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# COMPREHENSIVE DIAGNOSTIC AND TREATMENT ALGORITHM FOR THE SURGICAL MANAGEMENT OF POSTOPERATIVE ADHESIVE SMALL BOWEL OBSTRUCTION: RESULTS OF A COMPARATIVE CLINICAL STUDY

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## ABSTRACT

**Introduction.** Postoperative adhesive small bowel obstruction (ASBO) remains one of the most common indications for emergency surgery in abdominal surgery and accounts for up to 60–75% of all cases of mechanical intestinal obstruction.

**Aim.** To evaluate the effectiveness of a comprehensive diagnostic and treatment algorithm incorporating laparoscopic adhesiolysis, the hydrojet scalpel and the author's own surgical techniques compared with standard treatment in patients with postoperative adhesive small bowel obstruction, based on the incidence of postoperative complications, mortality and quality-of-life outcomes.

**Materials and methods.** A comparative cohort study of the treatment outcomes of 314 patients with postoperative adhesive small bowel obstruction was conducted: 163 patients in the control group, treated in 2006-2012 using the conventional approach, and 151 patients in the study group, treated in 2013-2019 after implementation of the improved algorithm. In the study group, a laparoscopic approach was used in 84 patients and the hydrojet scalpel in 82 (54.30%). The rates of bowel resection, stoma formation, postoperative complications, reoperations and in-hospital mortality, as well as quality-of-life outcomes, were assessed. The SF-36 was administered to 180 patients at discharge and at 1 and 3 months. The groups were comparable in terms of age, sex, stage of the disease, time to admission and grade of intra-abdominal hypertension. Owing to the retrospective nature of the control cohort, multivariable analysis was not performed; unadjusted ORs with 95% CIs are reported.

**Results.** The bowel resection rate was lower in the study group than in the control group: 14.57% vs. 25.15% (OR=0.51; 95% CI 0.29-0.90; p=0.02). The rate of wound complications was 6.62% vs. 20.24% (OR=0.28; 95% CI 0.13-0.59; p<0.001), and the rate of intra-abdominal complications requiring reoperation was 7.28% vs. 22.08% (OR=0.28; 95% CI 0.14-0.57; p<0.001). The rate of intestinal stoma formation was lower in the study group, but the difference was not statistically significant: 8.61% vs. 14.72% (p=0.09). In-hospital mortality was 1.32% vs. 3.07% (p=0.28). Use of the comprehensive diagnostic and treatment algorithm was associated with lower rates of bowel resection and postoperative complications, wider use of the laparoscopic approach and better quality-of-life outcomes.

**Conclusions.** Use of the comprehensive diagnostic and treatment algorithm was associated with lower rates of bowel resection and postoperative complications, wider use of the laparoscopic approach and better quality-of-life outcomes. Differences in the rates of intestinal stoma formation and in-hospital mortality did not reach statistical significance.

**Key words:** adhesive small bowel obstruction; laparoscopic adhesiolysis; hydrojet scalpel; complications; quality of life.

## INTRODUCTION

**Introduction.** Postoperative adhesive small bowel obstruction (ASBO) remains one of the most common indications for emergency abdominal surgery and accounts for up to 60-75% of all cases of mechanical intestinal obstruction. According to epidemiological studies, it accounts for 12% to 16% of emergency surgical admissions and up to 20% of emergency bowel operations [1, 2]. Intra-abdominal adhesions develop in 45-93% of patients after open abdominal surgery and in 16-33% after laparoscopic procedures [2]. Mortality associated with ASBO

 

ranges from 3% to 35%, increasing substantially with delayed hospital admission (more than 48 hours) and the development of bowel necrosis [2, 3].

Despite advances in operative techniques, anesthetic management, and intensive care, this condition continues to be associated with high rates of postoperative complications, the need for bowel resection and repeat operations, prolonged hospital stays, and considerable economic costs to the healthcare system.

For a long time, open laparotomy with adhesiolysis remained the standard surgical treatment for ASBO. At the same time, accumulating evidence of the advantages of a minimally invasive approach – in particular, a shorter hospital stay, a lower rate of wound complications, and faster return of bowel function – has prompted wider use of laparoscopic adhesiolysis [4, 5]. The international consensus of the World Society of Emergency Surgery (WSES) recommends that the laparoscopic approach be considered the method of choice for ASBO in selected patients in the absence of signs of peritonitis, bowel ischemia, and intra-abdominal hypertension above grade I [5]. The main reasons for unsatisfactory treatment outcomes are the difficulty of timely diagnosing bowel ischemia, the lack of universal criteria for selecting the optimal surgical strategy, and the high risk of intraoperative bowel injury during adhesiolysis. Conventional open surgery is associated with considerable tissue trauma, which may contribute to progression of the adhesive process and an increased rate of postoperative complications.

Modern abdominal surgery is actively adopting laparoscopic technologies, improved methods of preoperative imaging, hydrojet tissue dissection, and new approaches to the prevention of recurrent adhesion formation. However, the results of their combined use in ASBO remain insufficiently studied, and the optimal combination of modern technologies with conventional treatment methods requires further investigation.

## AIM

**The aim of the study was to evaluate** the effectiveness of a comprehensive diagnostic and treatment algorithm incorporating laparoscopic adhesiolysis, the hydrojet scalpel, and author-developed surgical techniques compared with standard treatment in patients with postoperative adhesive small bowel obstruction, based on the incidence of postoperative complications, mortality, and quality-of-life outcomes.

