Laparoscopic management of acute small bowel obstruction: Evaluating the need for resection

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BACKGROUND: Acute small bowel obstruction (SBO) is a common condition encountered by the on-call emergency surgeon. The role of laparoscopy in the management of SBO continues to be defined. This modality can be limited by dilated bowel and inadequate assessment of compromised tissue. This review was undertaken to determine the reliability of laparoscopic evaluation and the subsequent need for bowel resection.

METHODS: A retrospective review of all patients surgically managed for acute SBO between July 2005 and September 2010 was conducted. The clinical presentation, computed tomographic findings, indications for surgery, type of intervention, need for reoperation, length of stay (LOS), and outcomes were all abstracted.

RESULTS: A total of 119 patients were surgically managed for acute SBO during this period, 63 with initial laparoscopy and 56 with an open procedure. Twenty-five (40%) of the laparoscopy patients were converted to open, leaving 38 completed laparoscopically. Of the completed group, three patients underwent bowel resection compared with 16 in the converted group (8% vs. 64%, $p < 0.0001$). No patients in the completed group required a subsequent procedure for bowel resection. Twenty-three (41%) patients in the open cohort required a resection. LOS was significantly reduced in the completed group (7.7 days) compared with the converted (11.0 days, $p = 0.01$) and open groups (11.4 days, $p = 0.002$).

CONCLUSIONS: Overall, 32% of acute SBOs were managed solely with laparoscopy. No patients requiring a bowel resection were missed using this method of evaluation. Laparoscopic management should be considered as safe and effective initial therapy in most cases of acute SBO. (*J Trauma.* 2012;72: 25–31. Copyright © 2012 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: III, therapeutic study.

KEY WORDS: Small bowel obstruction; laparoscopy; bowel resection.

Small bowel obstruction (SBO) is a common condition that can lead to surgical management, occasionally on an emergent basis. Population-based studies have shown that 24% of patients admitted for SBO will undergo surgical intervention.[1] Timing of surgery, however, depends on certain clinical and radiographic findings that continue to be refined.[2] Identifying those patients with compromised bowel that may require resection depends on careful intraoperative evaluation. Adhesions because of previous abdominal surgery are the most common cause of SBO in modern societies. Approximately, 12% to 17% of patients who undergo an open abdominal surgical procedure in their lifetime will develop adhesions that lead to SBO.[3] Other causes of SBO include hernias, benign and malignant masses, volvulus, intussusception, and stricture.[4] Although current practice favors initial conservative management, operative intervention is required when this fails, or when there is concern for bowel strangulation or ischemia.

Historically, SBO was considered an absolute contraindication to laparoscopic surgery because of the risk of injury to the distended bowel and incomplete visualization in the evaluation of compromised tissue. The first laparoscopic lysis of adhesions for SBO was reported by Bastug et al.[5] in 1991 and involved the division of a single adhesive band. Since that time laparoscopic surgery has become more widely accepted, surgeons have become more facile in minimally invasive techniques and technological advances in laparoscopic equipment have been made. All these factors have combined to make the use of laparoscopy in the operative intervention for SBO more common, although this shift has been relatively slow when compared with many other types of abdominal surgery. In a nationwide study of surgery for SBO in 2002, only 11% of cases were performed laparoscopically.[6]

The potential advantages of laparoscopic surgery for SBO include decreased length of hospital stay, fewer complications, and shorter operative times. In contrast, higher rates of reoperation, unrecognized enterotomy, and inability to properly evaluate compromised bowel have all been cited as disadvantages to laparoscopic intervention for SBO.[7–9] Factors that may shift the management of SBO toward laparoscopy include proper patient selection, advanced laparoscopic surgical training, and improved operative techniques and equipment.

Defining the proper indications and timing for laparoscopic management of SBO should greatly impact the training of emergency surgeons. The development of treatment guidelines for acute care surgery will also be influenced by advancing these techniques. This study was undertaken to review the operative treatment of SBO and the safety and reliability of small bowel evaluation to determine the need for subsequent resection during a shift toward laparoscopic management at a single institution.

