Langenbecks Arch Surg (2010) 395:57–63
DOI 10.1007/s00423-009-0490-z

ORIGINAL ARTICLE

Management of acute small bowel obstruction from intestinal adhesions: indications for laparoscopic surgery in a community teaching hospital

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Received: 27 January 2009 / Accepted: 20 March 2009 / Published online: 28 March 2009

Abstract
Purpose The aim of this study is to compare the results of laparoscopic management of acute small bowel obstruction (SBO) from abdominal adhesions to both exploratory laparotomy and secondary conversion to open surgery.
Materials and methods Ninety-three patients (mean age 61 years) with adhesion-induced SBO were divided into successful laparoscopy (66 patients [71%]), secondary conversion (24 [26%]), and primary laparotomy (three patients).
Results Patients with successful laparoscopy had more simple adhesions (57%), fewer prior operations, and lower American Society of Anesthesiologists (ASA) class. Operative time was shortest in the laparoscopy group (74.3±4.4 min), as was the duration of both intensive care unit and hospital stay. Mortality was 6%, regardless of operative technique.
Conclusions A trial of laparoscopic adhesiolysis by a surgeon with advanced laparoscopic skills seems advisable in the majority of patients with acute adhesive SBO, whereas patients with more extensive adhesions, higher ASA class, and more than two prior abdominal operations often require laparotomy to achieve equally satisfactory outcome.

Keywords Small bowel · Obstruction · Ileus · Laparoscopy · Intestinal · Operation · Adhesion

Presented at the Annual Meeting of the Swiss Society of Surgery (Basel, May 2008).

Received the 2008 annual award of the Arbeitsgemeinschaft für Qualitätssicherung in der Chirurgie (Association for Quality Assurance in Surgery) for best data analysis in surgical quality assurance.

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Introduction

Small bowel obstruction (SBO) remains a common surgical emergency in hospitals worldwide, and is caused by intra-abdominal adhesions resulting from previous laparotomy or laparoscopy in 60–80% of patients [1, 2]. According to the Scottish Surgical and Clinical Adhesions Research database, an estimated 35% of patients with previous laparotomy for indications other than adhesiolysis require rehospitalization for problems either directly or possibly related to postoperative adhesions more than once within 10 years, and roughly 2–5% of these patients will be operated for SBO unresponsive to nonsurgical management [3]. An American study by Beck et al. using Medicare records found a comparable incidence of SBO in 14–20% of patients within 2 years of laparotomy and between 2% and 5% of patients requiring open adhesiolysis for failed conservative treatment [4].

Exploratory laparotomy followed by open adhesiolysis remains the procedure of choice for most practicing surgeons confronted with adhesion-related SBO. A recent large study by Mancini et al. found that, in the United States, only 11% of patients with adhesion-related SBO from the 2002 National Inpatient Sample were treated laparoscopically [5]. Laparotomy is regarded as a proven and reliable, albeit often demanding, procedure with significant morbidity and mortality.

Furthermore, each additional laparotomy with subsequent disruption of the visceral peritoneum predisposes affected patients to more adhesions and further episodes of bowel obstruction. An estimated 10–30% of patients will undergo repeat laparotomy for recurrent bowel obstruction following initial open adhesiolysis [6–8]. Despite a large effort on behalf of the pharmaceutical industry to develop substances capable of preventing adhesion formation following laparotomy, their use outside of clinical trials remains limited in most institutions today.

Ideally, laparoscopy would offer a possibility to (a) conduct adhesiolysis equally safe and effective as by laparotomy, (b) reduce the extent of de novo adhesions by using a less invasive technique [9, 10], and (c) reduce perioperative morbidity, mortality, and duration of hospital stay by avoiding the discomfort and rate of complications inherent to major laparotomy. One of the first reports of successful laparoscopic adhesiolysis was published by Bastug et al. in 1991, involving a patient with a single adhesive band [11]. In recent years, with the continuous propagation of laparoscopy for an ever-increasing range of indications, several authors have examined the use of laparoscopic adhesiolysis as an alternative to exploratory laparotomy in patients with adhesive SBO [12–20]. Together, these studies show that laparoscopic adhesiolysis can successfully be achieved in the majority of patients with adhesive SBO, with conversion rates ranging from 6% to 43%.

