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A. S. Sementsov, V. V. Ponomarenko

State Institution «Zaporizhzhia Medical Academy of post-graduate education Ministry of Health of Ukraine»  
Zaporizhzhia, Ukraine

O. S. Semenцов, B. B. Пономаренко

Державний заклад «Запорізька медична академія післядипломної освіти Міністерства охорони здоров'я України»  
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## MAGNETIC RESONANCE IMAGING OF THE LARGE AND SMALL INTESTINES

### Магнітно-резонансна томографія товстого та тонкого кишечника

#### Abstract

*Purpose of the work is to show the possibilities of radiation diagnosis of the normal anatomy of the small and large intestine, as well as their pathological changes through the use of MRI (Hydro-MRI).*

**Material and methods.** Thirty patients were examined by the method of Hydro-MRI. All patients underwent magnetic resonance imaging on a device with a magnetic induction of 1.5T. To carry out Hydro-MRI, we used T2-weighted sequences, such as a one-time fast spin echo signal obtained in several planes, STIR sequences in three mutually perpendicular sequences, so that, edema wall can be estimated with additional diffusion-weighted images.

**Results.** Twenty patients with the manifestations of Crohn's disease in the form of terminal ileitis, presence of interlope fistulous passages, paraproctitis (fistulous form) were detected. Colon tumors were detected in 8 patients, recurrence of gastrointestinal stromal tumor (GIST) of the small intestine in the anastomosis zone was detected in one patient, and no pathological changes were detected in one patient.

**Findings.** Hydro-MRI allows visualizing the mass of the small, large intestine and determining the degree of invasion of the intestinal wall and surrounding tissues. Enterography using magnetic resonance enterography has become the most effective methods for visualizing the small intestine in patients with Crohn's disease and can visualize inflammation of the intramural or proximal small intestine in about 50% of patients with Crohn's disease who have undergone endoscopically normal studies. Hydro-MRI is indicated for Crohn's disease and for determining the degree of

#### Резюме

**Мета роботи.** показати можливості променевої діагностики нормальної анатомії тонкої та товстої кишки, а також їх патологічних змін за допомогою використання МРТ (Гідро-МРТ).

**Матеріали та методи.** Обстежено тридцять пацієнтів методом Гідро-МРТ, яким було зроблено магнітно-резонансну томографію на апараті з магнітною індукцією 1,5 Тл. Для проведення Гідро-МРТ ми використовували T2-зважені послідовності, такі як одноразовий швидкий спин-ехосигнал, отриманий у декількох площинах, послідовності STIR у трьох взаємно перпендикулярних послідовностях, так що набряк стінки можна оцінити за допомогою додатково застосованого дифузного зображення.

**Результати.** Виявлено двадцять хворих із проявами хвороби Крона у формі термінального ілеїту, наявністю свищевих ходів, парапроктиту (свищева форма). Пухлини товстої кишки були виявлені у 8 пацієнтів, у одного пацієнта було виявлено рецидиви шлунково-кишкової стромальної пухлини (ГІСТ) тонкої кишки в зоні анастомозу, не виявлено патологічних змін у одного пацієнта.

**Одержані данні.** Гідро-МРТ дозволяє візуалізувати масу тонкого, товстого кишечника і визначити ступінь інвазії кишкової стінки і оточуючих тканин. Ентерографія з використанням магнітно-резонансної ентерографії стала найбільш ефективним методом візуалізації тонкої кишки у пацієнтів з хворобою Крона і може візуалізувати запалення інтрамуральної або проксимальної тонкої кишки приблизно у 50% пацієнтів з хворобою Крона, у яких ендоскопічне дослідження патології не виявило. Гідро-МРТ показана при хворобі Крона

*inflammatory activity. Recent evidence suggests that cross-section visualization may be useful in determining response to therapy, assessing bowel healing and monitoring disease progression. Also, according to researchers at the Medical Imaging Center, University College London, the quantitative motility of the small intestine is an objective biomarker of endoscopic and histopathological inflammatory activity in Crohn's disease and is comparable to previously confirmed estimates of MRI activity enhanced by gadolinium. The final ileal motility indicator showed a good correlation with endoscopic and histopathological activity in Crohn's disease. The study is painless, no radiation load. Hydro-MRI is a method of choice, when it is impossible to conduct an X-ray examination of the intestine, the inability/uninformativeness of an endoscopic examination of the small, large intestine. Along with video capsular endoscopy, it allows visualization of all departments of the small and large intestine [1].*

