Annals of Medicine and Surgery 16 (2017) 34–39

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.annalsjournal.com

A retrospective study of laparoscopic surgery for small bowel obstruction

Kensuke Otani*, Soichiro Ishihara, Hiroaki Nozawa, Kazushige Kawai, Keisuke Hata, Tomomichi Kiyomatsu, Toshiaki Tanaka, Takeshi Nishikawa, Koji Yasuda, Kazuhito Sasaki, Koji Murono, Toshiaki Watanabe

Department of Surgical Oncology, The University of Tokyo, Japan

HIGHLIGHTS

- Surgical treatment for small bowel obstruction in 48 patients were retrospectively reviewed.
- Laparoscopic surgery was performed in 14 patients, and 4 cases were converted to open surgery.
- Laparoscopic surgery is less invasive than open surgery and is equally feasible in selected patients.
- Band occlusion may be a preferable indication to laparoscopic surgery.

ARTICLE INFO

Article history:
Received 12 October 2016
Received in revised form
25 February 2017
Accepted 25 February 2017

Keywords:
Small bowel obstruction
Laparoscopic surgery
Retrospective study

ABSTRACT

Background: Open laparotomy is widely accepted as the standard surgical treatment for small bowel obstruction (SBO). However, laparoscopic surgery has recently become a treatment option. There is no consensus on the appropriate settings for the laparoscopic treatment of SBO. The purpose of this study is to evaluate the outcomes of laparoscopic surgery for SBO.

Patients and methods: From January 2012 to May 2016, 48 consecutive patients underwent surgical treatment for SBO in our department. We retrospectively reviewed these cases and compared the features and the outcomes between laparoscopic and open surgery.

Results: Thirty-four and 14 patients underwent open surgery and laparoscopic surgery, respectively. Four of the laparoscopic cases (28.6%) were converted to open surgery. Laparoscopic surgery tended to be associated with a shorter operative time than open surgery ($p = 0.066$). The first postoperative oral intake was significantly earlier in patients who underwent laparoscopic surgery ($p = 0.044$). The duration of hospitalization after surgery and the rates of postoperative complications did not differ to a statistically significant extent. Laparoscopic treatment was accomplished in 7 out of 8 cases (87.5%) with SBO due to band occlusion.

Conclusion: Laparoscopic surgery for SBO is less invasive than open surgery and is equally feasible in selected patients. SBO due to band occlusion may be a preferable indication for laparoscopic surgery. In order to confirm the safety of laparoscopic treatment, and to clarify the appropriate settings for laparoscopic surgery for SBO, it will be necessary to perform further studies in a larger population and with a long follow-up period.

1. Introduction

Small bowel obstruction (SBO) is one of the most common causes of hospital admission for acute abdominal pain. The most frequent etiology, adhesion due to previous laparotomy, is responsible for 65–80% of SBO cases [1–3]. The incidence of adhesive SBO after laparotomy has been estimated to be 12–17% [4–6]. Moreover, open laparotomy treatment for SBO is associated with postoperative adhesion and the recurrence of SBO. Open laparotomy is widely accepted as the standard approach for SBO in patients in whom conservative treatment fails or who present symptoms that suggest a clinical and physiological emergency such as toxemia or ischemia.

* Corresponding author. Department of Surgical Oncology, The University of Tokyo, Hongo7-3-1, Bunkyo-ku, Tokyo, 113-8655, Japan.
E-mail address: otanik-sur@h.u-tokyo.ac.jp (K. Otani).

http://dx.doi.org/10.1016/j.amsu.2017.02.045

Laparoscopy has taken the place of traditional laparotomy as an elective treatment for a number of conditions. It is associated with a lower rate of morbidity and shorter hospitalization. As laparoscopic surgery is becoming a treatment option in emergency surgery for acute cholecystitis, acute appendicitis, and peptic ulcer perforation, SBO could be a candidate for adaptation to laparoscopic surgery.

Bastug et al. first reported the successful performance of laparoscopic adhesiolysis in 1991 [7]. Since then, the laparoscopic approach to SBO has been expanded and carefully investigated. SBO was previously considered to be a contraindication to laparoscopic surgery because of the narrow working space and difficulties in manipulating the dilated bowel loops, which increase the risk of enterotomy. In these two decades, several cohort studies have shown that the laparoscopic approach has advantages over open laparotomy, including reduced pain, faster recovery, and reduced morbidity [3,8–13]. Moreover, laparoscopy is thought to be associated with a reduced incidence of postoperative adhesion in comparison to laparotomy [8,14,15], and the laparoscopic approach has been shown to significantly reduce the incidence of SBO in comparison to laparotomy [16]. Thus, the laparoscopic approach to SBO is an attractive alternative to laparotomy.

In surgery for SBO, the open and laparoscopic approaches have their own advantages and disadvantages. When deciding the surgical approach, the condition of the patient and the complexity of the procedure must be considered. There is no consensus on the appropriate settings for laparoscopic surgery. The purpose of this study is to evaluate the outcomes of laparoscopic surgery for SBO.

