ORIGINAL ARTICLE

Determining the need for surgery in small bowel obstructions based on clinical, laboratory, and radiological parameters

Determinación de la necesidad de cirugía en obstrucciones del intestino delgado según parámetros clínicos, de laboratorio y radiológicos

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Abstract

Objective: *Small bowel obstruction (SBO) is a common and important surgical emergency. Our aim in this study is to describe the clinical, laboratory, and computed tomography (CT) findings to facilitate the objective identification of SBO patients in need of operative treatment in this patient population.* **Methods:** *This retrospective study included 340 patients hospitalized due to a preliminary diagnosis of ileus. Retrieved data of patients included age, gender, comorbidities, previous hospitalization due to ileus, surgical history, physical examination findings, complete blood count and biochemistry test results, and CT findings at admission.* **Results:** *The study included 180 (52.9%) male and 160 (47.1%) female patients. Treatment was conservative in 216 patients and surgery in 124 patients. Of the patients included in the study, 36.4% needed surgery. Of the female patients, 38.90% received conservative treatment and 61.30% underwent surgery. Adhesions were the most common cause of obstruction in operated patients (43.50%).* **Conclusion:** *We have found that female gender, vomiting, guarding, rebound, C-reactive protein levels above 75 mg/L, increased bowel diameter, and a transition zone on CT images indicate a strong need for surgery, but a history of previous hospitalization for ileus may show that surgery may not be the best option.*

Keywords: *Surgical treatment. Ileus. Small bowel obstruction. Conservative approach.*

Resumen

Objetivo: *Describir los hallazgos clínicos, de laboratorio y de tomografía computarizada (TC) para facilitar la identificación objetiva de los pacientes con obstrucción del intestino delgado que necesitan tratamiento quirúrgico.* **Método:** *Este estudio incluyó 340 pacientes. Los datos obtenidos fueron edad, sexo, comorbilidad, hospitalización previa debida a íleo, historia quirúrgica, hallazgos de la exploración física, hemograma completo y resultados de las pruebas bioquímicas, y hallazgos de la TC al ingreso.* **Resultados:** *El estudio incluyó 180 (52.9%) varones y 160 (47.1%) mujeres. El tratamiento fue conservador en 216 pacientes y quirúrgico en 124 pacientes. De los pacientes incluidos en el estudio, el 36.4% necesitaron cirugía. De las mujeres, el 38.90% recibieron tratamiento conservador y el 61.30% se sometieron a cirugía.* **Conclusiones:** *Encontramos que el sexo femenino, los vómitos, la guardia, el rebote, los niveles de proteína C reactiva superiores a 75 mg/l, el aumento del diámetro intestinal y una zona de transición en las imágenes de TC indican una fuerte necesidad de cirugía.*

Palabras clave: *Tratamiento quirúrgico. Íleo. Obstrucción del intestino delgado. Enfoque conservador.*

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Introduction

Small bowel obstructions (SBOs) account for approximately 3% of all laparotomies[1]. A precise diagnosis of SBO may be difficult with the decision-making process for surgery mainly based on clinical findings. Clinical findings of SBO include signs of peritoneal irritation, abdominal pain, abnormal bowel sounds, and a history of previous abdominal surgery. The underlying cause of such symptoms needs to be identified for timely and appropriate intervention with reductions in morbidity and mortality. Adhesions are the potential complications of abdominal surgery and the leading cause of SBO[2].

Strangulated SBO (SSBO) may require immediate surgical intervention. Studies report 2-10 times higher mortality rates in patients with SSBO compared to those without[3]. The time from the onset of complaints to surgery has been identified as a risk factor for strangulation and surgical site complications[4]. Therefore, there is a need for the rapid identification of the characteristic findings of SBO to prevent potential strangulation and bowel necrosis and reduce morbidity and mortality rates[5]. Studies are available in the literature showing that a large number of SBO cases without strangulation can be successfully managed through conservative treatment[5-7]. This requires the identification of patients without SSBO to avoid the risk of immediate surgery and to start standard conservative treatment, which includes fluid and electrolyte resuscitation, nasogastric (NG) decompression, and fasting. Standard conservative treatment is most successful (80%) in patients with partial obstruction[8,9]. The maximum duration of allowed conservative treatment usually ranges from 3 to 5 days, depending on the surgeon and the institution[10]. Close monitoring of persisting and progressing symptoms and appropriate clinical management is necessary to avoid late recognition of strangulation associated with increased morbidity and mortality. In this study, accordingly, we aimed to develop an objective approach based on clinical, laboratory, and radiological data to predict the need for operative intervention in SBO.

