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Assessment of Magnetic Resonance Enterography in the Diagnosis of Small Bowel Diseases in Children with Crohn's Disease

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article

Abstract

Background. In pediatric patients Crohn's disease most commonly involves the colon and the ileocecal part of the intestine. MR enterography, a new method of small bowel imaging with magnetic resonance, has been introduced in the last decade.

Objectives. The aim of this study was to assess the usefulness of the MR enterography in the diagnosis of small bowel lesions in children with Crohn's disease.

Material and Methods. The study included 37 children (18 girls and 19 boys) aged from 5.5 to 18 years (average age, 13.3), diagnosed with Crohn's disease according to the Porto criteria. The disease duration ranged from 1 month to 12 years, on average 3 years. MR enterography was performed according to the Giles et al. protocol. The obtained results were compared with the location and the manifestation of the disease according to the Paris classification.

Results. In 13 children (35.1%), the disease began prior to 10 years of age, and in the remaining 24 children (64.9%) between 10 and 17 years of age. The gastrointestinal endoscopy confirmed Crohn's disease in the colon (45.9%) and in the colon and ileum (27.1%). An incomplete colonoscopy examination which did not reveal the location of the disease was conducted in 7 children (18.9%). A comparison of the location of Crohn's disease with the location of lesions in the small bowel as indicated by MR enterography revealed that the most common changes can be found in the final part of ileum, in ileum, and in 4 children in jejunum. MR enterography demonstrated, that 16 children (43.2%) had inflammation, 7 children (18.9%) stenosis, and 14 children (37.8%) had no lesions at all.

Conclusions. MR enterography is a non-invasive and safe procedure well tolerated by children that allows the visualization of lesions in the small bowel in children with Crohn's disease (*Adv Clin Exp Med* 2016, 25, 1, 111–115).

Key words: children, Crohn's disease, MR enterography.

Crohn's disease belongs to the group of inflammatory bowel diseases of unknown etiology and pathogenesis, but genetic, immunological and environmental factors (such as intestinal bacteria) are relevant. The disease can be diagnosed at any age, but the peak prevalence occurs in young people between 15 and 40 years of age. Approximately 15–25% of patients have been diagnosed prior to adulthood, and the number of new cases among children and adolescents has been increasing in the past 10 years. Currently, it is estimated at 1–8/100,000 (an average of 3/100,000). Crohn's disease is a chronic condition with a tendency to

relapse and to form complications such as strictures, abscesses and fistulae. Lesions may be segmental, transmural, and located in the entire gastrointestinal tract, from mouth to rectum. Bowel inflammatory changes in children are mostly located in the ileocecal area and in the colon. In about 15% of children, lesions may be found only in the small bowel [1–6]. Therefore, it is important to evaluate the entire gastrointestinal tract (with possible complications that appear beyond the intestinal lumen). And yet, the conventional endoscopic examinations allow only the macroscopic and histopathological evaluation of the upper (from

esophagus to the descending duodenum) and of the lower gastrointestinal tract (from the rectum to the terminal ileum), while the major part of the small bowel remains not depicted. Double-balloon enteroscopy is an examination likely limited in children due to its length, need of patients' sedation and low availability. Therefore, the small bowel imaging is dominated by radiological methods ranging from an X-ray with barium contrast, classical enteroclysis, new ultrasound technology, capsule endoscopy, computed tomography and, finally, magnetic resonance imaging. These examinations have their own disadvantages, advantages and limitations – especially in children (e.g. difficulty swallowing a capsule, the risk of choking, reduced value of the ultrasound examination when detecting pathologies located outside the distal end of the ileum). However, regardless of the diagnostic results, examinations that expose children to ionizing radiation should be limited.

