



CORRELATION BETWEEN THE LEVEL OF COLORECTAL ANASTOMOSIS AND ANORECTAL FUNCTION

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SUMMARY – Anterior rectal resection is a standard surgical procedure for treating carcinomas of rectum and distal sigmoid colon. In many cases of anterior rectal resection, postoperatively some level of fecal incontinence may occur. The aim of our study was to evaluate the impact of the colorectal anastomosis level on anorectal functional disorder. In our prospective study, the participants were patients diagnosed with carcinoma of rectum or distal sigmoid colon. All patients underwent standard open or laparoscopic anterior rectal resection. Six months after the surgery, the function of anorectum was evaluated in all participants. Finally, 38 patients were analyzed, including 13/38 (34.2%) patients with high rectal anastomosis, 11/38 (28.9%) with mid rectal anastomosis and 14/38 (36.8%) with low rectal anastomosis. Patients with a lower level of anastomosis had a statistically significantly greater number of stools, higher urgency and discrimination impairment, more pronounced solid, liquid and gas incontinence, and greater need for diapers ($p < 0.05$ all). Therefore, patients with lower anastomosis had a statistically significant impairment of their quality of life and higher Wexner score ($p < 0.001$ for both analyses). Our study results suggested reduced neorectal capacity to be the main pathophysiological factor for the development of postoperative anorectal function impairment.

Key words: *Anterior resection; Rectal cancer; Wexner incontinence score; Anorectal function*

Introduction

Colorectal carcinoma is the third most common malignant tumor in men and second most common in women¹⁻⁴. One third of all colorectal carcinomas are located in the rectum^{5,6}. Anterior rectal resection is a standard surgical procedure for treating carcinomas of the rectum and distal sigmoid colon. It includes resection of part of or the whole rectum and part of the

sigmoid colon while establishing intestinal continuity by creating colorectal or coloanal anastomosis.

Ever since the 4th decade of the last century, when Claude Dixon described and popularized this operation, complications such as postoperative incontinence have been observed⁷. In the early 1990s, new surgical-oncologic consensus was brought about a safe distal resection margin on the rectum of only 1 cm compared to the previous 5-cm margin. This greatly increased the rate of rectal cancers treated by anterior resection⁸. Many carcinomas of the middle and distal third of the rectum, which previously would have been treated with a much more radical operation such as abdominoperineal rectal amputation, then began being treated

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with low anterior resection. All of that led to actualization of the postoperative anorectal dysfunction problems. In fact, the problem became so common that a new term, "anterior resection syndrome", was introduced in medical literature⁹.

Anterior resection syndrome includes the following:

- fecal incontinence (measured by various scoring systems, of which one of the most commonly used is Wexner incontinence score)¹⁰;
- urgency (inability to postpone defecation for longer than 15 minutes after the first sense of urge);
- stool discrimination disorder (inability to recognize the type of stool before defecation); and
- increased number of daily stools (frequency).

The pathophysiological mechanism of anorectal dysfunction after anterior rectal resection is still not completely clear. Decreased capacity of the neorectum, damage to anorectal innervation during rectal dissection and mechanical lesion of the anal sphincter are considered as the most probable causes¹¹⁻¹⁴.

According to the location of colorectal anastomosis, anterior rectal resections are divided into low and high resections. However, exact distinction between these two groups is not clearly defined. Still, among surgeons, resections where anastomosis is created on the extraperitoneal part of the rectum are commonly referred to as low anterior resections.

The length of the rectum varies individually from 15 to 20 cm. Surgical rectum is considered to begin distally on the upper border of the puborectal muscle with gradual transitions to the sigmoid colon containing haustra coli and epiploic appendices. It is common among surgeons and anatomists to divide the rectum into three parts according to the absolute distance from the anal verge (<7 cm, 7-12 cm and >12 cm) or according to the relationship with the peritoneum (peritoneal reflection)¹⁵. Parietal peritoneum approaches different sides of the rectal wall at different levels. Looking from distally to proximally, the peritoneum first approaches the rectum on the anterior wall and after that it approaches on the lateral walls and the posterior wall. Taking that into account, the extraperitoneal part of the rectum is considered to be distal third of the rectum (part of the rectum below the rectovesical/rectouterine excavation), the retroperitoneal part of the rectum is middle third (only the anterior side of the rectum is covered with peritoneum), and

the intraperitoneal part of the rectum is considered to be proximal third of the rectum (anterior and both lateral walls of the rectum are covered with peritoneum)¹⁶⁻²⁰.

