https://doi.org/10.33878/2073-7556-2024-23-2-68-75

Ultrasound semiotics of solitary rectal ulcer

Anastasia E. Pershina, Yulia L. Trubacheva, Viktor V. Veselov, Oleg M. Biryukov, Olga A. Mainovskaya

Ryzhikh National Medical Research Center of Coloproctology (Salyama Adilya st., 2, Moscow, 123423, Russia)

ABSTRACT *AIM: to develop ultrasound semiotics of solitary rectal ulcer (SRU).*
PATIENTS AND METHODS: fifty-eight patients with a histologically verified SRU were included in the retrospective study. All patients underwent colonoscopy and transrectal ultrasound (TRUS). Changes in rectal wall detected by TRUS were compared with colonoscopy data.
RESULTS: On TRUS SRU is represented by a significantly thickened rectal wall (median thickness of the rectal wall in the region of SRU is 9 (7–10) mm and 5 (4–6) mm outside, p < 0.001), most often with a predominance of muscular and submucosal layers (46/58, 79%). The structure and echogenicity of these layers are changed: the connective tissue layer is visualized in muscular layer (51/58, 88%), submucosal layer is hypoechogenic (47/58, 81%), boundaries between rectal wall layers are faded (50/58, 86%). Ulcers in SRU are characterized by presence of areas where the mucous layer cannot be traced (sensitivity 100%, specificity 95%), its extent is comparable to extent of ulcers detected on colonoscopy (p = 0.528). Polypoid SRU is characterized by local thickening of the mucosa (sensitivity 89%, specificity 95%). TRUS location of the SRU in height (p = 0.644) is comparable with colonoscopy data.
CONCLUSION: the study determined general ultrasound signs of SRU and made it possible to differentiate macroscopic forms of SRU from each other with TRUS.

KEYWORDS: *transrectal ultrasound, solitary rectal ulcer*

CONFLICT OF INTEREST: *The authors declare no conflict of interest*

FOR CITATION: Pershina A.E., Trubacheva Y.L., Veselov V.V., Biryukov O.M., Mainovskaya O.A. Ultrasound semiotics of solitary rectal ulcer. *Koloproktologia.* 2024;23(2):68–75. (in Russ.). https://doi.org/10.33878/2073-7556-2024-23-2-68-75

ADDRESS FOR CORRESPONDENCE: *Pershina A.E., Ryzhikh National Medical Research Center of Coloproctology, Salyama Adilya st., 2, Moscow, 123423, Russia; e-mail: pershina_ae@gnck.ru*

Received — 27.02.2024 *Revised — 18.03.2024* *Accepted for publication — 24.04.2024*

INTRODUCTION

Solitary rectal ulcer (SRU) is considered a rare benign disease of the distal large intestine, the pathogenesis of which is associated with chronic trauma and local ischemic lesion of the rectal wall with prolonged straining, internal intussusception and rectal prolapse, as well as puborectal muscle spasm [1–5]. The term 'solitary rectal ulcer' is not correct, since the lesion site includes not only the rectum, but also the sigmoid colon, and macroscopic changes in the rectal wall are not limited to a single ulcerative lesion, but vary widely from local hyperemia of the mucous layer to extensive polypoid formations [1]. The SRU symptoms include discharge of blood and mucus from the rectum, impaired defecation, discomfort or pain in the lower abdomen, anal canal or rectum [1]. The rarity of the disease, the non-specificity of the symptoms, and a wide range of macroscopic manifestations make it difficult to diagnose SRU. Colonoscopy/proctoscopy in combination with biopsy and histology plays the main role in the diagnostics of SRU. The disadvantages of endoscopy include the need for long-term preparation, and a biopsy is an invasive procedure associated with risks of bleeding. TRUS is a diagnostic test that does not require long-term preparation. Due to its high resolution, TRUS makes it possible to visualize the layers of the rectal wall and is widely used in inflammatory bowel diseases, in the staging of rectal cancer [6]. However, ultrasound semiotics has not been developed for solitary rectal ulcer recently, and there are only descriptions of individual cases of SRU and a few series in the literature. Therefore, the aim of the study was to

develop ultrasonic semiotics of the SRU. To do this, we analyzed the changes in the rectal wall detected during TRUS in patients with histologically confirmed solitary ulcer and compared them with colonoscopy data.

