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## Diagnostic Criteria for Complicated Diverticular Disease of the Colon Using Contrast-Enhanced Computed Tomography

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### Abstract

Despite extensive research and publications on diverticular disease of the colon (DDC), the diagnostic algorithm and treatment strategy remain subjects of ongoing debate. The incidence of DDC is steadily increasing. The age distribution of patients diagnosed with complicated and uncomplicated DDC is as follows: under 30 years – less than 1%, under 40 years – 5%, under 60 years – 30%, and over 80 years – 50-60%. Approximately 10-25% of patients develop diverticulitis, and 15% of them experience a more severe complication – perforation with peritonitis.

Our study aimed to develop diagnostic criteria for complications of diverticular disease of the colon (DDC) using contrast-enhanced computed tomography (CT) for determining treatment tactics.

Methodically we analyzed 128 CT scans with intravenous contrast performed on patients with various manifestations of DDC complications, who were treated at the proctology department of the Minsk Regional Clinical Hospital between January 2020 and December 2023. Bowel preparation was carried out using a special diet and laxatives containing polyethylene glycol.

A risk assessment scale was developed and four risk groups were formed, to which patients were assigned depending on the number of points: 0 points - no risk, 1-3 points - low risk, 4-5 points - moderate risk, 6 or more points – high risk.

According to the results of our study, we determined the extent of diverticula distribution along the segments of the colon: isolated sigmoid - 71 (55.5%), left colon - 38 (29.7%), right colon - 1 (0.8%), total involvement - 18 (14%). Establish the localization of diverticula in relation to the mesentery was established: mesenteric border – 67 (52.3%), anti-mesenteric (free) border - 23 (18%), mixed localization (mesenteric and anti-mesenteric) - 38 (29.7%).

The analysis of the obtained results allowed us to determine the treatment tactics for each patient depending on the nature of the existing complications of diverticular disease of the colon.

Using a diagnostic map during computed tomography with bolus contrast is key for developing diagnostic criteria for complications of diverticular colon disease. Diagnostic maps are essential for accurate diagnosis and preoperative treatment planning.

**Key words:** CT, diverticular disease, bowel

## Introduction

Despite extensive research and publications on diverticular disease of the colon (DDC), the diagnostic algorithm and treatment strategy remain subjects of ongoing debate [1,2]. The incidence of DDC is steadily increasing. The age distribution of patients diagnosed with complicated and uncomplicated DDC is as follows: under 30 years – less than 1%, under 40 years – 5%, under 60 years – 30%, and over 80 years – 50-60% [3]. Clinical manifestations of the disease are variable, ranging from discomfort with mild abdominal pain to intestinal obstruction and peritonitis [4,5]. Approximately 10-25% of patients develop diverticulitis, and 15% of them experience a more severe complication – perforation with peritonitis [6,7]. The absolute prevalence of peritonitis in DDC is relatively low. However, its danger lies in the significant postoperative mortality, ranging from 4 to 26% regardless of the chosen surgical strategy [8]. The key to selecting the correct treatment for a particular form of DDC is a timely and well-founded diagnosis, taking into account both instrumental data and clinical manifestations [9,10].

Currently, there are over 30 different classification systems for diverticular disease of the colon. Of these, about ten are widely used [11]. The main drawbacks of these classifications include their artificial nature (a simple listing of known phenomena) and violation of the principle of mutually exclusive categories (a situation where the same clinical case can be assigned to different groups) [12,13]. The emergence of new diagnostic methods, such as computed tomography, which began to be widely used in many countries around the world since the mid-20th century, served as the basis for the development of a new type of classification taking into account computed tomography gradations of the course of diverticular disease of the colon. In 1989, Neff C.C. et al. proposed their classification, based on the results of computed tomography and including 5 stages [14,15]:

0. Uncomplicated diverticulitis; diverticulum, wall thickening, increased density of pericolic fat;
1. Localized complication with local abscess;
2. Pelvic abscess;
3. Presence of distant abscesses;
4. Presence of other complications.

