ANALYSIS AND ANTHROPOMETRIC STUDY OF PORT PLACEMENT IN ROBOTIC RECTAL CANCER SURGERY

Ts. Ivanov[1], D. Dimitrov[1], T. Deliyski[1], S. Iliev[2], E. Filipov[2], H. Feradova[1], K. Nedyalkov[2]

[1]Department of surgical oncology, Medical university of Pleven, Bulgaria
[2]Department of suppurative-septic surgery and coloproctology, Medical u niversity of Pleven, Bulgaria

ABSTRACT

Robotic surgery is an innovative, minimally invasive technique, which has already proved its advantages in the operative-technical field by providing ergonomics, three dimensional (3D) visualization of the operative field, more precise dissection in narrow spaces, etc. The additional time needed for docking of the console and collision (internal and external) between the robotic hands is a part of the specific difficulties related to this type of surgery. The aim of this study was to analyze the position of ports and their efficiency in robotic rectal surgery based on our initial experience with this type of surgery in the University Hospital of Pleven- Bulgaria as well as to seek for additional anatomical landmarks to improve the work process. The initial experience with robotic rectal resections for rectal cancer revealed that the recommended distance of 8 cm between the ports doesn't provide sufficient efficacy. Additional topography anatomical landmarks are required for personalized preoperative planning of port positions and enhanced effectiveness of the robotic system in rectal cancer treatment. Further studies in this field are necessary.

Keywords: *robotic rectal cancer surgery, port placement, anthropometrics*

INTRODUCTION

Robotic surgery is an innovative, minimally invasive technique, which has already proved its advantages in the operative-technical field by providing ergonomics, three dimensional (3D) visualization of the operative field, more precise dissection in narrow spaces, etc.[1]. Despite its advantages, some problems have occurred after implementation of the robotic surgery into the practice [2]. The additional time needed for docking of the console and collision (internal and external) between the robotic hands are a part of the specific difficulties related to this type of surgery. These disadvantages are especially common for the robotic rectal surgery, where the experience is still minimal. Various techniques with different port positions on the anterior abdominal wall have been described in the specialized literature about robotic surgery. Most of the authors recommend that the optimal distance between ports should be at least 8 cm, not considering the working depth and the patients' individual body mass index. Finding an optimal and specific port position could be the key to solving some of the main problems and developing a standard technique of robotic surgery [3].

AIM

The aim of this study was to analyze the position of ports and their efficiency in robotic rectal surgery based on our initial experience with this type of surgery in the University Hospital of Pleven- Bulgaria as well as to seek for additional anatomical landmarks to improve the work process.

MATERIALS AND METHODS

Two groups of patients were studied for the aims of the research. Group A included nine

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patients who underwent the first in Bulgaria robot-assisted rectal resections for treatment of rectal cancer. The resections were performed with the robotic systems da Vinci S and da Vinci Si in the University Hospital "Dr G. Stranski" – Pleven, Bulgaria (Fig.1). The port positions, their effectiveness during surgery as well as instrument collisions and performance were critically analyzed.

Group B consisted of 100 randomly selected patients, distributed by age and gender (Fig. 2).

Anthropometric measurement of different anatomical landmarks on the anterior abdominal wall was carried out in this patient group. These were some of the landmarks most often described in the specialized literature, which were used by the authors during their first robotic surgeries. All of the patients were examined with relaxed abdominal wall, some of them were also examined in the conditions of pneumoperitoneum. Overall, 34 anatomical landmarks were studied, 16 of them were measured in different positions because of their tendency to change in conditions of pneumoperitoneum. Thus, data about 64 parameters was obtained and included in the research. The selected data was registered in a special anthropometric protocol, created by the authors. (Fig. 3).

RESULTS

For all the patients in Group A, the surgeries were performed using four-arm robotic systems and five ports – one for the robotic camera, three for the robotic arms, and one 12-mm port for any additional laparoscopic instruments (Fig. 4). In one case reposition of ports 2 and 3 was needed due to insufficiency of the length of the second and third robotic instrument during dissection deep in the pelvis. This was a case of low rectal cancer at 6 cm from the dentate line after neoadjuvant radiotherapy and previous open hysterectomy. After the port reposition, low rectal resection with protective ileostomy was performed. In two other cases serious external collision between the second and fourth robotic arm occurred during the pelvic dissection. In another patient the movement of the fourth robotic arm was limited in cranial, dorsal and lateral direction during the whole surgical procedure (Fig. 5).