PATIENTS AND METHODS

The study retrospectively included patients with a histologically confirmed diagnosis of solitary rectal ulcer who underwent a comprehensive checkup in January 2018 -July 2023. The diagnostic program included colonoscopy with biopsy followed by histology and TRUS. Patients with area of not completely visualized ulcer by TRUS were excluded. The normal rectal wall has a five-layer ultrasound structure. The first layer, with increased echogenicity, reflects the interface between the wall of the balloon filled with water and the surface of the mucous layer. The second layer, with reduced echogenicity, corresponds to the mucous layer, the third layer, with increased echogenicity, corresponds to the submucosal layer. The fourth layer, of reduced echogenicity, is the muscular layer. High-frequency sensors make it possible to additionally visualize the connective tissue layer in its thickness, dividing the muscle layer into an inner circular and an outer longitudinal one. The fifth layer, with increased echogenicity, is the interface between the muscular layer and the perirectal tissue [6]. The upper margin of the normal rectal wall thickness is considered to be 3 mm [7]. The statistical analysis was carried out using the StatTech v. 4.0.5 program (developed by Stattech LLC, Russia). Quantitative indicators were evaluated for compliance with the normal distribution using the Shapiro-Wilk criterion (with fewer than 50 subjects) or the Kolmogorov-Smirnov criterion (with more than 50 subjects). Quantitative indicators with a normal distribution were described using mean (M) and standard deviations (SD), the boundaries of the 95% coincidence interval (95% CI). In the absence of a normal distribution, quantitative data were described using the median (Me) and the lower and upper quartiles (Q1-Q3). Categorical data were described with absolute values and percentages. The comparison of the two groups by a quantitative indicator with a normal distribution, provided that the variances are equal, was performed using the Student's t-test.

The comparison of the two groups by a quantitative indicator, the distribution of which differed from the normal one, was performed using the Mann-Whitney U-test. Comparison of three or more groups by a quantitative indicator, the distribution of which differed from the normal one, was performed using the Kraskel-Wallis criterion, a posterior comparisons were performed using the Dunn criterion with the Holm correction.

The comparison of percentages in the analysis of four-field conjugacy tables was performed using the χ^2-Pearson criterion (for values of the expected phenomenon over 10), the exact Fisher criterion (for values of the expected phenomenon less than 10). The comparison of percentages in the analysis of multipole conjugacy tables was performed using χ^2-Pearson criterion. When comparing relative indicators, the odds ratio (OR) was used as a quantitative measure of the effect. Sensitivity and specificity indicators were used to assess the diagnostic informativity of the TRUS compared with colonoscopy.

RESULTS

The study included 58 patients (41 women and 17 men) with histologically confirmed SRU. The mean age of the patients was 45 ± 16 years. When analyzing complaints, 35/58 (60%) patients showed symptoms of obstructive defecation syndrome (complaints of difficult emptying the rectum, a feeling of incomplete emptying, the need for manual assistance during defecation), 35/58 (60%) patients noted blood discharge from the rectum, four (7%) patients complained of incontinence. In 50/58 (86%) patients, internal rectal intussusception was detected, in 6/58 patients (10%) — rectal prolapse. During colonoscopy, all the patients had a variety of macroscopic changes in the rectal wall, which were regarded as SRU. The