The level of colorectal anastomosis depends on tumor location. Respecting the current surgical oncologic standards, patients with carcinomas of the middle or lower third of the rectum should be treated with low anterior resection including total mesorectal excision (TME), assuring a macroscopically clear distal margin of at least 1 cm. Patients with carcinomas of the distal sigmoid colon or proximal third of the rectum can be treated with high anterior resection and partial mesorectal excision (PME), but they require a distal resection margin of at least 5 cm from the lower end of the tumor²¹⁻²⁴.

When searching medical literature, clear worsening of anorectal function with decrease in the colorectal anastomosis level in the low anterior rectal resections is observed. On the other hand, results of studies with high resections are scarce and have varying results²⁵⁻²⁹.

The aim of our study was to evaluate the impact of the colorectal anastomosis level on anorectal functional disorder.

Patients and Methods

We conducted this prospective study in patients hospitalized at Department of Surgery, Sveti Duh University Hospital, in whom anterior rectal resection was indicated due to colonoscopically and histologically diagnosed carcinoma of the rectum or distal sigmoid colon in the period between January 2016 and December 2017. Preoperatively, fecal continence status was evaluated in all patients using Wexner incontinence score. Patients with pre-existing fecal continence disorder (Wexner score >0) were not included in this study. Also, patients with prior rectal surgeries, dementia or other psychiatric disorders that would prevent the patient from answering the questionnaires were not candidates for our study. Exclusion criteria included major postoperative complications (e.g., anastomosis dehiscence, postoperative abscess or hemorrhage), loss to follow up or death within six months of operation.

All patients underwent a standard open or laparoscopic anterior rectal resection procedure in respect to all of the above-mentioned oncologic principles in-

Table 1. List of participants and their parameters

Patient no.	Level of colorectal anastomosis	Number of daily stools	Urgency	Fecal discrimination disorder	Incontinence for: (0-4)*			Need for pads (0-4)	QOL impairment† (0-4)	Wexner score‡ (0-20)
					Solid stool	Liquid stool	Gas			
1	Low anastomosis	5	Yes	Yes	0	1	0	1	2	4
2		5	Yes	Yes	2	2	2	2	3	11
3		4	Yes	Yes	1	2	2	1	3	9
4		2	No	Yes	0	1	2	0	3	6
5		3	Yes	Yes	1	2	2	0	2	7
6		2	No	No	0	0	3	0	2	5
7		1	No	No	0	0	0	0	0	0
8		6	Yes	Yes	2	3	3	3	4	15
9		3	No	No	0	0	1	0	1	2
10		3	Yes	Yes	2	2	2	0	1	7
11		4	Yes	No	0	1	2	0	2	5
12		3	Yes	No	0	1	1	0	2	4
13		2	No	No	0	0	1	0	1	2
14		1	No	No	0	0	0	0	0	0
15	Mid anastomosis	4	Yes	Yes	3	2	2	1	3	11
16		2	Yes	Yes	0	0	0	0	1	1
17		3	No	No	0	1	1	1	1	4
18		1	No	No	0	0	0	0	0	0
19		3	Yes	No	0	1	1	0	1	3
20		2	No	No	0	0	0	0	0	0
21		1	No	No	0	0	0	0	0	0
22		1	No	No	0	0	0	0	0	0
23		2	No	Yes	0	0	1	0	2	3
24		2	No	No	0	0	0	0	0	0
25		1	No	No	0	0	0	0	0	0
26	High anastomosis	1	No	No	0	0	0	0	0	0
27		2.5	No	No	0	0	0	0	1	1
28		1	No	No	0	0	0	0	0	0
29		0.5	No	No	0	0	0	0	0	0
30		0.5	No	No	0	0	0	0	1	1
31		1	No	No	0	0	0	0	0	0
32		1	No	No	0	0	0	0	0	0
33		1	No	No	0	0	0	0	0	0
34		1	Yes	No	0	0	0	0	1	1
35		1	No	No	0	0	0	0	0	0
36		1	No	No	0	0	0	0	0	0
37		2	No	No	0	0	0	0	0	0
38	1	No	No	0	0	0	0	0	0	