The purpose of the present study, therefore, was twofold: First, we wished to compare the short-term outcome between patients with adhesive SBO treated successfully by laparoscopy alone versus outcome in patients who had to be converted to laparotomy and also to patients who were initially treated by exploratory laparotomy and open adhesiolysis. It was our hypothesis that, according to the existing literature, successful laparoscopic management might provide superior short-term results, with improved morbidity and mortality. Secondly, we wished to identify patient subgroups likely to benefit from a primary laparoscopic management or, alternatively, from direct open exploration, providing an aid for the choice of surgical technique to be used in a given case.

Materials and methods

Patient selection

The Limmattal Hospital is a 320-bed University of Zurich-affiliated community teaching hospital averaging 3,100 annual surgical inpatient admissions and 2,950 operative procedures annually. All patients undergoing operative treatment for SBO due to intra-abdominal adhesions between January 1, 1999 and December 30, 2007 were included in this retrospective analysis. Patients with SBO for nonadhesion-related etiologies (e.g., abdominal wall hernia, intussusception, etc.) and patients with colonic obstruction were excluded from further analysis. Patients were then differentiated according to the operative procedure performed into three groups: the "successful laparoscopy" group, the "conversion" group, and finally, the "laparotomy only" group. Prior to the operation, written informed consent was obtained in all patients.

Clinical variables

Clinical variables included demographic factors and factors of the present illness such as American Society of Anesthesiologists (ASA) classification or duration of symptoms (days) until the operation was performed. Diagnostic factors included routine preoperative hematology and blood chemistry parameters, plain abdominal radiographs, and in some patients, contrast-enhanced computed tomography. Intraoperative parameters include the duration of operation, aspect of adhesions encountered (single band versus extensive adhesions), and reasons for conversion if needed. Postoperative parameters include overall mortality, day of first postoperative bowel movement, and duration of hospital and intensive care unit (ICU) stay.

"Successful laparoscopy" was defined as complete clinical resolution of bowel obstruction following laparoscopy, regardless of the presence or absence of complications unrelated to bowel transit. "Conversion" was defined as the need to perform laparotomy and open adhesiolysis following initial unsuccessful laparoscopy, regardless of the reasons for aborting the initial laparoscopic approach.

Diagnostic and operative procedures

In the absence of obvious causes of SBO such as incarcerated abdominal wall hernia, patients with signs of adhesive SBO were assessed by clinical examination followed by conventional radiography to confirm radiographic signs of bowel distension. A water-soluble agent was given to patients with incomplete or recurrent obstruction to pinpoint and potentially relieve the obstruction thereby obviating subsequent surgery. Patients with multiple previous operations, especially due to intra-abdominal neoplasms, those with suspected colonic obstruction, and patients with other known intra-abdominal pathology were, in most instances, subjected to contrast-enhanced computed tomography. In patients with an established working diagnosis of adhesion-related SBO, laparoscopic adhesiolysis was the procedure of choice, unless contraindications to laparoscopy, such as extreme abdominal distension in the face of prolonged ileus, existed.

For the operation, patients were placed in the supine position with their arms tucked. The site of the initial port is usually chosen far from scars from previous abdominal operations; in doubtful cases, we use the left upper quadrant as an entry point. Pneumoperitoneum is established using either a Veress needle or, alternatively, through a minicut-down followed by open insertion of the Hasson trocar, according to surgeon preference. Laparoscopy itself is performed using a Laparo-CO_2-Pneu 2232 Insufflator (Richard Wolff, Knittlingen, Germany) and 3CCD Endocam X with RIWO Objektive 85261 (Richard Wolff, Knittlingen, Germany). Our standard routine includes examining the small bowel beginning at the ileocecal valve to the point of obstruction using atraumatic graspers, relieving all significant adhesions with laparoscopic scissors. Electrocautery is used sparingly to avoid thermal injury. Following the release of incarcerated loops of the small bowel, resection of doubtfully viable segments is usually withheld for 5 to 10 min to allow for spontaneous improvement of viability and contractility. Whenever resection is mandatory, the affected segment is grasped and exteriorized through a small adjacent incision. Following resection and enteroenterostomy using a continuous one-layered extramucosal running PDS 4-0 suture, the operation is continued laparoscopically.