2. Patients and methods

This retrospective study is a case series performed in single center. From January 2012 to May 2016, 48 consecutive patients underwent surgery for SBO in our department. Conventional open surgery and laparoscopic surgery were performed in 34 and 14 cases respectively. Four of the 14 patients who underwent laparoscopic surgery required conversion to open laparotomy. The clinical features and short-term outcomes of the patients who underwent laparoscopic surgery were retrospectively compared with those of the patients who underwent open surgery. We also compared the clinical features of the converted cases and the cases in which laparoscopic surgery was accomplished.

In deciding the surgical approach, the condition of the patient, the surgeon's experience and preference, and the complexity of the procedure were considered. Among laparoscopic cases, an extended port site short incision was made in 6 patients for intestinal resection, anastomosis and to check the bowel. In these cases, laparoscopic surgery was considered to have been accomplished. With regard to the etiology of SBO, band obstruction was considered independent from adhesion in the present analysis, because the complexity of the surgical procedure for releasing the band is generally very different from adhesiolysis. The diameter of the small bowel was measured by CT or a small bowel series taken just before surgery. Postoperative complications that were greater than class II (according to the Clavien-Dindo classification) were taken into account.

The categorical data were compared using the chi-squared test and Fisher's exact test. Continuous variables were compared using the Mann-Whitney *U* test. The statistical analyses were performed using the JMP software program (version 12.0 SAS Institute Inc., Cary, NC, USA). P values of <0.05 were considered to indicate statistical significance.

The study protocol was approved by the local ethics committees of the University of Tokyo (reference number: 3252-(1)), which thus met the standards of the Declaration of Helsinki in its revised version of 1975 and its amendments of 1983, 1989 and 1996. Written informed consent was obtained from all of the patients. This work has been reported in line with the PROCESS criteria [17].

3. Results

We experienced 48 consecutive SBO patients who underwent surgical treatment. The patients' demographic characteristics and clinical features are summarized in Table 1. Forty-two patients (87.5%) had previous abdominal surgery; among them, 19 (39.6%) had colorectal surgery, 15 (31.3%) had appendectomy, 11 (22.9%) had gastro-duodenal surgery, and 5 (10.4%) had gynecological surgery (including overlap patients). Only 1 patient (2.1%) had previously undergone surgery for SBO. Preoperative decompression of the bowel was performed in 41 patients (85.4%), 27 (56.3%) underwent the insertion of an ileus tube and 14 (29.2%) underwent insertion of a nasal-gastric tube. Surgical treatment was performed in an emergency setting in 31 patients (64.6%), and electively in 17 patients (35.4%). The duration between admission and surgery was 0–1 days in patients who needed emergency surgical treatment; other patients had conservative treatment first. The median duration before surgery was 9 days (range, 0–103 days).

In the present study, 34 patients (70.8%) underwent open surgery and 14 (29.2%) patients underwent laparoscopic surgery. Laparoscopic surgery was accomplished in 10 patients (71.4%); the remaining 4 (28.6%) were converted to open surgery. According to the intraoperative diagnosis, the etiologies of SBO were as follows: band occlusion (n = 13; 27.1%), adhesion (n = 11; 22.9%), neoplasm (n = 12; 25.0%), abdominal wall hernia (n = 5; 10.4%), internal hernia (n = 5; 10.4%), volvulus (n = 1; 2.1%), and intussusception

Table 1
The demographic characteristics and clinical features of the patients.

Age (years)		72 (37–95)
Sex	Male	25 (52.1%)
	Female	23 (47.9%)
Previous abdominal surgery	Yes	42 (87.5%)
Preoperative decompression	Ileus tube	27 (56.3%)
	Nasal-gastric tube	14 (29.2%)
	No	7 (14.5%)
Duration before surgery (days)		9 (0–103)
Surgery	Emergency	31 (64.6%)
	Elective	17 (35.4%)
Approach	Open	34 (70.8%)
	Laparoscopic	14 (29.2%)
	Accomplished	10 (20.8%)
	Converted	4 (8.3%)
Etiology of obstruction	Band	13 (27.1%)
	Adhesion	11 (22.9%)
	Neoplasm	12 (25.0%)
	Abdominal wall hernia	5 (10.4%)
	Internal hernia	5 (10.4%)
	Volvulus	1 (2.1%)
	Intussusception	1 (2.1%)
Intestinal resection	Yes	19 (39.6%)
Complication	Yes	13 (27.1%)
	Wound infection	5 (10.4%)
(Duplication included)	Aspiration pneumonia	3 (6.3%)
	Recurrence of obstruction	3 (6.3%)
	Interstitial pneumonia	1 (2.1%)
	Others	6 (12.5%)
Hospitalization after surgery (days)		21 (6–154)
Follow-up time (months)		8.5 (0.5–52.1)

The total number of patients was 48. The age, duration before surgery, hospitalization after surgery and follow-up time are shown as the median (range). The other data are shown as the number of patients. Postoperative complications that were greater than class II (according to the Clavien-Dindo classification) were taken in account. The data on the number of complications included duplications.

