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REVIEW

LOW ANTERIOR RESECTION SYNDROME AND METHODS OF ITS ASSESSMENT (LITERATURE REVIEW)

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ABSTRACT

Low anterior resection syndrome is a common problem due to the increased incidence of rectal cancer and the high incidence of anorectal dysfunction during sphincter-preserving surgical interventions. The influence of functional disorders on the quality of life of patients and changes in social adaptation makes it possible to attribute the syndrome of low anterior resection to topical and discussed issues.

Purpose of the study: to consider the features of the development of anorectal dysfunction in patients with rectal cancer by studying risk factors and pathogenetic aspects of the development of low anterior resection syndrome, as well as to evaluate the role of objective studies in assessing the syndrome according to published literature.

The etiology of low anterior resection syndrome is multifactorial. Unmodified and modified predictors are distinguished among the risk factors. Unmodified factors include female gender and age over 65 years. Among the modifiable predictors, radiation therapy, surgical intervention, the type of formed colorectal anastomosis and the development of its insolvency, as well as the elimination of intestinal stoma have a negative effect on anorectal function. Nevertheless, the greatest role in its development is played by organ-preserving surgery with total mesorecumectomy, radiation therapy and the formation of a preventive ileostomy. The complexity of the pathophysiological mechanism of the syndrome necessitates a detailed study of anorectal function and changes in its parameters in patients during treatment for rectal cancer. Functional disorders in low anterior resection syndrome vary in severity. In the study of the severity of clinical manifestations of the syndrome, the use of the LARS scale is important, and in the development of anal incontinence, the use of the Wexner scale is important. However, the most accurate assessment can be carried out by objective research methods, such as high-resolution anorectal manometry. This research method allows to control the function of the rectal obturator apparatus at different stages of combined treatment and unwraps the possibility of searching for new predictors of low anterior resection syndrome.

Keywords: colorectal cancer, low anterior rectal resection syndrome, high-resolution anorectal manometry

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ОБЗОР

СИНДРОМ НИЗКОЙ ПЕРЕДНЕЙ РЕЗЕКЦИИ И МЕТОДЫ ЕГО ОЦЕНКИ (ОБЗОР ЛИТЕРАТУРЫ)

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РЕЗЮМЕ

Синдром низкой передней резекции является распространенной проблемой в связи с повышенной заболеваемостью раком прямой кишки и высокой частотой развития аноректальной дисфункции при сфинктеросохраняющих оперативных вмешательствах. Влияние функциональных расстройств на качество жизни пациентов и изменение социальной адаптации позволяет отнести синдром низкой передней резекции к актуальным и обсуждаемым вопросам.
Цель исследования: рассмотреть особенности развития аноректальной дисфункции у больных раком прямой кишки путем изучения факторов риска и патогенетических аспектов развития синдрома низкой передней резекции, а также оценить роль объективных исследований в оценке синдрома по данным опубликованной литературы.
Этиология синдрома низкой передней резекции многофакторна. Среди факторов риска выделяют немодифицированные и модифицированные предикторы. К немодифицируемым факторам относят женский пол и возраст старше 65 лет. Среди модифицируемых предикторов отрицательное влияние на аноректальную функцию оказывает проведение лучевой терапии, оперативного вмешательства, тип сформированного колоректального анастомоза и развитие его несостоятельности, а также выведение кишечной стомы. Тем не менее наибольшую роль в его развитии играют органосохраняющее оперативное вмешательство с тотальной мезоректумэктомией, проведение лучевой терапии и формирование превентивной илеостомы. Сложность патофизиологического механизма синдрома обусловливает необходимость детального изучения аноректальной функции и изменения ее параметров у пациентов в процессе лечения по поводу рака прямой кишки. Функциональные расстройства при синдроме низкой передней резекции варьируются по степени тяжести. В изучении выраженности клинических проявлений синдрома имеет значение использование шкалы LARS, а при развитии анальной инконтиненции – применение шкалы Wexner. Однако наиболее точную оценку позволяют осуществить объективные методы исследования, такие как аноректальная манометрия высокого разрешения. Данный метод исследования позволяет контролировать функцию запирательного аппарата прямой кишки на разных этапах комбинированного лечения и открывает возможности поиска новых предикторов синдрома низкой передней резекции.