The results from the measurement of anatomical landmarks in Group B are presented on figure 6. The distances between individual

Patient	Gender	Location	TNM	Operation	Robotic system	Number of ports
1	M	Distal sigmoid	T3N0M1	RRA	Si	5
2	M	Rectal/10cm from DL	T3N0M1	Hartmann	S	5
3	F	Rectal/10см from DL	T2N0M0	RRA	S	5
4	F	Rectal/11cm from DL	T3N1M0	RRA	S	5
5	F	Rectal/6см from DL	T1N0M0	RRA	S	5
6	M	Rectal/12см from DL	T2N0M0	RRA	S	5
7	M	Recto-sigmoid	T1N0M0	RRA	Si	5
8	M	Rectal/12cm from DL	T3N0M0	RRA	S	5
9	M	Rectal/2см from DL	T3N0M0	APR	Si	5

Legend: DL-dentate line, M-male, F-Female, S – da Vinci S system, Si-da Vinci Si system, RRA - anterior resection of the rectum, APR - abdominoperineal resection of the rectum

Fig. 1 Group A – Robotic-assisted rectal resection for rectal cancer

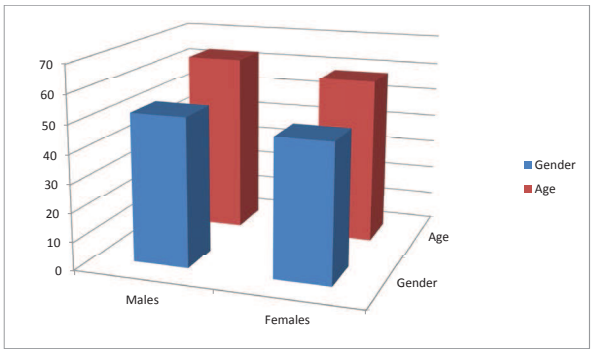

Fig. 2. Distribution of the patients of group B by age and gender

Fig. 3. Anthropometric protocol

Supine patient, hands harvested body		With a flexible line along the contour of the abdominal wall			With a rigid line along the contour of the abdominal wall		
Anthropometric parameters		distended abdomen	Pneumoperitoneum		distended abdomen volitional	Pneumoperitoneum	
			volitional	With gas		volitional	With gas
		1	2	3	4	5	6
1	Xipho---pubic line						
2	Xipho ---umbilical line						
3	Xipho ---central line						
4	Xipho---prominent line						
5	Umbilico---spinal line						
6	Bispinal line						
7	Xiphoid horizontal line						
8	Prominent horizontal line						
9	Central horizontal line						
10	Pubic horizontal line						
11	Umbilical projection						
12	Central projection						
13	Prominent projection						

Legend: The **center** is a point which splits the xipho-umbilical line; **Prominent point** is a point on the xipho-pubic line, which is most standed out most; **Prominent horizontal line** connects two middle axillary line and passes through the prominent; **projection** is a perpendicular line from the couch to the studied point or line;

Anthropometric parameters of single measurements in the supine patient

11. Axillar projection(from the couch to midaxillar line).... **cm**. 12. Xiphoid projection…**cm**. 13. Prubic projection..**.cm**.

14.Sagittal-pararectal line(from the sagittal line to the lateral side of m.rectus in level of the center)**.. cm**

Measurements on the middle axillar line: 15.Xipho---costalo distance**.cm**. 16.Costal-pelvic distance..**cm.** 17.Pelvic-spinal distance.. **cm**. 18.Pubic-spinal distance. **cm**.

Thickness of the subcutaneous tissue:19.Around the umbilicus **cm**. 20.Middle of the upper quadrant…**cm**. 21.Middle of lower quadrant **cm**. 22.Proc.xyphoideus **cm**. 23.Spina iliaca ant.sup **cm**. 24.Pubis…**cm**.

Anthropometric parameters in patient upright, hands on hips

25. Sagittal- midclavicular line……см. 26.Sagittal-mammilar line……см.

Anthropometric parameters for open surgery or autopsy

27. arterio---prominent line(a.mes.inf.)……..см. 28. venal---prominent line……..см. 29. central---prominent line(middle of the xipho-pubic line).....см.

