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Adhesive Intestinal Obstruction as One of the Causes of Emergency Conditiond in Children

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The article is dedicated to the issue of adhesive intestinal obstruction (AIO): causes, diagnosis and management. The article describes the role of radiographic, ultrasound and endoscopic methods in AIO diagnosis. The article presents a range of classifications used to differentiate not only between different types of AIO, but also between patient management options. The article describes conservative methods of treating AIO in children. Laparoscopy in the event of inefficient conservative therapy allows not only to assess the extent of the adhesive process in the abdominal cavity, but also to eliminate the cause of intestinal obstruction.
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INTRODUCTION

Acute adhesive intestinal obstruction (AIO) in children is one of the most prevalent abdominal surgery diseases that require emergency surgery. According to various researchers, the frequency of this pathology varies from 1.1 to 6 percent in children who have underwent abdominal surgery [1–4]. The prevalence of this disease among other types of intestinal obstruction is 30 to 40 percent. Up to 60% of pediatric relaparotomies are performed due to acute AIO [1]; 90% of those are performed within a year after surgery is done to treat the main condition [5–8].
Acute AIO is rare in children under three; it is equally frequent for all other ages.

ETIOPATHOGENESIS

According to some authors, AIO occurs most frequently after surgery treatment of acute appendicitis (true for some 80% of cases) [9]. Of importance is the unusual position of the appendix; if it is retrocecal, especially subhepatic, or if it is a low pelvic position, it renders appendectomy extremely difficult from the point of view of surgical techniques and leads to deserosalization, which in its turn contributes to the formation of adhesions [10].
If a child suffers abdominal pain, and their medical history mentions surgical interference at the abdominal organs, think of acute AIO first [9]; do not forget this principle.
There are various hypotheses on what causes adhesion formation in the abdominal cavity. Theories

suggest body sensitization to intestinal microflora, ischemia, perverted defensive response consisting in separating pathological inflammatory site, individual propensity to adhesive processes [11], mitochondrial disorders [12], etc. It is suggested that long-term persistence of inflammation in the abdominal cavity boosts adhesion formation. Many researches think adhesions are formed in the abdominal cavity due to the traumatic nature of surgical approach by laparotomy (Fig. 1), infections in the abdominal cavity, and prolonged postoperative intestinal paresis [11]. It is known that adhesions being bound to peristaltic organs cause not only pain syndrome or intestinal obstruction, but also chronic inflammation and sclerosis of tissue [13]. It may be the case that adhesive processes and the chronic inflammation they cause affect lymphoid elements located in the submucosal layers of the intestines (Peyer's patches, solitary follicles), which triggers pathological immune response. Therefore, there exists the autoimmune theory of AIO pathogenesis [14].

Fig. 1. A patient with adhesive intestinal obstruction after laparotomy

CLASSIFICATION

Researchers have suggested various classifications of adhesive intestinal obstruction. Those classifications were developed with due account of the etiology, pathogenesis, and clinical manifestations of intestinal obstructions, based on experimental data and surgeons' own observations. The classifications take into consideration both early and late obstruction [15].
Early AIO emerges within three or four weeks, late AIO develops months or years after surgery. Such separation is due to the fact that each of the above-mentioned AIO types is specific in terms of clinical manifestations and requires specific treatment strategy [9].
According to multiple laparotomies and videoscopic examinations performed by O.I. Blinnikov, A.F. Dronov, and A.N. Smirnov (1993), four degrees of this pathology are distinguished based on the adhesive area:

- I is a local adhesive process limited in area to a third of the postoperative scar or a portion of the abdominal cavity within a single floor; no adhesions in other areas;
- II is a local adhesive process with single occasional adhesions in other areas;
- III is an adhesive process covering a third of the abdominal cavity;
- IV is a diffuse adhesive process covering two thirds of the abdominal cavity.

Beside the adhesive area, the density viscero-visceral and viscero-parietal fibrous adhesions is important as well, because the complexity of adhesiolysis (surgical intervention) depends entirely on it [16, 17].

Clinical manifestations of acute AIO in children are quite diverse and largely depend on the form and the duration of the disease, the intestinal strangulation degree, the adhesive area, the child's age, and other factors [18–20]. Spasmodic abdominal pain that is sharply amplified by drug-stimulated peristalsis is an early symptom of postoperative adhesive obstruction. Such stimulation also results in scanty stool combined with mucus [15, 21, 22].

