Paediatric Adhesive Small Bowel Obstruction is Associated with a Substantial Economic Burden and High Frequency of Postoperative Complications

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ABSTRACT

Background: Intra-abdominal adhesions can lead to adhesive small bowel obstruction (ASBO). The incidence of ASBO is higher in paediatric surgery than in adult surgery. However, ASBO related complications, economic burden and clear management guidelines in the treatment of ASBO are lacking. The aims of this study were to investigate underlying diagnoses, treatments, complications and costs in paediatric ASBO.

Method: An observational retrospective study in children 0–15 years, hospitalised for ASBO during 2000–2020. Data were extracted from the medical records. Complications were classified based on Clavien Dindo Classification of Surgical Complications. Descriptive statistics were presented as median, continuous variables and categorical variables summarised with frequencies. Time to ASBO was presented as a Kaplan–Meier estimate.

Results: In total, 101 patients with 137 episodes of ASBO were included whereof 58.4% underwent first (index) surgery during the neonatal period. Median follow-up was 11.3 (0.6–19) years and median time to the first ASBO was 3.76 months (95%CI 2.23–12.02). The most common diagnoses at index surgery were necrotising enterocolitis, duodenal obstruction and primary ASBO. In 86.6% of the patients, first ASBO did not resolve with conservative treatment and a laparotomy was needed. Postoperative complications were found in 52%. Median cost for one episode of acute ASBO was 36 236 USD (1629–236 159).

Conclusion: Neonatal surgery was the dominating cause of ASBO and surgical intervention the most common treatment with a high frequency of postoperative complications and significant healthcare costs. Future studies are needed to develop safe management guidelines for the treatment of paediatric ASBO.

Levels of Evidence: III.

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1. Introduction

Every intra-abdominal surgical procedure can cause adhesion formation as a response to the peritoneal injury and the subsequent healing process [1]. While most adhesions are asymptomatic, some adhesion-related complications are a source of considerable morbidity. The formation of adhesions between segments of the bowel or to the abdominal wall could lead to adhesive small bowel obstruction (ASBO), which is a serious complication [2,3]. In adults, 93% of the patients develop intra-abdominal adhesions as a result of previous abdominal surgery and 1% of all surgical admissions and 3% of all laparotomies are caused by intestinal obstruction due to adhesions [4]. The highest incidence of ASBO has been found in paediatric surgery [5]. The majority of children recover with conservative treatment including bowel rest, nasogastric decompression, resuscitation with fluids and correction of electrolyte imbalances. However, some patients require emergency laparotomy if gastrointestinal ischemia or strangulation is suspected. Also, unresolved intestinal obstruction after conservative treatment will
need a surgical approach [6]. Surgery for ASBO is technically more challenging and adds significant time to the surgical procedure compared to patients without previous surgery [5,7]. In a Swedish study, 12.6% of the children with abdominal surgery during infancy developed ASBO requiring relaparotomy [8]. Duration of surgery over 1 h, stoma formation and postoperative complications were risk factors for ASBO. ASBO occurred within two years of the index surgery in 70% of the patients [8]. There are some studies [8–11] covering the morbidity following postoperative intra-abdominal adhesions in paediatric surgery, however compared to adult surgery this is a less explored field. There is still much to learn about the patient characteristics, underlying diagnoses, complications, economic burden and surgical procedures that predisposes to or reduces the risk of ASBO.

The aims of this study were to investigate underlying diagnoses, treatments, complications and costs in a cohort of children that were hospitalised due to ASBO.