PATIENTS AND METHODS

Following institutional review board approval, a retrospective analysis of all patients undergoing surgery for acute SBO at Mayo Clinic Hospital in Arizona between July 2005 and September 2010 was performed. Records were obtained from an integrated electronic medical record system for all patients with an International Classification of Diseases-9 code for bowel obstruction (560.x) listed as either a primary or secondary diagnosis. Patients with paralytic ileus and large bowel obstruction were excluded, as were patients with chronic SBO who were undergoing elective surgery. From the patients found to be hospitalized with acute SBO, charts were reviewed to determine those needing operative intervention. In addition, the operating room (OR) and emergency surgery databases and individual surgeon logs were examined to complete and cross-check this list. History, physical examination, and laboratory findings including the number of previous operations and the number of previous SBOs were abstracted from the records. The type of surgery performed,

any preoperative computed tomographic findings, the need for reoperation, length of hospital stay before and after surgery, and outcomes after the operation were all determined. Those patients undergoing conversion from initial laparoscopic exploration to an open procedure and the reasons for their conversions were obtained from reading the operative reports, and LOS was determined using dates of admission and discharge.

Patients were diagnosed with SBO before the time of surgery using clinical presentation and radiographic evaluation. The choice for surgical approach (initial laparoscopic vs. open) and operative timing were based on clinical evaluation and surgeon preference. Because of the retrospective nature of the study, the exact reason for choosing laparoscopy was difficult to determine but surgeon comfort with these methods likely played a significant role. Patients who initially underwent laparoscopic surgery were further categorized into those who were completed laparoscopically and those that were converted to open with a laparotomy. Patients who underwent laparoscopic-assisted surgery for bowel resection with incisions ≤3 cm were included in the group completed laparoscopically. The final group for comparison included patients who were treated with primary open surgery.

The data were analyzed using pair-wise χ^2 analysis where the data were reported as a percentage of the group represented. Other comparisons between the three groups were performed using an analysis of variance F-value to determine any significant differences. Where differences were noted, intergroup comparisons were made using Tukey's standardized range test with $p < 0.05$ considered significant.

RESULTS

This review found 845 patients who were admitted with SBO as one of their diagnoses. After excluding those patients with chronic obstructions and those who were managed conservatively, a total of 119 patients were identified as having surgery for acute obstruction. Sixty-three patients were initially managed laparoscopically, with 25 being converted to open (40%). Fifty-six patients were managed with a primary open procedure. Demographic comparisons of the three groups (laparoscopic, converted from laparoscopic to open, and open) are shown in Table 1. No significant differences were found between the three groups when comparing age, gender, number of previous SBO, or number of previous abdominal surgeries. Comparison of presentation of the patients, including vital signs (tachycardia and hypotension), laboratory values (elevated white blood cells), and physical examination findings (focal tenderness and peritoneal signs) did not show any significant difference between the three groups (Table 1).

The surgical management was successfully completed in 38 of 63 patients whose operation was started with a laparoscopic technique. Of these, three patients had a laparoscopic-assisted segmental resection of the small bowel. In the converted group, six were converted for compromised bowel, five for tumor or mass, five to improve exposure, four for dense adhesions, and four for repair of enterotomy or serosal injury. In one case, conversion was necessary after evidence of perforation was discovered and the exact site could not be localized (Table 2).

TABLE 1. Demographics, History, Clinical, and Laboratory Findings

	Laparoscopic, (n = 38)	Converted, (n = 25)	Open, (n = 56)	*p*
Age in years (SD)	67 (17)	67 (18)	69 (15)	0.74
Sex, males	14/38 (37%)	10/25 (40%)	26/56 (46%)	0.64
No. of previous abdominal surgeries (SD)	1.5 (1.5)	1.8 (1.1)	2.0 (1.7)	0.28
No. of previous bowel obstructions (SD)	0.5 (1.1)	0.36 (1.3)	0.32 (0.90)	0.64
Tachycardia (HR >100)	7/35 (20%)	2/20 (10%)	10/48 (21%)	0.55
Hypotension (SBP <90)	0/34 (0%)	1/20 (5%)	2/47 (4%)	0.45
Focal tenderness	7/37 (19%)	8/25 (32%)	13/56 (23%)	0.49
Peritonitis	1/37 (3%)	2/25 (8%)	4/56 (7%)	0.60
Elevated WBC (WBC >10.6)	12/35 (34%)	12/23 (52%)	28/53 (53%)	0.20

SD, standard deviation; HR, heart rate; SBP, systolic blood pressure; WBC, white blood cells.

