



Factors Predicting the Need for Early Surgical Intervention for Small Bowel Obstruction

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Purpose: Small bowel obstruction (SBO) is a common disease that requires hospitalization. The most common cause of SBO is postoperative adhesion. Delayed timing of operations in patients who need surgical intervention results in mortality or morbidity. A number of studies on SBO have established criteria for emergency surgery. However, few objective clinical parameters are available for screening patients who need a delayed operation. Therefore, we analyzed factors that affect the clinical course of SBO to select appropriate therapeutic plans for reducing the risk of complications in these patients.

Methods: We investigated the clinical characteristics of patients admitted to the surgery department of our hospital between January 1, 2015, and December 31, 2016, who were diagnosed with SBO. Patients were divided into an operative treatment group (n=12) and a conservative treatment group (n=96). We compared clinical characteristics between the 2 groups.

Results: The operative treatment group underwent more operations before SBO than the conservative treatment group (P=0.007). Initial leukocyte counts (P=0.004) and C-reactive protein (CRP) levels (P=0.028) were elevated in the operative group. Body mass index (BMI) was lower in the operative group (P=0.013).

Conclusion: The number of operations before SBO, leukocyte counts, CRP levels, and BMI were useful parameters for selecting patients who needed an urgent operation for SBO.

Keywords: *Body mass index; C-reactive protein; Leukocyte; Small bowel obstruction*

INTRODUCTION

Small bowel obstruction (SBO) is defined as a status that is a surgical emergency resulting from the inhibited passage of bowel contents [1]. SBO is a major cause of hospital admission [2]. The most common cause of SBO is adhesion, accounting for approximately 75% of all cases, followed by malignancy and inflammatory bowel disease [3]. Studies have aimed to prevent postopera-

tive adhesion, but no appropriate method has been established [4]. Therefore, the appropriate treatment for SBO remains an important surgical issue. Most cases of SBO are successfully treated with conservative management. However, some demand opportune surgical interventions [5]. Failing to perform appropriate surgical interventions increases mortality and morbidity.

According to a study from 2013, the incidence rate of complications such as surgical site infection, pneumonia, and sepsis and mortality is significantly higher in groups of patients whose surgical treatment is delayed by >24 hours compared to those who received early operative intervention for adhesive SBO [6].

Studies on SBO found some indications for emergency surgery. However, the analysis of specific clinical factors for delayed operation is lacking [7, 8]. Selecting operative management is difficult for patients who previously recovered through conservative care or who are at the boundary of indications for operative management. The aim of this study was to improve the therapeutic prognosis of SBO by identifying predictive factors for the early selec-

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tion of patients who need operative management.

METHODS

This was a single-center retrospective study conducted in the Surgery Department of our hospital from January 1, 2015, to December 31, 2016. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of our hospital (approval number: SGPAIK 2018-03-024). The IRB waived the need for informed consent for this retrospective chart review.

Study population

Patients admitted to the Surgery Department of our hospital with a diagnosis of SBO between January 1, 2015, and December 31, 2016, were evaluated. Patients who were readmitted after discharge during the study period; who had ileus within 1 month after surgery; who underwent surgery within 3 days after admission because they met immediate surgery criteria such as ischemic change or closed loop in computed tomography (CT); and patients with colon or rectal lesions were excluded.

Included patients were divided into 2 groups by conservative treatment or operative treatment. The conservative treatment group included patients whose symptoms improved with fasting, intravenous antibiotics, and total parenteral nutrition. The operative treatment group was patients whose clinical features improved after surgical interventions such as bowel resection or band adhesiolysis and those who died in spite of surgical interventions.

We reviewed baseline clinicopathologic characteristics such as age, sex, body weight, height, body mass index (BMI), history of smoking or alcohol consumption, diabetes mellitus, hypertension, and number of operations before index surgery. We also studied factors associated with the index surgery. Index surgery was defined as the last operation before SBO onset [9]. Factors included time to hospitalization for SBO after index surgery and characteristics of the index surgery such as malignancy, laparotomy, bowel resection, emergency, intraperitoneal drainage tube use, operation time (from incision to suture), American Society of Anesthesiologists (ASA) physical status classification, and hospitalization duration. Initial vital signs and laboratory findings such as systolic blood pressure, diastolic blood pressure, body temperature, heart rate, respiratory rate, hemoglobin level, leukocyte and differential counts, and C-reactive protein (CRP) level were reviewed. We compared the results between groups using statistical analyses. We also reviewed the outcomes of the operative management group.