General parameters: 30. Gender……31. Age……..years old.32. Weight…..…kg. 33. Height……cm.
34. BMI……

General information:35.Name……..36.Disiease……
37. Operation……

Date:……

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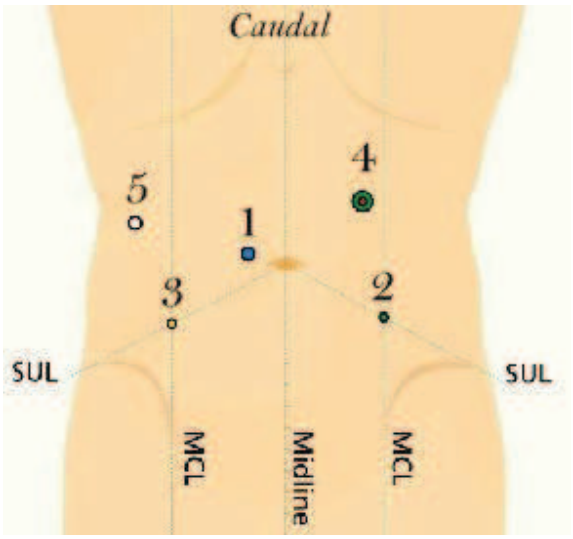

Legend: **1**- 12mm port for the robotic camera; **2**- 8mm port for the first robotic arm; **3**- 8mm port for the second robotic arm; **4**- 8mm port for the third robotic arm; **5**- 12mm assistance port

Fig. 4. Number and position of the ports in the patients with robotic rectal resection

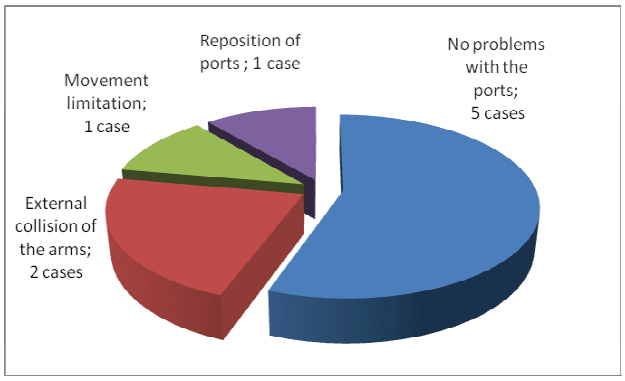

Fig. 5. Intraoperative difficulties related to the port positions and robotic arms during robotic rectal resection

points, lines and projections are described in centimeters. The average distance from the xiphoid process of the sternum to the pubis on relaxed abdominal wall is 33 cm, while in conditions of pneumoperitoneum it reaches up to 47 cm. In the present study the middle axillary line was fixed as the most lateral border of the abdominal wall. The central horizontal line which marks the distance between the two most lateral borders of the abdominal wall and divides the xipho-pubic line into two equal parts is 59 cm on relaxed abdomen, and 83cm - with pneumoperitoneum. The bispinal line, average 30 cm in conditions of relaxed abdomen, increases its length with 5 cm on the average in condition of pneumoperitoneum. The results show that the horizontal line is average 80 % longer than the xiphopubic line. In addition, the anterior abdominal wall increases its parameters with 40% average in conditions of pneumoperitoneum.

DISCUSSION

Robotic rectal surgery has been introduced into the practice in order to overcome the limitations of traditional laparoscopy [4]. The greatest advantage of this type of surgery is the more precise dissection in narrow spaces, which is essential in rectal surgery for malignant diseases [5-6]. Despite the obvious advantages, the experience with robotic surgery in the treatment of rectal cancer is still at an initial phase. This makes it especially difficult for surgical teams at the beginning of their learning curve [7].

During the port placement in all nine cases of robotic rectal resections, the authors followed the recommendations for a distance more than 8 cm between the ports. Despite this, in 4 of the cases technical difficulties related to the port positions and the freedom of instrument movement occurred. In one of the cases, the length of the robotic instruments turned out insufficient for dissection deep in the pelvis.

When the abdominal wall was studied in conditions of pneumoperitoneum, those of the investigated landmarks, which were based on bone structures, did not change their position compared to relaxed abdomen.