rectal mucous layer was locally swollen, loosened, hyperemic and infiltrated, of a tightly elastic consistency, with a whitish coating of fibrin. In some patients, these changes were detected at the top of the rectal folds, in the others they were located according to the type of 'screw track'. In most cases, single superficial ulcers, rounded, longitudinal and irregular in shape, covered with a fibrin coating, were detected in the center of the altered mucous layer. The margins of some deep ulcers were covered up and bolstered. Next to some ulcerative lesions, polypoid growths of granulation tissue, red and pink in color, with fibrin at the tips, were detected. The same lesions were detected in some patients without ulcers. For analysis, we have identified the following forms of SRU (Fig. 1): The most common form of SRU was ulcerative form — in 34/58 (59%) cases. The polypoid form of SRU occurred in 14/58 (24%) patients, focal mucosal hyperemia — in 6/58 (10%) patients, mixed form — in 4/58 (7%) patients. Biopsy revealed a violation of the crypts structure (elongation, deformation and expansion, irregular distribution) with reactive changes in the epithelium, a change in the number of goblet cells. In some patients, hyperplastic changes in crypts were accompanied with the formation of polypoid growths and an eroded surface, the imposition of fibrin and leukocytes. Ulcerative lesions were located within the mucosa, a necrosis zone and granulation tissue were detected at the bottom of them. Inflammatory infiltration in the ulcer area was poorly expressed. The proliferation of fibroblasts and smooth muscle cells, which formed vertically oriented bundles and fibers, was noted in the own plate of the mucosa.

In all the patients, the TRUS picture of the rectal wall differed from the normal one. In 56/58 (97%) patients, thickening of the rectal wall was noted. In all the patients, there was no uniform distribution of the rectal wall layers: in 30/58 (52%) patients, the predominance of the muscular and submucosal layers was detected, in 28/58 (48%) ones, the predominance of the submucosal layer. In 25/58 (43%) patients, the muscle layer was not homogeneous: a connective tissue layer of increased echogenicity was visualized in its thickness. Dilated vessels were detected in 36/58 (62%) patients in the submucosal layer. In 44/58 (76%) patients, the rectum was folded: mainly along the entire circumference (21/58, 48%) or along the posterior semicircle (20/58, 45%). In the pararectal tissue of 19/58 (33%) patients, lymph nodes were detected, the maximum size of which was 6.5 ± 1.5 mm (95% CI: 5.8–7.2 mm).

Against this background, with TRUS in the rectum, thickened sections of the rectal wall protruding into the lumen with a different structure were revealed, which coincided in localization with solitary rectal ulcers detected by colonoscopy (Fig. 1). When comparing the height of the solitary ulcer (the distance from the edge of the anal canal to the distal edge of the SRU), no significant differences were found according to colonoscopy

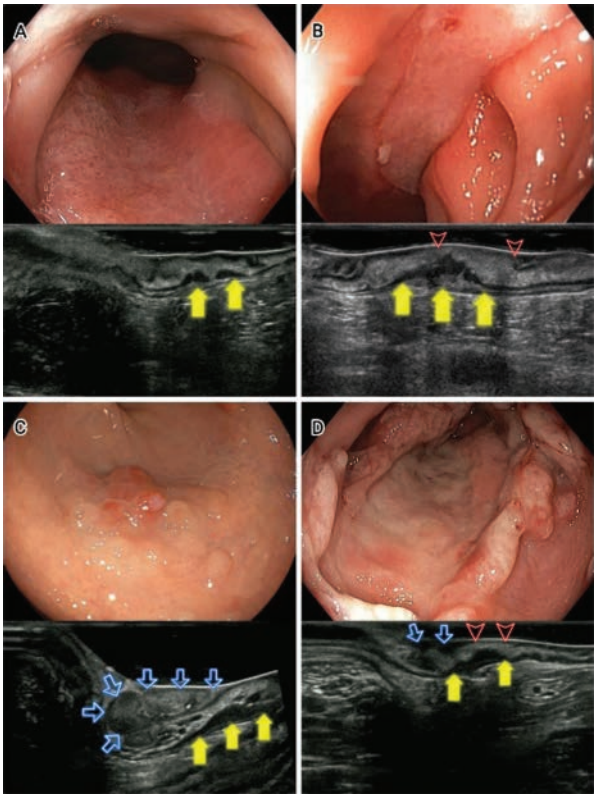

Figure 1. *Examples of SRU macroscopic forms (colonoscopy at the top, ERUS, B-mode at the bottom). A — focal hyperemic mucosa. B — ulcerative form. C — polypoid form. D — mixed form. Yellow arrows — thickened muscularis propria, red arrowheads — ulcer borders, blue arrows — thickened mucosa (polypoid lesions).*