2. Methods

This is a retrospective observational study including infants and children under the age of 15 years, who were hospitalised due to ASBO between the years 2000–2022 at the Department of Pediatric Surgery, University Children’s Hospital in Uppsala, Sweden. Patients were identified by their unique 10-digit identification number in the hospital discharge database. The database search was performed using the ICD-10 codes K56.0 (paralytic ileus), K56.5 (intestinal adhesions (bands) with intestinal obstruction), K56.6 (Other and unspecified intestinal obstruction) and K56.7 (ileus, unspecified). Patients with surgical treatment of ASBO had per-operatively confirmed adhesions at their hospitalisation for ASBO. Conservatively treated patients had adhesions described in the surgical records at other abdominal surgery before or after the episode of ASBO during the follow-up period. Patients with other specific, or unknown, causes for obstruction were excluded from the study. In patients who developed an episode of ASBO during a current hospitalisation, the start of the ASBO was set to the date when a small bowel follow-through radiology was initiated. Data were extracted from the medical records by a researcher not involved in the treatment of the patients. Collected parameters included sex, gestational age at birth, birthweight and comorbidities. Information on the first (index) abdominal surgery, surgical diagnosis, age at surgery, weight, duration of surgery and complications at surgery was retrieved from the medical records. The term primary ASBO was used for patients with intestinal obstruction without prior abdominal surgery. Finally, data collected from the hospitalisation for ASBO was start of symptoms, date of admission and discharge, surgically or conservative treatment of ASBO, duration of surgery, bowel resection due to ischemia or due to accidental damage of the bowel from adhesiolysis, postoperative complications, radiology and costs for the inward stay of ASBO.

The cost was derived according to the Swedish national principles, cost per patient, (KPP) which is a system to calculate the actual cost for the care of the patient. The cost was based on a daily charge of care at the hospital ward estimated on the burden of care of the patient on different levels from 1 to 8. The daily charge of care included cost for staff, premises, materials, drugs and radiology. Extra costs per minute were added for surgery and anaesthesia with an extra charge of 70% for on-call hours. The total cost of care for each inward stay was a sum for each inward stay in the patients’ charts.

Obstructive mechanisms were classified as band or diffuse adhesions as described by the surgeon in the surgical record. In cases of both diffuse adhesions and band, the main cause of obstruction was selected.

Complications were classified based on Clavien Dindo Classification of Surgical Complications (CDC), grade II-V. Total parenteral nutrition (TPN) was registered for grade II complications. For this cohort, TPN was registered as a grade II complication only if the patient did not have parenteral nutrition before the onset of ASBO. Data were collected until March 2022. Duration of follow-up was defined as the date from index surgery to the date when the medical record was reviewed.

Descriptive statistics were presented as median (range) for continuous variables and categorical variables were summarised with frequency (%). Time to ASBO was presented as a Kaplan–Meier estimate. All patients, except for those with primary ASBO, were included in the Kaplan–Meier estimate regardless of duration of follow-up. Difference in days from start of symptoms/admission to surgery and bowel resection were tested using the Mann–Whitney U-test for pairwise comparison. Univariable and multivariable logistic regression were used to test for risk factors for complications following surgery for ASBO. All analyses were performed using R version 4.1.1.

The study was approved by the Regional Ethical Review Board in Uppsala, Sweden. (DNR 2017/359; DNR 2021–00310; DNR 2021-05517-02).

3. Results

In total, 101 patients with peroperatively confirmed ASBO were identified from the medical records. The majority of patients were male, 64 (63.4%). The median duration of follow-up was 11.3 (0.6–19) years. Of the patients, 51 (54.8%), were born full term, 21 (22.6%) were born extremely preterm (<28 weeks), 5 (5.4%) very preterm (28–32 weeks) and 16 (17.2%) moderately preterm (33–37 weeks) (Table 1).

Index surgery was performed in 88 patients and 13 patients had primary ASBO (6 diffuse adhesions and 4 band) due to suspected earlier inflammation/perforation and 3 with unknown aetiology.

The most common diagnoses at index surgery were necrotising enterocolitis (NEC) 14 (15.9%) and duodenal obstruction 14 (15.9%) (Table 2).