Table 2
The preoperative characteristics of the patients.

		Laparoscopic (n = 14)	Open (n = 34)	p value
Age (years)		71 (39–95)	72 (37–95)	0.856
Sex	Male	8 (57.1%)	17 (50.0%)	0.756
	Female	6 (42.9%)	17 (50.0%)	
Strangulation (CT)	Yes	5 (35.7%)	14 (41.2%)	1.000
Ascites (CT)	Yes	7 (50.0%)	23 (67.6%)	0.330
Surgery	Emergency	9 (64.3%)	22 (64.7%)	1.000
	Elective	5 (35.7%)	12 (35.3%)	
Duration before surgery (days)		12 (0–30)	3 (0–103)	0.620
Preoperative decompression	Ileus tube	10 (71.4%)	17 (50.0%)	0.292
	Nasal-gastric tube	0 (0.0%)	14 (41.2%)	
	No	4 (28.6%)	3 (8.8%)	
Previous abdominal surgery	Yes	12 (85.7%)	30 (88.2%)	1.000

The age and duration before surgery are shown as the median (range). The other data are shown as the number of patients. Fourteen patients were initially treated via a laparoscopic approach, 34 were treated via an open approach. Strangulation and ascites were diagnosed based on the preoperative CT findings.

(n = 1; 2.1%). Intestinal resection was performed in 19 patients (39.6%). Postoperative complications occurred in 13 patients (27.1%) and 1 patient (2.1%) who underwent open adhesiolysis died with an acute exacerbation of interstitial pneumonia on the 16th day after surgery.

Table 2 shows the preoperative data of the patients who underwent open and laparoscopic surgery. Surgery was initiated with a laparoscopic approach in 14 patients (29.2%) and open approach in 34 patients (70.8%). There was no difference between the two procedures of approach. A laparoscopic approach was selected for patients in whom strangulation (n = 5) or ascites (n = 7) was detected on CT. Preoperative decompression was not underwent in 4 patients with laparoscopic approach. Nine of the laparoscopic surgeries were performed in an emergency setting; 4 were performed without preoperative bowel decompression.

In the course of laparoscopic surgery, 4 patients (28.6%) were converted to open surgery. The reasons for conversion were difficulty in understanding the arrangement of the bowel, dense adhesion and to prevention injury to the dilated bowel. There were no cases of iatrogenic organ injury. The clinical features of the patients who required conversion and those who did not are shown in Table 3. There were no differences between the two groups. In the laparoscopic surgery group, there were 8 cases in which SBO was caused by band obstruction. Laparoscopic surgery was accomplished in 7 (87.5%) of these cases; only 1 patient (12.5%) required conversion. Preoperative bowel decompression, the number of port sites and intraoperative findings of strangulation or intestinal resection were not the factors of conversion. In the 4 converted cases, the laparoscopic operation time to conversion was 11–54 min (mean, 35.8 min).

Finally, after excluding the 4 converted patients, laparoscopic surgery was accomplished in 10 patients (71.4%). Table 4 compares the 10 patients in whom laparoscopic surgery was accomplished and the 38 patients who underwent open surgery. Previous abdominal surgery was not associated with the procedure for SBO. The operative time of laparoscopic surgery (96.0 ± 53.0 min) tended to be shorter than that of open surgery (148.6 ± 84.5 min, p = 0.066). Cases of SBO with strangulation were treated with open surgery significantly more frequently than laparoscopic surgery (p = 0.044). Intestinal resection was performed by both procedures with no deviation. The first postoperative oral intake in the laparoscopic surgery group (mean, 4.5 days) was significantly earlier than that in the open surgery group (mean, 6 days; p = 0.044). The duration of hospitalization after surgery and the postoperative complication rate did not differ between the two groups. In the short follow-up period (median, 8.5 months; range, 0.5–52.1

Table 3
The clinical features of the patients in whom laparoscopic surgery was accomplished and those who underwent conversion to open surgery.