## MATERIALS AND METHODS

**Study design and patients.** A comparative cohort study using consecutive sampling was conducted, including 314 patients with ASBO admitted to the surgical departments of the Municipal Non-Profit Enterprise "Kyiv City Clinical Hospital No. 1" (KCCH No. 1) between 2006 and 2019. The inclusion criteria were clinical manifestations of postoperative adhesive small bowel obstruction, confirmation of the diagnosis by clinical and instrumental examination, and the need for surgical treatment. The clinical groups were formed chronologically, according to the diagnostic and treatment strategy applied. The control group comprised 163 patients treated in 2006-2012 using conventional approaches to diagnosis and surgical treatment. The study group included 151 patients treated in 2013-2019 after implementation of the improved diagnostic and treatment algorithm. Comparability of the groups was assessed using the main baseline demographic and clinical characteristics, in particular age, sex, comorbidity profile, features of the adhesive process and the main characteristics of the clinical course of postoperative adhesive small bowel obstruction (*see Table 1*). Since the groups were formed chronologically, the following conditions were observed in order to minimize the influence of temporal changes in clinical practice: both cohorts were treated in the same surgical departments of the Municipal Non-Profit Enterprise "Kyiv City Clinical Hospital No. 1" by the same clinical team; the inclusion criteria, the procedure for verifying the diagnosis and the principles of preoperative preparation and anesthetic management remained unchanged throughout the study period; no enhanced recovery after surgery (ERAS) programs or other systemic changes in perioperative management were introduced at the hospital, apart from those that are the subject of this study. In addition to age and sex, the baseline comparability of the cohorts was further assessed by the time from symptom onset to admission, the grade of intra-abdominal hypertension according to the WSACS (2013) classification, body mass index (BMI) and the pattern of comorbidity (*Table 1*).

The control and study groups were comparable in their main baseline clinical and demographic characteristics. No statistically significant differences were found in age distribution ($p=0.977$) or sex distribution ($p=0.815$). No statistically significant between-group differences were found in the stages of the clinical course of postoperative adhesive small bowel obstruction or in the pattern of causes of adhesion formation (all $p>0.05$), which indicates baseline clinical comparability of the study groups. The groups were also comparable in the time from symptom onset to admission ($p=0.821$), the distribution of intra-abdominal hypertension

Table 1. Baseline clinical and demographic characteristics of the patients in the control and study groups

| Variable | Control group (n=163) | Study group (n=151) | p |
|---|---|---|---|
| **Age distribution, n (%)** | | | 0.977 |
| 18–24 years | 7 (4.29) | 6 (3.97) | |
| 25–54 years | 32 (19.63) | 29 (19.20) | |
| 55–65 years | 77 (47.24) | 69 (45.70) | |
| ≥65 years | 47 (28.83) | 47 (31.13) | |
| **Sex, n (%)** | | | 0.815 |
| Men | 61 (37.42) | 54 (35.76) | |
| Women | 102 (62.58) | 97 (64.24) | |
| **Stage of the clinical course of ASBO, n (%)** | | | |
| Compensated | 92 (56.44) | 86 (56.95) | 1.00 |
| Subcompensated | 40 (24.54) | 42 (27.81) | 0.52 |
| Decompensated | 21 (12.88) | 17 (11.26) | 0.73 |
| Multiple organ failure | 10 (6.13) | 6 (3.97) | 0.45 |
| **Cause of adhesion formation, n (%)** | | | |
| Appendicitis / Meckel's diverticulum | 37 (22.70) | 35 (23.18) | 1.000 |
| Perforated ulcer | 28 (17.18) | 25 (16.56) | 1.000 |
| Traumatic injuries | 15 (9.20) | 12 (7.95) | 0.841 |
| Surgery on the liver/biliary ducts | 36 (22.09) | 34 (22.52) | 1.000 |
| Hernia surgery | 24 (14.72) | 22 (14.57) | 1.000 |
| Gynecological/urological surgery | 23 (14.11) | 23 (15.23) | 0.874 |
| **Time from symptom onset to admission, n (%)** | | | 0.821 |
| up to 24 h | 82 (50.31) | 78 (51.66) | |
| 24–48 h | 60 (36.81) | 57 (37.75) | |
| more than 48 h | 21 (12.88) | 16 (10.60) | |
| **Grade of intra-abdominal hypertension (WSACS, 2013), n (%)** | | | 0.550 |
| normal (IAP 7–10 mmHg) | 72 (44.17) | 65 (43.05) | |
| grade I (12–15 mmHg) | 37 (22.70) | 46 (30.46) | |
| grade II (16–20 mmHg) | 30 (18.40) | 21 (13.91) | |
| grade III (21–25 mmHg) | 19 (11.66) | 15 (9.93) | |
| grade IV (>25 mmHg) | 5 (3.07) | 4 (2.65) | |
| **Body mass index, n (%)** | | | 0.775 |
| obesity (BMI ≥30 kg/m²) | 24 (14.72) | 31 (20.53) | 0.229 |
| **Comorbidity, n (%)** | | | |
| comorbidity present | 96 (58.90) | 72 (47.68) | 0.060 |
| cardiovascular disease | 34 (20.86) | 22 (14.57) | 0.191 |
| coronary artery disease | 28 (17.18) | 21 (13.91) | 0.441 |
| diabetes mellitus | 16 (9.82) | 14 (9.27) | 1.000 |
| musculoskeletal disorders | 17 (10.43) | 10 (6.62) | 0.314 |

*Note.* Data are presented as the absolute number of patients and the proportion within the corresponding group – n (%). The p values for age distribution and sex distribution are given for the overall comparison of the corresponding categorical distributions between the control and study groups. Categorical variables were compared using Pearson's $x^2$ test or Fisher's exact test, depending on the expected frequency of observations. Differences were considered statistically significant at $p<0.05$. Time to admission, grade of intra-abdominal hypertension and body mass index distribution were compared as overall categorical distributions (Pearson's $x^2$ test).

*IAP* – intra-abdominal pressure; *WSACS* – World Society of the Abdominal Compartment Syndrome.
*ASBO* – postoperative adhesive small bowel obstruction.

grades (p=0.550) and body mass index (p=0.775). The proportion of patients with comorbidity was somewhat lower in the study group (47.68% vs. 58.90%; p=0.060), while no statistically significant differences were found for individual nosological classes (cardiovascular disease, coronary artery disease, diabetes mellitus, musculoskeletal disorders; all p>0.05). Thus, the possible residual imbalance in comorbidity favors the study group, which should be taken into account when interpreting the results obtained.