TABLE 2. Reason for Conversion From Laparoscopic to Open

	Number Converted, Total = 25, n (%)
Compromised/ischemic bowel	6 (24)
Tumor/mass	5 (20)
Adequate exposure	5 (20)
Dense adhesions	4 (16)
Enterotomy/serosal tears	4 (16)
Perforation (preexisting)	1 (4)

Operative findings and outcomes were compared between the groups in Table 3. Those patients whose surgery was completed laparoscopically had a significantly higher proportion of their SBO caused by adhesions (84% laparoscopic vs. 60% and 54% in the converted and open groups, respectively, $p = 0.01$). Operative time in the laparoscopic group was significantly lower as well. Bowel resection was significantly more common in the converted (64%) and open groups (41%) compared with the laparoscopic group (8%, 3 laparoscopic-assisted bowel resections). LOS, both for the total hospital stay and the days after operation, was significantly shorter in the laparoscopic group compared with the converted and open groups ($p = 0.002$ for total LOS, $p \leq 0.001$ for LOS after surgery). There were no hospital deaths in the entire series.

Causes of obstruction for the three groups are listed in Table 4. Adhesions were the most common cause in all of the study groups. Also noted in the laparoscopic group were obstructions caused by internal hernia, volvulus, incarcerated hernia, bezoar, and a jejunostomy tube were encountered. In

TABLE 3. Surgical Findings and Outcomes

	Laparoscopic (n = 38)	Converted (n = 25)	Open (n = 56)	*p*
No. of days between presentation and OR (SD)	2.2 (2.3)	2.8 (2.8)	2.3 (3.1)	0.74
Obstruction due to adhesions, n (%)	32 (84)	15 (60)	31 (55)	0.01*
Operative time, minutes (SD)	96 (53)	134 (37)	124 (59)	0.001†
Bowel resected, n (%)	3 (8)	16 (64)	23 (41)	<0.001‡
Return to OR, n (%)	1 (3)	0 (0)	2 (4)	0.64
Length of stay, d (SD)	7.7 (3.9)	11 (5.5)	11.4 (5.4)	0.002§
Length of stay after surgery, d (SD)	5.4 (2.8)	8.2 (4.7)	9.1 (4.7)	<0.001‖
Hospital mortality, n (%)	0 (0)	0 (0)	0 (0)	

SD, standard deviation.

* Using pair-wise χ^2 tests, the laparoscopic group had significantly higher incidence than both the converted and open groups ($p < 0.05$).

† Using Tukey's standardized range test, the laparoscopic group was significantly lower than both the converted and open groups ($p < 0.05$).

‡ Using pair-wise χ^2 tests, the laparoscopic group was significantly lower than both the converted and open groups ($p < 0.05$).

§ Using Tukey's standardized range test, the laparoscopic group was significantly lower than both the converted and open groups ($p < 0.05$).

‖ Using Tukey's standardized range test, the laparoscopic group was significantly lower than both the converted and open groups ($p < 0.05$).

