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"Choice of surgical approach for the treatment of acute small bowel obstruction: A retrospective analysis from a high-volume single center in Milan, Northern Italy"☆

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ABSTRACT

Background: Acute small bowel obstruction (aSBO) is the most common cause (76%) of acute intestinal obstruction. Laparoscopy use is still controversial in aSBO and indications not yet clearly defined. The aim of this study was to demonstrate the effectiveness and safety of a laparoscopic approach in aSBO by using specific pre-operative criteria for appropriate patient selection.

Methods: We retrospectively analyzed medical records of patients accepted at the Emergency Department for aSBO between January 2016 and March 2021 and performed a comparative analysis between types of treatment, considering demographics, clinical and radiological presentation, non-operative vs. operative management, intraoperative outcome, and postoperative course. We used a logistic regression to identify the variables related to surgical approach and built a predictive score upon the multivariable predictive model: the "SABO score".

Results: 198 patients were included in the study, of which 145 underwent surgery and 43 were successfully treated laparoscopically. Age and comorbidities were associated with open surgery (OR 3.2, 95% CI: 1.4–7.2, $p = 0.006$ and OR 2.7, 95% CI: 1.1–6.5, $p = 0.023$). A SABO score ≥ 0 identified an open approach with a sensitivity of 75.4% and a specificity of 69.8%.

Conclusions: Laparoscopy is growing in importance even in emergency settings. Our analysis suggests that a laparoscopic approach can be safe and feasible in aSBO management. Correct patient selection appears to be the key for a successful minimally invasive approach. SABO score therefore could be helpful in choosing the correct surgical strategy for patients with aSBO.

Introduction

Acute small bowel obstruction (aSBO) remains a leading cause of admission to surgical wards across the globe. According to Miller et al. [1], small bowel obstructions cause more than 3% of all emergency surgical admissions to a general hospital. The main etiological factor is adhesions from previous surgery, accounting for 60–70% [1,2]. aSBO management evolved during the last decades from an exclusive surgical disease to a more heterogeneous approach, tailored to patient's characteristics [3]. Nowadays, between 20 and 30% of patients with small bowel obstruction require operative treatment [4,5]. Length of hospitalization and morbidity depend on the need for surgical intervention [6]. Clinical guidelines [2,4], recommend a non-operative management (NOM) approach, unless signs of peritonitis, strangulation or bowel ischemia are present [7]. Recurrence rates in aSBO are high [4] and operative management of a first episode of aSBO may reduce the risk of recurrence [8]. Standard operative management consists of an exploratory laparotomy with adhesiolysis or resolution of the obstructive cause. With the rise of minimally invasive surgery, laparoscopy has been suggested as a new surgical approach [6] and the latest international

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guidelines accept it as a safe and feasible approach [2,4]. However, bowel distension is typical in aSBO reducing the working space and making intestinal loops very fragile. This increases the laparoscopic difficulty and raises the risk of iatrogenic injuries, leading several authors to concern for the proposed laparoscopic approach to aSBO. Di Saverio et al. [9] suggest a minimally invasive approach only in selected patients: a) without diffuse peritonitis and/or septic shock with suspicion of bowel perforation, b) radiological findings consistent with bowel obstruction (CT scan with a clear transition point suggestive of a single obstructing adhesive band and/or radiological/clinical evidence of NOM failure evidenced by hyperosmolar water-soluble contrast via nasogastric tube). As laparoscopy becomes widespread in emergency surgery, aSBO is a next target for a laparoscopic approach, even after taking into account the concerns [10]. We aim to confirm the safety of laparoscopic management in aSBO and searched for a predictive score to support the choice of surgical approach. We hypothesize that laparoscopy could offer some benefits in term of postoperative outcomes even in emergency setting, by contrast we suppose that some preoperative characteristics may affect laparoscopic feasibility, suggesting preferring a standard open approach.