Table 1. *Comparison of the height and extent of SRU depending on the diagnostic method*

Indicator	*n*	Diagnostic method				*p*
		Colonoscopy		TRUS		
		Me	Q1–Q3	Me	Q1–Q3	
Height of SRU, mm	29	80	50–80	64	53–80	0.644
Extent of pathological changes in the rectal wall, mm	49	20	10–30	25	20–35	0.002
Extent of the ulcerative lesion, mm	35	15	10–20	13	9–20	0.528

and TRUS (p = 0.644). The extent of pathological changes in the rectal wall by TRUS was significantly greater than by colonoscopy (p = 0.002) (Table 1).

A comparative analysis of the ultrasound picture of the rectal wall in the SRU area and outside it was carried out. The median maximum thickness of the rectal wall in the area of solitary rectal ulcer was 9 mm (7–10 mm), outside it — 5 mm (4–6 mm), the revealed differences were significant (p < 0.001). Both in the area of the solitary ulcer and outside it, the distribution of the layers of the rectal wall was not uniform. However, these changes occurred due to different layers (p < 0.001) (Fig. 2).

The maximal thickness of the muscle layer in the SRU area was 4 ± 2 mm. The muscle layer in the area of the solitary ulcer was changed in 51/58 (88%) patients: in 37/58 (64%) patients, a layer of reduced echogenicity was visualized in it, in 14/58 (24%) ones — increased echogenicity. The chances of visualizing a layer in the muscle layer in the SRU area were 9.617 times higher, compared to the area outside the SRU, the differences in chances were statistically significant (p < 0.001, 95% CI: 3.736–24.758). When comparing the thickness of the longitudinal and circular muscle layers in the SRU area, the latter prevailed in 27/58 (47%) patients, the layers were of the same thickness in 19/58 (33%) patients, and the longitudinal one prevailed in 5/58 (9%) patients. The echogenicity of the submucosal layer in the SRU area in 47/58 (81%) patients was changed: in 25/58 (43%) ones the submucosal layer had a mean echogenicity, in 22/58 (38%) patients it was reduced. Dilated vessels were detected in the submucosal layer in 18/58 (31%) patients. The chances of detecting dilated vessels in the SRU area were 3.636 times lower, compared with the area outside it, the differences in chances were statistically significant (p < 0.001, OR = 0.275; 95% CI: 0.128–0.593). Single and multiple cystic inclusions were detected in the submucosal layer in 2 patients in the SRU area and in 2 patients outside the SRU area: some with anechoic homogeneous contents, the others were filled with homogeneous contents of increased echogenicity, giving an acoustic shadow. The mucosal layer in the SRU area in 19/58 (33%) patients was traced throughout, in 39/58 (67%) patients it was not locally detected. The extent of the missing mucosal layer was comparable to the extent of ulcerative lesions detected during colonoscopy (Table 1). In 18/58 (31%) patients, local thickening of the mucous layer was noted. In 50/58 (86%) patients, the boundary between the layers of the rectal wall was indistinct: in 31/58 (53%), the boundary was 'faded' between the mucous and submucosal layers, in 19/58 (33%)

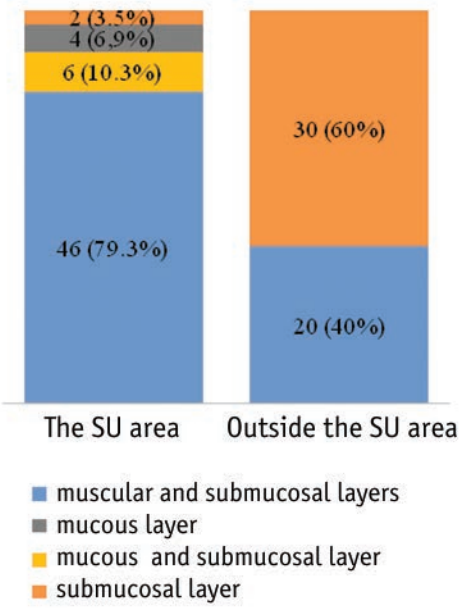

Figure 2. *The structure of predominant layer of rectal wall in the area of SRU and outside it*

