

## Robotically Performed Total Mesorectal Excision for Rectal Cancer

L. Alecu<sup>1</sup>, O. Stănciulea<sup>2</sup>, D. Poesina<sup>3</sup>, V. Tomulescu<sup>2</sup>, C. Vasilescu<sup>2</sup>, I. Popescu<sup>2</sup>

<sup>1</sup>Clinical General Surgery Department, Prof. Dr. Agrippa Ionescu Clinical Emergency Hospital, Bucharest, Romania

<sup>2</sup>Dan Setlacec Centre for General Surgery and Liver Transplant, Fundeni Clinical Institute, Bucharest, Romania

<sup>3</sup>Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

### Rezumat

#### *Excizia totală de mezorect efectuată robotic pentru cancerul rectal*

*Introducere:* Cancerul de rect este o problemă importantă de sănătate publică, prin numărul tot mai mare de cazuri nou apărute și prin aspectele de calitate a vieții pe care le ridică tratamentul chirurgical al acestor pacienți.

*Material și metodă:* Au fost analizați retrospectiv pacienții diagnosticați cu cancer rectal și operați folosindu-se chirurgia robotică, între anii 2008 și 2012, în Institutul Clinic Fundeni.

*Rezultate:* Au fost operați robotic un număr de 117 pacienți cu cancer rectal, dintre care la 79(67,52%) s-a practicat excizia totală de mezorect (TME). Operația cea mai frecvent efectuată a fost rezecția anterioară joasă, urmată de amputația de rect. Fistula de anastomoză am observat-o la 9 (11,39%) dintre pacienți. Recidiva locală a fost întâlnită la 2 (2,53%) dintre cazurile operate robotic.

*Concluzii:* 1. Excizia totală de mezorect asistată robotic este fezabilă, sigură și poate fi efectuată cu un număr scăzut de complicații și o rată mică de recidivă locală; 2. Principalele avantaje sunt siguranța oncologică și calitatea vieții; 3. Conversia la chirurgia deschisă este rar întâlnită; 4. Existența ileostomei de protecție permite evitarea reintervenției în caz de apariție a fistulei de anastomoză la pacienții cu rezecție

anterioară joasă. 5. Chirurgia robotică poate deveni standard de aur în tratamentul chirurgical al cancerului de rect.

**Cuvinte cheie:** abord robotic, excizie totală de mezorect, rezultate oncologice, morbiditate

### Abstract

*Background:* Rectal cancer is an important health problem, due to the increasing number of new cases and the quality of life issues brought forth by surgical treatment in these patients.

*Aim:* The aim of the study was to analyse the results of robotic surgery in the treatment of lower and middle rectal cancer, locations in which TME is performed.

*Material and Method:* Patients diagnosed with and operated on for rectal cancer by the means of robotic surgery between 2008-2012 at the Fundeni Clinical Institute were retrospectively analysed.

*Results:* A number of 117 patients with rectal cancer were operated on by robotic surgery, of which 79 (67.52%) were submitted to total mesorectal excision (TME). The most frequently performed surgery was low anterior resection, followed by rectal amputation through abdominoperineal approach. Anastomosis fistula was observed in 9 (11.39%) patients. Local recurrence was encountered in 2 (2.53%) of the robotically performed surgeries.

*Conclusions:* 1. Robotically assisted total mesorectal excision is feasible, safe and can be performed with a small number of complications and a low local recurrence rate; 2. The main advantages are oncological safety and quality of life; 3. Conversion to open surgery is rarely encountered; 4. Protection loop ileostomy existence allows avoiding reintervention in case

### Corresponding author:

Dr. Lucian Alecu  
Clinical General Surgery Department  
"Prof. Dr. Agrippa Ionescu" Clinical  
Emergency Hospital, Bucharest  
No. 7 Arh. Ion Mincu street, Sector 1,  
Bucharest, Romania  
E-mail: lucianalecu@yahoo.com

anastomotic fistula occurs in patients with low anterior resection. 5. Robotic surgery may become gold standard in the surgical treatment of rectal cancer.

