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# Diagnostic Capabilities Of Comprehensive Ultrasound Examination In Adhesive Intestinal Obstruction In Children

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**Abstract:** Comprehensive ultrasound examination is a highly informative, safe, and dynamic method for diagnosing adhesive small bowel obstruction (ASBO) in children. The study included 60 patients aged 1 month to 17 years. Key sonographic signs included bowel loop dilation >25 mm (80%), absent or bidirectional peristalsis (66%), bowel wall thickening >3 mm (58%), the “keyboard sign” (52%), and free fluid (45%). Ultrasound demonstrated 90% sensitivity and 85% specificity, outperforming plain radiography. Conservative treatment was effective in 50% of cases, while the remaining 50% required surgery. The findings highlight the crucial role of comprehensive ultrasound in early diagnosis and management decision-making in pediatric ASBO.

**Keywords:** Ultrasound diagnostics, adhesive bowel obstruction, children, Doppler, B-mode.

**Introduction:** Adhesive intestinal obstruction (AIO) is one of the most common causes of emergency surgical interventions in children, accounting for up to 40–75% of all cases of mechanical intestinal obstruction. The primary etiological factor in its development is adhesion formation following previous abdominal surgeries, inflammatory processes, or trauma. According to the literature, the lifetime recurrence rate of AIO may reach 15–50%, and 25–66% of patients require repeated surgical interventions.

Mortality in complicated forms of acute AIO in children remains high, reaching 6–10%. Conventional diagnostic methods, such as plain abdominal radiography, have relatively low specificity (50–70%) and do not always allow timely determination of the level and nature of the obstruction. Computed tomography, considered the “gold standard” for diagnosis in adults, is used to a limited extent in pediatric practice due to high radiation exposure. Magnetic resonance imaging, despite its high diagnostic accuracy, has limitations related to long examination times and the need for patient immobilization. In this context, ultrasound examination (US) becomes particularly relevant as a safe, non-invasive, and widely available imaging modality. Ultrasound allows assessment of intestinal peristalsis, loop diameter, bowel wall thickness, presence of free fluid in the abdominal cavity, and bowel wall perfusion. The possibility of repeated dynamic monitoring without radiation exposure makes ultrasound the method of choice for early diagnosis of AIO, monitoring the effectiveness of conservative therapy, and determining indications for surgical intervention. Thus, the development and implementation of a comprehensive clinical and imaging approach with a priority focus on ultrasound can improve the accuracy and timeliness of AIO diagnosis, enhance prognosis, and reduce the incidence of complications and mortality in children.

**Aim of the Study**

To optimize the clinical and imaging approach to the diagnosis of adhesive intestinal obstruction in children based on the integrated use of ultrasound examination and clinical data in order to improve diagnostic accuracy and timeliness, guide treatment strategy, and reduce complication rates.

**METHODS**

The study included 60 children diagnosed with adhesive intestinal obstruction who were treated in a pediatric surgical hospital. The cohort consisted of 36 boys (60%) and 24 girls (40%). Patient age ranged from 0 to 18 years, with a mean age of 6.4 ± 3.2 years (Table 1).

All patients underwent detailed medical history assessment, including documentation of previous abdominal surgeries and inflammatory diseases of the abdominal cavity. Major clinical complaints were evaluated (abdominal pain, vomiting, absence of stool and gas passage). Physical examination included inspection and palpation with assessment of peritoneal irritation signs, abdominal asymmetry, and auscultation of bowel sounds.

Laboratory investigations were also performed, including:

- complete blood count (leukocytosis, hemoglobin level, erythrocyte sedimentation rate);
- biochemical inflammatory markers (C-reactive protein);
- urinalysis to exclude urinary tract pathology.