		Converted (n = 4)	Accomplished (n = 10)	p value
Age (years)		72 (44–95)	71 (39–87)	0.671
Sex	Male	2 (50.0%)	6 (60.0%)	1.000
	Female	2 (50.0%)	4 (60.0%)	
Duration before surgery (days)		7 (0–24)	14 (0–30)	0.519
Preoperative decompression	Ileus tube	2 (50.0%)	8 (80.0%)	0.521
Diameter of the small bowel (cm)		3.3 ± 0.2	3.4 ± 0.8	0.832
Previous abdominal surgery	Yes	3 (75.0%)	9 (90.0%)	0.506
Surgery	Emergency	3 (75.0%)	6 (60.0%)	1.000
	Elective	1 (25.0%)	4 (40.0%)	
Number of port sites	1	1 (25.0%)	0 (0.0%)	0.822
	3	0 (0.0%)	3 (30.0%)	
	4	2 (50.0%)	4 (40.0%)	
	5	1 (25.0%)	3 (30.0%)	
Cause of obstruction	Band	1 (25.0%)	7 (70.0%)	N/A
	Adhesion	1 (25.0%)	0 (0.0%)	
	Neoplasm	1 (25.0%)	2 (20.0%)	
	Internal hernia	1 (25.0%)	1 (10.0%)	
Strangulation	Yes	1 (25.0%)	1 (10.0%)	0.506
Intestinal resection	Yes	1 (25.0%)	2 (20.0%)	1.000

The age and duration before surgery are shown as the median (range); the diameter of the bowel is shown as the mean ± S.D. The other data are shown as the number of patients. Laparoscopic surgery was converted to open surgery in 4 cases, and was accomplished in 10. Strangulation was diagnosed based on the intraoperative findings. The p value for the cause of obstruction was not available.

Table 4
Clinical features of the patients with laparoscopic surgery and open surgery.

		Laparoscopic (n = 10)	Open (n = 38)	p value
Previous abdominal surgery	Yes	9 (90.0%)	33 (86.8%)	1.000
Operative time (min)		96.0 ± 53.0	148.6 ± 84.5	0.066
Strangulation	Yes	1 (10.0%)	17 (44.7%)	0.044*
Intestinal resection	Yes	2 (20.0%)	17 (44.7%)	0.276
The first postoperative oral intake (day)		4.5 (2–7)	6 (2–19)	0.044*
Hospitalization after surgery (days)		14.5 (6–40)	22 (7–154)	0.217
Complication	Yes	2 (20.0%)	11 (28.9%)	0.706
	Wound infection	1 (10.0%)	4 (10.5%)	
(Duplication included)	Aspiration pneumonia	0 (0.0%)	3 (7.9%)	
	Recurrence of obstruction	1 (10.0%)	2 (5.3%)	
	Interstitial pneumonia	0 (0.0%)	1 (2.6%)	
	Others	1 (10.0%)	5 (13.2%)	
Recurrence of obstruction	Yes	1 (10.0%)	8 (21.1%)	0.661

The first postoperative oral intake and hospitalization after surgery are shown as the median (range); the operative time is shown as the mean ± S.D. The other data are shown as the number of patients. Ten patients underwent laparoscopic surgery, 38 underwent open surgery. Strangulation was diagnosed based on the intraoperative findings. Postoperative complications that were greater than class II (according to the Clavien-Dindo classification) were taken in account. The data on the number of complications included duplications. Asterisks indicate statistically significant values ($p < 0.05$).

months), we found no difference between the two groups with regard to the rate of recurrence.

4. Discussion

In this study, we retrospectively reviewed the preliminary experience in the surgical treatment of SBO in our department, and compared the features and outcomes of patients who underwent treatment with laparoscopic and open surgery. We found that laparoscopic surgery for SBO is less invasive than open surgery and is equally feasible in selected patients. In our department, laparoscopic colorectal surgery was introduced in 2012, when it replaced traditional open surgery to become the standard treatment for colorectal cancer. Recently, we began to use laparoscopic surgery to treat SBO.

In the initial treatment of adhesive SBO, conservative management is performed; this involves decompressing the intra-bowel lumen by inserting a long or short tube. SBO can be treated conservatively in up to 90% patients without signs of strangulation or peritonitis [18]. On the other hand, emergency surgery must be performed when SBO is accompanied by strangulation.