In recent years, computed tomography (CT) has gained increasing importance and has become the gold standard for determining the radiographic stage of the disease and differentiating complicated from uncomplicated cases of diverticular disease of the colon. However, therapeutic decisions made based on CT results should assume a correspondence between the nature of the inflammatory process as revealed by radiographic, clinical, and intraoperative findings, which is not always possible [16,17].


### **Objective of the Study:**

To develop diagnostic criteria for complications of diverticular disease of the colon (DDC) using contrast-enhanced computed tomography (CT) for determining treatment tactics.

### **Materials and Methods:**

To achieve our goal, we analyzed 128 CT scans with intravenous contrast performed on patients with various manifestations of DDC complications who were treated at the proctology department of the Minsk Regional Clinical Hospital between January 2020 and December 2023. The group included 69 women (53.9%) aged 34 to 86 years (mode = 58, median = 61.5) and 59 men (46.1%) aged 30 to 82 years (median = 54, mode = 59). During the CT scan with contrast, we evaluated pathological changes in the colon wall, its lumen, and the organs of the abdomen and pelvis in general, according to the diagnostic map we developed for this purpose (Table 1). Bowel preparation was carried out using a special diet and laxatives containing polyethylene glycol. The CT scan with contrast was performed in stages: first, a native scan, then scanning with bolus contrast in the late arterial, portal, and parenchymal phases. The bolus injection rate of the contrast agent was 3.5-5.0 ml/sec. The number of bolus phases was 3: 1st - saline, 2nd - contrast agent, 3rd - saline. This allowed us to thoroughly study the pathological changes and determine the segmental involvement of the colon wall with uncomplicated and complicated diverticula and their connections with other organs of the abdomen and pelvis. To avoid adverse reactions to intravenous contrast administration, all patients underwent a questionnaire the day before the CT scan with contrast to determine the risk of allergic reactions and signed a voluntary written informed consent, which indicated the purpose of the study, the features of the procedure, and possible complications. The questionnaire included a variety of questions, such as: the presence of any type of allergy, whether any studies with contrast media had been performed before and what the consequences were (manifestations of an allergic reaction from skin reactions to anaphylactic shock), the presence of chronic diseases (diabetes mellitus, bronchial asthma, renal failure, etc.), and pregnancy. Numerical values were assigned to the answers. As a result of calculating the sum of the scores, a risk assessment scale was developed and four risk groups were formed, to which patients were assigned depending on the number of points: 0 points - no risk (CT with contrast can be performed); 1-3 points - low risk (CT with contrast can be performed); 4-5 points - moderate risk (weigh the pros and cons, consider alternatives); 6 or more points - high risk: (CT with contrast is contraindicated, seek alternatives).

Table 1. Computed tomographic diagnostic chart of diverticular colon disease with bolus contrast (innovation proposal – certificate No. 289/24, 06/24/2021/ “Belarusian Medical Academy of Postgraduate Education”

- full name: gender: F/M – age: - weight: - height: - medical chart number - place of residence: - time spent on the procedure\min: - radiation exposure\mSv: - 18G (зелёный), 20G (розовый)\used catheter for IV: 18G (green), 20G (pink). - the model of the device used: - Date of filling in the protocol: «----»«--»«-----»Г.			 <p>Segments of the large intestine</p>			- Slice plane: axial. - reconstructions: coronal, sagittal, - MIP-reconstruction, 3D-reconstruction, - contrast agent: - Contrast enhancement: - volume of contrast medium: - colon cleansing: yes/no					
Segments of the large intestine			1	2	3	4	5	6	7	8	9
The wall of the colon	Its diameter\мм-mm										
	Its layers	Differentiated									
		Poorly differentiated									
		Not differentiated									
Её толщина - Its thickness\мм-mm											
Gastration	Reinforced										
	Absent										
	Uneven										
	Saved										
Mesenteric l/nodes	Enlarged										
	Not enlarged										
Intestinal blood stream	Not defined										
	Weak										
	Reinforced										
Diverticula	Their number	≤ 4									
		5-9									
		≥10									
	Their localization	Mesenteric margin									
		Anti mesenterial margin									
		Mixed									
Размер/мм Size\mm	The largest										
	The smallest										
Co mpla cte	Co mpla cte	Diverticulitis with infiltrate <3 cm									