Fig. 6. Average distances between some of the investigated landmarks in centimeters (cm)

Anthropometric parameters (cm)		*Relaxed abdomen*	*Distended abdomen (pneumoperitoneum)*
1	*Xipho---pubic line*	*33*	*47*
2	*Xipho ---umbilical line*	*18*	*28*
3	*Xipho ---central line*	*16.5*	*23.5*
4	*Xipho---prominent line*	*19*	*29*
5	*Spino-umbilical line*	*16*	*23*
6	*Bispinal line*	*30*	*35*
7	*Xiphoid horizontal line*	*54*	*76*
8	*Prominent horizontal line*	*59*	*83*
9	*Central horizontal line*	*59*	*42*
10	*Pubic horizontal line*	*59.4*	*84.6*
11	*Umbilical projection*	*26*	*62*
12	*Central projection*	*26*	*62*
13	*Prominent projection*	*27*	*63*

Legend: The **center** is a point which splits the xipho-umbilical line; **a prominent point** is a point on the xipho-pubic line, which stands out the most; **a prominent horizontal line** connects the two middle axillary lines and passes through the prominent point; **a projection** is a perpendicular line from the couch to the studied point or line

Preoperative planning and assessment of the anatomy are the milestone of success in robotic surgery and special attention is paid to the anatomical landmarks of the anterior abdominal wall [8]. Based on the anthropometric data, the port positions and the distance between them can be personalized during the preoperative planning. More accurate preoperative planning can be achieved by additional anthropometric study of computer tomography data of the patient with evaluation of subcutaneous and perivisceral fat tissue distribution [9]. As a result, individual preoperative planning of the port positions can lead to optimization of the surgical process and shorten the total operative time in favor of the patient.

CONCLUSION

The initial experience with robotic rectal resections for rectal cancer revealed that the recommended distance of 8 cm between the ports doesn't provide sufficient efficacy. Additional topographo-anatomical landmarks are required for personalized preoperative planning of port positions and enhanced effectiveness of the robotic system in rectal cancer treatment. Further studies in this field are necessary.

REFERENCES

1. Lanfranco, Anthony R., et al. „Robotic surgery: a current perspective." Annals of surgery 239.1 (2004): 14.
2. Feldmann, Timothy F., Raul M. Bosio, and Alessio Pigazzi. „Hybrid Robotic Technique for Rectal Cancer: Low Anterior Resection and Perineal Resection."Robotic Surgery. Springer Milan, 2015. 147-158.
3. Baik, Seung Hyuk, et al. „Robotic total mesorectal excision for the treatment of rectal cancer." Journal of robotic surgery 1.1 (2007): 99-102.

4. Zimmern, Andrea, et al. „Robotic colon and rectal surgery: a series of 131 cases.“ World journal of surgery 34.8 (2010): 1954-1958.

5. Scarpinata, Rosaria, and Emad H. Aly. „Does robotic rectal cancer surgery offer improved early postoperative outcomes?.“ Diseases of the Colon & Rectum 56.2 (2013): 253-262.

6. Baik, Seung Hyuk, et al. „Robotic versus laparoscopic low anterior resection of rectal cancer: short-term outcome of a prospective comparative study.“ Annals of surgical oncology 16.6 (2009): 1480-1487.

7. Park, Yoon Ah, et al. „Totally robotic surgery for rectal cancer: from splenic flexure to pelvic floor in one setup.“ Surgical endoscopy 24.3 (2010): 715-720.

8. Ritch, Chad R., and Ketan K. Badani. „Port placement in robotic urologic surgery.“ Robotics in Genitourinary Surgery. Springer London, 2011. 37-49.

9. Malietzis, G., et al. „The role of body composition evaluation by computerized tomography in determining colorectal cancer treatment outcomes: A systematic review.“ European Journal of Surgical Oncology (EJSO) 41.2 (2015): 186-196.

10. Thibault, Ronan, and Claude Pichard. „The evaluation of body composition: a useful tool for clinical practice.“ Annals of Nutrition and Metabolism 60.1 (2012): 6-16.

11. 11. Bianchi, P. P., et al. „Robotic versus laparoscopic total mesorectal excision for rectal cancer: a comparative analysis of oncological safety and short-term outcomes.“ Surgical endoscopy 24.11 (2010): 2888-2894.

12. Doyle, Suzanne L., et al. „Establishing computed tomography–defined visceral fat area thresholds for use in obesity-related cancer research.“ Nutrition Research 33.3 (2013): 171-179.