Materials and methods

This retrospective study included data from 340 patients, who were hospitalized due to a preliminary diagnosis of ileus in our clinic, the General Surgery Clinic of Bursa Yüksek İhtisas Training and Research Hospital of Health Sciences University, during the period between January 01, 2018, and December 31, 2021. Before starting the study, approval was obtained from the Clinical Research Ethics Committee of the Hospital with the decision number 2011-KAEK-25 2021/12-06 on December 15, 2021.

During the planning phase of our study, we performed a power analysis based on similar studies and calculated a sample size of 304 patients. Patients, who were hospitalized due to the diagnosis of ileus and received medical/surgical treatment, were included in our study. We retrieved patients' medical information from the patient information-processing system and medical files. We included clinical and laboratory findings and computed tomography (CT) images obtained in the emergency setting after admission. The recorded medical data of eligible patients for the study included age, gender, the history of previous hospitalization due to ileus, surgical history, physical examination findings, complete blood count and laboratory test results (leukocyte [white blood cell], neutrophil, platelet counts; hemoglobin levels, neutrophil-lymphocyte ratios, and sodium [Na], aspartate aminotransferase [AST], alanine aminotransferase [ALT], blood urea nitrogen, creatinine, and C-reactive protein [CRP] levels), and CT findings (intraperitoneal fluid volume, small bowel diameter, small bowel wall thickness, transition zone). An assigned physician reviewed CT findings. Intraperitoneal fluid volumes on CT images were measured according to the method described by Oriuchi et al.[11]. We used these recorded data for comparisons to examine the need for surgery and small bowel resection. Patients under the age of 18, patients with colonic obstruction, and missing data in medical records were excluded from the study.

Surgery or conservative treatment was decided based on clinical judgment by the current on-duty physician. Patients with suspected simple obstruction received conservative treatment with bowel rest, NG decompression, and intravenous fluid supply. Patients with suspected complicated SBO underwent emergency laparotomy. The diagnosis of complicated obstruction was made at laparotomy with macroscopic evidence of intestinal ischemia requiring small bowel resection.

We performed the statistical analyses of the study using the SPSS program (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). We tested the conformity of continuous variables to a normal distribution by the Shapiro–Wilk test. We summarized continuous

variables conforming to a normal distribution as mean ± standard deviation and those not as median (minimum: maximum). We summarized categorical variables as numbers and percentages. We performed the intergroup comparisons of normally distributed continuous variables using the independent double-sample t-test. We used the Mann–Whitney U test to perform intergroup comparisons of continuous variables not conforming to a normal distribution. We used the χ^2, Fisher's exact χ^2, and Fisher–Freeman–Halton tests to compare categorical variables between groups. We performed a logistic regression analysis to investigate potential risk factors favoring the decision for surgery. We accepted a type I error rate of 5% in statistical comparisons.

Table 1. Distribution of patients according to the cause of SBO in the surgical group

Cause of SBO	(n = 124) (%)
Adhesion	54 (43.50)
Inguinal hernia	16 (12.90)
Incisional hernia	12 (9.70)
Bezoar	9 (7.30)
Femoral hernia	8 (6.50)
Internal Herniation	8 (6.50)
Malignancy	8 (6.50)
Invagination	5 (4.0)
Umbilical hernia	3 (2.40)

SBO: small bowel obstruction.