in the remaining segments of the colon these changes are preserved.

## **2. Occult perforation of the diverticulum:**

### **2.1. Infiltrative occult perforation of the diverticulum. CT findings.**

Diverticula have a mesenteric or mixed localization, the source of occult perforation is the mesenteric border in 100% of cases. The integrity of the colon wall in the area of the bottom of the inflamed diverticulum is disrupted. There is a thickening of the colon wall and a narrowing of its lumen. The mesentery is infiltrated with regional lymphadenopathy. Dynamic changes in the colon wall (peristalsis) in the area of the infiltrate are absent, in the remaining segments of the colon, peristalsis is preserved. Depending on the thickness of the colon wall in the area of the inflammatory process, its extent and the size of the infiltrate, it is necessary to distinguish three degrees of change in the colon lumen.

**Marginal deformation of the colon wall** (without impaired intestinal passage).

Colon wall thickness: 0.6-0.7 cm, length of deformation: 3-4 cm, mesentery infiltrate size: 4-5 cm

**Stenosis of the colon lumen** (compensated impaired intestinal passage).

Circular wall thickness: 0.8-0.9 cm, stenosis length: 5-6 cm, mesentery infiltrate size: 6-7 cm

**Obstruction of the colon lumen** (decompensated impaired intestinal passage).

Circular wall thickness: 1.0-1.2 cm, obstruction length:  $\geq 7$  cm, mesentery infiltrate size:  $\geq 8$  cm.

### **2.2. Abscessing occult perforation of the diverticulum. CT findings.**

Diverticula has mesenteric or mixed location; Source of inflammation is mesenteric border in 100% of cases; Presence of gas and fluid in the abscess cavity (Hounsfield units: -150, -1000 HU and +5, +80 HU respectively) Absence of dynamic changes in the colon wall (peristalsis) in the area of the abscess; peristalsis is preserved in other segments of the colon.

**3. Perforation of the diverticulum with the development of diffuse purulent/fecal peritonitis. CT findings.** Diverticula location: Antimesenteric or mixed Perforation: Occurs due to diverticula of the free (antimesenteric) border Presence of gas and fluid of a mixed nature in the abdominal cavity (Hounsfield units: -50 HU, -1000 HU and +50 HU, +125 HU respectively) Widespread infiltration and clouding of the mesenteric and omental fat; asymmetric thickening and enhanced contrast of the peritoneum. Absence of dynamic changes in the colon wall (peristalsis).

**4. Intestinal fistulas** (internal and external). The development of intestinal fistulas in diverticular disease occurs in two stages: formation and functioning of the fistula.

**CT findings:** Diverticula are located on the anti-mesenteric border or mixed; the formation of fistulas occurs due to diverticula of the free (anti-mesenteric) border in 100%; tight adhesion of the colon wall to the adjacent organ. With native scanning and after bolus contrast: densification of the mesenteric and omental fat, thickening of the peritoneum in the area of the forming fistula tract. At the functioning stage, visualization of the fistula tracts is noted with non-contrast examination and after contrast administration. Dynamic changes in the colon wall (peristalsis) in the area of the fistula are absent, in the remaining segments peristalsis is enhanced.