CLINICAL MANIFESTATIONS

The clinical picture of AIO comprises two symptom groups. The first group is related to the alterations of the gastrointestinal tract (GIT) and abdominal cavity, while the second reflects the general body-wide response to this pathological process.

The first group includes symptoms like stool delay and inability to pass wind. However, in case of high small bowel obstruction wind passage and stool can be observed while distal sections of the intestine are being evacuated. Emesis is also an early symptom of this condition. Its frequency depends on how severely the intestines are obstructed, the type and form of obstruction, and the duration of the disease. Emesis is a reflex in its nature at the onset of the disease; later on, it is triggered by the overflow of the proximal GIT. There may be no emesis at all at the early stage of colonic obstruction. In case of low small intestine obstruction, emesis occurs at large time intervals, and large volumes of emetic matter are exuded. This matter becomes increasingly similar to the intestinal matter and smells like feces. Bloating is one of the local signs of the AIO. Auscultation identifies louder peristaltic sounds in the intestines.

The second group comprises generalized disorders caused by acute intestinal obstruction; endotoxicosis, dehydration, and impaired metabolism are characteristic of this condition. Notable symptoms are thirst, dry mouth, tachycardia, reduced diuresis, hemoconcentration (identified by laboratory indicators) [23–25].

DIAGNOSTICS

Timely diagnostics of early adhesive intestinal obstruction is possible if the patient is followed-up in the postoperative period; however, the most important methods are X-ray studies, ultrasonography, and endoscopy [15].

Non-Invasive Diagnostics

X-ray diagnostics of AIO takes at least 8 to 9 hours on average and can only confirm whether the intestines are obstructed [18, 26, 27]. Some researchers believe that survey roentgenogram combined with clinical data confirms early intestinal obstruction in 8 to 10 percent of patients only. The rest need to undergo dynamic roentgen contrast examination, i.e. small bowel series [10, 15, 21]. Survey roentgenograms are not very informative, especially at the onset of the diseases, which is due to the fact that liquids and wind in the intestines are not yet re-distributed to form classical X-ray signs (arcs and cups of Kloiber) [10, 28, 29].

Roentgen contrast study aimed at diagnosing acute intestinal obstructions is permissible only if there are reliable data indicating the presence of that condition, i.e. a specific clinical picture and an abdominal survey roentgenogram. It should only be done in case of non-strangulation obstruction, because strangulation threatens the viability of the strangulated intestinal loops.

X-ray diagnostics of acute adhesive intestinal obstruction corresponds to an effective radiation dose comparable to two years of natural exposure to radiation. Short wavelength X-rays have high penetrating power, and unlike natural radiation, are capable of inflicting far stronger damage upon the dividing cells of the reproductive system at the stages of spermatogenesis, mitosis, meiosis, and

embryogenesis [9, 27].
Abdominal sonography allows to visualize the pendular movements of the matter in the intestinal lumen, uneven intestinal inflation, free liquid in the abdominal cavity, and the aggregates of intestinal loops, i.e. infiltrates, abscesses, and omentites (Fig. 2).

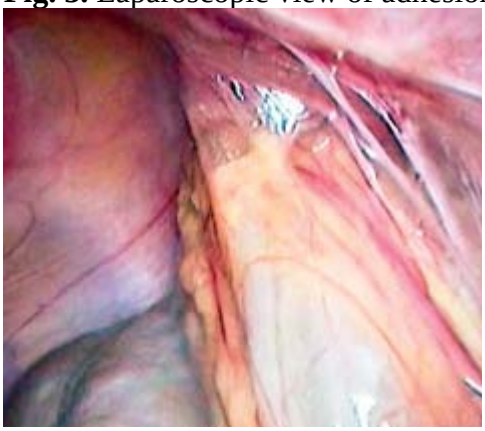
Fig. 2. Ultrasound picture of adhesive intestinal obstruction

