COMPUTER TOMOGRAPHY IN THE DIAGNOSIS OF SMALL BOWEL DISEASES

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Introduction. *The relevance of the study is caused by the difficulties in diagnosing diseases of the small bowel (SB). Due to the prevalence and widespread introduction of X-ray computed tomography (CT) into clinical practice, its capabilities in the diagnosis of small bowel diseases are of great interest and potential.* ***Objective.*** *to reveal the possibilities of computed tomography using intravenous bolus contrast enhancement in identifying the symptom of "wall thickening" of the small bowel and its prognostic significance in various nosologies.* ***Methods.*** *Analysis of the data from MSCT studies performed according to the Protocol for the study of abdominal organs using intravenous bolus contrast enhancement and oral water intake in adult patients from 18 to 87 years of age with small bowel diseases.* ***Results.*** *The article shows the possibilities of multispiral computed tomography performed according to the standard Protocol in detecting thickening of the SB wall. The range of diseases was determined for which thickening of the SB wall was one of the main radiological symptoms of the lesion. The prognostic significance of this radiological symptom is presented. The features of thickening of the intestinal wall in various diseases and other distinctive features that can be used in the differential diagnosis are described.* ***Conclusion.*** *Thickening of the wall is a common sign of SB damage, which is convincingly detected in CT studies with bolus contrast enhancement. In our study, the common causes of thickening of the SB wall in primary disease were: Crohn's disease (37%), lymphoma (20%) and anastomosis (13%). However, we determined thickening of the SB wall as a result of primary tumors (adenocarcinoma, sarcoma) in 7% and as a result of a secondary tumor lesion in 18.6% of cases. The considered diseases were different in the degree of thickening of the intestinal wall (from 6 to 70 mm), its spreading (focal thickening — 48%; segmental — 52%), number of affected areas (from 1 to 3) of their localization (proximal-middle or distal section), form of the transition area from the affected part of the intestine to the unchanged one (sharply defined or smooth), the presence or absence of symptoms of intestinal obstruction, and the features of contrast enhancement (severity and type).*

Keywords: *computed tomography, small intestine, Crohn's disease, lymphoma, adenocarcinoma, metastases.*

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BACKGROUND

For many decades, the X-ray method has been used in the diagnosis of pathology of the small intestine (SI), which included filling the intestine *per os* and probe enterography with barium suspension or double contrasting. Filling the intestines *per os* is easily tolerated bypatients, but the information obtained is minimal. Probe enterography (enteroclysis), proposed in 1986 as an alternative to operative enteroscopy used since the 1950s, allows for a more detailed assessment of SI, but it causes discomfort for the patient, thus requiring the use of anesthesia [1, 2]. With the advent of enteroscopy, endoscopic diagnostics became possible, and the method of active enteroscopy (push enteroscopy) allows the examination of the proximal sections of the jejunum, but not more than 100 cm behind the ligament of Treitz. The examination was technically difficult to perform, prolonged, and uncomfortable for the patient, involving sedation and intravenous anesthesia [3, 4].

The introduction of video capsule enteroscopy into clinical practice in 2001 opened a new stage in the diagnosis of SI diseases. This noninvasive method allows the evaluation of the internal lumen of the SI along the entire length and reveal intraluminal formations and strictures. With the introduction of video capsule enteroscopy, it became possible to visualize the distal SI, which increased the revealed cases of its pathology [5, 6]. The diagnostic value of video capsule enteroscopy varies from 63% to 90%. However, the method also has its restrictions, such as the impossibility of taking a biopsy sample, errors in determining the localization of the pathological process due to the anatomical variability of the SI length, and delayed video capsules in the stricture area with the need for emergency surgery.

An absolute breakthrough in the diagnosis of SI pathology was the development and implementation in practice of instrumental-associated types of video enteroscopy, namely, double-balloon and single-balloon enteroscopy. Double-balloon enteroscopy was developed by Dr. H. Yamamoto et al. [7] in 2001. Further improvement and simplification of the execution technique led to the introduction in 2007 of single-balloon enteroscopy, which is not inferior in diagnostic efficiency to double-balloon [8, 9]. The fixation of the intestine increases the maneuverability of the endoscope with the possibility of a repeated visual passage through the same area, with biopsy sampling, localization “mark” placement, and even resection of small intraluminal formations. The diagnostic accuracy of the double-balloon enteroscopy method reaches 80–96%, and according to the literature, complications are rare and are represented mainly by pain in the abdominal cavity [10].

As a simpler and relatively quick alternative method, spiral enteroscopy, which is more often used by specialists in Europe and the USA, using a spiral splint tube, was recently developed [11]. The concept of “rotation for advancement” in spiral enteroscopy, implemented in a device that facilitates the moving forward of an enteroscope, was proposed in 2006 by Paul Akerman [12]. Spiral enteroscopy uses the conversion of rotational force into a linear force, “picking up” the SI on the enteroscope. However, to perform the procedure, an assistant is required to rotate the tube. The method, like double- or single-balloon enteroscopy, requires deep sedation or anesthesia. Complications in the form of SI wall perforation in this type of study are 0.3%.

With the development of computed tomography (CT) scans and the emergence of multislice/multidetector devices with obtaining submillimeter slices, specialized research methods, such as CT enteroclysis and CT enterography, have been introduced into practical work. In the case of CT enteroclysis, an

X-ray negative or X-ray contrast agent is usually injected through the nasointestinal probe into the duodenum or proximal jejunum, approximately 30 cm distal to the Treitz ligament, with balloon fixation of the tip. CT enterography does not require additional devices. X-ray negative or X-ray contrast agent is taken orally. The sensitivity of the CT enterography method reaches 90%, and the specificity for Crohn's disease and tumor lesions is up to 95–98% [13, 14]. Compared with capsular endoscopy and instrumental-associated video enteroscopy, the CT enterography technique is slightly inferior in assessing the SI mucous membrane, exceeding them significantly in assessing transmural lesions of the wall, with pathological changes beyond its limits, as well as in diagnostics of hemorrhage and tumors [15]. The technique is not invasive, and it does not require sedation or anesthesia of the patient. The difficult points include the dependence on the preparation of the patient for the study, bowel spasm, and the possible presence of an allergy to an iodine-containing contrast agent. Nevertheless, CT methods for studying SI give an excellent result since they provide a visualization of the intestinal wall thickness, detect intraluminal/extraluminal and intramural formations, and assess the condition of adjacent adipose tissue and mesentery, blood vessels, and lymph nodes [16].

There are only a few publications on magnetic resonance (MR) enterography and MR enteroclysis. Liquids are used to contrast the intestines. SI MR imaging (MRI) involves filling the intestine with water through an intestinal probe inserted behind the Treitz ligament or *per os*. The bright lumen methods are used based on obtaining T2-WI in a fast pulse sequence and dark lumen on T1-WI with simultaneous intravenous administration of a contrast agent and dynamic contrasting [17–19]. The limitations of MRI in the study of SI, in addition to the contraindications of this method, are mediated by a long "exposure" when receiving a slice and dependence on peristalsis. The drug glucagon that used to suppress peristalsis is contraindicated in diabetes mellitus, hyperglycemia, and pancreatic and adrenal gland formations.

