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The minimally invasive approach, laparoscopic and robotic, in rectal resection for cancer. a single center experience.

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Background: Robotic approach for rectal cancer competes with laparoscopy in centers dedicated to minimally invasive surgery (MIS) due to the technologic advantage. This is a report of our experience with MIS for rectal cancer. Methods: A series of 84 consecutive patients with laparoscopic resection (between 1995-2010) and 38 consecutive patients with robotic resection (between 2008-2010) for primary rectal cancer were analyzed. Hartmann's procedures were excluded. Clinical and pathologic outcomes were reviewed retrospectively. Results: In the laparoscopic group (LG), 50 anterior rectal resections (ARR), 34 abdominal perineal resections (APR) were performed while in the robotic group(RG) there were 30 ARR and 8 APR. The median operative time was 182 min (140-220 min) in LG and 208 min (180-300 min) in RG (p=0.0002). No statistically significant difference was noticed between the groups in terms of conversion, morbidity, anastomotic leak and postoperative stay rates. Margin clearance was obtained in all patients and the median number of removed lymph nodes was similar: 11.37 in RG vs 11.07 in the LG (p=0.65) with a higher rate of metastatic lymph node involvement in laparoscopy (p=0.0012). Blood loss was higher in LG (150 ml vs. 100 ml; p=0.0001). There were 5 (5.9%) local recurrences in the LG at a median follow-up of 27.5 months and 2 (5.2%) in the RG at a median follow-up of 13 months (p=0.43).
Conclusions: Minimally invasive surgery for rectal cancer proved to be safe and efficient with similar results in the two groups. Technological advances of robotic approach compared to laparoscopy allowed better ergonomics, more refined dissection, easier preserving of hypogastric nerves and less blood loss. Long term outcomes are to be assessed in prospective randomized studies.

Key words : Rectal cancer, total mesorectal excision, laparoscopic surgery, robotic surgery

INTRODUCTION

The treatment of rectal cancer is currently based on a multidisciplinary approach which includes surgery, radiotherapy and chemotherapy. The surgical treatment aims to remove the rectum along with the entire mesorectum contained within the perirectal fascia that is called total mesorectal excision (TME). This technique proved to reduce the pelvic recurrence, to prolong survival and to preserve the erectile and urinary functions by avoiding nerve injury[1,2].

Laparoscopic TME was introduced more than a decade ago as a treatment option for rectal cancer and has gained wide acceptance in centers dedicated to minimally invasive surgery. Several studies have shown that the laparoscopic technique was oncologically safe with short term outcomes in favor of laparoscopy and long term outcomes equivalent to those obtained with open surgery[3,4,5]. Despite its technical feasibility in performing TME that was confirmed in studies conducted by surgeons well trained in laparoscopy, the laparoscopic approach is still difficult with high conversion rates and long learning curve[6,7]. Technical drawbacks in laparoscopic rectal resections are mainly due to the low ergonomics, the rigid instruments, the standard optical systems and the anatomy of the pelvis which all increase the difficulty of the maneuvers in a deep narrow space.Robotic approach has recently been introduced in the treatment of rectal cancer and experiences in small series of rectal resections have been published[8-12].

Technical advantages of the Da Vinci robotic system could overcome the limitations of laparoscopy by giving the surgeon a tridimensional (3D) view, better ergonomics, enhanced dexterity, precision and control due to the 3D optical system and EndoWrist® Instruments. The laparoscopic approach was introduced in our clinical practice in 1995[13,14,15] and the robotic approach in January 2008[16].

TABLE 1

THE PATIENTS' CHARACTETISTICS IN THE TWO GROUPS

Patient characteristics		RR	LR	P value
No of cases		38	84	
Mean age		53(±11.27)	60(±12.27_	0.0017
Sex n(%)	M	23	51	0.49NS
	F	15	33	0.49NS
Procedure	ARR	30	50	0.029
	APR	8	34	0.029
TNM	O	1 (2,6)	1 (1.19)	0.28 NS
	I	14 (36.8)	33 (39.2)	0.47NS
Staging n(%)	II	12 (31.5)	29 (34.5)	0.45NS
	III	10(26.3)	20 (23.8)	0.47NS
	IV	1 (2.6)	1 (1.19)	0.28NS

We have performed 84 laparoscopic rectal resections and 38 robotic resections eversince. Since the introduction of robotic approach patients were assigned to either laparoscopic or robotic approach based solely on the availability of the robot, whose use was shared among surgeons for a wide range of robotic procedures.This was designed as a retrospective comparative nonrandomized study in which we analyzed our experience in minimally invasive rectal surgery and evaluated the two techniques by comparing the intraoperative outcomes and postoperative short term and midterm outcomes.