Results

This study included 340 patients, who were admitted to the hospital due to SBO. Of these patients, 216 received conservative treatment and 124 underwent surgery. Of the patients, who underwent surgery, 93 underwent resection and 31 did not. Table 1 shows the causes of SBO in study patients. The most common cause of SBO was adhesion in patients, who underwent surgery because of the clinical signs and symptoms of SBO. Figures 1 and 2 show a case of SBO due to intussusception and adhesive tape.

Table 2 shows the comparison of the demographic, clinical, laboratory, and radiological characteristics of patients between the conservative treatment and surgical intervention groups.

There were significant differences in gender distribution, length of hospital stay, and mortality rates between the groups ($p < 0.001$). The median length of hospital stay was longer (9.50 days) in the surgical group compared to that found in the conservative treatment group (4 days). Women accounted for 38.90% and 61.30% of the patients in the conservative and surgical treatment groups, respectively.

The presence of vomiting ($p = 0.012$) and peritoneal irritation findings (tenderness [$p = 0.015$], guarding [$p < 0.001$], and rebound [$p < 0.001$]) were significantly different between the groups, occurring more commonly in the surgical group. When we examined the patient distribution under the CRP < 75 mg/L and CRP ≥ 75 mg/L categories, we observed that the patients with CRP ≥ 75 mg/L were more common in the surgical group ($p < 0.001$).

The median bowel diameter and the rate of patients with a transition zone were higher in the surgical intervention group compared to the conservative treatment group ($p = 0.001$ and $p < 0.001$, respectively) (Figs. 3 and 4). The wall thickness was not different between the groups. Elimination of the cause (adhesiolysis, inguinal hernia repair, etc.) was sufficient for the treatment of the obstruction in patients with no intraoperative complications such as strangulation, necrosis, or perforation.

Figure 1. *Small bowel obstruction due to invagination, intraoperative image.*

In the surgical group, when we compared demographic, clinical, laboratory, and CT findings between

Table 2. Comparison of the demographic, clinical, laboratory, and radiological findings between the conservative treatment and surgical intervention groups

Variables	Conservative treatment (n = 216)	Surgery (n = 124)	p-value
Age (Years)*	61 (19-95)	63.50 (19-95)	0.068[a]
Gender (%)			
Female	84 (38.90)	76 (61.30)	< 0.001[b]
Male	132 (61.10)	48 (38.70)	
Length of hospital stay (Days)*	4 (1-24)	9.50 (1-60)	< 0.001[a]
Outcome (%)			
Hospital discharge	215 (99.50)	112 (90.30)	< 0.001[c]
Death	1 (0.50)	12 (9.70)	
Pain duration (Days) (%)			
1-3	179 (82.90)	94 (75.80)	0.143[d]
4-7	35 (16.20)	26 (21.0)	
> 7	2 (0.90)	4 (3.20)	
Vomiting (%)	118 (54.60)	85 (68.50)	0.012[b]
Tenderness (%)	144 (66.70)	98 (79)	0.015[b]
Guarding (%)	3 (1.40)	17 (13.70)	< 0.001[b]
Rebound (%)	1 (0.50)	11 (8.90)	< 0.001[c]
Distention (%)	81 (37.50)	59 (47.60)	0.069[b]
Previous abdominal surgery (%)			
Major	96 (44.40)	43 (34.70)	0.175[b]
Minor	57 (26.40)	42 (33.90)	
None	63 (29.20)	39 (31.50)	
Previous hospitalization for ileus (%)	46 (21.30)	18 (14.50)	0.124[b]
History of radiation exposure (%)	10 (4.60)	2 (1.60)	0.223[c]
WBC (10^3/ml)*	12.63 (3.87-48.14)	11.49 (2.20-28.80)	0.077[a]
NLR*	7.07 (0.51-50.26)	6.43 (1.43-42.83)	0.810[a]
PLT (10^3/mL)*	285 (103-738)	298.50 (101-632)	0.217[a]
Hgb (g/dL)*	14.20 (7.80-18.60)	13.45 (8.20-17.70)	0.024[a]
CRP (mg/L)*	16.85 (2.86-434)	38 (2.86-349)	< 0.001[a]
CRP (mg/l) (%)			
< 75	176 (81.50)	76 (61.30)	< 0.001[b]
≥ 75	40 (18.50)	48 (38.70)	
Sodium (mmol/L)*	137 (122-151)	136 (125-145)	0.022[a]
AST (u/L)*	21 (6-174)	24 (12-87)	0.030[a]
ALT (u/L)*	15 (4-309)	17 (5-107)	0.122[a]
BUN (mg/dL)*	17.48 (5.37-76.31)	20.77 (4.44-154.70)	0.011[a]
Creatinine (mg/dL)*	0.91 (0.46-6.88)	0.89 (0.53-6.01)	0.434[a]
DRR	1.45 (0.21:5.40)	1,42 (0,39:6,20)	0.951[a]
CT: Presence of intraperitoneal fluid (%)	31 (14.40)	26 (21.0)	0.116[b]
CT: Bowel diameter (mm)*	38.50 (18-60)	40.50 (26-75)	0.001[a]
CT: Wall thickness (mm)*	3 (1.50-7)	2.70 (1.50-7)	0.413[a]
CT: Presence of a transition zone (%)	52 (24.10)	85 (68.50)	< 0.001[b]