Table 2. *Comparison of SRU ultrasound characteristics depending on macroscopic form*

Parameters of the rectal wall in the SRU area	SRU form				p
	Hyperemia	Ulcerative	Mixed	Polypoid	
SU Length (mm), Me (Q1–Q3)	32 (24–46)	23 (18–34)	28 (24–33)	30 (25–50)	0.200
Maximal wall thickness (mm), Me (Q1–Q3)	9 (7–11)	9 (7–10)	8 (7–9)	10 (8–12)	0.529
Maximal thickness of the muscle layer (mm), Me (Q1–Q3)	3 (2–4)	4 (3–5)	4 (4–5)	4 (2–4)	0.271
The predominant layer of the rectal wall, *n* (%)					< 0.001* $P_{\text{ulcerative form — polypoid form}} < 0.001$
Submucosal layer	–	2 (6%)	–	–	
Mucous and submucosal layers	2 (33%)	–	–	4 (29%)	
Mucous layer	–	–	–	4 (29%)	
Muscular and submucosal layers	4 (67%)	32 (94%)	4 (100%)	6 (43%)	
Muscle layer, *n* (%)					0.010* $P_{\text{ulcerative form — polypoid form}} = 0.009$
The layer is not visualized	1 (17%)	2 (6%)	1 (25%)	3 (21%)	
Hyperechoic layer	3 (50%)	4 (12%)	–	7 (50%)	
Hypoechoic layer	2 (33%)	28 (82%)	3 (75%)	4 (29%)	
Echogenicity of the submucosal layer, *n* (%)					0.021* $P_{\text{ulcerative form — polypoid form}} = 0.011$
Reduced echogenicity	5 (83%)	32 (94%)	3 (75%)	8 (57%)	
Increased echogenicity	1 (17%)	2 (6%)	1 (25%)	6 (43%)	
Preservation of the mucous layer, *n* (%)					< 0.001* #
The mucous layer is partially untraceable	1 (17%)	34 (100%)	4 (100%)	–	
The mucous layer is completely traceable	5 (83%)	–	–	14 (100%)	
Thickness of the mucous layer, *n* (%)					< 0.001* ##
The mucous layer is locally thickened	2 (33%)	–	2 (50%)	14 (100%)	
The mucous layer is of uniform thickness	4 (67%)	34 (100%)	2 (50%)	–	
The boundary between the layers, *n* (%)					< 0.001* $P_{\text{ulcerative form — polypoid form}} < 0.001$
'Faded'	5 (83%)	34 (100%)	4 (100%)	7 (50%)	
Preserved	1 (17%)	–	–	7 (50%)	

 # $P_{\text{hyperemia of the mucous layer — ulcerative form}} < 0.001$, $P_{\text{hyperemia of the mucous layer — mixed form}} = 0.029$, $P_{\text{ulcerative form — polypoid form}} < 0.001$, $P_{\text{mixed form — polypoid form}} < 0.001$;
$P_{\text{hyperemia of the mucous layer — ulcerative form}} = 0.002$, $P_{\text{hyperemia of the mucous layer — polypoid form}} = 0.002$, $P_{\text{ulcerative form — mixed form}} < 0.001$, $P_{\text{ulcerative form — polypoid form}} < 0.001$, $P_{\text{mixed form — polypoid form}} = 0.010$

patients — between all the layers due to a decrease in their echogenicity.

An analysis of the ultrasound pattern of SRU was also performed depending on the macroscopic form (Table 2).

We found no significant differences between the forms of SRU in terms of the extent of pathological changes, the maximum thickness of the rectal wall and the muscle layer in the area of the solitary ulcer. Statistically significant differences were revealed in the analysis of the ultrasonic structure of the layers of the rectal wall in the SRU area, depending on the macroscopic form.