In the early 2000s, several authors suggested that laparoscopic surgery may be inadequate for achieving adhesiolysis in patients with SBO because it might be associated with a higher risk of iatrogenic injury than conventional laparotomy [14,19–22]. However, the results of laparoscopic surgery for SBO showed improvement in the late 2000s, reflecting increased experience and expertise. Laparoscopic surgery for SBO appears to be feasible and safe when performed by trained surgeons who are usually engaged in elective laparoscopic surgery. However, there is no consensus on the selection of patients for laparoscopic surgery, and laparotomy remains the standard approach to SBO. In addition to the progression of laparoscopic equipment, advanced laparoscopic surgery training has made laparoscopic adhesiolysis an option in the surgical treatment of SBO. In the United States, 11.4% of SBO patients underwent laparoscopic surgery in 2008 [23]; another report showed that the rate increased to 14.9% in 2014 [24]. Mancini et al. suggested that when laparoscopic adhesiolysis is applied to selected patients with SBO, there are reductions in the incidence of postoperative complications, length of stay, and cost [23]. Sajid et al. conducted a systematic review comparing laparoscopic adhesiolysis to open adhesiolysis in patients with adhesional SBO [25]. They revealed that laparoscopic adhesiolysis reduced the risk of morbidity, mortality, and surgical infections, while shortening the hospitalization period. However, the operative time and the incidence of iatrogenic enterotomy were not reduced. Other previously published systematic reviews [26,27] also showed the benefit of laparoscopic surgery for SBO. They demonstrated that laparoscopic adhesiolysis is safe and feasible in patients with SBO. In the present study, laparoscopic approach was performed in 29.2%. Laparoscopic surgery was introduced in our department in 2012, and the first laparoscopic surgery for SBO was performed in February 2014. Since 2014, SBO was performed via a laparoscopic approach in 50% (14/28) of the cases in our department. We showed that the operative time of laparoscopic surgery tended to be shorter than that of open surgery ($p = 0.066$). The first postoperative oral intake in patients who underwent laparoscopic surgery was significantly earlier than that in patients who underwent open surgery ($p = 0.044$). The duration of hospitalization after surgery and the postoperative complication rate did not differ to a statistically significant extent. These results show that laparoscopic surgery for SBO is less invasive and equally feasible to open surgery. SBO caused by band occlusion may be a preferable indication to laparoscopic surgery. In our cases, laparoscopic surgery was accomplished in 7 out of the 8 (87.5%) patients who were treated for band occlusion. With regard to strangulation, 5 out of 19 patients who were diagnosed with strangulation based on the preoperative CT findings underwent surgery via a laparoscopic approach. Among the 5 patients, only 2 were diagnosed with strangulation based on the intraoperative findings; 1 patient was converted to open surgery. Finally, strangulation was found in 18 patients, only 1 (5.6%) of whom was treated by laparoscopic surgery. The indication for laparoscopic surgery in SBO patients with strangulation might be controversial. Sallinen et al. warned that previous retrospective studies have a selection bias because the easiest cases are selected for laparoscopic surgery, and conducted a multicenter prospective randomized controlled trial [28].

Other than adhesion, the etiologies of SBO include (but are not limited to) hernia, malignancy, Crohn's disease, volvulus, and gallstone ileus. In most cases of SBO caused by internal hernia, incarceration of abdominal wall hernia, mesenteric torsion or neoplasms, conservative treatment fails and surgical treatment is required. Yao et al. described the laparoscopic management of SBO of various etiologies, and concluded that the laparoscopic approach was safe and effective, especially in patients with isolated bands, simple enteral angulation and foreign bodies or tumors [29]. There are not enough reports on the successful reduction of internal hernias by laparoscopic surgery [30,31]. In the present study, we experienced one case in which a patient with an internal hernia was initially treated via a laparoscopic approach. However, in order

to avoid damaging the dilated bowel, the case was converted to open surgery.

During laparoscopic surgery for SBO, the surgeon faces concerns with regard to the possibility of iatrogenic organ injury and difficulties in bowel manipulation, which may lead to conversion to open surgery. Several studies have reported that the laparoscopic approach did not increase the risk of iatrogenic bowel injury in comparison to open surgery [14,27,32]. Recent reports have shown the rate of conversion to be 10–39% [24,33–36]. Two reviews showed that the laparoscopic surgery for SBO was completed in 55% [37] and 64% [3] of cases, with conversion rates of 33.5% and 29%, respectively. The common cause for conversion to laparotomy is the inability to maintain a field of vision and to control the operative field to allow for the safe and effective handling of the dilated loops of bowel. Previous reports pointed out that, extensive dense and matted adhesion, patients who have undergone more two laparotomies, the need for intestinal resection, bowel distention with a diameter of more than 4 cm, iatrogenic bowel injury, hernias, and neoplastic obstruction are the factors for conversion [20,21,32,37,38]. In our study, the conversion rate was 28.6%, and the reasons for conversion included difficulty in understanding the arrangement of the bowel, dense adhesion, and to protect the dilated bowel from injury. The decision to convert to open surgery was made after a mean of 35.8 min. The diameter of the small bowel and the preoperative decompression of the bowel were not associated with conversion.

The laparoscopic approach does not necessarily fail when conversion is needed, because the laparoscopic approach is also useful in intra-abdominal detection. In the process of detecting the cause of obstruction and in performing surgical treatment by laparoscopy, the surgeon must select the safest and most effective method at all times. Conversion is an option for accomplishing the surgical treatment. Morbidity after conversion is equal to that after primary laparotomy [39,40]. However, the reason for conversion may affect morbidity; that is, early conversion due to poor visibility or dense adhesion are associated with significantly lower rates of morbidity than reactive conversions due to iatrogenic bowel injury [41]. In our study, there were no cases of iatrogenic organ injury. In laparoscopic surgery, we deliberately introduced the first trocar in the open method, while the other remaining trocars were inserted under laparoscopic vision. Under laparoscopy, when faced with difficult adhesion or access, we did not hesitate to convert. Wang et al. reported their experience of 46 patients with recurrent adhesive SBO and noted that there were no cases of intraoperative bowel injury, and suggested that this was probably because of their early laparoscopic intervention and meticulous atraumatic technique for handling the dilated and edematous bowel during adhesiolysis [42]. In our present report, the rates of complications did not differ between patients who underwent laparoscopic surgery and those who underwent open surgery.