Ключевые слова: колоректальный рак, синдром низкой передней резекции прямой кишки, аноректальная манометрия высокого разрешения

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INTRODUCTION

The functional consequences associated with the formation of a low colorectal anal anastomosis have an adverse effect on the quality of life of patients who underwent this intervention [1; 2]. The change in anorectal function can manifest itself in the form of an increase in imperative urges to defecate and stool frequency (up to 6 times a day or more), sensitivity disorders and associated evacuation disorders, feelings of incomplete emptying, the development of anal incontinence. The described symptom complex is called low anterior resection syndrome (LARS) [3; 4]. Manifestations of this syndrome are observed in 41–90 % of patients after low anterior resection [5–8]. The wide variability in the prevalence of LARS in different studies reflects inconsistencies in its assessment and diagnosis [5].

The problem of anorectal dysfunction remains relevant at the present time, since LARS affects the quality of life of patients and changes social adaptation. The study of risk factors for possible functional disorders can help in predicting LARS, improving methods of its prevention and correction.

The purpose of the study: to consider the features of the development of anorectal dysfunction in patients with rectal cancer by studying risk factors and pathogenetic aspects of low anterior resection syndrome, as well as to evaluate the role of objective studies in assessing this syndrome according to published literature.

MATERIALS AND METHODS

A systematic search of literary sources in databases was carried out elibrary.ru, PubMed using keywords: "low anterior resection syndrome", "anorectal dysfunction", "rectal cancer", "total mesorectumectomy", "LARS score". The papers devoted to the study of risk factors for the development of LARS and research methods that allow assessing the severity of anorectal dysfunction in patients undergoing combined treatment for rectal cancer were considered. Publications devoted to the occurrence of LARS in other nosologies were excluded. The selected articles have been published over the past 5 years in Russian and English.

An initial search revealed 105 articles. At the next stage of the search, literature reviews and non-original articles were excluded, as a result of which 38 original studies were analyzed.

RESULTS

The incidence of LARS in patients treated for rectal cancer varies widely, and the manifestations of anorectal dysfunction are diverse and variable [1; 5–8]. In most modern studies, LARS is observed on average in 64.8 % of cases, while more than half of patients develop a pronounced clinical picture [8]. In a study by Bao-Jia Luo et al. (2021), 27 % of patients had a stool frequency of more than 5 times a day, and 30 % of patients had imperative urges associated with a change in the evacuation function of the sphincter apparatus [9]. At the same time, the duration of functional disorders can be short-term and last for 6–12 months or long-term with the preservation of symptoms for more than 1 year [10; 11]. In Bryant C. L. et al. up to 71 % of the observed patients noted incontinence of intestinal contents, and 12–74 % of patients reported violations of evacuation [12]. There is also evidence that a violation of rectal sensitivity, manifested in a deterioration in the recognition of gases and intestinal contents, is more common than incontinence, and affects the quality of life of patients to a greater extent [13].

From the point of view of normal physiology, the functioning of the anorectal region is a delicate balance between the level of pressure in the rectum and the tone of the anal sphincters. Defecation is carried out with coordinated contraction of the pelvic floor and anterior abdominal wall muscles and relaxation of the external anal sphincter and puborectal muscle in response to increased rectal pressure [3; 8; 14] Somatic innervation of the external sphincter and puborectal muscle is carried out by sexual nerves, and pelvic floor muscles – by motor and sensory nerves of segments S3–5. Vegetative innervation of the rectum and the internal anal sphincter is provided by the lower submandibular and pelvic plexuses. The nerves run anterolateral to the rectum between the posterolateral border of the prostate gland or vagina and the lower medial part of the muscle that raises the anus, reaching the anorectal junction [15].

One of the main components of the evacuation function is the rectoanal inhibitory reflex (RAIR), coordinated by neuroregulation of intramural plexuses [16]. The reflex participates in the recognition and retention of intestinal contents due to changes in the rectoanal pressure gradient [17]. Physiologically, the mechanism is a reflex relaxation of the internal anal

sphincter after stretching the walls of the rectum and contraction of the external sphincter, which makes it possible to contact the sensitive transition zone with intestinal contents and differentiate its quality: decorated or liquid stools, gases [16].

Pathophysiological mechanisms of LARS

Various physiological consequences of both surgical intervention and radiation therapy suggest that the pathophysiology of LARS is multifactorial and includes anatomical, sensory and functional changes. The pathophysiological mechanisms of LARS include dysfunction of the internal anal sphincter, decreased sensitivity of the anal canal, violation of RAR, decreased capacity and elasticity of the rectal stump [3; 14].

According to published studies, low anterior resection leads to a change in the functioning of the internal anal sphincter, responsible for maintaining resting pressure and participating in the implementation of RAR. An increase in the relaxation coefficient of the internal anal sphincter is recorded in 40 % of cases of incontinence in the form of a decrease in pressure in the anal canal [16]. Changes in this structure were studied by endosonographic examination, while all 39 patients showed signs of damage after surgical treatment, 7 patients persisted after 2 years of follow-up [17].