In the study group, an improved diagnostic and treatment algorithm was used that included modern radiological diagnostic methods, wider use of the laparoscopic approach, hydrojet dissection of adhesions and the author's own methods for preventing intraoperative bowel wall injury and recurrent adhesion formation (Fig. 1).

All patients underwent standard clinical examination, laboratory testing, and instrumental diagnostic assessment. Where indicated, abdominal ultrasonography, plain abdominal radiography, computed tomography, measurement of intra-abdominal pressure, and Doppler ultrasonography for assessment of mesenteric blood flow were performed. The combined use of these methods enabled determination of the level of obstruction, timely detection of signs of bowel ischemia, and selection of the optimal surgical strategy.

The treatment strategy was selected on an individualized basis, taking into account the patient's clinical condition, the duration and severity of bowel obstruction, imaging findings, intra-abdominal pressure, signs of ischemic bowel injury, the extent of the adhesive process, and the technical feasibility of performing laparoscopic surgery safely. The improved diagnostic and treatment algorithm involved a stepwise assessment of the patient's clinical condition, imaging findings, grade of intra-abdominal hypertension, and signs of ischemic bowel injury.

Indications for laparoscopic adhesiolysis included the absence of intra-abdominal hypertension or grade I hypertension that decreased following gastrointestinal decompression, the presence of a safe ultrasound window for insertion of the first trocar, and the absence of clinical signs requiring emergency open surgery. In cases of an extensive adhesive process, when safe laparoscopic dissection was not feasible or the extent of the required procedure exceeded the capabilities of the laparoscopic approach, conversion to laparotomy was performed. In the study group, the hydrojet scalpel was used in 82 patients (54.30%) according to predefined clinical and intraoperative indications. Author-developed techniques for peritonization of injuries to the bowel serosa were likewise applied on an individualized basis, depending on the nature and extent of the intraoperative injury.

One component of the improved surgical approach was the author's own method of peritonization of extensive longitudinal injuries to the serous membrane of the bowel, protected by Ukrainian utility model patent UA146063. The method was used in cases of extensive longitudinal deserosation of the bowel wall arising during the division of dense adhesions, provided that the muscular layer remained viable and there were no indications for bowel resection. The technique involved a continuous inverting seromuscular suture with the initial and

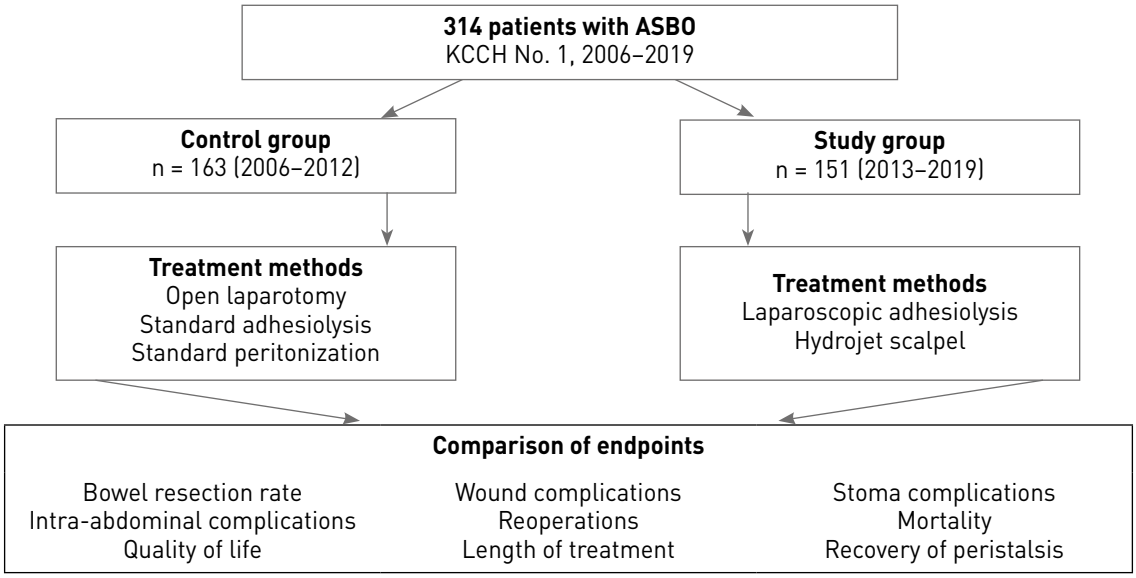


Fig. 1. Study design

final knots placed beneath the serous membrane. The stitch length was approximately 0.2 cm and the distance between stitches approximately 0.3 cm; every 3 cm of the sutured defect, an additional fixing stitch was placed in the muscular layer to prevent puckering of the bowel wall. This technique made it possible to appose the edges of the serous membrane without significant deformation or narrowing of the bowel lumen. The indications for the method were longitudinal deserosation of the bowel wall more than 2 cm long arising during the division of dense adhesions, provided that the muscular layer remained viable, there was no full-thickness defect of the bowel wall and there were no indications for bowel resection. The contraindications were necrosis or doubtful viability of the bowel segment, full-thickness perforation and the risk of critical narrowing of the lumen of a small-diameter bowel. The pathophysiological rationale for the method is that restoration of a smooth serosal surface without externally placed knots and thread ends eliminates two key factors of recurrent adhesion formation – the exposed deserosed surface and contact of the suture material with the peritoneum – and also reduces the risk of perforation of the deserosed area in the early postoperative period.