**Key words:** robotic approach, total mesorectal excision, oncological results, morbidity

## Introduction

Rectal cancer represents an important health problem due to the growing number of new cases and to the quality of life aspects brought forth by surgical treatment in these patients. Given this fact, the anatomy of the rectum and the surgical techniques employed in rectal cancer treatment have been thoroughly studied, improved and coded. In 1982 Heald introduced the notion of total mesorectal excision, the key to preventing local recurrence after rectal cancer operations (1). The importance attributed to quality of life in these patients led to the development of sphincter preservation techniques, as well as of preservation of the hypogastric plexus for the prevention of urinary and sexual postoperative dysfunctions. In July 1991 Joseph Uddon reported the first laparoscopic right colectomy (2). In Romania the first laparoscopic abdominoperineal resection was performed at Fundeni Clinical Institute in 1995 (3). The limitations of the laparoscopic technique led to the development of robotic surgery, which offers as main advantages 3D visualization, dexterity, instrument precision (with 7 degrees of freedom) and handling of the camera by the operating surgeon, allowing for a good control of the work area (4). In 2008, a pilot program for robotic surgery was initiated at Fundeni Clinical Institute, funded by the Ministry of Health. One of the aims of these program was to define which procedures are worth being robotically assisted and which not, for future surgeries to be performed after the pilot programme and funding would come to an end. Rectal cancer surgery was introduced into this program from the very beginning for the advantages enumerated above, but also with the purpose of it becoming gold standard

The aim of the paper was to analyse the result of employing robotic surgery in the treatment of inferior and middle rectal cancer, localizations which allow for total mesorectal excision (TME).

## Material and Method

Patients diagnosed with rectal cancer and operated on by robotic surgery over a period of 5 years, between 2008 and 2012, at Fundeni Clinical Institute, were retrospectively analysed. Data were extracted from patient charts, surgical records and histopathological records. The following types of data were extracted and processed: age, sex, comorbidities, abdominal surgery personal history, tumour localization, presence or absence of metastases, follow-up period, neoadjuvant chemoradiotherapy, type of surgery, need for protec-

tion ileostomy, conversion, distal resection margin size, tumour size, number of lymph nodes examined and number of tumour invaded lymph nodes, postoperative staging and tumour grading, postoperative hospital stay, postoperative complications and reinterventions, sexual and urinary dysfunctions, operative time. These patients were investigated and treated by a multidisciplinary team, following existing guides and protocols. Endoscopic and imaging investigations performed to establish diagnosis and postoperative staging were: rectocolonoscopy (with biopsy and histopathological exam), CT exam (abdomen and pelvis) and pelvic MRI. Neoadjuvant radiochemotherapy was used in the treatment of these patients.

Postoperative follow-up consisted in examining these patients at one, three, six and twelve months after the operation, and then every year. During these controls we performed: clinical examinations, tumour marker dosing, rectocolonoscopy, ultrasound exam, thoracic radiography, CT exam and (pelvic) MRI. Also, the development of urinary and sexual dysfunctions (important aspects in connection to the quality of life of these patients) were investigated using the International Prostatic Symptom Score (IPSS), International Index of Erectile Function (IIEF) and Female Sexual Function Index (FSFI).

## Results

Thusly, 117 patients with rectal cancer were operated on with robotic assistance, of which 79 (67.52%) were submitted to TME due to tumour localization at the level of the middle and inferior rectum. Of these 50 (63.29%) were males and 29 (36.71%) females. The average age of these patients was 61.53 years old. Most cases corresponded to decades 6 and 7 of life.

Associated diseases were present in 43 (54.43%) of the cases. A previously operated on abdomen does not mandatorily represent a contraindication for minimally invasive robotic surgery. Tumour localization at the level of the middle rectum was more frequently encountered.