All data were obtained according to the University of Zürich Institutional Review Board guidelines and in strict adherence to the ethical guidelines for human research of the Swiss Academy of Medical Sciences (Schweizerische Akademie der Medizinischen Wissenschaften; http://www.samw.ch/docs/Richtlinien/d_Forschungsunters.pdf).

Statistical analysis

Data are presented as the median (range) or mean±standard error of the mean, as appropriate. Descriptive statistical analysis was performed using SigmaStat 3.11.0 (Systat Software, Richmond, CA, USA). Comparative statistics were omitted on purpose due to the low number of patients in the "primary open adhesiolysis" group.

Results

Study collective

A total of 93 patients operated on at the Limmattal Hospital between January 1999 and December 2007 for adhesion-related SBO were enrolled into this study. Twenty-four patients (26%) had to be converted to laparotomy and open adhesiolysis following initial laparoscopy. Three patients (3%) did not undergo laparoscopy but were primarily treated by laparotomy and open adhesiolysis. Tables 1 and 2 provide an overview of the entire patient material.

Table 1 Overview of patient collective

Patient parameters	Successful laparoscopy (n=66)	Secondary conversion (n=24)	Primary open adhesiolysis (n=3)
Age (years)	59±2	63±4	75±4
Females (%)	71	58	33
ASA classification[a]	2.3±0.1	2.8±0.1	3±0
Number of previous surgery	2±0.2	2.2±0.2	4.3±1.3
Number of carcinomas, n (%)	2 (3)	1 (4)	0
Days until operation	2.5±0.3	2.5±0.6	4.3±2.8

[a] Classification of the American Society of Anesthesiologists

Preoperative variables

Preoperatively, the three groups differed with respect to ASA classification and the number of previous operations: patients treated by laparoscopy alone had lower preoperative ASA scores compared to both patients who had to be converted and those who had undergone primary laparotomy (Table 1). Both the numbers of previous abdominal operations and the duration of time without bowel movements or passage of gas were highest in patients treated with primary laparotomy. Age, sex, and preoperative laboratory tests did not differ between the groups. Twenty-three patients in the successful laparoscopy group (35%) had small bowel loops of >4 cm diameter on plain radiographs versus nine (38%) in the conversion group (P=0.89).

Intraoperative and postoperative course

The duration of operation was shortest in patients with successful laparoscopy compared to both the conversion group and patients with primary laparotomy. Secondary conversion actually led to a mean increase in operative time of 103%. With respect to intraoperative findings, we found that almost two thirds of our patients (64%) with successful laparoscopy suffered from simple bands (Fig. 1) as opposed to extensive adhesions (Fig. 2), which predominated in the converted group as well as in the group with primary laparotomy. In fact, none of the 24 patients who had to be converted or the three patients who were treated by primary laparotomy had SBO due to simple bands.

Duration of ICU stay was shorter in patients with successful laparoscopy than in both other groups, as was the duration of hospital stay. In fact, patients who had to be converted stayed almost 7 days longer in the hospital than patients with successful laparoscopy, and patients with primary laparotomy were discharged, on average, after 20 hospital days. Similarly, the first postoperative bowel movement occurred 1 day earlier in patients with successful

Table 2 Perioperative course

Patient parameters			Successful laparoscopy (n=66)	Secondary conversion (n=24)	Primary open adhesiolysis (n=3)
Operation	Duration of procedure (min)		74±4	151±14	113±32
	Intraoperative findings	Single bands, n (%)	42 (64)	0	0
		Diffuse adhesions, n (%)	24 (36)	24 (100)	3 (100)
Postoperative course	First bowel movement (days)		2.5±0.3	3.5±0.4	7.6±4.3
	Duration of hospital stay (days)		8.6±0.9	15.1±2.6	20.7±1.4
	Duration of ICU stay (days)		0.8±0.2	3.0±1.5	6.3±1.0
	Early mortality, n (%)		3 (5)	2 (8)	1 (33)

laparoscopy compared to patients who had to be converted and 5 days earlier than in patients with primary laparotomy.