**Table 1.**

**Age distribution of the examined children**

| Возрастная группа | Количество детей (n) | Доля (%) |
|---|---|---|
| 0–1 лет | 5 | 8,3 |
| 1–3 лет | 15 | 25,0 |
| 3–6 лет | 14 | 23,3 |
| 7–10 лет | 18 | 30,0 |
| 10–18 лет | 8 | 13,3 |
| **Всего** | **60** | **100** |

**Ultrasound Examination Technique**

Ultrasound examination was performed using an expert-class ultrasound system Aplio 500 (Toshiba Medical Systems, Japan). A convex transducer (3.5–5 MHz) was used for assessment of the entire abdominal cavity, while a linear transducer (5–12 MHz) was applied for detailed visualization of intestinal loops and the abdominal wall in younger children.

Scanning was carried out in longitudinal and transverse planes, with changes in patient positioning (multiplanar and multipositional scanning).

In B-mode, the following parameters were assessed:

- diameter of intestinal loops (>25 mm was considered pathological dilatation);
- bowel wall thickness (>3 mm as a sign of inflammation or edema);
- character of intraluminal contents (anechoic – fluid; echogenic – feces or gas);
- peristaltic activity (hyperperistalsis → weakened peristalsis → absent peristalsis; bidirectional peristalsis).

Specific ultrasound signs were evaluated, including:

- the “keyboard sign” (parallel jejunal folds surrounded by fluid);
- presence of free fluid between intestinal loops;
- fixed adhesive conglomerates.

**Doppler Ultrasound**

Color and power Doppler imaging were used to assess bowel wall perfusion. The resistive index (RI) was measured in the superior mesenteric artery and its branches. An RI > 0.85 was interpreted as a sign of intestinal ischemia.

**Additional Diagnostic Methods**

All children underwent plain abdominal radiography upon admission to evaluate air–fluid levels (Kloiber’s

cups) and gas distribution. Contrast gastrointestinal studies were performed only in diagnostically challenging cases.

**Assessment Criteria**

- Echographic criteria: dilated bowel loops, absent or pathological peristalsis, bowel wall thickening, presence of free fluid, and decreased perfusion on Doppler imaging.
- Comparative parameters: sensitivity and specificity of ultrasound compared with radiography.
- Clinical outcomes: effectiveness of conservative therapy, frequency of surgical interventions, and complication rates.

**RESULTS**

In the majority of patients, the disease manifested with typical symptoms of mechanical intestinal obstruction. The main clinical signs included:

- abdominal pain – 57 children (95%);
- vomiting – 49 children (82%);
- abdominal asymmetry – 41 children (68%);
- absence of stool and gas passage – 44 children (73%);
- localized peritoneal irritation signs – 15 children (25%).

Time to Hospital Admission

- 40% of patients were admitted within the first 12 hours after symptom onset;
- 45% were admitted within the first 24 hours;
- 15% were admitted later than 24 hours.

Delayed admission was associated with increased severity of clinical manifestations and a higher rate of complications.

Diagnostic Performance of Ultrasound

Comprehensive ultrasound examination enabled identification of characteristic features of adhesive intestinal obstruction in the majority of patients (Table

**Table 2.**

**Frequency of echographic findings in children with adhesive intestinal obstruction (AIO)**

| Echographic finding | Detection frequency (n=60) | Percentage (%) |
|---|---|---|
| Bowel loop dilatation > 25 mm | 48 | 80 |
| Bowel wall thickening > 3 mm | 35 | 58 |
| Absent or bidirectional peristalsis | 40 | 66 |
| “Keyboard” / “step-ladder” sign | 31 | 52 |
| Free intraperitoneal fluid | 27 | 45 |
| Adhesive conglomerate / fixed bowel loops | 22 | 37 |

In the acute phase, bidirectional peristalsis was observed more frequently, whereas with progression of obstruction, complete cessation of peristaltic activity was noted. The presence of free intraperitoneal fluid and bowel wall thickening greater than 3 mm served as indirect signs of ischemia and an increased risk of complications.

