Adhesions after abdominal surgery in children
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Abstract
Purpose: The objective of this study is to quantify the overall burden (operative and nonoperative) of small bowel obstruction caused by adhesions after laparotomy in children.

Methods: Data from the Scottish National Health Service Medical Record Linkage database were used to assess risk of an adhesion-related readmission in the 5 years after open abdominal surgery in children and adolescents younger than 16 years from April 1996 to March 1997.

Results: A total of 1581 children underwent abdominal surgery (ie, from duodenum downward). Patients undergoing surgery on the ileum had the highest risk of readmission because of adhesions in the subsequent 5 years after surgery (9.2%)—formation/closure of ileostomy had the greatest risk (25%); 6.5% of children were readmitted after general laparotomy, 4.7% after duodenal surgery, and 2.1% after colonic surgery. The incidence of readmissions was 0.3% after appendicectomy. The overall readmission rate was 5.3% (if appendicectomy was excluded) and 1.1% (if appendicectomy was included).

Conclusion: This population-based study has demonstrated that children have a high incidence of readmissions owing to adhesions after lower abdominal surgery. The risks are related to the site and the type of the original surgery. The risk of further readmissions was highest in the first year but continued with time. The data enable surgeons to target antiadhesion strategies at procedures that lead to a high risk of adhesions.

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Adhesions are part of the normal healing process and occur in 93% of patients after a general laparotomy [1]. Adhesions can cause many problems—symptoms include abdominal pain, time off school, restrictions to normal activities, discomfort or pain, failure to thrive, hospital readmissions, and further surgery. The overall operative burden was recently reported by Grant et al [2]: 1.1% of younger than 16 years had a readmission to hospital after lower abdominal surgery as a direct consequence of adhesions, and 8.3% had a readmission “possibly” related to adhesions over a 4-year follow-up. This is the first study to systematically report readmissions owing to adhesions after specific types of abdominal surgery in a large population of children. This large cohort was followed up for 5 years, specifically looking at the operative and nonoperative burden.
1. Patients and methods

The study used anonymous data from the linked Scottish Morbidity Records (SMR01) database. SMR01 is an episode-based patient record relating to all inpatients and day cases discharged from Scottish National Health Service hospitals.

An incident cohort of patients undergoing abdominal procedures (duodenum to rectum) that could cause adhesions was established by matching operative codes from the Office of Population Censuses and Survey, fourth revision (OPCS-4), to inpatient admissions in Scotland for the year April 1996 to March 1997. This cohort was followed up for 5 years using the Scottish record linkage system by matching patient details to hospital readmissions (operative and nonoperative) defined according to OPCS-4 or International Statistical Classification of Diseases, 10th Revision (ICD-10) diagnostic codes.

Patient readmissions were included if the codes mentioned adhesiolysis or nonoperative readmission for adhesions. The selection of the incident (OPCS-4) and outcome (OPCS-4 or ICD-10) codes was undertaken by at least 2 surgeons from the Surgical and Clinical Adhesions Research (SCAR) group; any disagreements were adjudicated by a third surgeon. This approach underestimated the incidence of admissions owing to adhesions because an explicit reference was required on OPCS or ICD codes to indicate that the patient was in this category. Many adhesion-related episodes without an operation may have been coded as abdominal pain, nausea, and vomiting, and were therefore not reported in this study.

The Scottish Medical Record Linkage Database was chosen because of its size, comprehensiveness, and proven accuracy. Scotland is a geographically distinct country with a stable population of 5 million. There is less than 1% migration per year [3]. The previous accuracy, data quality, and confidence in the information provided an unrivalled source of reliable data [4,5].

The influence of previous operations on adhesion-related readmissions was determined for all surgical sites. Patients were excluded if they had undergone surgery in the previous 5 years to the index operation. Adhesion-related readmission rates were reported based on a site of the initial surgical procedure and then subdivided by recognized surgical procedures within each site according to the OPCS-4.

Readmission rates are expressed as the percentage of patients who were readmitted at least once within 5 years after surgery. In line with previous publications from the SCAR group, confidence intervals for readmission rates have not been calculated because the findings are based on the total population of Scotland and not a sample of the population.

2. Results

A total of 1581 children younger than 16 years underwent lower abdominal surgery (ie, from duodenum downward) in the year April 1996 to March 1997 inclusive. Overall, 17 children had 24 readmissions owing to small bowel obstruction caused by adhesions (1.1%), and surgery took place in 22 readmissions. If the 1336 children who underwent appendicectomy were excluded, 5.3% of patients were readmitted because of small bowel obstruction caused by adhesions. The breakdown according to the type of operation and the anatomical site is itemized below.

