



Epidemiology of adhesions in infants and children following open surgery



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ABSTRACT

Adhesions following intra-abdominal surgery are a major cause of small bowel obstruction. The nature of surgical interventions in children (especially neonates) increases the risk of adhesion-related complications. Following laparotomy in neonates, the collective literature reveals an aggregate mean incidence of adhesive small bowel obstruction (ASBO) of 6.2%; malrotation, 14.2%; gastroschisis, 12.6%; necrotising enterocolitis, 10.4%; exomphalos, 8.6%; Hirschsprung's disease, 8.1%; congenital diaphragmatic hernia, 6.3% and intestinal atresia, 5.7%. In children beyond the neonatal period, the aggregate mean incidence was 4.7%; colorectal surgery, 14%; open fundoplication, 8.2%; small bowel surgery, 5.7%; cancer surgery, 5.5%; choledochal cyst, 3.1%; appendicectomy, 1.4% and pyloromyotomy, 0.1%.

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Introduction

Adhesions are a common and inevitable consequence of surgery. Adhesion formation is part of the natural healing process and occurs in up to 93% of patients following abdominal surgery.¹ Unfortunately, this natural healing process can result in serious and life-threatening complications. The workload caused by adhesion-related complications is large. For an average paediatric surgery department, the readmission rate can vary from 0.3% following appendicectomy to as high as 25% after closure/formation of ileostomy.² In the paediatric age group, the impact of adhesions affects not only the child in terms of pain, discomfort and time off school but also the parents in terms of time off work, which in turn affects their economic activity. Although a common problem, the deleterious impact of adhesions has been largely under-estimated and overlooked.

While adhesion formation following open abdominal surgery is the norm, it is difficult to define and quantify its full clinical significance. This is hampered by the fact that there are no sensitive or specific investigations that identify when and where adhesions are the cause of the problem and no specific symptom complex caused by adhesions. Pain is to be expected after surgery, but when it persists or recurs, adhesions should be considered in the differential diagnosis. It is known that adhesions contain nerves and can cause pelvic pain in adult women,

but it is much more difficult to obtain a clear history in children. Consequently, the only time it can be concluded incontrovertibly that adhesions are the cause of pain is when they lead to adhesive small bowel obstruction (ASBO). In a systematic review of the adult and paediatric literature, ASBO requiring surgical intervention occurred in 2% of cases.³ In children under 5 years of age, the admission rate related to ASBO was 4.2%.⁴

The following review looked at proven complications of adhesions in infants and children after common neonatal laparotomy and other open general abdominal surgery of childhood in order to quantify the overall incidence.

ASBO following neonatal open abdominal surgery

The aggregate mean incidence of ASBO following common neonatal surgical procedures is summarised in [Table 1](#). A total of 11 papers documented the incidence of ASBO in this population group. The total number of patients in these 11 studies amounted to 2956.^{5–15} The overall incidence of ASBO in the individual papers ranged from 2.3% to 19.5% and, when aggregated, the mean overall incidence of ASBO was 6.2% (185 patients).

Overall, malrotation had the highest risk (14.2%) of developing ASBO. This is not surprising as there is a lot of handling of bowel when performing a Ladd's procedure. The mere handling of bowel seems to be enough to stimulate the formation of adhesions. Murphy and Sparnon¹⁰ reported that as many as 19% of patients were readmitted due to ASBO after malrotation surgery.

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Table 1
Aggregate (mean) incidence of ASBO in specific neonatal laparotomy.

Condition	Total cases	Case with adhesions (%)
Malrotation	196	28 (14.2)
Gastroschisis	252	32 (12.6)
Necrotising enterocolitis	125	13 (10.4)
Exomphalos	185	16 (8.6)
Hirschsprung's disease	122	10 (8.1)
Congenital diaphragmatic hernia	394	25 (6.3)
Intestinal atresia	363	21 (5.7)

Gastroschisis was the second most common cause of ASBO in neonates (12.6%). The literature did not indicate whether the application of a silo or primary closure affected this outcome. This may be because the chemical injury to the peritoneum caused by exposure to amniotic fluid for a prolonged period pre-dates the trauma caused by handling at the time of surgery.^{16,17} In contrast, the incidence of ASBO in exomphalos was much lower (8.6%). The reason for this difference may be due to the intact sac protecting the peritoneum from chemical and physical injury.