Material and methods

A retrospective observational cohort study was conducted through a complete data review of consecutive adult patients (over 18 years old) with aSBO diagnosis accepted at the Emergency Department of San Raffaele Hospital in Milan between January 2016 and March 2021. The STROBE guideline was used to ensure proper reporting methods, results, and discussion (Supplemental Digital Content, SDC 1). The study was performed in accordance with the standards of Good Clinical Practice and the ethical principles contained in the Helsinki Declaration (in its last version, 2013). Data was collected retrospectively from hospital records in structured format for analysis and checked for heterogeneity and any outliers checked manually. Data acquisition, management and use were in accordance with the European Union regulation 2016/679, European Parliament and Council, April 27th 2016. Due to its retrospective nature, ethics committee approval was not needed. An informed consent for surgery was obtained from every patient undergoing operative treatment. aSBO etiology [1] was classified into the following categories: 1. adhesions (either spread adhesions or internal hernias), 2. abdominal wall hernias, and 3. miscellaneous. Exclusion criteria were malignant cause of obstruction (including both primitive tumors and carcinosis), inguinal or femoral hernias, diaphragmatic hernias and other Upper GI obstructions, complications of ileostomy/-colostomy. We analyzed these variables:

A) Pre-treatment: age, sex, body mass index (BMI), American Society of Anaesthesiologists (ASA) score [11], Charlson Comorbidity Index (CCI) [12], number and causes of previous abdominal operations and their approach (laparoscopic vs. laparotomic and urgent vs. elective), clinical presentation, and SBO history.
B) Diagnostic workup: plain abdominal X-ray, oral contrast X-ray, and computed tomography (CT) scan.
C) Treatment: failure of non-operative management (NOM), surgery timing, surgical approach, intraoperative findings, conversion, bowel resections, and operative time.
D) Post-treatment: morbidity, mortality, onset of oral intake, time to flatus, reoperation, length of hospital stay, readmission, and aSBO relapses.

Post-operative complications were assessed according to the Clavien-Dindo classification [13].

Simple adhesion was defined as a single well-defined band adhesion; otherwise, adhesions were classified as complex [14]. In this setting, internal hernias were included in the simple adhesion category.

The diagnostic workup included a plain abdomen X ray and/or a CT scan according to the clinical presentation.

The same NOM protocol was applied by all faculty and was defined as nil per os and decompression using a naso-gastric tube (NGT) [4] along with correction of fluid and electrolyte imbalances; water soluble contrast study was performed in all non-responders to simple gastric decompression. We considered a treatment failure if a clear stop was found, a worsening of clinical conditions occurred, or no improvement was observed after 72 h [2,4,15].

Hemodynamic instability, suspected massive intestinal ischemia, severe cardiopulmonary diseases, uncorrectable coagulopathy and patent foramen ovale were considered contraindications for laparoscopy.

Radiological signs of suspected ischemia included parietal pneumatosis, lack of bowel wall enhancement at contrast-enhanced CT, or high bowel wall attenuation at unenhanced CT [16].

Each patient included in the study had at least one year of follow-up by means of outpatient visits and new Emergency Department accesses.

Statistical analysis

The entire analysis was performed with IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Normality was tested with the Kolmogorov – Smirnov test.

Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A one way-ANOVA was used to compare continuous and categorical variables. A Spearman's rank order correlation was run to assess the relationship between surgical history of peritonitis and/or intestinal obstruction and conversion rate. All the analysis on intra- and post-operative outcomes was based on an intention-to-treat method. A logistic regression including all preoperative characteristics as independent variables and surgical approach (open vs. laparoscopic) as the dependent one was run to identify those variables related to surgical approach. SABO score – Surgical Approach in aSBO – was obtained from the final multivariable predictive model, as follows:

$$1.2 \times [age \geq 70] + [ASA \geq 3] + 0.8 \times [aSBO\ history] - 1.5$$

Each predictive variable, considered as a binary variable, was multiplied by its β-coefficient, and summed to the others, −1.5 was the logistic regression constant. The scale ranges from −1.5 to 1.5.

Receiver Operating Characteristic (ROC) curve analysis was used to assess the discriminative ability of the predictive model. Values of area under curve (AUC) $\geq$ 0.7 were considered as acceptable [17]. The optimal cut-off value, combining the balance between sensitivity and specificity, was identified through calculation of the Youden Index [18]. Sensitivity, specificity, positive and negative predictive values (PPV and NPV) were calculated for the above-mentioned cut-off. Logistic regression analysis was applied to identify variables related to post-operative major complications (Clavien-Dindo equal or higher than IIIa) as well.

Results are expressed as n (%), mean values ± standard deviation (SD), median (interquartile range (IQR)) and odd ratios (OR) with 95% confidence intervals (CI). A p value less than 0.05 was considered significant.