Ultrasound diagnostics (US) of intestinal obstruction reveals considerable expanded intestinal loops, which are then 2 to 3 times wider than they should normally be; their walls are thinned and become more echogenic. A day later, Kerckring's folds, i.e. circular mucosal folds, are visualized more clearly. The intestinal lumen is filled with structurally homogeneous liquid echogenic chyme. The most reliable symptom is the pendular movements of intestinal matter, which should be identified at least in several intestinal loops; in case of excessive adhesive process, they can be found in different sections of the abdominal cavity. Sometimes it is possible to visualize the collapsed loops of the small intestine, especially in neonates and toddlers. The location thereof relative to the abdominal sections can roughly determine where the obstruction is. At later stages, anechoic effusion is generated in the abdominal cavity. Peristalsis may become unidentifiable [30].
Abdominal ultrasonography is limited in its diagnostic capabilities due to intense intestinal Pneumatization, which complicates abdominal visualization. Besides, during the inspiratory-expiratory phase the motility small intestine is insignificant, which renders it impossible to determine to the necessary extent whether adhesions are present in different sections of the abdominal cavity. There are no adhesions in some sections of the abdominal cavity, but the intestines may not move during the inspiratory-expiratory phase due to bloating, insufficient diaphragmatic excursion, or the severity of the patient's conditions [31, 32]. Unfortunately, interpretation of such data is not always objective due to the identical nature of the ultrasound picture; this is especially true in cases of intense GIT paresis. In this respect, laparoscopy offers undisputable advantages; when acute AIO has to be confirmed or excluded, laparoscopy is accuracy combined with haste [18, 33, 34].

Endoscopic Diagnostics

Diagnostic capabilities of laparoscopy allow to clarify at which level obstruction takes place, the mechanism thereof, the area of the adhesive process in the abdominal cavity, and the intensity of circulatory intestinal impairments (Fig. 3). In its turn, analysis of these data helps determine further strategies, first of all whether adhesions can be divided endoscopically [3]. Laparoscopic diagnostics of acute intestinal obstruction can be up to 100% accurate [10, 35].

Fig. 3. Laparoscopic view of adhesion



Endoscopic semiotics of early and late AIO is somewhat peculiar. In case of early acute AIO, moderate amounts of transparent effusion are found in the abdominal cavity; this effusion can also be cloudy and hemorrhagic in color. The location of obstruction is mostly the location of the postoperative scar, where intestinal loop aggregates are found, glomerated to the anterior abdominal wall. Adhesions are mostly friable and edematous. Swollen and collapsed loops of the small intestine are rather specific in their abdominal location, which depends on the obstruction level; they are attached to the surgical injury site.

The endoscopic picture of late AIO is also specific, mostly because of the presence of well-formed and dense adhesions. There almost always are seams at the site of the postoperative scar. During laparoscopy, stretched intestinal loops feel rigid and fixed if displaced. While the manipulator is being moved via the intestines, loops need to be forced to move apart and tend to follow the manipulator; after removal, they fix at their previous positions. This endoscopic symptom, i.e. the attachment of intestinal loops, is due to the immobility of the intestines at the obstruction site, which in its turn due to intestinal deformation and adhesive attachment. This symptom is especially distinctive in case of strangulation or intestinal v. Rigidity of the intestinal wall is due to its edema, elevated intraintestinal pressure, and accumulation of matter in its lumen [9, 36].

Some surgeons believe laparoscopy treatment of AIO does not make sense or can even be dangerous due to the possibilities of iatrogenic intestinal injuries under paretic and adhesive conditions of the abdominal cavity. However, surgery by laparotomic approach is associated with increased risk of adhesion recurrence in near and distant postoperative period; extensive viscero-visceral and viscero-parietal adhesions can be formed, causing a relapse of intestinal obstruction [11, 22[/

TREATMENT

As of now, acute AIO in children is treated by laparoscopic adhesiolysis. This method can be successfully applied to different age groups, different types and anatomical varieties of obstruction, different areas covered with adhesions [3, 12, 16, 37–39].

There are distinguished 7 types of intestinal obstruction in children suffering acute AIO; the following methods of laparoscopic adhesiolysis are proposed [18].

1. Adhesion-caused strangulation. Laparoscopic exploration identifies fibrous adhesions in form of bands attached to the parietal peritoneum at one end and to the intestine or its mesentery at the other end. Such strangulation of the intestine and the mesentery is accompanied by intense microcirculatory impairments of the intestinal wall. Laparoscopic surgery should separate such fibrous adhesions. They are visualized all over, separated, and intersected closer to the intestinal wall.

