

INTERNAL DISEASES

ASSESSMENT OF THE DEGREE OF ACTIVITY OF CROHN'S DISEASE IN PATIENTS USING A SPECIALIZED SCALE BASED ON MAGNETIC RESONANCE ENTEROGRAPHY

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RESUME

Background. Magnetic resonance enterography is increasingly being used to diagnose Crohn's disease due to its non-invasiveness, absence of ionizing radiation, and high information content. Despite this, there is still no consensus in the international medical community regarding the use of inflammation indices during MR enterography.

The aim. The presented study examines the possibility of using a specialized scale based on magnetic resonance enterography data to assess the degree of disease activity in patients with Crohn's disease.

Materials and methods. The analysis was conducted on a group of 40 patients with a confirmed diagnosis of Crohn's disease, whose intestinal tract was evaluated according to the criteria of the specialized scale.

Results. During data processing, it turned out that 24 patients (60.0 %) had a score range of 0 to 7, which indicated remission, 10 (25.0 %) had a score range of 8 to 15 (minimal activity), and 6 (15.0 %) had a score range of 16 or more (severe clinical manifestations).

Conclusion. Thus, the scale we developed for assessing the activity of Crohn's disease serves as an effective tool for standardizing diagnosis and monitoring patients' conditions. This method provides an objective assessment of the level of inflammation and the course of the disease.

Keywords: Crohn's disease, magnetic resonance enterography, MR indices of inflammatory activity

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ОЦЕНКА СТЕПЕНИ АКТИВНОСТИ БОЛЕЗНИ КРОНА У ПАЦИЕНТОВ С ИСПОЛЬЗОВАНИЕМ СПЕЦИАЛИЗИРОВАННОЙ ШКАЛЫ НА ОСНОВЕ МАГНИТНО-РЕЗОНАНСНОЙ ЭНТЕРОГРАФИИ

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РЕЗЮМЕ

Обоснование. Магнитно-резонансная энтерография (МР-энтерография) все шире используется для диагностики болезни Крона благодаря своей неинвазивности, отсутствию ионизирующего излучения и высокой информативности. Несмотря на это, в международном медицинском сообществе пока нет единого мнения относительно применения индексов воспаления при проведении МР-энтерографии.

Цель. В представленном исследовании изучается возможность применения специализированной шкалы, основанной на данных магнитно-резонансной энтерографии, для оценки степени активности заболевания у пациентов с болезнью Крона.

Материалы и методы. Анализ проведен на группе из 40 пациентов, на базе ГБУЗ «ООД» г. Иркутска с марта 2023 по май 2025, с подтвержденным диагнозом болезнь Крона, у которых оценивалось состояние кишечного тракта согласно критериям специализированной шкалы.

Результаты. В ходе обработки данных оказалось, что у 24 пациентов (60,0 %) сумма баллов находилась в диапазоне от 0 до 7, что означало ремиссию, у 10 (25,0 %) – от 8 до 15 баллов (минимальная активность) и у 6 (15,0 %) – сумма баллов составляла от 16 и выше (ярко выраженные клинические проявления).

Заключение. Таким образом, разработанная нами шкала для оценки активности болезни Крона служит эффективным инструментом стандартизации диагностики и мониторинга состояния пациентов. Применение данного метода обеспечивает объективную оценку уровня воспаления и динамики течения заболевания.

Ключевые слова: болезнь Крона, магнитно-резонансная энтерография, МР-индексы активности воспалительного процесса

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INTRODUCTION

Crohn's disease (CD) is an inflammatory bowel disease (IBD) that can affect any part of the digestive tract, from the oral cavity to the anus. The pathological process most commonly occurs in the terminal ileum. This condition involves the intestinal wall, causing damage to it in a segmented or transmural manner, leading to the formation of ulcers, strictures (narrowing), and fistulas [1-3].

