



# Journal of Coloproctology


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## Original Article

# Colorectal robotic surgery: INCA's experience



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### ARTICLE INFO

#### Article history:

Received 16 December 2018

Accepted 16 January 2019

Available online 1 March 2019

#### Keywords:

Colorectal robotic surgery

Morbidity and mortality in robotic surgery

Colon neoplasms

Rectal neoplasms

### ABSTRACT

**Introduction:** Minimally invasive surgery has revolutionized surgical management in the treatment of colorectal neoplasms, reducing morbidity and mortality, hospitalization, inactivity time and minimizing cost, as well as providing adequate oncological results when compared to the conventional approach. Robotic surgery, with Da Vinci Platform, emerges as a step ahead for its potentials. The objective of this article is to report the single institutional experience with the use of Da Vinci Platform in robotic colorectal surgeries performed at a reference center in oncological surgery in Brazil.

**Materials and methods:** A retrospective cohort study was conducted based on the prospective database of patients from the institution submitted to robotic surgery for treatment of colorectal cancer from July 2012 to September 2017. Clinical and surgical variables were analyzed as predictors of morbidity and mortality.

**Results:** A total of 117 patients underwent robotic surgery. The complications related to surgery occurred in 33 patients (28%), the most frequent being anastomotic fistula and surgical wound infection, which corresponded to 11% and 3%, respectively. Conversion rate was 1.7%. Median length of stay was 5 days. The only variable associated with increase of complications and death risk was BMI >30, with *p*-value of 0.038 and 0.027, respectively.

**Conclusion:** Robotic surgery is safe and feasible for approaching colorectal cancer surgeries, presenting satisfactory results regarding length of hospital stay and rate of operative complications, as well as presenting a low rate of conversion. Obesity has been shown to be a risk factor for surgical complication in robotic colorectal surgery.

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<https://doi.org/10.1016/j.jcol.2019.01.002>

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## Cirurgia robótica colorretal: experiência do INCA

### R E S U M O

#### Palavras-chave:

Cirurgia robótica colorretal  
Morbidade e mortalidade em  
cirurgia robótica  
Neoplasias do cólon  
Neoplasias Retais

**Introdução:** A cirurgia minimamente invasiva revolucionou o tratamento cirúrgico no manejo das neoplasias colorretais, reduzindo a morbidade e mortalidade, a hospitalização, o tempo de inatividade e minimizando os custos, além de fornecer resultados oncológicos adequados quando comparada à abordagem convencional. A cirurgia robótica, com a Plataforma Da Vinci, surge como um passo à frente por seus potenciais. O objetivo deste artigo é relatar a experiência institucional única com o uso da Plataforma Da Vinci em cirurgias robóticas colorretais realizadas em um centro de referência em cirurgia oncológica no Brasil.

**Materiais e métodos:** Foi realizado um estudo de coorte retrospectivo, baseado na base de dados prospectiva de pacientes da instituição que foram submetidos à cirurgia robótica para tratamento de câncer colorretal, de julho de 2012 a setembro de 2017. As variáveis clínicas e cirúrgicas foram analisadas como preditores de morbidade e mortalidade.

**Resultados:** Um total de 117 pacientes foram submetidos à cirurgia robótica. As complicações relacionadas à cirurgia ocorreram em 33 pacientes (28%), sendo as mais frequentes fistula anastomótica e infecção da ferida cirúrgica, correspondendo a 11% e 3%, respectivamente. A taxa de conversão foi de 1,7%. O tempo mediano de permanência foi de 5 dias. A única variável associada ao aumento de complicações e risco de óbito foi o IMC >30, com p-valor de 0,038 e 0,027, respectivamente.

**Conclusão:** A cirurgia robótica é segura e viável para a abordagem de cirurgias de câncer colorretal, apresentando resultados satisfatórios quanto ao tempo de internação hospitalar e taxa de complicações operatórias, além de apresentar baixo índice de conversão. A obesidade tem se mostrado um fator de risco para complicações cirúrgicas na cirurgia colorretal robótica.