Postoperative changes may affect not only the function of the internal anal sphincter, but also the sensory ability of the anal canal. The functioning of the anorectal region is provided by information from the mucous membrane distal to the anastomosis and the side walls of the pelvis. Damage to afferent innervation under the influence of radiation therapy leads to an altered perception of the urge to defecate [18]. Research by Tomita R. and co-authors (2008) demonstrated a statistically significant decrease in the sensitivity of anal canal prescriptions in patients with clinical manifestations of LARS. At the same time, sensitivity correlates with the distance between the level of colorectal anastomosis and the edge of the anus with a tendency to greater disruption of gas and stool recognition at lower levels of anastomosis [19]. In addition, in the work of Haas S. and co-authors (2020), abnormal integration of anorectal stimuli on encephalograms was recorded in patients after combined treatment of rectal cancer, which may also play a role in the pathogenesis of LARS [20].

A decrease in RAIR is an independent predictor of deterioration of the functional state of the anorectal region after surgery for rectal cancer. Observation of patients at different stages of treatment made it possible to note a decrease in RAIR in a quarter of patients a year after low anterior resection. Nevertheless, 85 % of the subjects had the reflex present after 2 years, which is probably due to the restoration of the innervation of the colorectal anastomosis. Studying the RAIR and the maximum threshold volume, Kupsch J. and co-authors (2018), using anorectal manometry and balloon proctometry, noted the most satisfactory functional results in patients with a length of the remaining rectum > 4 cm [21].

The capacity of the neorectum also contributes to the development of the LARS. According to some studies, the large capacity of the neorectum was associated with a significant decrease in the number of bowel movements per day. However, chemoradiotherapy and anterior resection reduce the capacity and elasticity of the rectum, which in turn leads to an increase in false urges [19].

Risk factors

According to the data of the reviewed publications, a significant number of predictors that increase the risk of developing LARS are currently being identified [8; 11; 14; 18; 22; 23]. After the literature review, a number of modifiable and unmodifiable risk factors were identified. Unmodified risk factors include female gender and age over 65. Among the modifiable factors, first of all, radiation therapy and surgical intervention have a negative effect on anorectal function. The type of formed colorectal anastomosis, the development of its insolvency, the formation of a preventive ileostomy, the patient's body mass index of more than 30 kg/m^2 are also considered by some authors as possible predictors [18; 24–29].

Low anterior rectal resection with total mesorectumectomy leads to a change in reservoir function and impaired evacuation of intestinal contents [3; 18]. In 2019, Keiji Koda et al. It has been shown that damage to the internal anal sphincter as a result of removal of most of the rectum can play a role in the development of LARS [23]. Features of surgical intervention in the form of dilation of the anal pulp can affect both the external and internal sphincter with a transient zone and a "hemorrhoidal pillow" [30].

The location of the tumor and, accordingly, the level of colorectal anastomosis after sphincter-preserving surgical interventions was one of the most frequent factors analyzed. The proportion of patients suffering from this LARS increases as the level of anastomosis approaches the anal sphincter. Analysis of the height of the colorectal anastomosis revealed that an anastomosis at a level up to 5–6.5 cm from the anal margin can be considered a risk factor for the development of LARS [8; 13; 22].

The potential pathophysiological mechanisms of LARS also include a violation of autonomic innervation due to the rupture of intrahepatic neuronal connections between the rectal ampoule and the internal sphincter, causing loss of RAR and impaired stool differentiation. The removal of the rectal ampoule, the loss of the reservoir and evacuation function of the rectum, which in turn leads to accelerated transit of unformed intestinal contents, are considered among the reasons for LARS [3; 31].

Combined treatment according to the results of randomized trials is associated with a higher frequency of defecation compared to performing only total mesorectumectomy [10; 15; 32]. Despite the current use of conformal radiation therapy aimed at reducing the area of irradiation, its effect causes ischemic and fibrous changes in blood vessels, pelvic and musculoskeletal nerve plexuses, muscle fibers of the sphincter apparatus [18; 32–34].

The formation of a preventive ileostomy and the occurrence of diversionary colitis due to bacterial recolonization of the colon are also considered by some authors as possible factors for the development of LARS [35]. Enteral deprivation of nutrients associated with the formation of a preventive ileostomy leads to a deficiency of nutrients. Among the structural and functional changes, there may be atrophy of the muscles of the anal sphincter, atrophy of the villi and inflammation of the mucous membrane, leading to dysfunctional colitis. This factor has an adverse effect on the metabolism and microflora of the colon due to changes in the oxidation of butyrate and increased formation of free radicals [36]. Postoperative dysbiosis with a tendency to a significant decrease in the diversity of the intestinal microbiota correlates with increased stool frequency regardless of the endoscopic activity of the inflammatory process. According to some sources, increased defecation occurs when the composition of the microbiota is unbalanced with a decrease in the relative number of Bacteroidetes and an increase in Enterobacteriaceae [37].