Patients stage T3/T4 and with no distant metastases and those with stage 4 disease and only hepatic metastases benefited from preoperative radiochemotherapy. This consisted in 46 – 50.4 Gy associated with general administration of 5 fluorouracil. Surgical intervention was performed 6 weeks after finalization of neoadjuvant treatment. Pelvic MRI was employed for staging. Pelvic MRI plays a crucial role in primary staging of rectal cancer, guiding the therapeutic management. It has high accuracy in determining the circumferential resection margin (CRM) and sphincter invasion. Preoperative MRI accurately identifies the risk factors for local recurrence and metastases at a distance, thus facilitating the preoperative prognostic classification and establishing treatment, and becoming a standard in many centres.

The most frequently performed operation was low anterior resection, followed by rectal amputation. The latter was performed preponderantly in male patients. A number of 9 (11.39%) ultralow resections with coloanal anastomosis were also performed, also more frequently in male patients (Table 1).

When a safety margin of 1.5-2 cm below the inferior

**Table 1. Results**

Results	Males	Females
Associated diseases	28(56%)	15(51.72%)
Personal history of abdominal surgery	10 (20%)	6 (29.69%)
Tumour localization		
Inferior rectum	18(36%)	6(20.69%)
Middle rectum	31(62%)	22(75.86%)
Middle and superior rectum	0(0%)	1(3.45%)
Entire rectum	1(2%)	0(0%)
Metastasis presence	1(2%)	0(0%)
Surgery type		
Rectal amputation	17(34%)	8(27.58%)
Low anterior resection	26(52%)	19(65.52%)
Ultralow resection with coloanal anastomosis	7(14%)	2(6.9%)

macroscopic margin of the tumour is accepted, one can perform surgery for low or ultralow anterior resection (preserving the anal sphincter) for a tumour located at 3-4 cm from the anal orifice. Abdominoperineal resection remains reserved for anorectal cancer, but also for advanced stage tumours, with perirectal tissue invasion.

For rectal excision with TME all 4 arms of the robot were used. Dissection always started from the medial side towards the lateral, with primary approach of the inferior mesenteric vessels. Ligation of the inferior mesenteric vein was performed at the inferior margin of the pancreas, and the inferior mesenteric artery was ligated at its origin in the abdominal aorta, with or without preservation of the left colic artery. During the dissection of the inferior mesenteric artery special attention was paid to preservation of the hypogastric nerves. These nerves were also protected during posterior, lateral and anterior mobilization of the rectum. In some cases, the splenic angle of the colon cannot be mobilized and lowered, a repositioning of the robot being necessary (time consuming manoeuvre). In order to avoid this inconvenience, after finishing robotic dissection of the rectum and removing the surgical robot proximal dissection is performed through conventional laparoscopy to lower the splenic angle. After sectioning the stapler with EndoGIA stapler, one extracts the rectum along with the tumour via a Pfannenstiel incision, sections the proximal colon, installs the anvil of the circular stapler, and low colorectal anastomosis is performed under robotic or laparoscopic guidance, using the transanally introduced EEA stapler. Low colorectal anastomosis was always performed with mechanic suture. When the extremely low localization of the tumour does not allow employment of the EndoGIA stapler, there being however a safety margin of approx. 1.5 cm below the inferior margin of the tumour, anastomosis with manual coloanal suture is resorted to. There were no incidents or intraoperative accidents, with the exception of small bleeds during dissection.

Protection ileostomy was used in cases with low anterior resection, but also in 7 (77.77%) of the extremely low anastomosis cases, and wasn't employed in 2 (22.22%) of these. Of the patients with very low anastomoses, preoperative chemoradiotherapy was used in 3 (33.33%) of these, one developing anastomotic fistula. It is to be observed that both cases without

protection ileostomy developed anastomotic fistula, one of these benefitting from preoperative chemoradiotherapy.

The volume of blood lost intraoperatively was on average 150 ml (between 0 – 300 ml).

Conversion was resorted to in 2(4%) patients, due to expansion of the tumoral process in the neighbouring organs, an aspect which had not been diagnosed preoperatively.

Average operative time was 216.45 minutes.

Postoperative histopathology exam results are described in Table 2.

Average distal resection margin for patients with rectal cancer operated on is 2.78 cm.