Surgical technique

Due to the extreme variability of cases, there is no standardized surgical technique for emergency treatment of aSBO. Open surgery starts with an explorative laparotomy, most frequently median.

For minimally invasive technique we adapt elective procedures to emergency surgery; depending on the suspected site of obstruction.

An open technique with Hasson's trocar to start pneumoperitoneum inflation is always performed to minimize bowel injuries [9]. In case of irreversible ischemia, we usually convert to open surgery, to have a better control on field's contamination and a more complete evaluation of the bowel [15].

Results

Population characteristics

We admitted 678 patients to our Emergency Department for aSBO in the study period. According to the study design, 480 were excluded for etiology (Fig. 1), leaving an analyzed population of 198 cases: 104 (52.5%) male, median age of 70 years (IQR 55–78), a median BMI of 23.6 (IQR 20.5–27) and a median CCI and ASA score of three (IQR 1–6 and 1–3 respectively). aSBO etiology included:

- adhesions in 70.7%;
- spread adhesions in 53.5% and internal hernias in 17.2%;
- abdominal wall hernias (mainly incisional hernias) in 15.7%;
- miscellaneous in 13.6% (including 4 cases of invagination, 1 case of ab extrinseco compression, 1 case of volvulus, 1 case of IBD stricture, 4 case of gallstone ileus, 12 cases of foreign body/bezoars and 3 cases of iatrogenic stenosis).

Clinical presentation included abdominal distension in 97 (49%), vomiting in 125 (63.1%) and peritoneal signs in 38 (19.2%) patients. If signs of peritonitis were present a surgical treatment was chosen ($p = 0.033$), without any difference in the type of approach ($p = 0.561$), nor any association with conversion in the minimally invasive group ($p = 0.271$).

Based upon our internal protocols, a plain abdominal X-ray was performed in 83.3% and a CT scan in 88.9% of patients. One-hundred and forty-six patients underwent both diagnostic exams. 152 patients (87.4%) had a transition point on CT scan, defined as an internal hernia or as a sudden change in bowel diameter. 142 (81.6%) had a backward distension suggesting the suspicion of an open-loop obstruction. Peritoneal fluid was seen in 62 (35.6%) cases; 26 (14.9%) had signs of suspected ischemia. We opted for surgery in patients with suspected ischemia on imaging ($p = 0.006$), again without any difference in the type of approach ($p = 0.518$), nor any association with conversion in the minimally invasive group ($p = 0.106$).

NOM was successful in 53 of patients (26.8%), with water soluble contrast study performed in 73.6% of them (39) and failed in 12 cases (22.6%). Among 145 cases surgically treated, 74 (51%) underwent laparoscopy. Table 1 shows the patients' preoperative characteristics (entire sample and subgroups). NOM was adopted more frequently in patients with previous multiple open surgeries and in cases with a small bowel obstruction history. Patients who underwent laparotomy were significantly older and with a higher CCI. In particular, age higher than or equal to 70 years old, likewise major comorbidities – expressed by a CCI greater than or equal to 7 – were associated with open approach ($p < 0.001$ and $p = 0.026$, respectively). Timing of previous abdominal operation, either urgent or elective, did not show any significant difference in the treatment choice ($p = 0.524$). The technique of previous operations, instead, guided the choice of surgical approach for aSBO, with a preference for laparoscopy in patients with a history of minimally invasive surgery ($p = 0.031$). Nonetheless, the number of previous laparotomies was significantly higher in the open group ($p = 0.003$). Multi-operated patients (defined as those with at least three previous laparotomies) were mostly approached with open surgery ($p = 0.043$).