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## Introduction

Minimally invasive surgery has revolutionized surgical management in the treatment of colorectal neoplasms, reducing morbidity and mortality, hospitalization, inactivity time and minimizing costs, as well as providing adequate oncological results when compared to the conventional approach.<sup>1</sup> Robotic surgery, with Da Vinci Platform, emerges as a step ahead for its potentials. When compared to conventional laparoscopy, robotic surgery contributes with ergonomics, camera stability and articulated instruments, facilitating surgical dissection under spatially restricted anatomical conditions.<sup>2-4</sup> The robotic approach in colorectal cancer offers the same oncologic results of conventional surgery associated with faster recovery due to the minimally invasive procedure without all the technical limitations of the laparoscopic surgery.<sup>5</sup>

The main concern about robotic surgery is how much this technology costs. Recently a randomized, multi-centric study (ROLARR) has compared the robotic to laparoscopic approach on rectal cancer, reporting similar rates of conversion and also the larger costs of robotic surgery. The subgroup of male obese patients was benefited when compared to laparoscopy. Furthermore, robotic surgery for rectal cancer is still in full development worldwide.<sup>6</sup> In our hospital, it has been in use since 2013 under constant control, as to allow future evaluations of cost/effectiveness.

This article's objective is to report the single-center experience with the use of Da Vinci platform in colorectal robotic surgeries performed in a national reference surgical oncology center in Brazil.

## Methods

This is a Retrospective Cohort study based on the prospective database of the Brazilian National Cancer Institute José de Alencar (INCA/MS) of patients who underwent robotic surgery as treatment for colorectal cancer between July 2012 and September 2017. All surgeries were performed at Hospital of Cancer 1/INCA by three staff surgeons from INCA's abdominal-pelvic team (JP, MV, EL), trained in laparoscopic and robotic surgery.

The clinical and surgical variables selected for distribution and frequency analysis were: age, gender, Body Mass Index (BMI), comorbidities, Length of stay, histopathologic staging, tumor location, distance from anal verge, neoadjuvant and adjuvant therapy, type of surgery, conversion to open surgery, distal and proximal surgical margins, and tumor recurrence.

Surgical complications were defined as all adverse events related to the surgical act according to the Clavien-Dindo Classification<sup>7</sup> taken place up to 60 days postoperative, and all deaths from surgical act complications in the same period.

**Table 1 – Clinical and surgical variable frequency distribution, regarding the 117 patients.**

Variables	n = 117	Min–Max
Age (average)	61 years	20–80
BMI (average)	24	18–40
BMI ≥30 kg/m <sup>2</sup> (average)	33 kg/m <sup>2</sup> n = 12 (11%)	30–40 kg/m <sup>2</sup>
Length of stay (median)	5 days	3–69
Gender, male (M), female (F)	M – 62 (53%) F – 55 (47%)	
Comorbidities (Yes/No)	Yes – 73 (62%) No – 44 (48%)	
Neoadjuvant therapy (Yes/No)	Yes – 66 (56%) No – 51 (44%)	
Adjuvant therapy (Yes/No)	Yes – 62 (53%) No – 55 (47%)	
Conversion (Yes/No)	Yes – 2 (1.7%) No – 115 (98.3%)	
Free margins (Yes/No)	Yes – 116 (99.2%) No – 1 (0.8%)	
Overall Recurrence (Yes/No)	Yes – 22 (19%) No – 95 (81%)	
Staging (7th AJCC)	0–8 (7%) I–24 (21%) IIA – 36 (31%) IIB – 9 (8%) IIC – 4 (3%) IIIA – 4 (3%) IIIB – 26 (22%) IIIC – 4 (3%) IVA – 0 (0%) IVB – 2 (2%)	

BMI, Body Mass Index.

The Da Vinci Si platform is available on INCA and was used for all patients.

