Robotic Surgery versus Laparoscopy in Colorectal Cancer Resection: A Systematic Review

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Abstract

Introduction: Colorectal cancer is a malignant disease, more predominantly observed in men and the third most incident tumor among all cancers, with an estimated risk of 26.6 / 100 thousand. Despite its high incidence and prevalence, it is amenable to treatment, and in most cases, it is curable -when detected in early stages.Objective: To compare the safety and efficacy of performing robotic surgery with traditional laparoscopic surgery in patients undergoing colorectal cancer resection regarding the variables: intra and postoperative complications, surgical conversion, and mortality.

Index terms— colorectal neoplasm. colectomy. laparoscopy. robotics.

Objetivo: Comparar a segurança e eficacia da realização da cirurgia robótica com a cirurgia laparoscópica tradicional em pacientes submetidos à ressecção de câncer colorretal, quanto às variáveis: complicações intra e pós-operatórias, conversão cirúrgica e mortalidade.

Métodos: Trata-se de uma revisão sistemática caracterizada pela busca de artigos na literatura, com aplicação de metodologia sistematizada, através de bases de dados MEDLINE/PubMed, Scielo, Embase e Cochrane, por meio da combinação de descritores, incluindo termos do Medical Subject Headings (MeSH) e dos Descritores em Ciência da Saúde (DECs), incluindo publicações em inglês e português: robotic-assisted conventional laparoscopic surgery colorectal cancer resection, além de busca ativa. Foram incluídos ensaios clínicos randomizados, estudos de coorte e estudos retrospectivos publicados partir de 2010, em português e inglês, que compararam o emprego das técnicas laparoscópicas minimamente invasiva e a ressecção colorretal pela abordagem robótica. Foram excluídos revisões, relatos de casos, série de casos, comentários e correspondências. A análise e aplicação das ferramentas CONSORT e STROBE foram feitas por dois avaliadores separadamente.

Resultados: Foram encontrados 20 artigos na estratégia de busca, e 07 foram selecionados. As amostras variaram de 56 a 471 participantes (n total = 1589), com variação de idade de 61,2 -69,0. Todos os estudos incluíram ambos os gêneros e, dentre estes, apenas um20 relatou uma proporção maior de mulheres. Dentre os trabalhos selecionados, cinco estudos se caracterizam como coortes retrospectivas e dois estudos como ensaios clínicos randomizados. A variação de duração das intervenções foi de 12 -120 meses. Realizando uma comparação entre as abordagens laparoscópica e robótica acerca da taxa de complicações intraoperatórias, o percentual apresentado pelo grupo da cirurgia robótica (6,0%) foi maior que a taxa de complicações relacionadas à cirurgia

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laparoscópica (5,2%). Sobre as taxas de conversão, a cirurgia robótica apresentou percentual consideravelmente menor: 0% -8,1% contra 0% -37%. Em relação à morbidade pósoperatória as prevalências foram de 22,6% -60% para a laparoscopia e 8,9% -42,3% para a cirurgia robótica, sendo observada uma notória variação em ambas as abordagens.

No que tange ás taxas de mortalidade foi identificada prevalência que variou entre 0% -5,6% na cirurgia laparoscópica, enquanto que na cirurgia robótica as taxas variaram entre 0% e 0,8%.

Conclusão: Frente aos achados descritos, evidências de boa a moderada qualidade, sustentam que a cirurgia robótica para a ressecção de câncer colorretal, apesar de promover melhor ergonomia e conforto para o cirurgião, produz resultados peri e pós-operatórios semelhantes. A cirurgia robótica, no entanto, possui menor taxa de conversão cirúrgica e mortalidade. Contudo, diante de uma literatura ainda carente de evidências mais abrangentes sobre o tema, outros trabalhos se fazem necessários para uma maior constatação das inferências reproduzidas nesse estudo .

Palavras-Chave: neoplasias colorretais. colectomia. laparoscopia. robótica.

Introduction: Colorectal cancer is a malignant disease, more predominantly observed in men and the third most incident tumor among all cancers, with an estimated risk of 26.6 / 100 thousand. Despite its high incidence and prevalence, it is amenable to treatment, and in most cases, it is curable -when detected in early stages.

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Methods: This is a systematic review characterized by the

1 Introduction

ince the 1980s, when the first robotic surgery was performed 1 , much has been said regarding this new technology and its potential future capabilities. Over the years, robotic surgery has broken the boundaries of innovation in health technology for better clinical outcomes. Thus, linked to a growing need for more precise and minimally invasive surgeries, robotics was developed to meet these demands. Nowadays, it performs several functions related to surgical practice -from assisting in the conduct brain biopsies to performing resection of malignant colorectal tumors. Several specialties such as urology, gynecology, cardiology, neurosurgery, and general surgery can use robotic surgery 1 .