The author's own methods of hydrojet adhesiolysis. Hydrojet dissection was performed in accordance with two of the author's own methods protected by Ukrainian utility model patents: "Method for dividing and mobilizing intra-abdominal infiltrative masses with a hydrojet scalpel" (UA146064) and "Method for dividing intra-abdominal adhesions with a hydrojet scalpel" (UA146645) [21, 22]. A jet of sterile 0.9% sodium chloride solution 0.1 mm in diameter was used. When dividing infiltrative–adhesive conglomerates, the nozzle was positioned at an angle of 10-15° to the axis of the bowel at a pressure of 30–40 atm, which made it possible to detach ("blast off") the edge of the conglomerate from the bowel wall; after the mass had been grasped and retracted with forceps, the jet angle was temporarily increased to 45° for hydrodissection of the tissues, after which it was returned to 10-15°. When dividing individual adhesions, hydrodissection ("flooding") of the adhesion was first performed at an angle of 90° and then at 45° at a pressure of 20-30 atm; the nozzle was then repositioned at an angle of 10–15° to the axis of the bowel and the pressure was increased to 40–50 atm, which allowed the adhesion to be separated without injury to the serous membrane, the mesentery or the vessels. Where vessels had grown into the thickness of an adhesion, the adhesion was additionally coagulated with a tissue welding device. The indications for hydrojet dissection were dense and vascularized adhesions and infiltrative–adhesive conglomerates with a high risk of deserosation, as well as areas of interloop adhesions in which mechanical or electrosurgical division was potentially hazardous. The hydrojet scalpel was not used in the presence of bowel necrosis requiring resection or in an extremely dense ("armored") adhesive process in which safe hydrodissection was technically impossible. Overall, the method was used in 82 patients (54.30%) of the study group.

Quality-of-life assessment. The long-term outcomes of surgical treatment were assessed using the standardized Short Form Health Survey (SF-36) questionnaire. The analysis was performed in 180 patients selected from five etiological groups in order to form subgroups of comparable size: after operations for appendicitis, its complications and Meckel's diverticulum – 45 patients; for perforated gastric and duodenal ulcer – 30; for liver and biliary tract disease – 45; for anterior abdominal wall hernias – 30; and after gynecological and urological operations – 30. Patients who had undergone surgery for traumatic injuries of the abdominal organs were not included in the SF-36 analysis because of an insufficient number of observations to form subgroups of comparable size. In the study group, the SF-36 was completed at discharge and at follow-up visits at 1 and 3 months. In the control-group patients, the corresponding data were obtained retrospectively by telephone interview. Patients were selected for the quality-of-life analysis according to a predefined quota sampling plan: within each etiological group, three subgroups of equal size were formed according to the operation actually performed (standard open surgery; open surgery using the improved technologies; laparoscopic surgery using the improved technologies) – 15 patients each in the groups after operations for appendicitis, its complications and Meckel's diverticulum and for liver and biliary tract disease, and 10 patients each in the remaining groups. The analysis included patients who were available for contact, who consented to the interview and who had complete questionnaire data at all three time points. Random selection (randomization) procedures were not used; the number of patients whom an attempt was made to contact and the reasons for non-participation in the survey were not documented retrospectively, so the response rate cannot be calculated. Thus, the SF-36 analysis covered 180 (57.32%) of the 314 patients in the study. The subgroups compared were balanced by the sampling design itself, both in the pattern of etiological causes of the adhesive process and in size; however, the allocation of patients between them was

 

not randomized and was determined by the operation actually performed, which is a source of potential selection bias.

Depending on the surgical strategy used, three subgroups of 60 patients each were formed: standard open surgery; open surgery using the improved surgical technologies; and laparoscopic surgery using the improved technologies. Assessments were performed at discharge and at 1 and 3 months after treatment. Eight SF-36 domains were analyzed: physical functioning (PF), role limitations due to physical health (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH); higher scores indicated better quality of life. Complete SF-36 data at all three time points were available for all 180 patients included in the quality-of-life analysis; no patients were lost to follow-up during the three-month period. Patients who had undergone surgery for traumatic injuries of the abdominal organs (n=27) were not included in the analysis because the number of available observations was insufficient to form three subgroups of comparable size.

Statistical analysis was performed using Microsoft Excel 2010 for construction of the electronic patient database and Statistica 10.0. Quantitative variables with a normal distribution were presented as the arithmetic mean and standard deviation (M±SD). Between-group differences in quantitative variables were assessed using Student's t-test. Categorical variables were presented as absolute values and percentages and were compared using Pearson's $\chi^2$ test or, when expected frequencies were small, Yates's correction or Fisher's exact test. Differences were considered statistically significant at $p<0.05$. For the main binary endpoints, unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) were additionally calculated, with the study group as the exposure group and the control group as the reference group.

Multivariable analysis using multiple logistic regression was not performed for the following reasons. The control cohort was formed retrospectively from archival medical records for 2006-2012, and complete individual data for all potential covariates (age, a standardized comorbidity index, exact time from symptom onset to admission, intra-abdominal pressure, and intraoperative severity of the adhesive process) could not be reconstructed for every patient. In addition, the number of events for the main endpoints (10 wound complications and 11 intra-abdominal complications in the study group) did not provide the generally accepted minimum events-per-predictor ratio (≥10) required to obtain stable adjusted estimates. Therefore, unadjusted ORs with 95% CIs are reported, and potential confounding was addressed by alternative means: (1) an extended assessment of baseline comparability between the cohorts with respect to age, sex, ASBO stage, cause of adhesion formation, time to admission, grade of intra-abdominal hypertension, body mass index, and comorbidity (Table 1); and (2) analysis of outcomes within the study cohort (2013-2019), in which all patients were treated during the same time period, thereby reducing the potential influence of calendar time on the comparison.

SF-36 scores were compared across the three subgroups, three time points, and eight domains. Given the large number of simultaneous comparisons, the significance level for these analyses was adjusted using the Bonferroni method.

## RESULTS

In the control group, a primary laparotomy approach was used in 154 (94.48%) of the 163 patients, whereas laparoscopic surgery was performed in 9 cases. Five patients required conversion to laparotomy. In the study group, a laparoscopic approach was used in 84 patients, and conversion to laparotomy was required in 8 cases. Thus, the laparoscopic approach was used more frequently in the study group than in the control group. Of the 9 laparoscopic operations in the control group, 4 (2.45%) were completed laparoscopically, compared with 76 (50.33%) of the 84 (55.63%) started in the study group; the conversion rate was 5 (55.56%) of 9 versus 8 (9.52%) of 84, respectively.