Statistical analyses

Continuous variables were analyzed using the Mann-Whitney U-test. The Kruskal-Wallis test was used for categorical variables. Multiple logistic regression analysis was performed for related factors with P-values < 0.05 in univariate analysis. All analyses

were considered statistically significant at P-value < 0.05. Statistical analysis was performed using IBM SPSS Statistics ver. 24.0 (IBM Co., Armonk, NY, USA).

RESULTS

We investigated the clinical features of patients who were diagnosed as having SBO between January 1, 2015, and December 31, 2016. During the study period, 172 patients were hospitalized for SBO. Patients with ileus within 1 month after surgery (n = 19); who underwent surgery within 3 days after admission because they met immediate surgery criteria such as ischemic change and closed loop on CT (n = 18); and patients with colon or rectal lesions (n = 27) were excluded. The 108 included patients were divided into a conservative care group (n = 96) and an operative management group (n = 12) (Fig. 1).

Baseline clinical data analysis showed no significant differences between groups on age, sex, height, history of smoking or alcohol consumption, diabetes mellitus, or hypertension. BMI (P = 0.013) (Table 1) was significantly higher in the conservative care group than the operative management group. The number of operations before index surgery was significantly higher in the operative management group than the conservative care group (P = 0.007) (Table 1).

No significant differences were found between the 2 groups in time to hospitalization for SBO after index surgery or characteristics of the index surgery such as malignancy, laparotomy, bowel resection, emergency, or intraperitoneal drainage tube (Table 2).

Initial vital signs and laboratory findings demonstrated no significant differences in systolic blood pressure, diastolic blood pressure, body temperature, heart rate, respiratory rate, hemoglobin level, or differential leukocyte count between the 2 groups. Initial leukocyte count (P = 0.004) (Table 3) and CRP level (P =

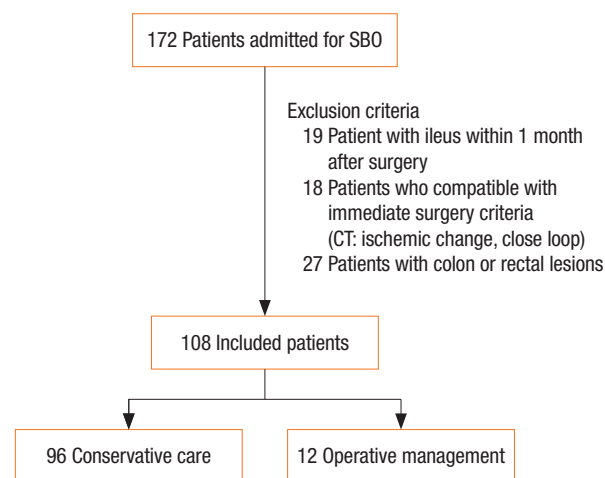


Fig. 1. Study population of this study. SBO, small bowel obstruction; CT, computed tomography.

0.028) (Table 3) were significantly higher in the operative management group than the conservative care group.

Multiple logistic regression analysis

To analyze independent factors, multiple logistic regression analysis was performed for variables with P-values <0.05 for each group (Tables 1–3). Among the factors, the number of operations before SBO was significantly higher in the operative management group than the conservative care group and was identified as independent (odds ratio, 7.50; 95% confidence interval, 1.75–32.21;

Table 1. Baseline demographic data of each group

Characteristic	Conservative care (n=96)	Operative management (n=12)	P-value
Sex			0.309
Male	47 (49.0)	4 (33.3)	
Female	49 (51.0)	8 (66.7)	
Age (yr)			0.973
<60	38 (39.6)	6 (50.0)	
≥60	58 (60.4)	6 (50.0)	
BMI (kg/m ²)			0.013*
<18.5	9 (9.4)	0 (0)	
18.5–22.9	43 (44.8)	10 (83.3)	
23.0–24.9	24 (25.0)	2 (16.7)	
≥25.0	20 (20.8)	0 (0)	
History of smoking			0.687
Yes	12 (12.5)	2 (16.7)	
No	84 (87.5)	10 (83.3)	
History of alcohol consumption			0.879
Yes	26 (27.1)	3 (25.0)	
No	70 (72.9)	9 (75.0)	
Diabetes mellitus			0.849
Yes	14 (14.6)	2 (16.7)	
No	82 (85.4)	10 (83.3)	
Hypertension			0.435
Yes	35 (36.5)	3 (25.0)	
No	61 (63.5)	9 (75.0)	
No. of operations before SBO			0.007*
1	59 (61.5)	6 (50.0)	
2	31 (32.3)	2 (16.7)	
3	5 (5.2)	2 (16.7)	
4	1 (1.0)	2 (16.7)	

Values are presented as number (%).

