# The Association of Polish Surgeons (APS) clinical guidelines for the use of laparoscopy in the management of abdominal emergencies. Part II

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## Abstract

***Introduction:*** *Over the past three decades, almost every type of abdominal surgery has been performed and refined using the laparoscopic technique. Surgeons are applying it for more procedures, which not so long ago were performed only in the classical way. The position of laparoscopic surgery is therefore well established, and in many operations it is currently the recommended and dominant method.*

***Aim:*** *The aim of the preparation of these guidelines was to concisely summarize the current knowledge on laparoscopy in acute abdominal diseases for the purposes of the continuous training of surgeons and to create a reference for opinions.*

***Material and methods:*** *The development of these recommendations is based on a review of the available literature from the PubMed, Medline, EMBASE and Cochrane Library databases from 1985 to 2022, with particular emphasis on systematic reviews and clinical recommendations of recognized scientific societies. The recommendations were formulated in a directive form and evaluated by a group of experts using the Delphi method.*

***Results and conclusions:*** *There are 63 recommendations divided into 12 sections: diagnostic laparoscopy, perforated ulcer, acute pancreatitis, incarcerated hernia, acute cholecystitis, acute appendicitis, acute mesenteric ischemia, abdominal trauma, bowel obstruction, diverticulitis, laparoscopy in pregnancy, and postoperative complications requiring emergency surgery. Each recommendation was supported by scientific evidence and supplemented with expert comments. The guidelines were created on the initiative of the Videosurgery Chapter of the Association of Polish*

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*Surgeons and are recommended by the national consultant in the field of general surgery. The second part of the guidelines covers sections 6 to12 and the following challenges for surgical practice: acute appendicitis, acute mesenteric ischemia, abdominal injuries, bowel obstruction, diverticulitis, laparoscopy in pregnancy and postoperative complications requiring a reoperation.*

***Key words:*** *acute abdomen, laparoscopy, guidelines, evidence-based medicine.*

## Introduction

Over the past three decades, almost every abdominal surgery has been performed and refined laparoscopically. Currently, consideration of laparoscopic access should be an integral part of the decision-making process for emergency surgery for all abdominal pathologies [1]. The position of laparoscopic surgery is therefore well established, and in many operations, it is currently the recommended and dominant method. The aim of the preparation of these guidelines was to concisely summarize the current knowledge on laparoscopy in acute abdominal diseases for the purposes of the continuous training of surgeons and to create a reference for opinions.

The guidelines were created on the initiative of the Videosurgery Chapter of the Association of Polish Surgeons and are recommended by the national consultant in the field of general surgery. The second part of the guidelines covers sections 6 to 12 and the following challenges for surgical practice: acute appendicitis, acute mesenteric ischemia, abdominal injuries, bowel obstruction, diverticulitis, laparoscopy in pregnancy and postoperative complications requiring an reoperation.

## Methodology

In preparing this study, the authors conducted a thorough analysis of the current literature on the management of acute surgical conditions. The summary is made through an extensive review of research from the last decades. The main goal was to select the current knowledge on the possibility of using the laparoscopic technique [2–6].

The development of these recommendations is based on a review of the available literature from the PubMed, Medline, EMBASE and Cochrane Library databases from 1985–2022, with particular emphasis on systematic reviews and clinical recommendations of recognized scientific societies and monographs [7]. Reference was made to the positions of recognized scientific societies, in particular EAES and SAGES, adapting them to the Polish health care system. A total of 388 publications were selected and analyzed and used to support the recommendations. The recommendations are general and require individual analysis and adaptation to a given clinical situation.