**Keywords:** *Hydro-MRI or hydro-magnetic resonance imaging, Crohn's disease, small bowel and colon tumors.*

*і для визначення ступеня запальної активності. Останні дані свідчать про те, що візуалізація поперечного перерізу може бути корисна для визначення відповіді на терапію, оцінки загоєння кишкового і моніторингу прогресування захворювання. Також, на думку дослідників з Медичного центру візуалізації Університетського коледжу Лондона, кількісна рухливість тонкої кишки є об'єктивним біомаркером ендоскопічної та гістопатологічної запальної активності при хворобі Крона і порівнянн з раніше підтвердженими оцінками активності МРТ, посиленою гадолинієм. Кінцевий показник рухливості клубової кишки показав хорошу кореляцію з ендоскопічною та гістопатологічною активністю при хворобі Крона. Дослідження безболісне, променевого навантаження немає. Hydro-MRI є методом вибору, коли неможливо провести рентгенологічне дослідження кишечника, неможливість/неінформативність ендоскопічного дослідження тонкої, товстої кишки. Разом з відео-капсульною ендоскопією, вона дозволяє візуалізувати всі відділи тонкої і товстої кишки [1].*

**Ключові слова:** *Hydro-MRI або гідромагнітна резонансна томографія, хвороба Крона, пухлини тонкої і товстої кишки.*

## INTRODUCTION

In Ukraine, an increase in the number of patients with chronic inflammatory bowel disease (HVZK) is recorded, which is characterized both by systemic manifestations and by a polymorbid course. CVDVs, which nowadays include ulcerative colitis (UC) and Crohn's disease (CD), are one of the most serious and unresolved problems in modern gastroenterology and coloproctology [2]. According to the World Health Organization (WHO), more than 500 000 cases of cancer of the colon (colorectal cancer) are recorded annually in the world. The highest incidence is noted in the USA, Canada, Western Europe and Russia. Colorectal cancer takes the second place in the structure of female cancer

incidence, second only to breast cancer, and the third place in the structure of male incidence after prostate and lung cancer [3]. Hydro-MRI is a technique for imaging the small and large intestine with MRI. The method is based on double contrasting of the intestinal wall: fluid in the intestinal cavity, which is achieved by taking a large amount of water and using drugs that reduce the rate of its absorption (mannitol, sorbitol, etc.), in combination with intravenous contrasting, which allows to contrast the intestinal wall. Magnetic resonance (MR) enterography and enteroclysis are important methods for evaluating the small intestine, combining good soft tissue contrast, detection, absence of radiation exposure, and repeated data collection for functional bowel assessment (figure 1).

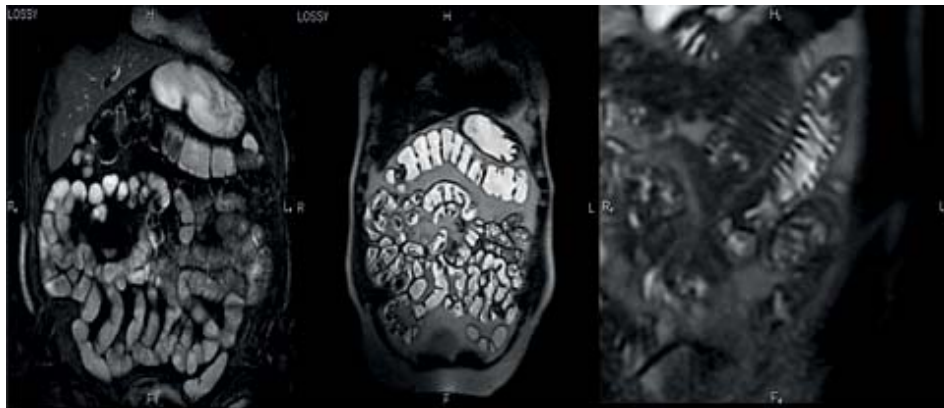


Figure 1. Hydro-MRI of the colon and small intestine in the coronary projection (normal)