The results of the present study are generally consistent with previous reports, which have indicated that laparoscopic surgery for SBO is as safe and feasible as open surgery. Conversions are necessary in some cases. The outcomes of laparoscopic surgery were not inferior. Based on the results of our preliminary study, a laparoscopic approach may be used in the surgical treatment of SBO patients with band occlusion without strangulation or dense adhesion. The present study is associated with some limitations, including its small size, retrospective nature, and short follow-up time. In order to confirm the safety of laparoscopic surgery for SBO, and to clarify the settings in which laparoscopic surgery is appropriate in the treatment of SBO, it will be necessary to perform further studies in larger numbers of patients with a long follow-up period, and a randomized control study must be undertaken.

5. Conclusions

Laparoscopic surgery for SBO can be safely performed in selected patients, and band occlusion may be a good indication for this procedure. However, the indications for laparoscopic surgery in cases involving strangulation still remain controversial.

Ethical approval

The study protocol was approved by the local ethics committees of the University of Tokyo, and the reference number is 3252-(1).

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution

Please specify the contribution of each author to the paper, eg study concept or design, data collection, data analysis or interpretation, writing the paper, others, who have contributed in other ways should be listed as contributors.

K. Otani; study design, data collection, data analysis, writing, drafting.
S. Ishihara; study design, data collection, data analysis, drafting.
H. Nozawa; data collection, data analysis, drafting.
K. Kawai; data collection, data analysis, drafting.
K. Hata; data collection, data analysis, drafting.
T. Kiyomatsu; data collection, drafting.
T. Tanaka; data collection, drafting.
T. Nishikawa; data collection, drafting.
K. Yasuda; data collection, drafting.
K. Sasaki; data collection, drafting.
K. Murono; data collection, drafting.
T. Watanabe; study design, drafting.

Conflicts of interest

All the authors have no conflicts of interest.

Researcher registration unique identifying number (UIN)

researchregistry 1568.

Guarantor

Kensuke Otani.

Consent

Studies on patients or volunteers require ethics committee approval and fully informed written consent which should be documented in the paper.

Authors must obtain written and signed consent to publish a case report from the patient (or, where applicable, the patient's guardian or next of kin) prior to submission. We ask Authors to confirm as part of the submission process that such consent has been obtained, and the manuscript must include a statement to this effect in a consent section at the end of the manuscript, as follows: “Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request”.

Patients have a right to privacy. Patients' and volunteers' names, initials, or hospital numbers should not be used. Images of patients or volunteers should not be used unless the information is essential for scientific purposes and explicit permission has been given as part of the consent. If such consent is made subject to any conditions, the Editor in Chief must be made aware of all such conditions.

Even where consent has been given, identifying details should be omitted if they are not essential. If identifying characteristics are altered to protect anonymity, such as in genetic pedigrees, authors should provide assurance that alterations do not distort scientific meaning and editors should so note.

Written informed consent was obtained from all of the patients, and this statement was documented in the article.

References

[1] I. Tierris, C. Mavrantonis, C. Stratoulias, G. Panousis, A. Mpetsou, N. Kalochristianakis, Laparoscopy for acute small bowel obstruction: indication or contraindication? Surg. Endosc. 25 (2011) 531–535.

[2] N. Vettoretto, A. Carrara, A. Corradi, G. De Vivo, L. Lazzaro, L. Ricciardelli, F. Agresta, C. Amodio, C. Bergamini, G. Borzellino, M. Catani, D. Cavaliere, R. Cirocchi, S. Gemini, A. Mirabella, N. Palasciano, D. Piazza, M. Piccoli, M. Rigamonti, M. Scatizzi, E. Tamborrino, M. Zago, Laparoscopic adhesiolysis: consensus conference guidelines, Colorectal Dis. 14 (2012) e208–e215.

[3] D.B. O'Connor, D.C. Winter, The role of laparoscopy in the management of acute small-bowel obstruction: a review of over 2,000 cases, Surg. Endosc. 26 (2012) 12–17.

[4] H. Ellis, B.J. Moran, J.N. Thompson, M.C. Parker, M.S. Wilson, D. Menzies, A. McGuire, A.M. Lower, R.J. Hawthorn, F. O'Brien, S. Buchan, A.M. Crowe, Adhesion-related hospital readmissions after abdominal and pelvic surgery: a retrospective cohort study, Lancet 353 (1999) 1476–1480.

[5] D.E. Beck, F.G. Opelka, H.R. Bailey, S.M. Rauh, C.L. Pashos, Incidence of small-bowel obstruction and adhesiolysis after open colorectal and general surgery, Dis. Colon Rectum 42 (1999) 241–248.