BMI, body mass index; SBO, small bowel obstruction.

*P < 0.05, statistical significance.

Table 2. Factors associated with index surgery

Factors associated with index surgery	Conservative care (n=96)	Operative management (n=12)	P-value
Time to hospitalization for SBO after the index surgery (yr)			0.887
<5	22 (22.9)	4 (33.3)	
5–10	21 (21.9)	1 (8.3)	
>10	53 (55.2)	7 (58.3)	
Index surgery for malignancy			0.476
Yes	34 (35.4)	3 (25.0)	
No	62 (64.6)	9 (75.0)	
Index surgery performed for laparotomy			0.917
Yes	79 (82.3)	2 (16.7)	
No	17 (17.7)	10 (83.3)	
Index surgery including bowel resection			0.193
Yes	53 (55.2)	3 (25.0)	
No	43 (44.8)	9 (75.0)	
Emergent index surgery			0.119
Yes	36 (37.5)	2 (16.7)	
No	60 (62.5)	10 (83.3)	
Index surgery requiring intraperitoneal drainage tube use			0.068
Yes	20 (20.8)	4 (33.3)	
No	76 (79.2)	8 (66.7)	

Values are presented as number (%).

SBO, small bowel obstruction.

Table 3. Initial vital signs and laboratory findings

Initial vital signs and laboratory finding	Conservative care (n=96)	Operative management (n=12)	P-value
Initial systolic BP (mmHg)	120 (90–160)	120 (90–136)	0.948
Initial diastolic BP (mmHg)	70 (50–100)	75 (60–100)	0.421
Initial body temperature (°C)	36.8 (36.0–38.0)	36.9 (36.1–38.2)	0.829
Initial heart rate (/min)	80 (37–118)	83 (62–108)	0.141
Initial respiratory rate (/min)	18 (15–84)	19 (16–20)	0.436
Initial hemoglobin level (g/dL)	13.7 (6.4–20.0)	13.5 (10.7–17.0)	0.656
Initial leukocyte count (μL)	9,715 (3,490–18,050)	13,610 (4,580–28,070)	0.004*
Initial neutrophil count (%)	80.3 (40.6–92.9)	71.9 (59.9–94.3)	0.434
Initial CRP level (mg/dL)	0.3 (0.3–12.0)	0.55 (0.3–7.0)	0.028*

Values are presented as median (range).

BP, blood pressure; CRP, C-reactive protein.

*P < 0.05, statistical significance.

$P = 0.007$). However, BMI, initial leukocyte count, and initial CRP levels showed no significant differences between groups (Table 4).

Operative management group outcomes

In the operative management group, 12 patients underwent segmental resection of the small bowel. Four patients underwent adhesiolysis and one underwent bandlysis. The characteristics of outcomes for the operative management group are in Table 5.

DISCUSSION

The choice of surgical or conservative treatment for patients with SBO is still controversial [10]. Partial obstruction with no sign of strangulation usually necessitates conservative treatment for SBP. When complete obstruction or strangulation is confirmed, the treatment of choice is early surgery [11, 12].

This study was a retrospective analysis of clinical factors predicted to be associated with the therapeutic prognosis of SBO. We found several factors that could help identify patients who require early operative treatment.

A previous report suggested that patient age and ASA score are closely related to postoperative mortality in patients with SBO [13]. However, this factor was not statistically relevant in this

study. In agreement with a 2014 study by Meier et al. [9], we found that the number and type of previous abdominal operations did not affect the therapeutic prognosis of SBO. However, Lee et al. [14] found that history of operation was associated with the occurrence of early postoperative SBO ($P = 0.044$). In that study, patients who underwent surgery more than 3 times were more likely to have surgery for SBO. However, no difference was observed according to surgical method. This finding was because patients who received the operation once had the operation to treat their disease and patients who received the operation more than 3 times had the operation for SBO. The most common cause of SBO is reported to be adhesion due to a previous surgery, and risk of adhesion is expected to rise as the number of operations increases [3].