Comparative studies between MRI and other small bowel imaging for the diagnosis of inflammatory diseases are often rare, include a relatively small number of patients, and often do not have a good reference standard. A meta-analysis of imaging methods in inflammatory bowel disease showed that there were no significant differences in diagnostic accuracy between ultrasound, computed tomography, scintigraphy and MRI in the diagnosis of inflammatory bowel disease. Therefore, it is preferable to use a non-invasive, non-irradiated (MRI) technique to detect lesions of the small intestine in patients with Crohn's disease. The advantages of ultrasound are the availability and cost, but important advantages of MRI are unlimited review, ease of comparison between examinations and improved transmission of results to the doctor. Therefore, MRI is the method of choice in many centers [4]. Diagnosis of Crohn's disease and detection of disease activity is the main indication for MRI of the small intestine in most centers, and most radiologists are familiar with these MRI results. The study is shown in the visualization of formations of the small intestine, interlope fistulous passages, lesions of the mucous membrane in Crohn's disease, especially in the case of lesion of the terminal ileum, which cannot be visualized by other methods; The inability to enter the endoscope and conduct a study of all parts of the colon: large masses of the colon significantly narrowing the lumen; Pronounced pain, impeding colonoscopy, refusal to carry out endoscopic examination with anesthesia; the inability to conduct irrigoscopy; Additional information on the state of the submucous and muscular layers of the intestine after the endoscopic videocapsular examination.

#### PURPOSE OF THE STUDY

Show of the radiation diagnosis possibilities at normal anatomy of the small and large intestine as well as their pathological changes through the use of MRI.

#### MATERIAL AND METHODS

Object of study. 30 patients examined for the period 2016–2018 using the HYDRO-MRI technique on an MRI device with a magnetic field strength of 1.5 T Echelon, Hitachi in the Unimed medical center, Zaporizhzhia, Ukraine [5]. Twenty patients with manifestations of Crohn's disease in the form of terminal ileitis, presence of interlope fistulous passages, paraproctitis (fistulous form) were identified. Colon tumors were detected in 8 patients, recurrence of gastrointestinal stromal tumor (GIST) of the small intestine in the anastomotic zone was detected in 1 patient, and in 1 patient no pathological changes were detected. Diagnosis of diseases of the small intestine is associated with significant difficulties. This is due to the low availability of the

body for traditional radiological and instrumental studies, the variability of the functional parameters of the small intestine.

Diagnostic methods: blood test (clinical, biochemical and immunological studies). For the endoscopic examination with simultaneous biopsy, only the proximal part of the jejunum and the distal part of the ileum are available, which is important mainly for the diagnosis of rare forms of diseases of the small intestine (celiac disease, Wipla's disease, lymphoma, Crohn's disease). X-ray signs of small bowel disease include thickening of folds, widening of the lumen of the intestine, changes in the mucosal surface, graininess of its surface, alternation of hypertonic and atonic segments, determination of fluid and gas accumulation in the loops of the small intestine, horizontal fluid levels. Preparation for the Hydro-MRI of the small intestine (MRI enterography). The day before the study, a high cleansing enema, or take inside 3–4 bags of «Fortrans». On the evening before the study and on the day of the study (before it), food is not accepted. 45–50 minutes before the Buscopan 2 ml study, if it is intolerable, or there are contraindications to its use, 2 ml of Drotaverin intramuscularly. 30–45 minutes prior to the study, take 1.5–2 liters of a 2% solution of «Sorbitol» (preferably), or a 2% solution of «Mannitol». Preparation for MRI examination of the small and large intestine (figure2).

Take Espumizan (3 capsules daily with meals) for 5 days. Drink 2–3 liters of non-carbonated water for five days. For 5 days before the study, stop eating food containing fiber, which increases gas formation in the intestines: coffee, whole milk, strong tea, beer, carbonated drinks. A day before the study (in the evening) a high cleansing enema, or the reception of «Fortrans». In the presence of constipation is daily intake of mild laxatives. On the evening before the study and on the day of the study, food is not accepted. The patient should have with him 1 liter of non-carbonated water, if it is necessary to refill the stomach and 12 duodenal bowels.

#### RESULTS

Twenty patients with manifestations of Crohn's disease in the form of terminal ileitis, presence of interlope fistulous passages, paraproctitis (fistulous form) were identified. Colon tumors were detected in 8 patients, recurrence of gastrointestinal stromal tumor (GIST) of the small intestine in the anastomotic zone was detected in one patient, and in 1 patient no pathological changes were detected.