Methods of assessment of LARS

The complexity of the pathophysiological mechanism of LARS necessitates a detailed study of anorectal function and changes in its parameters in patients during treatment for rectal cancer. To study the severity of symptoms of anorectal dysfunction, the most used and proven method is the LARS scale [38]. This questionnaire separately examines the frequency of defecation, imperative urges, cases of incontinence of gases and liquid stools. According to the scale, the severity of functional disorders is classified as the absence of LARS (0–20 points), small LARS (21–29 points) and large LARS (30–42 points) [26].

Among the analyzed sources, some authors associate the female sex with higher rates of LARS [18; 25]. Juul T. et al. (2019) demonstrated that in the general population of Denmark, significant symptoms (≥ 30 points on the LARS scale) were observed in women in the age group from 50 to 79 years compared with men (p = 0.001). In this article, the age of patients was not associated with impaired anorectal function, however, the work of Sandberg S. et al. (2020) showed that among the 334 studied within 2 years after the completion of treatment, elderly patients had a more pronounced clinic of LARS [18]. In the study by Benli S et al. (2021), age (more or less than 65 years) and gender did not affect the incidence of LARS (p = 0.14, p = 0.69, respectively) [39].

In a study by Bohlok et al. (2020) conducted among 43 patients with rectal cancer after combined treatment, a body mass index of more than 30 kg/m^2 was a prognostic predictor of pronounced LARS (p = 0.047) [26]. However, no statistical significance of the negative influence of this factor was found in other analyzed sources [8; 39]. According to the results of the paperwork of Nafedzova I. O. (2021), there was also no effect on the occurrence of pronounced LARS of such parameters as elderly age (OR = 0.99 (95 % CI: 0.95–1.02), p = 0.44), gender (OR = 1.04 (95 % CI: 0.74–1.47), p = 0.82) and elevated index body weight (OR = 0.99 (95 % CI: 0.9–1.08), p = 0.8) [8].

The LARS scale was also used in the Trenti L. et al. (2018) study conducted in Spain among 152 pa-

tients to assess anorectal function within a year after sphincter-preserving intervention for rectal cancer. According to the data obtained by the authors, the risk of developing pronounced clinical symptoms in 80 % of the subjects increased with a smaller anastomosis distance from the anal margin ($p < 0.05$). Multivariate analysis revealed the statistical significance of a low level of colorectal anastomosis (OR = 3.82 (95 % CI: 1.46–12.01; $p = 0.005$) and neoadjuvant radiation therapy (OR = 2.38 (95 % CI: 0.98–5.96; $p = 0.048$) as independent risk factors for LARS [13].

According to the analysis of the ROC curve of a retrospective research study by Miacci FLC et al. (2020), the threshold distance between the colorectal anastomosis and the anal margin, which increases the risk of anorectal dysfunction, is 6.5 cm ($p < 0.001$). The study of anorectal function using the LARS scale made it possible to distinguish among statistically significant predictors in addition to the level of colorectal anastomosis ($p < 0.001$) The same applies to radiation therapy ($p = 0.0014$) and ileostomy formation ($p = 0.0023$) [22]. At the same time, such studied parameters as gender, age, the presence of bad habits, the type of formed anastomosis did not have a significant impact on the development of LARS.

In the work of Nafedzova I. O. (2021), the relationship between the level of colorectal anastomosis below 5 cm from the outer edge of the anal canal was also demonstrated by an increase in the frequency of development of LARS by 2.6 times (OR = 2.61 (95 % CI: 1.47–4.62), $p = 0.001$ [8].

In the work of Rasulov and co-authors (2021), the degree of anorectal dysfunction after total mesorectumectomy with various methods of reconstruction of the rectum was assessed. According to the LARS scale, the least pronounced manifestations of LARS were noted in the group of patients with the formation of a J-shaped reservoir in comparison with end-to-end and side-to-side anastomoses. The preservation of the functional advantage of the J-reservoir design was also observed after 12 months in the postoperative period [27]. However, in other studies comparing anorectal function in patients with side-to-end and end-to-end anastomosis, no statistical significance was revealed ($p > 0.05$) [26; 28; 33].