Thus, the diagnosis and treatment of SI diseases have been and remain relevant issues. Because of the introduction of new methods and techniques into medical practice, the diagnosis of SI pathology has evolved. Old methods such as surgical enteroscopy and probe enterography became history. They were replaced by new types of instrumental-associated enteroscopy, namely, double- and single-balloon enteroscopy, which have several significant disadvantages, including the duration of the procedure in the first case and restriction of examination of the proximal jejunum in the second. The disadvantages of most of the above methods are also their complexity, as they often need to involve other specialists in the study (endoscopist, endoscopist assistant, and anesthesiologist) and to sedate or anesthetize patients. Probably, for these reasons, the above methods are not widely used in the diagnosis of SI pathology and are limitedly used only for solving specific diagnostic and clinical problems. The possibilities of field-specific MR and CT enterography/enteroclysis are actively studied and highlighted. New technology and specialized techniques open up even greater diagnostic and therapeutic possibilities in this field.

Despite the widespread introduction of MRI and CT studies in Russia, in our opinion, the role and possibilities of abdominal and retroperitoneal CT performed with bolus contrast enhancement, according to the standard protocol in the diagnostics of SI pathologies, are not adequately covered.

This study aimed to reveal the capabilities of multidetector or multislice CT (MSCT), performed according to the standard protocol us-

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ing intravenous bolus contrast enhancement, in identifying one of the leading and common, in our opinion, symptoms — SI wall thickening. The prognostic value of this radiological symptom was assessed for various nosologies.

METHODS

CT studies were performed on multislice CTs according to standard programs for the study of the abdominal cavity and retroperitoneal space.

The study group included adult patients with a known pathology of the SI and a thickening of its wall of more than 4 mm, revealed by MSCT of the abdominal cavity and retroperitoneal space with bolus contrast enhancement. Patients with no SI wall thickening according to MSCT of the abdominal cavity and retroperitoneal space with a bolus contrast enhancement were not included in the study group.

Conditions

To achieve this goal, an analysis of the MSCT results of the abdominal cavity and retroperitoneal space with bolus contrast enhancement of patients admitted to the surgical and gastroenterological departments of the N.I. Pirogov Russian National Research Medical University and N.I. Pirogov State Clinical Hospital No. 1, Moscow City Health Department, was conducted. The age of the patients ranged from 18 to 87 years, with an average of 55 years.

Description of medical intervention

MSCT was performed according to the protocol of the study of abdominal organs using intravenous bolus contrast enhancement and 500 mL oral water intake immediately before the study. Tomography was performed with a submillimeter section thickness, pitch 1, with an intravenous bolus contrast enhancement with a nonionic radiopaque agent. The volume of the contrast agent depended on the patient's weight (1.5 mL/kg), and the rate of administration was 4 mL/s.

SI wall thickness was measured in a plane perpendicular to the axis of the lumen. The SI wall was considered thickened when it measured greater than 4 mm. A total of 86 cases with SI wall thickening were selected out of the total number of studies.

Study design

The study included 86 cases of patients with SI diseases and was carried out of the case histories and CT scans. Preliminarily, the cases were divided into changes associated with SI wall thickening limited in extension and with segmental thickening. The degree of contrast enhancement of the thickened SI wall and changes of its type, SI lumen, in adjacent tissues and SI structures were evaluated. The CT pattern and case conclusions were compared with the final verified diagnoses (clinical and instrumental and morphological or intraoperative).

RESULTS

Patient characteristics

All patients were divided into two groups. Group 1 included patients with a focal SI wall thickening of length less than 100 mm, whereas Group 2 comprised patients with thickened segments over a length of 100 to 400 mm.

Additionally, the solitariness or multiplicity of thickening, the degree, nature of contrast enhancement, and changes in adjacent organs and structures were determined. Cases of multiple localizations of focal thickening were assigned to the group with segmental SI changes (Group 2).

Primary study outcomes

Of the SI wall thickening cases, 86 were analyzed. The distribution according to the type of thickening, frequency, and prognostic indicator of the symptom of intestinal wall thickening by nosologies is presented in Table 1.

Focal SI wall thickening was detected in 41 (48%) cases and segmental thickening in 45 (52%). In the vast majority of cases, the detected thickening of the intestinal wall was accompanied by the inflammatory process (47 cases) or tumor growth (37 cases). In all cases, the considered sign enabled us to suspect pathology, and further analysis of the images enabled us to formulate the conclusion. More often, a wall thickening was found in the terminal ileum. The revealed symptom of thickening was accompanied by a narrowing of the intestinal lumen in 73 (85%) cases. In 13 (15%) cases caused by lymphomas, wall thickening was accompanied by local lumen dilatation.

A common cause of the symptom under consideration was Crohn's disease (37%), which was more often manifested by segmental thickening (78%) and less often by focal thickening (22%), with predictive positive values of 55.5% and 17.1%, respectively. Crohn's disease was characterized by transmural inflammation of the wall, lymphadenitis, ulcers, and scars of the SI wall. In our cases of Crohn's disease, the terminal ileum was most often affected (84%), which was often combined with the involvement of other SI departments, as well as the colon and stomach. Notably, the affected SI segments alternated with intact areas. The wall thickness of the affected intestine increased to 8 mm. In the field of pathology, wall thickening was accompanied by a narrowing of the lumen of varying severity. The transition of thickening to the intact part of the wall was smooth, but the boundary of the transition was visualized well due to the difference in contrast enhancement (Fig. 1).

Increased contrast enhancement of the wall of the affected areas is the second characteristic sign of Crohn's disease of SI. The type and degree of contrast enhancement depended directly on the phase of inflammation. The active inflammation phase was characterized by a single-layer or two-layer stratified contrast enhancement due to the bright background of the mucous membrane and edema of the submucosal layer, respectively, with the formation of a one-layer or two-layer layering pattern or stratification (Fig. 2). In the adjacent part of the mesentery, a marked vascular pattern with minimally dilated lumens (a comb symptom) was determined, and enlarged lymph nodes were determined along the mesentery vessels.

Table 1

Comparative characteristics of patients of the study groups

Number of patients / Revealed cases of the disease	Total number of examined patients by disease	Number of detected focal thickenings		Number of detected segmental thickenings	
		n	PPV (%)	*n*	PPV (%)
Crohn's disease	32	7	17.1	25	55.5
Peritonitis	4	3	7.3	1	2.3
Anastomositis	11	11	26.8	0	0
Cancer	3	3	7.3	0	0
Lymphoma	17	9	21.9	8	17.8
Sarcoma	3	3	7.3	0	0
Metastases on the serous cover of the intestine	16	5	12.3	11	24.4

Note. PPV, positive predictive value.