#### DISCUSSION

The most important role played by MRI in the diagnosis of tumor, Hodgkin's disease and non-



Hodgkin's lymphoma of the small intestine, as well as Crohn's disease, tuberculosis ileitis, nodular lymphoid hyperplasia of the mucous membrane of the small intestine with general immunodeficiency. Crohn's disease is a chronic autoimmune inflammatory bowel disease characterized by a

progressive course. Hydro-MRI is a relatively new imaging technique that provides for the filling of the small intestine with the contrast adopted per os. Hydro-MRI makes it possible to accurately assess the degree and severity of small intestinal lesions in Crohn's disease (figure 3).

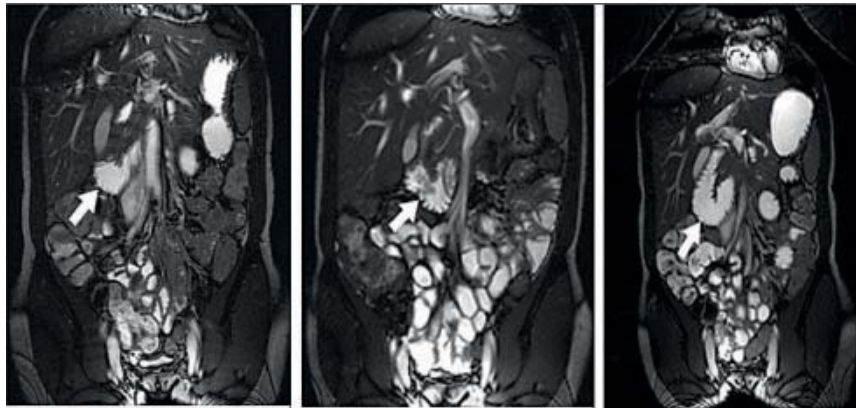


Figure 2. The effect of a contrast agent on image quality. Presents MRI images in coronary projection with the visualization of one of the loops of the jejunum filled with a contrast agent. Optimal visualization of the lumen of the intestine is achieved when using a 2% solution of Sorbitol [5]

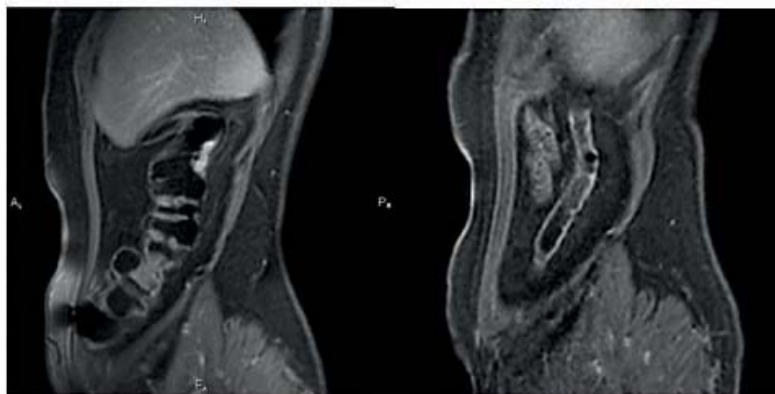


Figure 3. MRI image of the transverse colon colon in sagittal projection (STIR mode). Clearly visualized a limited area of thickening of the mucous membrane with signs of active contrast enhancement, which is typical for the activation of the inflammatory process

This method allows you to get an idea of the extent of the lesion, the presence of extramural manifestations in the penetrating form of the disease, as well as the degree of activity of inflammatory changes (figure 4, 5).

The possibilities of MRI in the diagnosis of formations of the small and large intestine. Determining the boundaries of education, the degree of involvement of the intestinal wall in the pathological process (figure 6, 7).