Median age at index surgery was 0.1 years (0–12.8) and 55 patients (62%) underwent index surgery during the neonatal period (<44 gestational weeks). Median duration of index surgery was 104 min (21–555) and 68 (79%) of the patients underwent emergency surgery. In 18 (20%) of the patients an intestinal perforation was found, 36 (41%) had a stoma formation and 21 (26%) underwent a bowel resection. A postoperative complication occurred in 38 patients (46%). In 20 patients the complication required a reoperation whereof 17 (85%) were caused by ASBO. Median time to ASBO 1 after index surgery was 3.76 months (95% CI 2.23–12.02) (Fig. 1). A second episode of ASBO (ASBO 2) occurred in 23 patients, missing data on birthweight (22.8%, n = 78), gestational age (7.9%, n = 93).
median time from discharge from hospital for ASBO 1 to admission for ASBO 2 were 30 days (1–831), 6 of the patients with ASBO 2 were treated conservatively for ASBO 1. For the 101 patients there were 137 episodes of ASBO, 126 were acutely hospitalised and the remaining 11 underwent elective surgery for subacute obstruction caused by adhesions. In total, 97 individuals had one episode of acute hospitalisation for ASBO (ASBO 1), 23 had a second episode, (ASBO 2), and two patients had five episodes each of ASBO during follow-up. For ASBO 1, 49 patients were transferred from another hospital, in 7 cases the transportation was made the same day as admission to the local hospital and 42 during initiation of conservative treatment. Median time of stay at the local hospital was 1 day (0–6 days). On average, median time from admission at the pediatric surgical centre to surgery was for ASBO1 1 (0–13) days and median time from start of symptoms to surgery 3 (0–13) days, for ASBO2 1 (0–5) days and median time from start of symptoms to surgery 2 (0–5) days.

Laparotomy for ASBO 1 was carried out in 84 patients (86.6%) at a median age of 1.5 years and laparotomy for ASBO 2 in 14 (60.9%) patients at a median age of 1.9 years (Table 3). Conservative treatment for ASBO 1 was successful in 13 patients (13.4%) whereof 9 were admitted from another hospital. The obstructive mechanism for ASBO 1 was diffuse adhesions in 45 (54.2%) and adhesive band in 38 (45.8%). In total 21 patients were treated conservatively for ASBO at some point during follow-up. The presences of intra-abdominal adhesions in these patients were

![Fig. 1. Kaplan–Meier plot of time to ASBO from index surgery. Patients with primary ASBO as index surgery are excluded.](image)

Table 2
Diagnoses at index surgery.

<table>
<thead>
<tr>
<th>Diagnose (n = 88)</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC</td>
<td>14 (15.9)</td>
</tr>
<tr>
<td>Duodenal obstruction</td>
<td>13 (14.8)</td>
</tr>
<tr>
<td>Others</td>
<td>13 (14.8)</td>
</tr>
<tr>
<td>Appendicitis</td>
<td>10 (11.3)</td>
</tr>
<tr>
<td>Intestinal atresia</td>
<td>8 (9.1)</td>
</tr>
<tr>
<td>Gastrochisis</td>
<td>7 (8.0)</td>
</tr>
<tr>
<td>Aganglionosis</td>
<td>6 (6.8)</td>
</tr>
<tr>
<td>CDH</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Intussusception</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Tumor</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Gastrostomy</td>
<td>2 (2.3)</td>
</tr>
</tbody>
</table>

a NEC 10 and other perforation 4.
b Malrotation 9 and other duodenal obstruction 4.

Table 3
Descriptive statistics in the patients at the acute admission for ASBO.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ASBO 1 (n = 97)</th>
<th>ASBO 2 (n = 23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at ASBO (median (range) years)</td>
<td>1.5 (0–12.8)</td>
<td>1.9 (0–10.3)</td>
</tr>
<tr>
<td>Number of abdominal surgeries prior to ASBO (median (range))</td>
<td>1 (0–6)</td>
<td>2 (1–5)</td>
</tr>
<tr>
<td>Treatment of ASBO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical</td>
<td>84 (86.6)</td>
<td>14 (60.9)</td>
</tr>
<tr>
<td>Conservative</td>
<td>13 (13.4)</td>
<td>9 (39.1)</td>
</tr>
<tr>
<td>Surgery time (median (range) minutes)</td>
<td>130 (30–360)</td>
<td>115 (64–216)</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffuse adhesion</td>
<td>45 (54.2)</td>
<td>7 (50.0)</td>
</tr>
<tr>
<td>Adhesive band</td>
<td>38 (45.8)</td>
<td>7 (50.0)</td>
</tr>
<tr>
<td>Bowel resection</td>
<td>27 (32.1)</td>
<td>3 (21.4)</td>
</tr>
<tr>
<td>Stoma</td>
<td>13 (15.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Intestinal injury at surgery</td>
<td>21 (25.0)</td>
<td>3 (21.4)</td>
</tr>
<tr>
<td>Length of hospital stay (median (range) days)</td>
<td>9 (1–41)</td>
<td>7.5 (0–70)</td>
</tr>
</tbody>
</table>