Among the technical advantages offered to surgeons are: the potential for three-dimensional visualization of the structures analyzed, elimination of the physiological tremors produced by the movementsallowing greater accuracy-improved surgical maneuvers permitted by the "robotic wrist" mechanism (positioning of surgical instruments at angulations not previously allowed by the laparoscopic technique), less fatigue of the surgeon, faster surgical recovery and with fewer complications compared to laparoscopy [1][2][3] . However, robotic surgery should be reserved for procedures in which technology can provide maximum benefit, in general when it is necessary to perform precise dissections in confined areas, due to its current high operational cost 3 .

This procedure has been becoming more popular since Pigazzi et al. 3 described for the first time the total excision of a malignant rectal tumor performed through robotic surgery in 2006. However, there is still not enough evidence in the literature regarding the safety and effectiveness of robotic surgery compared to traditional laparoscopy in cases of resection of malignant colorectal tumors 2,3 .

2 II.

3 Objectives a) Primary objective

To compare the safety and effectiveness of robotic surgery with traditional laparoscopic surgery in patients undergoing colorectal cancer resection.

4 b) Secondary objective

To compare intraoperative complications rates, surgical conversion, postoperative complications, and mortality of robotic surgery with laparoscopy in colorectal cancer resection surgeries.

5 III.

6 Literature Review a) Colorectal cancer

Colorectal cancer is a tumor that affects the large intestine, which is divided into colon and rectum. An essential aspect of this pathology is that the vast majority originates from polyps -small elevations in the colon and/or rectum wall -which grow slowly, starting with an aberrant crypt and developing into a neoplastic precursor lesion and then, finally becoming colorectal cancer. This process can take 10 to 15 years to occur. Thus, these polyps can be palliatively identified and removed before they can even produce malignancy characteristics.

However, some decades ago, colorectal cancer was rarely diagnosed due mainly to a lack of preventive practices and technological resources. Hence, this pathology used to be diagnosed at extremely advanced stages when no therapy could reverse the existing problem 4 .

Currently, colorectal cancer is the fourth most lethal cancer globally, causing the death of about 900,000 people each year, accounting for about 10% of the incidence of all cancers diagnosed annually and of cancer-related deaths worldwide 4,5 . It ranks as the second most common cancer among women and the third most common cancer among men. Its major risk factors are lifestyle-related. Intake of red meat, processed meat, fats, sedentariness, obesity, smoking, alcoholism, family predisposition, previous polyps, and age over 50 are conditions that predispose new polyps to appear and consequently increase the likelihood of developing colorectal cancer 4 .

The most common signs and symptoms associated with this pathology are hematochezia, anemia with no apparent cause, abdominal discomfort, mild fever, severe weight loss, bowel habit changes, a continued desire to evacuate even after the evacuation, and gas or colic. Nevertheless, colorectal cancer can progress as a silent and asymptomatic disease until it reaches an advanced stage 4 .

The diagnosis is based on the association of clinical findings with performing a colonoscopy and other imaging examinations such as computed tomography and laboratory tests such as blood count and concentration of carcinoembryonic antigen that can be used as complementary tests 4 . Colonoscopy should regularly investigate rectal bleeding in patients over 45 years of age. In younger patients, some additional factors should be considered for increasing diagnostic suspicion: the presence of unfavorable family history, marked and unexplained weight loss, and changes in intestinal habit 4 .

Through technological advances and the increased possibility of early diagnosis, some cancers are only amenable to local treatment. Incipient polyps can be resected endoscopically, also allowing precise evaluation of risk characteristics, such as the depth of submucosal invasion, lymphatic invasion, presence of the tumor, and its differentiation 4 .

Surgery is the main therapeutic procedure for treating colorectal cancer, often with radio-and chemotherapy support. The optimal resection of the tumor is fundamental and can be evaluated through safe and objective parameters. Rectal cancer surgery is a complex process because of the difficult access to the surgical site, provided by the limiting pelvic anatomy. Total mesorectal excision is the standard oncologic approach for rectal cancer, and its extent depends mainly on the involvement of the sphincter complex and other surrounding structures. 4 Several factors are associated with better prognosis and increased quality of life after surgical treatment. These factors are mostly the same related to colorectal cancer prevention. Thus, patients who adapt to a healthy lifestyle after definitive diagnosis had a 33% lower risk of death during follow-up than those who did not include this habit in their daily practices 4 .