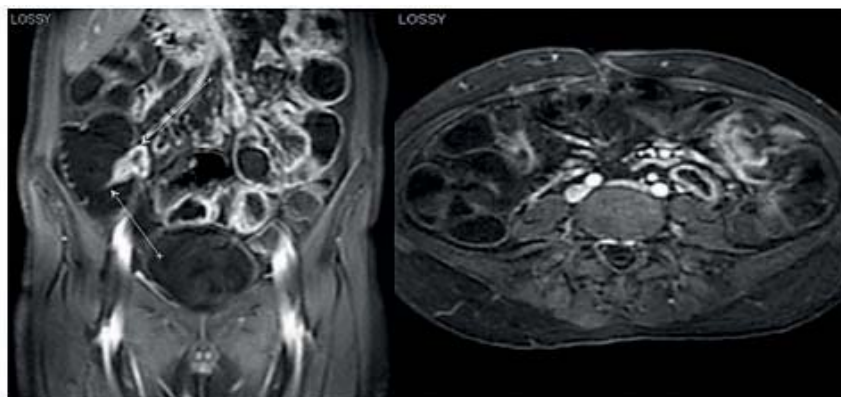


Figure 4. The defeat of the jejunum, terminal ileum, Bauhinov valve, with signs of active pathological contrast enhancement of the walls. MRI images in coronary and axial projections (T1 and T1 FatSat mode)



Figure 5. Total accumulation of a contrast by the rectal wall. MRI image in coronary projection (T1 FatSat mode)

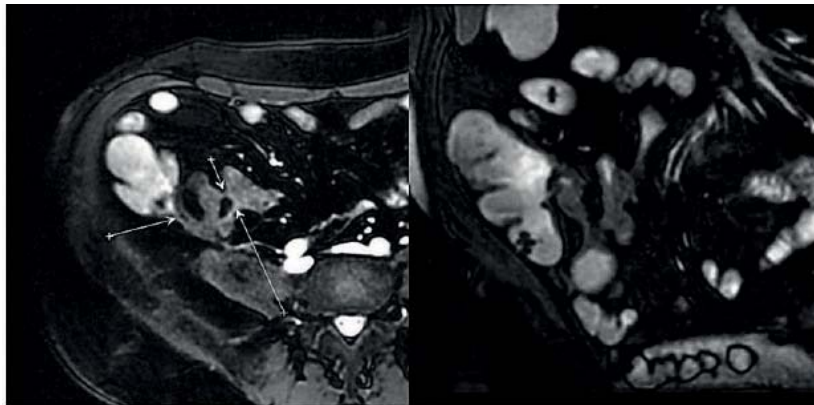


Figure 6. Ileal fistulas. MRI image in axial projections (T1 FatSat mode)

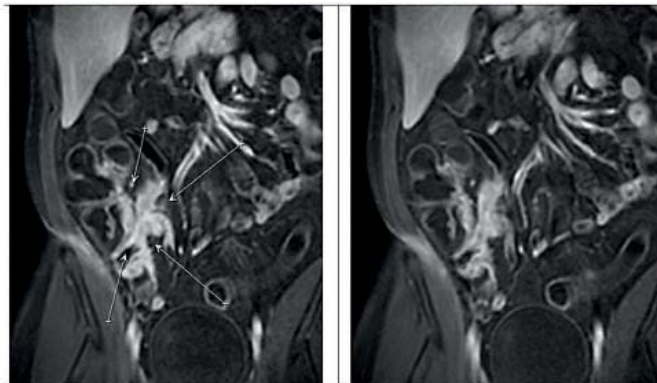


Figure 7. Zones of contrast enhancement of the cecum, terminal ileum. MRI images in coronary projection (T1 FatSat mode)

Identify the relationship of the pathological focus to the sphincter and pelvic floor muscles. Monitoring the state of the lymph nodes and blood vessels. Tumors of the small intestine. Rare formations, up to 23% of the total number of gastrointestinal tumors; Clinical manifestations are nonspecific, include abdominal pain, anemia, and in the later stages, symptoms of intestinal obstruction; The most common histological types of formations: adenocarcinomas, lymphomas, carcinoids, GIST. Hydro-MRI is the only non-invasive technique, which allows to determine

the size, extent of the process in the intestinal lumen and beyond the intestinal wall, allowing to determine the degree of invasion of the surrounding tissue, lymph nodes, vessels (figure 8).

Colon cancer is classified according to various parameters: the nature of growth, the histological structure of the tumor, the stage of development of the disease, the degree of differentiation (figure 9, 10, 11). All these colon tumor divisions and classifications are of practical importance in choosing the appropriate cancer treatment.