There are also data on the effect of colorectal anastomosis failure on postoperative functional results [3; 15; 35]. The work of Hain E et al. (2017) showed that the occurrence of anastomosis failure is associated with pronounced clinical symptoms of anorectal dysfunction on the LARS scale in 46 studied patients after laparoscopic low anterior resection ($p = 0.02$) [28]. The results of other studies also demonstrate the statistical significance of anastomosis failure in increasing the risk of developing LARS ($p < 0.001$) [8; 29; 33].

The effect of radiation therapy on the functioning of the anorectal zone has reached statistical significance not only in the works of Trenti L. et al. (2018) and Miacci FLC et al. (2020), but also in most of the analyzed publications [11; 15; 22]. A study by Danish scientists Hughes D. L. et al. (2017) showed that the use of non-adjuvant radiation therapy in 85 patients was associated with an almost 20-fold increase in the risk of LARS ($p < 0.01$) [11]. In 18 % of cases, the symptoms were insignificant, and in 56 % of cases, signs of a large LARS were detected. The average score on the LARS scale a year after the treatment was 35.5, after 4 years – 27.9. However, the difference in these indicators did not reach significance ($p = 0.19$), which demonstrates the continued negative effect of radiation therapy on anorectal function in the long term.

According to the results of a study conducted by van der Sande M. E. et al. (2019), the relationship between the dose of radiation therapy and the severity of anorectal dysfunction in patients with rectal cancer was tracked ($p < 0.01$). 2 years after radiation therapy, 11 patients had pronounced clinical symptoms of anorectal dysfunction (30–39 points on the LARS scale), 10 patients had minor manifestations of LARS (21–29 points) [40]. Based on the above, surgical trauma is significant in the early postoperative period, but the negative impact of surgery on anorectal function is leveled in the long term, which cannot be said about radiation therapy.

The use of combined treatment of rectal cancer improves oncological results, however, patients in the long term may be burdened with persistent symptoms of anorectal dysfunction. The manifestations of LARS may decrease during the first 2 years, however, in almost 60 % of patients, symptoms persist for more than 24 months [41]. It is reliably known that the quality of life correlates with the severity of this syndrome [15].

Combined treatment according to the results of randomized trials is associated with a higher fre-

quency of defecation compared to performing only total mesorectumectomy [9; 15; 26; 42]. In the work of Sun W et al. (2019), within 40 months after combined treatment, 119 (54.1 %) of 220 observed patients reported the occurrence of a large LARS. At the same time, the group of patients without radiation therapy showed fewer signs of functional disorders compared to the group of patients undergoing combined treatment (38.6 and 64.4 %, respectively, $p < 0.001$). The effect of neoadjuvant irradiation (OR = 2.20 (95 % CI: 1.24–3.91), $p = 0.007$) on anorectal function was a statistically significant predictor of the development of pronounced LARS [34].

A logistic regression analysis conducted in Luo B. et al. (2021) showed that preoperative chemoradiotherapy ($p = 0.003$) and the proximity of the lower edge of the tumor to the dentate line ($p = 0.015$) are independent risk factors for LARS [38].

Benli S. et al. (2021) analyzed the clinical manifestations of anorectal dysfunction on the LARS scale in 276 patients after combined treatment of rectal cancer. The authors present a low level of anastomosis (OR = 42.40 (95 % CI: 11.14–161.36), $p < 0.0001$) and radiation therapy (OR = 2.51 (95 % CI: 1.38–4.57), $p = 0.003$) as important predictors of the development of LARS (OR = 42.40 (95 % CI: 11.14–161.36), $p < 0.0001$). In addition to the above data, the study made it possible to distinguish among statistically significant predictors of anorectal dysfunction the formation of a preventive ileostomy (OR = 12.83 (95 % CI: 6.58–25.0), $p < 0.0001$). At the same time, the term of closure of the ileostomy (early less than 6 months and late more than 6 months did not affect the incidence of LARS ($p = 0.56$) [39].

The LARS scale helped to demonstrate the negative effect of preventive ileostomy on postoperative functional results of the rectal sphincter apparatus and in other sources. Sun W et al. (2019) describe ileostomy as an independent risk factor for pronounced LARS (OR = 2.59 (95 % CI: 1.27–5.30), $p = 0.009$) [37]. In a study by Hughes D. L. et al. (2017), the presence of ileostomy within 6 months after completion of treatment was associated with a 3.7-fold increase in the risk of LARS ($p = 0.03$) [42]. Formation of a preventive ileostomy in a meta-analysis conducted by I. O. Nafedzov. (2021), was associated with a threefold increase in the risk of severe functional problems after surgery (OR = 3.32 (95 % CI: 1.99–5.55), $p < 0.00001$) [8].

Nuytens F. et al. (2018) evaluated the effect of the time of performing reconstructive surgery on the small intestine in 100 patients over 50 months. However, the study did not reveal a relationship between the time of closure of the ileostomy and the severity of symptoms of anorectal dysfunction ($p = 0.38$) [33].

