, inferior mesenteric artery and the splenic angle are approached with an initial positioning of the robotic arms, and a different configuration of the arms is made to approach the pelvis. The third generation robotic platform (da Vinci Xi) allows the work in these two fields with the same arrangement of the arms, and there is no need to change the configuration of the arms during the surgical procedure.

Complications

There was no difference between groups regarding the rate of postoperative complications in 2 meta-analysis.[18,19] Both Li et al.[18] and Prete et al.[19] demonstrated similar anastomotic fistula rate, operative bleeding amount and surgical wound infection rate. Li et al.[18] also described similar 30 day reoperation rate between robotic and laparoscopic groups. Prete et al.[19] showed a similar mortality rate between the 2 groups (0.58% in the robotic group and 0.59% in the laparoscopy group). On the other hand, Ng et al.[20] demonstrated that robotic cohort was associated with significant reduction in the mortality rate (overall) as compared to the laparoscopic group. Similarly, in the subgroup of non-randomized trials, the all-cause mortality rate was significantly lower in robotic group. However, in the subgroup of randomized trials, all-cause mortality rate in robotic group was similar to laparoscopic group. Moreover, there was a significant difference in the incidence of surgical site infection, the risk being lower in the robotic than laparoscopic group. In the subgroup of non-randomized trials, Surgical Site Infection (SSI) was more likely to occur in laparoscopic compared to robotic group. However, in the subgroup of randomized trials, no difference in SSI was observed.[20]

Conversion

Several cases' series of robotic rectal cancer surgery demonstrated a low conversion rate[21–23] when compared to the large multicenter studies of laparoscopy.[2,3] Conversion rates on robotic series ranged from 0% to 5%[21–23] while the laparoscopy series reported rates of up to 34% of conversion.[2,3] This higher conversion rate of laparoscopy is directly related to anatomical issues, since patients with a higher BMI (Body Mass Index) presented a greater chance of conversion than the leaner patients, as evidenced in several publications.[24–26] On the other hand, obesity does not seem to influence the rate of conversion in robotics as demonstrated by Pai et al.,[27] in which the authors compared the conversion rate between 2 groups of patients undergoing robotic surgery (a group of obese and other non-obese) and showed the same conversion rate. To answer this question a prospective multicenter randomized trial comparing robotics and laparoscopy in rectal cancer was conducted. This study ROLARR[28] aimed to evaluate the conversion rate in these two groups and randomized a total of 471 patients (237 patients in the robotic group and 234 in the laparoscopic group). ROLARR trial[28] showed a slightly higher conversion rate in the laparoscopy group, but with no statistically significant difference (laparoscopy 12.2% and robotic 8.1%, $p = 0.16$). Despite being the largest prospective randomized study comparing robotics with laparoscopy in rectal cancer, this study received some important criticism of potential bias that may have influenced its results. The major criticism is that surgeons of the 2 groups were at different stages of learning curve once surgeons of the laparoscopic group had performed on average 91 laparoscopic surgeries before starting the study, while in the robotic group the surgeons had performed only 50 cases on average before the start of the protocol. This difference in surgeon's experience may have contributed to the findings of the study since the group of robotic surgeons could still be in a learning curve phase; different from the group of laparoscopic surgeons who would already had their learning curves consolidated. Despite this, it is worth mentioning an interesting data from the study: the analysis of subgroups identified that male and obese patients had a lower rate of conversion in the robotic group.[28]

Regarding the last three meta-analysis, there was agreement regarding the conversion rate for open surgery. Li et al.,[18] Prete et al.[19] and Ng et al.[20] showed that the conversion rate was significantly lower with robotics. A subgroup analysis performed by Prete et al.[19] (Prete et al.[19] included the ROLARR[28] study in the analysis) showed that male patients had a significantly lower conversion risk when compared to the laparoscopy group. The most recent published meta-analysis[20] showed that robotic group had significantly lower incidence of open conversion rate compared with the laparoscopic group. In the subgroup of non-randomized trials, the open conversion rate was more likely to occur in laparoscopic group as compared to robotic, although the heterogeneity in this subgroup was substantial. However, no significant difference was observed in the subgroup of randomized controlled trials (RCTs). Based on all the included RCTs, the trial sequential analysis of a diversity-adjusted required information size for incidence of conversion rate was 2.140 patients, based on 5% risk of type I error (two-sided), power 80%, low bias-based relative risk reduction of 36.47% and incidence in control arm of 8.38% with a model variance-based heterogeneity correction. Thus, this meta-analytic data based on 4 RCTs analyzed in the aforementioned meta-analysis[20] were inconclusive that robotic approach reduces the incidence of open conversion rate for colorectal cancer.

The lower conversion rate in the robotic approach can be explained by the additional features provided by the robotic platform: (1) High-definition 3D camera controlled by the surgeon; (2) Endowrist technology that allows for the articulation of the surgical forceps and reproduces all hand movements and (3) Fixed exposure of the field with the use of the third robotic arm, in addition to (4) Elimination of the tremor that prevents the transmission of the tremor of the hand of the surgeon and provides greater dexterity of the movements. All these elements contribute to an easier pelvic dissection, especially in adverse anatomical situations such as the narrow pelvis of the male and obese patients.