TABLE 4. Causes of Obstruction

Laparoscopic (n = 38)	
Adhesions	32
Internal hernia	2
Hernia	1
Volvulus	1
Bezoar	1
J-tube	1
Converted (n = 25)	
Adhesions	15
SB mass/tumor	4
Internal hernia	3
Intraluminal SBO	1
Volvulus	1
Meckel's	1
Open (n = 56)	
Adhesions	31
Hernia	9
Crohn's stricture	3
SB mass/tumor	3
Internal hernia	2
Carcinomatosis	2
Meckel's diverticula	2
Appendicitis	1
Ileocecal intussusception	1
Gallstone ileus	1
Omental band	1

the converted group, other causes included small bowel mass or tumor, internal hernia, intraluminal SBO, volvulus, and a Meckel's diverticulum. The open group contained the most diverse set of reasons for obstruction, including Crohn's stricture, carcinomatosis, appendicitis, ileocecal intussusception, and gallstone ileus.

DISCUSSION

Open exploration has traditionally been the mainstay of surgical management for acute SBO that requires intervention. Although minimally invasive techniques have revolutionized many aspects of abdominal surgery, laparoscopy has been slow to change practice patterns in the treatment of SBO. Presented here is a single-institution experience with operative intervention for SBO during a period of gradual transition in surgical technique from open to laparoscopic surgery.

Over the five-year period represented in this article, 119 patients were operated on for SBO, with 63 patients undergoing laparoscopy as initial surgical technique. This would be one of the larger series examining laparoscopic intervention for SBO, and one of the select few that have directly compared laparoscopic intervention to those that were converted to laparotomy and those that were initially managed with open surgery.[10,11] Although our patient population was relatively uniform, both in terms of their demographics and in their clinical presentation with SBO, it does differ from other reported series in that our patients were relatively older (average age, 67 years) as compared with other published reports (55 years[12] and 53 years[13]).

The broad range of causes of SBO treated in this series highlights the efficacy of laparoscopy in evaluating and/or treating SBOs of many etiologies, not just those related to adhesions. This variety of disease processes evaluated and treated may be one of the primary causes of the relatively high rate of conversion found in this data (40%), although this rate of conversion does fall within previously published ranges (6.7–43%[14]; 20–51.9%[15]). These diverse causes are also likely responsible for the high rate of bowel resection (64%) found within the group that was converted from laparoscopic to open and the high rate of overall resection (35%).

Remarkably, no patients in the laparoscopy group required return to the OR for persistence of SBO or subsequent bowel resection, highlighting the efficacy of laparoscopy in evaluating the etiology of SBO, dividing adhesions when appropriate, and determining whether compromised bowel needs to be removed. One patient in the laparoscopic group, however, did return to the OR for unrecognized enterotomy on postoperative day 1. There were no returns to the OR in the converted group and two in the open group, one for continued obstruction and one for an infected hematoma. There was no mortality in any group during their hospitalizations for SBO. This confidence in evaluation of SBO by laparoscopy should minimize the need for laparotomy in SBO, potentially reducing future formation of adhesions and hypothetically lowering the risk of future SBO.[16,17]

Another benefit of laparoscopic management observed in this series include shorter average operative time (96 minutes) when compared with the converted and open surgery groups (134 and 124 minutes, respectively). Similar

differences have been reported in other articles comparing laparoscopic with converted and laparoscopic with open operations.[10,13] For those cases completed laparoscopically, 96 minutes falls within the previously published range of 58 minutes to 108 minutes.[14] Moreover, no significant difference in operative time was found between the converted and open groups, suggesting that initial laparoscopic evaluation does not significantly prolong operations in which the patient requires subsequent laparotomy for more extensive surgery or bowel resection.

LOS was also significantly shorter among those patients who were successfully treated laparoscopically (7.7 days vs. 11 and 11.4 days for converted and open). This too is similar to that seen in other reports that have compared laparoscopic with converted and laparoscopic with open operations.[10,11,18] Our study also found significantly shorter hospital stay following the time of the operation (5.4 days vs. 8.2 and 9.1 days for converted and open, respectively). This analysis negates some inherent bias introduced to a patient's LOS by the amount of time the patient was managed conservatively before undergoing their operation and is a more valid assessment of the benefit of the laparoscopic method.