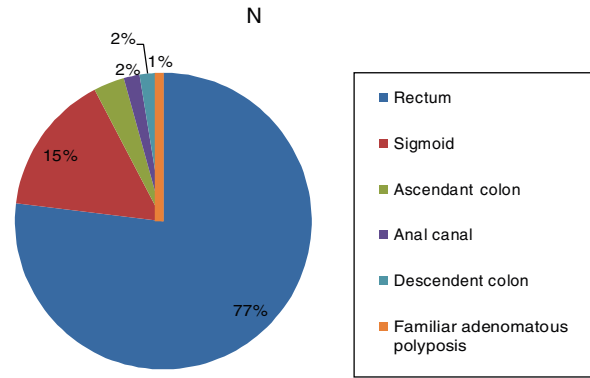
For the quantitative variables, mean and/or median were calculated and to verify the association between variables, Chi-square and Fisher’s exact test were used. Significant *p*-value was considered <0.05. Software SPSS V. 17 was used for statistical analysis. Associations of surgical complications were verified with the following variables: age, comorbidities, gender, BMI, surgeon, neoadjuvant therapy and tumor localization.

The study was submitted to and approved by INCA’s Ethics and Research Committee. Informed consent was obtained from the patients before the surgical procedure.

**Results**

117 patients underwent robotic surgery, clinical and surgical variables frequency distributions are shown in Table 1. The most common histological type was adenocarcinoma, found in 113 patients, followed by epidermoid carcinoma in three patients, and 1 patient with Gastrointestinal Stromal Tumor (GIST). The most frequent location was the rectum, with 90 patients, and the most performed surgery was Low Anterior Resection (LAR) with primary anastomosis (Figs. 1 and 2). Regarding pathological staging (7th edition of the AJCC), the most frequent staging was IIA, in 31% of patients (Table 1).

Complications related to surgery occurred in 33 patients (28%), the most frequent being anastomotic fistula and



**Fig. 1 – Tumor location distribution.**

surgical wound infection, corresponding to 11% and 3%, respectively (Table 2). Regarding the severity of complications, according to the Clavien–Dindo classification, Classes II and IIIb were the most frequent, with 36% and 34% occurrence respectively (Table 3). Regarding the association between clinical and surgical variables and the occurrence of complications and death, the only variable that showed statistical significance was the BMI ≥30, with higher risk of complications and death, with a *p*-value of 0.038 and 0.027, respectively. The other mentioned variables did not show a statistically significant *p*-value (Table 4).

Surgical conversions were necessary in two patients (1.7%), re-interventions were needed in 16 patients (13.6%) and 3 patients came to death (2.5%) related to post-operative complications. The subgroup analysis of rectal cancer showed conversion rate of 2.1%, anastomotic fistula of 11% and death rate of 2.1% (two patients) (Table 5).

**Discussion**

Minimally invasive surgery is a fundamental tool in colorectal cancer treatment due to its associated advantages, such as less surgical trauma, extended visualization and technological association for better identification of vascular and nervous structures.<sup>4,8,9</sup> With the advent of robotic surgery, some new technologies were added to the minimally invasive surgery arsenal, such as tridimensional imaging, articulated and precise tweezers, better ergonomics and comfort for the surgeon.<sup>10,11</sup> Being so, robotic surgery has come with the expectation to present satisfactory results compared to the already common surgical modalities such as laparoscopic and conventional surgery, with its high cost being justified through the generated benefits.

Comparing the results between the possible surgical modalities for colorectal cancer treatment, Uhrich et al. reported uncomfortable positions during laparoscopic surgery increased surgeon fatigue and brought a higher chance of iatrogenic injury, which was minimized in the robotic approach.<sup>12</sup> Liao et al. conducted a meta analysis with 1074 patients, comparing the robotic approach versus conventional surgery for rectal cancer treatment and showed that robotic surgery is safe, presents with lower blood loss and transfusion, shorter time of hospital stay, return for normal intestinal

