

Risk Factors for the Development of Adhesive Small Bowel Obstruction after Abdominal and Pelvic Operations

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Received 23 February 2015; accepted 19 March 2015; published 25 March 2015

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Abstract

Introduction: Adhesive small bowel obstruction (SBO) is a disease process that has been difficult to prevent. Mechanical barriers and chemical agents exist to disrupt the formation of adhesions following surgery but each associated with medical risk and financial burden. Identifying risk factors for developing SBO in patients post laparotomy would aid in the appropriate use of such agents. We hypothesize that there might be additional risk factors that are associated with a higher likelihood of SBO. **Methods:** A retrospective analysis from 2008 to 2012 was performed. Cases of SBO following previous laparotomy were compared to those without SBO. **Results:** 468 medical records were reviewed (57% male). Operations that caused the highest risks for SBO included gynecological, colorectal and hernia operations with prosthetic materials. 66% percent of patients underwent a prior abdominal or pelvic high-risk procedure. The average time from surgery to the development of SBO was 24 months (median 19 months). Patients who developed SBO had a median age of 58.4 years on initial surgery, average previous operative time of 4.3 hours, and an average of two prior operations. For every hour of operative time, the odds of developing SBO increased by 33% ($p < 0.05$) and for every prior surgery, the odds increased by 24% ($p < 0.05$). The presence of ASA Classification > 3 decreased the odds of SBO ($p = 0.05$). **Conclusions:** Longer operative times are associated with post-operative adhesive small bowel obstruction. Patients with an ASA score greater than or equal to 3 appear to have a reduced risk of adhesive small bowel obstruction.

Keywords

Adhesions, Obstruction, Intestinal, Laparotomy, Small Bowel, Post-Operative, Complication

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1. Introduction

Adhesive small bowel obstruction (ASBO) is a pathologic condition that has been a significant burden on post-surgical patients, both financially and medically. Traditionally, initial conservative management has been utilized with nasogastric decompression and intravenous hydration. In cases where obstructions do not resolve, operative adhesiolysis is utilized to mechanically resolve the obstruction.

Numerous attempts have been made to prevent peritoneal adhesion formation with the purpose of preventing ASBO, with some success. For example, the use of laparoscopy has been shown to decrease the formation of peritoneal adhesions and adhesion related readmissions [1]. Additionally, adjunctive measures such as hyaluronic acid-carboxymethylcellulose membrane (Seprafilm™ - Genzyme, Cambridge, MA), *Icodextrin* solution (Adept™ - Baxter International, Deerfield, IL), knitted fabric of modified *cellulose* (Interceed™ - Johnson and Johnson, New Brunswick, NJ), or polyvinyl alcohol-based gels such as A-Part Gel™ - Aesculap AG, Tuttlingen, Germany) have also been shown to decrease adhesion burden to some extent. However, their efficacy in the prevention of ASBO has yet to be identified [2].

Several scoring systems for peritoneal adhesion formation have been described. These systems score the physical character of the adhesions. There has not been a model described that helps predict a given patient's risk for ASBO. The purpose of this study was to identify risk factors for the development of small bowel obstruction; this would assist in predicting who might be at higher risk for developing an ASBO after laparotomy. By identifying these particular patients, a more scientific approach to the utilization mechanical adhesion barriers could be used.

We hypothesize that additional factors might be associated with a higher likelihood of SBO development following prior abdominal operations.

2. Patients and Methods

The purpose of the study was to compare the preoperative and intraoperative characteristics of patients following open surgery that developed ASBO to those that did not. With that data additional insight could be obtained to help predict which patients are at greater risk developing ASBO after laparotomy.