PATIENTS AND METHODS

84 laparoscopic rectal resection and 38 robotic rectal resections for cancer were analyzed retrospectively. Hartman procedures were excluded. The same patient selection criteria were used for both surgical procedures. We excluded all T4 staged rectal cancers which would involve multiple organ resection, carcinomatosis, previous colonic resection and patients with contraindications for prolonged pneumoperitoneum.

Preoperative patient work-up included: colonoscopy with biopsy of the tumor; chest, abdominal and pelvic imaging by computed tomography (CT) and magnetic resonance of the pelvis.Perioperative clinical data included general patient's characteristics and TNM staging.

The intraoperative results consisted of technical aspects of the procedures, skin-to-skin operative time, intraoperative complications, amount of blood loss and conversions to laparotomy. The postoperative results included the time to oral diet, the time to bowel function recovery and the postoperative stay. Pathological data included pathological stage, number of lymph node harvested and status of distal resection margins.

OPERATIVE TECHNIQUES

Laparoscopic technique.

A standard mechanical bowel preparation was performed 24h prior to the operation. Standard laparoscopic instruments were used in all cases. The patient was placed in supine position with legs apart in 30º Trendelenburg position and 15º right down. The surgeon and the first assistant stay on the right side of the patient and the second assistant on the left side (Fig.1a). Pneumoperitoneum of 10-12mm Hg was achieved. Four to five trocars were used: a 10mm trocar was placed at the umbilicus for the camera, a 12 mm operational trocar in the right iliac fosa used also for stapling, a 10mm trocar in the right abdominal flank and 1or 2 trocars of 5mm in the right upper abdomen and the left flank for the assistant (Fig.1b). Mobilization of the left colon was undertaken after the inferior mesenteric artery (IMA) at its origin and the inferior mesenteric vein at inferior margin of the pancreas were divided using clips and the LigaSure device. Then the TME was performed using monopolar hook or scissors, harmonic scalpel and Liga Sure Atlas device. In the upper rectal cancer we performed partial mesorectal excision 3-4 cm bellow the inferior border of the tumor. The rectum was divided using an Endo-GIA. The specimen was removed trough a small transverse incision in the left iliac fosa or suprapubic of 4-5 cm. After placing the stapler anvil in the proximal colonic stump and closure of the incision, pneumoperitoneum was restored and stapled anastomosis was performed using the circular EEA stapler of 29 or 33mm. For those tumors located less than 6 cm from the anal verge a sphincter saving coloanal anastomosis was done with manual suture. One or two drains were usually left in place for 3 to 4 days. If abdominal-perineal

TABLE 2

INTRAOPERATIVE HISTOLOGICAL FINDINGS

Pathology		RR	LR	P value
Lymph nodes harvested		11.37(+/-3.8)	11.07(+/-3.2)	0.65 NS
Lymph nodes metastatic		1.81(+/-1.3)	2.84)+/-1.7)	0.0012
Distal resection margins		Negative	Negative	
T n(%)	CIS	1(2.6)	1(1.19)	0.28NS
	T1	3 (7.8)	10(11.9)	0.36NS
	T2	12 (31.5)	24 (28.5)	0.45 NS
	T3	22 (57.8)	49 (58.3)	0.48 NS
G n(%)	G1	18 (47.3)	47 (55.9)	0.24 NS
	G2	16 (42.1)	34 (40.4)	0.43 NS
	G3	4 (10.5)	3 (3.57)	0.13 NS

TABLE 3

INTREOPERATIVE DATA OF THE RR AND LR

Surgical outlooks	RR	LR	P value
Operative time (min)	212(±47.23)	182(±37.23)	0.0002
Conversion n(%)	2(5,2%)	9 (10,5%)	0.26 NS
L,O	O		
Blood loss	100 (±50)	150(±50)	0.0001

resection (APR) was performed, the splenic flexure was not mobilized; after TME was completed the left colon was transected using the Endo-GIA linear stapler. In the left abdominal flank a definitive stoma was performed and the specimen was removed through the perineal incision.