In patients diagnosed with the inflammatory bowel disease prior to 17 years of age, the risk of developing malignant neoplasms, as a result of received, accumulated radiation doses, is twice as high as in adults. This is influenced by the duration of the disease, whose course requires repeated testing of its subsequent exacerbations, as well as by the higher rate of cell division in young organisms. Patients who have developed Crohn's disease are particularly vulnerable, because the accumulation of a risky dose (adopted as ≥ 50 mSv), occurs in more patients than in ulcerative colitis (by Chatur 11.1% vs. 2%), [4, 7–10].

Therefore, in the diagnosis of inflammatory bowel diseases, especially in children, methods of imaging the small bowel with magnetic resonance (MRI) are becoming increasingly important, as they do not expose patients to ionizing radiation.

According to the Porto criteria from 2005, the inflammatory bowel disease in children is diagnosed with an endoscopic examination of the upper and lower gastrointestinal tract (full ileocolonoscopy), along with a biopsy for histopathological evaluation, and with a contrast radiology that depicts the small bowel (the latter is applicable, unless there is a suspicion of ulcerative colitis) [11]. However, the European Crohn's and Colitis Organisation (ECCO) in its guidelines from 2010, apart from conducting ileocolonoscopy and endoscopy of the upper gastrointestinal tract with sampling numerous stretches for histopathological examination, stresses the essential role of the small bowel imaging with alternative to X-ray examinations to avoid exposure to ionizing radiation. If available, MR contrast examinations (enterography and enteroclysis) are the preferred method of choice in fistulas and abscesses imaging [1, 6, 10–11]. MR

enterography is better tolerated and less aggravating for patients, which is particularly important in children [4, 7].

Objectives of the Work

The aim of this study was to evaluate the usefulness of MR enterography in the diagnosis of small bowel lesions in children with Crohn's disease.

Material and Methods

The analysis included 37 children from 5.5 to 18 years of age, with mean age of 13.8 years, 18 girls (mean age 14.4 years) and 19 boys (mean age 13.3 years), diagnosed with Crohn's disease according to Porto criteria [11]. The duration of the disease that allowed us to perform the enterography ranged from 1 month to 12 years, on average 3 years. The MR enterography was performed in children during the period of clinical improvement, 1–2 months after the endoscopic examination of the upper and lower part of the gastrointestinal tract. MR enterography was performed based on the Giles et al. protocol [8] in their own modification. On the day before the examination patients went on a liquid diet, they received warm soup 5 times a day and drank from 1.5 to 2 L of water. The procedure was performed in the morning, on an empty stomach with an intravenous gadolinium-containing contrast.

Small bowel was evaluated in fat-suppressed T1- and T2-weighted images and in 3D projection after administration of contrast in T-weighted images. The obtained results were compared with the clinical manifestation of the disease and the endoscopic location of inflammatory lesions according to the Paris classification [2].

Results

In 13 patients (35.1%) Crohn's disease began prior to 10 years of age (A1a), and in the remaining patients (64.9%) from 10 to 17 years of age (A1b) (Table 1). Ileocecal localization (L1) of the disease was reported in 3 children (8.1%), small bowel inflammation was reported in 2 children (66.7%), stenosis in 1 child (33.3%). The average age of patients in this group was 13.8 years. Another 17 patients (45.9%) were younger (average age of 8.3 years), and they were diagnosed with lesions only in the colon (L2). In 47.1% of patients were diagnosed with lesions in the small bowel: 35.3% had inflammation, 11.8% stenosis, and 52.9% had