*Incontinence: 0 - never; 1 - rarely (<1/month); 2 - sometimes (<1/week, ≥1/month); 3 - usually (<1/daily, ≥1/week); 4 - always (≥1/daily); QOL = quality of life; †QOL impairment: 0 - not at all; 1 - little; 2 - moderate; 3 - quite; 4 - a lot; ‡Wexner score = sum of scores of incontinence, need for pads and QOL impairment; range 0-20; 0 - perfect continence; 20 - total incontinence

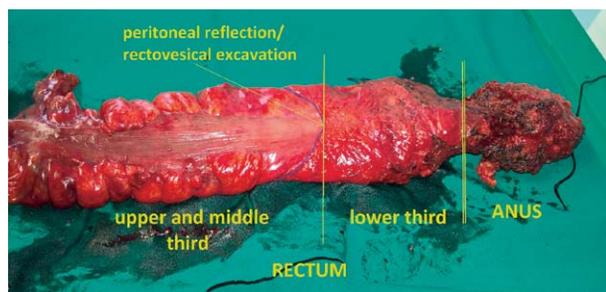


Fig. 1. Rectal specimen after total mesorectal excision – anterior view.

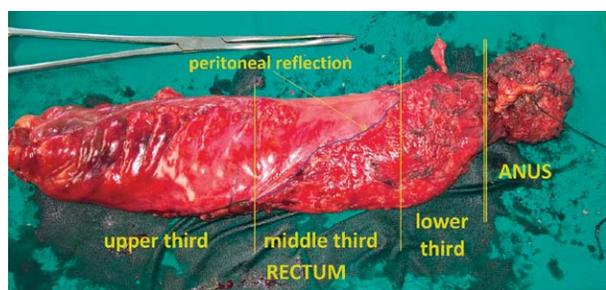


Fig. 2. Rectal specimen after total mesorectal excision – lateral view.

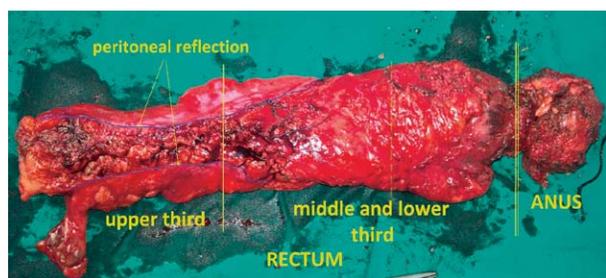


Fig. 3. Rectal specimen after total mesorectal excision – posterior view.

cluding ligation of the inferior mesenteric artery with or without preservation of the left colic artery. The splenic flexure was only mobilized when necessary. All colorectal anastomoses were created in end to end fashion using a circular mechanical stapler number.

Six months after surgery, the function of the anorectum was evaluated in all participants. The existence and severity of anterior resection syndrome was examined using a questionnaire that contained Wexner incontinence score and questions about the number of daily stools, urgency and discrimination. Wexner score takes into account five parameters that are scored on a scale from 0 to 4: incontinence for solid and liquid

stool, incontinence for gas, urgency, discrimination disorder, the need to wear pads and quality of life impairment (Table 1). Final score ranges from 0 to 20, where 0 indicates perfect continence and 20 indicates total fecal incontinence.

In order to evaluate the impact of anastomosis level on anorectal functional disorder, we divided our patients into three groups according to their intraoperative finding of the colorectal anastomosis location, as follows: 1) high rectal anastomosis: colorectal anastomosis is located on the proximal third of the rectum (intraperitoneal part of the rectum, anterior and both lateral sides are covered with peritoneum) (Figs. 1-3); 2) mid rectal anastomosis: colorectal anastomosis is located on the middle third of the rectum (retroperitoneal part of the rectum, only anterior side of the rectum is covered with peritoneum) (Figs. 1-3); and 3) low rectal anastomosis: colorectal/coloanal anastomosis is located on the distal third of the rectum (extraperitoneal part of the rectum, below rectovesical/rectouterine excavation) (Figs. 1-3)