Perioperative outcomes

Table 2 displays intraoperative variables: no differences in intraoperative etiology were found among subgroups. The 29.7% of patients required a resection, which was more frequent in the laparotomic group ($p = 0.012$). The mean operative time was comparable between open and laparoscopic operations ($p = 0.140$). Excluding the cases of conversion from the laparoscopic group, we found a drastic reduction in operative time (81.64 ± 45.95 vs. 141.9 ± 63.6; $p < 0.001$). There was no significant difference in operative time in laparotomic vs. converted group (120.3 ± 61.2 vs. 141.9 ± 63.6; $p = 0.109$). Conversion rate was 41.9% (31). The main reason for conversion was extreme bowel overdistension, strong adherences and intraoperative injuries (35.5%, 22.6%, 22.6% and 6.5% of conversions respectively). In almost all cases of suspected bowel hypoperfusion during laparoscopy, an intestinal resection was performed ($p = 0.002$) and nearly all resections required conversion to open surgery (13 conversions, 41.9%, $p < 0.001$). About converted cohort, we noticed that previous surgery for peritonitis and/or intestinal obstruction significantly related with conversion rate (63.6% of cases converted, $r = 0.296$, $p = 0.012$). Although no significant difference was found, patients with CCI equal or greater than 7 were more frequent in the converted group (62.5% vs. 37.5%, $p = 0.267$). Among intraoperative findings, conversion rate was lower ($p = 0.034$) in cases with abdominal wall hernias causing aSBO. Even if statistical significance was not reached in the comparison of type of adhesions, we observed a higher conversion rate in the complex adhesion cases (62.5% converted in complex adhesions vs. 38.3% in simple ones).

Outcome comparison among types of surgical treatment is shown in Table 3. Minimally invasive approach was associated with a quicker oral intake (3.5 ± 2.1 vs. 4.6 ± 2.9 days; $p = 0.014$) and a shorter length of stay (7.5 ± 5.2 vs. 11.4 ± 8.2 days; $p = 0.001$). No differences in postoperative complications were found ($p = 0.065$ and $p = 0.557$, respectively). A subgroup analysis was performed between open, fully laparoscopic and converted patients (Table 4). In laparoscopic cohort, conversion to open surgery resulted in a higher length of stay (9.4 ± 6.2

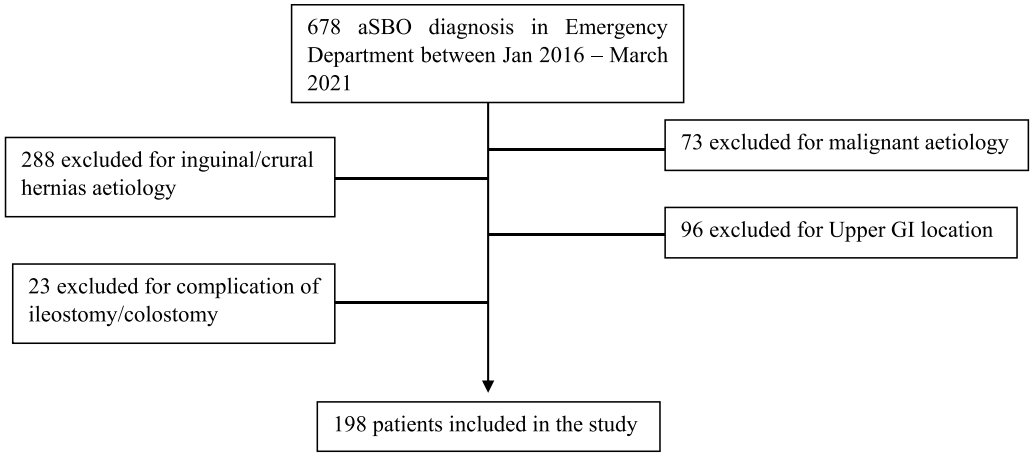

Fig. 1. Cases flowchart according to exclusion criteria.

Table 1
Population characteristics.