*Data are expressed as median (minimum-maximum) and numbers and percentages. [a]Mann–Whitney U Test, [b]χ^2 test, [c]Fisher's exact χ^2 test, [d]Fisher–Freeman–Halton test.
WBC: white blood cell leukocyte count; NLR: neutrophil–to–leukocyte ratio; PLT: platelet count; HgB: hemoglobin; CRP: C-reactive protein; AST: aspartate aminotransferase; ALT: alanine aminotransferase; BUN: blood urea nitrogen; DRR: De Ritis ratio; CT: computed tomography.

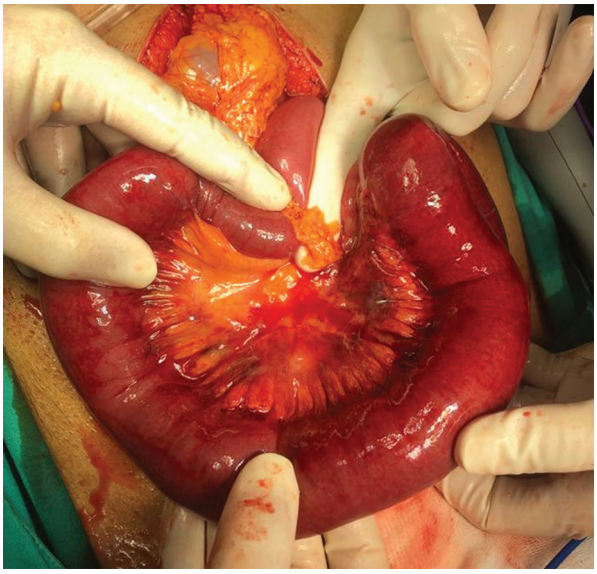

Figure 2. *Small bowel obstruction due to adhesive tape and disruption of intestinal blood flow.*

