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ROBOTIC SURGERY IN RECTAL CANCER - TECHNIQUE AND DISCUSSION

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ABSTRACT

The term robot first appeared in 1921 when Karel Capek mentioned it in his play Rossom's Universal Robots, which in free translation means forced labor. Today, robots are still unintelligent machines, but great strides have been made to integrate them as much as possible into people's daily lives. At present, this statement can no longer be supported, robots are used in the field of surgery almost daily in some specialized medical centers, the surgical system is used even to perform a trans-continental cholecystectomy in 2000. However, robotic surgery belongs to the field of minimally invasive surgery that began in 1987 with the first laparoscopic cholecystectomy. Since then, this type of surgery has grown rapidly and has been assigned more and more interventions as the skills and confidence of the surgeons who used it to increase. The degrees of movement of laparoscopic instruments are limited, namely, most of them have only 4 degrees of movement, also the physiological tremor of the surgeon is transmitted to the instrument he works with making delicate interventions such as anastomosis of 2 vessels very difficult. Therefore, the origin of robotic surgery lies in the desire to overcome these shortcomings of laparoscopy and to exploit to the maximum the resources of minimally invasive surgery.

Keywords: robotic surgery, TME, rectal cancer

INTRODUCTION

The history of robotic surgery began with the puma 560 robot, which was used in 1985 to take high-precision brain biopsies [1].

Three years later, using the same but modified puma 560 robot, the first urethral biopsy of the prostate was performed. Thus was born PROBOT a robot developed for transurethral prostate biopsy [2].

This period saw an explosion in robots developed to perform a single task. Orthopedics also developed its robot called ROBODOC to drill with great precision the femoral canal in hip arthroplasty thus replacing the classic hammer chisel [3].

The principle behind robotic surgery today is telesurgery, which was developed by NASA in the early 1990s. Since then, the team of researchers has been joined by surgeons and endoscopists who have understood the potential of this technology and the possibility of it to overcome the limitations of classical laparoscopic surgery. Observing the development of the project, the army (US ARMY) was actively involved and provided the necessary funds to carry out the project in order to treat the wounded soldiers on the battlefield, by a doctor at a distance. A number of engineers and surgeons who were initially involved in this project and further developed the technology, giving it applicability in civil life.

So the history of robotic surgery can be summarized as follows:

-in 1985 PUMA 560 performs the first brain biopsy by a robot

-in 1988 PROBOT is used for the first time in prostate biopsy

-in 1992 ROBODOC produced by Integrated Surgical Systems is used in orthopedic surgery

- INTUITIVE SURGICAL developed the da Vinci surgical system and in 1998 it was used successfully to perform a cardiac bypass.

-COMPUTER MOTION has developed 2 other robotic surgical systems - namely AESOP, a robotic arm that responds to the surgeon's voice commands, and the ZEUS robotic system first used in 1997 to successfully reconnect the fallopian tubes.

-in 2003 Intuitive Surgical bought Computer Motion so ZEUS is taken off the market, and the da Vinci robotic system remains the only one in operation

The first robotic cholecystectomy was performed in 1997. Subsequently, more and more operations were performed robotically, the greatest applicability being in urology and gynecology. Thus robotic prostatectomy became the gold standard. The first robotic colectomy was performed in 2001 [4].

The concept of total robotic mesorectum excision was introduced in 2006 [5].

These authors, as well as others subsequently, compared the results obtained in patients in whom total mesorectal excision (TME) was performed robotically and laparoscopically and concluded that robotic anterior resection with total mesorectal excision and robotic autonomic nerve preservation is feasible and safer, but requires increased operative time [6, 7, 8]

In Romania, studies on robotic surgery and on rectal resection and TME were published by the team of the Center for General Surgery and Liver Transplant "Dan Setlacec" from the Fundeni Clinical Institute. In 2008, at the Fundeni Clinical Institute, a pilot program of robotic surgery began, funded by the Ministry of Health. One of the purposes of this program was to define what is worth doing robotically and what is not. In this program, rectal cancer surgery was introduced from the beginning for the advantages listed above, but also in order to become the gold standard [9, 10, 11, 12].

The system was approved by the FDA (Food and Drug Administration) in July 2000 to perform advanced surgical techniques such as incisions or sutures.

Advantages of the robotic platform

The robot consists of 4 components: the surgeon's console, the EndoWrist instruments, the high-resolution 3-D Vision Insite system, the winch next to the patient and the image processing equipment.