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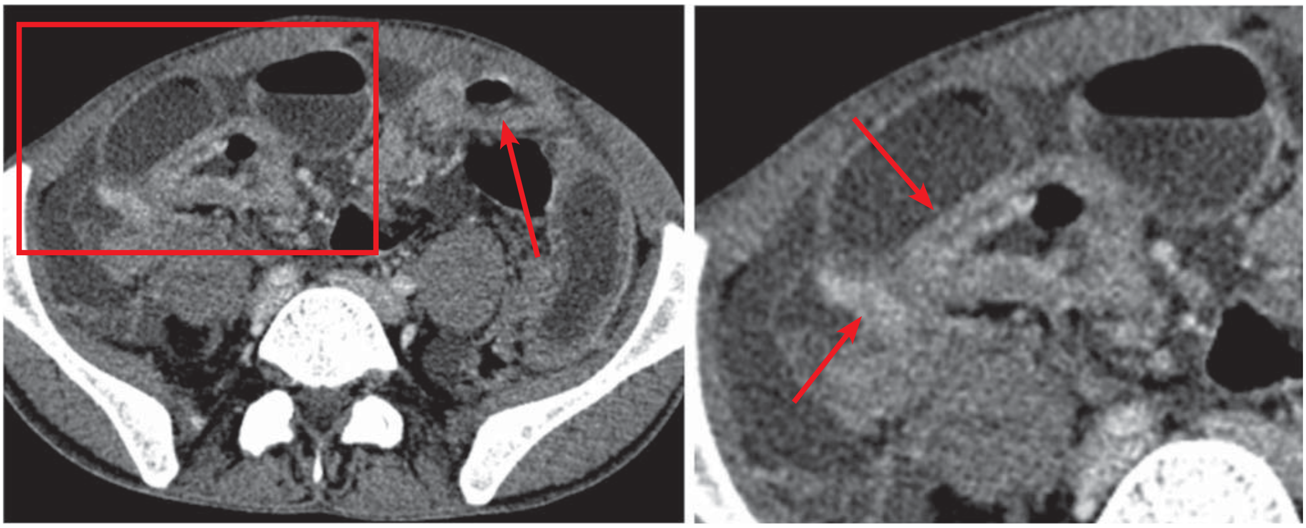
Fig. 1. Patient, 34 years old. Multidetector or multislice computed tomography: Crohn's disease of the stomach, small and large intestine with lesions of the stomach, and terminal ileum and cecum. Chronic recurrent course complicated by intestinal obstruction, severe form, high activity, exacerbation phase. Arterial phase of contrast enhancement.



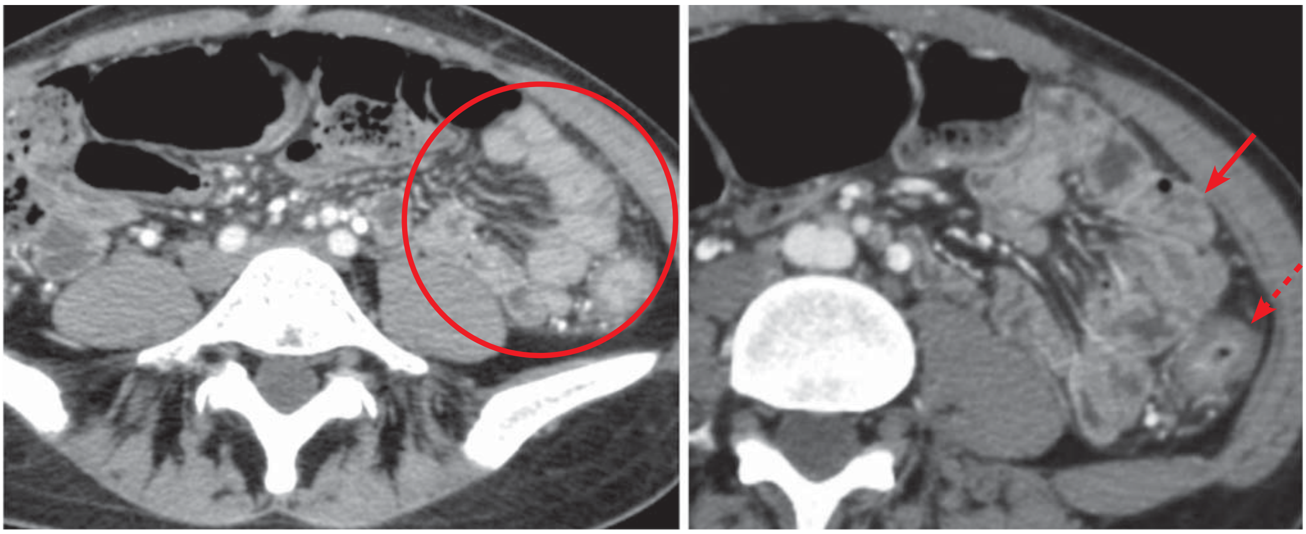
Note. Multiple SI wall thickening (arrows) is determined, which causes narrowing of the lumen. The wall in places of thickening accumulates a contrast agent layered with increased contrast enhancement of the inner and outer layers (arrows). Between the extended loops of the intestine, an accumulation of free fluid is registered.

The structure of the lymph nodes was homogeneous, and the contour was even and clear. The transverse size in most cases (89%) did not exceed 10 mm.

In the phase of Crohn's disease remission, wall contrasting was characterized by transmural thickening and stratification against the development of fibrotic changes in the submucosal layer and increased contrast enhancement of the mucous membrane (Fig. 3A) or the deposition of fatty inclusions in the submucosal layer (Fig. 3B).

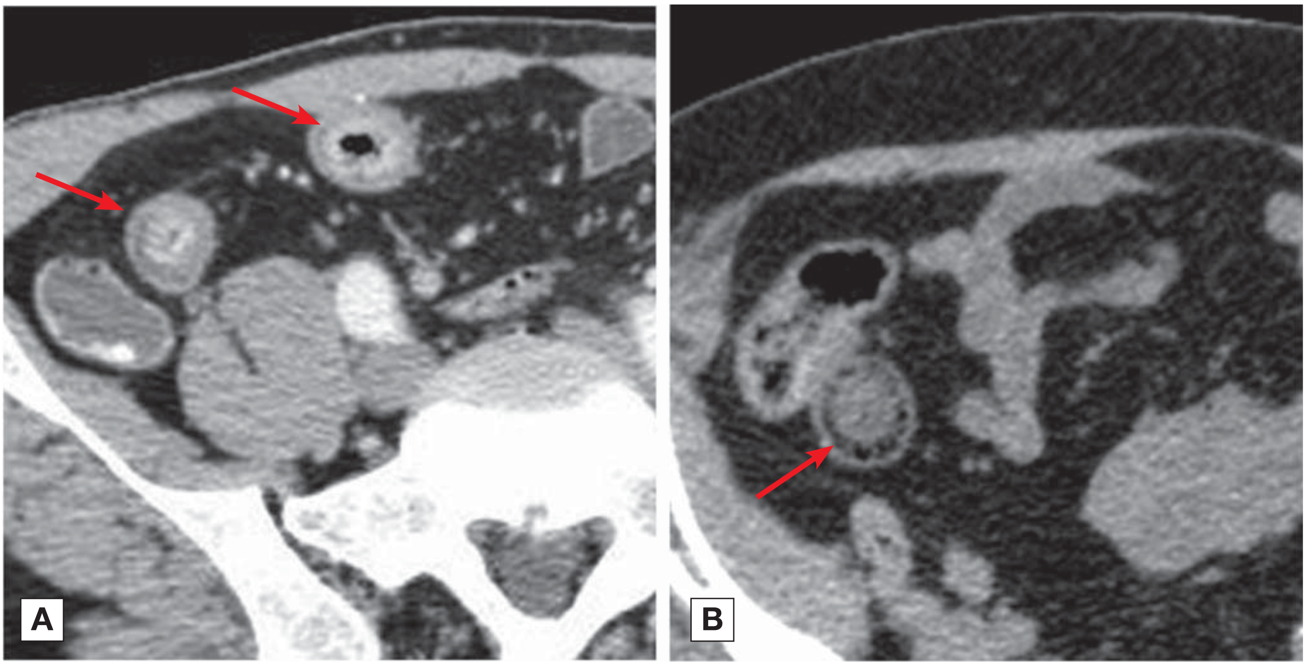
In the group of changes of inflammatory genesis, accompanied by intestinal wall thick-