Ethics

The study was approved by the Sveti Duh University Hospital Ethics Committee. All patients included in the study provided their informed consent prior to inclusion. All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional research committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Statistics

Relevant data collection was followed by data processing using appropriate statistical methods. Normality of numerical variable distribution was tested by Shapiro-Wilk test. Numerical variables with normal distribution were expressed as arithmetic mean \pm standard deviation (SD) and compared among the groups using one-way analysis of variance (ANOVA). Non-normally distributed variables were expressed as median and interquartile range (IQR) and compared among the groups by use of Kruskal Wallis ANOVA. Categorical variables were expressed as ratio and percentage and compared between the groups using χ^2 -test. The increasing or decreasing trends in study parameters relative to the level of resection were tested

Table 2. Characteristics of patients stratified according to the level of anastomosis

	All patients	High anastomosis	Mid anastomosis	Low anastomosis	p for difference†	p for trend‡
Number of participants	38	13/38 (34.2%)	11/38 (28.9%)	14/38 (36.8%)	-	-
Age (years)	67±8.9	68.2±10	69.6±8.6	63.9±7.8	0.237	0.305
Male	25/38 (65.8%)	10/13 (76.9%)	6/11 (54.5%)	9/14 (64.3%)	0.510	0.501
Number of stools	2 IQR (1-3)	1 IQR (1-1)	2 IQR (1-2.5)	3 IQR (2-4)	<0.001*	<0.001*
Urgency	12/38 (31.6%)	1/13 (7.7%)	3/11 (27.3%)	8/14 (57.1%)	0.021*	0.006*
Discrimination disorder	10/38 (26.3%)	0/13 (0%)	3/11 (27.3%)	7/14 (50%)	0.013*	0.003*
Solid incontinence	0 IQR (0-0)	0 IQR (0-0)	0 IQR (0-0)	0 IQR (0-1)	0.044*	0.012*
Liquid incontinence	0 IQR (0-1)	0 IQR (0-0)	0 IQR (0-0.5)	1 IQR (0-2)	0.002*	<0.001*
Gas incontinence	0 IQR (0-1)	0 IQR (0-0)	0 IQR (0-1)	2 IQR (1-2)	<0.001*	<0.001*
Need for pads	0 IQR (0-0)	0 IQR (0-0)	0 IQR (0-0)	0 IQR (0-0.75)	0.120	0.039*
QOL impairment	1 IQR (0-2)	0 IQR (0-0)	0 IQR (0-1)	0 IQR (1-2.75)	<0.001*	<0.001*
Wexner score	1 IQR (0-4)	0 IQR (0-0)	0 IQR (0-3)	5 IQR (2.5-7)	<0.001*	<0.001*

*statistically significant at $p < 0.05$; QOL = quality of life; †comparison if there is a statistically significant difference of tested parameters among different levels of anastomosis. One-way ANOVA/ χ^2 test/Kruskal Wallis ANOVA tests were used; ‡comparison if there is trend of increase or decrease of tested parameter with higher anastomosis level. Spearman correlation and χ^2 -test for trend were used.

by use of Spearman correlation and χ^2 -test for trend. The level of statistical significance was set at $p < 0.05$. Statistical analysis was performed by use of the MedCalc statistical software (MedCalc, Ostend, Belgium).

Results

Between January 2016 and December 2017, a total of 43 patients were registered for participation in the trial. During the study, five patients were excluded; three patients were lost during follow up or rejected participation in the study, one patient died during follow up, and one patient suffered from colorectal anastomosis dehiscence. Finally, 38 patients were analyzed, including 13/38 (34.2%) patients with high rectal anastomosis, 11/38 (28.9%) with mid rectal anastomosis and 14/38 (36.8%) with low rectal anastomosis. Patient data are shown in Table 1 and characteristics of patients stratified according to the level of anastomosis in Table 2.