One of the most important clinical results was the reduction in the bowel resection rate. In the study group, resection was performed in 22 patients (14.57%) compared with 41 (25.15%) in the control group (OR=0.51; 95% CI 0.29–0.90; p=0.02). The rate of intestinal stoma formation was also lower in the study group – 13 (8.61%) versus 24 (14.72%) in the control group – although this difference did not reach statistical significance (OR=0.55; 95% CI 0.27–1.11; p=0.09). The results obtained indicate a higher proportion of organ-preserving operations in the study group.

The rate of postoperative wound complications was lower in the study group than in the control group – 10 (6.62%) versus 33 (20.24%) cases (OR=0.28; 95% CI 0.13–0.59; p<0.001). Similarly, the rate of intra-abdominal complications was 11 (7.28%) versus 36 (22.08%), respectively (OR=0.28; 95% CI 0.14–0.57; p<0.001). All the intra-abdominal complications recorded required reoperation. A comparative description of the main treatment outcomes and postoperative complications is presented in Table 2.

Table 2. Comparative description of the main treatment outcomes and postoperative complications in the control and study groups

| Variable | Control group (n=163) | Study group (n=151) | Unadjusted OR (95% CI) | p |
|---|---|---|---|---|
| Bowel resection | 41 (25.15) | 22 (14.57) | 0.51 (0.29–0.90) | 0.02 |
| Intestinal stoma formation | 24 (14.72) | 13 (8.61) | 0.55 (0.27–1.11) | 0.09 |
| Wound complications, n (%) | 33 (20.24) | 10 (6.62) | 0.28 (0.13–0.59) | <0.001 |
| -seroma | 16 (9.82) | 6 (3.97) | | 0.041 |
| -suppuration | 17 (10.43) | 4 (2.65) | | 0.006 |
| -wound dehiscence | 7 (4.29) | 2 (1.32) | | 0.17 |
| -evisceration | 4 (2.45) | 1 (0.66) | | 0.21 |
| Pneumonia, n (%) | 19 (11.66) | 5 (3.31) | | 0.007 |
| Intra-abdominal complications requiring reoperation, n (%) | 36 (22.08) | 11 (7.28) | 0.28 (0.14–0.57) | <0.001 |
| -early adhesive small bowel obstruction | 26 (15.95) | 6 (3.97) | | <0.001 |
| -perforation of deserosed bowel segments | 6 (3.68) | 2 (1.32) | | 0.17 |
| -anastomotic leak | 4 (2.45) | 3 (1.99) | | 0.73 |
| In-hospital mortality, n (%) | 5 (3.07) | 2 (1.32) | 0.42 (0.08–2.22) | 0.28 |

*Note.* Data are presented as the absolute number of patients and the proportion within the corresponding group – n (%). OR – odds ratio; CI – confidence interval. Unadjusted ORs with 95% CIs were calculated for the main endpoints for the study group relative to the control group; an OR<1 indicates lower odds of the corresponding adverse event in the study group. ORs were not calculated for the individual subtypes of postoperative complications. Differences were considered statistically significant at p<0.05.

In the study group, the hydrojet scalpel was used as one component of the improved diagnostic and treatment algorithm in 82 patients (54.30%). A separate analysis of the effect of hydrojet dissection on the time to recovery of peristalsis was not performed in this study because no dedicated comparison group was formed for this purpose, and the method was used in combination with other components of the algorithm, particularly the laparoscopic approach. Therefore, its independent contribution could not be separated from the effects of the surgical approach and other components of the improved strategy. Accordingly, only clinically relevant endpoints indirectly related to the recovery of bowel motor and evacuatory function were assessed in this study. The rate of postoperative ileus was lower in the study group than in the control group: 12 (7.95%) vs. 27 (16.56%) (OR=0.43; 95% CI, 0.21-0.89; p=0.03). The rate of planned lavage reoperations performed because of failure of conservative management of ileus was 4 (2.65%) vs. 10 (6.13%) (p=0.17). These differences reflect the effect of the comprehensive algorithm as a whole and cannot be attributed to hydrojet dissection alone. Assessment of the independent effect of hydrojet adhesiolysis on the time to recovery of peristalsis requires a prospective study with a predefined comparison group and standardized assessment of this outcome.

Across all three subgroups, SF-36 scores improved over the three-month follow-up period, with the most pronounced improvement observed after laparoscopic treatment using the improved technologies. At 3 months, physical functioning (PF) scores ranged from 78.41 to 81.32 points after standard open surgery, from 83.12 to 85.43 points after open surgery using the improved technologies, and from 91.23 to 93.25 points after laparoscopic surgery. A similar pattern was observed across the other SF-36 domains, with most between-group differences reaching statistical significance (p<0.001).

## DISCUSSION

The results of this study indicate that the comprehensive use of modern diagnostic and surgical technologies in ASBO is associated with improved short-term treatment outcomes. In the study group, the rate of successful laparoscopic adhesiolysis increased, while the need for bowel resection and the rates of postoperative complications and repeat operations were lower than in the control group; a trend toward a lower rate of intestinal stoma formation was also observed. These findings are consistent with systematic reviews and meta-analyses demonstrating that laparoscopic adhesiolysis is associated with a lower overall complication rate (OR=0.42; 95% CI, 0.25-0.70; p<0.01) and a shorter duration of paralytic ileus compared with the open approach [6]. In the WSES consensus document by Sermonesi et al. (2023), based on the available systematic reviews and meta-analyses, laparoscopic adhesiolysis in selected patients with ASBO is

 

reported to be associated with lower 30-day mortality, fewer severe postoperative complications, and fewer early unplanned reoperations, without an increase in the rate of iatrogenic bowel injury [5].