Fig. 2. Patient, 34 years old. Multidetector or multislice computed tomography: Crohn's disease, multiple lesions of the small and large intestines. Arterial phase of contrast enhancement. Fragments of axial tomograms.



Note. The segmental SI wall thickening (arrows) and the descending colon (dashed arrow) are determined. With contrast enhancement, transmural contrast enhancement of the wall and strengthening of the mesentery vessels (indicated by a circle) are noted.

Fig. 3. Multidetector or multislice computed tomography: Crohn's disease, stage of incomplete remission



Note. (A) Arterial phase of contrast enhancement: a three-layer structure of the wall of the terminal ileum (arrow) is determined because of fibrotic changes in the submucosal layer and increased contrast enhancement of the mucous membrane. (B) A patient aged 67 years: Crohn's disease, stage of remission; the native study revealed the three-layer structure of the wall of the terminal ileum, which is explained by the deposition of fatty inclusions in the submucosal layer (arrow).

ening, in our cases, anastomositis was noted in 11 (13%) cases and peritonitis in 4 (5%). Wall thickening with anastomositis had the greatest prognostic value of a positive result and did not cause difficulties in differential diagnostics. The obvious relation of the changes with the area of the enteroenteroanastomosis was visualized as a distinctive radiological sign. Patients had a characteristic clinical presentation and anamnestic data. Peritonitis in our cases was a rarer cause of the symptom under consideration, convincingly confirmed by the clinical presentation and history, and thickening of the wall was focal in nature more often (75%).

SI tumors are a relatively rare pathology (up to 3–6% of all detected tumors of the gastrointestinal tract). According to the frequency of SI lesions by neoplastic process in our sample, the first place belonged to lymphomas (17 [20%] cases) and the second to secondary lesions of the serous membranes of the intestine and peritoneum (16 [18.6%] cases). We defined sarcoma and cancer (adenocarcinoma) in equal proportions, 3 (3.5%) cases each.

According to the literature, lymphomas account for approximately 25% of all primary malignant tumors of this localization and approximately 40% of all primary gastrointestinal lymphomas [20]. The tumor develops from lymphoid cells of the intestinal wall and is more often the result of secondary extra nodal involvement of the intestine in systemic lymphoproliferative disease; however, there is also a primary lesion. According to the morphological presentation, endophytic (infiltrative form), exophytic (nodal and polypous), and combined (mesenteric form) lesions are distinguished [21]. The X-ray pattern is due to the above forms of the lesion. In all forms of lymphoma, we visualized intestinal wall thickening and an increase in regional lymph nodes. On CT, the SI wall infiltrated by lymphoid cells acquired a homogeneous soft tissue structure, with a thickness of 6 to 70 mm. The lesion had a length of 50 to 200 mm. The infiltrative form

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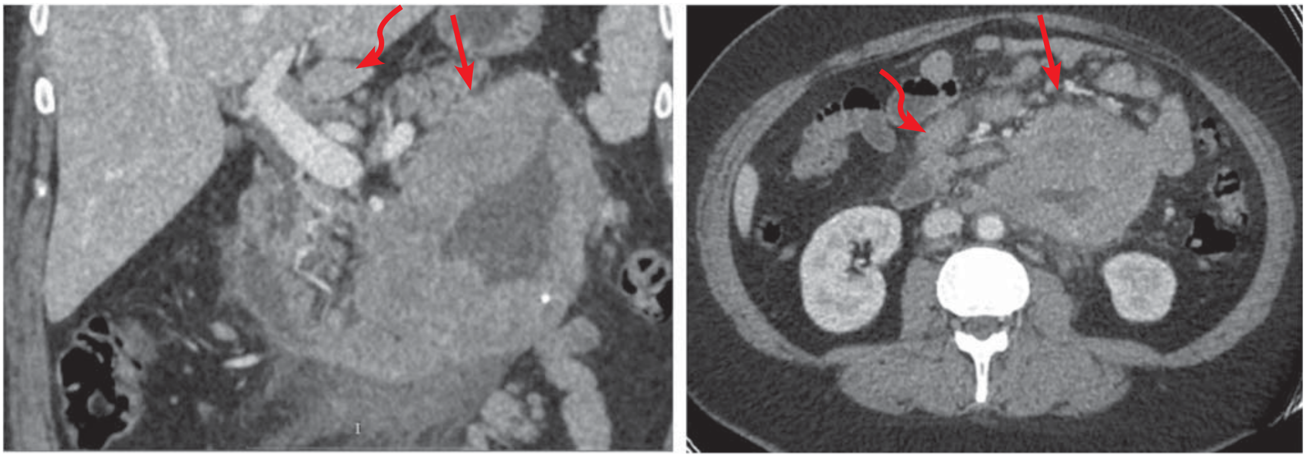
of lymphoma in eight (47%) cases on CT had a specific pattern with a significant wall thickening, more than 20 mm, traceable in the length of 80 to 200 mm. The thickened wall had a uniform structure before and after contrast enhancement. The internal lumen of the affected area of the intestine was unevenly expanded. Here, there were no signs of intestinal obstruction. The lymphatic nodes of the mesentery and retroperitoneal space were visualized with a minimally heterogeneous structure and an increase in the average to 15 mm in diameter. During intravenous bolus contrasting, there was a predominant contrast enhancement of the mucous layer of the wall and, to a lesser extent, tumor tissue, which accumulated the agent uniformly and mildly (Fig. 4). In one case, a single nontypical segment of cystic-like degeneration was visualized in the tumor structure.

Less commonly, lymphoma was manifested by solid eccentric nodular or polypoid growths (nodular and polypoid forms, respectively). These forms (four cases, 25%) differed from the "classical" lymphoma variant described above. In these cases, such a pronounced wall thickening was not determined. Changes in the wall were accompanied by an uncharacteristic narrowing of the lumen. In this sign, the nodular form had common features with a cancerous tumor, and the polypoid form had common features with cancer and Crohn's disease. Figure 5 presents the case of a patient with a nodular form of B-cell lymphoma. In the case presented, nodular growths reduced the lumen of the intestine; the extent of the lesion was 100–150 mm. In the "transitional" zone, minimal prestenotic dilatation was determined, which resembled a presentation of the exophytic form of adenocarcinoma. The polypoid form of lymphoma, according to the thickening and extent of lesions to the SI wall, had a pattern possible with a cancerous tumor or Crohn's disease. The wall thickening with this form usually did not exceed 10 mm, and the length was 50 to 100 mm.