7 b) Robotic versus laparoscopic surgery

During the years of development of surgical practice, minimally invasive techniques allowed laparoscopic interventions in the treatment of colorectal cancer patients. Subsequently, several randomized studies have shown that laparoscopic colectomy is associated with lower morbidity rates, less surgical trauma, and better immediate postoperative results, with shorter recovery times and hospital stays compared to surgery performed through laparotomy 6 .

However, a laparoscopic approach in rectal cancer patients is significantly different and more difficult than laparoscopic procedures in patients with colon cancer 6 . This is explained by the difficulty of visualization and surgical access at the pelvic anatomic site where the procedure should occur. Deep dissection in the pelvis to perform a total mesorectal excision and obtain a sample with intact margins, making a safe anastomosis are demanding techniques, besides promoting a considerable probability of reoperation 6 .

Corroborating the hypothesis that the laparoscopic approach for rectal neoplastic procedures is a complex and laborious procedure, the British randomized clinical trial CLASICC 7 in 2006 compared laparotomy and laparoscopy performing 794 colorectal cancer surgeries. This study indicated that rectal excision by laparoscopy resulted in a high conversion rate (38% in the first year, decreasing up to 16% in the last year) and a tendency for greater positivity of the circumferential excision margin. Some other studies also present the same conclusion regarding high conversion rates during colorectal laparoscopic surgery [8][9][10] .

The recent introduction of the robotic surgical system has revolutionized the field of minimally invasive surgery. This new technology allows surgeries with a three-dimensional visual field, better ergonomics for the surgeon (by reducing the fatigue), more extensive and better movement amplitudes of the forceps and other surgical instruments, besides eliminating the physiological tremors produced by human arms [1][2][3]11,12 . Thus, adopting a robotic surgical system to perform colorectal cancer resection procedures seems attractive from this perspective. Since this new technique can be safer for patients submitted to it -mainly concerning the greater ease of management of an area as confined as the pelvic region -always aiming at a safe surgical procedure, free of complications, with higher overall survival, disease-free survival, and quality of life, which are the most relevant objectives of colorectal cancer treatment.

Another advantage related to the robotic surgical procedure is the possibility of using an infrared fluorescent intraoperative imaging system with indocyanine green. This system allows the best identification of noble structures such as vessels, nerves, and lymphatic ducts, thereby facilitating solid organs' partial resection, without damaging their neighboring anatomical structures 13 .

Nevertheless, robotic surgery still demands a high financial investment to be performed 14 , besides counting on some practical obstacles such as the long learning curve, longer surgical time, and size of the robotic system 15 . Hence, within a publicly funded health system, the replacement of laparoscopic surgeries by I robotic ones in colorectal operation requires a complete and thorough analysis so that their benefits are indeed validated.

The current literature evidence is that robotic rectal excision has been verified as feasible and safe, but these conclusions were mostly based on statistically non-significant differences. Therefore, this systematic review has great value to clarify the evidence available in the literature about the advantages of robotic surgery in comparison to traditional laparoscopic surgery in cases of colorectal cancer resections.

IV.

8 Material and Methods

9 a) Study design

Systematic literature review.

10 b) Search strategy

The literature review was carried out on September 10, 2019, in the electronic databases MEDLINE/PubMed, Scielo, Embase, and Cochrane, through the combination of descriptors, including terms from Medical Subject Headings (MeSH) and Health Science Descriptors (DECs), using publications in English and Portuguese: robotic-assisted conventional laparoscopic surgery colorectal cancer resection. The terms used for the search were related to the population of interest, the parameters to be studied and the outcomes of morbidity and mortality: robotic-assisted

11 [All Fields] AND conventional[All Fields] AND (”laparoscopy”[MeSH Terms] OR ”laparoscopy”[All Fields] OR (”laparoscopic” [All Fields] AND ”surgery”[All Fields]) OR ”laparoscopic surgery”[All Fields]) AND (”colorectal neoplasms” [MeSH Terms] OR (”colorectal”[All Fields] AND ”neoplasms” [All Fields]) OR ”colorectal neoplasms” [All Fields] OR (”colorectal”[All Fields] AND ”cancer” [All Fields]) OR ”colorectal cancer”[All

Fields]) AND resection[All Fields]. References in the articles identified by the search strategy were also manually searched to add to the study and literature review.

12 c) Inclusion criteria

There were included studies, with a sample size greater than 30, published from October 2006 to December 2018, comprising patients who underwent robotic or laparoscopic surgery to perform cancer resection in the colorectal region. The clinical outcomes of interest were: surgical time, surgical conversion, other intraoperative and postoperative complications, length of hospital stay, and mortality.