## Discussion

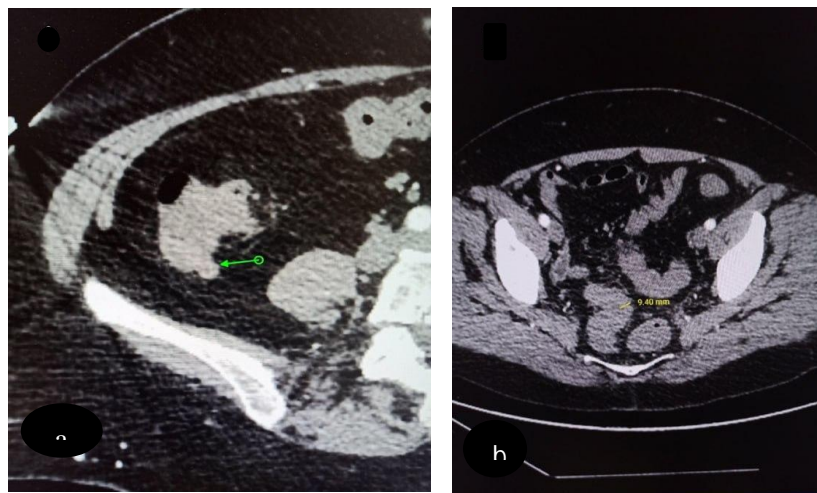
Thus, the analysis of the obtained results allowed us to determine the treatment tactics for each patient depending on the nature of the existing complications of diverticular disease of the colon, where the following groups were identified:

- 54 (42.2%) patients with diverticulitis were admitted to the hospital with the first attack of the disease. At this stage, all received medical therapy and were discharged home after improvement. Within the next year, 26 (48.1%) of them were re-hospitalized with a more severe clinical picture and serious complications. They were provided with surgical care in accordance with the complications that arose. The remaining 28 (51.9%) patients continue to be treated conservatively;
- 51 (39.8%) patients with infiltrative covered perforation, depending on the nature of the infiltrate, the following pathological changes in the wall of the colon and its lumen were diagnosed: **marginal deformity** in 21 (41.2%), without impaired bowel passage, which was an indication for elective surgery, **stenosis of the colon lumen** in 22 (43.1%) patients with compensated impaired bowel passage, these patients also underwent elective surgery, and **obstruction of the colon lumen** in 8 (15.7%) patients with decompensated large bowel obstruction (acute obstructive large bowel obstruction), which was an indication for emergency surgery;
- 14 (11%) patients with abscessing covered diverticular perforation, who were operated on urgently after a comprehensive examination and a short course of conservative therapy.
- 19 (14.8%) patients with perforation of the diverticulum into the free abdominal cavity with peritonitis, in 4 of them, according to the history, spontaneous perforation without a previous clinic was noted, patients in this group were operated on urgently;
- 16 (12.5%) patients with various intestinal fistulas: external - 7 (43.7%), internal - 9 (56.3%), these patients were operated on electively.

**Our observation:** Patient R., born in 1963, was admitted to the emergency department of the Minsk Regional Clinical Hospital with complaints of abdominal pain, which intensified with palpation in the left iliac region, disordered bowel movements for the past two weeks, loss of appetite, and general weakness. According to a colonoscopy performed a year prior, the patient had diverticula of the colon of various sizes (from 4 to 8 mm in diameter) without signs of inflammation.

She was hospitalized in the proctology department for further examination and treatment. A fibrogastroduodenoscopy, computed tomography (CT) with bolus contrast of the abdominal cavity (AC) and pelvic organs (PO), and an additional irrigoscopy were performed.