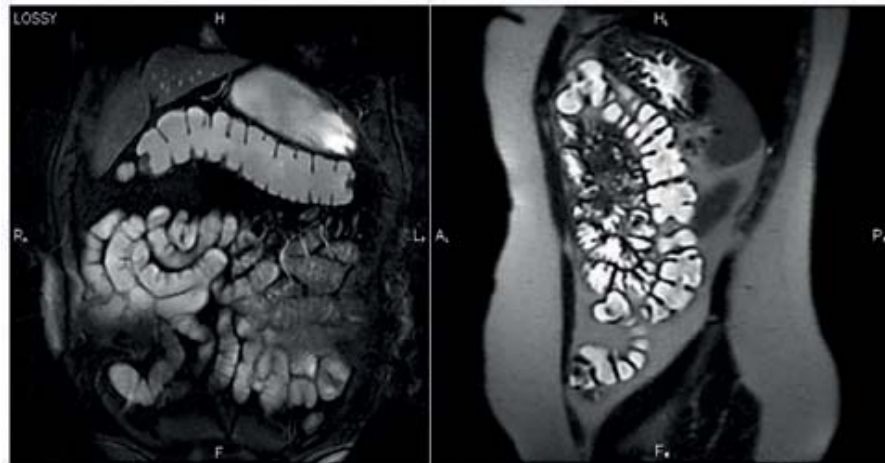


Figure 8. MRI of the colon and small intestine in the coronary projection in the STIR mode in the sagittal projection (mode T2 VI). Clearly visualized lumen of the intestine. Accurately determined wall thickness of the colon and small intestine

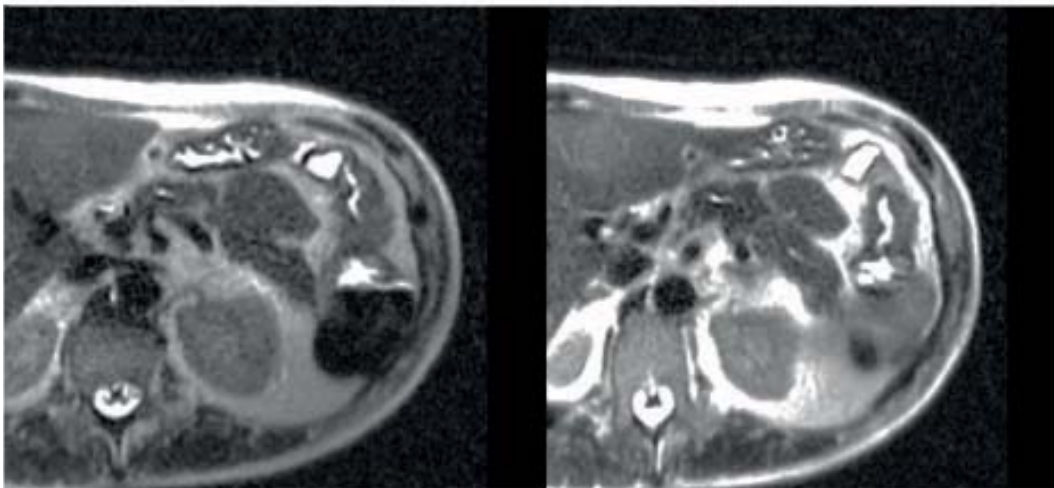


Figure 9. Adenocarcinoma of the splenic angle of the colon. Hydro-MRI in axial projection (mode T2). Endophytic formation with signs of significant narrowing of the intestinal lumen will be determined