13 d) Exclusion criteria

Reviews, case reports, case series, comments, and correspondence were excluded.

14 e) Identification and selection of studies

The authors read each pre-selected article’s titles and abstracts from the electronic database research to identify only those studies that correctly fulfill the inclusion and exclusion criteria. Subsequently, the full texts were read, ensuring the criteria for the systematic review.

Both authors discussed the divergences trying to respect the inclusion and exclusion criteria previously defined.

15 f) Data extraction

Two authors collected the data using a predefined collection form. The characteristics of interest of the studies included: geographical origin, title, type of study, duration of the study, number of participants, and mean age of the sample. Finally, data were collected related to surgical time, intraoperative and postoperative complications, conversion, length of hospital stay, and mortality. The quality of each study characterized as a randomized clinical trial was evaluated by the Cochrane Tool -Consolidated Standards of Reporting Trials (CONSORT) 16 to assess the risk of bias, which contains the following criteria: adequate randomization; allocation of participants; blinding of participants; blinding of the outcome evaluator; integrity of results; incomplete data; selective outcome reports; and other sources of bias (e.g., the effect of small studies). Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) 17 was used for the methodological evaluation of observational articles.

V.

16 Results

17 a) Identification and selection of studies

Through the search strategy, 20 records were identified after the exclusion of duplicate studies. Based on the reading of the title and abstract, 8 articles were left for a full reading. Of these, one study was excluded because it did not reach the minimum sample size. Therefore, 7 articles were selected for the systematic review (Figure 1).

18 b) General characteristics of the obtained studies

The samples ranged from 56 to 471 participants (n total = 1589), with an age range of 61.2 -69.0. All studies included both genders, and among these, only one20 reported a higher proportion of women. Among the selected studies, five are characterized as retrospective cohorts and two as randomized clinical The quality assessment of the selected observational studies was performed with the STROBE17 tool, available in the STROBE initiative, verified in Chart 3. 6 conducted an analysis exclusively related to low rectal cancer. The records were collected and prospectively acquired from all patients at Kyungpook University Hospital with rectal cancer located 8 cm from the anal margin. After this process, the information was reviewed retrospectively. Patients with tumors causing intestinal obstruction or perforation, local resectable tumor with transanal access, invasion of adjacent organs requiring multiple organ en bloc resection, and distant metastasis were not considered suitable for laparoscopy or robotic surgery.

The choice between the two different surgical approaches was based on a joint decision between patients and physicians, and the use of robots did not Levic et al. 19 Ramji et al. 14 Yamaguchi et al. 20 Crolla et al.

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20 Participants 13

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liver function tests, serum carcinoembryonic antigen (CEA), chest X-ray, and electrocardiogram. Colonoscopy, abdominopelvic computed tomography, and pelvic magnetic resonance imaging were routinely performed to evaluate distant metastases, local infiltration of the disease, and tumor characteristics. This study had limitations due to its retrospective nature and its inherent selection bias. Another established limitation is related to the lack of a detailed economic comparison between the two groups. Some differences in short-term results were considered insufficient to justify the costs of using the new technology. Rodríguez et al. 18 , in 2011, besides analyzing rectal cancers, evaluated the occurrence of tumors in the sigmoid. All patients underwent preoperative analysis, including hemogram, liver function, and biochemical tests, chest radiographs, and electrocardiograms. Patients diagnosed with rectal cancer were also submitted to colonoscopy with biopsy for the histological diagnosis of the lesion, accompanied by thoracoabdominal computed tomography, magnetic resonance imaging, and ultrasound examinations. This study analyzed patients' clinical conditions through the American Society of Anesthesiology (ASA) classification and performed histological analyses to define the distance of the distal margin, the total number of resected lymph nodes, and the total length of the sample. This research did not present its eventual limitations.

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Levic et al. 19 conducted a retrospective and multicenter analysis in 2014. The patients considered appropriate for the laparoscopic technique were over 18 years old and had rectal cancer without metastasis. Exclusion criteria were magnetic resonance imaging (MRI) or preoperative computed tomography (CT) showing tumor size >4 cm in diameter or evidence of local invasion (T4 cancer); ASA class IV/V; the anticipated need for intensive care unit (ICU); a history of major anterior abdominal surgery and obese patients with body mass index (BMI) >32 kg / m2. Inclusion criteria for robotic surgery were practically the same, except that high BMI was not a reason for exclusion. The tumor staging and preoperative evaluation consisted of a digital rectal examination, proctoscopy, histopathological examination, thoracoabdominal computed tomography, and pelvic magnetic resonance imaging. All patients were discussed at the multidisciplinary team conference before the treatment decision.