Surgeon's console. It is located a few meters or thousands of kilometers from the patient's table. The surgeon keeps his head tilted inside the console where he views a magnified 3-D real-time image of the working field. Due to the commands on the main console, the operator only needs 1 m to operate

The winch next to the patient. This component contains robotic arms that are in direct contact with the patient. It consists of 2 or 3 arms equipped with instruments and an endoscopic arm. Since 2003, a 4th arm has been introduced that can be used for complex interventions but has an additional cost of $ 175,000.

Endo Wrist Instruments (Endowrist® Instruments SI Intuitive® Masters). These tools allow robotic arms to move in a manner similar to the human hand. Each instrument has its own suturing and clamping functions. The robot memorizes the position of the arm before the instrument is changed so the new instrument will be positioned in the same position as the first one. The tools can rotate in a complete circle. The 7 degrees of movement offer a multitude of choices regarding the pivoting and rotation of the instrument [13].

The surgeon's tremor is also canceled by the robot. Generally, CO2 is introduced into the abdominal cavity to create the necessary working chamber.

3-D viewing system (Insite® Vision and Navigator Camera Control). The robotic arm that also contains the endoscope renders enlarged 3-D images, giving the surgeon an advantage over classical surgery. The system provides over 1,000 frames per second regarding the position of the instrument. The endoscope is programmed to automatically adjust the temperature to eliminate lens fogging during surgery [14].

ADVANTAGES AND DISADVANTAGES OF ROBOTIC SURGERY

The advantages of robotic surgery over laparoscopic/classical surgery are:

- Instrument stability in the operating field
- Mechanical advantages over laparoscopic instruments (360º rotating tip)
- Better ergonomics for the operator
- Superior visibility (3D system)
- Availability: minimally invasive approach - for cases where laparoscopy has no chance of success: for interventions involving fine gestures (dissection, fine sutures, reconstructions)

- Low complication rate due to increased accuracy
- Robotic assistance improves ambidexterity, improving performance with the non-dominant hand

The advantages of robotic surgery for the surgeon include greater dexterity, better visualization of the working field, higher accuracy. The robot also identifies the physiological tremor of the surgeon and eliminates it through various filters. Compared to the classic laparoscopic surgery, the hand-eye coordination is restored to the surgeon, the instruments moving according to the hand movement, and the discomfort created by the standing posture.

The advantages of using robotic surgery for the patient include reduced blood loss, reduced hospitalization time, faster recovery according to the study published by Tewari, and Ashutosh in November 2004. The patient's return time to work after a robotic intervention is on average 11 days while in open surgery this average is 49 days in the case of robotic prostatectomies performed [15].

When using robotic surgery for the treatment of colorectal cancer Poston et. identify a reduction in the complication rate from 19% for the open approach to 9% for the da Vinci robot.

Disadvantages of robotic surgery is that is still another new technology whose effectiveness has not been proven. Another disadvantage is the cost, at a cost of at least $ 1 million dollars per unit, for much of the world's medical systems this technology is inaccessible. However, it is rumored that as experience with the use of these systems increases and technology improves, their costs will decrease [16].

Another problem is the costs of upgrading these systems because as technology advances, the robotic system needs to be improved, so the dilemma arises how much hospitals have to spend and how often to cope with these technological advances. Regardless of the situation for such a system to become cost-effective for a hospital, it must have wide, multidisciplinary applicability [17]

The lack of compatible tools and equipment is another shortcoming of this technology, as additional people are needed in the operating room to deal with this deficit.

Total mesorectal excision (TME) - the key to preventing recurrences in rectal cancer

The term mesorectum was first mentioned by the Romanian anatomist Toma Ionescu (89).

Poirier and Charpy later published Ionescu's descriptions of the mezorect in 1896 in the book Trăite d'Anatomie Humaine [18].

Ionescu was the first to notice that the rectum is closed in a capsule of fibrous tissue that separates it from the rest of the pelvic organs. He also described how the rectum can be mobilized within this mass of fibrous tissue without damaging the presacral vessels[18].