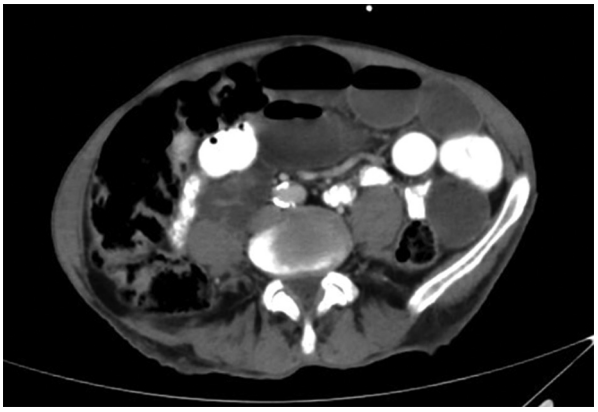

Figure 3. *Computed tomography of the abdomen shows dilated small intestines.*

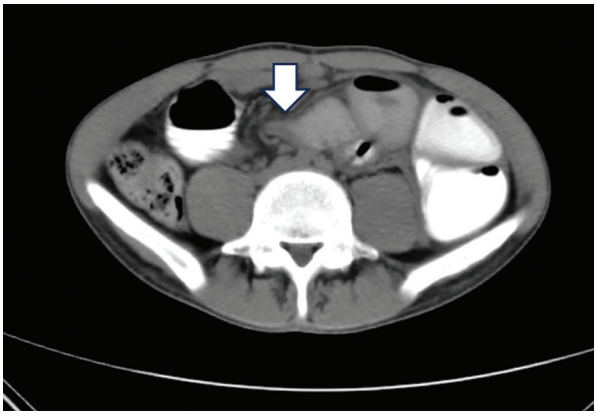

Figure 4. *Abdominal computed tomography showing the transition zone (arrow).*

the resection and non-resection groups, we found no significant differences in demographic data and clinical findings. However, in laboratory tests, we found a significant difference in the percentage of neutrophils and sodium levels between the resection and non-resection groups. The percentage of neutrophils and sodium levels were higher in patients, who underwent resection ($p = 0.026$ for both). Receiver operator characteristics curve (ROC) analysis was conducted to establish the cutoff point for neutrophil percentage in predicting the presence of resection in the patients included in the study (Fig. 5). If the neutrophil percentage was > 81.6, the area under the ROC curve was calculated as 0.63 (sensitivity 52.69%, specificity 74.19%, $p = 0.016$). It was concluded that a neutrophil percentage exceeding 81.6% was associated with the presence of resection. The comparison of CT findings between the resection and non-resection groups revealed that the intestinal wall thickness was higher in patients, who did not undergo resection ($p = 0.037$). No significant differences were found in other parameters between the resection and non-resection groups (Table 3).

We performed the logistic regression analysis method to examine the factors leading to the patient's referral for surgical intervention. First, we examined the variables in Table 2 by univariate logistic regression analysis. Then, we included the variables that met the $p < 0.25$ condition in the multivariate logistic regression analysis. In the multivariate logistic regression analysis, we performed a variable selection process using the forward elimination method. Table 4 shows the findings obtained by the model in the final step.

The logistic regression model obtained in the final step of the logistic regression analysis was significant ($p < 0.001$) and the regression model fitted the data set ($p = 0.625$). Gender was a risk factor for surgery, and the rate of surgery was 2.66 times higher in women than in men. The rate of referral to surgery was 2.59 times higher in patients with vomiting compared to those with no vomiting. Patients with guarding and rebound were 6.16 and 29.31 times more likely to be referred to surgery, respectively, compared to patients without. In the patient group with a history of previous hospitalization for ileus, the rate of surgical intervention was 60% lower compared to patients with no such history. The rate of referral to surgery was 2.83 times higher in the patient group with CRP levels of ≥ 75 mg/L compared to the patient group with CRP levels of < 75 mg/L. A one-unit increase in the bowel diameter increased the rate of referral to surgery by

Table 3. Comparison of patients, who underwent small bowel resection, to those, who underwent surgery but no small bowel resection

Variables	Resection (n = 93)	No resection (n = 31)	p-value
Neutrophil %	82 (50.20-94)	77.30 (56.70-91.7)	0.026[a]
Sodium (mmol/L)	137 (125-145)	136 (127-144)	0.026[a]
CT: Wall Thickness (mm)	2.50 (1.50-7)	3 (2-7)	0.037[a]
DRR	1.40 (0.39:4.25)	1.50 (0.52:6.20)	0.427[a]

Data are expressed as median (minimum-maximum) and numbers and percentages.
a: Mann–Whitney U test; CT: computed tomography; DRR: de Ritis ratio.