The results obtained are consistent with current data on the potential advantages of a minimally invasive approach in carefully selected patients with postoperative adhesive small bowel obstruction. In a large-scale analysis of the outcomes of surgical treatment of small bowel obstruction (SBO) over a 10-year period, use of a minimally invasive approach was associated with a lower rate of postoperative complications, lower in-hospital mortality and a shorter hospital stay; after multivariable adjustment, the minimally invasive approach remained independently associated with a reduced risk of complications. At the same time, the authors emphasize the need for careful patient selection, taking into account age, comorbidity and the complexity of previous operations [7].

In the study group, conversion of laparoscopic surgery to laparotomy was required in 8 patients. The results obtained should be considered in the light of the differentiated selection of patients for laparoscopic treatment, since the extent of the adhesive process and the difficulty of safely dissecting the bowel loops are important factors determining whether the operation can be completed laparoscopically [8]. In all the patients who underwent conversion, the postoperative period ended in recovery, with no deaths.

Predicting the success of laparoscopic adhesiolysis remains a relevant issue. In a retrospective study of 168 patients with ASBO, Morelli et al. (2024) analyzed the clinical and radiological factors associated with the need for conversion. In multivariable analysis, the independent predictor of conversion was the CT small bowel feces sign [9]. Wang et al. (2025) demonstrated the value of a comprehensive preoperative assessment of risk factors for predicting conversion and selecting the optimal surgical approach [10]. Taken together, these data underline the importance of well-founded patient selection for laparoscopic treatment and of timely decision-making on conversion to an open approach.

Hydrojet dissection was used as one component of the improved surgical algorithm aimed at the precise division of adhesions and the minimization of bowel wall trauma. The lower bowel resection rate in the study group (14.57% vs. 25.15%; OR=0.51; 95% CI 0.29-0.90; p=0.02) may indicate the potential advantages of precise tissue division within a comprehensive surgical approach [11]. At the same time, the study design does not allow the contribution of hydrojet dissection to the clinical effect obtained to be assessed in isolation.

A separate component of the improved surgical approach was the author's own method of peritonization of extensive longitudinal injuries to the serous membrane of the bowel (Ukrainian patent UA146063). The method involved restoration of the serosal covering with an inverting seromuscular suture, with the knots and thread ends placed beneath the serous membrane, which made it possible to create a smooth bowel wall surface without substantial deformation or narrowing of its lumen. A potential advantage of this approach is reduced trauma to the injured area and reduced contact of the suture material with the peritoneum, which may help to lower the risk of recurrent adhesion formation and the associated postoperative complications. At the same time, within this study the independent contribution of the peritonization method to the overall reduction in the complication rate was not assessed separately; the clinical effect obtained should be regarded as the result of the comprehensive application of the improved diagnostic and treatment algorithm.

The results obtained confirm the value of the early use of modern imaging methods and of a differentiated choice of surgical strategy. The use of computed tomography, Doppler ultrasound, measurement of intra-abdominal pressure and laparoscopic exploration made it possible to detect signs of ischemic bowel injury in a timely manner and to determine the optimal extent of surgery. These data are consistent with the differentiated approach to the choice of treatment strategy used in our study [12].

No less important is the timely determination of the moment to proceed to surgical treatment. According to a recent systematic review and meta-analysis, early surgery in appropriately selected patients with SBO was associated with reductions in mortality, the bowel resection rate and the overall number of complications, whereas prolonged delay of surgery when conservative treatment was ineffective was accompanied by worse outcomes. These data support the differentiated approach used in our study, based on a comprehensive assessment of the clinical picture, signs of bowel ischemia, intra-abdominal pressure and imaging findings [13].

It is important to emphasize that the improvement in treatment outcomes cannot be attributed to a single component of the improved algorithm alone. In the study group, modern radiological diagnostic methods, the laparoscopic approach, hydrojet dissection of adhesions and the author's own methods of preventing intraoperative bowel wall injury and

recurrent adhesion formation were introduced simultaneously. The clinical results obtained should be regarded as associated with the comprehensive application of these approaches, without the possibility of determining the independent contribution of each component of the algorithm.

The influence of the time factor on the results obtained deserves particular attention. By its very nature, a comparison of the 2006-2012 and 2013-2019 cohorts does not make it possible to separate completely the effect of the algorithm introduced from the general development of surgical and anesthetic practice, the accumulated experience of the operating team and improvements in intensive care and postoperative management. At the same time, a number of circumstances limit the likelihood that the differences obtained are due solely to a temporal trend. Both cohorts were treated at the same institution and by the same clinical team, with unchanged inclusion criteria and diagnostic verification procedures; the cohorts proved comparable in age, sex, stage of the clinical course of ASBO, cause of adhesion formation, time to admission, grade of intra-abdominal hypertension and body mass index, that is, in the factors with the greatest prognostic influence in ASBO. In addition, the difference in the rates of wound and intra-abdominal complications (an approximately threefold reduction) substantially exceeds the effect size usually associated with the general improvement of perioperative management over a comparable period. A further argument is that the most pronounced differences concern outcomes directly related to surgical trauma and adhesiolysis technique (resection rate, wound complications, early adhesive obstruction), whereas outcomes less sensitive to surgical technique, in particular in-hospital mortality, did not change significantly. Nevertheless, the influence of temporal changes cannot be completely excluded, and this is precisely why the results obtained are interpreted as an association rather than as a proven causal relationship.

Assessment of the long-term outcomes using the SF-36 showed more pronounced functional recovery in patients after laparoscopic treatment using the improved technologies. Advantages were observed both in the physical health components, in particular PF, RP, BP and GH, and in the social and emotional domains SF, RE and MH. At the same time, the SF-36 results should be interpreted with caution, since the analysis was performed in specially formed subgroups according to the type of operation, and the method of data collection differed between the control and study cohorts, which creates a risk of selection bias and recall bias.

At the same time, the long-term advantages of the laparoscopic approach remain a matter of debate. At the 5-year follow-up of the LASSO randomized trial, no statistically significant differences were found between laparoscopic and open adhesiolysis in the rates of recurrent bowel obstruction, incisional hernias or quality-of-life scores on the SF-36. This indicates that the short-term functional advantages of laparoscopy do not necessarily translate into a long-term benefit, and it underlines the need for cautious interpretation of our SF-36 results and for further prospective studies [14].