The mean patient age was 67±8.9 years, with male predominance (25/38; 65%). Patients with different levels of colorectal anastomosis were matched for age and sex. Patients with a lower level of anastomosis had

a statistically significantly greater number of stools, higher urgency and discrimination impairment, more pronounced solid, liquid and gas incontinence, and greater need for diapers ($p < 0.05$ all). Therefore, patients with lower anastomosis had a statistically significant impairment of their quality of life and higher Wexner score ($p < 0.001$ for both analyses) (Fig. 4).

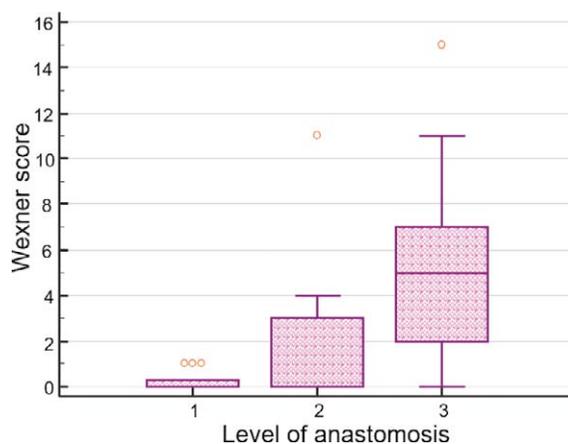


Fig. 4. Wexner score was statistically significantly different among 3 different levels of colorectal anastomosis (1 - high anastomosis; 2 - mid anastomosis; 3 - low anastomosis).

Discussion

Analysis of study results revealed worsening of anorectum functioning in all parameters of the anterior resection syndrome with decrease in the anastomosis distance from the anal verge. Thus, almost all patients with anastomosis in the lower third of the rectum (12/14) suffered from some form of fecal incontinence. In contrast, all patients with anastomosis in the proximal third of the rectum had nearly normal continence, and only three patients reported slightly impaired quality of life.

In the group of patients with anastomosis in the middle third of the rectum, results varied from normal to markedly impaired continence. Yet, taken together, their characteristics were more similar to those recorded in the group with high anastomosis. More than half of the patients with mid-third anastomosis had normal continence (6/11), while continence impairment was less pronounced in the remaining five patients when compared to the group with low anastomosis.

Our study results suggested reduced neorectal compliance to be the main pathophysiological factor for the development of postoperative anorectal function impairment. The lower rectum wall is known to be specifically capable of adapting by stretching to the increased intraluminal fecal volume, with consequential intrarectal pressure decrease, thus enabling temporary defecation delay. In our patients with anastomosis on the distal and middle third of the rectum, the distal half of the rectum had been completely or partially removed, resulting in urgency and fecal incontinence occurring more frequently in these patients. Accordingly, our study indicated saving the lower half of the rectum to be the key factor for preserving fecal continence.

Anal sphincter provides the mechanism that is indispensable for fecal continence. The question is whether and to what extent anal sphincter suffers damage during rectum resection. Currently, ever lower anastomoses with resection within internal sphincter in the form of partial or even total intersphincteric resection have been created. In case of correct indication and considering histologic type of the tumor and depth of invasion, it has been demonstrated that oncologic principles are not compromised with such ultra-low rectum resections. This very fact encourages surgeons to perform these procedures. However, fecal continence is frequently seriously impaired in these

patients. The surgeons unwilling to perform these procedures refer to these anastomoses as perineal stomata. On the other hand, many patients will prefer impaired continence with preserved natural position of the anus to colostomy. That is why it is crucial to talk to the patient preoperatively and warn them of all the potential complications, and then decide on the type of the procedure accordingly.

Besides preserving anatomical integrity, normal anal sphincter function also depends on preserving its innervation. Anal sphincter is controlled by the somatic and autonomic nervous systems *via* pudendal and hypogastric nerves. Hypogastric nerves are most susceptible to injury at two sites, i.e. during preparation at high ligation of the inferior mesenteric artery and on their passing across the sacral promontory to the presacral space.

Intersphincteric resection was not performed in our patients and they all had anatomical integrity of anal sphincter preserved, thus the possible anal sphincter dysfunction could have only been caused by innervation injury.