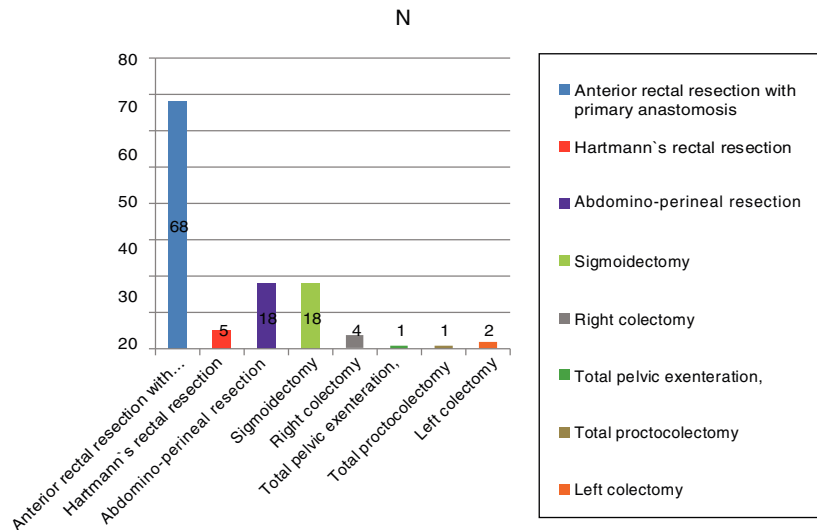


Fig. 2 – Surgery type distribution.

Table 2 – Post surgical complications from robotic colorectal surgeries.

Complications		
Type	n	%
Anastomotic fistula	13	11%
Surgical wound infection	4	3%
Pneumonia	3	2.5%
Intestinal obstruction	3	2.5%
Colostomy necrosis	3	2.5%
Perineal infection	3	2.5%
Deep vein thrombosis	2	1.7%
Metabolic ileus	2	1.7%
Pelvic abscess	2	1.7%
Urinary fistula	2	1.7%
Colostomy prolapse	1	0.85%
Necrotic omentum	1	0.85%
Total	33	100%

Table 3 – Complications according to Clavien–Dindo.

Clavien–Dindo classification		
Type	n	%
I	1	3
II	12	36
IIIa	3	9
IIIb	11	34
IVa	3	9
V	3	9

activity, and eating. However, there was no statistical difference in evaluating the oncological resection and there was a longer surgery time for patients under robotic surgery. Xiong et al. have published a meta-analysis with 1229 cases (554 robotic surgeries and 675 laparoscopies), concluding that robotic surgery lowers the rates of hospitalization and surgical conversion. On the other hand, there was no difference on circumferential margin and sexual dysfunction when compared to laparoscopy.<sup>13</sup> Fernandez et al. have shown that there was

no difference between robotic and laparoscopic surgery on post-operative morbidity or on quality of mesorectal excision, however, it was described that robotic surgery showed lower rates of conversion compared to laparoscopy (8% vs. 17%).<sup>14</sup> The studies made by Patriti et al., Lin et al., Trastulli et al. and Ortiz-Oshiro et al. corroborate on these data.<sup>15-18</sup>

Conversely, the Da Vinci system has some technical disadvantages compared to the other surgical modalities. First, there is lack of tactile sensation and tension for the surgeon, which can lead to tissue damage during the robotic arm traction and instrument movement. Besides, the technology costs are higher than conventional laparoscopy, suture material can be cut because there is no tension return during surgery and the docking process is time consuming and requires trained assistance.<sup>19,20</sup> Recently, the ROLARR, a multicentric and randomized study, questioned and opposed other studies about the potential benefit of robotic surgery on rectal cancer treatment, showing that this technology increases costs significantly while showing no potential benefits on conversion rates, circumferential margins or complication rates.<sup>6</sup> One criticism of the ROLARR study is that the robotic surgeon group had a 25 procedures experience in average, versus almost 100 for the laparoscopic surgeon group, which probably contributed to the findings in the study. We believe that these findings of clear non-superiority of robotic surgery may be overcome by surgeon and team experience, and that there are many benefits to the robotic approach on treating colorectal cancers, as mentioned in previous studies.<sup>2-5</sup>