Robotic technique.

For robotic approach was used the DaVinci ***S*** and DaVinci ***Si*** Surgical Systems (Intuitive Surgical, Sunnyvale, CA, USA) The Da Vinci ***S*** robotic system consists of surgeon console, three arms robotic cart, electronic tower with video system and robotic instruments: camera of 0º and 30º and EndoWrist® articulated instruments. The more advanced DaVinci ***Si*** system has a four arm robotic cart and a tridimensional (3D) image processing. The three robotic arms technique was used in all cases of rectal resection.

The patient position is the same with laparoscopy. The robotic cart is placed on the side of the patient near the left hip. Trocar positioning differed from laparoscopic technique: a 12mm camera trocar was placed on the right side of the umbilicus and 3 robotic trocars of 8mm were placed in the right iliac fosa, upper abdomen on the midline and left iliac fosa respectively. Side assistant had a laparoscopic trocar of 12 mm in the right abdominal flank for laparoscopic assistance and stapling.

Operative steps were the same with laparoscopy: vascular access, left colon mobilization and splenic flexure takedown and TME. Isolation and division of the IMA and IMV and left colon mobilization were performed using robotic trocars placed in right iliac fosa and epigastrum respectively. Sometimes, at tall or obese patients, splenic flexure takedown is difficult to perform in this trocar setup due to inability of the right robotic instrument to reach the splenic flexure. In these cases either the right robotic arm was switched to the trocar placed in the left iliac fosa or standard laparoscopic instruments were used. Then for the TME robotic arms were docked to the trocars placed in right and left iliac fosae and the side assistant could use the robotic trocar from epigastrum to manipulate the rectum (fig.2a,2b).

TME was performed with sharp dissection in the plane of mesorectal fascia using monopolar hook, monopolar robotic scissors or Harmonic Scalpel. Care was taken to preserve hypogastric nerves and pelvic autonomic nerve plexus. After the completion of the TME the rectum was divided using the same Endo-GIA stapler as in laparoscopy, inserted through the 12mm trocar from right abdominal flank. Then the robot was disengaged, a small transverse incision was made in the left iliac fosa or suprapubic and the specimen was extracted from the abdomen. The proximal colonic stump was prepared outside the abdomen and the anvil from circular stapler was inserted. The abdominal incision was then closed after the

TABLE 4

POSTOPERATIVE COMPLICATIONS

Complications	RR	LR	P value
Total n(%)	6 (15,7)	13(15,29)	0.48 NS
Bowel obstruction	1a		
Anastomotic leakage	2b (5,26)	6d(7,05)	0.34 NS
Interperitoneal abscesses	-	3c	
Postoperative bleeding	1c		
Wound infection	2	4	0.45 NS

a-open reoperation; b i p - Hartmann procedure; lp conservative treatment; d.3p-conservative treatment; 3p - open reoperation; c 2p- US and CT guided drainage; 1p - open reoperation

colonic stump was reintroduced in the abdomen. The anastomosis was performed using the circular EEA stapler of 29 mm or 33mm in the same manner as in laparoscopy and one or two drains were left in place for few days. For those tumors located less than 6 cm from the anorectal verge, a sphincter saving coloanal anastomosis was performed manually. For the APR the procedure was the same with laparoscopy.

STATISTICAL ANALYSIS

Data were analyzed using SPSS (Statistical Product and Service Solutions 11.5 for Windows, SPSS Inc., Chicago,IL). The chi-squared test for categorical variables and Student's t-test for continuous variables were used for statistical comparisons of patient characteristics, perioperative clinical results, and pathologic details between robotic cases and laparoscopic cases. P values smaller than 0.05 were considered to be statistically significant.

RESULTS

Patient characteristics were analyzed comparing the robotic rectal resections (RR) with laparoscopic rectal resections (LR) (table 1). RR and LR groups contained 38 cases and 84 cases respectively. In the robotic group 30 ARR and 8 APR were performed while in the laparoscopic group there were 50 ARR and 34 APR. The mean age was slightly lower in the robotic group (53 years vs. 60.53 years) but the gender distribution was similar. Also the TNM staging was similar in the two groups.