Values in parentheses are percentages unless otherwise indicated. Missing data on surgery time ASBO 1 (3.1%, n = 94), type of surgery ASBO 1 (1.2%, n = 83), length of stay ASBO 1 (3.1%, n = 94), length of stay ASBO 2 (4.3%, n = 22).
confirmed during an episode of surgically treated ASBO in 12 patients, in 6 patients during previous abdominal surgery and for the remaining 3, the admissions were confirmed during a subsequent closing of a stoma.

Bowel resections were done in 27 cases (32.1%) (Table 3). No significant correlation was found between days from start of symptoms and need for bowel resection, 3 days for no bowel resection versus 1 day for bowel resection (p-value: 0.559). No correlation was found on days from admission to surgery with need for bowel resection, 1 day versus 1 day (p-value: 1). Regarding the use of radiology for the acute 126 episodes of ASBO at least one plain abdominal view was carried out in 99 patients (79%), small-bowel follow-through in 86 (68%), ultrasound in 56 (44%) and CT in 23 (18%). Small-bowel follow-through was successful for resolution of ASBO in 24 patients (28%). Among the 27 episodes of ASBO without a plain abdominal view, ASBO was diagnosed at the current hospital by 15 small bowel follow-through, 4 CT scans, 2 pulmonary views, 1 ventricle view, and 1 contrast enema. In the remaining, 2 is missing and the other 2 transferred from another hospital. In total 16 patients were diagnosed at another hospital and transferred. We can assume that they had some type of radiology prior to the diagnosis in 37 patients in ASBO 2). Life-threatening complications requiring ICU intervention was most likely in children younger than one year. A complication CDC grade II-V (Table 4) was noted in total for 57 (50%) patients for ASBO 1 and ASBO 2 combined (51 patients in ASBO 1 and 6 patients in ASBO 2). The majority of complications were classified as CDC grade II. Out of 32 cases with CDC grade II, 28 cases were due to isolated total parenteral nutrition (TPN) (24 patients in ASBO 1 and 4 patients in ASBO 2). Relaparotomy due to ASBO was found in four cases (5%) (4 patients in ASBO 1 and 0 patients in ASBO 2). Life-threatening complications requiring ICU management, CDC grade IV, were present in 10 cases (10%) (9 patients in ASBO 1 and 1 patient in ASBO 2), out of these there were four cases with multi-organ dysfunction grade IVb. No complication grade V (death of a patient) was recorded. No specific risk factors (number of previous abdominal surgery, stoma, duration of surgery, perforation, postoperative complication at index surgery, age group or gestational age) for developing a CDC complication were identified using univariable and multivariable logistic regression (S1).

The total cost for ASBO for the years 2017–2021 was 1 298 870 USD. The median cost per hospitalisation for acute ASBO was 36 236 USD and range (1629–236 159 USD).

4. Discussion

Following abdominal surgery, infants and children represent one of the highest risk groups of future ASBO, a risk that continues over a lifetime [10,12]. In this study we report underlying diagnoses, treatment, complications and the costs in a cohort of 101 children with 137 episodes of ASBO and with a median follow-up of 11.3 years.

The majority of children underwent index surgery during the neonatal period and the dominating diagnoses were NEC and duodenal obstruction, both diagnoses have been previously shown to predispose ASBO [8,10,13,14]. Both are examples of surgeries involving extensive handling of the tissue or an inflammatory process. Schattenkerk et al. studied the incidence of different types of ileus following surgery for birth defects. Surgery for duodenal obstruction such as malrotation, small intestinal atresia and gastroschisis were the most common diagnoses for future ASBO [13]. Another common index diagnosis in our patients was appendicitis. Even though appendectomy itself does not pose a high risk of ASBO, appendicitis is the most common abdominal surgical procedure in childhood and contributes to a significant amount of the total ASBO in children [10,15,16]. Perforated appendicitis and postoperative intra-abdominal abscess are risk factors in developing ASBO following appendectomy [17,18].