The ulcerative form of SRU was characterized by thickening of the rectal wall due to the muscular and submucosal layers (32/34, 94%); in the polypoid form of SRU, thickening of the rectal wall also occurred due to the mucous or mucous and submucosal layers (8/14, 58%).

In patients with the ulcerative form of SRU, the connective tissue layer in the muscle layer was predominantly of reduced echogenicity (28/34. 82%), in contrast to patients with the polypoid form of SRU: in 7/14 (50%) cases, they had a layer of increased echogenicity and only in 4/14 (29%) cases — reduced echogenicity. Significant differences between ulcerative and polypoid forms in the echogenicity of the submucosal layer were also revealed: in the first subgroup, the submucosal layer was predominantly of reduced echogenicity (32/34, 94%), in the second subgroup– both increased echogenicity (6/14, 43%) and reduced echogenicity (8/14, 57%). When evaluating the mucosal layer, statistically significant differences were observed between all forms of SRU: in all patients with ulcerative lesions (ulcerative and mixed forms), areas where the mucous layer was absent were detected. The mucosal layer was

visualized throughout in all the patients with a polypoid form, as well as in most cases of SRU by the type of focal hyperemia (5/6, 83%). The sensitivity of this sign in the detection of ulcerative lesions in SRU was 100% (95% CI: 91–100%), specificity was 95% (95% CI: 75–100%). In all the patients with the polypoid form of SRU, in 2/4 (50%) patients with mixed form and in 2/6 (33%) patients with focal hyperemia, local thickening of the mucous layer was noted, unlike in patients with ulcerative form, none of whom it was detected. The sensitivity of this sign in the detection of polypoid formations in SRU was 89% (95% CI: 65–99%), specificity was 95% (95% CI: 83–99%).

With an additional comparison of subgroups with ulcerative and non–ulcerative forms of SRU, we revealed statistically significant differences: the chances of visualizing pararectal lymph nodes were 7.286 times higher in the presence of ulcerative lesions, the differences in chances were statistically significant (p = 0.008, OR = 0.137; 95% CI: 0.028–0.676).

DISCUSSION

Currently, the number of papers mentioning ultrasonic imaging of SRU is small: there are descriptions of individual cases and a few series of cases of SRU in the literature. This study is the first in which the ultrasound semiotics of SRU was determined in a large sample of patients with a histologically confirmed diagnosis and ultrasound-endoscopic parallels with macroscopic forms of SRU were carried out. The disadvantage of the study is its retrospective nature. A thickening of the rectal wall is characteristic of SRU. This has been shown both in our study and in others [8–11]. In most of our patients with ulcerative and mixed forms of SRU, as well as with SRU by the type of mucosal hyperemia, thickening of the rectal wall occurred due to the muscular and submucosal layers. Other researchers have also noted a thickening of the muscle layer in the SRU area [8–10,12]. In the studies by Blanco, F., et al. and Simsek, A., et al., cases of SRU (5 patients) were described where not only pronounced thickening was observed in the area of ulcerative lesions, but also a change in the structure of the muscle layer, simulating tumor invasion into the pararectal tissue [13,14]. In the study, in 8 patients, in the area of thickening of the muscular layer, the outer contour of the intestine was uneven, which could also be regarded as an 'invasion'. Petritsch, W., et al. and Sharma, M., et al. also noted visualization of the connective tissue layer in the muscle layer in the SRU area [11,12].

In some patients, single or multiple cystic inclusions, resembling changes in deep cystic colitis, are observed in the submucosal layer in the SRU area and outside it [11,16]. Such inclusions were found in 4 patients in our study, as well as in the works by Hizawa, K., et al. and Cola, B., et al. [9,15]. In the studies by Van Outryve, M., et al., Petritsch, W., et al., Blanco, K., et al., cystic inclusions in the submucosal layer were not detected in patients with SRU [8,11,14]. In this study, enlarged lymph nodes were found in the pararectal tissue in some patients with SRU. In one of the SRU cases described by Blanco, F., et al., a lymph node was detected in the pararectal tissue [14]. Tang, X., et al. noted that in none of the SRU cases lymph nodes in the pararectal tissue were visualized, which does not coincide with our data [10].