Table 4. Risk factors acting on the decision of the patient's referral for surgery

Variables	Wald	p-value	OR	%95 (CI)	
				Lower	Upper
Gender (Female)	10.67	0.001	2.66	1.48	4.79
Vomiting	9.04	0.003	2.59	1.39	4.82
Guarding	5.17	0.023	6.16	1.28	29.58
Rebound	6.48	0.011	29.31	2.17	395.04
Previous hospitalization for ileus	4.94	0.026	0.40	0.18	0.90
CRP Level (≥ 75) (mg/L)	9.63	0.002	2.83	1.47	5.44
Bowel diameter (mm)	4.85	0.028	1.05	1.01	1.10
Presence of a transition zone	43.17	< 0.001	7.49	4.11	13.65
Model χ^2 = 114.68; p < 0.001					

Hosmer and Lemeshow test: *P* = 0.625; OR: odds ratio; CI: confidence interval; CRP: C-reactive protein.

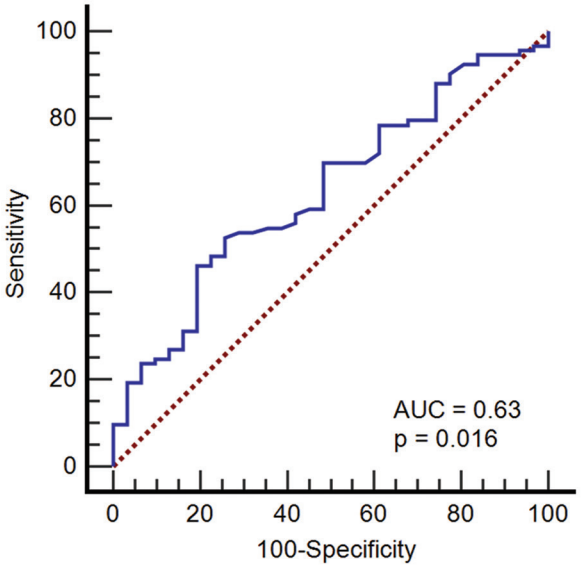

Figure 5. *Receiver operator characteristics analysis for neutrophil percentage.*

1.05 times. When there was a transition zone, the rate of referral to surgery was 7.49 times higher compared to the patients without a transition zone on CT images.

Discussion

Intestinal obstruction is the partial or complete inhibition of the distal passage of intestinal contents in the gastrointestinal tract[12]. The decision to operate on a patient with suspected SBO is based on physicians' clinical evaluation. The lack of widely accepted guidelines encouraged us to evaluate the accuracy of the clinical diagnosis of SBO. Timely and appropriate operative treatment of SBO should improve morbidity and mortality rates; however, it may be difficult to accurately identify patients in need of surgery during their hospital stay[13].

To this end, several attempts have been made to construct a predictive model to help guide the provision of appropriate treatment for SBO, but these studies used data from selected parts of the entire clinical scenario[14-16]. Instead, we examined all clinical parameters routinely tested during a hospital stay due to SBO, including history, physical examination, laboratory, and CT findings.

It is reported that 20-30% of patients with SBO need surgery[2]. This rate was 36.4% in our study. SBO is caused by adhesion, hernia, or malignancy in 90% of cases[17]. In our study, the most common cause of obstruction in operated patients was adhesion (43.50%), and the second most common cause was incarcerated inguinal hernia (12.90%).

Non-surgical follow-up is possible for most patients with intestinal bowel obstruction with no indication for emergency surgery. In many patients with SBO, non-surgical treatment improves symptoms, but success rates depend on the etiology. In adhesive SBOs, non-surgical management is usually successful in 65-80% of patients[18-21]. However, non-surgical management of adhesive SBO is associated with higher recurrence rates and shorter disease-free intervals compared to surgical management[2,7]. While approximately 40% of cases with complete obstruction can be managed conservatively, the need for bowel resection is high

(30%) in patients with unsuccessful conservative treatment outcomes[8,9]. In our study, on 340 patients, 216 patients received conservative treatment and 124 patients underwent surgery. Patients receiving conservative treatment in our study received fluid resuscitation, underwent NG decompression, and fasted during an appropriate period depending on their clinical condition.