A large proportion, around 75%, of ASBO in infants and children occurs within the first two years after index surgery [8,14,18], this is in agreement with the findings in our study.

In a systematic review, Lin et al. evaluated the success rate in conservative treatment of ASBO in children, the seven studies included demonstrated a wide range of success, 0–75% [19]. In our study, the majority of children with ASBO required laparotomy. The incidence of laparotomy in our study was within the higher range compared to other reports which have presented surgical intervention in 37–93% [12,14,18,20–22]. When interpreting the results from our study it is important to keep in mind that many children will never be referred to a paediatric surgical centre if conservative treatment is successful at the local hospital. On top of that, about half of the patients in our study were transferred from a local hospital where conservative treatment had been initiated. If a child is suspected to have bowel obstruction at a regional hospital a contact is generally initiated with the pediatric surgeons at the paediatric surgical centre. Individual advice about diagnostics, management and at times the need for transferal to the tertiary surgical centre is given by the surgeon on call. In this study we describe data of children admitted for ASBO at the paediatric tertiary surgical centre.

In agreement with other reports, we found a low median age at surgery for ASBO [11,12,14,18,20,23]. In a recent study of 88 cases with ASBO, only including children under the age of three, 93% required surgical intervention for the treatment of ASBO [14]. In a study from Texas including 202 patients, the need for surgical intervention was most likely in children younger than one year. Surgical interventions were carried out in 76% which is 3.7 times more common than in older children [23]. In contrast, Nasir et al. did not find statistical significance regarding age and operative vs non-operative management of ASBO. 53% were treated surgically. However, the median age was 4.5 years and there was only one

### Table 4

<table>
<thead>
<tr>
<th>Clavien Dindo Classification of Surgical Complications</th>
<th>Definition of grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Any deviation from the normal post-operative course not requiring surgical, endoscopic or radiological intervention. Accepted therapeutic regimens include drugs such as: anti-emetics, anti-pyretics, analgesics, diuretics and electrolytes, treatment with physiotherapy and wound infections that are opened at bedside</td>
</tr>
<tr>
<td>II</td>
<td>Complications requiring pharmacological treatments other than those allowed for grade I complications; this includes blood transfusion and total parenteral nutrition</td>
</tr>
<tr>
<td>III</td>
<td>Complications requiring surgical, endoscopic or radiological intervention</td>
</tr>
<tr>
<td>IV</td>
<td>Life-threatening complications: these include CNS complications which require intensive care</td>
</tr>
<tr>
<td>V</td>
<td>Death of the patient</td>
</tr>
</tbody>
</table>

...
In the present study, 32.1% of the patients underwent bowel resection at the first episode of ASBO. In contrast to previous studies, we found no correlation between days from start of symptoms or days from admission to surgery with bowel resection [20,23]. In contrast to our study, Hyak et al. excluded patients with ASBO earlier than four weeks from previous abdominal surgery and only bowel resection due to ischemia were included, in total 23% (24/105) patients required bowel resection [23]. In our study 56% (15/27) of patients required bowel resection due to ischemia.

To our knowledge, this is the first study that presents complications of ASBO in children with the application of CDC. The system focuses mainly on consequences of a complication, hence medically orientated [24]. The high complication rate (50%), including CDC grade II-V, was similar to complications described in the adult population but with a different landscape of complications. Infection was the most common complication in adults following surgery for ASBO [25]. In a study for malrotation in children, Salò reported CDC grade II-IV in 30.2%. Half of the complications were caused by infections and 50% of the complications required relaparotomy [26]. Thompson et al. looked into the application of CDC in a paediatric surgical network including both urological and gastrointestinal surgery and found that wound infection as well as intra-abdominal abscess following appendectomy were the most common complications, CDC III and above were more common in neonatal surgery [27]. In our study, most complications were due to postoperative TPN. We believe that the high frequency of complications seen in our study could be explained by several factors. Firstly, the emergency character of surgery for ASBO. Secondly, surgery for ASBO caused by diffuse adhesions is technically more challenging and adds significant time to the surgical procedure [5,7]. Thirdly, the high frequency of isolated TPN, classified as a complication. If we exclude the isolated cases with TPN as a complication, the total complication rate drops from 50% to 21%. The use of TPN further reflects the population. Prolonged fasting in children, especially small children, is not accepted. Whether this high number reflects the management of ASBO in small children rather than a complication to surgery will be left for future investigations.