Patient data was collected retrospectively through the hospital medical records of an urban tertiary care hospital (Mount Sinai Beth Israel). This investigation was approved by the Ethics Committee of the Medical Center (IRB #114-13) and patient data was de-identified for privacy purposes. All patients admitted under International Classification of Diseases, Ninth Revision (ICD-9) code "small bowel obstruction" and Current Procedural Terminology (CPT) code "exploratory laparotomy" were gathered, between the years 2008 and 2012. Each patient's medical record was extensively reviewed. Cases in which records were incomplete, indeterminate or patients with ASBO successfully treated with conservative therapy were excluded from this analysis.

The following were documented for each patient: standard demographic data, year of operation, estimated blood loss (EBL), operative time, and the number of prior abdominal surgeries. Additionally, the presence of American Society of Anesthesiologists Score greater than 3 ($ASA > 3$), prior abdominal wall prosthetic mesh, postoperative small bowel obstruction, "high risk" surgical operation and time to development of obstruction were documented. $ASA > 3$ refers to a patient with severe systemic disease, such as heart, respiratory, or complicated diabetes that severely impairs normal functions. The term "high risk" refers to procedures that known to be highest risk for developing ASBO; this includes open colorectal, gynecologic, abdominal wall, and ileal surgery. For patients with multiple abdominal surgeries, the most recent laparotomy and/or the laparotomy that immediately preceded the small bowel obstruction was reviewed. None of the patients reviewed had any mechanical peritoneal adhesion barriers placed during the time of operation.

After the data was collected, the two cohorts were delineated: Those patients who developed an ASBO after laparotomy (SBO) and those who did not (non-SBO). A logistic regression model was used to analyze this data. Univariate and multivariate analysis was utilized to identify additional risk factors related to the development of postoperative adhesive small bowel obstruction.

3. Results

A total of 1494 patient charts were reviewed; 468 charts were subsequently used for the study. There were 94 patients in the SBO cohort and 374 in the non-SBO cohort. **Table 1** represents a summary of the data analysis.

Table 1. Comparison of demographics and characteristics of patients who developed small bowel obstruction (SBO) and patients who did not develop small bowel obstruction (Non-SBO).

	SBO (n = 94)	Non-SBO (n = 374)	p Value (<0.05)	Odds Ratio
Mean Age (Years)	57.4	61.0	NS	
Gender	Male: 42.6% Female: 57.4%	Male: 47.9% Female: 52.1%	NS	
Mean OR Time (Hours)	4.3	3.1	0.000	1.34
Mean EBL (mL)	415.4	223.7	NS	
Mean Number of Prior Surgeries	1.7	1.2	0.007	1.24
Presence of ASA Score > 3	44.7%	59.9%	0.009	0.48
“High Risk” Procedure	66.0%	62.8%	NS	
Presence of Mesh	16.0%	19.3%	NS	
Mean Time to SBO (Months)	23.8			

Legend: OR time: Operating Room time; EBL: Estimated Blood Loss; ASA Score > 3: American Society of Anesthesiologists Score greater than three; High Risk Procedure: Colorectal, Gynecologic, Abdominal Wall, and/or Ileal Surgery.

The mean age of SBO cohort was less than 60 years of age, while the non-SBO cohort was above 60. The demographic distribution was similar between the two cohorts, with a slightly higher proportion of females. Mean operative time and number of prior abdominal surgeries were higher in the SBO group, which were both statistically significant. The estimated blood loss was also higher in the SBO group, although it was not significant. Of note, EBL was 415.4 mL in the SBO group versus 223.7 mL in the non-SBO. The presence of an ASA score > 3 and prior mesh were noted in higher frequency in the non-SBO cohort. Lastly, the mean time to SBO was approximately 23.8 months after prior open surgery.

The presence of a previous “high risk” procedure was noted to be slightly higher in the SBO cohort. In total, 63.5% of procedures performed in this study fell under the “high risk” category. The remaining 36.5% included a variety of operations: gastric, hepatobiliary, retroperitoneal/urological and various other procedures not under the “high risk” heading.