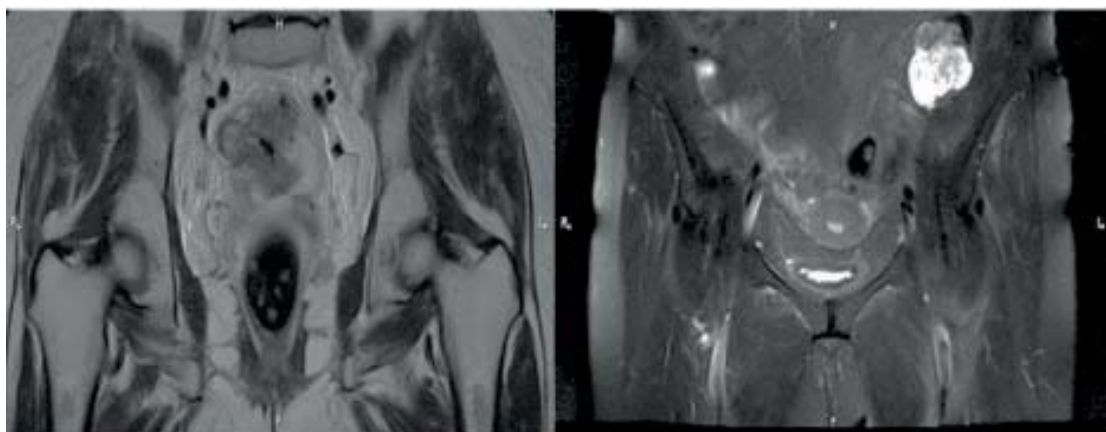


Figure 10. Colon adenocarcinoma stage T3 N1 M0. 04/01/2016 - endoscopic examination, CT of the small pelvis, OBP, preoperative radiotherapy was performed. SOD 50 Gr. 01/19/16, Laparoscopic anterior resection of the rectum, protective ileostomy. MRI examination (03/20/2016) - condition after surgery, combination therapy, carcinoma (continued growth) of the upper ampular part of the rectum and rectosigmoid junction with preservation of the malignancy process, complicated by contact invasion of the posterior surface of the visceral peritoneum and regional mts lymphadenopathy. Stage III B (T4a, N1, Mx). Intrinsic volume formation of the sigmoid colon is most characteristic of Villous (tubular) adenoma



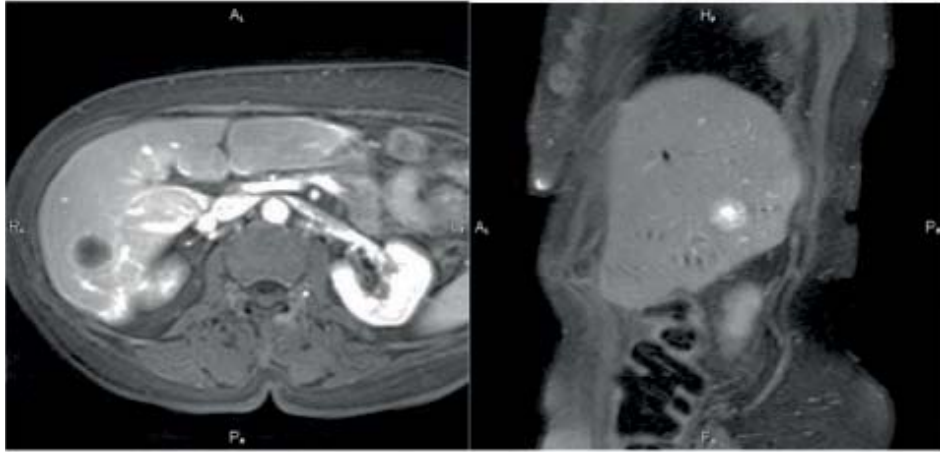


Figure 11. During MRI of the abdominal cavity and retroperitoneal space in the same patient - a lesion mts in the VII segment of the right lobe of the liver

When conducting hydro-MRI, it is always possible to assess the degree of invasion of the intestinal wall, the spread of the process into the surrounding fiber, the prevalence of the process along the intestinal length, which is not always possible to perform when performing irrigoscopy

or endoscopic examination (figure 12, 13, 14).

In the second image in the STIR mode in the sagittal projection, there is a total pathological contrasting of the walls of the descending-colonic section of the large intestine with signs of a lack of haustration (a symptom of a «garden hose»).