Oncological results

Numerous studies[21–23,27–29] have shown that robotic surgery in rectal cancer is safe from the cancer standpoint, offering the same results of open and laparoscopic surgery: both for the short-term (number of resected lymph nodes, compromised circumferential margin, quality of mesorectal excision) and long-term oncological results (relapse rate, disease free survival and overall survival).[21–23,27–29] All published meta-analysis corroborate this data.[14–20]

Functional results

An important aspect of robotic TME is the better visualization of the autonomic pelvic plexus and the greater capacity of nervous preservation during the dissection, translating into better preservation of the urinary and sexual functions. The MRC CLASSIC study[3] showed worse sexual function in the laparoscopic arm when compared to open surgery. On the other hand, the comparison between robotics and laparoscopy published by Kim and colleagues[30] demonstrated a reduction of sexual desire and urinary function in both groups 1 month after surgery with a faster and more complete recovery of the two parameters in the robotic group. Luca et al.,[31] found better preservation of urinary and sexual functions in the robotic group compared to the open and laparoscopic surgery groups, with complete recovery of functions at 1 year post-surgery. Broholm et al.[32] published a meta-analysis in 2014 on this topic. The authors included 4 studies in the analysis of urinary and sexual function using the IPSS (International Prostate Symptom Score) and IIEF (International Index of Erectile Function) questionnaires. IPSS is a subjective score system that evaluates urinary function in 7 categories (incomplete voiding, frequency, intermittence, urgency, weak flow, urinary power and nocturia) with a score between 0 and 35. High scores mean a higher degree of dysfunction. IIEF is a self-administered score system that includes questions that explore 5 domains (erectile function, orgasm function, sexual desire, sexual satisfaction and overall satisfaction) with a score between 0 and 75. The higher the score, the better the erectile function. The meta-analysis mentioned above[31] showed better urinary function in 3 and 12 months, as well as better sexual function in 3 and 6 months in the robotic group when compared to the laparoscopic group. The ROLARR study[28] also evaluated urinary and sexual function between the 2 groups as one of the secondary objectives but did not find differences between the groups. It is worth noting that the IPSS and IIEF questionnaires were answered in only 75.3% and 56.6%, respectively, a fact that compromised the accurate analysis of the results. For this reason, we designed a prospective randomized study (RAR Protocol) at the National Cancer Institute of Brazil (INCA) comparing robotics with laparoscopy in rectal cancer, whose primary objective is the evaluation of urinary and sexual function through quality of life questionnaires and urodynamic study. The study is on-going and we hope to answer those questions soon.

In view of the above, the benefits of robotics regarding the reduction of functional sequelae caused by rectal cancer surgery are evident, thanks to the resources provided by robotics as an image of better quality and more precise dissection of delicate structures such as the pelvic nerves.

Costs

To the present the main limitation to widespread adoption of the robotic surgery is its high cost. Several studies[28,33–35] have confirmed the greater cost with the use of robotics compared to laparoscopy. For this reason, some strategies were created that aim to reduce the cost of robotics: increase in the surgical volume of the robot, that is, the greater the use of the robot by the institution, the lower the cost per procedure; specific nursing team training for the robot; surgeons with high volume of robotic surgery aimed at optimizing results and reducing costs.[36,37] The implementation of these strategies can reduce

Table 1 – Comparative summary of the 2 techniques.

Variable	Laparoscopy	Robotic	Conclusion
Operating time	√		Lower operative time in laparoscopy postoperative
Recovery time	=	=	No difference
Complications	=	=	No difference
Conversion rate		√	Lowest conversion rate in robotics
Resected lymph nodes	=	=	No difference
Radial margin	=	=	No difference
Recurrence rate	=	=	No difference
Disease-free survival	=	=	No difference
Global survival	=	=	No difference
Sexual function		√	Improved functional outcome in robotics
Urinary function		√	Better functional outcome in robotics
Cost	√		Higher cost in robotics

(√) Result in favor of the technique used; (=) similar results among the techniques used.
Source: Dr. Marcus Valadão and Dr. Eduardo Linhares.

the costs for the use of the robot, but the most expected is that as new robotic platforms are created, there is a significant price reduction due to increased market competition (Table 1).

Conclusion

The minimally invasive approach to the treatment of rectal cancer provides a faster postoperative recovery and a lower complication rate when compared to conventional surgery. However, minimally invasive surgery of rectal cancer is a complex procedure due to several factors: the need for a long learning curve and a high volume case series, in addition to the technical limitations of laparoscopy. The development of robotics had the objective of overcoming the technical difficulties of laparoscopy, providing oncological outcomes similar to those of laparoscopy, but offering better functional results and a lower conversion rate.

Conflicts of interest

The authors declare no conflicts of interest.

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