The intraoperative results are presented in tables 2 and 3. The average number of harvested lymph nodes was similar but there were less metastatic lymph nodes in the robotic group. However the operative time was significantly longer in the robotic group meanwhile the same group had a significantly reduced blood loss. Postoperative complications (table 4) accounted for were: bowel obstruction, anastomotic leakage, intraperitoneal abscess, postoperative bleeding and wound infection. The specific complication rates were similar between groups. Postoperative recovery was also similar (table 5)

TABLE 5

POSTOPERATIVE RECOVERY IN ROBOTIC AND LAPAROSCOPIC RESECTIONS

Postoperative results	RR	LR	P value
Time to oral diet	2.14 (±0.72)	2.25(±0.64)	0.39 NS
Time to bowel function recovery	3.02(±1.2)	3.07(±1.25)	0.83 NS
Postoperative stay	8.14(±4.5)	8.37(±3.5)	0.75 NS

There were 5 (5.9%) local recurrences in laparoscopic group at a median follow-up of 27.5 months while 2 (5.2%) in the robotic group at a median follow-up of 13 months (p=0.43 NS). In the laparoscopic group there were 3 isolated Š3.5%Ć local recurrences after 2 ARR and 1 APR, 1 local combined with distant recurrences (1.1%)Ć after an ARR and 1 distant recurrence (1.1%) after an ARR. In the robotic group there were 1 local isolated recurrence (2.6%) after an ARR for a midrectal cancer and 1 local combined with distant peritoneal recurrences (2.6%) after an APR for a low rectal cancer.

DISCUSSION

Laparoscopic TME has been assessed in multiple studies which found that the procedure was oncologically safe and long term outcomes were similar to those achieved with open surgery[5,6,17-19]. The three-year results of the UK MRC CLASICC Trial Group showed also no statistical difference between the laparoscopic and open groups in terms of overall survival, disease free survival, local recurrence and quality of life rates[4]. The laparoscopic approach for rectal cancer is technically demanding due to the anatomy of the narrow pelvis and to the difficult dissection with rigid instruments necessitating a long learning curve[20]. These difficulties not only prolong the operative time but can increase the learning curve and result in high conversion rates to laparotomy. In a study assessing the learning curve for laparoscopic TME, it was considered that at least 90 operations were required to achieve adequate oncologic results[21]. 84 laparoscopic rectal resections were performed in our center between 1995 and June 2010. We consider that the most difficult to perform were low rectal bulky tumors in male patients in which sharp dissection in the anterior and lateral planes in order to keep the oncologic safety and to preserve the autonomic pelvic nerves as well is very demanding to achieve with rigid hook, harmonic scalpel or LigaSure device.

Robotic approach in rectal cancer was demonstrated to be feasible in recent studies which emphasized the technical advantages of the Da Vinci robotic system in TME[8-

