УДК 616-053.2:616.34-089:617.55

TREATMENT TACTICS FOR CHILDREN WITH MAGNETIC FOREIGN BODIES OF THE GASTROINTESTINAL TRACT

R.V. Bocharov[1,2], V.G. Pogorelko[1,2], G.V. Slizovskiy[1], Ya.V. Shikunova[1]

[1] Siberian State Medical University, 634050, Tomsk, Russian Federation
[2] Regional State Autonomous Healthcare Institution "Emergency Hospital №2", 634021, Tomsk, Russian Federation

ТАКТИКА ЛЕЧЕНИЯ ДЕТЕЙ С МАГНИТНЫМИ ИНОРОДНЫМИ ТЕЛАМИ ЖЕЛУДОЧНО-КИШЕЧНОГО ТРАКТА

Р.В. Бочаров[1,2], В.Г. Погорелко[1,2], Г.В. Слизовский[1], Я.В. Шикунова[1]

[1] Сибирский государственный медицинский университет, 634050, Томск, Российская Федерация
[2] Областное государственное автономное учреждение здравоохранения «Больница скорой медицинской помощи №2», 634021, Томск, Российская Федерация

Resume. Twenty clinical cases of magnetic foreign bodies in the gastrointestinal tract in children were analyzed. The age of the affected children ranged from 7 months to 10 years, with an average of 3.7±0.9 years. The main method of detecting magnetic objects in the gastrointestinal tract was radiographic examination of the chest and abdominal organs. Due to the age-specific characteristics of the patients, the anamnestic data (n=12) had a lower percentage of reliability in diagnosing foreign bodies. In three cases, magnetic objects became an intraoperative finding during surgery for suspected appendicular peritonitis. Clinical symptoms of passage of a single magnetic object in the gastrointestinal tract in children were absent. In cases of multiple magnetic objects, nonspecific signs of "acute abdomen" were observed: vomiting, abdominal pain, muscle tension of the anterior abdominal wall, and "black-colored" stool. Single metallic objects were spontaneously evacuated from the digestive tract with conservative management (n=10). Removal of multiple magnetic objects was performed by various methods (n=10). The position of the magnets in the lumen of the esophagus and stomach determined the need for fibro-esophagogastroduodenoscopy (n=3). The presence of foreign bodies at various levels of the intestine, in the absence or presence of peritoneal symptoms, required surgical interventions: endovideo-assisted laparoscopy or laparotomy. Complications of magnetic foreign body ingestion were identified during surgical procedures (n=7): intestinal wall perforation, intestinal obstruction, peritonitis, sepsis. Based on the experience gained, a diagnostic and therapeutic strategy has been developed for managing pediatric patients with magnetic foreign bodies in various parts of the gastrointestinal tract.
Keywords: *children, magnetic foreign bodies, gastrointestinal disorders, intestinal wall perforations*

Резюме. Проанализировано 20 клинических случаев магнитных инородных тел желудочно-кишечного тракта у детей. Возраст пострадавших детей составил от 7 месяцев до 10 лет, средний возраст составил 3,7±0,9 года. Основным методом выявления магнитных объектов в желудочно-кишечном тракте являлось рентгенологическое исследование органов грудной клетки и брюшной полости. В связи с возрастными особенностями пациентов анамнестические данные (n=12) имели меньший процент достоверности диагностики инородных тел. В трех случаях магнитные предметы стали интраоперационной находкой при операции по поводу подозрения на аппендикулярный перитонит. Клинические симптомы прохождения одиночного магнитного предмета по желудочно-кишечному тракту у детей отсутствовали. В случаях множественных магнитных предметов наблюдались неспецифические признаки «острого живота»: рвота, боли в животе, напряжение мышц передней брюшной стенки, стул «черного цвета». Одиночные металлические предметы самопроизвольно эвакуировались из пищеварительного тракта при консервативном лечении (n=10). Удаление множественных магнитных предметов проводилось различными методами (n=10). Расположение магнитов в просвете пищевода и желудка определяло необходимость проведения фиброэзофагогастродуоденоскопии (n=3). Наличие инородных тел на разных уровнях кишечника при отсутствии или наличии перитонеальных симптомов требовало хирургических вмешательств:

эндовидеоассистированной лапароскопии или лапаротомии. В ходе хирургических вмешательств были выявлены осложнения проглатывания магнитных инородных тел (n=7): перфорация стенки кишечника, кишечная непроходимость, перитонит, сепсис. На основании полученного опыта разработана диагностическая и лечебная стратегия ведения детей с магнитными инородными телами в различных отделах желудочно-кишечного тракта.