The circumferential resection margins were negative in all cases except one, which developed local recurrence 9 months after surgery.

Average tumour size for rectal cancer patients operated on was 3.36 cm. The average number of excised lymph nodes in patients with rectal cancer is 14.24, and the average number of tumour invaded lymph nodes for operated patients is 1.01. In 57 (72.15%) cases there were no tumour invaded lymph nodes. In the remaining 22(27.84%) patients between 1 and 8 positive lymph nodes were identified. One can notice that most operated patients presented with stage II of the disease. Stages I and III were also identified in an almost equal number of patients. 6 patients had stage IV disease. Also, most of the excised tumours pertained to G1 and G1-2 differentiation grading stages. There was a connection between preoperative and postoperative staging in the majority of cases.

Postoperative complications occurred in 20 (25.31%) patients and required reintervention in 4 (5.06%) of these (Table 3).

Anastomotic fistula was present in 9 (11.39%) cases, being treated conservatively in 6 of these. The fistula developed between the 5th and 7th postoperative day. Reintervention was necessary in 3(3.79%) cases, all by coloanal anastomosis. Of the 9 cases presenting anastomosis fistula, in 4 of them coloanal anastomosis was performed, and in low anterior resection with protection ileostomy. In cases with ultralow resection and coloanal anastomosis having developed anastomosis

**Table 2. Histopathological results**

Results	Males	Females
Distal resection margin	2.69 cm	2.94 cm
Average tumour size	3.39 cm	3.30 cm
Average number of excised lymph nodes	13.86	14.9
Progression stage		
0	2(4%)	2(6.9%)
I	11(22%)	6(20.69%)
II	23(46%)	11(37.93%)
III	11(22%)	7(20.14%)
IV	3(6%)	3(10.34%)
Tumour grading		
G1	35(70%)	18(62.07%)
G1-2	7(14%)	7(24.13%)
G2	3(6%)	1(3.45%)
G2-3	4(8%)	2(6.9%)
G3	1(2%)	1(3.45%)

**Table 3.** Postoperative complications

Postoperative complications	Males	Females
Anastomotic fistula	6(12%)	3(10.34)
Urinary complications	4(8%)	0
Other complications (occlusion, wound infection, etc)	4(8%)	3(10.34%)
No complications	36(72%)	23(79.31%)

fistula the following aspects must be taken into account: 1. the large percentage of cases developing anastomotic fistula (44.44%); 2. 3 of these required reintervention, either at local perineal level with resection and reestablishment of the coloanal anastomosis, either by suppressing the anastomosis and performing a terminal colostomy (by laparoscopic approach); 3. in 2 cases protection ileostomy was not performed, and in one of them anastomosis suppression and creation of a terminal colostomy were necessary.

Of the 9 cases developing anastomotic fistula preoperative chemoradiotherapy was not performed in 4 (44.44%) of these. Of the total 13 cases of anastomotic fistulas and urinary complications preoperative CRT was not performed in 6 (46.15%) of these.

In one case reintervention (by open approach) was necessary for intestinal occlusion.

There were 4(5.063%) patients with urinary complications (urinary retentions - all treated non-surgically), but also 3 (3.79%) cases with important sexual dysfunctions (severe erectile dysfunction).

The average postoperative hospital stay for patients operated on for rectal cancer was 9.89 days. Average survival of operated patients was 24.57 months. Local recurrence was encountered in 2(2.53%) of the robotically operated cases. One case was admitted for and operated under emergency status (by open approach) for intestinal occlusion (through peritoneal carcinomatosis) 8 months after the robotic surgery. The second case was a patient with positive circumferential resection margin at the time of the surgery, diagnosed with local recurrence 9 months after the operation through postoperative follow-up imaging investigations.

5(6.32%) patients died during the follow-up period, mostly men (4 cases - 67.52%).