The etiology and pathogenesis of Crohn's disease are not fully understood. Current research identifies several interconnected factors: a genetic predisposition, an excessive immune response to microbial stimuli, and a disruption in the composition and function of the intestinal microbiota. These factors together lead to an abnormal immune response, chronic inflammation, and recurring, alternating episodes of exacerbation [4, 5]. In addition to these main mechanisms, external triggers such as smoking, specific dietary factors, and stressors may also contribute to the development of the disease [6].

Among instrumental diagnostic methods, the gold standard for the examination of the intestinal tract is endoscopic examination with biopsy. However, despite its effectiveness, this technique has certain limitations when it comes to diagnosing CD [7]. Since any part of the gastrointestinal system can be affected by this pathology, colonoscopy cannot examine the proximal small intestine or assess the condition of all layers of the intestinal wall. Moreover, this invasive procedure is not well tolerated by patients and therefore is not desirable for repeated use [8, 9]. Radiation diagnostic methods such as ultrasound of the intestines, computed tomography enterography (CTE), and magnetic resonance enterography (MRE) demonstrate high efficacy in diagnosing CD. These techniques allow for visualization of both the large and small intestines without invasive procedures. They also allow for assessment of damage to deep layers of the intestine and detection of complications such as strictures, abscesses, fistulas, etc. [10-12].

Furthermore, CTE and MRE imaging allow assessment of the condition of other organs and systems within the area being scanned, identifying both CD-related and non-CD-related pathological conditions [13, 14].

Currently, an increasing number of healthcare professionals prefer MRE for its non-invasive nature, excellent contrast resolution, and absence of ionizing radiation [15]. In addition to assessing the condition of the intestines, MRE can detect extraintestinal conditions such as cholangitis, sacroiliitis, avascular necrosis of the femoral head, and other conditions. Early detection of these conditions allows for timely intervention and maintenance of patient quality of life. The high resolution of MRE imaging provides accurate visualization of the perianal area, allowing for the identification of fistula tracts, which aids in surgical planning. Cine mode MRE enables real-time assessment of intestinal

peristalsis, helping to diagnose reduced intestinal motility and differentiate between strictures and peristaltic waves [16].

Increasingly, MRE has been considered an alternative to colonoscopy for visualization of the intestines, as post-inflammatory or postoperative fibrotic strictures can impede endoscope advancement [17].

A meta-analysis conducted by M. Chavoshi et al. found that, when comparing different age groups, the sensitivity and specificity of MRE was 80 % and 95 %, respectively, compared to 62 % and 94 %, for children and adults [18].

Various indices for assessing active inflammation in MRE have been developed to facilitate interpretation, but none currently enjoys universal acceptance [19]. To date, the most studied is MaRIA (Magnetic Resonance Index of Activity), which has been validated pathologically, but it does not cover the entire small intestine. The Clermont index does not require contrast enhancement, but it also fails to examine the entire bowel and lacks histological validation. The simplest to use is the CDMI (Crohn's Disease Management Index), although it also does not comprehensively cover the small bowel. Unlike other indices, the Magnetic Resonance Enterography Grading Score (MEGS) evaluates the entire gastrointestinal tract and extraintestinal lesions and correlates with fecal calprotectin (FC) and C-reactive protein (CRP) levels, but it lacks pathological validation. Special mention should be made of the Lémann index. It does not assess the activity of a process, but rather provides a comprehensive understanding of the overall condition of the gastrointestinal tract. Additionally, Lémann is correlated with endoscopic, CT, and MRI results, although its application is challenging due to the requirement for multiple examination techniques [19].

THE AIM OF THE STUDY

The study presented here examines the potential use of a specialized scale derived from magnetic resonance enterography (MRE) data to evaluate the level of disease activity in patients diagnosed with Crohn's disease.

MATERIALS AND METHODS

The analysis was conducted on a group of 40 adult patients with a confirmed diagnosis of Crohn's disease who were treated at the Irkutsk City Regional Oncological Clinic between March 2023 and May 2025. The condition of their intestinal tract was assessed using a specialized scale to evaluate the severity of the disease.