Table 1. Characteristics of patients

Age at the time of diagnosis (years)	No. of children	Age (years)		Gender				Duration of the disease (years)	
		from-to	average	girls (18)		boys (19)			
				age from-to	average age	age from-to	average age	from-to	average
< 10	13 (35.1%)	1.1–9	5.8	1.1–8	5.3	3–9	7.0	0.16– 12	4.4
> 10< 17	24 (64.9%)	10–17	13.4	10–17	13.3	10–16	13.5	0.1–8	2.3
Total	37(100.0%)	1.1–17	11.0	1.1–17	11.2	3–16	10.8	0.1–12	3.0

correct small bowel. Another group of 10 patients (27%) had endoscopic changes in both the small and large bowel (L3) – average age of this group was 12.6 years. In 60% of patients enterography presented lesions in the small bowel such as inflammation (50%), stenosis (10%), and the small bowel were correct in 40%. In 7 patients (18.9%) the

colonoscopy was incomplete and did not include the terminal ileum, more than 85% of patients in enterography presented lesions in the small bowel (in 42.8% inflammatory and in 42.8% stenosis) (Table 2 and 3). 46% patients had perianal lesions and fistulas. MR enterography revealed lesions in the small bowel and confirmed Crohn's disease in

Table 2. Comparison of endoscopic localization with lesions in small bowel in the magnetic resonance enterography

Endoscopic localization (Paris classification)	No. of children	Location of lesions in small bowel in MR enterography							
		jejunum		ileum		final section of ileum		no lesions	
		n	%	n	%	n	%	n	%
Ileum ± cecal disease (L1)	38.1	0	0	2*	66.7*	3	100	0	0
Colonic (L2)	1745.9	3	17.6	0	0	5	29.4	9	52.9
Ileocolonic (L3)	1027.1	1	10.0	2*	20.0*	5	50.0	4	40.0
Isolated to the upper disease (L4a and L4b)	0	0		0		0		0	
Incomplete colonoscopy	718.9	1	14.3	1	14.3	4	57.1	1	14.3
Total	37 100.0	5	13.5	5*	13.5*	17	45.9	14	37.8

*lesions affecting 2 sections were confirmed in 4 children (ileum and the final part of the ileum).

Table 3. Comparison of endoscopic localization with results of disease manifestation in MR enterography of small bowel in children

Endoscopic localization (Paris classification)	No. of children		Average age (years)	Lesions in small bowel revealed in MR enterography							
				inflammatory		stricturing		penetrating		no lesions	
	n	%		n	%	n	%	n	%	n	%
Ileum ± cecal disease (L1)	3	8.1	13.8	2	66.7	1	33.3	0	0	0	0
Colonic (L2)	17	45.9	8.3	6	35.3	2	11.8	0	0	9	52.9
Ileocolonic (L3)	10	27.1	12.6	5	50.0	1	10	0	0	4	40.0
Isolated to the upper disease (L4a and L4b)	0			0		0		0		0	
Incomplete colonoscopy	7	18.9	12.9	3	42.8	3	42.8	0	0	1	14.2
Total	37	100.0	11.2	16	43.2	7	18.9	0	0	14	37.8

Table 4. Comparison of clinical manifestation of Crohn's disease with disease manifestation in MR enterography of small bowel in children

Clinical manifestation of the disease (Paris classifications)	No. of children		Lesions in small bowel depicted in MR enterography							
			inflammation		stricturing		penetrating		no lesions	
	n	%	n	%	n	%	n	%	n	%
Nonconstricting, nonpenetrating (B1)	22	59.5	11	50.0	2	9.1	0		9	24.3
Stricturing (B2)	6	16.2	0		5	83.3	0		1	16.7
Penetrating (B3)	6	16.2	3	50.0	0		0		3	50.0
Penetrating and stricturing (B2B3)	3	8.1	2	66.7	0		0		1	33.3
Perianal disease modifier (p)	17	45.9	6	35.3	2	11.8	0		9	52.9
Growth delay (G1)	15	40.5	8	53.3	3	20.0	0		4	26.7

13 patients (35.1%), in whom the endoscopic examination had revealed lesions only in the colon, or had not revealed ileum. The examination of the clinical manifestation of Crohn's disease presented a nonconstrictive and nonpenetrating form of disease (B1) in 22 examined patients (59.5%); half of them had small bowel inflammation, 9.1% stenosis, and 40.9% no lesions at all.