Concerning our study, when compared with literature, the median of hospital stay was 5 days, which corroborates with Park et al. and Casillas et al., who found a median of 4 days for robotic surgery and 7 days for laparoscopy.<sup>11,21</sup> The conversion rate specific to rectal cancer found on our study was 2.1%, consistent with the literature findings that vary between 0% and 9% (Table 5).<sup>22</sup>

The most common post operative complications reported in our study were anastomotic fistula in 11% and surgical wound infection in 3% of patients, within Clavien–Dindo II

**Table 4 – Association between clinical and surgical complications and death.**

Variables	Complications	p-value	Deaths	p-value
Age ( $\geq 65$ years)	S 11 (24%) N 35 (76%)	0.535	S 2 (4%) N 44 (96%)	0.885
Gender		0.308		0.6
Male (M)	S 21 N 41		S 1 N 61	
Female (F)	S 13 N 42		S 2 N 53	
BMI ( $>30$ )	S 7 (58%) N 5 (42%)	0.038	S 2 (17%) N 10 (83%)	0.027
Comorbidities	S 22 (30%) N 51 (70%)	0.835	S 1 (1%) N 72 (99%)	0.555
Neoadjuvant therapy	S 23 N 43	0.151	S 2 N 64	0.596
Location		0.45		0.26
Rectal (R)	S 28 N 62		S 2 N 88	
Non Rectal (NR)	S 6 N 21		S 1 N 26	

**Table 5 – Comparative robotic surgery complication results analysis.**

Comparative robotic surgery results for rectal cancer				
Author	n	BMI	Conversion n (%)	Anastomotic fistula n (%)
Valadão (2018)	90	24	2.1	11
Hellan (2007)	39	26	2.6	12.1
Baik SH (2009)	56	23.4	0	1.8
Choi DJ (2009)	50	23.2	0	8.3
Baek JH (2010)	64	26.8	9.4	7.7
Pigazzi A (2010)	143	26.5	4.9	10.5
Baek SH (2013)	370	23.3	0.8	7.7
Pai A (2013)	102	28.2	1.9	6.6

and IIIb.<sup>7</sup> Table 5 shows studies of Hellan et al. and Pigazzi et al. with rates of anastomotic fistula, specific to rectal cancer, from 12.1% to 10.5% respectively, which are compatible to the rates we have found.<sup>23,24</sup> However, the meta-analysis conducted by Liao et al. showed 6.5% of anastomotic fistula on robotic surgery versus 5% on conventional surgery, and rates of around 2% of surgical wound infection both in conventional and robotic approaches.<sup>19</sup> We found higher rates of anastomotic fistula in robotic surgery than that described in literature, but wound infection rates, the second most frequent complication, are consistent with the ones described. This fact may be associated to the higher percentage of patients with advanced tumors (T3 and T4) than the ones reported in Asian, American and European studies, besides the fact that most rectal cancer patients underwent neoadjuvant therapy and, consequently, had a higher chance of anastomotic fistula occurrence.<sup>4</sup> In addition, BMI  $\geq 30$ , presented in 11% of subjects, was shown as a risk factor for surgical complications in robotic surgery with a p-value of 0.038.<sup>6,25</sup> Harr et al. described higher rates of complications on robotic surgeries on obese patients, especially when BMI  $\geq 30$ , such as we have found in our study.

## Conclusion

Robotic surgery is safe and feasible for surgical approach of colorectal cancer, showing satisfactory results in hospital stay and complication rates, added to a low surgical conversion rate. Obesity has been shown as a risk factor for surgical

complications in robotic colorectal surgery. In relation to advanced tumors, more in depth studies are necessary to denote their relationship with higher complication rates.

## Compliance with ethical standards

The content has not been published or submitted for publication elsewhere.

The protocol for the research project has been approved by a suitably constituted Ethics Committee of the Brazilian National Cancer Institute within which the work was undertaken and that it conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000).

The study had a statement that the subject gave informed consent and patient anonymity should be preserved.

## Conflicts of interest

The authors declare no conflicts of interest.

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