Following surgery for necrotising enterocolitis (NEC), 10.4% of neonates developed adhesion-related complications. Choudhry and Grant¹¹ observed that faecal peritonitis from perforated necrotising enterocolitis tended to lead to the formation of more dense adhesions compared with malrotation, possibly reflecting the influence of the infective/inflammatory process on the development of adhesions.

ASBO in infants and children

The difference in the incidence between neonates and infants/children may reflect the different pathologies and procedures, or it may reflect differences in the physiology and repair process. There are insufficient data to comment. Young et al.¹² reported that adhesion-related problems were more common in infants (4.7%) than in older children (2.1%). The incidence in older children was comparable with the adult literature.

The aggregate mean incidence of ASBO following major trans-abdominal surgery in infants and older children from 16 papers is demonstrated in Table 2.^{12,18–31} The total number of patients in these 16 papers amounted to 4328. The overall incidence of ASBO was 4.7% (204 patients).

Appendicectomy

Appendicectomy is the commonest surgical emergency performed in children. The incidence of adhesion-related complications following this commonly performed operation is low. In a retrospective comparative study of open versus laparoscopic appendicectomy for both perforated and non-perforated appendicitis Tsao et al.¹⁸ reported a 1.5% incidence of ASBO in 477 children who had open appendicectomy. The incidence was 3% following perforated appendicitis (performed as open surgery), compared

Table 2
Aggregate mean incidence of ASBO in general surgery of childhood.

Condition	Total cases	Case with adhesions (%)
Colorectal surgery	248	35 (14)
Tumour surgery	2043	113 (5.5)
Fundoplication	473	39 (8.2)
Small bowel surgery	123	7 (5.7)
Choledochal cyst	63	2 (3.1)
Appendicectomy	477	7 (1.4)
Pyloromyotomy	901	1 (0.1)

with 0.35% for uncomplicated appendicectomy. Although, this incidence was low when compared with other intra-abdominal procedures, in view of the large number of appendicectomies performed, it leads to a significant workload.

Colorectal surgery

The common types of colorectal surgery performed in children are “pull-through” for Hirschsprung's disease and colectomy for ulcerative colitis or for familial adenomatous polyposis. In a review of 4 papers^{19,20,22,23} on paediatric colorectal surgery, out of a total of 248 children, 35 patients (14%) developed ASBO, the majority required operative intervention. In many articles, the adhesion-related complications were not reported.

Small bowel surgery

Handling of the small bowel (with or without resection) occurs in the excision of Meckel's diverticulum, reduction of intussusception and during resection of duplication cysts, mesenteric cysts and abdominal lymphangiomas. Unfortunately, the data are poor for these indications, but Grant et al.⁴ reported that ASBO occurred in 9.3% of children following small bowel surgery. In a series of 87 cases of intussusception managed by operative intervention ASBO occurred in 24 patients (5%).

Trans-abdominal solid tumour surgery

Children undergoing resection of trans-abdominal tumours are also at risk of ASBO. Aguayo et al.²⁵ reported 133 children with intra-abdominal solid tumour (Wilm's, neuroblastoma, rhabdomyosarcoma and lymphoma), who underwent surgical resection; ASBO occurred in 9 children (6.7%) and the majority of these were in children who had a Wilm's tumour.

The Third National Wilm's Tumour Study looked at the incidence of small bowel obstruction after primary nephrectomy for Wilm's tumour. In 1910 enroled patients, there was a 5.4% incidence of ASBO. Factors that increased the risk of small bowel obstruction were—tumour staging higher than stage III, tumour rupture, vascular invasion, residual disease and tumour spill during nephrectomy.²⁶

Fundoplication

A total of 4 papers looked at adhesions as a complication following open fundoplication. Out of a total of 473 children, 39 patients (8.2%) developed ASBO.^{12,27,28,32} However, the risk increased when combined with additional procedures such as Ladd's procedure or incidental appendicectomy or gastrostomy insertion. The clinical presentation of the ASBO is complicated by the fact that these children cannot vomit and hence have a delayed presentation and a higher risk of death (12.5%).²⁷

Open cholecystectomy and choledochal cyst surgery

There is no paediatric literature that has documented the incidence of ASBO after open cholecystectomy. There is evidence from adult literature that this complication can be as high as 7.1%.³³

Surgery for a choledochal cyst not only involves excision but reconstruction with hepaticojejunostomy and can cause ASBO. Mid- to long-term retrospective studies from 2 papers,^{29,30} with a total of 63 children, reported 2 (3.1%) patients who developed ASBO.

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