Overall mortality was six patients or 7%, and although patients treated by either primary or secondary laparotomy had higher mortality, these differences did not reach statistical significance (Table 2). All six patients who died following adhesiolysis were in poor physical condition upon admission or transfer to our service (all ASA III–V), suffered from prolonged ileus >48 h, and all required primary or secondary laparotomy. One of the patients who died initially refused surgical therapy but changed his mind upon critical deterioration. Seven patients in the successful laparoscopy group (11%) had to undergo a second, unplanned operation following initial adhesiolysis; of these, three patients (5%) had persistent ileus, two (3%) had iatrogenic bowel perforations unrecognized during the initial operation, and another two (3%) suffered from anastomotic leakage following intestinal anastomosis. In the conversion group, two patients had to be reoperated on (8%); one due to iatrogenic small bowel perforation, the other due to early postoperative torsion and strangulation of a small bowel segment.

Iatrogenic bowel lesions occurred in seven patients, five of which (four small bowel lesions and one colonic lesion) were immediately recognized and repaired by means of laparotomy and open revision. The two other lesions were not recognized during the initial operation, leading to secondary revision following development of clinical signs of peritonitis in the early postoperative period. All seven lesions occurred in patients with extensive adhesions.

Factors associated with successful laparoscopic treatment of SBO

In retrospect, a number of parameters which were associated with successful laparoscopic management of SBO can be identified. Among these was the presence of isolated bands as opposed to extensive adhesions as the cause of SBO. All patients with SBO due to isolated bands could successfully be managed laparoscopically, whereas 53% of

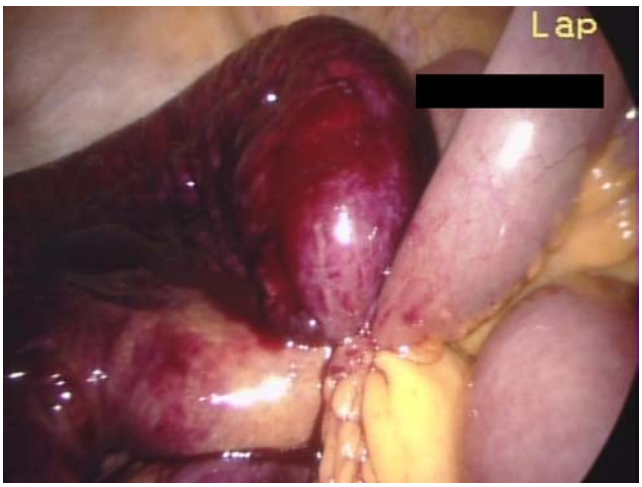

Fig. 1 Simple band-like adhesion leading to acute SBO with associated edema and intestinal venous congestion

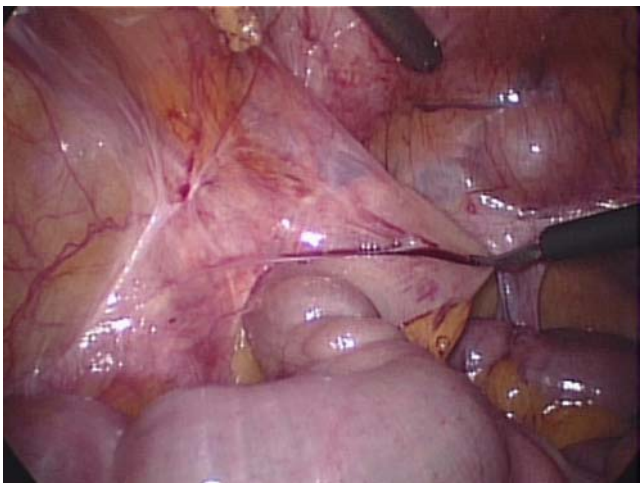

Fig. 2 Extensive adhesions in the right lower quadrant being lysed with the use of bipolar scissors

patients with extensive adhesions had to undergo either primary or secondary laparotomy. Patients in the successful laparoscopy group showed lower ASA scores than both other groups (Table 1), were younger, had fewer prior operations, and had a shorter duration of SBO obstruction prior to their operation.