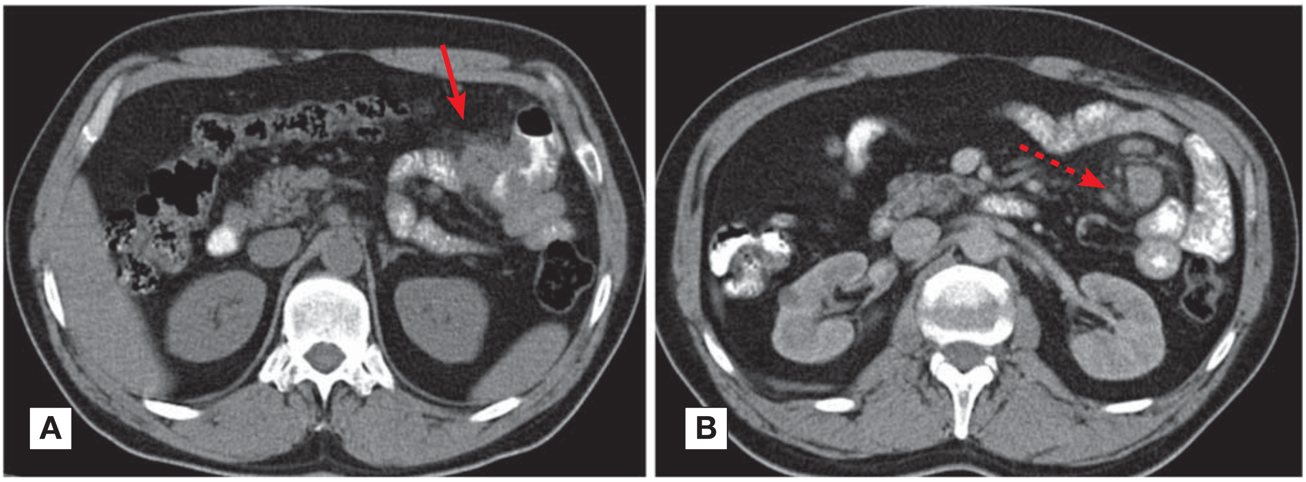
Contrasting the internal lumen of the intestine *per os* enabled us to visualize relatively large polyps, which were displayed as characteristic filling defects along the contour (Fig. 6). Small polyps were difficult to visualize on CT, even under conditions of internal lumen filled

Fig. 4. Patient, 36 years old. Multidetector or multislice computed tomography: B-cell lymphoma, infiltrative form



Note. In segment 4 of the duodenum and proximal jejunum, wall thickening of up to 40 mm and uneven lumen dilatation due to tumor tissue growth (straight arrows) are determined. Tumor growths have a uniform solid structure, which, when intravenously contrasted, uniformly accumulates the contrast agent. According to the accumulation intensity, the tumor tissue is isodense with an intact intestinal wall. The lymph nodes of the mesentery and retroperitoneal space are enlarged (curved arrows).

Fig. 5. The patient, 46 years old. Multidetector or multislice computed tomography: B-cell lymphoma of the jejunum, nodular form. Anemia

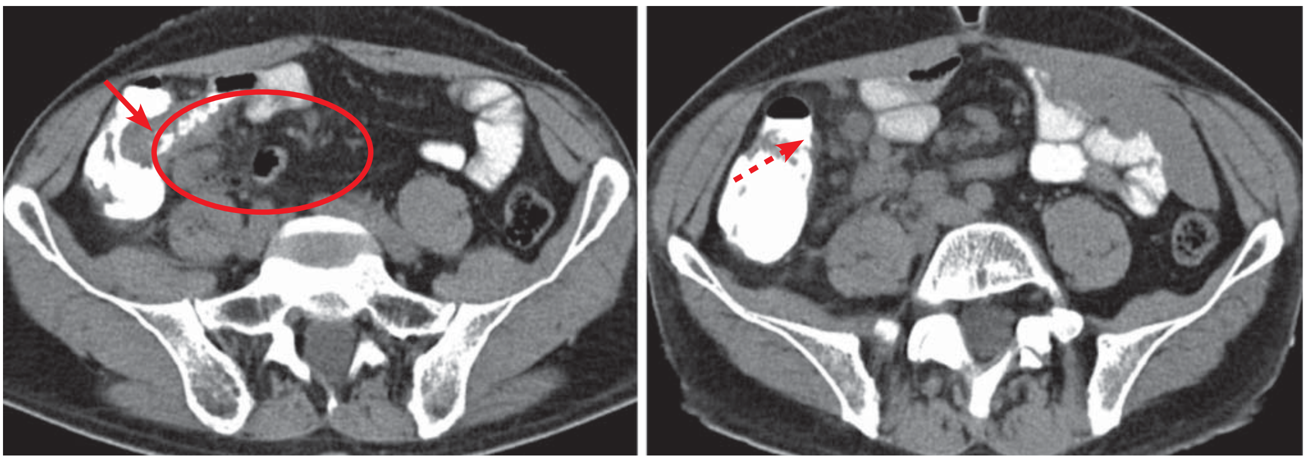


Note. (A) A study with contrasting of the intestinal lumen *per os*. (B) Arterial phase of contrast enhancement revealed soft tissue nodal growths in the jejunum wall, which narrowed and deformed the intestinal lumen; there are no signs of intestinal obstruction. The induration of the adjacent mesentery segment without signs of a desmoplastic reaction (arrow). In the mesentery, there are enlarged lymph nodes (dashed arrow).

with water. In one of two cases of the polypoid form of lymphoma, narrowing of the intestinal lumen caused obturation obstruction. Among other complications, we diagnosed the formation of an abscess on the mesentery of the affected intestine of the patient with a nodular form of lymphoma, in which ulceration in the wall resulted in penetration and perforation. On CT, a typical picture of the encapsulated fluid accumulation was determined, and one of the walls of which was the SI.

Mesenteric, primarily multiple forms of lymphoma (five cases) were manifested by a CT presentation of a generalized lesion of the lymph nodes. In our cases, lymphomas of the stomach, SI, and colon in various combinations were repeatedly found and accompanied by widespread lymph node enlargement. The affected areas of the intestine were located in areas remote from each other. Fig. 7 presents the case of primary multiple lymphomas in a 68-year-old female patient. Over the past year,

Fig. 6. Patient, 51 years old. Multidetector or multislice computed tomography: B-cell lymphoma, polypoid form. Intestinal lumen contrasting *per os*



Note. Terminal ileum wall thickening is determined. On the contour of the contrasted lumen, polyp-like growths (arrow) are visible. There is a propagation of the lesion to the mesentery (dashed arrow) and a significant increase in regional and retroperitoneal lymph nodes (the areas are indicated by an oval).