The extent to which fecal incontinence in our patients with low anastomoses was caused by reduced neorectum compliance or by possible nerve injury could not be defined with certainty. Additional manometric measurements of the anorectum postoperative function would certainly help resolve the issue. However, considering all the facts presented above, along with due intraoperative caution exercised to preserve the nerves, we still believe that reduced neorectum compliance was the main cause of fecal incontinence in our patients.

The ability to recognize the type of stool before defecation (stool discrimination) is of utmost importance for the quality of life. This ability is regulated by communication between the lower segment of the rectum and anus *via* intramural plexus. The increasing stool volume in the rectum with consequential rise in the intrarectal pressure leads to short-term relaxation of the upper part of internal anal sphincter innervated by the autonomic nervous system. This mechanism known as rectoanal inhibitory reflex (RAIR) ensures brief contact of the rectum content with the upper anus mucosa that contains sensory nerve endings ('sampling'), thus identifying the stool type. In our patients, the rate of stool discrimination impairment increased with lowering the level of anastomosis (0%,

27% and 50% for high, middle and low anastomosis, respectively). Therefore, we are inclined to believe that the lower the resection line on the rectum, the higher is the risk of cutting the intramural nerve fibers responsible for RAIR function.

The rectal resection line can be preoperatively estimated from colonoscopy finding of tumor distance from the anocutaneous border, and thus at least in part predict the risk of postoperative incontinence. According to our study, there is no risk of continence impairment in patients with tumors of the sigmoid and rectosigmoid junction scheduled to undergo high anterior resection with anastomosis in the proximal third of the rectum. On the other hand, in patients with tumors on the middle and distal third of the rectum scheduled for low anastomosis in the extraperitoneal segment of the rectum, some degree of fecal incontinence can be predicted with high probability.

Conclusion

Owing to advances in surgical technique and oncologic chemoradiotherapy, rectal cancers can currently be treated very successfully³⁰. That is why the postoperative quality of life rather than just cure of the malignant disease has been increasingly considered by both the surgeons and patients. Unfortunately, there is no method yet to prevent postoperative continence impairment in patients with low anterior resection. Attempts at creating a J colonic pouch and other pouch modifications (e.g., transverse colectomy pouch) failed to prove successful³¹⁻³³.

For the time being, there is no alternative for the surgeon but to approach the patients with rectal tumors with due responsibility, which implies careful structure preparation and searching for appropriate total mesorectal excision plane with preservation of innervation, as for now it is the only way to minimize the risk of continence impairment.

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Sažetak

KORELACIJA IZMEĐU RAZINE KOLOREKTALNE ANASTOMOZE
I FUNKCIJE ANOREKTUMA

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Anteriorna resekcija rektuma je standardni operacijski zahvat kod liječenja karcinoma rektuma i distalnog dijela sigmoidealnog kolona. U mnogim slučajevima anteriorne resekcije poslijeoperacijski se pojavljuje određena razina fekalne inkontinencije. Cilj naše studije bio je istražiti utjecaj visine kolorektalne anastomoze na funkcijski poremećaj anorektuma. Svi ispitanici su podvrgnuti standardnoj otvorenoj ili laparoskopskoj anteriornoj resekciji. Šest mjeseci nakon operacije funkcija anorektuma je evaluirana. Ukupno je analizirano 38 bolesnika, tj. 13/38 (34,2%) s visokom kolorektalnom anastomozom, 11/38 (28,9%) sa srednjom kolorektalnom anastomozom i 14/38 (36,8%) s niskom kolorektalnom anastomozom. Bolesnici s niže postavljenom anastomozom imali su statistički značajno veći broj stolica, češće su imali urgenciju i poremećaj diskriminacije, kao i jače izraženu krutu, tekuću i inkontinenciju plinova, češće su trebali pelene ($p < 0,05$ za sve navedene analize). Sukladno tome, bolesnici s niže postavljenom anastomozom imali su statistički značajno jače narušenu kvalitetu života i viši Wexnerov zbir ($p < 0,001$ za obje analize). Mišljenja smo da je smanjeni kapacitet neorektuma glavni patofiziološki čimbenik za razvoj poslijeoperacijskog funkcijskog poremećaja anorektuma.

Ključne riječi: *Anteriorna resekcija; Karcinom rektuma; Wexnerov bodovni sustav; Funkcija anorektuma*