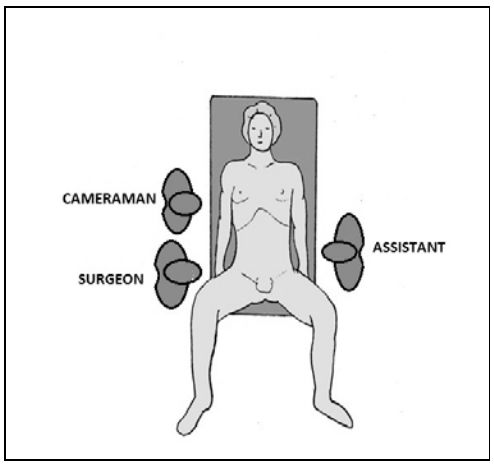

FIGURE 1A
SET-UP OF THE OPERATING ROOM

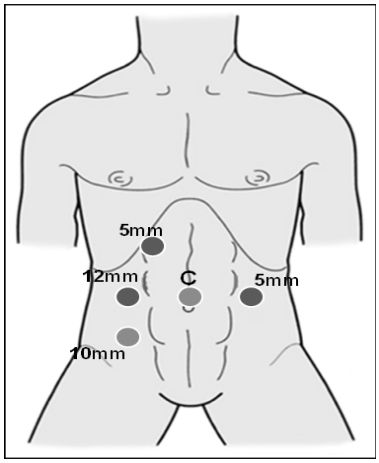

FIGURE 1B
TROCAR PLACEMENT IN LG

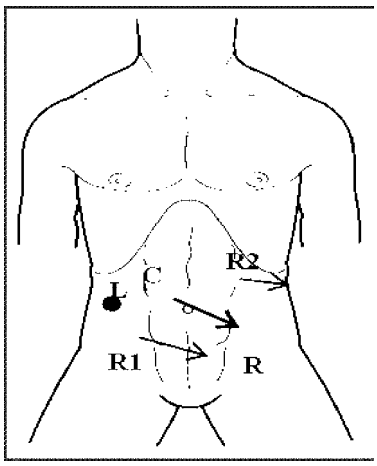

FIGURE 2A
TROCAR PLACEMENT IN RG FOR ARR

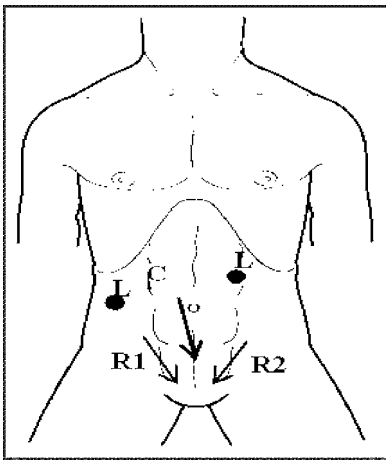

FIGURE 2B
TROCAR PLACEMENT IN RG FOR APR

[12]. These advantages are: three-dimensional (3D) panoramic view, intuitive motion with motion scaling, fingertips control, 7 degrees of freedom, tremor disappearance and ambidexterity. Using the EndoWrist® articulated instruments, the robotic system offers enhanced dexterity, precision and control[22]. An additional benefit of the robotic system may be a relatively short learning curve. Most robotic surgeons are already skilled laparoscopists with very good knowledge of the procedure. Moreover a recent report showed the transfer of open surgical skill to a video-assisted environment required only 12 robotic operations with outcomes similar to those of a skilled laparoscopist with more than 100 laparoscopic procedures performed[23].

38 rectal resections for cancer were performed in our center between January 2008 and May 2010. All robotic procedures were performed by surgeons with good expertise in laparoscopy[24]. The operative time was longer in robotic approach than in laparoscopy due to the robotic set-up and the initial learning curve. In both procedures the operative times were comparable with those reported in other robotic or laparoscopic TME series[6,11,25]. In order to reduce the operative time in robotic approach we used a hybrid technique in which the robot is placed in a single position on the left side of the patient and all operative steps are performed robotically except completion of splenic flexure takedown in tall or obese patients and colorectal anastomosis which were made laparoscopically as described by other authors[26].

The conversion rates between the two groups was not significantly different but with higher trend in laparoscopy (5.2% vs. 10.5%, p=0.26) and comparable with those reported in other studies[6,27]. This was probably due to the longer learning curve in laparoscopy and to the technical superiority of robotic technique. Indications for conversion to laparotomy in both groups included: extensive dense adhesions, tumor inaccessibility, evidence of T4 malignancy which implied multiple organ resection, carcinomatosis and intraoperative bleeding that couldn't be managed by minimally invasive way.

The 3D aspect and magnification of the operative field as well as the more precise dissection provided by the robotic system allowed us to better identify and preserve the hypogastric nerves and the autonomic plexus in the deep pelvis as well as to lower the blood loss compared to laparoscopy (100ml vs. 150 ml, p=0.0001).

Short term outcomes and oncologic radicality analyzed in our study showed also no statistically significant difference. The anastomotic leak rate was found similar in both groups and it was probably due to the same laparoscopic method of performing the anstomosis using the EndoGIA stapler. It was comparable with other recent studies which compared the two techniques[28-30]. Margin clearance was obtained in all patients and the number of harvested lymph nodes was similar in the two techniques and compared favorably with other series[27,29,30]. A higher rate of metastatic lymph node involvement was noticed in the laparoscopic approach (1.81- robotic vs. 2.84- laparoscopic; p=0.0012).