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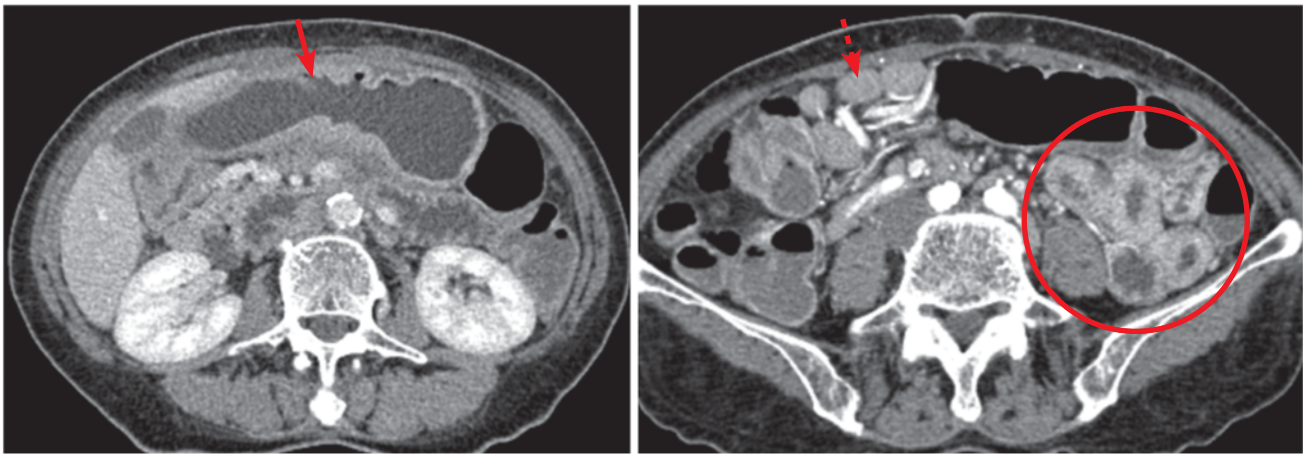
the patient complained of general weakness, sweating, temperature rise, periodic aching pain in the abdomen, and weight loss. Computer tomograms revealed primary multiple lymphoma with lesions of the stomach and intestines. The final diagnosis was mucosa-associated lymphoid tissue lymphoma of the stomach (stage IV) with lesions to the SI and lymph nodes of the chest cavity, abdominal cavity, and retroperitoneal space. There was a lymphoma from the cells of the mantle zone with total lesions to the colon (stage IVB).

Cancer of SI is the rarest disease. SI adenocarcinomas are 50 times less common than colon cancer. More often, it affects men aged 60 years and older. In 50% of cases, the tumor is localized in the duodenum, and the jejunum is affected in 30% of cases. Localization in the ileum accounts for 20%, with a higher frequency of distal segment lesions. CT picture depends on the anatomical structure of the tumor. Endophytic cancer invades into the inner layers of the intestine at a relatively small extent and, usually located on one of the walls, does not initially narrow the lumen. Stenosis occurs later when the tumor propagates circularly [22]. Tumors of the endophytic type include ulcerative infiltrative cancer, which is characterized by a rapid and aggressive propagation of the deep layers of the intestine and surrounding tissues. Ulcerous neoplasms are quite deep and quickly manifest themselves with hemorrhage. Diffuse-infiltrative cancer is formed in the submucous and mucous layers of the intestine. Such tumors are not predisposed to ulceration and metastasize relatively late. Sometimes tumors of this type reach large sizes, and the affected part of the intestine becomes immobile and difficult to differentiate from large carcinoids [23]. In a CT study conducted according to a standard method, it is difficult to identify an endophytic tumor when it occupies a part of the intestinal wall since it is necessary to ensure tight filling of the intestinal lumen to visualize such formations. In the advanced stages of adenocarcinomas, on CT, a circular narrowing of the lumen, 50–100 mm long, was detected. The transition border between the affected part of the intestine and the intact part is characterized by overhanging the wall. Prestenotic dilatation and symptoms of acute obstruction are not mandatory signs

Fig. 7. Patient, 68 years old. Multidetector or multislice computed tomography: primary multiple synchronous lymphomas (mesenteric form). Arterial phase of contrast enhancement.



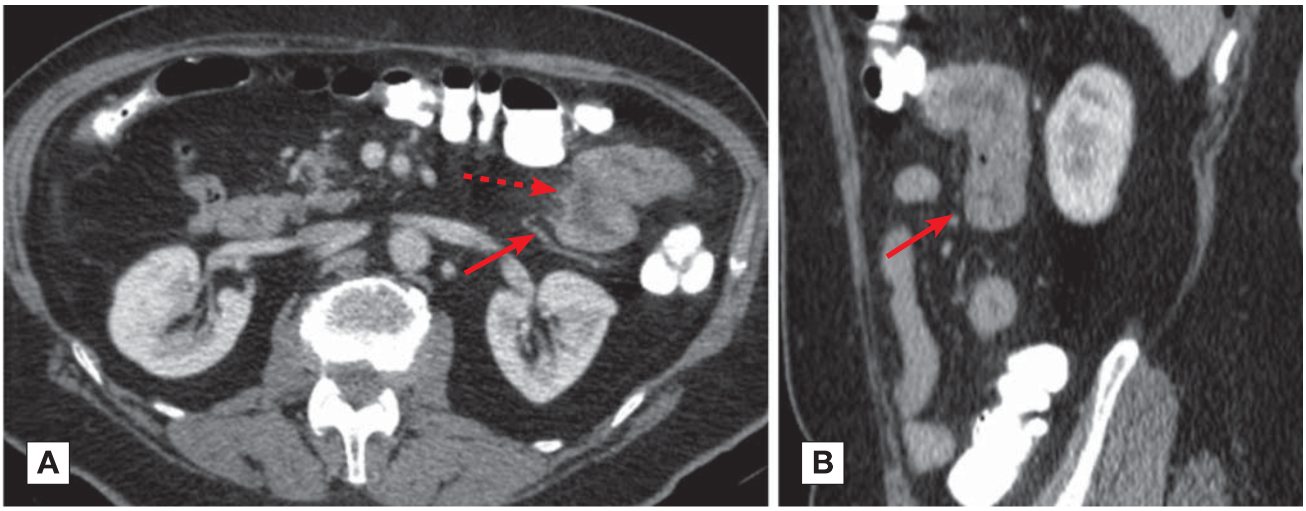
Note. Thickening of the wall of the stomach (arrow), thin (marked with an oval), and sigmoid colon are determined. The propagation of lymphoid infiltration to several adjacent segments of the jejunum is visualized. Intestinal wall thickening is accompanied by a moderate and uneven dilatation of the lumen. With contrast enhancement, increased contrast enhancement of the affected areas is noted, to a greater extent, because of the mucous layer. Enlarged lymph nodes are visible in the greater omentum (dashed arrow) and the retroperitoneal space.

of SI cancer, but there are always compensated forms of obstruction. With contrast enhancement, the tumor tissue was contrasted transmurally, without layering, and the heterogeneity of the contrast enhancement was noticeable (Fig. 8).