Ключевые слова: *дети, магнитные инородные тела, желудочно-кишечные расстройства, перфорации стенки кишечника*

Для цитирования: Р.В. Бочаров, В.Г. Погорелко, Г.В. Слизовский, Я.В. Шикунова. ТАКТИКА ЛЕЧЕНИЯ ДЕТЕЙ С МАГНИТНЫМИ ИНОРОДНЫМИ ТЕЛАМИ ЖЕЛУДОЧНО-КИШЕЧНОГО ТРАКТА. INNOVATIVE SURGERY ON THE SILK ROAD. 2024. 1.

For citation: R.V. Bocharov, V.G. Pogorelko, G.V. Slizovskiy, Ya.V. Shikunova. TREATMENT TACTICS FOR CHILDREN WITH MAGNETIC FOREIGN BODIES OF THE GASTROINTESTINAL TRACT. INNOVATIVE SURGERY ON THE SILK ROAD. 2024. 1.

Introduction. Curiosity and lack of internal and parental supervision in preschool-aged children often lead to unintentional ingestion of foreign objects, including metallic items of technical or play purposes, the ingestion of which often goes unnoticed and does not cause any early specific symptoms [1-6]. Migrating magnetic foreign bodies (MFBs) in quantities of two or more can actively interact with each other at different levels of the gastrointestinal tract (GIT), compressing and damaging the walls of the stomach and intestines, which can lead to complications such as intestinal obstruction, perforation, bleeding, fistulas, and peritonitis [1-3, 5-7]. Timely diagnosis of MFBs and tactical selection of their extraction remain crucial aspects in the treatment of this pathology.

The aim of this study was to analyze clinical cases of MFBs in the gastrointestinal tract in children to determine a rational treatment strategy in situations of detecting a magnetic object.

Material and methods. From 2013 to 2023, 20 children (14 boys, 6 girls) were hospitalized at the State Autonomous Healthcare Institution "BSMP № 2", with ages ranging from 7 months to 10 years, with an average age of 3.7±0.9 years. In 18 cases, based on anamnestic data of ingestion of foreign objects (n=10) and signs of "acute" abdomen (n=8), diagnostic overview radiography of the thoracic organs (CHO) and abdominal organs (ABO) was performed. The remaining 2 patients, due to the severity of their condition, underwent only ultrasound examination of the abdominal organs. In children without signs of perforation and peritoneal symptoms, removal of foreign bodies from the esophagus and stomach was performed under general anesthesia: fibroesophagogastroduodenoscopy (FEGDS) using biopsy forceps (grasper "Storz", *Germany*), esophagoscope ("Storz", *Germany*), fibroscope ("Olympus XPE", *Japan*). In situations of prolonged presence of multiple MFBs in the intestinal lumen, and the presence of peritoneal signs of "acute" abdomen after hospitalization, surgical intervention was performed: endovideo-assisted laparoscopy, laparotomy. All operations were completed with radiological control of the abdominal cavity.

Results. In 10 children with no complaints and clinical signs, single magnetic objects were confirmed by radiographic examination of the abdominal cavity. A conservative approach was chosen: dynamic observation and radiological monitoring of the abdominal region. In these patients, the magnetic foreign bodies were spontaneously evacuated from the gastrointestinal tract. Out of 10 children with multiple magnets, in 8 observations with the presence of symptoms of "acute" abdomen during examination, foreign objects of metallic density were visualized in various parts of the gastrointestinal tract on overview radiography of the abdominal cavity. In 2 children who were admitted in a severe condition, ultrasound examination (USE) of the abdominal region diagnosed diffuse peritonitis, and therefore radiological diagnosis before surgery was not performed, and the magnetic foreign objects became an intraoperative finding.

Clinical Observations. Patient *L.*, 3 years 5 months old, was admitted from the Central District Hospital of the Tomsk Region on 25.09.14. In the history, the mother reported the ingestion of several magnetic objects by the child. On the overview radiograph of the CHO and ABO, a foreign body (two magnets) was visualized in the lower third of the esophagus. An attempt to remove the foreign object by FEGDS procedure was unsuccessful. Six hours after admission to

BSMP № 2, the child complained of epigastric pain, and on the radiograph, a foreign body was detected in the projection of the stomach (Fig. 1). Under general anesthesia, FEGDS was performed: a metallic cylinder with a diameter of 8 mm, fixed to the esophageal mucosa, was found in the cardiac part of the esophagus. Upon manual examination, another magnet was found, which attracted each other from the stomach side. After several attempts, the magnet in the cardiac part of the esophagus was captured and forcefully extracted. A pronounced hematoma was visualized on the stomach mucosa in the area of fixation of the second magnet. Due to the difficulty in removal and the absence of complications, the second single magnet was left for spontaneous evacuation from GIT. The subsequent period was uneventful, control X-rays of the ABO confirmed the evacuation and spontaneous passage of the magnet.