Inclusion criteria: male and female patients aged 18 to 70 years with a confirmed diagnosis of Crohn's disease.

Exclusion criteria: pediatric patients, those with other gastrointestinal conditions, individuals who did not provide informed consent, and pregnant women.

The study was conducted using a 1.5 T Tesla GE OPTIMA 45W scanner. MRE was performed at least 48 hours following a colonoscopy. If there was a significant interval between the endoscopic examination and MRE, patients were required to follow similar preparation as for a colonoscopy or use a cleansing enema until wash water became clear. Four hours prior to the procedure, patients ceased all food intake, and 1–1.5 hours before the examination, they started taking 1,200–1,500 mL of mannitol solution in five-minute increments (the intake duration and volume of the mannitol solution varied based on the extent of surgical intervention).

MRE was performed using a flexible coil. Prior to the administration of the intravenous contrast agent, a short-acting peristalsis suppressant, glucagon (Glucagon HypoKit™), was administered intramuscularly to allow for clearer visualization of the bowel walls and mesenteric vessels during contrast imaging. The intravenous contrast was administered via an automated injector. The patient was positioned supine with their feet towards the gantry during the examination, with a communication device in their hand to enable communication with the radiologist in case of emergency. The MRE protocol included specific pulse sequences and imaging planes, which were tailored to optimize image quality and accuracy:

T2-weighted SSFSE images in the coronal, axial, and sagittal planes, without fat suppression, and with fat suppression, to assess the intestinal walls, detect intramural edema, strictures, ulcerations, peri-intestinal edema/inflammation, fibro-fat proliferation (“creeping fat” sign), abdominal anatomy, the retroperitoneal space, and the pelvis, as well as bone structures;

- FIESTA images in the coronal plane, without contrast, to assess vessels;
- DWI images in coronal and axial planes, to assess active inflammation and the presence of purulent content, lymphadenopathy;
- 3D LAVA FLEX, to assess for the presence of hemorrhagic or purulent content and bone structures;
- dynamic FIESTA imaging (Cine Free breath), to assess peristalsis;
- scanning with intravenous contrast (3D LAVA Flex), using automatic digital subtraction, helped confirm active inflammation, detect dilation of mesenteric vessels (“comb sign”), differentiate fibrosis from inflammation, and detect thrombosis/occlusion of mesenteric veins;
- additionally, all patients underwent scanning of the perianal region in coronal and axial planes on T2-weighted images with intravenous scanning in 3D LAVA Flex mode.

The total data acquisition time was 50–60 minutes.

In all patients who underwent MRE, the following parameters were assessed: transmural wall thickness, intramural and mural edema, inflammation, stenosis, stricture, abscesses, fistula formation, infiltration,

ulceration, saccularization, increased blood flow along the mesenteric border of the inflamed bowel (“comb sign”), perivascular inflammation, fibrofatty proliferation (“creeping fat” sign), perimesenteric edema, reduced peristalsis, mesenteric venous thrombosis/obstruction, lymphadenopathy, and perianal findings.

Additionally, sacroiliac joints were evaluated for sacroiliitis, visible parts of the spine were examined to exclude compression fractures, and femoral heads were assessed for avascular necrosis.

Furthermore, a comprehensive assessment of all organs in the scanning area was performed, including the liver, bile ducts, pancreas, kidneys, and pelvic structures.

A specialized scale was developed to evaluate the activity of the inflammatory process in the small and large intestines (Table 1).

The scale was developed based on a thorough analysis of the patient’s intestinal condition, which was divided into nine distinct segments: jejunum, ileum, terminal ileum, cecum, ascending colon, transverse colon, descending colon, sigmoid colon, and rectum. For each segment, several key parameters were identified that were measured using MRE imaging. These included intestinal wall thickness, changes in signal intensity on T2-weighted images with fat suppression, degree of diffusion restriction in tissue, and intensity and pattern of contrast enhancement. Additionally, a point was awarded for the presence of any strictures, pre-stenotic dilation, “comb sign”, and “creeping fat” sign. The points were then summed to generate a total score for the patient.