	Total ($N = 198$)	NOM ($N = 53$)	Laparotomic ($N = 71$)	Laparoscopic ($N = 74$)	p	p (between surgically treated)
Age	66 ± 16.6	64 ± 17	70.6 ± 15.9	63.4 ± 16.1	*0.018*	*0.007*
Previous abdominal surgery	181 (91.4%)	50 (94.3%)	63 (88.7%)	68 (91.9%)	0.378	
N° previous abdominal operation:						
LPT	1.69 ± 1.09	1.96 ± 1.24	1.7 ± 1.1	1.49 ± 0.93	0.060	*0.003*
LPS	1.29 ± 1.09	1.67 ± 1.26	1.41 ± 1.06	0.92 ± 0.86	*< 0.001*	*0.034*
	0.41 ± 0.75	0.36 ± 0.74	0.3 ± 0.62	0.56 ± 0.85	0.086	
Type of previous abdominal operation:					0.524	
Urgent	93 (47%)	22 (41.5%)	31 (43.7%)	40 (54.2%)		
Elective	32 (16.2)	9 (17%)	11 (15.5%)	12 (16.2%)		
Both	54 (27.3%)	19 (35.8%)	20 (28.2%)	15 (20.3%)		
SBO history	71 (35.9%)	28 (52.8%)	27 (38%)	16 (21.6%)	*0.001*	*0.045*
CCI	3.76 ± 2.97	3.49 ± 3	4.77 ± 3.1	2.99 ± 2.56	*0.001*	*0.046*
ASA	3 (2–3)		3 (3–3)	2 (2–3)		*0.001*
- I	4 (2.8%)		1 (1.4%)	3 (4.1%)		
- II	45 (31%)		14 (19.7%)	31 (41.9%)		
- III	68 (46.9%)		40 (56.3%)	28 (37.8%)		
- IV	11 (7.6%)		10 (14.1%)	1 (1.4%)		
Clinical presentation:	97 (49%)	27 (50.9%)	32 (45.1%)	38 (51.4%)	0.711	
- Abdominal distension	125 (63.1%)	40 (75.5%)	40 (56.3%)	45 (60.8%)	0.080	0.518
- Emesis	38 (19.2%)	4 (7.5%)	15 (21.1%)	19 (25.7%)	*0.033*	
- Peritoneal sings						
Duration of symptoms (hours)	36.9 ± 64.4	37.85 ± 66.9	44.2 ± 83.2	29.6 ± 37.9	0.453	
Surgery timing	20.8 ± 29.5		24.6 ± 34	17.1 ± 24.1		0.126

Table 2
Intraoperative data.

	Total ($N = 145$)	Laparotomic ($N = 71$)	Laparoscopic ($N = 74$)	p overall	p fully laparoscopic/converted vs. open
Surgery timing, hours ± SD	15.2 ± 26.6	26.4 ± 34	17.1 ± 24.1	0.126	
Intraoperative findings, n (%):	69 (47.6)	34 (47.9)	35 (47.3)		
Adhesions	- 53 (76.8)	- 26 (76.5)	- 27 (77.1)	0.393	
- Simple	- 16 (23.2)	- 8 (23.5)	- 8 (22.9)		
- Complex	33 (22.8)24 (16.6)19	13 (18.3)15 (21.1)9	20 (27)9 (12.2)10		
Internal herniasIncisional herinasOther	(13.1)	(12.7)	(13.5)		
Resections, n (%)	43 (29.7)	28 (39.4)	15 (20.3)	*0.012*	
Conversion, n (%)			31 (41.9)		
Operative time, minutes ± SD	112.6 ± 61.59	120.34 ± 61.17	105.23 ± 61.48	0.140	
- Fully laparoscopic			- 81.64 ± 45.95		*< 0.001*
- Converted			- 141.9 ± 63.6		0.109

Table 3
Postoperative outcomes of surgically treated patients.

	Total ($N = 145$)	Laparotomic ($N = 71$)	Laparoscopic ($N = 74$)	p
Complications, n	55 (27.8)	30 (42.3)	21 (28.4)	
(%)	8 (4)	3 (4.2)	5 (6.8)	0.700
CD I	36 (18.2)	21 (29.6)	11 (14.9)	*
CD II	3 (1.5)	0 (0)	3 (4.1)	
CD IIIa	7 (3.5)	5 (7)	2 (2.7)	
CD IIIb	1 (0.5)	1 (1.4)	0 (0)	
CD IV				
Mortality, n (%)	2 (1)	2 (2.8)	0 (0)	0.238
Onset of oral intake, days ± SD	3.64 ± 2.5	4.6 ± 2.9	3.5 ± 2.1	*0.014*
Open bowel, days ± SD	1.9 ± 1.3	2.3 ± 1.3	2 ± 1.3	
- Gas	3 ± 1.9	3.8 ± 2	3.4 ± 1.6	0.173
- Feces				0.171
Reoperation, n (%)	7 (4.8)	5 (7)	2 (2.7)	0.269
Length of stay, days ± SD	7.8 ± 6.8	11.4 ± 8.2	7.5 ± 5.2	*0.001*
Readmission, n (%)	18 (9.1)	3 (4.2)	7 (9.5)	0.327
Relapse, n (%)	24 (12.1)	6 (8.5)	7 (9.5)	0.832

* between major complications (CD ≥ IIIa).

vs. 6.2 ± 3.9 days; $p = 0.010$) and a longer postoperative fasting (4.7 ± 2.3 vs. 2.7 ± 1.5 days; $p < 0.001$), without any differences in time to oral intake, length of stay, postoperative complications, mortality, readmission and relapses if compared with the laparotomic upfront subgroup. From the logistic regression analysis on major complications (CD ≥ IIIa) the only variables associated with a higher risk of complications were history of previous surgery (OR: 24.63, 95% CI: 1.40–434.23, $p = 0.029$) and intestinal resection (OR: 12.41, 95% CI: 1.80–85.60, $p = 0.011$).