2.1. General laparotomy and abdominal wall

These procedures covered the OPCS-4 codes T281-T398. Pyloric stenosis, inguinal hernias, and incisional hernias were not included. The results are reported in Table 1. In this period, 12 babies had closure of gastrostomies/exomphalos, and none was readmitted because of small bowel obstruction. The remaining operations included diagnostic laparotomy, relook laparotomy, exploratory laparotomy, drainage of abscesses, excision of intraperitoneal masses, and biopsy of

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Abdominal procedures, 5-year follow-up</th>
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<tr>
<td>No. of original operations</td>
<td>Patient readmissions</td>
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<tr>
<td>Exomphalos</td>
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<tr>
<td>General laparotomy</td>
<td>92</td>
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<tr>
<td>Small intestine</td>
<td>Overall</td>
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<td>Duodenum</td>
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<tr>
<td>Jejunum</td>
<td>Jejunostomy</td>
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<tr>
<td>Other jejunal ileum</td>
<td>Open resection intussusception</td>
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<td>Meckel's</td>
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<tr>
<td>Ileostomy formation and closure</td>
<td>Ileal resection</td>
</tr>
<tr>
<td>Appendicectomy</td>
<td>Overall</td>
</tr>
<tr>
<td>Emergency (subtotal)</td>
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<tr>
<td>Unspecified</td>
<td>Abnormal and drainage</td>
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<tr>
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<td>Elective (subtotal)</td>
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<tr>
<td>Colon</td>
<td>Overall</td>
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<tr>
<td>Colostomy formation and closure</td>
<td>Other colon</td>
</tr>
<tr>
<td>Panproctocolectomy</td>
<td>22</td>
</tr>
</tbody>
</table>

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intraabdominal lesions. The overall readmission rate for this group was 6 (6.5%) of 92 children.

2.2. Appendicectomy

This covers the OPCS-4 codes H01-H03. The results are shown in Table 1. Children who had an appendicectomy had a relatively low readmission rate (overall, 0.3%). No patient who had an elective appendicectomy was readmitted with small bowel obstruction. The highest readmission rate followed emergency removal of an abnormal or unspecified state of appendix (0.36%). Interestingly, 20 patients who had excision of an abnormal appendix and drainage (appendix abscess) had no readmission owing to small bowel obstruction.

2.3. Duodenum

This covers the OPCS-4 codes G49-G57. The results are shown in Table 1. Twenty-one children had surgery on the duodenum, and only one child (with perforated duodenal ulcer) was readmitted with small bowel obstruction owing to adhesions. The overall readmission rate for duodenal surgery was 4.7%.

2.4. Small intestine

This covers OPCS-4 codes G58-G82. The results are shown in Table 1. Surgery in the small intestine resulted in the highest rate of readmission. Surgery of the ileum had the highest overall readmission rate with ileostomy procedures resulting in a 1 (25%) in 4 readmission risk, followed by ileal resection at 8.3%. There were no readmissions after excision of a Meckel’s diverticulum or after open reduction of intussusception. Twenty-three children had surgery on the jejunum; none was readmitted. Altogether, there was a 5.4% readmission rate after surgery on the small intestine.

2.5. Colon

This covers OPCS-4 codes H04-H30. Results are shown in Table 1. Forty-eight children had surgery on the colon, and only one child was readmitted with small bowel obstruction owing to adhesions. This child had a panproctocolectomy and ileoanal anastomosis (restorative proctocolectomy). There were no readmissions as a result of raising or closing a colostomy or any other colonic procedure. Overall, the readmission rate after colonic surgery was 2.1%.

Fig. 1 shows the trend in patient readmissions over 5 years. Altogether, 17 children had 24 readmissions as a direct result of adhesions: 10 readmissions in the first year, 10 in the second, 1 in the third, 3 in the fourth, and none in the fifth. Some children were readmitted more than once for adhesion-related problems. The highest incidence was in the first year.

3. Discussion

Previous studies on adhesions in children have been hampered by small numbers, results from single institutions, or because of loss of patients during follow-up. In a previous report from the SCAR group [2], the risk of small bowel obstruction owing to adhesions in children was quantified for specific anatomical areas. This is the first report to look at the burden of adhesions associated with specific surgical procedures in a population of children after lower abdominal surgery and followed up for 5 years.