This method, which allows for quantitative assessment of a patient’s condition, has significantly enhanced the diagnostic and monitoring processes.

Statistical analysis was conducted in accordance with the CONSORT guidelines, with the determination of the sensitivity (Se), specificity (Sp), and accuracy (Ac) of the method, as well as the positive predictive value (PPV) and negative predictive value (NPV). Additionally, Spearman’s correlation coefficient was used in IBM SPSS Statistics 27 for the analysis.

RESULTS AND DISCUSSION

When analyzing the results obtained from patients using our proposed specialized scale, the following findings were made: 24 patients (60 %) scored 0–7, indicating remission (no clinical manifestations); 10 patients (25 %) scored 8–15, indicating minimal activity (slight clinical manifestations); and 6 patients (15 %) scored 16 or higher, indicating severe activity (significant clinical manifestations).

After completing the main phase of measurements in accordance with the scale, the collected data were analyzed using the statistical software IBM SPSS Statistics 27. As a result, the scale showed a good Spearman’s correlation coefficient (r) with endoscopic signs

TABLE 1
A SPECIALIZED SCALE FOR ASSESSING THE ACTIVITY AND SEVERITY OF THE DISEASE

Parameter	Degree of severity	Score
Wall thickness	Less than 3 mm	0
	3 to 5 mm	1
	5 to 7 mm	2
	More than 7 mm	3
T2 signal from the intestinal wall with fat suppression	Corresponds to normal wall	0
	Dark gray	1
	Light gray	2
	High signal (similar to signal from intestinal contents)	3
Diffusion-weighted images	No diffusion restriction	0
	Moderate diffusion restriction (moderate signal drop on ADC)	1
	Marked diffusion restriction (pronounced signal drop on ADC)	2
Intensity and pattern of contrast accumulation in the intestinal wall	Corresponds to normal intestinal wall	0
	Accumulation more pronounced than in normal wall	1
	Markedly pronounced accumulation or signs of "layering"	2
Stricture	No	0
	Yes	1
Pre-stenotic dilatation	No	0
	Yes	1
"Comb sign"	No	0
	Yes	1
"Creeping fat" sign	No	0
	Yes	1

($r = 0.49$ – moderate correlation, $p = 0.002$ – moderate statistical significance), as well as with the outcome of the disease ($r = 0.8$ – high correlation, $p < 0.001$ – high statistical significance) (Table 2). Despite the promising findings, no significant association was identified between the scale and laboratory or histological markers of inflammation. We suggest that expanding the study sample size could enhance the accuracy of the findings. Additionally, mathematical modeling may be necessary to develop a more precise formula.

In addition, the specialized scale demonstrated a strong correlation with MaRIA outcomes ($r = 0.8$ – high

correlation, $p < 0.001$ – high statistical significance) (Table 3).

The proposed scale for evaluating disease activity in Crohn's disease has demonstrated a high degree of information value. A true positive result was obtained in 14 cases (35 %), while a true negative result was achieved in 23 cases (57.5 %). False positive and false negative results were observed in 1 and 2 cases, respectively (2.5 % and 5 %, respectively) (Table 4).

A comparison of the proposed specialized scale with other available inflammation indices derived from MRE data is presented in Table 5.