The Wexner scale allows to expand the understanding of anorectal dysfunction when signs of incontinence occur. This questionnaire evaluates the severity of anal incontinence by studying the frequency of incontinence of gases, liquid or solid intestinal contents. The score varies from 0 to 20 points.

In the study of A. A. Medvednikov and co-authors (2020), the functional activity of the anorectal zone after low anterior rectal resection was evaluated in 100 patients [41]. During the year after surgical treatment, when analyzing the degree of incontinence, I degree of insufficiency was observed in 15 % of patients (up to 5 points on the Wexner scale), II degree of insufficiency – in 33 % (6–10 points on the Wexner scale), III degree – in 52 % of cases (11–20 points on the Wexner scale). After a year of sphincter-preserving intervention, an improvement in anorectal function was observed, and in 45 % of patients there were no significant violations of the locking function ($p < 0.01$).

With respect to the type of anastomosis, the Wexner scale demonstrates better anal retention 6 months after surgery with the formation of a J-shaped reservoir compared with anastomoses "end-to-end" and "side-to-side" ($p = 0.01$). However, by 12 months, the clinical manifestations of anal incontinence decreased and became the same between the groups under consideration ($p > 0.05$) [40].

Another incontinence scale, the use of which has been found in literary sources, is the Vaizey scale, consisting of 7 points, including incontinence of solid and liquid stools, flatulence, the severity of lifestyle changes, the need to wear pads, the use of antidiarrheal drugs. The score is built by summing up each item (range from 0 to 24), where 0 indicates the absence of incontinence, and 24 indicates complete incontinence of intestinal contents [21].

In the work of Trenti L. et al. (2018), the median incontinence index on the Vaizey scale was higher in patients with colorectal anastomosis by 5 cm or less compared to its higher level (7.5, range 3–12; $p = 0.036$) [13].

In a study by Kupsch J. et al. (2018), the Vaizey scale was used as an additional indicator to the

LARS scale in assessing anorectal function in patients undergoing treatment for rectal cancer [21]. Among 144 (55.2 %) of the examined patients, signs of small (51 patients (19.5 %)) or large (93 patients (35.6 %)) LARS were noted. In the group of patients undergoing radiation therapy, more than 20 points were scored on the LARS scale (64.6 %), which reflected less satisfactory functional indicators of the anorectal zone compared to patients who did not receive radiation therapy (43.1 %) (p = 0.001). The Vaizey scale also demonstrated significant differences between groups 10.0 (± 6.7) and 6.3 (± 6.1), respectively (p < 0.001), which correlated with the LARS scale data (r = 0.81, p < 0.001).

However, these questionnaires are based solely on the patient's assessment of the severity of symptoms and do not accept changes in the functional parameters of the anorectal zone. For full-fledged counseling, objective research methods should be included in the examination plan.

The first methods of studying the tonic and neuroreflex activity of the anorectal region were based on the use of rectal cylinders that register pressure and RAIR created by internal and external sphincters [16].

To date, anorectal manometry is an objective method in assessing postoperative anorectal function and diagnosing functional disorders [43; 44]. For a long time, there were two types of systems in the equipment of anorectal manometry: air (balloon catheters) and water-perfusion (open catheter method) [3]. Improved diagnostic accuracy has improved the appearance of high-resolution anorectal manometry (HRAM).

HRAM is a complex research method that provides an opportunity to create a spatio-temporal model of pressure distribution. The advantage of HRAM is the use of a higher physiological resolution created by the increased density of sensitive sensors and their location around the circumference [45; 46; 47]. The HRAM system can consist of miniature semiconductor pressure indicators on 2D and 3D solid-state catheters with a diameter of 4 mm, capable of providing functional and morphological indicators of the anorectal region [48]. HRAM displays changes in anorectal activity at rest and with various functional tests in the form of a color contour graph.

According to the recommendations of the International Working Group of Experts on Anorectal Physiology, the examination of patients is carried out in a supine position on the left side with the hip and knee joints bent at right angles [49]. There is also an opinion in the literature about the effectiveness of determining the anal resting pressure and compression pressure in the lithotomic position. However, this modification has not been introduced into clinical practice at the moment, since it did not reflect the benefits for monitoring rectal sensitivity [50].

Recommended measurements of anorectal manometry assess the following parameters: anal resting pressure, anal canal pressure and fatigue time during voluntary contraction, rectal pressure during straining and coughing, rectal sensitivity, RAR, rectal capacity and extensibility [49].