In 2012, Angenete et al. [15] reported an increased incidence for SBO after open surgery compared to laparoscopic surgery. Similar to a previous study, we found that the percentage of SBO was significantly higher for open surgery than for laparoscopic surgery. Generally, colorectal surgery is the most frequent type of surgery associated with SBO, followed by gynecological surgery, herniorrhaphy, and appendectomy [16, 17]. This result seems to be related to the degree of small intestine manipulation.

BMI was significantly higher in the conservative treatment group than in the operative management group. A 2007 study by Davies on obesity and appendicitis in children compared a normal weight group with a very obese group, defined as >2 standard deviations over the mean weight for age. The appendicitis perforation rate was 20.0% in the very obese group and 25.5% in the normal weight group [18]. This paradoxical positive effect of obesity can be explained by higher expression of anti-inflammatory cytokines and antibacterial peptides in human omental tissue [19]. According to a 1992 animal study by Adams et al. [20], omental wrap is protective and contributes to wound repair by preventing premature leakage of vulnerable anastomosis and becoming a source of granulation tissue and neovascularization. For

Table 4. Multiple logistic regression analysis for the operative management

Variable	OR (95% CI)	P-value
BMI (kg/m ²)	0.13 (0.02–1.09)	0.060
No. of operations before SBO	7.50 (1.75–32.21)	0.007*
Initial leukocyte count (/μL)	4.28 (0.84–21.68)	0.079
Initial C-reactive protein level (mg/dL)	3.67 (0.72–18.74)	0.118

OR, odds ratio; CI, confidence interval; BMI, body mass index; SBO, small bowel obstruction.

* $P < 0.05$, statistical significance.

Table 5. Characteristics of outcomes in operative management group (n=12)

Characteristic	Bandlysis (n = 1)		Adhesiolysis (n = 4)			Segmental resection of small bowel (n = 7)						
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
Days from admission to surgery	5	17	5	13	9	8	6	5	7	6	6	7
Days from surgery to discharge	20	22	13	55	17	31	23	25	9	18	9	16
Operative time (min)	100	110	100	150	155	243	205	110	90	100	95	165
Amount of bleeding (mL)	10	10	30	100	10	100	200	50	10	10	5	100
Drainage	Yes	No	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Morbidity	WC	WC	WC	WC	No	WC	WC	No	No	No	No	No
Bowel ischemic change	Yes	No	No	No	No	No	No	Yes	No	No	No	No
Bowel stricture	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No

WC, wound complication.

this reason, omentum with abundant adipocytes is called an “abdominal policeman” [21]. Therefore, we hypothesized that at the time of index surgery, the adipocyte-induced anti-inflammatory response of adipocytes in patients with obesity would be effective in reducing risk of intestinal adhesion after surgery. Thus, the results of this study can be explained by the better therapeutic prognosis for SBO after index surgery for patients with obesity.

Initial leukocyte count and CRP level were significantly higher in the operative management group than in the conservative care group. In 2010, Schwenter et al. [22] suggested that clinicoradiological score predicts risk of strangulated SBO. In the study, small bowel resection was significantly more frequently required for leukocyte counts $>10^4/\mu\text{L}$ or CRP levels exceeding 7.5 mg/dL. The results of these studies may be due to both leukocyte counts and CRP levels being proportional to inflammation severity.

A limitation of this study is that randomization among the comparative groups was not practical because of the innate characteristics of a retrospective study. Another limitation is the lack of a plan to set a cutoff value for each predictive factor that was found to be significant. In addition, the lack of a study of initial CT findings remains a limitation. Further studies are needed to overcome these limitations and establish more sophisticated SBO management guidelines.