This study's limitations were the restricted number of patients in each group and the short followup, which made it impossible to reach satisfactory conclusions about the long-term oncologic effects and any possible differences in late complication rates. Moreover, the authors presented the selection bias as a limitation since the study was not randomized, as well as the learning curve of surgeons for both techniques since this can cause distorted results in any direction.

The retrospective study by Ramji et al. 14 , in 2015, additionally compared robotic and laparoscopic surgical procedures to laparotomy. The analysis was the only one that compared the economic feasibility between the surgical techniques. This study also analyzed the patients' tumor characteristics according to the ASA classification and comorbidities' existence through the Charlson score. The included cases required a confirmed histological diagnosis of rectal adenocarcinoma and could not be associated with recurrent or synchronous disease. Cases with multivisceral involvement and palliative intention were excluded. The study showed limitations related to the small number of cases assisted by robotics concluded until its institution.

In their study in 2015, Yamaguchi et al. 20 included all patients who underwent proctectomy for rectal adenocarcinoma at Shizuoka Cancer Center Hospital. Patients undergoing open surgery, high anterior resection, lateral lymph node dissection, or multiple resections were excluded. The preoperative tumor staging was carried out according tocolonoscopy findings, computed tomography, magnetic resonance imaging, and barium enema. The rectal cancers were staged using the tumor-node-metastasis (TNM) classification. The surgical method to be performed was decided through a physician's discussion with the patient. After providing informed consent, the patients selected their preferred approach -however, rectal cancer surgery with lateral lymph node dissemination was performed by the open method if the patient did not desire to undergo robotic surgery -a condition that reproduces a selection bias, somehow restricting the internal validity of the study. The first limitation present in the study was related to the fact that it was a retrospective analysis that potentially included several selection biases. The second limitation was established because of the lack of evaluation of sexual function after surgery.

Jayne et al. 21 conducted a randomized multicenter study in 2017, which included 29 different medical centers in 10 countries and 40 surgeons. The patients included were those with an indication for resection and were diagnosed with rectal adenocarcinoma. Patients with benign lesions of the rectum, anal canal cancers, locally advanced cancers, or those requiring multivisceral block resection or multiple surgical resections were excluded from the study. The study additionally evaluated bladder function and sexual function through the International Prostate Symptom Score (I-PSS), International Index of Erectile Function (IIEF), and Female Sexual Function Index (FSFI). This research presented limitations related to the low number of patients analyzed -conferring statistically insignificant results among the treatment groups. No blinding was established for this study, consequently affecting the study's primary outcome and mortality measures.

In 2018, Crolla et al. 22 carried out their study using a prospectively filled database -with data routinely collected from patients. Multiple organ resections were excluded. Regarding its limitations, this study presented several diagnostic and therapy protocol changes throughout the development period. The randomization process was not performed. This study also did not consider the surgeons' learning curve or adequacy. Besides, the authors showed that confounding factors related to general morbidity might have been neglected. The main intraoperative complications recorded by the studies, besides the surgical conversion, were: significant hemorrhage, need for intraoperative transfusion, injury and/or perforation of the rectum, equipment failure, fecal contamination, and inadvertent perforation of the tumor. Rodríguez et al. 18 , in 2011, and Ramji et al. 14 , in 2015, did not detail the intraoperative complications analyzed in their studies.

The most significant postoperative complications described by the studies included in this review: anastomotic dehiscences, urinary retention, need for reoperation, anemia with the need for transfusion, and infection of the wound or surgical region. Rodríguez et al. 18 , in 2011, did not perform an analysis of postoperative morbidities, and Yamaguchi et al. 20 , in 2015, did not specify the postoperative morbidities recorded besides anastomotic dehiscence and infection of the surgical site.

From the studies added to the systematic review, Park et al. 6 , in 2010, Ramji et al. 14 , in 2015, and Yamaguchi et al. 20 , in 2015, classified patients through Clavien-Dindo postoperative complications severity classification system, verified in Table 2. Park et al. 6 , in 2010, divided patients into two groups: the first integrating classifications I and II, while the second joined classifications III and IV. The other researches did not make any reference to this classification tool. The most used type of surgery among the studies was the low anterior resection, followed by the abdominoperineal resection, shown in Table 4. Most studies included only rectal cancer in their analysis. Park Robotic Surgery versus Laparoscopy in Colorectal Cancer Resection: A Systematic Review et al. 6 , in 2010, were even more specific and analyzed only low rectal cancers. Only Rodríguez et al. 18 , in 2011, additionally analyzed colon cancers in their studytotaling 44 patients.