## Discussions

Robotically assisted laparoscopic surgery presents important differences compared to conventional laparoscopy. Thus, robotic surgery presents the following advantages: 3D visibility, excellent ergonomics, high precision, absence of tremor, instruments with 7 degrees of freedom. For these reasons robotic surgery presents a shorter learning curve and a far higher implementation rate compared to conventional laparoscopy (especially in terms of colorectal surgery). The main advantages of robotic surgery are oncological safety and quality of life. Of the disadvantages one could enumerate the high cost and increased operative time, but as the papers published so far

report, this operation could be performed by experienced teams with operative times similar to those of open and laparoscopy surgery. (5,6,7,8,9)

The first robotic colectomy was accomplished in 2001 (10). The concept of robotic total mesorectal excision was introduced in 2006 (11). These authors, as well as others following, have compared the results obtained in patients in which TME was performed robotically and those in which it was performed by conventional laparoscopy and concluded that low anterior resection with total mesorectal excision and robotically assisted autonomous nerve preservation is feasible and safer, but requires a longer operative time (12,13,14). In Romania studies on robotic surgery and rectal resection, as well as TME by this technique, were published by the team at the "Dan Setlavec" Centre for General Surgery and Liver Transplant from Fundeni Clinical Institute (15,16,17,18).

Low or ultralow anterior resection can be performed entirely robotically in the majority of cases. Lowering the splenic flexure of the colon can involve repositioning of the robot, with subsequent increase in operative time. Under these conditions a hybrid robotic-laparoscopic technique was developed, involving robotically assisted lymphovascular dissection with sectioning of the inferior mesenteric pedicle, as well as pelvic dissection of the entire rectum, followed by proximal laparoscopic dissection with mobilization and lowering of the splenic angle.

In the papers published in the literature the results are comparable to those described in our study (Table 4). Thus sphincter preservation surgeries were preponderant, and conversion rate to open surgery was low or even null. Anal sphincter preservation is one of the measures for improving these patients' quality of life. One must also bear in mind the highly important aspect of not sacrificing oncologic safety for sphincter preservation. In order to prevent anastomotic fistula consequences most cases of low and ultralow anterior resection benefited from protection ileostomy. Ileostomy presence led to avoiding reintervention. In case of fistulas developed after ultralow anterior resection with coloanal anastomosis the impact of the fistula is only local and cannot lead to postoperative peritonitis. For this reason the treatment is locally conservatory or with resection and reestablishment of the coloanal anastomosis.

All published articles depict the significantly better quality of dissection in performing TME (19,20,21,22). Of these studies, one must highlight the one by Baik et al., from 2013, including 370 cases, representing the largest series published so far (23).

Data referring to the histopathological results are also very close (Table 5).

In terms of postoperative morbidity the percentages vary very much in the studies identified in the literature. Thus, if some authors present very small percentages for anastomotic fistula occurrence, there are studies presenting it as up to 10 - 13%, results similar to those identified in our study (11.39%). Urinary and sexual postoperative dysfunctions were observed in a number of patients similar in value to the figures identified in the literature and presented in Table 6. Thus Kim

**Table 4.** Current status of robotic rectal cancer surgery worldwide  
Published series > 100 patients (LAR - Low Anterior Resection, u-LAR - ultra-Low Anterior Resection, APR - Abdominoperineal Resection, ISR- IntraSphincterian Resection)

Authors /Year	Nr of cases	Procedure type/ technique	Operative time	Conversion	Leak	Morbidity	Follow up (mth)
NK Kim et al, 2010 (5)	100	98% sphincter saving surgery	385±102.6	2%	8.2%	20%	-
Pigazzi et al, 2010 multicentric (11)	143	80 LAR, 32 u-LAR 31 APR	297(90-660)	4.9%	10.5%	41.3%	17.4
Baik et al 2013 (23)	370	319 LAR, 46 u-LAR 3 APR	215 ±69.7 (92-477)	0.8%	7.7%	23.2%	24(15-38)
Zeng et al. 2013 (24)	101	73 LAR 28 APR	210,3 ±47,2	0%	2.7%	6.9%	12.9 ±8.0
Popescu et al 2013 (25)	100	77 LAR 23 APR	160 APR 180 LAR	4%	11%	30%	24
Bianchi et al 2013 (26)	259	-	240 (170-420)	2.3%	7.7%	-	-
Shiomi A et al 2014 (27)	113	82 LAR, 8 APR, 23 ISR	302 (135-683)	0		2, 7% III-IV CD	-