The process of creating recommendations was planned and carried out in the following stages:

1. Development of the document process and plan, identification and invitation of experts (J. Sobocki, M. Pędziwiatr),
2. Literature review and draft recommendations with comments (all authors),
3. Ddraft wording (all authors),
4. Correction of the draft version and preparation of the version for evaluation (J. Sobocki, A. Obcowska-Hamerska),
5. Evaluation and submitting corrections (J. Sobocki, M. Pędziwiatr, W. Hołówko, P. Major, K. Mitura, P. Myśliwiec, M. Orłowski, J. Szeliga, M. Zawadzki),
6. Wording of the revised document (all authors),
7. Reassessing and submitting corrections using the Delphi method (TCHP Expert Group),
8. Formulation of the final version of the document (all authors).

The document, consisting of 63 recommendations with comments, was reviewed by the authors (1st iteration). It was then evaluated using the Delphi method with the inclusion of a wider group of 24 experts (2nd iteration) with the following acceptance scale:

3 – Strong acceptance,
2 – Acceptance with some reservations,
1 – Acceptance with serious reservations,
0 – Rejection.

Numerous corrections and arrangements were made at the stage of document creation, thus avoiding repeated iterations at subsequent stages. It was assumed that recommendations with an average acceptance > 2 would be accepted as strong, recommendations with an average acceptance ≤ 2 and

≥ 1 as weak, and recommendations with an average acceptance < 1 would be rejected. All recommendations received an average score > 2. All expert comments were incorporated into the text. Due to the highest strength of recommendations obtained and the lack of proposals for corrections, the Delphi process was completed. The authors and invited experts participated in the process of formulating recommendations and evaluation using the Delphi method: Prof. T. Banasiewicz, Prof. A. Budzyński, Prof. A. Dziki, Prof. M.Grąt, Prof. M. Jackowski, Prof. W. Kielan, Prof. A. Matyja, Prof. M. Michalik, Prof. K. Paśnik, Prof. P. Richter, Prof. A. Szczepanik, Prof. M. Szura, Prof. W. Tarnowski, Prof. K. Zieniewicz.

## Recommendations

The summary of recommendations, average rating, indication of experts raising objections and the strength of recommendation are presented in Table I. The word "Recommend" emphasizes the recommendation sentence on which the authors have reached agreement regarding the benefits for the patient from the indicated procedure, and the recommendation should be followed only if it is possible. The word "suggest" means that the patient may benefit from the indicated treatment and should be considered in making a treatment decision. The phrase "We do not recommend" emphasizes a recommendation statement on which the authors fully agreed on the increased risk or lack of additional benefit to the patient with the indicated procedure.

## 6. Acute appendicitis

6.1. We recommend laparoscopic appendectomy for the treatment of all forms of acute appendicitis in all age groups and all body mass indexes (BMI).

Removal of the appendix for inflammation is one of the most common interventions in emergency surgery [8]. The evolution of minimally invasive techniques has made laparoscopic appendectomy possible. Due to the small incisions in the abdominal wall, laparoscopic procedures provide less post-operative pain, lower rates of wound infection, and shorter time to return to daily activities. In a 2018 Cochrane analysis, Jaschinski *et al.* evaluated a total of 85 reports involving 9,765 patients with acute appendicitis [9]. They found that after laparoscopic appendectomies compared to open appendectomies, there was significantly less pain on the first postoperative day (MD –0.75 VAS points; 95% CU –1.04 to –0.45), wound infections were less frequent (OR = 0.42, 95% CI: 0.35–0.51), but intra-abdominal abscesses were more common (OR = 1.65, 95% CI: 1.12–2.43). After minimally invasive surgery, hospital stay was shorter (MD = –0.96 days; 95% CI: –1.23 to –0.70), and patients returned to daily activities more quickly (MD = –4.97 days; 95% CI: 6.77 to –3.16) and rated their quality of life higher a few weeks after surgery.