Children and adolescents younger than 16 years were investigated because this is the typical age group treated by pediatric surgeons in the UK (and most of Europe). Abdominal procedures from the duodenum downward were chosen because surgery on these organs has been noted to have a high incidence of adhesions [6].

This study demonstrated that surgery on the ileum had the highest readmission rate as a result of adhesions. Formation and closure of ileostomy was the single commonest cause of readmissions at 25%. Overall, ileal resection had a readmission rate of 8.3%, whereas duodenal surgery had a 4.7% readmissions rate, and jejunal surgery had no readmissions. The reason for the difference is open to conjecture but is probably related to the underlying pathology, the indication for surgery, the surgical technique, and the amount of handling of the bowel. These data compare with an overall readmission rate of 10.6% in adults who underwent ileostomy and 7.7% for ileal surgery from the same SCAR 3 series [7].

Interestingly, colectomy had a relatively low readmission rate at 2.1%. The only colonic procedure that caused small bowel obstruction was restorative proctocolectomy. This operation involves extensive dissection, bowel handling, and manipulation of the ileum and colon. It may be the small bowel manipulation (rather than the colonic handling) that leads to adhesion formation. Restorative proctocolectomy is well recognized as having a high incidence of small bowel
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obstruction—Fazio et al [8] reported 17.8% incidence of small bowel obstruction owing to adhesions after this procedure in adults, and Parker et al [7] reported 15.4% from the SCAR 3 data. Rintala and Lindahl [9] reported that 30% of children who underwent restorative proctocolectomy for ulcerative colitis had a late small bowel obstruction.

Appendicectomy had a relatively low overall readmission rate (0.31%). Not surprisingly, inflamed and complicated appendicectomy had a higher risk of readmission (0.36%) than elective or interval appendicectomy (which had no readmissions). In a large population-based study from Sweden, Andersson [10] reported that 0.5% of adults with nonperforated appendicitis were readmitted over a 10-year period, whereas 2.1% of patients with perforated appendicitis were readmitted. Although the readmission rate after appendicectomy is low, it remains the most commonly performed operation in this cohort of patients and therefore represents an important burden.

The data in this study were collected according to procedure rather than by diagnosis. The emphasis was to look at surgery from the duodenum downward. As a result, data on neonatal procedures are difficult to extrapolate from this study. However, gastroschisis and exomphalos were identified in the data set. Interestingly, none was readmitted as a result of adhesions. This contrasts with recent data from Choudhry and Grant [11] who reported a reoperation rate of 6.25% owing to adhesions after gastroschisis repair. Wilkins and Spitz [12] reported an even higher reoperation rate of 15.4% in 1986.

The approach taken in our analysis was conservative in that only confirmed hospitalizations owing to adhesions were counted as episodes related to adhesions. These data consequently describe the minimum quantifiable burden of hospital readmissions caused by small bowel obstruction owing to adhesions. However, this undoubtedly underestimates the total morbidity caused by adhesions. Small bowel obstruction is the worst complication of adhesions, but adhesions can cause many lesser forms of morbidity—malaise, pain, discomfort, time off school, reduction in activities, failure to thrive, malabsorption, and other gastrointestinal complications. Admissions that are possibly related to adhesions are more difficult to quantify but are estimated to affect up to 19.2% of patients 4 years after initial abdominal surgery (excluding appendicectomies) [2].

When a child is admitted with a small bowel obstruction owing to adhesions, there is a high incidence of surgical intervention. In a study of children, Akgur et al [13] reported that 81 (44%) of 181 children presenting with small bowel obstruction owing to adhesions had immediate surgery, and 56% were initially managed conservatively. Of the children managed conservatively, a further 39 children (22%) required operative intervention. In another study by Vijay et al [14], 5 (7%) of the 74 children who presented with small bowel obstruction required urgent laparotomy. The remaining children were initially managed conservatively, and a further 33 children (45%) required surgical intervention. The figures from this study underline the high risk of reoperation after adhesions. In addition, surgery for small bowel obstruction owing to adhesions causes a greater morbidity, it is technically more difficult, there is larger blood loss, and operative time is longer [15,16].

Informed consent is becoming an increasingly important issue in surgery [17]. Historically, doctors have often been casual about operative risks when taking consent for surgical procedures. At best, surgeons might specify complications related to the surgical procedure, but very few surgeons mention medium- and long-term complications of their operative interventions. New guidelines in the UK and Europe mean that doctors have to give an informed consent and must tell the patient about any relevant and significant complications that could result from the operative procedure. Courts now expect that the “reasonable” doctor would notify the patient of the risk of adhesions particularly for high-risk procedures [18]. Informed consent (or the lack of it) is becoming an increasingly large source of litigation [19]. The data from this study enable pediatric surgeons to give patients relevant information about the risk of adhesions after specific operations.