Comprehensive preoperative risk stratification is of particular importance in the choice of treatment strategy in bowel obstruction. A large multicenter study by Schulwolf et al. (2023), which included 4,478 cases of confirmed SBO, demonstrated the possibility of predicting the need for surgical treatment on the basis of a combination of the patient's clinical characteristics [15]. At the same time, the results of a prospective multicenter study by Paisant et al. (2023) confirmed the prognostic value of CT criteria for determining the risk of failure of conservative management of ASBO [16]. Current review data also emphasize the need for the combined use of clinical, laboratory and imaging criteria in preoperative decision-making in patients with ASBO [17]. These points are consistent with the principles of the diagnostic and treatment algorithm we propose, according to which the surgical strategy was chosen on the basis of a comprehensive assessment of the patient's condition and the results of instrumental investigations.

The timely identification of patients with a high likelihood of failure of conservative therapy remains an important task. Ng et al. (2023) found that the presence of a distinct transition point and of free intra-abdominal fluid on CT, as well as the absence of the small bowel feces sign, were predictors of the need for surgery [18]. A promising direction is the use of integrated clinical and radiological prognostic models: a proposed and prospectively validated risk scoring system made it possible to identify patients with an increased likelihood of failure of conservative treatment and of a need for surgery [19]. At the same time, the results of a comparative study by Yamamoto et al. (2022) using propensity score matching demonstrated a shorter postoperative hospital stay after laparoscopic surgery than after open surgery, with no statistically significant differences in postoperative morbidity, mortality or recurrence [20]. Taken together, these data confirm the need for an individualized choice of treatment strategy, taking into account the risk of

 

failure of conservative treatment and the feasibility of performing laparoscopic surgery safely.

## CONCLUSIONS

The comprehensive use of modern diagnostic methods, laparoscopic adhesiolysis, hydrojet dissection of adhesions and the author's own surgical techniques in the treatment of ASBO is associated with improved immediate treatment outcomes compared with conventional approaches.

In the study group, compared with the control group, statistically significant reductions were found in the rates of bowel resection (14.57% vs. 25.15%; OR=0.51; 95% CI 0.29-0.90; p=0.02), postoperative wound complications (6.62% vs. 20.24%; OR=0.28; 95% CI 0.13-0.59; p<0.001) and intra-abdominal complications (7.28% vs. 22.08%; OR=0.28; 95% CI 0.14-0.57; p<0.001). The rate of intestinal stoma formation was also lower in the study group (8.61% vs. 14.72%), although this difference did not reach statistical significance (OR=0.55; 95% CI 0.27-1.11; p=0.09).

In the study group, wider use of the laparoscopic approach in combination with modern diagnostic and surgical technologies was associated with a higher proportion of organ-preserving procedures and better short-term treatment outcomes. In-hospital mortality was lower in the study group, although the difference did not reach statistical significance.

Assessment of quality of life using the SF-36 questionnaire demonstrated higher scores across several domains in patients who underwent laparoscopic adhesiolysis using the improved technologies than in those who underwent standard open surgery (p<0.001 for most comparisons).

These findings support the potential value of a comprehensive approach combining modern diagnostic and surgical technologies in the treatment of patients with ASBO. Prospective multicenter studies are warranted to confirm the effectiveness of the proposed algorithm and to determine the independent contribution of its individual components.

### Article Declarations

**Prospects for further research.** Further research should be aimed at the prospective multicenter validation of the proposed diagnostic and treatment algorithm, the evaluation of its effectiveness in different clinical groups of patients with postoperative adhesive small bowel obstruction, and the determination of the independent contribution of its individual components – in particular laparoscopic adhesiolysis, hydrojet dissection and the author's own surgical techniques – to the immediate and long-term outcomes of treatment.

**Study limitations.** The author of the manuscript explicitly acknowledges that the limitations of this study arise from its single-center design, the retrospective nature of the control cohort and the availability of the primary data. At the same time, the results of the study must be interpreted in the light of its limitations. The comparison was made between retrospective groups of patients treated in different time periods. Therefore, alongside the implementation of the improved diagnostic and treatment algorithm, the results may have been influenced by the general development of surgical technologies and anesthetic management, the accumulation of clinical experience and improvements in the postoperative management of patients. At the same time, the comparability of the groups in the main available baseline clinical and demographic characteristics and the large volume of clinical material increase the validity of the comparative analysis performed, but do not eliminate the potential influence of temporal and other unaccounted confounding factors. Because of the retrospective nature of the control cohort and the unavailability of the complete set of individual primary data for a repeat multivariable analysis, adjusted effect estimates were not calculated. Unadjusted ORs with 95% CIs are reported for the main binary endpoints. Baseline comparability was assessed using the main clinical and demographic characteristics. At the same time, the impossibility of full adjustment for potential confounding factors, in particular age, comorbidity, ASBO severity and time to admission, entails a risk of residual confounding, which should be taken into account when interpreting the results obtained. A further limitation is that the quality-of-life analysis using the SF-36 was performed in a specially formed sample of 180 patients rather than in the entire study cohort, which does not allow selection bias to be completely excluded. At the same time, complete SF-36 data at all three time points were available for all the patients included in this analysis, and no losses to follow-up were recorded over the 3 months. In the control cohort, SF-36 data were obtained retrospectively by telephone interview, which may have been accompanied by recall bias. The main limitation is the non-randomized design, with the groups formed according to the calendar period of treatment. Such a design does not make it possible to separate the effect of the algorithm introduced from temporal changes in surgical strategy, anesthetic management, intensive care and postoperative care and from the accumulated clinical experience of the operating team, or from possible changes in the pattern of primary hospital admissions over the 14 years. The retrospective nature of the control cohort additionally entails a risk of incomplete documentation of some mild complications, which could have led to their underestimation specifically in the control group and, accordingly, to a conservative bias in the effect estimate. Multivariable analysis was not performed because the complete set of individual covariates of the retrospective cohort could not be reconstructed and because the number of events for the main endpoints was insufficient to build a stable model; the ORs reported are unadjusted and therefore do not eliminate the potential influence of age, comorbidity, ASBO severity, time to admission and other unaccounted factors. The proportion of patients with comorbidity was somewhat lower in the study group (47.68% vs. 58.90%; p=0.060), which may have partly contributed to the better outcomes. The independent contribution of the individual components of the algorithm (the