In 83.3% of patients with the structuring manifestation of Crohn's disease had stenosis. 50% of patients with a penetrating manifestation of disease (B3), had a correct small bowel (Table 4).

In 3 patients (8.1%) with stricturing and penetrating manifestation of disease (B2B3) MR enterography revealed inflammatory changes in 66.7%, while the remaining patients had no lesions. Perianal lesions (p) occurred in 45.9% of children, 35.3% had inflammatory changes, 19% had fistulas and 11.8% stenosis. Moreover, 40.5% of children with Crohn's disease presented of growth delay (G1), and 17.3% had other abnormalities – mostly inflammation in the small bowel (53.3%) or stenosis (20%) (Table 4).

Discussion

MR small bowel imaging in children with Crohn's disease is an extremely useful examination allowing for the evaluation of the gastrointestinal tract sections which are inaccessible in endoscopic evaluation. The quality of MR and CT examinations is similar, but MR does not expose patients to harmful ionizing radiation. MR enterography most often reveals irregularities such as the bowel wall thickening, bowel stenosis, swollen lymph nodes, as well as parenteral complications of the disease such as abscesses or fistulae [5, 6].

MR examination allows for a better evaluation of the inflammatory activity and fibrosis in

intestinal walls. In the chronic course of the disease intestinal wall stratification is blurred, which is an irreversible process called a progressive fibrosis. Moreover, there is a progressive steatosis and fibrous proliferation of adipose tissue demonstrated by heterogeneous signal near intestinal fat. The acute phase of Crohn's disease is indicated by irregular bowel outer contours, increased signal after administration of contrast in T1-weighted images, layering walls, high signal in T2 imaging in the submucosal layer – edema – image of the disc and mesenteric hypervascularisation. It is essential to plan further therapeutic procedures such as the pharmacological treatment intensification or a surgical procedure [3–6]. Analyzing the value of the MR enterography in pediatric patients, Silverstein et al. demonstrated its high specificity and positive predictive value for terminal ileitis. The severity of inflammation on MRE had a statistically significant positive correlation with PCDAI (Pediatric Crohn's Disease Activity Index). Sauer et al. [13] presented that in pediatric Crohn's disease the active inflammation on MRE is associated with a higher C-reactive protein, erythrocyte sedimentation rate, platelets and lower albumine.

In our studies, MR enterography was an important complement to diagnostic examinations. In the group of patients with ileocecal Crohn's disease (L1), MR enterography allowed us to determine the types of lesions – less than 67% of them were inflammation, other lesions were stenosis. However, in the group of patients with confirmed endoscopic lesions only in the colon (L2), MR enterography allowed us to reveal inflammation also within the small bowel in more than 47%. In over 85% of patients who had undergone an incomplete endoscopic examination of the lower part of the colon that did not involve ileum terminale, MR enterography revealed inflammation in the small bowel. MR enterography revealed lesions

in the small bowel and confirmed Crohn's disease in 13 children (35.1%) in which endoscopic examination had revealed lesions only in the colon, or in which ileum had not been depicted in the colonoscopy.

MR enterography, despite its many advantages, is not without flaws. Some patients need to be sedated before the examination due to the fact that it is often longer than CT and can be difficult to tolerate by patients suffering from claustrophobia (contrary to the CT examination which is shorter and not conducted in a tunnel-like machine). The only absolute contradiction to the MR examination

is the presence of a pacemaker, while relative contraindications include the presence of solid metal components in a patient's body [3, 6, 14].

Analyzed patients tolerated both the magnetic resonance imaging enterography itself as well as the preparation for the procedure. All patients were able to take the required amount of oral fluids, and despite the fact that the youngest patient was 5.5 years old, they did not require sedation.

The authors concluded that MR enterography is a non-invasive, safe method and well tolerated by children, which allows the visualization of the small bowel lesions in pediatric Crohn's disease.

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