2. Window strangulation. This type of strangulation is rarely accompanied by microcirculatory impairments. Laparoscopic surgery is needed for a thorough exploration of the obstruction site to visualize the window-forming intestinal loops, the loops therein strangulated, and the present short (max. 1 cm) adhesion that causes the same obstruction. After explored, the adhesion is separated along its circumference and then intersected.
3. Volvulus caused by attached adhesion. Abdominal endoscopy identifies one or more twisted intestinal loops. Sometimes such inversion is attached with single adhesions, which seem to fix these loops. Operative exploration with two non-traumatic clamps allows to approach the location where such adhesion is attached to the intestine, separate and intersect the adhesion that fixes the volvulus; this volvulus can be easily dealt with then.
4. Strangulation caused by attached omentum. In these cases, intestinal obstruction occurs due to an intestinal loop being strangulated by the omentum attached to the parietal peritoneum, intestinal wall, or mesentery. Laparoscopy should separate the omentum close to where it is attached to the intestine, mesentery, or parietal peritoneum; the omentum should be dissected at this site, and then resected within health tissue.
5. "Double-Barreled Gun." There can be clearly identified a bloated section before the bending, and a collapsed efferent section. Usually, there are no intense circulatory impairments. All the adhesions that deform the loop are divided, then the loop is separated at the site from the bloated section to the collapsed one.
6. Multiple Adhesions. Operative exploration of the abdominal cavity often finds aggregate of chaotically glomerated intestinal loops at the site of the postoperative scar. Multiple adhesions deform intestinal loops into "double-barreled guns", and it is impossible to find the precise location of the obstruction without dividing this aggregate. In such a case, consecutive viscerolysis is performed all over the intestine in the aggregate by means of laparoscopy, starting from the collapsed distal section and then proximally separating all the encountered adhesions that deform the intestinal tube.
7. Inflammatory Infiltrate Amidst Loops Intestinal obstruction develops after surgery is performed to treat destructive appendicitis and may be related to the generation of inflammatory infiltrate in the abdominal cavity, involving the loops of the small intestine, the cecum, the omentum, and the parietal peritoneum. Cloudy effusion is found in the abdominal cavity, intestinal loops are covered with fibrin pellicle, and there is a specific response of the parietal peritoneum, which may indicate infiltrate abscessation. In such cases, infiltrate should be divided, the omentum should be resected within health tissue, the abdominal cavity should be sanitized and drained [18, 40].

When laparoscopy is performed during abdominal exploration, collapsed intestinal loops are identified first. Then the site is examined towards the upper intestinal sections to find the problematic adhesion. After the cause of intestinal obstruction is identified, the adhesion is intersected, mostly with "cold" scissors. In case the adhesive process is more extensive, no other adhesion in the abdominal cavity is dissected. In most cases, isolated adhesions are found in the abdominal cavity. Surgical interference ends in the sanation of the abdominal cavity; drainage is usually unnecessary.
Postoperative period is characterized by inhibited pain, quick recovery of intestinal peristalsis and the child's activity, no complications of postoperative wounds, the operated site looks nice, inpatient treatment can be reduced in duration; overall, the patient's Quality of Life is improved [29; 41].
As of today, none of the existing methods of adhesion prevention is reliable enough in preventing adhesions and intestinal obstruction. This is why it is necessary to look for other, more efficient methods to combat postoperative adhesions in the abdominal cavity. Mesogel is a water-based gel of sodium carboxymethylcellulose. It is the brand new medicine for prevention and treatment of

adhesions, and is efficient against this pathology [42, 43]. Its effects are based on separating the damaged surfaces for until recovered; it enables friction-free relative sliding of organs to each other; and it also reduces the amounts of fibrin required for adhesions to form. It is important that when applied to health tissue, this gel helps avoid dehydration caused by eventration of the intestines or other internal viscera, by generating a protective layer.

CONCLUSION

Therefore, acute adhesive intestinal obstruction is an important and yet unsolved issue of urgent pediatric surgery. There has been found no reliable means to prevent generation of adhesions. The method of choice for diagnosing and treating of adhesive obstructions is laparoscopy. This type of surgery is preferable to approach by laparotomy, because the latter technique is more traumatic, boosts generation of adhesions, and puts the patients at greater risk of recurrent acute adhesive intestinal obstruction. Laparoscopy allows to reduce the future risks of viscero-visceral and visceroparietal adhesions that can lead to recurrent acute adhesive intestinal obstruction; it also allows to decrease the probability of postoperative complications.

CONFLICT OF INTEREST

The authors of this article have declared absence of reportable financial support / conflict of interest.

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