Table 2 summarizes the four factors that were found to have statistical significance in the development of an ASBO. A longer operative time was associated with a higher risk; specifically, with each hour there was a 33% increase in the odds ratio. With each prior abdominal surgery, there was a 24% in the odds ratio for the development of ASBO. Conversely, an ASA score greater than 3 was associated with a decreased risk of ASBO. This was associated with a 52% risk reduction of the odds.

4. Discussion

This study attempts to identify which risk factors for adhesive small bowel obstruction based on patient demographics and variables from their most recent abdominal operation. Increased operative time and blood loss appear to be associated with a higher risk of SBO. One might expect that increased operative time and EBL both indirectly represent a more complicated operation, which might be associated with a more tedious dissection and resulting in more local tissue trauma and the development of adhesions in the site of dissection. Conversely, presence of an ASA score > 3 was an unexpected finding. Perhaps this might be explained that such patients with greater comorbidities respond to the laparotomy with a less pronounced inflammatory response resulting in fewer adhesions.

Intra-abdominal adhesions are likely the result of the inflammatory response to operative injury and infection. These adhesions represent the effect of the imbalance between fibrin deposition and degradation [3] [4]. While they result in almost all patients after abdominal and pelvic operations, only a minority will develop symptoms and still fewer suffer the morbidity of intestinal obstruction [5]. It is clear that intra-abdominal adhesions are the most common cause of mechanical intestinal obstruction [6]. Adhesive small bowel obstruction can be a difficult illness to manage for both patients and surgeons. Peritoneal adhesions are the most common cause of SBO, accounting for 65% - 75% of cases [7]. The risk to patients following abdominal and pelvic operations is life-long. Even when operation for gynecological indications was excluded, females appear to be at a greater risk for

Table 2. Statistically significant risk factors for adhesive small bowel obstruction.

	Odds Ratio	Standard Error	Z Score	p Value	95% Confidence Interval
Operative Time	1.336141	0.0800077	4.84	0.000	1.188181 - 1.502526
Prior Abdominal Surgery	1.241234	0.0996051	2.69	0.007	1.06059 - 1.452647
ASA > 3	0.4801588	0.1221049	-2.88	0.009	0.2916912 - 0.790399

Legend: ASA Score > 3: American Society of Anesthesiologists Score greater than 3.

small intestinal obstruction than men [8]. While the conservative treatment of nasogastric decompression can be uncomfortable for the patient, the postoperative complications from adhesiolysis can be catastrophic. Paralytic ileus, wound infection, chronic abdominal pain, and enterocutaneous fistula from iatrogenic enterotomy are all within the spectrum of complications [9]-[11]. Therefore it is critical to identify a way to minimize the peritoneal adhesion burden after initial laparotomy.

The incidence of peritoneal adhesions after open abdominal surgery is 54% - 90% [12] [13]. The incidences of readmissions and small bowel obstructions following laparotomy have been extensively studied in the Surgical and Clinical Adhesions Research (SCAR) studies. There is a 5% - 9% risk of readmission directly related to adhesions after lower abdominal surgery [14], [15] but this risk is nearly 20% after proctocolectomy with ileal-pouch anastomosis [16]. It has also been shown that the rates of adhesion related readmissions increase every year after open colorectal surgery. As shown in the SCAR-2 study, the rates of adhesion related readmissions were 12.4% one-year post laparotomy and 29.7% after four years [17].

The rates of bowel obstruction do differ with regard to the type of procedure performed. The SCAR-3 study analyzed this exact issue. Duodenal and jejunal surgery were found to have a 1.8% 5 year readmission risk (readmission directly related to adhesions). Ileal surgery was associated with a 6.9% risk, compared to 10.6% for ileostomy surgery. Colonic, rectal and abdominal wall operations were all roughly associated with a 5 % risk. Interestingly, panproctocolectomy had a 15.4% overall risk [17].