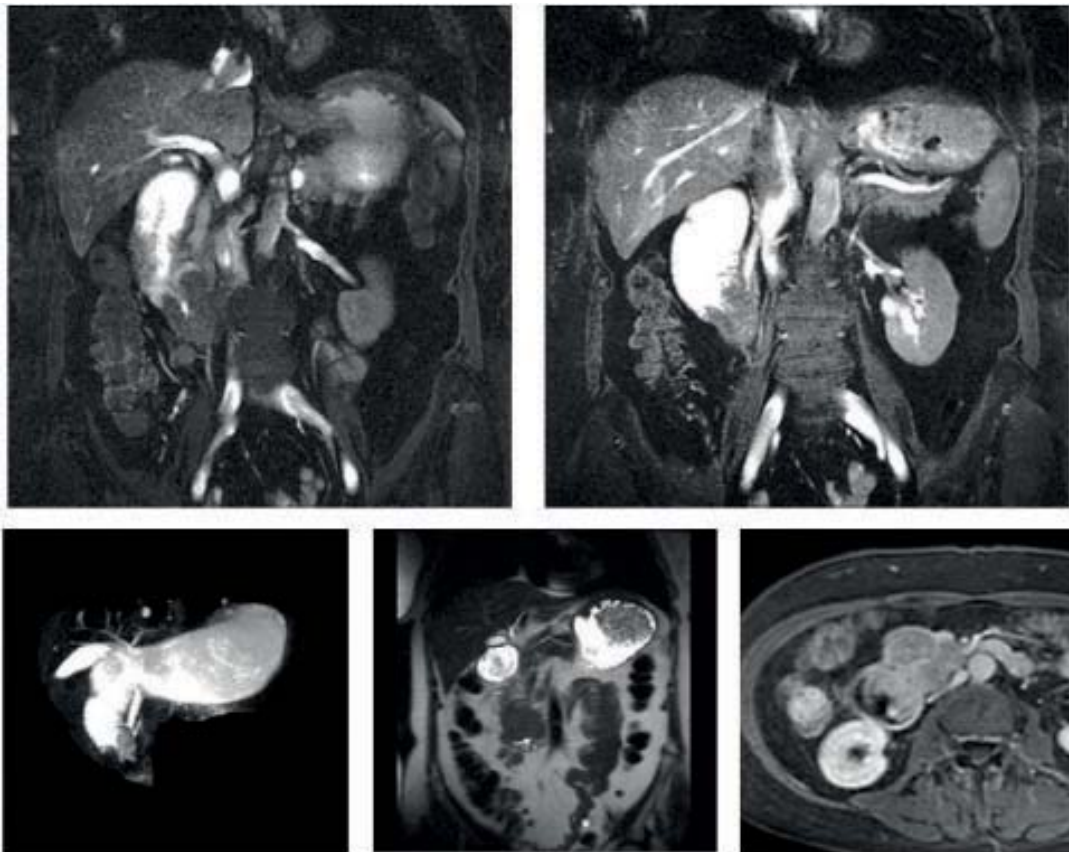


Figure 12. Patient S., 65 years old. Complaints of severe pain in the abdomen for three months, vomiting. Anamnesis data: a sharp weight loss in the last 2 - 3 months (up to 20 kg). According to fluoroscopy: the stomach is significantly enlarged in size, there is no passage of barium suspension in the duodenum. Endoscopic examination was carried out to the level of the horizontal part of the duodenum, then the endoscope was not possible to carry out (tissue masses in the lumen of the intestine; (according to the PGI - adenocarcinoma of the duodenum). MRI-signs of duodenal tissue formation with a rough narrowing of its lumen, active contrast enhancement of the solid part of the formation. MRI images in coronary and axial projections (T2, STIR, T1 modes and three-dimensional reconstruction)



Figure 13. Hydro-MRI in sagittal projection (T2 VI mode). Large formation of the mid-ampulla of the rectum, mixed endo-exophytic form with signs of massive invasion of the surrounding tissue and the posterior wall of the bladder

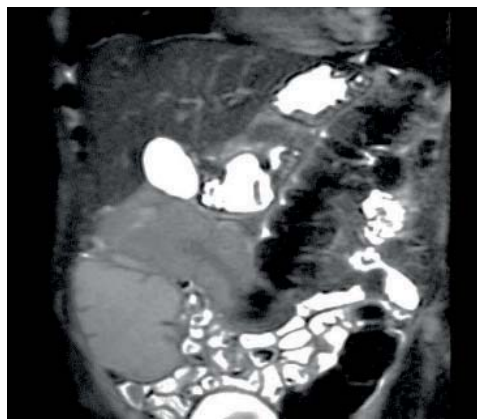


Figure 14. Hydro-MRI in coronary projection (STIR mode). The formation of the transverse colon is significantly narrowing its lumen and not beyond the walls of the intestine

#### FINDINGS

Hydro MRI allows visualizing the mass of the small, large intestine and determining the degree of invasion of the intestinal wall and surrounding tissues. HYDRO MRI is indicated for Crohn's disease and for determining the degree of inflammatory activity. The study is

painless, no radiation load. HYDRO-MRI is the method of choice, if it is impossible to conduct an X-ray examination of the intestine, the inability/uninformativeness of the endoscopic examination of the small, large intestine. Along with video capsular endoscopy, it allows visualization of all departments of the small and large intestine.

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