The purpose of this study was to make surgeons who operate on children more aware of postoperative adhesions both in the medium and long term. In the past, there was a perception that children were less at risk of adhesions than adults. These data show that children also have a significant risk of adhesions and that certain surgical procedures carry an appreciably high risk of readmissions. Because children have most of their lives ahead, they have more time to experience the complications of adhesions than adults.

This study has identified procedures with a particularly high risk of readmission owing to adhesions—restorative proctocolectomy and formation of an ileostomy. There are currently a number of products available that have been demonstrated to reduce adhesions both in experimental and clinical situations. Barrier products (eg, Seprafilm) have been shown to reduce adhesions below the incision [20], and hydroflotation products (eg, Adept) have shown promise in general surgery [21]. There are no data on these products in children. With the information from adult studies, surgeons can now target the use of such adjuvant treatments for specific high-risk procedures in children.

Acknowledgments

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References

Discussion

Mary Brandt, MD (Houston, TX): In your conclusion, you say that surgeons should look at their practice to decrease adhesions. How has this study affected what you do in your practice?

HW Grant, MD (Oxford, UK): Adhesions are due to a number of factors, some intrinsic and some extrinsic. In a different study, we looked at the type of adhesions in different disease processes. Inflammatory processes were associated with denser adhesions. Surgeons can also affect outcome by what they do—the handling of bowel, leaving contaminants in the peritoneum, leaving foreign bodies, and by their surgical approach. It is quite a big topic, but a “nontouch” surgical technique (as in laparoscopy) as a hypothesis may be associated with fewer adhesions. That is a difficult hypothesis to prove, but we are in the process of trying to do that.

Burton Harris, MD (Bronx, NY): The most adhesiogenic operation that I seem to come across is the fundoplication, which I did not see mentioned on your list. Do Scottish surgeons do this operation?

HW Grant, MD (response): We specifically looked at surgery from the duodenum downwards. That was the group we were looking at. In a separate study, we have looked at fundoplications and we are presenting our data at BAPS later on this year. We found that, in over 200 laparoscopic fundoplications, we had no readmissions due to adhesions at all, whereas in another cohort of 42 open procedures, we had about 3 readmissions (7% readmission rate). You are right in saying that upper GI procedures are associated with adhesions, but that was not the purpose of the study.

Burton Harris, MD (response): Thank you.

HW Grant, MD (response): But that also answered the point that I think you were asking, ie, can we change our surgical technique, can we alter the outcome? I think it is possible.

Donald Nuss, MB, ChB (Norfolk, VA): Have you tried any of the substances that are on the market to reduce adhesions?

HW Grant, MD (response): We do. We have not done a prospective study, but there are data from the adult literature particularly with regard to hydrodynamics, and there is pretty good evidence that a number of these substances do reduce adhesions. The problem is proving that, by reducing adhesions, you also reduce small bowel obstruction (which, if you like, is the ultimate end point). There is plenty of supportive evidence in the literature. My practice is to use some of the hydrodynamics products for small bowel surgery and contaminated surgery. I target the high-risk procedures.

Daniel Ryan, MD (Boston, MA): Because you had such a remarkable difference in patients with ileal surgery, which in patients that we see is usually for inflammatory bowel disease, were you able to control for that and how many of those patients who were readmitted with “adhesions” from small bowel obstruction actually had recurrent disease?

HW Grant, MD (response): I am sorry—I did not hear the first part of your question.

Daniel Ryan (response): Because the high rate of readmission after ileal surgery, which is often in this population due to inflammatory bowel disease like Crohn’s disease, were
you able to control for that factor? And how many of the patients who were readmitted actually had recurrent disease and not just adhesions?

HW Grant, MD (response): What we used as our end point were diagnostic and operative codes for small bowel obstruction due to adhesions. The coding is done by the doctors and then checked by clerical staff. An OPCS code, if you like, is by definition an operative code, so any OPCS code had to stipulate the above. There are a number of codes that are associated with adhesions—the surgeon had seen adhesions at surgery, and it was therefore clear that was the adhesion rather than other disease. The ICD-10 code, which is a diagnostic code, had to stipulate adhesions and small bowel obstruction. What these data show is an understatement of the burden of adhesions because we only used adhesions leading to small bowel obstruction as our definition.