Patient *F.*, 2 years 3 months old, was admitted on 19.02.15 to the emergency room of BSMP № 2 due to the ingestion of an unknown number of round magnets approximately 2 days prior, according to the mother. Upon examination, the child exhibited vague discomfort, with a soft, tender abdomen in the paraumbilical area upon palpation. On the overview radiograph of the ABO, a chain of multiple rounded radiopaque shadows in the projection of the stomach and intestines was visualized (Fig. 2). Under general anesthesia, FEGDS was performed, and part of the magnetic foreign bodies was removed. For the removal of the remaining chain of magnets, fixed by the magnetic field through the walls of the stomach and duodenum, an upper laparotomy was performed: the stomach was brought out through the wound, gastrotomy was performed, the magnetic objects were extracted, and a two-row suture was applied to the stomach wall. A total of 78 magnetic balls were removed. Radiological control of the abdominal cavity: no magnetic foreign bodies were detected. The postoperative period was uneventful, and the child was discharged in satisfactory condition for a 14-day follow-up.

In the following case, child *V.*, 6 years old, on 26.12.19, swallowed approximately 30 magnetic objects with a diameter of 0.7 cm while playing and informed his mother about it. Considering the absence of complaints, medical attention was not sought. After 36 hours, abdominal pain appeared, and the child was hospitalized by ambulance. The abdomen was soft, tender in all quadrants, with negative signs of peritoneal irritation. On abdominal cavity radiography, a foreign object composed of 32 metallic density spheres was visualized. During FEGDS, a metallic conglomerate was found in the gastric space. The magnetic conglomerate adhered to the endoscope, and the foreign elements were removed as a single unit, totaling 31 elements (Fig. 3). On the follow-up FEGDS, no foreign bodies were found in the gastric and duodenal expanse. On X-ray ABO, one object of circular shape was projected in the left mesogastrium. After 2 days, the 32-nd magnetic sphere was spontaneously evacuated, and the child was discharged in satisfactory condition.

Patient *G.*, 10 years old, independently presented to the emergency room of BSMP № 2 on 07.08.16 with complaints of abdominal pain that had started 25 hours prior, vomiting, and liquid stool. Considering the complaints, medical history, clinical presentation, and USE cavity findings, a diagnosis of acute appendicitis with peritonitis was made. After preoperative preparation, endovideoassisted laparoscopy was performed: the appendix was unremarkable, but a loop of the intestine was found twisted around a dense local connection resembling the junction of two loops of the small intestine, in which foreign bodies of dense structure were palpated using endoscopic forceps (Fig. 4). Conversion to midline laparotomy was performed: the intestinal junction was separated and the magnets were extracted (9 balls, diameter 4 mm). Perforations of the small intestine (upper at 2-2.5 meters, lower at 1.5 meters from the ileocecal angle) were sutured with two-row sutures, and abdominal cavity drainage was performed. Radiological control of the abdominal cavity confirmed the absence of foreign objects. The postoperative period was uneventful, and the child was discharged in satisfactory condition on the 11-th day.

In the following case, patient *M.*, 4 years old, was brought in by ambulance on 30.04.21 with complaints of abdominal pain for 35 hours and recurrent vomiting. Upon palpation, the abdomen was soft, with tenderness in the epigastrium and right iliac fossa, and negative signs of peritoneal irritation. USE revealed an unremarkable appendix and a conglomerate of unchanged bowel loops, maintaining their shapes and sizes during multi-positional examination. On X-ray in the projection of the pelvis, contrast shadows in the form of a chain of balls (diameter 0.47 mm, 7 pieces) were identified on the right side. Surgical intervention was performed: a midline pararectal incision on the right; upon abdominal cavity exploration, up to 100 ml of serous transparent effusion was found. During intestinal revision, two perforations were found (the dome of the ileocecal angle and the base of the appendix) with foreign bodies

(magnets) in their lumens (Fig. 5), and a third perforation was found on the small intestine (distance up to 50 cm from the ileocecal angle), covered with fibrin and with leakage of intestinal contents. Seven magnetic foreign objects were removed from the perforation in the area of the appendix base, an appendectomy was performed, perforations were sutured with two-row sutures, and abdominal cavity drainage was performed. Radiological control of the abdominal cavity confirmed the absence of foreign bodies. The postoperative period was uneventful, the child was discharged in satisfactory condition on the 16 day.