The causes of obstruction reported here are diverse, with over a dozen different causes included (Table 4). Although not all these etiologies of obstruction were included in the laparoscopic or converted groups, this does highlight the challenge facing the surgeon evaluating SBO. These results, with infrequent return to the OR, no mortality, and effective resolution of SBO after operative intervention highlights the success that can be attained in laparoscopic evaluation and/or treatment of SBO from a wide variety of causes, not just adhesive obstruction.

As the laparoscopic experience grows, the proper indications, patient selection, and the learning curve will be better defined. This study adds to the existing body of literature by demonstrating safety and the accurate evaluation of the integrity of the bowel. Laparoscopy has gradually become first choice management for most patients requiring surgical management for acute SBO at our institution. There seem to be few contraindications with the possible exception of those patients who have had multiple previous explorations for bowel obstruction. Laparoscopy should be considered effective early management in those patients who present with clinical or radiographic evidence of intestinal compromise, as some of these conditions are potentially reversible after the obstruction is released.

These findings should be of particular interest to surgeons who cover acute care surgery services and provide fellowship training. As well, some of the management paradigms for acute SBO will invariably change. The use of laparoscopy may, in fact, lead to earlier exploration, effective treatment, and prompt recovery of certain types of patients with SBO. Patients with minimal or no previous surgery, single or few adhesions, closed loop obstructions, and evidence of bowel distress should be included in this category.

CONCLUSION

The role of laparoscopy in the management of acute SBO continues to broaden. As initial management, the abdomen can be entered and adhesions divided with minimal risk to the bowel. The need for bowel resection can be accurately assessed and, if conversion is not required, operating time and LOS are reduced. Laparoscopy should be considered as initial management for most patients requiring surgery for acute SBO.

AUTHORSHIP

D.J.J. designed this study. A.B.C. conducted the literature search and K.N.J. collected data. M.V.M. was involved with chart and data acquisition. K.N.J. and D.J.J. prepared the manuscript and its revision, which were reviewed by A.B.C. and K.L.H.

DISCLOSURE

The authors declare no conflict of interest.

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DISCUSSION

Dr. Andrew B. Peitzman (Pittsburgh, Pennsylvania): This is a retrospective review of 119 patients who underwent operation for small bowel obstruction over a five-year period with approximately one-half of these patients, the procedure initiated as laparoscopy. I have several questions for you, Dr. Johnson.

Number one: You stated in the paper that "surgical approach and operative timing were based on clinical evaluation and surgeon preference." What were the indications and contraindications to laparoscopy? And was degree of bowel distention a factor in using or not using laparoscopy?

I assume when you say "surgeon preference" was an issue that this was a major factor in laparoscopy versus laparotomy. What are the differences in the laparoscopic skill sets of your surgeons?

How do you gain abdominal access in these patients with small bowel obstruction? Is it by cut-down? Is it with a Veress needle? And where in the abdomen do you gain abdominal access for the first port?

Do you limit insufflation pressure with concern that if you over distend that you will tear a bowel wall that is densely adherent to the abdominal wall?

In the paper you state, and I quote, "remarkably no patient returned to the OR for persistent bowel obstruction" end quote. Do you routinely lyse all the adhesions laparoscopically and free the entire small bowel?

Give us your indications for a conversation from laparoscopy to open procedure. Is length of the operation, is time a factor in this decision?

You had one laparoscopic case who was returned to the operating room on post-operative day number 1 for an unrecognized small bowel injury. Do you have any sense of what the cause was? Was it the result of a dissection? Of port access? Could you tell from the operative findings?

As Acute Care Surgery expands, papers such as this become vital to our meeting and I thank the Association for the privilege of discussing the paper.

Dr. William S. Hoff (Bethlehem, Pennsylvania): I'm probably one of the same questions that Dr. Peitzman brought up, but perhaps in a different way.

The first point in your algorithm on your methodology where you break up between open, the decision to perform open and laparoscopic, I just wonder whether there was any provider specificity in that. In other words, are some of your general surgeons just less comfortable with laparoscopic approach?

Dr. Richard Mullins (Portland, Oregon): It seems the critical decision in this series would be the conversion from laparoscopic to open.