According to anorectal manometry, anal resting pressure is maintained by the work of the internal sphincter. While the parameter of maximum compression pressure depends on the functioning of the external sphincter and is responsible for the retention of intestinal contents when intra-abdominal pressure increases under stressful conditions. The literature describes a significant decrease in both indicators in the postoperative period [22; 30].

HRAM can also reflect the myogenic activity of smooth muscle cells of the anal sphincter by evaluating rhythmic pressure fluctuations called slow and super slow waves. Slow waves in the anal sphincter arise from interstitial Cajal cells, and in healthy people are recorded with a frequency of approximately 16–18 cycles per minute [51].

According to the data of the analyzed studies, the indicators of high-resolution anorectal manometry are associated with the degree of severity of LARS [15; 32]. In patients who have undergone sphincter-preserving surgery for rectal cancer, the indicators of anal pressure at rest and maximum rectal volume decrease, while RAIR may be absent in 80 % of cases a month after completion of treatment [52]. It was also noted that defecation dysfunction, manifested by a violation of rectal sensitivity, is more common than incontinence, and affects the quality of life to a greater extent [13].

In a study by Luo B. et al. (2021), a decrease in the physiological parameters of the anorectal zone was observed after low anterior rectal resection in 146 patients [9]. The greatest changes were manifested in a decrease in the indicators of anal resting pressure, maximum compression pressure, maximum

volume transferred ($p < 0.001$). The threshold volume of the first sensation was significantly higher in healthy people than in the surgical group ($p < 0.001$).

Liu L. et al. (2017) to assess the effect of laparoscopic anterior resection on anorectal function, high-resolution anorectal manometry was performed in 51 patients. The patients were divided into two groups depending on the level of anastomosis more or less than 5 cm from the edge of the anus. 3 months after surgery, a decrease in anal resting pressure and maximum compression pressure ($p < 0.05$) was registered in both groups, while after 6 and 9 months there was an improvement in indicators to the preoperative level. The intergroup comparison noted higher values in the group of patients with a high level of anastomosis: the maximum compression pressure was significantly higher 3 months after surgery ($p < 0.05$), and after 6 months – a higher level of average and maximum pressure at rest ($p < 0.05$) was observed. A similar trend was also observed with respect to changes in the volume of the rectum, but all these parameters remained significantly lower compared to preoperative values after 9 months [53].

The work of Fratta C. et al. (2022), conducted among 48 patients who received a course of neoadjuvant radiation therapy, demonstrates a decrease in manometric indicators of anal pressure at rest and average compression pressure ($p < 0.05$). At the same time, there were no statistically significant changes between the initial values of the maximum compression pressure and their value after radiation therapy ($p = 0.05$). From the side of clinical manifestations, the authors report a higher frequency of loose stools and urge to defecate after radiation therapy, but the assessment of the degree of incontinence on the Wexner scale also revealed no significant differences ($p > 0.05$) [43].

According to the work of Baichorov A. B. (2019), prolonged radiation therapy leads to a significant decrease in manometric indicators: resting pressure and contraction, endurance of the sphincter apparatus of the rectum ($p < 0.05$) [54].

In a study by Ihnát P. et al. among 65 patients, the effect of combined treatment was manifested in the form of a change in the normal ratio of manometric parameters: there was a significant increase in the threshold level of the first sensation and a significant decrease in anal pressure at rest and with maximum contraction, extensibility and maximum volume of the rectum ($p < 0.001$) [32].

There is also information in the literature about the correlation of manometric indicators with the clinical picture of LARS 3 and 6 months after surgery. A higher LARS index was observed in patients with focal pressure defects in the anal canal and with the appearance of spastic peristaltic waves from the colorectal anastomosis to the anus. Spastic hypermobility of the rectal stump, probably caused by external denervation, is associated with the severity of imperative urges to defecate [15]. Patients who developed spastic peristaltic contractions in the postoperative period had a higher stool frequency both 3 and 6 months after surgery.

Anorectal profilometry, which is a type of anorectal manometry, is based on the operation of a thin water-perfusion catheter with a radial arrangement of channels and registers the pressure along each channel throughout the entire process of moving the sensor. The clinical value of this method lies in a quick and objective assessment of the activity of the structures of the internal anal sphincter and the contractility of the pelvic floor muscles, especially in patients with painful sensations when using a sphincteromanometric sensor [31]. Anorectal sphincterometry, as one of the methods of studying the anorectal zone, allows you to diagnose the work of the pelvic floor muscles, taking into account the study of reservoir and evacuation function indicators.

A segmental sphincterometer is used to measure the absolute value of the pressure created by the rectal locking apparatus [55]. The study is carried out by determining the tone of the anal pulp in a relaxed state and with maximum compression. The sensor of the device increases the accuracy of the pressure measurement results by registering indicators from the segments of the sphincter apparatus.