His description of the sheath of the rectum preceded that of Waldeyer's in Das Becken, Cohen, Bonn, 1899 [19]

Local recurrence in colorectal cancer posed a major problem for surgeons who had to prevent it through primary curative surgery. Thus due to the small space in the human pelvis, there is a higher incidence of local and regional recurrences for rectal cancer than for colon cancer. Although wide safety margins can be obtained for colon cancer without sacrificing important anatomical structures, this is much more difficult to perform in the case of rectal cancer [20]

Blunt rectal dissection has been associated with a high recurrence rate [21, 22]

Rectal tumors tend to have an increased rate of local recurrence and colonic tumors have an increased rate of recurrence at a distance from the primary tumor [23]

The importance of complete elimination of the perirectal lymphovascular test as well as the release of a circumferential safety margin was understood.

Heald et al, as well as Enker et al. reported a reduction in the incidence of recurrences in colorectal cancer by perimesorectal dissection followed by total mesorectal excision [24, 25]

Thus, there have been studies that have indicated a decrease in local recurrence in rectal cancer after total mesorectal excision has been performed from 30-40% to 5% [26]

Currently, total mesorectal excision aided by neoadjuvant chemoradiotherapy has become the gold standard in the treatment of locally advanced rectal cancer [27]

Total resection of the mesorectum can also be performed laparoscopically with satisfactory results from an oncological point of view, although initially this minimally invasive technique was adopted more slowly due to fears of non-compliance with oncological safety principles and dissemination possibilities due to pneumoperitoneum and the risk of metastasis at the implantation site of the trocars [28, 29, 30]

Erectile dysfunction why it needs to be taken into account in rectal cancer Erectile dysfunction remains a common complication of rectal cancer treatment. The high incidence of sexual or urinary dysfunctions is due to the radical nature of the resection procedure and sometimes secondary to radiotherapy or colostomy.

These patients need specialized urological treatment for these dysfunctions [31]

There are studies that indicate a rate of up to 75% of patients treated surgically for rectal cancer [32]

Postoperative impotence has a higher incidence in patients over 60 years of age and patients under 50 years of age have a minimal risk of developing sexual dysfunction [33]

Among the factors that can influence the rate of sexual dysfunction are: the stage of the tumor, the surgical technique adopted, or the surgeon's experience that is reflected in the correct dissection of the plans. By using sphincter-saving techniques, the incidence of sexual disorders in the resection of rectal tumors in which TME is practiced decreases [34]

Preservation of the hypogastric plexus is essential in preventing these complications and will be achieved by a thorough dissection of the mesorectum Numerous studies have shown that preservation of nerves and the hypogastric plexus does not affect the attempt at oncological curability of surgery [35]

Therefore, disorders of sexual dynamics are common after surgical treatment of rectal cancer, insufficiently discussed and of multifactorial origin, and efforts to prevent them must be increased. The treatment of sexual dysfunctions is evolving rapidly. The recent introduction of nitric oxide as a neurotransmitter in corpora cavernosa has given rise to a new generation of pharmacological molecules that can restore potency [36]

Sphincter-saving procedures, the role of robotic surgery and why it matters

In patients with rectal cancer, the development of new surgical techniques has allowed an improvement in local control of tumors while increasing the survival rate. Sphincter saving procedures have become one of the main goals, the third after increasing overall survival and disease-free survival when attempting to surgically remove a rectal tumor [37].

Engel et al. reported that patients with colostomy suffer from a degraded physical image, decreased sexual appetite, and decreased physical activity compared to their non-stoma peers [38]. The method of preserving the anal sphincter was introduced in the 1950s for recto-sigmoid tumors and recently for low rectal tumors [39]

Historically, at least 5 cm was needed between the distal edge of the tumor and the anal orifice in order to ensure a resection within oncological limits without subsequently changing the quality of life of the individual by transit disorders caused by damage to the anal sphincter. By introducing total mesorectal resection (TME) this imposed limit was reduced to 2 cm. Considering the length of the anal canal 3- 4 cm, all tumors that were not at least 5 cm away from the anal orifice were not candidates for sphincter-saving intervention [40].

Of course, in the situation where the tumor is regionally invasive and the distance between the tumor and the anal orifice is less than 2 cm, the intervention of choice remained the abdominal-perineal resection MILES. The preservation of the anal sphincter and the maintenance of the continuity of the digestive tract will be achieved by dissecting the rectum transanally and by removing a portion or all of the internal anal sphincter for the ultimate purpose of obtaining an R0 resection [41]

This method of treatment cannot be applied to all rectal tumors, staging will be taken into account. The intervention proved to be effective in the case of rectal tumors that do not invade locally, respectively stages T1 and T2.