Just as in this study, most of the SRU described in the literature are represented by ulcerative lesions.

In the study by Van Outryve, M., et al., in 8/13 (62%) patients with ulcerative form of SRU, the lesion looked like an 'echogenic section of the rectal wall layer that violates its continuity', those areas were visualized within the mucous layer [8]. The described changes are similar to the areas we have detected in the SRU area, where the mucous layer was not traced. In the studies by Van Outryve, M., et al., Tang, X., et al., Sharma, M., et al., in the area of ulcerative lesions, the margins between the layers of the rectal wall were 'faded' [8,10,12]. Blanco, F., et al. described a case of transmural SRU imitating an invasive tumor: the structure of the rectal wall in the area of the ulcerative lesion

was severely impaired, the layers of the rectal wall did not differentiate, and there was reduced echogenicity [14]. In the study by Tang, X., et al., thickening of the mucous and submucosal layers was described in all 4 patients with ulcerative lesions [10]. In our study, the predominance of the mucous layer was not observed in patients with ulcerative and mixed forms of SRU. This discrepancy is probably due to the different sizes of polypoid formations contributing to the thickening of the mucous layer: in the study by Tang, X., et al., in all patients, large polypoid growths were observed along the edges of ulcerative lesions, whereas in our study there were single formations of 2–4 mm in size. In both patients of Tang, X., et al. with SRU with the type of focal hyperemia of the mucous layer, thickening of the rectal wall due to the muscle layer was observed [10]. In our study, in most patients with this form of SRU, thickening of the rectal wall occurred due to the muscular and submucosal layers. Thickening of the submucosal layer may be a consequence of internal or external rectal prolapse, which was absent in patients of Tang, X., et al., but was observed in our patients.

In our study, in the case of the polypoid form, in most cases, the predominance of the mucous or mucous and submucosal layers was observed in the SRU area.

In the study by Tang X., et al., local thickening of the rectal wall due to all layers, with a predominance of the mucous layer, was noted in all 4 patients with the polypoid form of SRU, which is consistent with our data [10]. In the studies by Hizawa, K., et al. and Cola, B., et al., the polypoid form of SRU was represented by a local thickening of the submucosal layer [9,15]. The conducted ultrasound-endoscopic parallels allow us to suggest that the detected forms of SRU are sequentially transitioning stages of a single process. However, it was not possible to find confirmation of this in the literature sources available to us.

CONCLUSION

Thus, with TRUS SRU is represented by a significantly thickened section of the rectal wall, most often with a predominance of the muscular and submucosal layers, the structure and echogenicity of which are changed: the connective tissue layer is visualized in the muscular layer, the echogenicity of the submucosal layer is lowered, the boundaries between the layers of the rectal wall are 'faded'. The characteristics of the mucous layer (its preservation, the presence of local thickening) make it possible to differentiate between macroscopic forms of SRU ('mucosal hyperemia', ulcerative, polypoid and mixed forms). The developed ultrasonic semiotics of SRU will allow the use of TRUS in the diagnostic program in patients along with endoscopy and monitoring at the stages of treatment.

AUTHORS CONTRIBUTION

Concept and design of the study: *Yuliya L. Trubacheva*

Collection and processing of the material: *Anastasiya E. Pershina*

Writing of the text: *Anastasiya E. Pershina*

Editing: *Yuliya L. Trubacheva, Viktor V. Veselov, Oleg M. Biryukov, Olga A. Mainovskaya*

INFORMATION ABOUT THE AUTHORS (ORCID)