Although the total number of prior abdominal operations was not different between the groups, we found that patients who only had prior appendectomy (n=6) or cholecystectomy (n=5) could all be managed laparoscopically without need for secondary conversion.

Reasons for primary laparotomy or secondary conversion to open adhesiolysis

Three patients underwent primary laparotomy and open adhesiolysis. Reasons for this approach included a state of prolonged ileus (mean 4.3 days) with progressive abdominal distension and a higher number or more extensive previous operations. The reasons for converting to open adhesiolysis following initial laparoscopy were inadequate laparoscopic control due to intestinal distension (41%, ten patients), extensive adhesions (30%, seven patients), iatrogenic intestinal perforation (21%, five patients; in 17% [four patients] small bowel, in 4% [one patient] colonic perforations), and the presence of necrotic segments of the small bowel upon initial laparoscopy, necessitating secondary open resection (8%, two patients).

Discussion

The precise role of laparoscopic surgery in the treatment of adhesive SBO remains intensely debated. A number of reports clearly demonstrate its usefulness and safety in the hands of experienced laparoscopic surgeons, yet concerns remain as to whether this technique may be recommended as a standard treatment in affected patients [12–21]. Furthermore, no randomized controlled trial comparing open to laparoscopic adhesiolysis exists to this date to the authors' knowledge, and both the precise indications and specific outcomes of laparoscopic adhesiolysis for adhesive SBO remain poorly understood.

Our data show that laparoscopic adhesiolysis may be successfully performed in the majority of patients treated in a community teaching hospital without compromising the patient's safety. In addition, short-term outcome until discharge clearly demonstrates the superiority of a successful laparoscopic management in terms of decreased operative time, length of hospital and ICU stay, and reduced overall mortality. Our conversion rate of 30% compares favorably to existing reports in which conversion rates range from 6.7% to 43% [20, 22–24]. The comparably low conversion rate of 17% by Mancini et al. in their study of 6,165 patients with adhesion-related SBO may be explained by the low initial percentage (11%) of patients treated laparoscopically, indicating a positive selection of patients amenable to successful laparoscopic adhesiolysis [5]. As stated by the authors, patients undergoing laparoscopy were significantly more likely to be women, younger, have less comorbidity, and have private health care insurance.

Furthermore, we found that patients with adhesive SBO who previously had undergone appendectomy or cholecystectomy alone could all be successfully managed laparoscopically, as had earlier been reported by Navez et al. [17]. This fact may also indicate the relative "simplicity" of adhesions encountered in patients after minor operations such as appendectomy or cholecystectomy. Needless to say, experience in advanced laparoscopic surgery appears advisable for the treatment of patients with more extensive adhesion formation.

A number of observations were made about the probability of successful laparoscopy, and the category of patients which may have to be converted to open adhesiolysis: Suter et al. reported that a bowel diameter >4 cm on plain abdominal X-rays was predictive of intraoperative conversion [20]. Although feasible, this was not the case in our material, as the presence of bowel diameters >4 cm did not predict the necessity for intraoperative conversion. In our series, patients undergoing secondary conversion did only differ with respect to preoperative ASA scores, which were significantly higher in this group as well as in patients undergoing primary laparotomy. In our experience, patients with successful laparoscopy were younger and had fewer previous operations than patients who had to undergo laparotomy, although these differences did not reach statistical significance.

Intraoperatively, however, we found that patients suffering from simple band-like adhesions could all be managed laparoscopically, whereas the majority of patients suffering from multiple, vast adhesions had to undergo open adhesiolysis. Léon et al., in their experience of 40 patients, noted that a previous history of severe and dense adhesions is a contraindication to laparoscopic treatment, as only 10% of patients with dense adhesions could be treated laparoscopically [14].