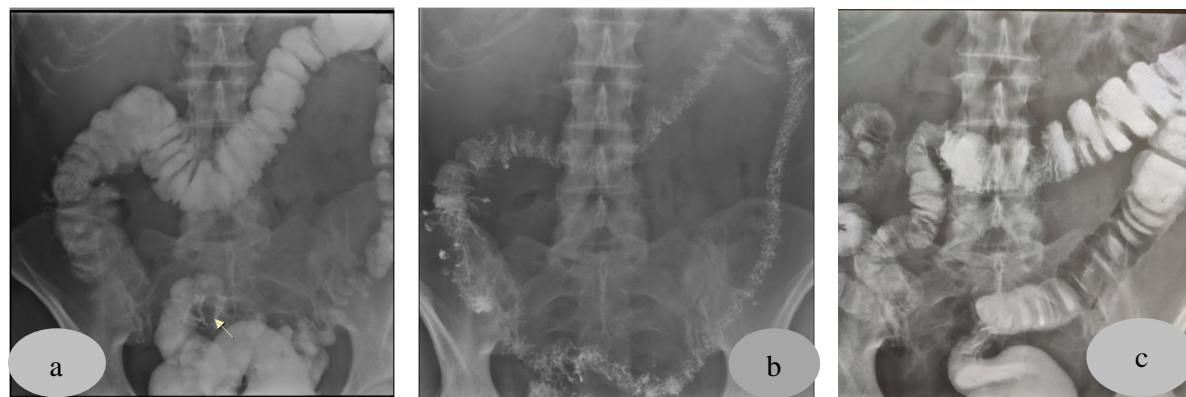
CT of the AC and PO with bolus contrast revealed a thickening of the sigmoid colon wall up to 9 mm, approximately 100 mm in length, a blurred contour of the colon in the area of wall thickening, and densification of the adjacent tissue. Multiple diverticula of the left and right colonic flexures of various sizes from 5 to 9 mm in diameter were found. (Fig. 1).



**Fig. 1.** CT of abdominal organs with bolus contrast: a) the diverticulum of the colon (indicated by an arrow), round in shape, 8 mm in diameter, without signs of diverticulitis (has clear smooth contours, adjacent fatty tissue, the intestinal wall in the adjacent sections are not changed); b) a section of the sigmoid colon up to 10 cm long with a wall thickened to

9 mm, the outer contour of the intestine in this area is indistinct, the adjacent fiber is somewhat compacted, the mesentery is heavy, small lymph nodes are visualized along the mesentery (short axis – up to 4 mm).

During the examination to determine the boundaries of the proposed colon resection, an irrigoscopy with double contrast was performed in three stages: 1) tight filling of the large intestine with barium suspension; 2) emptying of the bowel with study of the relief; 3) inflation of the bowel with air, which allowed us to confirm the presence of diverticula in the wall and partially characterize the existing complications (Fig. 2).



**Fig. 2.** Aiming R-grays obtained by barium enema (irrigoscopy) with double contrast during tight filling and emptying:

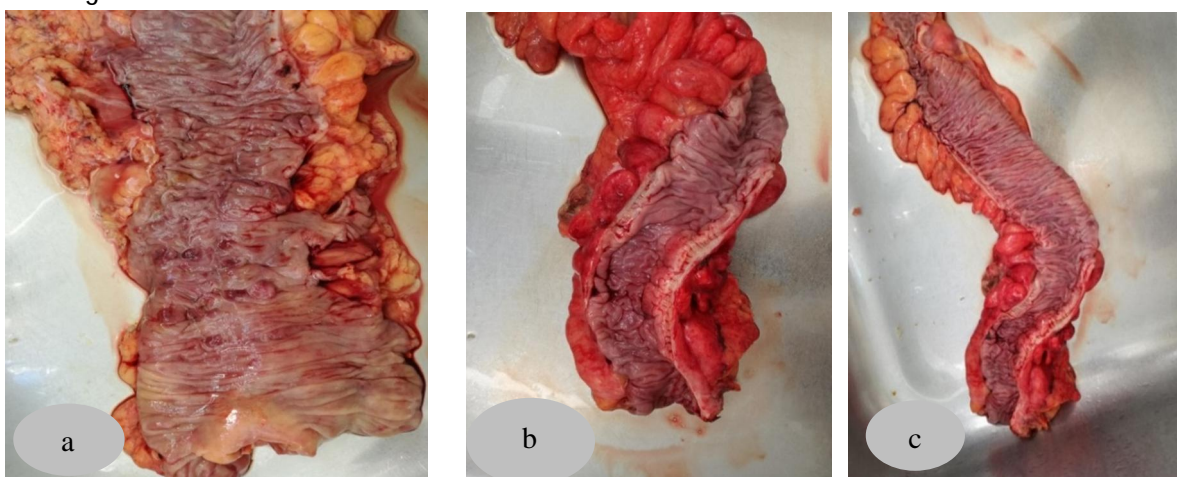
- a) irrigoscopy with tight filling of the colon (clearly visible covered perforation of the sigmoid colon with stenosis of its lumen – indicated by an arrow);
- b) irrigoscopy after emptying the large intestine, many diverticulae of the left and right flanks of the colon are visualized;
- c) control irrigoscopy (one year after surgery), well-functioning End-to-end ileotransversoanastomosis and End-to-end transversorectoanastomosis are visible