TABLE 2
THE RESULTS OF CALCULATING THE SPEARMAN'S CORRELATION COEFFICIENT

		Fecal calprotectin level (µg/g)	C-reactive protein level (mg/L)	ESR, mm/h	Histological activity (0 – no, 1 – yes)	Active inflammation on endoscopy (0 – no, 1 – yes)	Outcome (0 – no activity, 1 – minimal activity, 2 – severe activity)	Total score according to the specialized scale
Spearman's r	Fecal calprotectin level (µg/g)	Correlation coefficient						
		Sig. (two-tailed)						
	C-reactive protein level (mg/L)	N						
		Correlation coefficient						
		Sig. (two-tailed)						
	ESR, mm/h	N						
		Correlation coefficient						
		Sig. (two-tailed)						
	Histological activity (0 – no, 1 – yes)	N						
		Correlation coefficient						
		Sig. (two-tailed)						
	Active inflammation on endoscopy (0 – no, 1 – yes)	N						
		Correlation coefficient						
		Sig. (two-tailed)						
	Outcome (0 – no activity, 1 – minimal activity, 2 – severe activity)	N						
		Correlation coefficient						
		Sig. (two-tailed)						
	Total score according to the specialized scale	N						
		Correlation coefficient						
		Sig. (two-tailed)						
		N						

Notes. * – Correlation is significant at the 0.05 level (two-tailed); ** – Correlation is significant at the 0.01 level (two-tailed).

TABLE 3

THE RESULTS OF CALCULATING THE SPEARMAN'S CORRELATION COEFFICIENT

			Total score according to the specialized scale	MaRIA results (0 – no activity, 1 – active phase, 2 – severe course)
Spearman's r	Total score according to the specialized scale	Correlation coefficient	1.000	0.814**
		Sig. (two-tailed)	.	<0.001
		N	40	40
	MaRIA results (0 – no activity, 1 – active phase, 2 – severe course)	Correlation coefficient	0.814**	
		Sig. (two-tailed)	<0.001	.
		N	40	40

Note. ** – correlation is significant at the 0.01 level (two-tailed).

TABLE 4

THE INFORMATIVE VALUE OF THE SPECIALIZED SCALE METHOD FOR ASSESSING THE ACTIVITY OF CROHN'S DISEASE

Indicator	%
Sensitivity	85.7
Specificity	95.8
Accuracy	92.1
PPV*	92.0
NPV**	92.3

Notes. *PPV – positive predictive value; **NPV – negative predictive value.

TABLE 5

COMPARISON OF A SPECIALIZED SCALE WITH OTHER EXISTING INDICES OF INFLAMMATION ACCORDING TO MR-ENTEROGRAPHY

Index	Advantages	Disadvantages
MaRIA	Most studied, histologically confirmed	Does not assess the entire small intestine, requires use of rather complex formulas for calculation
Clermont	Does not require intravenous contrast, high correlation with MaRIA	Does not assess the entire small intestine, not histologically confirmed
CDMI	Simplest (only two parameters), histologically confirmed	Does not assess the entire small intestine
MEGS	Assesses the entire intestine, considers extraintestinal lesions, correlates with fecal calprotectin and CRP	Requires complex interpretation, special training and sufficient physician experience, lacks pathological validation
Lémann (assesses degree of wall damage, not activity)	Assesses the entire gastrointestinal tract, correlates with endoscopy, CT, MRI	Complex method due to need for multiple diagnostic modalities (gastroscopy, colonoscopy, CT, MRI)
Proposed specialized scale	Assesses the entire intestine, ease of use, correlates with endoscopic results, high correlation with disease outcome and MaRIA index	Studied in a small cohort, does not correlate with laboratory markers of inflammation (FC, CRP, ESR)

CONCLUSIONS

MRE is a highly accurate, non-invasive imaging technique effective in detecting extraintestinal manifestations of Crohn's disease (CD) and providing a detailed view of the intestinal state. The scale developed for assessing CD activity is a useful tool for standardizing diagnosis and monitoring the condition of patients, allowing physicians to accurately assess the degree of inflammation and the dynamics of the disease. While further research is needed to validate the scale and perhaps refine it through additional studies on larger groups of patients, it is anticipated that its use could potentially facilitate the monitoring of treatment efficacy and early detection of CD activity in the future. Mathematical analysis of the data collected could also be used to develop a formula for accurately measuring inflammation levels.

Information on ethical approval

The study was approved by the Committee for Bio-medical Ethics of the Irkutsk Scientific Centre of Surgery and Traumatology (Protocol No. 1 dated February 6, 2023).

Conflicts of interest

The authors declare no conflicts of interest.

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