Yuliya L. Trubacheva — 0000-0002-8403-195X

Anastasiya E. Pershina — 0000-0002-4884-876X

Viktor V. Veselov — 0000-0001-9992-119X

Oleg M. Biryukov — 0000-0002-1081-1793

Olga A. Mainovskaya — 0000-0001-8189-3071

REFERENCES

1. Madigan MR, Morson BC. Solitary ulcer of the rectum. *Gut*. 1969;10:871–881. doi: 10.1136/gut.10.11.871

2. Sadeghi A, Biglari M, Forootan M, et al. Solitary rectal ulcer syndrome: A narrative review. *Middle East Journal of Digestive Diseases*. 2019;11(3):129–134. doi: 10.15171/mejdd.2019.138

3. Rutter KR. Electromyographic changes in certain pelvic floor abnormalities. *Proceedings of the Royal Society of Medicine*. 1974;67(1):53–56.

4. Rutter KR. Solitary rectal ulcer syndrome. *Proceedings*

of the Royal Society of Medicine. 1975;68(1):22–26.
5. Alexander-Williams J. Solitary-ulcer syndrome of the rectum. Its association with occult rectal prolapse. *Lancet*. 1977;1(8004):170–171. doi: 10.1016/s0140-6736(77)91766-4
6. Nuernberg D, Saftoiu A, Barreiros AP, et al. EFSUMB Recommendations for Gastrointestinal Ultrasound Part 3: Endorectal, Endoanal and Perineal Ultrasound. *Ultrasound international open*. 2019;5(1):E34–E51. doi: 10.1055/a-0825-6708
7. Nylund K, Maconi G, Hollerweger A, et al. EFSUMB Recommendations and Guidelines for Gastrointestinal Ultrasound. *Ultraschall in der Medizin*. 2017;38(3):e1–e15. doi: 10.1055/s-0042-115853
8. VanOutryve MJ, Pelckmans PA, Fierens H, et al. Transrectal ultrasound study of the pathogenesis of solitary rectal ulcer syndrome. *Gut*. 1993;34(10):1422–1426. doi: 10.1136/gut.34.10.1422
9. Hizawa K, Iida M, Suekane H, et al. Mucosal prolapse syndrome: diagnosis with endoscopic US. *Radiology*. 1994;191(2):527–530. doi: 10.1148/radiology.191.2.8153334
10. Tang X, Han C, Sheng L, et al. Rectal mucosal prolapse with an emphasis on endoscopic ultrasound appearance. *Digestive and liver disease: official journal of the Italian Society of Gastroenterology and the Italian Association for the Study of the Liver*. 2021;53(4):427–433. doi: 10.1016/j.dld.2020.11.023
11. Petritsch W, Hinterleitner TA, Aichbichler B, et al. Endosonography in colitis cystica profunda and solitary rectal ulcer syndrome. *Gastrointestinal endoscopy*. 1996;44(6):746–751. doi: 10.1016/s0016-5107(96)70067-6
12. Sharma M, Somani P, Patil A, et al. Endoscopic ultrasonography of solitary rectal ulcer syndrome. *Endoscopy*. 2016;48:E76–E77. doi: 10.1055/s-0042-102449
13. Simsek A, Yagci G, Gorgulu S, et al. Diagnostic Features and Treatment Modalities in Solitary Rectal Ulcer Syndrome. *Acta Chirurgica Belgica*. 2004;104(1):92–96. doi: 10.1080/00015458.2003.11978402
14. Blanco F, Frasson M, Flor-Lorente B, et al. Solitary rectal ulcer: Ultrasonographic and magnetic resonance imaging patterns mimicking rectal cancer. *European Journal of Gastroenterology and Hepatology*. 2011;23(12):1262–1266. doi: 10.1097/MEG.0b013e32834b0dee
15. Cola B, Cuicchi D, Dalla Via, B, et al. Endosonographic pattern of solitary polypoid rectal ulcer. *Techniques in Coloproctology*. 2005;9(1):71–72. doi: 10.1007/s10151-005-0199-0
16. Hulsmans FJ, Tio TL, Reeders JW, et al. Transrectal US in the diagnosis of localized colitis cystica profunda. *Radiology*. 1991;181(1):201–203. doi: 10.1148/radiology.181.1.1887033