In the modern literature there are data on the use of anorectal sphincterometry and profilometry to study anorectal function in the formation of different types of anastomoses. Rasulov and co-authors (2021) noted significantly higher rates of neorectal sensitivity, the first and constant urge to defecate in patients with a J-shaped reservoir [27]. The greater ability of this type of anastomosis to accumulate and retain intestinal contents is reflected in the highest indicator of the maximum tolerated volume (by 12 months of the postoperative period – 224, 204 and 190 ml in groups

with a J-shaped reservoir, "side-to-end" and "end-to-end" anastomoses, respectively, $p < 0.0001$). There were no significant differences between the compared groups with respect to the indicators of maximum resting pressure and contraction ($p > 0.05$).

Another way to study the functional state of the anorectal zone is defectofluometry with a weight optical sensor that reflects the readings in the form of a curve on the monitor screen. This method makes it possible to evaluate the reservoir function by registering sensitivity thresholds and urge to defecate with slow introduction of filler, as well as to evaluate the evacuation function by residual volume [56].

In the Ssu-Chi Chen et al. (2021) study, physiological variables were evaluated in patients with LARS using a Fecobionic device. Testing was carried out during the evacuation of a balloon with three sensors located in front, behind and inside, which made it possible to measure not radial pressure in a fixed position, but axial pressure during defecation. Obtaining the defecation index allows the parameters of anorectal manometry to better correlate with the Wexner scale and the manifestations of LARS, which in the future may provide a more detailed analysis of anorectal dysfunction [26].

In the work of Liu L. et al. (2017), endoanal ultrasound examination was used, which allowed us to note a tendency to decrease the thickness of the internal and external sphincters and to decrease the volume of the rectum after surgery [53].

Intraanal electromyography is one of the most common methods and allows to obtain a quantitative and qualitative assessment of the work of the external anal sphincter and pelvic floor muscles [57]. By studying background and arbitrary bioelectric activity, the study reflects the indicators of the total contractility of the rectal locking apparatus. The measurement is carried out at rest and arbitrary contraction, as well as during straining tests and with an increase in intra-abdominal pressure. The tonic activity of the external sphincter at rest is 15.2 ± 2.1 mv, and with a decrease and increase in intra-abdominal pressure increases to 74.3 ± 13.7 mv. A normal physiological reaction during straining is observed with synchronous inhibition of the bioelectric activity of the external sphincter and pelvic floor muscles, while an increase in this indicator is regarded as a paradoxical reaction of the puborectal muscle [58].

A study by Vollebregt P. F. et al. (2021) expanded the understanding of the functional activity of the anorectal region by comparing the frequency of slow waves of the anal canal in 21 patients who underwent anterior rectal resection with 37 healthy subjects. The authors were able to demonstrate a decrease in anal slow-wave activity in the first group of patients. In 52.4 % of patients in the postoperative period, the frequency of slow waves of 6–8 cycles per minute without activity at higher frequencies was noted. Changes in the observed pressure activity may reflect damage to pelvic nerves innervating cells of the smooth muscles of the anus [51].

Battersby N. J. et al. (2018) developed a POLARS preoperative nomogram to predict the severity of anorectal dysfunction after low anterior rectal resection. A nomogram is a graphical representation of the function of the variables under study, based on the analysis of parameters such as the patient's gender and age, the height of the tumor, radiation therapy, partial or total mesorectomy, ileostomy formation. After entering the data, the program calculates the number of predicted points on the LARS scale [59].

In the work of Nafedzova I. O. (2021), based on the analyzed predictors of anorectal function disorders, a nomogram was created that allows predicting the occurrence of pronounced LARS in patients in the postoperative period. The probability of the development of significant functional disorders was calculated with a combination of different risk factors: chemoradiotherapy, the height of the anastomosis level, the failure of the anastomosis, the removal of preventive ileostomy and chemotherapy. The authors draw attention to the need to inform patients with a high probability of pronounced LARS according to nomogram data during the formation of a low colorectal anastomosis in order to carry out conservative rehabilitation in the form of complex BOS therapy and tibial modulation [8].

CONCLUSION

LARS is a socially significant problem due to the increasing morbidity and high frequency of development with low sphincter-preserving surgical interventions. Surgical treatment and radiation therapy can improve the oncological results of patients with rectal cancer. However, radiation therapy and the formation

of a low colorectal anastomosis are independent risk factors for functional disorders that have the greatest impact on the development of LARS. A more thorough study of LARS at different stages of treatment of patients can help in the search for new approaches to the prevention of anorectal dysfunction.

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