Even though we found a high frequency of CDC complications in this study it could be even higher as retrospective studies are often associated with underreporting of adverse events [28]. CDC grade I complications were excluded as we assessed that it would be difficult to obtain reliable data on these slightly adverse events in data retrospectively collected.

Regarding healthcare resources, only two previous studies have calculated the costs of paediatric ASBO [29]. Linden et al. estimated a net operating cost per admission at 16,974 USD, in surgically treated patients 28,009 USD and in conservatively treated 9,237 USD [29]. Lee et al. described a significant reduction in hospital charges associated with laparoscopic adhesiolyis to 38,241 USD compared to 48,552 USD in open surgery. In our study, the median cost per admission was 36,236 USD and the total cost 1,298,870 USD over the last five years. Only the costs for hospitalisations for acute ASBO were included, neither additional cost for elective surgery for subileus, nor outpatient visits for ASBO were included in this study. Nevertheless, the calculated cost represents a gross underestimate of the actual economic burden of adhesion-related problems in children. Time off work and school and frequent out-patient visits for the caregivers and for the child, pain, discomfort and a risk of female infertility [10] are other economic posts that could be taken into account for a fair calculation of economic burden on society. Tingstedt et al. found the loss of production to be 5.2 times the cost of sick leave itself in adult patients with ASBO [30]. In the paediatric population the economic burden on society is even greater than for adult ASBO as at least one caregiver will be off work with the child. Also, future costs for potential female infertility need to be considered in our patients. Ten Broek et al. estimated a 50% higher cost for adhesion-related complications in fertile-aged females taking secondary infertility into account [31].

Development of guidelines in the treatment of paediatric ASBO is warranted. At the moment there is no available protocol for the treatment of ASBO at the clinic. The decision on how long the conservative management should proceed is made by the surgeon in charge. Treatment with water-soluble contrast agents has been used in the adult and paediatric population with a high success rate [32,33]. Rubalcava et al. recently presented a management algorithm for the contrast challenge for ASBO in children [34]. In our study 32% of the patients did not undergo small bowel follow-through. Successful treatment with contrast agents could avoid surgical intervention with the risk of bowel injury. On the other hand, a recent Canadian study in adults by Behman et al. suggested that early surgery for ASBO may be cost effective in terms of QUALys, quality adjusted life years, as the non-operative management may have greater downstream morbidity [35]. Further, new hospitalisations for ASBO are lower after surgical compared to conservative treatment in children [22].

We agree with Schattenkerk et al. that future studies for ASBO in children should be carried out separately in younger and in older children [14] as age seems to have an impact on the need for surgical intervention. Another reason to make this division is that the incidence of ASBO in neonates and infants appears to be more common than in older children, 4.7% versus 2.1% [18], the latter comparable with the adult literature. Whether this difference is explained by different diagnoses or if it is due to different physiology and repair processes remains to be explained [10].

The strengths of this study were the long follow-up time, and that the majority of the children had their index surgery and treatment of ASBO in the same hospital.

Limitations of this study include the retrospective design with the risk of missing children conservatively treated and not referred to a paediatric surgical centre. The CDC grade I was not included as the registration of these possible deviations from the normal postoperative course were not always documented in the medical charts, whereas more severe complications were more likely to be documented as earlier reported [28].

5. Conclusion

We found that neonatal surgery was the dominating cause of ASBO in this cohort of children. ASBO was related to diagnoses associated with inflammatory processes or surgeries with extensive handling of the tissue and ASBO usually occurred within the first two years after index surgery. The dominating treatment of ASBO was surgical intervention with a high frequency of postoperative complications and significant healthcare costs. Future studies are needed to develop safe management guidelines for the treatment of paediatric ASBO.

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Previous communication
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Declaration of competing interest
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Appendix A. Supplementary data
Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpedsurg.2023.05.017.

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