[6] M.R. Cox, I.F. Gunn, M.C. Eastman, R.F. Hunt, A.W. Heinz, The operative aetiology and types of adhesions causing small bowel obstruction, Aust. N. Z. J. Surg. 63 (1993) 848–852.

[7] D.F. Bastug, S.W. Trammell, J.P. Boland, E.P. Mantz, E.H. Tiley 3rd, Laparoscopic adhesiolysis for small bowel obstruction, Surg. Laparosc. Endosc. 1 (1991) 259–262.

[8] C.L. Garrard, R.H. Clements, L. Nanney, J.M. Davidson, W.O. Richards, Adhesion formation is reduced after laparoscopic surgery, Surg. Endosc. 13 (1999) 10–13.

[9] A. Nagle, M. Ujiki, W. Denham, K. Murayama, Laparoscopic adhesiolysis for small bowel obstruction, Am. J. Surg. 187 (2004) 464–470.

[10] F. Catena, S. Di Saverio, M.D. Kelly, W.L. Biffl, L. Ansaloni, V. Mandala, G.C. Velmahos, M. Sartelli, G. Tugnoli, M. Lupo, S. Mandala, A.D. Pinna, P.H. Sugarbaker, H. Van Goor, E.E. Moore, J. Jeekel, 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. 6 (2011) 5.

[11] B. Bohm, J.W. Milsom, V.W. Fazio, Postoperative intestinal motility following conventional and laparoscopic intestinal surgery, Arch. Surg. 130 (1995) 415–419.

[12] P. Strickland, D.J. Lourie, E.A. Suddleson, J.B. Blitz, S.C. Stain, Is laparoscopy safe and effective for treatment of acute small-bowel obstruction? Surg. Endosc. 13 (1999) 695–698.

[13] E.M. Burns, A. Currie, A. Bottle, P. Aylin, A. Darzi, O. Faiz, Minimal-access colorectal surgery is associated with fewer adhesion-related admissions than open surgery, Br. J. Surg. 100 (2013) 152–159.

[14] C. Wullstein, E. Gross, Laparoscopic compared with conventional treatment of acute adhesive small bowel obstruction, Br. J. Surg. 90 (2003) 1147–1151.

[15] C.N. Gutt, T. Oniu, P. Schemmer, A. Mehrabi, M.W. Buchler, Fewer adhesions induced by laparoscopic surgery? Surg. Endosc. 18 (2004) 898–906.

[16] H.J. Duepree, A.J. Senagore, C.P. Delaney, V.W. Fazio, Does means of access affect the incidence of small bowel obstruction and ventral hernia after bowel resection? Laparoscopy versus laparotomy, J. Am. Coll. Surg. 197 (2003) 177–181.

[17] R.A. Agha, A.J. Fowler, S. Rajmohan, I. Barai, D.P. Orgill, Preferred reporting of case series in surgery; the PROCESS guidelines, Int. J. Surg. 36 (2016) 319–323.

[18] A. Assalia, M. Schein, D. Kopelman, A. Hirshberg, M. Hashmonai, Therapeutic effect of oral Gastrografin in adhesive, partial small-bowel obstruction: a prospective randomized trial, Surgery 115 (1994) 433–437.

[19] D. Chosidow, H. Johanet, T. Montariol, R. Kielt, C. Manceau, J.P. Marmuse, G. Benhamou, Laparoscopy for acute small-bowel obstruction secondary to adhesions, J. Laparoendosc. Adv. Surg. Tech. A 10 (2000) 155–159.

[20] H. Levard, M.J. Boudet, S. Msika, J.M. Molkhou, J.M. Hay, Y. Laborde, M. Gillet, A. Fingerhut, Laparoscopic treatment of acute small bowel obstruction: a multicentre retrospective study, ANZ J. Surg. 71 (2001) 641–646.

[21] M. Suter, P. Zermatten, N. Halkic, O. Martinet, V. Bettschart, Laparoscopic management of mechanical small bowel obstruction: are there predictors of success or failure? Surg. Endosc. 14 (2000) 478–483.

[22] J.J. Liauw, W.K. Cheah, Laparoscopic management of acute small bowel obstruction, Asian J. Surg. 28 (2005) 185–188.

[23] G.J. Mancini, G.F. Petroski, W.C. Lin, E. Sporn, B.W. Miedema, K. Thaler, Nationwide impact of laparoscopic lysis of adhesions in the management of intestinal obstruction in the US, J. Am. Coll. Surg. 207 (2008) 520–526.

[24] K.N. Kelly, J.C. Iannuzzi, A.S. Rickles, V. Garimella, J.R. Monson, F.J. Fleming, Laparotomy for small-bowel obstruction: first choice or last resort for adhesiolysis? A laparoscopic approach for small-bowel obstruction reduces 30-day complications, Surg. Endosc. 28 (2014) 65–73.