A predictive score to support the choice of surgical approach: the SABO score

Based on logistic regression analysis, the most significant preoperative characteristics for the choice of surgical approach were age (greater than or equal to 70 years old) and ASA (greater than or equal to three). Both were associated with a higher probability of open approach (OR: 3.2, 95% CI: 1.4–7.2, $p = 0.006$ and OR: 2.7, 95% CI: 1.1–6.5, $p = 0.023$ respectively). aSBO history presented an OR of 2.2 for open surgery, although was slightly over the statistical significance in the logistic regression. SABO score was computed from these variables and seems to present good performance in predicting surgical approach (AUC: 0.752, $p < 0.001$) (Fig. 2). A SABO score ≥ 0 showed a sensitivity of 75.4%, a specificity of 69.8%, a PPV of 72.1% and a NPV of 73.3% in identifying patients who underwent a laparotomic approach. Fig. 3 shows SABO

Table 4
Postoperative outcomes: comparison of open, fully laparoscopic and converted subgroups.

	Laparotomic (*N* = 71)	Laparoscopic (*N* = 43)	Converted (*N* = 31)	p overall	p open vs. fully laparoscopic	p open vs. converted	p fully laparoscopic vs. converted
Complications,			12 (38.7)	0.700	–	–	–
n (%)	30 (42.3)	9 (20.9)	3 (9.7)				
CD I	3 (4.2)	2(4.7)	6 (19.4)				
CD II	21 (29.6)	5 (11.6)	2 (6.5)				
CD IIIa	0 (0)	1 (2.3)	1 (3.2)				
CD IIIb	5 (7)	1 (2.3)	0 (0)				
CD IV	1 (1.4)	0 (0)					
Mortality, n (%)	2 (2.8)	0	0	0.238	–	–	–
Onset of oral intake, days ± SD	4.6 ± 2.9	2.7 ± 1.5	4.7 ± 2.3	*0.014*	*< 0.001**	0.952	*< 0.001**
Open bowels, days ± SD					–	–	–
- Gas	2.3 ± 1.3	1.7 ± 1.2	2.3 ± 1.4	0.173			
- Feces	3.8 ± 2	3.1 ± 1.5	3.7 ± 1.8	0.171			
Reoperation, n (%)	5 (7)	1 (2.3)	1 (3.2)	0.269	–	–	–
Length of stay, days ± SD	11.4 ± 8.2	6.2 ± 3.9	9.4 ± 6.2	*0.001*	*< 0.001**	0.230	*0.020**
Readmission, n (%)	3 (4.2)	3 (7)	4 (12.9)	0.327	–	–	–
Relapse, n (%)	6 (8.5)	3 (7)	4 (12.9)	1	–	–	–

* p values adjusted for multiple comparisons with Holm correction.

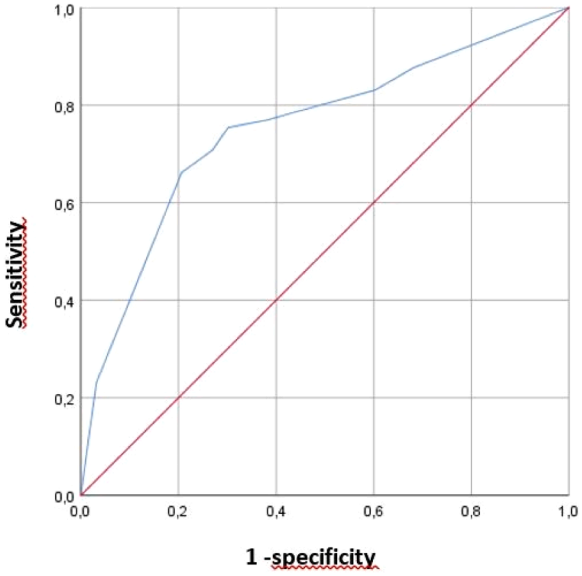

Fig. 2. Receiver Operating Characteristic (ROC) curve analysis to assess the discriminative ability of the SABO score *Caption: AUC: 0.752, p < 0.001.*