**Table 5.** Histopathological results published in the literature

Reference	No. of cases	Excised lymph nodes	DRM (cm)	CRM (invasion)	Complete TME
Pigazzi et al. (11)	143	14.1	2,9	0.70%	
Baik et al. (13)	56	18.4±9.2	4	7.10%	92.90%
Patriti et al. (28)	29	10.3±4	2.1±0.9	0	
Park et al. (29)	41	17.3±7.7	2.1±1.4	4.90%	
Kwak et al. (30)	59	20	2.2	1.70%	
Popescu et al (25)	100	14	3		

**Table 6.** Postoperative morbidity and mortality in the literature

Reference	Early morbidity (<30 days)							Late morbidity (>30 days)						
	Anastomotic fistula	Wound infection	Haemorrhage	Paralytic ileus	Intestinal occlusion	Enteritis	Urinary retention	Others	Urinary dysfunction	Sexual dysfunction	Faecal incontinence	Constipation	Local recurrence	Mortality
Alberto Patrizzi et al. (28)	6.8%	3.4%	3.4%	6.8%		6.8%	3.4%			5.5%	6.8%	13.7%		3.4%
Jo Park et al. (22)	4.2%	13.3%	3.3%		3.3%		10.0%	8.3% (pelvic abscess)		6.3%				
Nam Kyu Kim et al. (5)	8.2%	1%	1%	3%				2% (pelvic abscess)						
Pigazzi et al. (11)					41.3%									
Baik et al. (13)					5.4%									
Park et al. (29)					29.3%									
Kwak et al. (30)					32.2%									
Popescu et al. (25)					30.0%									
	9%	4%	1%	4%	1%		4%	2%	4%	3%			2%	

et al. published similar results on early postoperative recovery of sexual and urinary functions in patients from the robotically assisted group comparing to the group operated by conventional laparoscopy (31). Luca et al showed that the sexual function

and satisfaction decrease significantly one month after the operation, but one year postoperatively they are similar to those before the surgery. Also, the urinary function and degree of incontinence measured 1 year after the operation were the same

for both genders (32).

No data referring to local recurrence in robotically assisted operated patients were found in the studies published in the literature. Postoperative morbidity is very important, as it influences greatly the quality of life of these patients.

## Conclusions

Robotically assisted total mesorectal excision is feasible, safe and can be performed with a small number of complications and a low rate of local recurrence.

The main advantages for the patient are oncological safety (highlighted by the low percentage of local recurrence cases) and the quality of life (underlined by the large number of sphincter preserving operations and small number of patients with sexual or urinary postoperative dysfunctions).

Conversion to open surgery is very seldom encountered.

The protection ileostomy prevents reintervention in case of anastomotic fistula in patients with low anterior resection.

Robotic surgery may become gold standard in the surgical treatment of rectal cancer.

## Acknowledgements

„This paper was co-financed from the European Social Fund, through the Sectorial Operational Programme Human Resources Development 2007-2013, project number POSDRU /159/1.5/S/138907 "Excellence in scientific interdisciplinary research, doctoral and postdoctoral, in the economic, social and medical fields - EXCELIS", coordinator The Bucharest University of Economic Studies”.