Based on the results of instrumental examinations (CT with bolus contrast and irrigoscopy), the following diagnosis was made: Diverticular disease of the left colon, complicated by covered



perforation with an infiltrate and stenosis of the sigmoid colon. Diverticular disease of the right colon with diffuse hypertrophy of its layers.

Intraoperative findings: During the revision of the abdominal organs, a large infiltrate was found in the region of the rectosigmoid junction with involvement of the sigmoid wall and its mesentery. In the right lateral channel, numerous adhesions were found involving the cecum, ascending colon, and greater omentum. Operation performed: left hemicolectomy with formation of a transverse-recto-anastomosis "end-to-end", right hemicolectomy with formation of an ileo-transverse anastomosis "end-to-end", omentopexy. At the end of the operation, a visual assessment of the gross specimens was performed (Fig. 3). The right colon had multiple diverticula with signs of chronic inflammation. The left colon had multiple diverticula, stenosis of the lumen, and a thickened wall approximately 10 cm in length.



**Fig. 3.** Gross morphology:

- a) the right flank of the colon with diverticula and signs of inflammation;
- b) the left flank of the colon with covered perforation of the diverticulum and stenosis of the sigmoid colon length = 10 cm;
- c) diverticula of the left flank of the colon with hypertrophy of its wall throughout.

**Conclusions.** Diverticular disease of the colon and its complications pose a significant problem, not only medically but also socially, requiring a systematic approach and close collaboration between physicians of diagnostic specialties and surgeons. The use of a diagnostic map when performing computed tomography with bolus contrast is an important tool for developing diagnostic criteria for complications of diverticular disease of the colon. Diagnostic maps are a necessary condition for making a correct diagnosis and determining the treatment tactics in the preoperative period.

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## მსხვილი ნაწლავის გართულებული დივერტიკულური დაავადების დიაგნოსტიკური კრიტერიუმები, კონტრასტით გაძლიერებული კომპიუტერული ტომოგრაფიის გამოყენებით

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<sup>2</sup>ასოც. პროფესორი, კომპიუტერული ტომოგრაფიის განყოფილების ხელმძღვანელი, მინსკის რეგიონული კლინიკური ჰოსპიტალი, მინსკის რეგიონი, ბელორუსიის რესპუბლიკა;

<sup>3</sup>ზოგადი ქირურგიის კადეტრის რეზიდენტი, ჯანდაცვის პერსონალის მომზადებისა და გადამზადების საგანმანათლებლო დაწესებულება, ბელორუსიის სახელმწიფო სამედიცინო უნივერსიტეტი, მინსკის რეგიონი, ბელორუსიის რესპუბლიკა.