25 Rodríguez

et al. 18 Levic et al. 19 Ramji et al. 14 Yamaguchi et al. 20 Jayne et al. 21 Crolla et al. 22 Low anterior resection

26 Discussion

The present study aimed to select four main variables related to the efficacy and safety of different surgical approaches: prevalence of intraoperative complications, surgical conversions, postoperative morbidities, and mortality. This systematic review obtained a total sample of 1,589 patients submitted to colorectal cancer surgery, either by laparoscopic or robotic technique.

The prevalence of intraoperative complications from laparoscopy ranged from 0% to 14.8%, and the most prevalent among the complications mentioned in the studies were: significant hemorrhage, damage to some organ or structure, low rate of anal sphincter preservation and surgical equipment failure. Yamaguchi et al. 20 , in 2015, and Crolla et al. 22 , in 2018, showed no results for this variable. Park et al. 6 , in 2010, Ramji et al. 14 , in 2015, and Levic et al. 19 , in 2014 presented prevalence below the average of studies included in the review, while in the studies by Rodríguez et al. 18 , in 2011, and Jayne et al. 21 , in 2017, showed above average results. The reason for Rodríguez et al. 18 , in 2011 and Jayne et al. 21 , in 2017 being the only studies with an above-average prevalence of intraoperative complications is because most studies did not present an adequate sample size in order to obtain statistically significant results and avoid type II error -this being the main limitation mentioned in the studies. Thus, Jayne et al. 21 , in 2017, probably because of a more significant sample number (230), was the study that most closely resembled the data available in the literature, which present an approximate average prevalence of intraoperative complications of 16.5% [23][24][25][26][27] . The prevalence of intraoperative complications related to robotic surgery ranged from 0% to 15.3%. Yamaguchi et al. 20 , in 2015, and Crolla et al. 22 , in 2018, also showed no results for this variable. Park et al.6, in 2010 and Ramji et al. 14 , in 2015 reported no intraoperative complications related to robotic surgery, while Rodríguez et al. 18 , in 2011, Levic et al. 19 , in 2014, and Jayne et al. 21 , in 2017 presented similar results with those found in the literature, which has an average prevalence of approximately 14% [28][29][30][31][32] . The rationale used by these studies is related to the lack of tactical sensitivity that the robotic system transmits to the surgeon, especially to those who are at the beginning of their learning curve, consequently causing damage to the patient's organs and structures. To prove this rationale, Rodríguez et al. 18 , in 2011, went further, and performed a brief review on the possible causes of intraoperative complications in robotic surgery, finding a result that corroborates with the rationale mentioned above.

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Comparing the laparoscopic and robotic approaches concerning the rate of intraoperative complications, the rate related to the robotic surgery group (6.0%) was higher than the rate of complications related to laparoscopic surgery (5.2%), being registered 7 more cases.

As mentioned by Crolla et al. 22 , in 2018, "a low conversion rate is important because, in general, the conversion is associated with more complications, longer hospital stay and worse long-term outcome". Thus, regarding surgical conversion rates during laparoscopic surgeries, a prevalence ranging from 0% to 37% was found. Park et al. 6 , in 2010, and Levic et al. 19 , in 2014, registered no surgical conversion. Rodríguez et al. 18 , in 2011, had a conversion rate of 7.14% and reported no statistical differences about robotic surgery. Other studies that found significant differences about laparoscopy varied their prevalence between 3.3% -37% and reported that the main reasons for the occurrence of surgical conversions in this type of technique were: difficulty of visualization, visible anastomotic leaks, adhesions, stapler complications, tumor invasion of adjacent structures and difficulty in manipulating the target organ.

The robotic technique's prevalence of surgical conversion rates was found to vary between 0% -8.1%. Park et al. 6 , in 2010, and Yamaguchi et al. 20 , in 2015, did not report surgical conversion. The study by Levic et al. 19 , in 2014, was the only one that presented more conversions (3 versus 0) during robotic surgery. The other studies always showed a lower conversion rate compared to laparoscopic surgeries. The leading causes for surgical conversion during the robotic approach were: the presence of severe fibrosis in the pelvis as a sequel to radiotherapy with a rectal lesion, tumor fixation, and perforation of the rectum due to a narrow pelvis. The studies justified a better performance of robotic surgery in this field by the improved visualization with the 3D camera and a better capacity to maneuver the surgical instruments. Jayne et al. 21 , in 2017, still mention that the benefits of robotic surgery for surgical conversion rates are enhanced when surgeons already have some experience in the practice of robotic surgery itself, i.e., when they are at a high level in their learning curve.