Various risk factors have been identified to have a significant relationship to the development of adhesive SBO. The SCAR-3 study demonstrated that Crohn's disease had no effect on risk while colorectal cancer decreased ones risk of readmission. Higher risk was noted in those patients younger than 60 years of age and a history of peritonitis [14]. However, the age of the patient is not so straightforward. Andersson and colleagues showed that patients less than 16 years of age had less rates of adhesion related admissions than those patients over age 16 [18]. Additionally, Duron and colleagues demonstrated an age less than 40 as an independent risk factor for development of recurrent adhesive small bowel obstruction [19]. The role of gender in development of adhesive small bowel obstruction appears unclear, as several studies have had conflicting results [20].

The approach to peritoneal adhesion prevention is broad based. It includes any of the following principles: 1) Minimizing peritoneal dissection; 2) Utilizing minimally invasive techniques whenever possible; 3) The selective use of mechanical adhesion barriers and 4) Adjunctive pharmacologic agents.

Basic principles of surgical technique include minimizing peritoneal dissection and avoidance of intestinal or biliary spillage. From a historical perspective, it is also important to note that the use of starch gloves has also been associated with the development of adhesive SBO after laparotomy, as noted by Cooke and colleagues [20]. The use of laparoscopy has had a profound impact on adhesive SBO but outcomes are mixed. In one large review by Schnurgier and colleagues, laparoscopic techniques for cholecystectomy, hysterectomy, colectomy, and adnexal surgery were all found to have a lower incidence of adhesion related readmissions. Scholin did not find a reduced rate of post-operative intestinal obstruction after laparoscopic colon and rectal surgical procedures [21]. Following laparoscopic appendectomy for appendicitis a 1.3% readmission rate was observed compared to 1.4% for open technique [22].

FDA approved synthetic barriers include Seprafilm, Interceed, A-Part Gel and ADEPT. The use of these barriers in prevention of peritoneal adhesions has been well demonstrated; yet their utility in prevention of small bowel obstruction has not [2]. After proctocolectomy, hyaluronic acid-carboxymethylcellulose membrane (Seprafilm) might reduce postoperative adhesions but does not appear to reduce the incidence of intestinal obstruction [23].

There are several scoring systems that currently exist to characterize the severity of peritoneal adhesions. These include the Operative Laparoscopy Study Group (OLSG), American Fertility Society (AFS), Bristow and

Suhlke scoring systems. Each of these systems rates the density and physical severity of the adhesions [1]. However, there is no scoring system that addresses a patient's risk of development of symptomatic adhesions based on prior relevant historical factors.

Whether laparoscopy reduces the incidence of post-operative adhesions or intestinal obstruction is controversial. Some studies report a dramatic reduction in post-operative intestinal obstruction for certain procedures such as cholecystectomy and gynecological pelvic procedures [2]. However, Scholin did not find a reduced rate of post-operative intestinal obstruction after laparoscopic colon and rectal surgical procedures [24] [25].

There were limitations that we encountered while conducting this study. Notably, there was large number of patients were excluded after initial chart review. This was because many patients' charts did not possess all of the requisite variables from their most recent abdominal surgery or their episodes of postoperative bowel obstruction resolved with conservative management. In the present study, we chose to focus only on patients that developed adhesive small bowel obstruction that ultimately required operative intervention.

What this study hopes to accomplish is to highlight the need to identify the patients at highest risk for ASBO. This might allow the use of additional preventive measures to reduce the risk of future intestinal obstruction.

5. Conclusion

Patients that undergo open and some laparoscopic abdominal and pelvic operations are at a lifetime risk for the development of adhesions and subsequent adhesive small bowel obstruction. On the other hand, patients who undergo prolonged surgery and those that have had multiple prior operations might be at greatest risk and might benefit from the use of mechanical adhesion barriers. These patients should be further evaluated for the use of these agents in the hope of reducing a life-long increased risk of reoperation for intestinal obstruction for these patients.

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