In conclusion, we found that the number of operations before SBO, leukocyte count, CRP level, and BMI were statistically significant factors in patients with SBO treated surgically. By closely examining these factors, we inferred that early selection of patients who need surgery may help improve their therapeutic prognosis.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Richard PG, Pepijn K, Salomone DS, Federico C, Walter LB, Luca A, et al. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2017 update of the evidence-based guidelines from the world society of emergency surgery ASBO working group. *World J Emerg Surg* 2018;13:24.
2. Di Saverio S, Catena F, Kelly MD, Tugnoli G, Ansaloni L. Severe adhesive small bowel obstruction. *Front Med* 2012;6:436-9.
3. Miller G, Boman J, Shrier I, Gordon PH. Etiology of small bowel obstruction. *Am J Surg* 2000;180:33-6.
4. Bizer LS, Liebling RW, Delany HM, Gliedman ML. Small bowel obstruction: the role of nonoperative treatment in simple intestinal obstruction and predictive criteria for strangulation obstruction. *Surgery* 1981;89:407-13.
5. Diaz JJ Jr, Bokhari F, Mowery NT, Acosta JA, Block EF, Bromberg WJ, et al. Guidelines for management of small bowel obstruction. *J Trauma* 2008;64:1651-64.
6. Teixeira PG, Karamanos E, Talving P, Inaba K, Lam L, Demetriades D. Early operation is associated with a survival benefit for patients with adhesive bowel obstruction. *Ann Surg* 2013;258:459-65.
7. Hajibandeh S, Hajibandeh S, Panda N, Khan RMA, Bandyopadhyay SK, Dalmia S, et al. Operative versus non-operative management of adhesive small bowel obstruction: a systematic review and meta-analysis. *Int J Surg* 2017;45:58-66.
8. Catena F, Di Saverio S, Kelly MD, Biffl WL, Ansaloni L, Mandalà V, et al. Bologna Guidelines for Diagnosis and Management of Adhesive Small Bowel Obstruction (ASBO): 2010 Evidence-Based Guidelines of the World Society of Emergency Surgery. *World J Emerg Surg* 2011;6:5.
9. Meier RP, de Saussure WO, Orci LA, Gutzwiller EM, Morel P, Ris F, et al. Clinical outcome in acute small bowel obstruction after surgical or conservative management. *World J Surg* 2014;38:3082-8.
10. Lo OS, Law WL, Choi HK, Lee YM, Ho JW, Seto CL. Early outcomes of surgery for small bowel obstruction: analysis of risk factors. *Langenbecks Arch Surg* 2007;392:173-8.
11. Fevang BT, Jensen D, Svanes K, Viste A. Early operation or conservative management of patients with small bowel obstruction? *Eur J Surg* 2002;168:475-81.
12. Lou Z, Yan FH, Hu SJ, Meng RG, Zhang W, Yu ED et al. Predictive factors for surgical intervention in patients over the age of 80 with adhesive small-bowel obstruction. *Indian J Surg* 2015;77:1280-4.
13. Duron JJ, du Montcel ST, Berger A, Muscari F, Hennes H, Veyrieres M, et al. Prevalence and risk factors of mortality and morbidity after operation for adhesive postoperative small bowel obstruction. *Am J Surg* 2008;195:726-34.
14. Lee SY, Park KJ, Ryoo SB, Oh HK, Choe EK, Heo SC. Early postoperative small bowel obstruction is an independent risk factor for subsequent adhesive small bowel obstruction in patients undergoing open colectomy. *World J Surg* 2014;38:3007-14.
15. Angenete E, Jacobsson A, Gellerstedt M, Haglund E. Effect of laparoscopy on the risk of small-bowel obstruction: a population-based register study. *Arch Surg* 2012;147:359-65.
16. Miller G, Boman J, Shrier I, Gordon PH. Natural history of patients with adhesive small bowel obstruction. *Br J Surg* 2000;87:1240-47.
17. Parker MC, Wilson MS, Menzies D, Sunderland G, Clark DN, Knight AD, et al. The SCAR-3 study: 5-year adhesion-related readmission risk following lower abdominal surgical procedures. *Colorectal Dis* 2005;7:551-8.
18. Davies DA, Yanchar NL. Appendicitis in the obese child. *J Pediatr Surg* 2007;42:857-61.
19. Chandra A, Srivastava RK, Kashyap MP, Kumar R, Srivastava RN, Pant AB. The anti-inflammatory and antibacterial basis of human omental defense: selective expression of cytokines and antimicrobial peptides. *PLoS One* 2011;6:e20446.
20. Adams W, Ctercteko G, Bilous M. Effect of an omental wrap on the healing and vascularity of compromised intestinal anastomo-

- ses. *Dis Colon Rectum* 1992;35:731-8.
21. Flint R. Differences in acute general surgical admissions between obese or overweight patients compared to normal-sized patients. *N Z Med J* 2015;128:35-41.
 22. Schwenter F, Poletti PA, Platon A, Perneger T, Morel P, Gervaz P. Clinicoradiological score for predicting the risk of strangulated small bowel obstruction. *Br J Surg* 2010;1119-25.