## References

1. Paul F. Ridgway, MD, MMedSc, Ara W. Darzi, MD, FRCS, FACS, The Role of Total Mesorectal Excision in the Management of Rectal Cancer, *Cancer Control*, 2003;10(3).
2. V. Tomulescu, O. Stanciulea, A. Kosa, Hemicolectomia dreaptă laparoscopică, *Chirurgia* 104(4): 463-469.
3. Vasilescu C., Tomulescu V., Tonea A., Pietroreanu D., Tulbure D., Droc G., Popescu I., Amputație de rect pe cale laparoscopică, *Chirurgia* 1995; 3:55-58.
4. Sorinel Luncă, George Bouraş, Alexandru Călin Stănescu, Gastrointestinal robot-assisted surgery. A current perspective, *Roumanian Journal of gastroenterology* 2005, 14(4):385-391
5. Nam-Kyu Kim, Jeonghyun Kang, Optimal Total Mesorectal Excision for Rectal Cancer: the Role of Robotic Surgery from an Expert's View, *J Korean Soc Coloproctol* 2010; 26(6):377-387
6. Bokhari MB, Patel CB, Ramos-Valadez DI, Ragupathi M, Haas EM. Learning curve for robotic-assisted laparoscopic colorectal surgery. *Surg Endosc*. 2011;25(3):855-60.
7. Popescu I, Vasilescu C, Tomulescu V, Vasile S, Sgarbura O. The minimally invasive approach, laparoscopic and robotic, in rectal resection for cancer. A single center experience. *Acta Chir Iugosl*. 2010;57(3):29-35.
8. Bianchi PP, Rosati R, Bona S, Rottoli M, Elmore U, Ceriani C, et al. Laparoscopic surgery in rectal cancer: a prospective analysis of patient survival and outcomes. *Dis Colon Rectum*. 2007;50(12):2047-53. Epub 2007 Sep 29.
9. Leung KL, Kwok SP, Lam SC, Lee JF, Yiu RY, Ng SS, et al. Laparoscopic resection of rectosigmoid carcinoma: prospective randomised trial. *Lancet*. 2004;363(9416):1187-92.
10. Weber PA, Merola S, Wasielewski A, Ballantyne GH. Telerobotic-assisted laparoscopic right and sigmoid colectomies for benign disease. *Dis Colon Rectum*. 2002;45:1689-94.
11. Pigazzi A, Luca F, Patrili A, Valvo M, Ceccarelli G, Casciola L, et al. Multicentric study on robotic tumor-specific mesorectal excision for the treatment of rectal cancer. *Ann Surg Oncol*. 2010;17(6):1614-20.
12. D'Annibale A, Morpurgo E, Fiscon V, Trevisan P, Sovernigo G, Orsini C, Guidolin D. Robotic and laparoscopic surgery for treatment of colorectal diseases. *Dis Colon Rectum*. 2004;47:2162-8.
13. Baik SH, Kwon HY, Kim JS, Hur H, Sohn SK, Cho CH, et al. Robotic versus laparoscopic low anterior resection of rectal cancer: short-term outcome of a prospective comparative study. *Ann Surg Oncol* 2009;16:1480-7.
14. Spinoglio G, Summa M, Priora F, Quarati R, Testa S. Robotic colorectal surgery: first 50 cases experience. *Dis Colon Rectum*. 2008;51:1627-32.
15. Tomulescu V, Stănciulea O, Bălescu I, Vasile S, Tudor S, Gheorghe C, et al. First year experience of robotic-assisted laparoscopic surgery with 153 cases in a general surgery department: indications, technique and results. *Chirurgia (Bucur)*. 2009;104(2):141-50.
16. Vasilescu C. Current problems in surgical oncology. Part 3. Total mesorectal excision with curative intent. Why are not all patients with rectal cancer treated with minimally invasive procedures (either by laparoscopy or by robotic surgery)? *Chirurgia (Bucur)*. 2011;106(3):297-9.
17. Vasilescu C, Popescu I. Robotic surgery-possibilities and perspectives. *Chirurgia (Bucur)*. 2008;103(1):9-11.
18. O. Sgarbură, V. Tomulescu, C. Blajut, I. Popescu, 5-Year Perspective over Robotic General Surgery: Indications, Risk Factors and Learning Curves, *Chirurgia* 2013, 108(5):599-610
19. Memon S, Heriot AG, Murphy Dg, Bressel M, Lynch AC, Robotic versus laparoscopic proctectomy for rectal cancer a Meta-analysis, *Ann Surg Oncol*, 2012 Jul, 19(7):2095-101. doi:10.1245/s10434-012-2270-1. Epub 2012 Feb 16.
20. Trastulli S, Farinella E, Cirocchi R, Cavaliere D, Avenia N, Sciannoneo F, Guiala N, Noya G, Boselli C. Robotic resection compared with laparoscopic rectal resection for cancer: systematic review and meta-analysis of short-term outcome. *Colorectal Dis*. 2012 Apr, 14(4):ce134-56. doi:10.1111/j.1463-1318.2011.02907.x.
21. Tony Wing chung Mak, Janet Fung Yee Lee, Kaori Futaba, Sophie Sok Fel Hon, Dennis Kwok Yu Ngo, Simon Siu Man Ng. Robotic surgery for rectal cancer: A systematic review of current practice. *World Gastrointest Oncol* 2014 June 15, 6(6): 184-193. ISBN 1948-5204
22. Ja Park, M.D., Ph.D., Y. Nancy You, M.D., MHS, Erika Schlette, Sa Nguyen, M.S., John M., Skibber, M.D., Miguel A. Rodriguez-Bigas, M.D., and George J. Chang, M.D., M.S. Reverse-Hybrid Robotic Mesorectal Excision for Rectal Cancer. *Dis Colon Rectum*. 2012 February ; 55(2): 228-233.
23. Baik Sm, Kim Nk, Liu Dr et al. Oncologic Outcomes and Perioperative Clinicopathologic Results after robot-assisted Tumor-specific Mesorectal excision for Rectal Cancer, *Ann Surg Oncolog* 2013.
24. Zeng Dz, Slei Y, Lei X, Tang B, Hao YX, Luo Hx, Lan Yz, Wei Chang Wai. Short-term efficacy of da Vinci robotic surgical