score distribution in laparotomic vs. laparoscopic subgroups. Sixteen patients (22.5%) of the open subgroup had a SABO score < 0 – definable as false negative of the score – and we noticed they had a lower age (52.1 ± 11.9 vs. 77.7 ± 9.9, $p < 0.001$), a lower ASA (2, IQR: 2–2.75 vs. 3, IQR: 3–3, $p < 0.001$) and a lower CCI (1, IQR: 0–2.75 vs. 6, IQR: 5–7, $p < 0.001$) if compared to the rest of the subgroup.

Discussion

As adhesions are caused by previous abdominal surgery, surgical treatment of aSBO may seem a paradox. Successful conservative treatment may leave adhesions that could cause recurrence, but surgery may be the source of new adhesions [19]. Trying to solve this dilemma, we rely on clinical severity and operate only in case of NOM failure, or in high suspicion of intestinal hypoperfusion. Considering the total number of patients admitted for aSBO in the study period (678), according to literature around 203 of them should be candidate for surgery, which is not far from our surgical population. If saying so might assume that we have excluded most NOM patients, advocating a selection bias, we cannot confirm such numbers, since those patients were excluded from the analysis ab initio. About half of the surgically treated patients underwent laparoscopy. Open surgery was preferred in the elderly (age ≥ 70 years old), in the sicker (CCI ≥ 7) or those ones with a history of multiple previous laparotomies (especially more than 3). Otherwise, patients with a history of laparoscopic surgery mostly underwent a

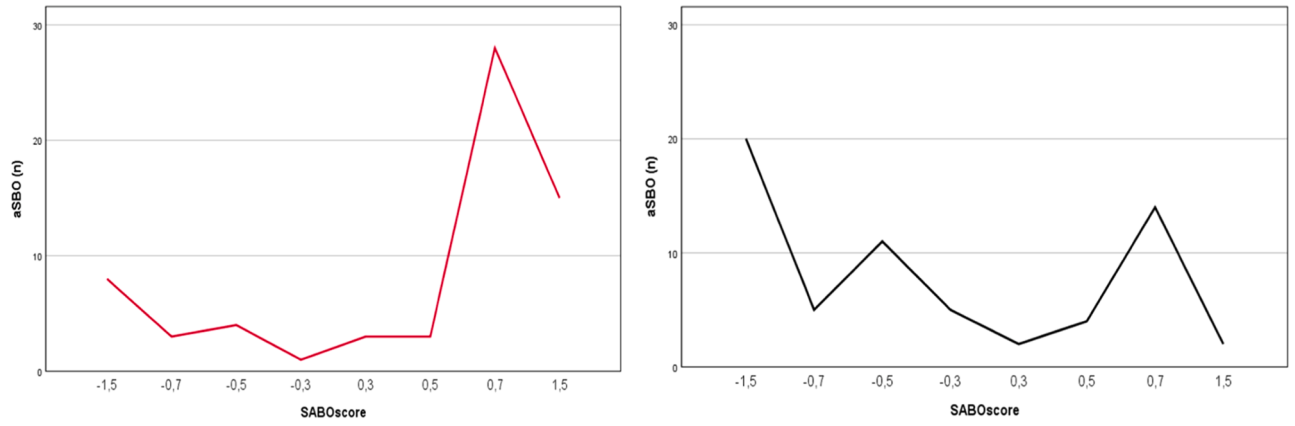

Fig. 3. SABO score distribution among laparotomic vs. minimally invasive subgroups. *Caption: The graphic on the left (red) shows SABO score distribution in laparotomic subgroup, the graphic on the right (black) shows SABO score distribution in laparoscopic subgroup.*