The exophytic form of cancer is predominantly characterized by nodular invading in the intestinal lumen. Visually malignant tumors of this type resemble a mushroom on a broad basis. Sometimes, there are exophytic tumors of a saucer-shaped or polyposis form, widely adjacent to the intestinal wall and obstructing its lumen [24]. With all anatomical forms of growth of the intestinal tumor, the regional lymph nodes of the mesentery are involved in the pathological process, and they become denser, and their volume increases; the maximum width usually reaches 10 mm or more. In our cases, with contrast enhancement, the tumor tissue was contrasted transmurally and unevenly, and the intensity of the contrast enhancement did not differ from that of the intact intestinal wall (Fig. 9). Exophytic forms of the lesion were accompanied by varying degrees of severity with prestenotic dilatation of the lumens.

SI sarcomas are more common in young men, and a tumor is formed from different types of connective tissue of the intestine. More often, sarcoma affects the final segments of the ileum and the initial sections of the jejunum. Exo-intestinal and endo-intestinal forms invade into the abdominal cavity and directly into the SI wall, respectively [25]. The tumor metastasizes quite late, usually to distant organs (lungs, liver, etc.). According to the microscopic structure, lymphosarcomas, encephaloid sarcoma, and fascicular sarcoma are more common. Tumors with diffuse and nodal growth types are distinguished by their macroscopic appearance. Intestinal sarcoma is prone to disintegration, so it can manifest itself with hemorrhage, and less often with wall perforation. Intestinal stenosis develops rarely [26]. In two of our cases, SI sarcoma had an exo-intestinal type of growth. On CT, these tumors were manifested by wall thickening, mainly from the side of the mesenteric edge, and intestinal lumen deformation. According to the extent of the lesion, these

Fig. 8. Patient, 58 years old. Multidetector or multislice computed tomography: cancer of the colon. Venous phase of contrast enhancement (on the eve, contrasting of the intestinal lumen per os was performed; therefore, the residual contrast agent is noted in the lumen of the colon).



Note. (A) Axial tomogram and (B) sagittal reconstruction. The wall of the jejunum for approximately 150 mm in length is thickened to 10 mm. The lumen of the intestine is unevenly narrowed. The contrast enhancement of the wall is transmural and isodense with the remaining segments of the intestine (arrows). There is an induration of the adjacent part of the mesentery due to the desmoplastic reaction (dashed arrow).

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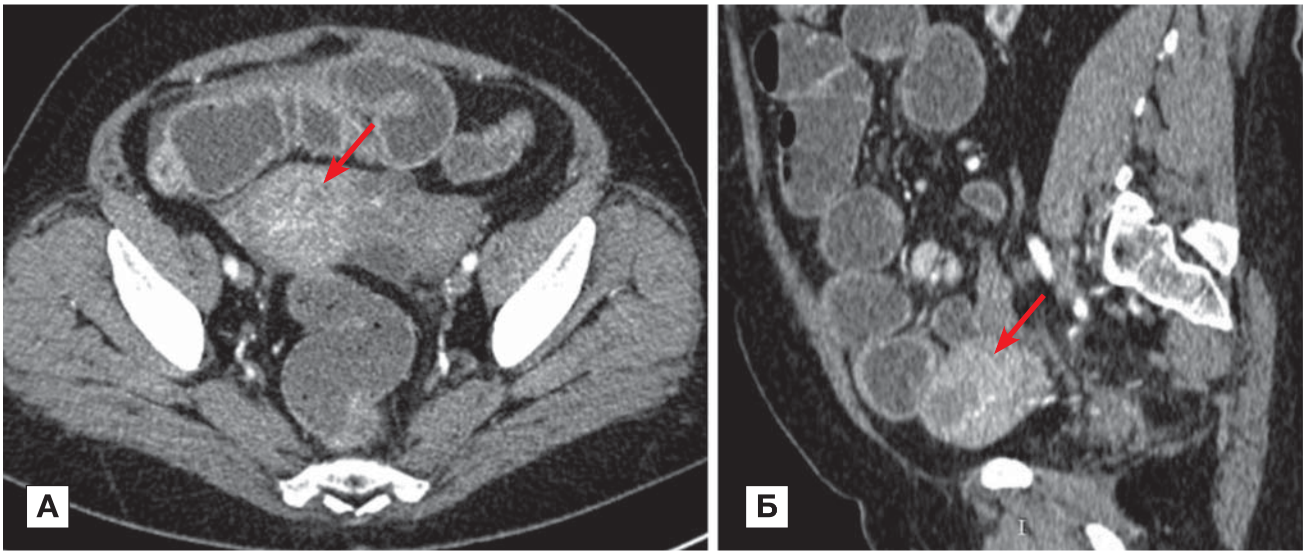
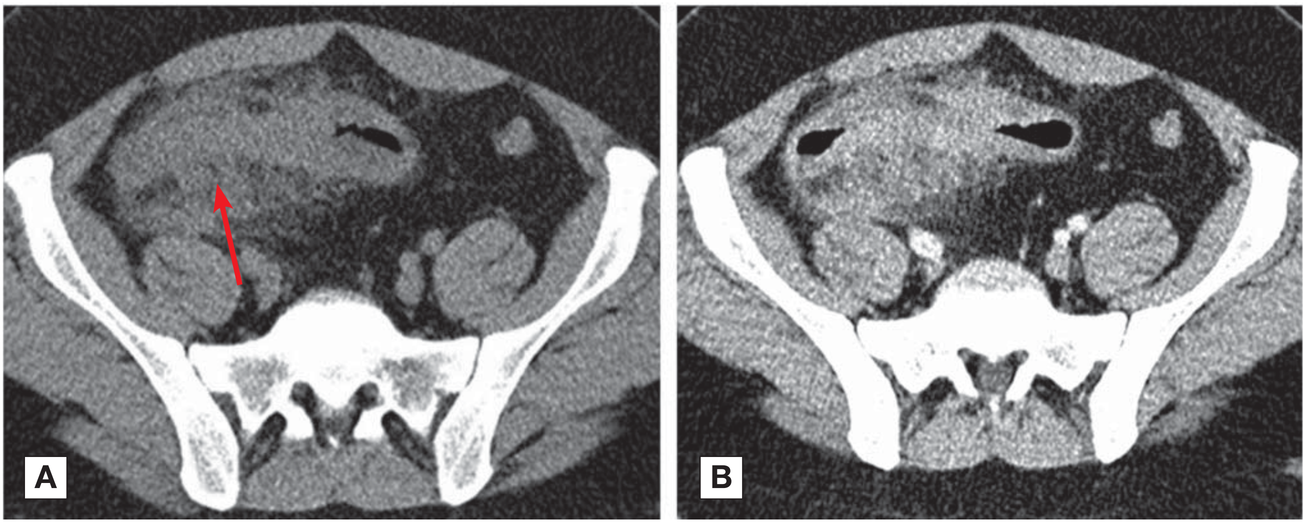
Fig. 9. Patient, 53 years old. Multidetector or multislice computed tomography: cancer of the distal ileum. Small intestine obstruction



Note. (A) Axial tomogram and (B) sagittal reconstruction of the tomogram. Arterial phase of the contrast enhancement. In the distal ileum for 10 cm in length, an exophytic formation is defined, which narrows the lumen (arrows). A tumor transmurally accumulates the contrast agent. In the SI, there are signs of compensated SI obstruction.