[25] M.S. Sajid, A.H. Khawaja, P. Sains, K.K. Singh, M.K. Baig, A systematic review comparing laparoscopic vs open adhesiolysis in patients with adhesional small bowel obstruction, Am. J. Surg. 212 (2016) 138–150.

[26] M.Z. Li, L. Lian, L.B. Xiao, W.H. Wu, Y.L. He, X.M. Song, Laparoscopic versus open adhesiolysis in patients with adhesive small bowel obstruction: a systematic review and meta-analysis, Am. J. Surg. 204 (2012) 779–786.

[27] T. Wiggins, S.R. Markar, A. Harris, Laparoscopic adhesiolysis for acute small bowel obstruction: systematic review and pooled analysis, Surg. Endosc. 29 (2015) 3432–3442.

[28] V. Sallinen, H. Wikstrom, M. Victorzon, P. Salminen, V. Koivukangas, E. Haukijarvi, B. Enholm, A. Leppaniemi, P. Mentula, Laparoscopic versus open adhesiolysis for small bowel obstruction - a multicenter, prospective, randomized, controlled trial, BMC Surg. 14 (2014) 77.

[29] S. Yao, E. Tanaka, A. Ikeda, T. Murakami, T. Okumoto, T. Harada, Outcomes of laparoscopic management of acute small bowel obstruction: a 7-year experience of 110 consecutive cases with various etiologies, Surg. Today (2017) [Epub ahead of print].

[30] K. Sasaki, H. Kawasaki, H. Abe, H. Nagai, F. Yoshimi, Retrocecal hernia successfully treated with laparoscopic surgery: a case report and literature review of 15 cases in Japan, Int. J. Surg. Case Rep. 18 (2016) 45–47.

[31] M. Zizzo, N. Smerieri, I. Barbieri, A. Lanaia, S. Bonilauri, Laparoscopic treatment of acute small bowel obstruction due to left paraduodenal hernia: a case report and literature review, Int. J. Surg. Case Rep. 20 (2016) 87–91.

[32] F.C. Grafen, V. Neuhaus, O. Schob, M. Turina, Management of acute small bowel obstruction from intestinal adhesions: indications for laparoscopic surgery in a community teaching hospital, Langenbecks Arch. Surg. 395 (2010) 57–63.

[33] F. Cantarella, L.P. Evoli, C. Renzi, E. Cavazzoni, A. Contine, M. Cesari, A. Donini, Indications for the laparoscopic approach to acute small bowel obstruction: a retrospective review of 50 cases, a literature review, and a single hospital's preliminary experience, Asian J. Endosc. Surg. 9 (2016) 152–156.

[34] S. Lombardo, K. Baum, J.D. Filho, R. Nirula, Should adhesive small bowel obstruction be managed laparoscopically? A National Surgical Quality Improvement Program propensity score analysis, J. Trauma Acute Care Surg. 76 (2014) 696–703.

[35] J. Byrne, F. Saleh, L. Ambrosini, F. Quereshy, T.D. Jackson, A. Okrainec, Laparoscopic versus open surgical management of adhesive small bowel obstruction: a comparison of outcomes, Surg. Endosc. 29 (2015) 2525–2532.

[36] F. Saleh, L. Ambrosini, T. Jackson, A. Okrainec, Laparoscopic versus open surgical management of small bowel obstruction: an analysis of short-term outcomes, Surg. Endosc. 28 (2014) 2381–2386.

[37] B. Ghosheh, J.R. Salameh, Laparoscopic approach to acute small bowel obstruction: review of 1061 cases, Surg. Endosc. 21 (2007) 1945–1949.

[38] E. Farinella, R. Cirocchi, F. La Mura, U. Morelli, L. Cattorini, P. Delmonaco, C. Migliaccio, A.A. De Sol, L. Cozzaglio, F. Sciannameo, Feasibility of laparoscopy for small bowel obstruction, World J. Emerg. Surg. 4 (2009) 3.

[39] R. Chopra, C. McVay, E. Phillips, T.M. Khalili, Laparoscopic lysis of adhesions, Am. Surg. 69 (2003) 966–968.

[40] M. Khaikin, N. Schneidereit, S. Cera, D. Sands, J. Efron, E.G. Weiss, J.J. Nogueras, A.M. Vernava 3rd, S.D. Wexner, Laparoscopic vs. open surgery for acute adhesive small-bowel obstruction: patients' outcome and cost-effectiveness, Surg. Endosc. 21 (2007) 742–746.

[41] D. Dindo, M. Schafer, M.K. Muller, P.A. Clavien, D. Hahnloser, Laparoscopy for small bowel obstruction: the reason for conversion matters, Surg. Endosc. 24 (2010) 792–797.

[42] Q. Wang, Z.Q. Hu, W.J. Wang, J. Zhang, Y. Wang, C.P. Ruan, Laparoscopic management of recurrent adhesive small-bowel obstruction: long-term follow-up, Surg. Today 39 (2009) 493–499.