minimally invasive approach. Signs of peritonitis as well as suspected ischemia on imaging did not influence the type of surgical approach, nor were related to a higher conversion rate in the laparoscopic subgroup. Laparotomy is still considered the standard operative approach in aSBO treatment [2,4] even if the growing application of minimally invasive surgery in emergency settings is crossing the frontiers of intestinal obstruction disease. Conversion rate is expectably high because of the working space reduction and increased fragility caused by bowel distension, but conversion without iatrogenic injury should not be considered a failure [15,20]. Dindo et al. [21] suggested that the reason for conversion could affect morbidity. They concluded that only reactive conversion, following iatrogenic injury with bowel perforation and bleeding, was an independent risk factor for postoperative morbidity. The main reason for conversion in our study was bowel hypoperfusion, followed by extreme bowel overdistension and strong adherences. Reactive conversions due to intraoperative injuries occurred in 6.5%, even a lower rate if compared to others [20–22]. We found that a history of previous peritonitis and/or intestinal obstruction was related with a higher conversion rate; however, we observed no differences in operative time nor postoperative complications between converted and laparotomic upfront cases, adding reliability to our hypothesis that laparoscopic approach is a safe and feasible option in aSBO treatment. Furthermore, laparoscopy was related to a faster restoration of patients' physiological balance and a shorter length of stay [23,24]. Some Authors [25–27] demonstrated laparoscopy to even reduce relapse rate. Di Saverio et al. [9] and Behman R et al. [28], proposed some inclusion and exclusion criteria of laparoscopic adhesiolysis, focusing on adhesive small bowel obstruction and ruling out all the other possible aetiologies. The LASSO trial [23] proved that a laparoscopic approach is safe and feasible when a single band aSBO is highly suspected. With the present study we would like to expand laparoscopic indications in aSBO to most small bowel obstruction with benign etiologies. In this emergency setting conversion should be considered relatively common, understanding that it would not be deleterious to patient outcomes. From the multivariate analysis on major complications only a history of previous surgery and the need for intestinal resection were associated with a higher risk of complications [14,21]; the width of CI on this regression could be explained by the small number of events, with 6 major complications in the open and 2 in the laparoscopic subgroup. A wider sample should be analyzed to confirm these results. Surgeons should incorporate this minimally invasive mindset, leaving the laparotomic approach for only the most complex cases. Patient selection remains the crucial step in choosing the correct surgical approach. Using a multivariable predictive model, we built the SABO score to help identify patients in which an open approach could be preferred, with an acceptable accuracy. Certainly, a retrospective study is not the best design to obtain such a tool; in fact, our score does not perform well enough to be applied in common clinical practice. Anyway, from the analysis of the false negative we observed that those with a SABO $<$ 0 that underwent to open surgery had preoperative features more like the minimally invasive ones. Clearly, we would never know if a laparoscopic to completion procedure would have been successful on them. For all these reasons we are willing to conduct a prospective analysis to improve our results.

The main limitation of our work lays in its retrospective nature, based upon a small sample from a single center analysis. The heterogeneity of our population brought power and weakness to the study: on the one hand it allowed us to generalize our results to the overall aSBO population, on the other it reduced the strength of our findings by fragmenting our already small number of patients. Surgeons were all from the same team, even though with different laparoscopic skills; an internal protocol, anyway, requires conversion in case of resection. This technical strategy clearly influenced our conversion rate but can only increase the value of laparoscopy in aSBO, since conversions are expected to be even less if minimally invasive resections are performed. SABO, like all scores, creates a cut-off on the edge of which there are clearly doubtful cases. The objective is to try to identify the potentially correct approach. Nevertheless, we do not consider it is mandatory to strictly follow the score in such cases, and nothing prevents the surgeon from trying a laparoscopic approach if deemed potentially effective. The SABO score should be seen as a forerunner of a better predictive score. Future studies are awaited to validate and improve this rudimentary tool.

Conclusions

Our study supports the safety and feasibility of the laparoscopic approach in the treatment of aSBO, with no fear of conversion. In our experience, we preferred an open approach in selected patients: older, with more comorbidity and/or with a history of previous aSBO. On the one hand, with the growth of laparoscopic skills, even these cases could have a minimally invasive indication; on the other, such open approach-related variables led us to create the SABO score in order to predict when a laparoscopic approach could be associated with a lower success rate. Tools like the SABO score, albeit immature, might help in the often-tricky decision-making process of complex cases of aSBO.

Data availability

Data for the current study is owned by the Department of General and Emergency Surgery- San Raffaele Hospital, Milan, Italy - and may be requested to the corresponding author.

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Conflicts of interest/disclosure

The authors have no relevant financial disclosures.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sipas.2023.100213.

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