By making a parallel between the two approaches analyzed, robotic surgery compared to conventional laparoscopic surgery in colorectal cancer improved the conversion rate, presenting a considerably lower percentage. However, the authors showed that although data related to robotic surgery have achieved better blood loss rates and fewer conversions compared to laparoscopy, this may be less a reflection of the surgical tools used and more a result of the surgeon's improved skill and experience in minimally invasive surgery, which can be considered a confounding bias.

The prevalence of morbidity after surgery related to laparoscopy ranged from 22.6% to 60%. Rodríguez et al. 18 , in 2011, presented no results for this variable. he other studies presented similar prevalence, ranging from 22.6% to 31.7% -except Crolla et al. 22 , in 2018, who reported a rate of about 60% -well above the average of approximately 29% found in the literature 21,[31][32][33] . This discrepant result was established due to the introduction of an additional variable combined with the postoperative complications mentioned, called by the study of "any other complications" without, however, describing what these possible complications would be. The most mentioned postoperative complications in the analyzed studies were: anastomotic dehiscence, urinary retention and other urinary complications, the need for reoperation, infection of the surgical site, bleeding with the need for transfusion, and cardiorespiratory complications.

Regarding postoperative morbidity related to robotics, the prevalence varied between 8.9% -42.3%. Rodríguez et al. 18 , in 2011, presented no data for this variable. Yamaguchi et al. 20 , in 2015, showed the lowest prevalence of morbidity. The study identified fewer occurrences of urinary retention, wound infection, small bowel obstruction, anastomotic dehiscence, intraabdominal or intraluminal bleeding, and enteritis. Among these complications, the least recurrence of urinary retention was emphasized, and the rationale found for such an event was that "[...] This is probably due to the superior free-moving multi-joint forceps, highquality three-dimensional imaging, and steady "traction and counter-traction" allowing easier recognition and preservation of the pelvic splanchnic nerves and inferior hypogastric plexus". Crolla et al. 22 , in 2018, presented a 42.3% prevalence

-a result above the average found in the literature of approximately 27% 28,34,35 Furthermore, it is worth mentioning that colorectal cancer surgery is a high-risk intervention, which depends significantly on the patient's tumor characteristics and good general condition. Therefore, it is expected that about 1/3 of the patients present postoperative complications in less than 30 days 21 . This data agrees with the selected studies' variation and is valid for both the laparoscopic and robotic techniques, with no significant difference being observed concerning general postoperative morbidity.

The mortality variable in the laparoscopic surgery subgroup was identified as a prevalence ranging from 0% to 5.6%, similar to data found in the literature, which defines average mortality of 2% 33,36 . Park et al. 6 , in 2010, Rodríguez et al. 18 , in 2011, Ramji et al 14 , in 2015, and Yamaguchi et al. 20 , in 2015, reported no deaths, while Levic et al. 19 , in 2014, Jayne et al. 21 , in 2017, and Crolla et al. 22 , in 2018, showed a mortality rate of 5.6% , 0.9% and 4.9%, respectively. Levic et al. 19 , in 2014, despite recording the highest percentage of mortality, presented only two deaths in a total of 36 patients, not representing statistical significance. In all studies reported in this review, there were a total of 13 deaths related to laparoscopy. Most of the deaths were associated with organ and structure perforation-causing extensive hemorrhage during surgery and postoperative sepsis.

Regarding robotic surgery, mortality prevalence variation was between 0% -0.8%, a result compatible with the average found in the literature of about 1%28, 37. The only studies reported deaths were conducted by Jayne et al. 21 , in 2017, and Crolla et al. 22 , in 2018, recording 3 negative outcomes. The rationales for the deaths involving robotic surgery were the same as for laparoscopy.

By comparing the mortality rates of the two surgical techniques, robotics presented 3 deaths out of a total of 789 patients included in the study, which represents a percentage of 0.38%, while laparoscopy showed a total of 13 deaths out of a universe of 800 patients, representing a percentage of 1.6%. Thus, robotic surgery proved promising since the researches revealed a lower mortality rate compared to laparoscopic surgery.

The different methodologies presented by the studies, besides the low sample value of some of them during the analysis of the variables, indicate the need for additional research on the comparison between laparoscopy and robotic surgery in colorectal cancer resection. Larger samples and clearly defined methodological criteria are needed to establish the safety and efficacy of each approach. Also, this present study has not been extended to a meta-analysis to obtain a better statistical result is defined as a limitation.