For stage T3 (tumor invades the rectal muscle and perirectal adipose tissue) per-primam intersfincteric resection is not indicated due to the proximity of the tumor to the rectal sphincters, pelvic narrowing, and difficulty in obtaining safe oncological margins. In stage 3 patients who received neoadjuvant radiochemotherapy received improved results in terms of local oncological and functional control after rectal tumor resection and application of the sphincter-saving procedure [42].

Robot anterior low resection performed for rectal cancer

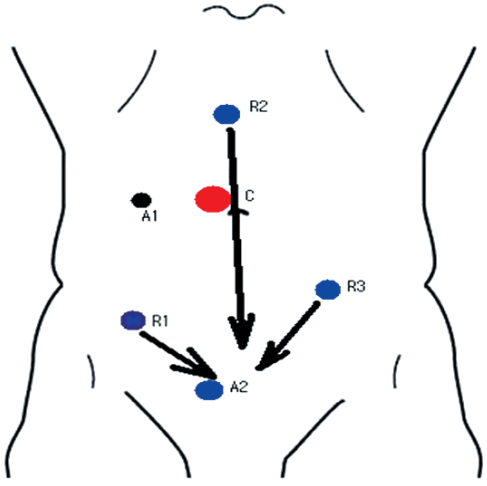

Figure 1 - Trocars placement in rectal surgery

The pneumoperitoneum, of 10-12 mm Hg pressure, will be made with a Veress needle inserted 2-3 cm superior to the umbilicus. Subsequently, a trocar for the 12 mm chamber is inserted. Another 4 trocars

are introduced as follows: in the right iliac fossa at 10 cm from the optic trocar, in the upper abdomen slightly to the left, one in the left iliac fossa on the spino-umbilical line and for the robotic port and the assistant will be inserted in the right abdominal flank 8 cm from the optical trocar. The patient is then positioned in Trendelenburg (30 degrees) and tilted slightly to the right. The da Vinci robot will be fixed above the patient's left hip. To facilitate vascular access and to facilitate the mobilization of the left colon and splenic flexures, a three-arm procedure will be used initially and trocars from the right iliac fossa and upper abdomen will be used. If at this stage the arm no. 4 of the robot is mounted there will be a risk of subsequent collisions. It will be fixed for TME. The lower mesenteric vein will be sectioned at the lower edge of the pancreas. The inferior mesenteric artery will be dissected and isolated between the clips and then be sectioned 1 cm from the origin to preserve the hypogastric nerves. When it is reached with the dissection in the pelvis, arm no. 4 of the robot is used to perform the TME. The dissection can be performed with the monopolar hook, with the Harmonic scalpel or with the robotic monopolar scissors depending on the surgeon's preferences. Attention should be paid to the preservation of the hypogastric nerves during the posterior, anterior, and lateral dissection of the rectum. After completion of the dissection, the anastomosis will be performed below the peritoneal reflection. The rectum will be sectioned with an Endo GIA stapler with blue clips. After the robot has been moved, the resection piece will be extracted through a 4-5 cm Phannenstiel incision. The proximal colon will then be sectioned and the anastomosis anvil will be placed in the proximal abutment which will be reintroduced into the abdomen. After the pneumoperitoneum is restored, the anastomosis will be completed robotically with the help of arm no. 4 which will be used for tissue retraction. An EEA circular stapler will be used.

Robotic Low anterior resection for rectal cancer (Intraoperative images)