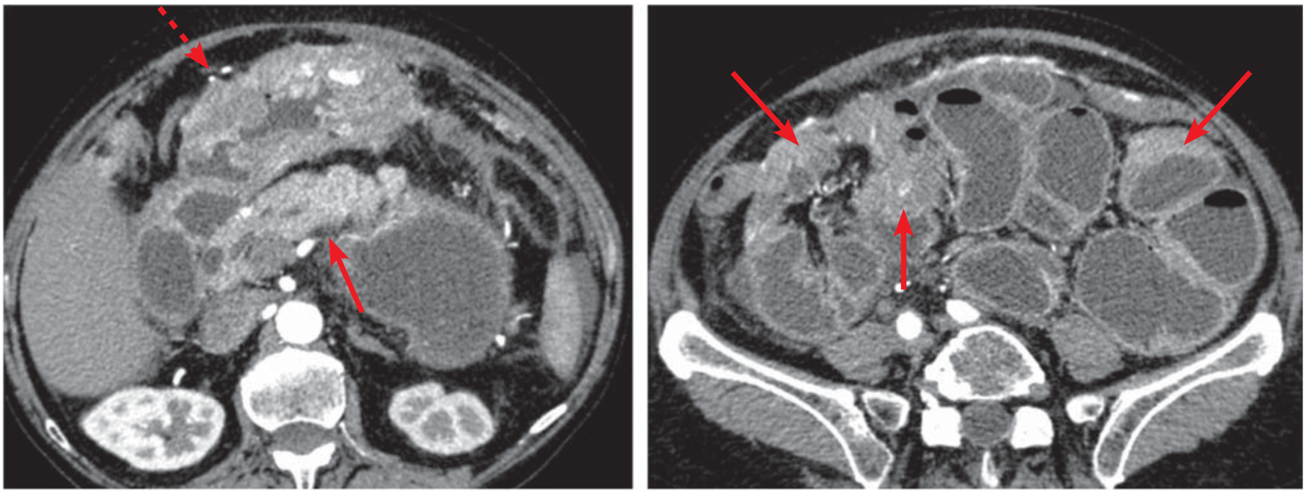
cases belonged to the focal type of lesion. In all cases, there was a pronounced induration of the adjacent mesentery by the mesh type without lymph node enlargement (Fig. 10). In one case, perforation of the intestinal wall occurred with the formation of an interintestinal abscess. By contrast enhancement, transmural contrast enhancement of the thickened intestinal wall was determined, with an increase in the density of the affected part of the mesentery, which manifested itself to the greatest extent in the delayed phase. In the clinical presentation of the disease, a stomachache of psychogenic nature prevailed in these patients. Despite the

Fig. 10. Patient, 48 years old. Multidetector or multislice computed tomography: ileum sarcoma



Note. (A) Native study and (B) arterial phase of contrast enhancement. Along the mesenteric margin of the ileum wall, there is a segmental wall thickening (arrow), which, with contrast enhancement, accumulates the contrast agent evenly and transmurally. In the adjacent part of the mesentery, the proliferation of tumor tissue elements is determined.

Fig. 11. The patient, 68 years old. Multidetector or multislice computed tomography: gastric cancer. Metastatic lesion of the serous membranes. Intestinal obstruction. Arterial phase of contrast enhancement



Note. In the antrum, a tumor is determined (dashed arrow). Irregular thickening of the intestinal wall due to a secondary lesion of the serous cover (arrows) is visualized.

large size of the tumors, no cases of intestinal obstruction have been determined.

Metastatic lesion of the visceral peritoneum caused intestinal wall thickening in 16 (18.6%) patients. Tumors of the gastrointestinal tract and pancreas often cause secondary lesions of the peritoneum. On the tomograms, metastatic lesion of the peritoneum was manifested by the deposition of solid masses in the form of planar or tuberous thickening on the serous membranes covering the intestines (Fig. 11). During progression, tumor invasion into the intestinal wall was determined by wall thickening and lumen narrowing, which caused intestinal obstruction. The lesion was often multiple in nature. In length, segmental thickening (67%) was more common than focal (33%), with a prognostic value of a positive result of 20% and 12.2%, respectively. Common lesions were accompanied by accumulation of fluid in the abdominal cavity. With contrast enhancement, solid masses on the serous membranes were characterized by increased contrast enhancement.

CONCLUSION

Along with the use of specialized methods and techniques for diagnosing diseases of the SI, we believe that abdominal MSCT with intravenous contrast enhancement, performed according to the standard protocol, can also be used to detect the pathology of the SI. In this respect, regardless of the main purpose of the study, it is necessary to examine the intestinal wall condition, focusing on well-identified and obvious pathological signs of lesions, namely, pathological changes in the lumen, thickening of the wall, presence of intramural or intraluminal formations, and presence of sites of pathological contrast enhancement.

Wall thickening is a common sign of SI lesion, which is convincingly detected using a CT scan with intravenous bolus contrast enhancement. In our sample, the causes of wall thickening of the SI were often Crohn’s disease (37%), lymphoma (20%), and anastomositis (13%). However, in 7% of cases, this symptom is defined as a consequence of a primary tumor (adenocarcinoma and sarcoma), and in 18.6%, it is identified as a result of a secondary tumor lesion. The considered diseases differed in the degree of intestinal wall thickening (from 6 to 70 mm), its length (48% in focal thickening and 52% in segmental thickening), the number of affected areas (from 1 to 3) of their localization (proximal — middle or distal

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sections), the form of transition of the affected segment of the intestine to intact one (sharply defined or smooth transition), the presence or absence of symptoms of intestinal obstruction, and the characteristics of contrast enhancement (severity and type). Certainly, in diagnostics of secondary lesions of the SI, along with the asymmetric thickening of the pathologically contrasted wall, the knowledge of the anamnesis or the simultaneous identification of the primary tumor node was important.

Thus, abdominal CT with an intravenous bolus contrast enhancement can be used in the diagnosis of both pathologies of parenchymal organs and diseases of the SI. In addition to the endoscopic method, CT enables us to identify the involvement of extraintestinal structures and organs in the pathological process and determine the state of regional lymph nodes. In all cases examined, the sign of SI wall thickening enabled us to suspect its pathology, and further analysis of the totality of signs enabled us to formulate a conclusion.

CONTRIBUTION OF AUTHORS

E.G. Koshelev collected the material, performed data analysis, and wrote the text. S.V. Kitaev created the concept and the study design and edited. G.Yu. Belyaev performed processing of literature and wrote the text. A.A. Egorov collected and processed the material. O.A. Kurzantseva created the study design.

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CONFLICT OF INTERESTS

No conflict of interest was reported by the authors.

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