### აბსტრაქტი

მიუხედავად მსხვილი ნაწლავის დივერტიკულოზის (მნდ) ფართომასშტაბიანი კვლევისა და გამოქვეყნებული მასალებისა, დიაგნოსტიკური ალგორითმი და მკურნალობის სტრატეგია კვლავ დისკუსიის საგანია. მნდ-ის შემთხვევების რაოდენობა მუდმივად მზარდია.

გართულებული და ჩვეულებრივი დივერტიკულოზის დიაგნოზით პაციენტების ასაკობრივი განაწილება შემდეგია: 30 წლამდე - 1%-ზე ნაკლები, 40 წლამდე - 5%, 60 წლამდე - 30% და 80 წელზე მეტი - 50-60%. პაციენტების დაახლოებით 10-25%-ს უვითარდება დივერტიკულიტი და მათგან 15%-ს უვითარდება უფრო მძიმე გართულება - პერფორაცია პერიტონიტით.

ჩვენი კვლევის მიზანი იყო მნდ-ის გართულებების დიაგნოსტიკური კრიტერიუმების შემუშავება კონტრასტირებული კომპიუტერული ტომოგრაფიის (კტ) გამოყენებით მკურნალობის ტაქტიკის განსაზღვრისთვის.

მეთოდურად გავანალიზეთ 128 კტ სკანირება ინტრავენური კონტრასტით, რომელიც ჩატარდა მნდ-ის სხვადასხვა გამოვლინებების მქონე პაციენტებზე, რომლებიც მკურნალობდნენ „მინსკის რეგიონულ საკლინიკო საავადმყოფოს“ პროქტოლოგიის განყოფილებაში 2020 წლის იანვრიდან 2023 წლის დეკემბრამდე. ნაწლავების მომზადება ჩატარდა სპეციალური დიეტისა და პოლიეთილენგლიკოლის შემცველი საფაღარათო საშუალებების გამოყენებით.

შემუშავდა რისკის შეფასების სკალა და ჩამოყალიბდა ოთხი რისკ-ჯგუფი, რომლებშიც პაციენტებს განათავსებდნენ ქულების რაოდენობის მიხედვით: 0 ქულა - რისკი არ არის, 1-3 ქულა - დაბალი რისკი, 4-5 ქულა - საშუალო რისკი, 6 ან მეტი ქულა - მაღალი რისკი. ჩვენი კვლევის შედეგების მიხედვით, განვსაზღვრეთ დივერტიკულების გავრცელების ხარისხი მსხვილი ნაწლავის სეგმენტების გასწვრივ: იზოლირებული სიგმოიდური - 71 (55.5%), მარცხენა მსხვილი ნაწლავი - 38 (29.7%), მარჯვენა მსხვილი ნაწლავი - 1 (0.8%), სრულად ჩართულობა - 18 (14%).

დადგინდა დივერტიკულების მდებარეობა მეზენტერიის მიმართ: მეზენტერული კიდე - 67 (52.3%), ანტიმეზენტერული (თავისუფალი) კიდე - 23 (18%), შერეული მდებარეობა (მეზენტერული და ანტიმეზენტერული) - 38 (29.7%). მიღებული შედეგების ანალიზმა საშუალება მოგვცა განვსაზღვროთ მკურნალობის ტაქტიკა თითოეული პაციენტისთვის მსხვილი ნაწლავის დივერტიკულოზის არსებული გართულებების ბუნების მიხედვით.

ბოლუსური კონტრასტით კომპიუტერული ტომოგრაფიის დროს დიაგნოსტიკური რუკის გამოყენება საკვანძოდ მნიშვნელოვანია კოლონის დივერტიკულოზის გართულებების დიაგნოსტიკური კრიტერიუმების შემუშავებისთვის. დიაგნოსტიკური რუკები აუცილებელია ზუსტი დიაგნოზისა და ოპერაციამდელი მკურნალობის დაგეგმვისთვის.

**საკვანძო სიტყვები:** კტ, დივერტიკულოზი, ნაწლავი.