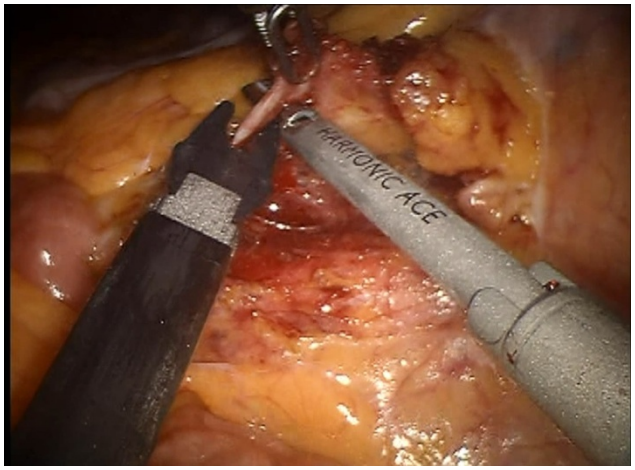

Figure 2 - Clip and resection of the inferior mesenteric vein

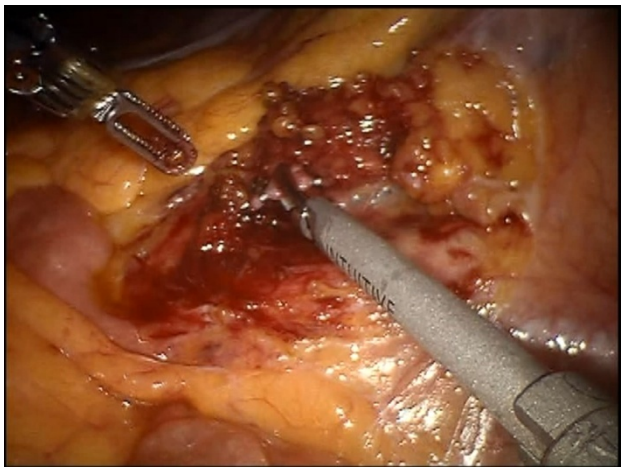

Figure 3 - Resection of the inferior mesenteric artery with the Harmonic Scalpel

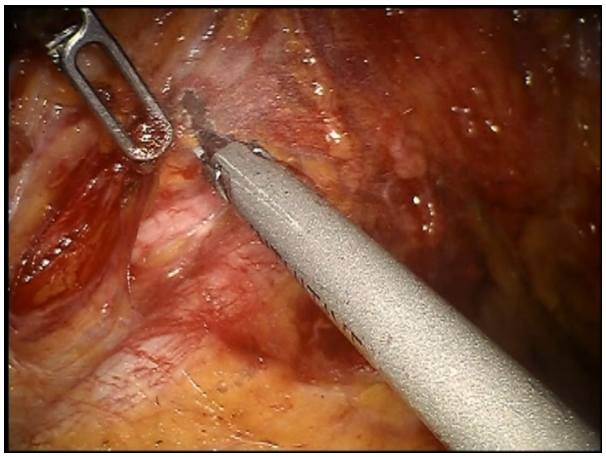

Figure 4 - Sigmoid dissection and uretherus visualization

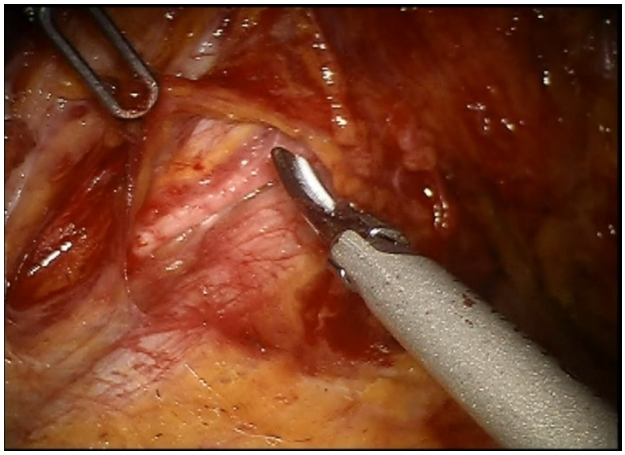

Figure 5 - Left ureter

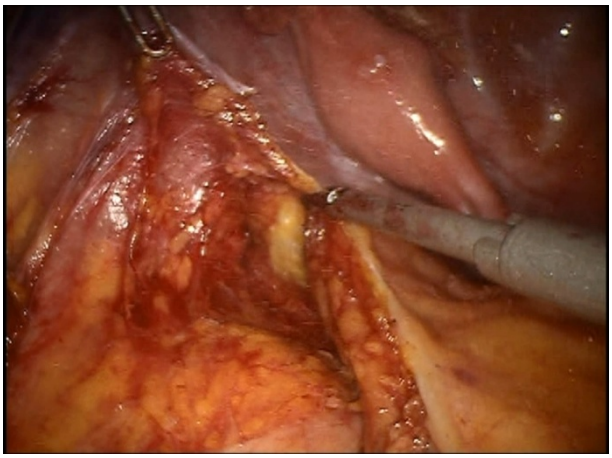

Figure 6 - Lateral dissections of the rectum

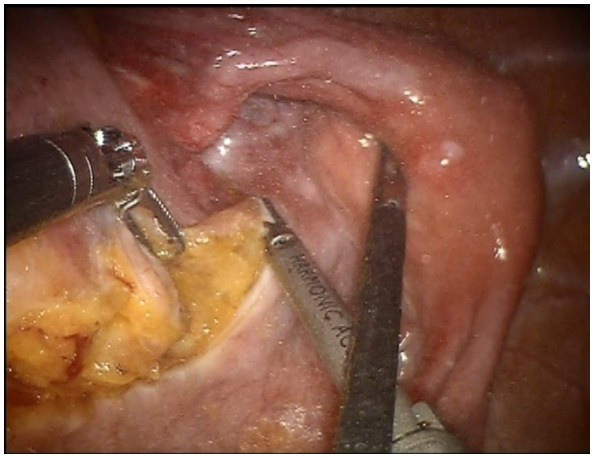

Figure 7 - Incision of the peritoneum at the level of the Douglas sac

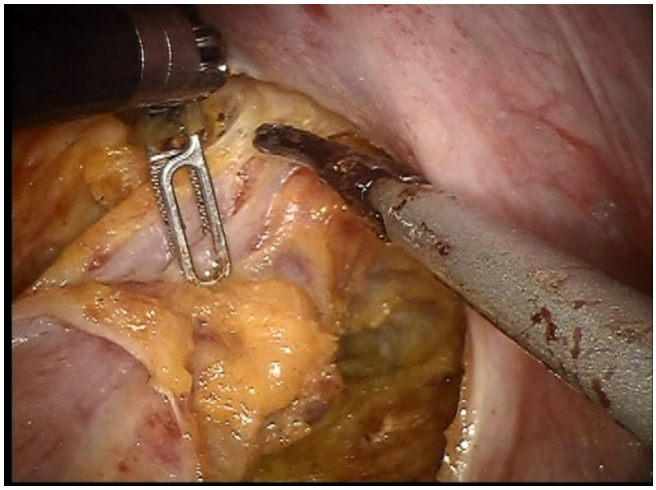

Figure 8 - Anterior mobilisation of the rectum

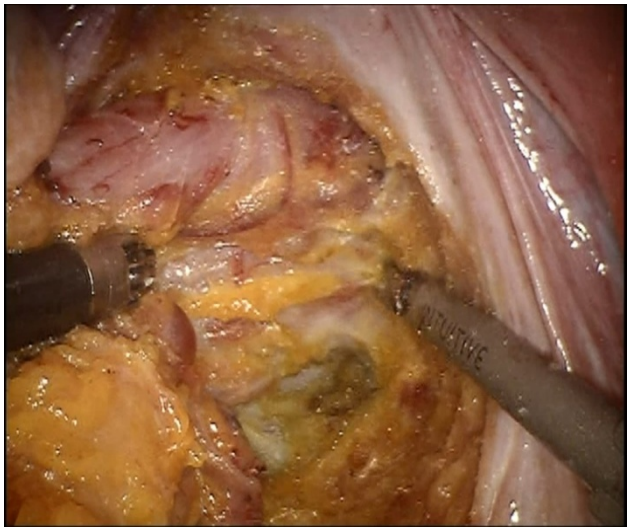

Figure 9 - Distal rectal mobilization at the level of the levator ani muscles

In the works published in the literature on robotic surgery for rectal cancer, the sphincter rescue operations were predominant, and the conversion rate to open surgery was very low or even zero. Thus, the sphincter-saving procedures are performed in more than 2/3 of the operated cases. NK Kim et al. in 2010 published an article on a number of 100 cases, in which it communicates a percentage of 98% sphincter saving procedures. Saving the anal sphincter is one of the ways to improve the quality of life of patients operated on for rectal cancer. Oncological safety should not be sacrificed for the preservation of the anal sphincter at any cost. To avoid the consequences of anastomosis fistula, a protective ileostomy needs to be performed in most cases with low and ultra-low anterior resection.

The conversion rate reported by Pigazzi et al. sits under 5%. There are studies in which the conversion rate is 0. The duration of surgery is longer, but it decreases as the operating team gains experience. It is

noteworthy that the assembly and disassembly of the surgical robot increase the duration of the operation. Also, in cases where the operation is performed entirely robotically, the repositioning of the robot to lower the splenic angle of the colon and the subsequent repositioning to perform the anastomosis are time. The postoperative morbidity as reported by NK Kim et al. sits at (20%) but higher values have been reported by Pigazzi et al in 2010 (41.3%), and values as low as 6.9% have been reported by Zeng et al. Regarding the rate of occurrence of anastomosis fistula, Pigazzi et al confirmed values of 10.5% higher than the values reported by other authors who published series of over 100 cases.

A significant number of published articles show significantly better dissection quality for performing TME [43-47]

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