28 VII. Conclusion

Given the described findings, evidence of good to moderate quality supports that robotic surgery for colorectal cancer resection produces similar perioperative and postoperative results, even though it promotes better ergonomics and comfort for the surgeon. However, robotic surgery reflects lower surgical conversion and mortality rates. In the face of the literature still lacking more extensive evidence on the topic, other studies are necessary for more significant verification of the inferences reproduced in this study.

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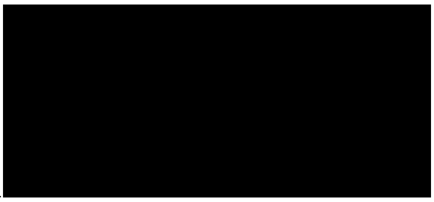
1 

Figure 1: Figure 1 :

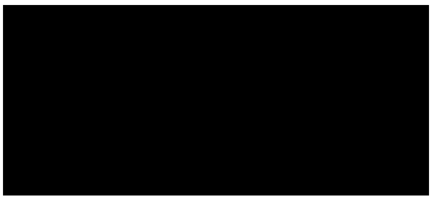


Figure 2:

[1]

2 [redacted]

Figure 3: Chart 2 :

3 [redacted]

Figure 4: Chart 3 :

[redacted]

Figure 5:

[redacted]

Figure 6:

[redacted]

Figure 7:

[redacted]

Figure 8:

Park et al. 6	Retrospective cohort	2010	South Korea	41	82	(73/50)	63.0	61.2	120
Rodríguez et al. 18	Randomized clinical trial	2011	Spain	28	28	(29/27)	61.5	68.0	19
Levic et al. 19	Retrospective cohort	2014	Denmark	36	56	(51/41)	69.0	65.0	24
Ramji et al. 14	Retrospective cohort	2015	USA	27	26	(38/15)	63.7	62.1	24
Yamaguchi et al. 20	Retrospective cohort	2015	Japan	239	203	(294/148)	65.9	64.8	45
Jayne et al. 21	Randomized clinical trial	2017	United King-dom	234	237	(234/237)	65.5	64.4	12
Crolla et al. 22	Retrospective cohort	2018	Netherlands	184	168	(216/136)	68.1	67.0	60

Figure 9: Mean age (years) Study time (months) Laparoscopy Robotics Laparoscopy Robotics

Introduction	
Background/Rationale	2
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Bias	9
Study size	10
Quantitative variables	11
Statistical methods	12

Figure 10: 22 Title and abstract 1

1

Source: The author (2020)
Legend: NR: Not referred

Figure 11: Table 1 :

Study	Surgical time (in minutes) Laparoscopy	Robotics Laparoscopy Robotics Laparoscopy Robotics Laparoscopy Robotics	Surgical conversion (n)		M p
Park et al. 6	168.6	231.9	0	0	1
Rodríguez et al. 18	135.1	159.4	2	2	N
Levic et al. 19	295	247	0	3	1
Ramji et al. 14	240	407	10	3	7
Yamaguchi et al. 20	227.6	232.9	8	0	5
Jayne et al. 21 al. 22 Crolla et	261 172	298.5 219	28 23	19 3	7

Study Park et al. 6	Length of hospital stay (days) Laparoscopy Robotics 9.4 9.9		Postoperative Cla	
Rodríguez et al. 18 Levic et al. 19 Ramji et al. 14	9.2 7 11.3	9.3 8.0 7	NR NR 0:14 I:6 II: 0 III: 0 IV: 4	N 0 I 3 I
Yamaguchi et al. 20	9.3	7.3	0: 1 I: 107 II: 41 III: 73 IV: 17	0 I I I I
Jayne et al. 21	8.2	8	NR	N
Crolla et al. 22	7	6	NR	N

Figure 12:

2

[Note: Source: The author (2020) Legend: NR: Not referred]

Figure 13: Table 2 :

4

Types

Figure 14: Table 4 :

Figure 15: of surgery Study Park et al. 6

Figure 16:

	Surgery time (min)		Surgical conversion		Postoperative morbidities (Extra which ones?) Table? Describe	
	Laparoscopy	Robotics	Laparoscopy	Robotics	Laparoscopy	Robotics
1	168.6	231.9	0	0	19	12
2	135.1	159.4	2	2	x	x
3	295	247	0	3	10	12
4	240	407	10	3	1	0
5	227.6	232.9	8	0	54	18
6	261	298.5	28	19	73	78
7	172	219	23	3	223	178

Figure 17:

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.2 Appendixes

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