Peritoneal irritation findings are vital findings favoring an emergency surgery decision. When similar studies in the literature are reviewed, peritoneal irritation findings come to the forefront in determining the need for surgery[22-24]. In our study, the rate of peritoneal irritation findings (tenderness, guarding, and rebound) was higher in the surgical group compared to the conservative treatment group. Tenderness occurred in 79% and 66.7%, guarding in 13.7% and 1.4%, and rebound occurred in 8.9% and 0.5% of the patients in the surgical and conservative treatment groups, respectively.

Animal experiments have shown that CRP levels are associated with the severity of bacterial translocation in acute intestinal obstruction[3]. In our study, we obtained findings consistent with the literature on this subject matter. When we grouped the patients under the CRP < 75 mg/L and CRP ≥ 75 mg/L categories, we observed that the patients with CRP ≥ 75 mg/L were more common in the surgical group ($p < 0.001$).

In clinical situations such as intestinal ischemia, hepatocyte damage may occur and AST and ALT ratios measured in blood may change. In one study, the De Ritis ratio was found to be a significant marker in predicting small bowel necrosis[25]. In our study, no significant difference was detected between the groups.

One study reported some inherent limitations of using CT alone to diagnose SBO and suggested that a combination of clinical and CT findings could improve diagnosis[26]. Two prospective studies examining the benefits of CT in the diagnosis of SBO showed an accuracy rate of 83-94% in differentiating obstruction from non-obstruction[27,28]. In a retrospective study on SBO patients, Jones et al. tested the correlation between CT scores and actual treatment and reported that images of dilated small bowel or free fluid on CT predicted SBO[29].

The transition zone is defined as the region between the small bowel loops proximal and distal to the obstruction. When the diameter difference between the dilated proximal and collapsed distal small bowel segments is small, it is difficult to identify the transition zone and the level of obstruction. Therefore, it is not as much as easy to detect the transition zone in patients with adhesions compared to tumors and hernias. In their study, Fukuya et al. reported an increased diagnostic value by the use of oral contrast material in cases with unclear transition zones on CT images[30]. Gazelle et al. reported in their study that the presence of the transition zone on CT was a statistically significant parameter to make the diagnosis of SBO[31]. In our study, the rate of patients with a transition zone was higher in the surgical group ($p < 0.001$).

Similar studies reported the presence of intraperitoneal fluid as the most important factor in the diagnosis of SBO[29,32]. In our study, we found that the rates of patients with intraperitoneal fluid did not differ statistically between the surgical and conservative treatment groups ($p = 0.116$). However, there was a difference between the groups by the bowel diameter. The median bowel diameter was statistically significantly higher in the surgical group compared to the conservative treatment group ($p = 0.001$).

Vomiting is a common symptom in patients with SBO. In the study by Zielinski et al., patients with vomiting were 4.7 times more likely to undergo surgery[32]. In our study, the need for surgery was 2.59 times more in patients with vomiting than in patients without.

Our study has some limitations: it is a retrospective study and our data are based on the existing records in our hospital's database. Because it is a single-center study, our results require further validation. Larger-scale and well-designed studies are needed.

Conclusion

Overall, our study on patients with symptoms and signs of SBO has shown that being a woman and having the following symptoms and signs including vomiting, guarding, rebound, CRP levels of ≥ 75 mg/L, increased bowel diameter, and a transition zone on CT increase the need for surgery. However, having a history of previous hospitalization due to ileus is associated with a reduced rate of surgery. The statistically significant results in our study are comparable with similar studies in the literature.

In light of the data obtained from our study, we have concluded that a comprehensive evaluation based on clinical, laboratory, and radiological parameters is necessary to determine the need for surgery in cases with SBO. Our statistically significant results can be used as objective findings to guide surgical decision-making in the management of patients with SBO.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that no patient data appear in this article. Furthermore, they have acknowledged and followed the recommendations as per the SAGER guidelines depending on the type and nature of the study.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Use of artificial intelligence for generating text. The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript or for the creation of images, graphics, tables, or their corresponding captions.

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