Another frequently stated cause of concern is the risk of inadvertent enterotomy during laparoscopic treatment of SBO, a justified concern considering the presence of dilated, vulnerable loops of the small bowel in the face of prolonged ileus. The complication occurred in two patients (3%) in our series, with rates ranging from 3% to 17% in the literature [1, 18, 22, 25, 26]. Bailey et al. further reported a higher rate of early unplanned reoperations due to unrecognized iatrogenic injuries in their patients treated laparoscopically [27], and Wullstein and Gross found that

the risk of inadvertent bowel injury increases in patients with more than one prior laparotomy [28]. Mancini et al. reported no increase in morbidity in patients treated laparoscopically in their large series, not even in patients requiring secondary conversion, when compared to open adhesiolysis. In our experience, the risk of inadvertent bowel injury should not be held against this indication, as the majority of iatrogenic enterotomies could be repaired laparoscopically [20]. Furthermore, laparotomy does not safeguard patients from iatrogenic bowel injuries. Incidentally, one patient in our series had to undergo repeat laparotomy for a missed iatrogenic enterotomy, despite being treated by open adhesiolysis during his initial operation.

With respect to placement of the initial trocar, the use of a fully open Hassan approach is the preferred method for most practicing surgeons, as the risk of inadvertent enterotomy appears lower compared to the "blind" placement of a Veress needle, which is still very much in use in European hospitals. In our experience, a minicutdown followed by open insertion of the Hasson trocar in the left upper quadrant, which often times is least affected even in cases of severe adhesion formation, provides the safest access to the peritoneal cavity in patients with distended loops of bowel. In view of potentially serious entry complications, a number of "visual entry systems" combining conical or spherical crystal ends with hollowed trocars to accommodate 0° laparoscopes to display entry pictures were introduced in recent years. Despite the potential benefit of such devices, their clinical use remains limited in most institutions known to the authors.

Three patients in our series underwent primary laparotomy and open adhesiolysis. The rationale behind this was to avoid losing time and risk increased surgical morbidity by initial laparoscopic treatment in patients in whom successful laparoscopic adhesiolysis appeared unlikely preoperatively, which precludes a more in-depth analysis of the factors associated with these patients.

The shortcomings of the present study must be noted: First and foremost, it is a retrospective and nonrandomized analysis with an evident selection bias in the choice of operative procedure. Likely, patients prone to benefit from laparoscopic adhesiolysis did not undergo primary laparotomy and vice versa. However, the fact that only three patients underwent direct open adhesiolysis minimizes this confounding effect and underlines the interest of the surgeons involved in this study to pursue laparoscopic treatment whenever feasible. Main factors considered in this decision were a preoperative ileus of more than 3–4 days duration, progressive abdominal distension, higher numbers and more extensive previous abdominal operations, all making extensive adhesion formation more likely. The decision to proceed with primary laparotomy was made by the attending surgeon unrelated to the purpose of this study. Secondly, different staff surgeons with varying clinical background and expertise in laparoscopic surgery were involved in this study, thereby potentially affecting the rate of secondary laparotomy in cases where successful laparoscopic adhesiolysis depended on individual advanced skills in laparoscopic surgery.

Conclusions

Together, our study indicates that the majority of patients with acute adhesive SBO following common, less extensive abdominal operations such as appendectomy or cholecystectomy may successfully be treated using a primary laparoscopic approach in a community teaching hospital. These patients benefit from a shorter length of operation, decreased ICU and hospital length of stay, and potentially, lower mortality compared to direct laparotomy and open adhesiolysis. On the other hand, patients with SBO following extensive adhesiolysis or those with a markedly distended abdomen due to dilated intestines are likely better candidates for primary exploratory laparotomy. Care must further be taken in patients with ileus of more than 3 days duration, higher ASA scores, and multiple, more extensive preceding operations, which in turn may suffer from an expectedly unsuccessful trial of laparoscopy with subsequent prolongation of operative time and an increased potential of iatrogenic injury. Until definitive evidence on the advantages of laparoscopic treatment of adhesion-related SBO from a prospective randomized multicenter trial exists, we believe that laparoscopy in the hands of surgeons trained in minimally invasive surgery may provide a real benefit to this challenging group of patients.

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