Local recurrences in both groups compared favorably with those reported in related series[4,27]. Even though the follow-up period for robotic group does not allow the assessment of robotic TME in terms of locoregional disease control, the data obtained were encouraging to continue using this technology in radical rectal surgery.

Surgeons performing laparoscopic surgery often assume unnatural body postures which may result in physical symptoms and discomfort[31,32]. Robotic approach may overcome these drawbacks due to more ergonomically position for the surgeon sitting at the console and less eye strain because of enhanced 3D visualization. We could assess the robotic technique as more comfortable and surgeon-friendly based upon the subjective opinion of surgeons involved.

The present study is the retrospective comparison of our consecutive experience in laparoscopy and robotics for rectal cancer. However there are significant differences between groups concerning potentially confounding variables. Therefore case-matched studies or prospective randomized data might increase the statistical relevance of such results.

In conclusion our results indicated that short-term and mid-term outcomes obtained with robotic rectal resections are closely similar to those obtained by laparoscopy. Thus, robotic approach in rectal cancer may be considered a feasible and safe alternative to conventional laparoscopic technique. Minimally invasive TME remains a challenging procedure. Technological advances of robotic approach compared to laparoscopy allowed more refined dissection, easier preserving of hypogastric nerves, less blood loss and improved surgeon's confort. Further prospective studies should analyze whether robotic TME may increase local control of the neoplastic rectal disease, disease free patient survival and preserve the postoperative urinary and sexually functions.

SUMMARY

MINIMALNO INVANZIVNI PRISTUP, LAPAROSKOPSKI I ROBOTICKI, KOD RESEKCIJE REKTUMA ZBOG KARCINOMA. ISKUSTVO JEDNIG CENTRA

Uvod: Robotički pristup karcinomu rektuma nadmeće se sa laparoskopijom u centrima posvećenim minimalno invazivnoj hirurgiji (MIS) zbog tehnoloških prednosti. Ovo je prikaz našeg iskustva u MIS za karcinom rektuma.

Metode: Analizirana je serija od 84 uzastopno operisanih pacijenata laparoskopskim pristupom (izmedju 1995-2010 god.) i 38 uzastopno operisanih pacijenata robotičkim pristupom (izmedju 2008-2010. god.) zbog primarnog karcinoma rektuma. Hartmann-ove procedure su isključene iz analize. Klinički i patološki rezultati su retrospektivno analizirani.

Rezultati: U grupi laparoskopski operisanih pacijenata (LG) uradjeno je 50 prednjih resekcija rektuma (ARR), 34 abominoperinealne resekcije (APR), dok je u grupi robotički operisanih pacijenata (RG) bilo 30 AAR i 8 APR. Srednje operativno vreme iznosilo je 182 min (140-220 min) u LG i min (180-300 min) u RG (p=0.0002). Nije nadjena statistički značajna razlika u smislu konverzije, morbiditeta, dehiscencije anastomoze i dužine postoperativnog oporavka. Klirens margina je postignut kod svih pacijenata obe grupe, a srednji broj uklonjenih limfnih nodusa je bio sličan: 11.37 u RG vs 11.07 u LG (p=0.65), sa višom stopom metastatski izmenjenih limfnih nodusa u laparoskopskoj grupi (p=0.0012). Gubitak krvi bio je veći u LG (150 ml vs. 100 ml; p=0.0001). Bilo je 5 lokalnih recidiva i LG, za srednje vreme praćenja 27.5 meseci i 2 (5.2%) u RG sa sred-njim vremenom praćenja 13 meseci (p=0.43).

Zaključak: Minimalno invazivna hirurgija za karcinom rektuma se pokazala kao bezbedna i efektivna sa sličnim rezultatima u obe grupe. Tehnološke prednosti robotičkog pristupa u poredjenju sa laparoskopskim pružile su bolju ergonomiju, rafiniranisaniju disekciju, lakšu prezervaciju hipogastričnih nerava i manji gubitak krvi. Dugotrajni rezultati bi trebali da se ocene kroz prospektivne randomizirane studije.

Ključne reči: karcinom rektuma, totalna mezorektalna ekscizija, laparoskopska hirurgija, robot hirurgija

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