Child *T.*, 3 years 2 months old, was admitted on 05.02.13 as an emergency case. From the history, it was known that the child had episodic abdominal pain, fever up to 37.5°C, two episodes of liquid stool, and vomiting since 01.02.13. The parents were unaware of the child ingesting any magnetic objects. Despite treatment by the local pediatrician, the abdominal pain persisted, fever increased to 37.6°C, and vomiting became frequent. The child presented with a severe, lethargic, and adynamic state. Visible mucous membranes and tongue were dry. The skin was pale, dry, with a "marbled" pattern. Abdominal palpation revealed tenderness in all quadrants. Abdominal cavity USE was performed, showing echographic signs of peritonitis, and the appendix was not visualized. A diagnosis of acute appendicitis with diffuse peritonitis was made. Surgical intervention included midline laparotomy, during which 9 perforations were found in the intestines with diameters up to 0.5 cm (2 on the dome of the cecum and 7 on the jejunum, of which two are 10 cm from the Treitz ligament and five spanning 30-60 cm from the Treitz ligament). Nine magnetic foreign bodies were removed. Perforations in the jejunum were sutured with two-row sutures, followed by resection of the ileocecal angle, enterocecostomy, appendectomy, lavage of purulent fluid and intestinal contents, abdominal cavity drainage, and laparostomy. X-ray ABO during surgery confirmed the absence of foreign objects. The postoperative period was complicated by sepsis. The laparostomy was closed on 12.02.13. The child was discharged on 15.03.13 in satisfactory condition with a functioning enterocecostomy.

Discussion. Our observations align with findings from various authors indicating that young age, unsupervised presence, negative emotional reactions to examination, and the severity of the condition hinder the collection of disease history, and the reliable visual diagnostic method for MFBs is abdominal plain radiography [2, 3, 5-7]. Undoubtedly, the increasing magnetic attraction between objects leads to intestinal wall damage. Our clinical examples showed that the time required for the formation of a magnetic intestinal tract is significantly shorter than the time for the onset of intestinal perforations. Multiple magnetic objects, two or more, do not present early symptoms, and emerging clinical manifestations correspond to the development of complications (intestinal obstruction, perforations, formation of intestinal tracts, peritonitis) [1-3, 5]. Differences in the localization of multiple MFBs in the digestive tract and the presence of signs of an "acute" abdomen determine the individual therapeutic approach: fibroesophagogastroduodenoscopy, endovideoassisted laparoscopy, or laparotomy.

Conclusions. X-ray examination of the abdominal cavity in children is a mandatory and reliable method of identifying metallic density foreign bodies if they are suspected of ingestion or if there are signs of an "acute" abdomen.

Patients with a single magnet are shown conservative management tactics with migration control and self-evacuation from the intestinal tube.

The location of multiple magnetic bodies in the projection of the esophagus, stomach and upper intestinal tract requires prompt fibroesophagoduodenoscopy in order to remove them and prevent the development of complications.

Verification of multiple magnets in the underlying parts of the intestine requires emergency surgery, individual choice of surgical access.

An intraoperative X-ray examination of the abdominal cavity is mandatory to confirm the complete removal of magnetic objects.

References

1. Averin VI., Golubitskiy SB., Zapolyansky AV., Valek LV., Nikulenkov AV. Diagnostics and treatment tactics for magnetic foreign bodies of the gastrointestinal tract in children. *Surgery news*. 2017; 25 (3): 317-324. (In Russ.). https://doi.org/10.18484/2305-0047.2017.3.317
2. Barskaya MA., Zavyalkin VA., Varlamov AV., Kuzmin AI., Rodionov VG., Timashev IV., Busov NA., Terekhina MI. Therapeutic and diagnostic tactics for magnetic foreign bodies of the gastrointestinal tract in children. *Modern problems of science and education*. 2018; (2). (In Russ.). https://doi.org/10.17513/spno.27493

3. Babich IM., Bagnovsky IO. Foreign bodies of the digestive tract in children. *Russian Bulletin of Pediatric Surgery, Anesthesiology and Reanimatology*. 2017; 7 (4): 26-30. (In Russ.). https://doi.org/10.30946/psaic369
4. Donskoy DV., Ionov DV., Korovin SA., Vorobyov VV., Solovova VP., Tumanyan GT., Sokolov YuYu. Classification and treatment tactics for foreign bodies of the gastrointestinal tract in children. *Children's surgery*. 2017; 21(3): 127-130. (In Russ.). https://doi.org/10.18821/1560-9510-2017-21-3-127-130
5. Yakovleva OP., Lishke DV., Demina OV. Consequences of the influence of magnetic foreign bodies on the stomach and duodenum in a 2.5-year-old boy. *Topical issues of pediatrics*. Materials of the interregional scientific-practical conference. 2015; 150-154. (In Russ.).
6. Lin A., Chan LCN., Hon KLE., Tsui SYB., Pang KKY., Cheung HM., Leung AKC. Magnetic Foreign Body Ingestion in Children: The Attractive Hazards. *Case Reports in Pediatrics*. 2019; Vol. 19: 2-8. https://doi.org/10.1155/2019/3549242
7. Helen HL., Wong, Bruce A. Phillips. Opposites attract: a case of magnet ingestion. *CJEM*. 2009; 11(5): 493-495. https://doi.org/10.1017/S1481803500011696