laparoscopic approach, hydrojet dissection, the author's own peritonization method) to the overall clinical effect was not assessed separately. The quality-of-life analysis was performed in 180 (57.32%) of the 314 patients, in specially formed subgroups the allocation between which was not randomized, and the data for the control cohort were obtained retrospectively by telephone interview, which entails a risk of both selection bias and recall bias; in particular, a retrospective assessment of the condition at discharge after a long interval may differ systematically from prospective questionnaire administration. The analysis of current scientific sources for comparison with the results obtained was carried out using a search strategy covering the PubMed (https://pubmed.ncbi.nlm.nih.gov/), Scopus and Web of Science databases.

**Primary data and materials.** The primary clinical data on which the study was based were obtained from the medical records of the patients, which are held at the Municipal Non-Profit Enterprise "Kyiv City Clinical Hospital No. 1". Data processing and analysis were carried out in compliance with the requirements of Ukrainian legislation on the protection of personal data and with the principles of confidentiality.

**Research ethics.** The study was conducted in accordance with the principles of the Declaration of Helsinki of the World Medical Association and the requirements of Ukrainian healthcare legislation. For the prospective part of the study, informed consent to participation in the study and to the processing of clinical data was obtained from the patients. The use of medical record data for the retrospective part of the study was approved by the bioethics committee.

**Declaration of AI use.** In preparing the manuscript, the author used artificial intelligence tools exclusively for the linguistic and stylistic editing of the text, for improving the structure of the manuscript and for checking the academic style of presentation. All clinical data, the statistical analysis, the interpretation of the results, the scientific conclusions and the final content of the article belong entirely to the author. The author did not use artificial intelligence tools to create or modify primary scientific data, statistical results or clinical conclusions.

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**Conflict of interest.** The author declares that there is no conflict of interest related to the preparation, conduct and publication of this study. The author has no financial, commercial or other personal relationships that could influence the interpretation of the results obtained. The study was conducted in accordance with the principles of academic integrity and objectivity.

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# КОМПЛЕКСНИЙ ЛІКУВАЛЬНО-ДІАГНОСТИЧНИЙ АЛГОРИТМ У ХІРУРГІЧНОМУ ЛІКУВАННІ ПІСЛЯОПЕРАЦІЙНОЇ ЗЛУКОВОЇ КИШКОВОЇ НЕПРОХІДНОСТІ: РЕЗУЛЬТАТИ ПОРІВНЯЛЬНОГО КЛІНІЧНОГО ДОСЛІДЖЕННЯ

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РЕЗЮМЕ

**Мета.** Оцінити ефективність комплексного лікувально-діагностичного алгоритму із застосуванням лапароскопічного адгезіолізу, гідроструменевого скальпеля та авторських хірургічних методик порівняно зі стандартною лікувальною тактикою у пацієнтів із післяопераційною злуковою кишковою непрохідністю за частотою післяопераційних ускладнень, летальністю та показниками якості життя.

**Матеріали і методи.** Проведено порівняльне когортне дослідження результатів лікування 314 пацієнтів із післяопераційною злуковою кишковою непрохідністю: 163 пацієнти контрольної групи, пролікові у 2006–2012 рр. із застосуванням традиційної тактики, та 151 пацієнт досліджуваної групи, пролікований у 2013–2019 рр. після впровадження удосконаленого алгоритму. У досліджуваній групі лапароскопічний доступ застосовано у 84 пацієнтів, гідроструменевий скальпель - у 82 (54,30%). Оцінювали частоту резекцій кишечника, формування стом, післяопераційних ускладнень, повторних операцій, госпітальної летальності та показники якості життя. SF-36 оцінювали у 180 пацієнтів при виписці, через 1 та 3 місяці. Групи були зіставними за віком, статтю, стадією перебігу захворювання, строками госпіталізації та ступенем внутрішньочеревної гіпертензії. Через ретроспективний характер контрольної когорти багатофакторний аналіз не виконували; наведено нескориговані OR із 95% ДІ.

**Результати.** У досліджуваній групі частота резекцій кишечника була нижчою, ніж у контрольній: 14,57% проти 25,15% (OR=0,51; 95% ДІ 0,29-0,90; p=0,02). Частота ранових ускладнень становила 6,62% проти 20,24% (OR=0,28; 95% ДІ 0,13-0,59; p<0,001), внутрішньочеревних ускладнень, що потребували повторного втручання, -7,28% проти 22,08% (OR=0,28; 95% ДІ 0,14-0,57; p<0,001). Частота формування кишкових стом була нижчою у досліджуваній групі, але статистично незначущою: 8,61% проти 14,72% (p=0,09). Госпітальна летальність становила 1,32% проти 3,07% (p=0,28). Застосування комплексного лікувально-діагностичного алгоритму асоціювалося з нижчою частотою резекцій кишечника та післяопераційних ускладнень, ширшим використанням лапароскопічного доступу та кращими показниками якості життя.

**Висновки.** Застосування комплексного лікувально-діагностичного алгоритму асоціювалося з нижчою частотою резекцій кишечника та післяопераційних ускладнень, ширшим використанням лапароскопічного доступу та кращими показниками якості життя. Відмінності щодо частоти формування кишкових стом і госпітальної летальності не досягли статистичної значущості.

**Ключові слова:** злукова непрохідність кишечника; лапароскопічний адгезіоліз; гідроструменевий скальпель; ускладнення; якість життя.

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