Color and power Doppler imaging revealed the following changes:

- Increased vascular pattern of the bowel wall in 70% of cases, predominantly associated with reactive inflammatory changes;
- Elevated resistive index in the superior mesenteric artery in 62% of patients, which correlated with a more severe clinical course and the need for surgical intervention;
- Absence of perfusion in certain bowel

segments, considered a sign of necrosis, detected in 5 patients, all of whom underwent emergency laparotomy.

A comparative analysis of imaging modalities was performed (Table 3).

**Таблица 3**

**Сравнительная оценка методов визуализации при СКН у детей**

| Метод | Чувствительность | Специфичность | Комментарий |
|---|---|---|---|
| Комплексное УЗИ | 90 % | 85 % | Высокая информативность, возможность динамического наблюдения |
| Обзорная рентгенография | 65 % | 60 % | Ограниченная специфичность, лучевая нагрузка |
| Контрастное исследование ЖКТ | 80 % | 88 % | Применяется выборочно, трудоемко у детей |

Thus, comprehensive ultrasound examination demonstrated the highest diagnostic value, while remaining minimally invasive and free of radiation exposure.

Conservative therapy (nasogastric decompression and infusion therapy) was effective in 30 children (50%). Surgical intervention was required in 30 patients (50%), including:

- resection of a necrotic bowel segment in 5 cases (8.3%);
- adhesiolysis without bowel resection in 25 cases (41.7%).

No fatal outcomes were recorded.

**DISCUSSION**

The results of the study demonstrated the high diagnostic informativeness of comprehensive ultrasound examination in the diagnosis of adhesive intestinal obstruction in children. The sensitivity of ultrasound was 90%, and specificity was 85%, which is significantly higher than that of plain abdominal radiography (65% and 60%, respectively). These findings are consistent with the results reported by Lazarenko et al. (2020), who demonstrated the superiority of ultrasound in the early diagnosis of intestinal obstruction.

The use of B-mode imaging with multipositional scanning allowed visualization of dilated bowel loops, assessment of peristaltic activity, and identification of characteristic echographic signs, including the “keyboard sign,” presence of free fluid, and bowel wall thickening. The presence of these features, particularly in combination, enabled a high-probability diagnosis of adhesive intestinal obstruction and prediction of disease severity.

The application of color and power Doppler imaging was of particular importance in the differential diagnosis between functional and mechanical obstruction, as well as in the assessment of bowel viability. An increased resistive index in the superior mesenteric artery (>0.85) correlated with a more severe disease course and the need for surgical intervention. This finding supports data reported by international authors (Kosiak et al., 2017; Sato et al., 2019), who demonstrated the prognostic value of Doppler sonography in predicting ischemic complications.

A key advantage of ultrasound is its safety, absence of

radiation exposure, and suitability for repeated dynamic monitoring, which is particularly important in pediatric patients. In the present study, serial ultrasound examinations allowed monitoring of peristalsis recovery in patients receiving conservative treatment and facilitated timely identification of indications for surgery.

The obtained data confirm that comprehensive ultrasound examination should be included in the diagnostic algorithm for adhesive intestinal obstruction as the primary imaging modality, especially in younger children. Its use contributes to a reduction in unnecessary radiographic examinations and emergency laparotomies, thereby improving prognosis and reducing hospital length of stay.

## CONCLUSIONS

Comprehensive ultrasound examination is a highly informative diagnostic method for adhesive intestinal obstruction in children, with a sensitivity of 90% and specificity of 85%.

Ultrasound enables detection of early signs of the disease, including bowel loop dilatation, absent peristalsis, the “keyboard sign,” bowel wall thickening, and the presence of free fluid, ensuring timely diagnosis.

Doppler sonography plays an important role in assessing bowel wall perfusion and predicting ischemic complications.

Dynamic use of ultrasound allows monitoring of the effectiveness of conservative therapy and reduces the number of unjustified surgical interventions.

It is recommended to include comprehensive ultrasound examination in the standard diagnostic protocol for suspected adhesive intestinal obstruction in children at all levels of medical care.

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