Can you tell us whether or not cases that were converted from laparoscopic to open in your institution needed to be presented at the morbidity and mortality conference? Can you give us some idea of what were the issues discussed at morbidity and mortality conference regarding whether that decision was done correctly or not.

Dr. Alicia Mangram (Phoenix, Arizona): You basically said that that we should consider using laparoscopic as our first line of therapy in patients with small bowel obstructions. But you excluded patients with chronic small bowel obstruction. And when you compared the two groups, those that presented for the second time it was .3 and .6.

So basically are you saying if this is the first time that you present with a small bowel obstruction, you should consider laparoscopic as the primary treatment? And can you just define what is "chronic small bowel obstruction"? Because you excluded patients with chronic small bowel obstruction.

Dr. Jay N. Collins (Norfolk, Virginia): Did you look at infectious complications such as wound infections or intra-abdominal abscesses, especially in the group of open patients that did not undergo a bowel resection? Did you look at the incidence of incisional hernias or other long-term complications?

I would ask a question in a different way regarding the first point on your slide, which patient would you take to the operating room and absolutely not start with laparoscopy? Which patients would you start with an open procedure?

Dr. Brian S. Shapiro (Grand Blanc, Michigan): The NSQIP database shows nationally about a 10 percent mortality rate for small bowel obstructions. Why are you so good? Do you need a longer follow up? What was the readmission rates? Were there any differences?

Dr. Kevin N. Johnson (Phoenix, Arizona): Thank you for your questions.

Starting with looking at surgeon preference versus actual clinical criteria for how to determine which patients had laparoscopic versus open surgery, these were done by a diverse group of surgeons. The majority were done by our acute care surgery service but there were also general surgeons, surgical oncologists and colorectal surgeons that participated in this series. Because of that there are no strict criteria for which patients received laparoscopy versus open and that's why we discussed the surgical judgment and clinical presentation.

The terms of the differences in surgical skill set, obviously, there will be some. Some surgeons will be more comfortable both with laparoscopic surgery in general and laparoscopic intervention for small bowel obstructions.

In terms of whether we routinely lyse all adhesions during the time of the surgery and subsequently how we had no returns for persistent obstruction, it is not our practice to lyse all adhesions during the time of surgery. In our practice if we can find a definitive transition point we will lyse it at that time. However, if we feel that we cannot adequately determine the source of the obstruction laparoscopic then it will be converted to open.

The cause for return to the OR in the one laparoscopic case, it was an unrecognized laparotomy enterotomy during the time of the case. In the operative report for the subsequent surgery the ideology of the enterotomy was not readily apparent, and it could not be determined whether this was

related to port placement or an enterotomy that had occurred during dissection.

In determining how the abdomen is entered, that, again, was dependent upon the surgeon and their personal preferences and how to enter the abdomen in a patient with an obstruction and then their degree of comfort with the amount of bowel distension that is present at the time of presentation.

When answering the questions in terms of conversion to open and whether these needed to be presented at M&M, that currently does not meet our criteria for presentation at our morbidity and mortality conference at our hospital. In fact, our feeling is conversion to open shouldn't necessarily be seen as a failure of laparoscopic surgery but, instead, should be seen as a way of properly evaluating the bowel laparoscopically and then opening if necessary to properly treat the patient.

In our study we defined chronic obstruction we defined as patients that had had multiple previous cases of small bowel obstruction, and whose cases were performed on an elective basis. Based on this criteria we did have several of our patients that had two or three obstructions in the past and were able to have laparoscopic surgery for their management of that acute small bowel obstruction.

Looking at complications or morbidity of these patients, we looked at the patients during their hospitalization for their acute small bowel obstruction. We did not look at long-term complication rates. The complication rates during that initial hospitalization were reviewed and no significant differences in morbidity were found between the groups so that data wasn't presented.

Finally, discussing which patients should initially be managed with an open operation, those patients that have had numerous previous abdominal operations and are likely to have a large amount of scar tissue in their abdomen we feel likely would be better served by having an open operation initially to try and minimize any risks of bowel injury.