- system on rectal cancer in 101 patients. *Ke Za Zhie* 2013, 16(5):451-4.
25. O. Stănciulea, M. Eftimie, L. David, V. Tomulescu, C. Vasilescu, I. Popescu, Robotic Surgery for Rectal Cancer: A Single Center Experience of 100 Consecutive Cases, *Chirurgia* (2013) 108(2): 143-151
  26. Paolo Pietro Bianchi, Fabrizio Luca, Wanda Petzi, Manuella Vulvo, Sabin Cenciorelle, Maximilian Zucaro, Roberto Biffi. The role of the robotic technique in minimally invasive surgery in rectal cancer. *Ecance rmedical science* 2013.357/ doi:10.3332
  27. Shiomi A, Kingasa Y, Yamaguchi T, Tamiaka H, Kagawa H. Robotic-assisted rectal cancer surgery: short-term outcomes for 113 consecutive patients. *Int J. Colorectal Div.* 2014 sep, 29(9) 1105-11.
  28. Alberto Patriti, MD, PhD, Graziano Ceccarelli, MD, Alberto Bartoli, MD, Alessandro Spaziani, MD, Alessia Biancafarina, MD, Luciano Casciola, MD. Short- and Medium-Term Outcome of Robot-Assisted and Traditional Laparoscopic Rectal Resection, *JLS* (2009)13:176-183
  29. Park JS, Choi GS, Lim KH, Jang YS, Jun SH. Robotic-assisted versus laparoscopic surgery for low rectal cancer: case-matched analysis of short-term outcomes. *Ann Surg Oncol* 2010 ;17:3195-202.
  30. Kwak JM, Kim SH, Kim J, Son DN, Baek SJ, Cho JS. Robotic vs laparoscopic resection of rectal cancer: short-term outcomes of a case control study. *Dis Colon Rectum* 2011;54:151-6.
  31. Kim JY, Kim NK, Lee KY, Hur H, Min BS, Kim JH. A comparative study of voiding and sexual function after total mesorectal excision with autonomic nerve preservation for rectal cancer: laparoscopic versus robotic surgery. *Ann Surg Oncol.* 2012;19(8):2485-93.
  32. Luca F, Cenciarelli S, Valvo M, Pozzi S, Faso FL, Ravizza D, et al. Full robotic left colon and rectal cancer resection: technique and early outcome. *Ann Surg Oncol.* 2009;16(5): 1274-8.