In the guidelines published in the 2020 *World Society of Emergency Surgery*, it was emphasized that the current results of scientific analyses indicate that the most effective method of treating acute appendicitis is laparoscopic appendectomy and that the minimally invasive approach should be used in patients with suspected or confirmed appendicitis [10]. Similar recommendations were adopted and published by the EAES a little earlier [11]. Numerous publications emphasize that laparoscopic access is indicated both at the stage of searching for the cause of pain in the right lower abdomen in the differential diagnosis of acute abdominal pain and in complications of appendicitis (perforation, abscess, diffuse peritonitis) [12–15]. Bhangu *et al.* emphasize that despite the progress made in the development and availability of diagnostic methods in laboratory and imaging tests, the clinical diagnosis of acute appendicitis is still ambiguous, and laparoscopic access allows the patient to avoid unnecessary laparotomy in the event of diagnostic doubts [16].

In elderly patients, laparoscopic appendectomy should be the method of choice. The minimally invasive technique allows one to achieve a lower rate of complications and deaths also in the group of patients over 65 years of age. Elderly patients are burdened with higher morbidity, reduced physiological reserves and a weakened inflammatory response of the body, which increases the perioperative risk. Masoomi *et al.* conducted an analysis of data from a national registry of 65,464 patients over 65 years of age who underwent surgical treatment for acute appendicitis [17]. In the group of elderly people, they found significantly higher incidence of perforation of the appendix compared to younger patients (50% vs. 25%, $p < 0.01$). At the same time, to the surprise of the authors, the percentage of patients treated laparoscopically was lower in the group of older patients (52% vs. 63%, $p < 0.01$), despite the

**Table I.** Laparoscopic recommendations in the ER

| Recommendation | Rating | Strength of the recommendation |
|---|---|---|
| **6. Acute appendicitis** | | |
| 6.1. We recommend laparoscopic appendectomy for the treatment of all forms of acute appendicitis in all age groups and all body mass indexes (BMI). | 2.80 | Strong |
| 6.2. We do not recommend routine peritoneal irrigation during laparoscopic appendicitis. | 2.60 | Strong |
| 6.3. We recommend simple closure of the appendix stump (with ligature, snare, metal or polymer clip). Routine use of appendectomy stump sutures has no additional benefit. | 2.88 | Strong |
| 6.4. We do not recommend routine peritoneal drainage after laparoscopic surgery for uncomplicated or perforated appendicitis in adults without abscess or purulent peritonitis. | 2.52 | Strong |
| 6.5. We suggest laparoscopic appendectomy in each trimester of pregnancy for patients with suspected appendicitis. | 2.44 | Strong |
| **7. Acute mesenteric ischemia** | | |
| 7.1. We suggest exploratory laparoscopy when other non-invasive tests cannot exclude the suspicion of acute mesenteric ischemia (AMI). | 2.80 | Strong |
| 7.2. We suggest "second-look" exploratory laparoscopy in case of doubt about the proper blood supply to the intestine. Indocyanine green (ICG) visualization may be useful intraoperatively. | 2.71 | Strong |
| 7.3. We do not recommend laparoscopy in hemodynamically unstable patients or in cases where the use of this approach would result in a significantly prolonged or postponed procedure. | 2.88 | Strong |
| **8. Abdominal injuries** | | |
| 8.1. We do not recommend laparoscopy in patients with hemodynamically unstable abdominal injuries, gastroschisis, penetrating injuries of the anus and vagina, serious multi-organ injuries, or symptoms of diffuse peritonitis. | 2.92 | Strong |
| 8.2. We recommend laparoscopy in hemodynamically stable patients with blunt and penetrating abdominal injuries requiring further investigation. Such a procedure allows for reduction of the number of diagnostic laparotomies. | 2.84 | Strong |
| 8.3. We suggest laparoscopic repair in patients with abdominal trauma where it can be performed in accordance with general surgical principles. | 2.76 | Strong |
| **9. Bowel obstruction** | | |
| 9.1. We recommend careful pre-operative assessment of the feasibility of laparoscopic surgery, taking into account the benefits and risks of the procedure. | 3.00 | Strong |
| 9.2. We recommend a contrast-enhanced computed tomography (CT) scan of the abdomen and pelvis for preoperative assessment of the severity and cause of obstruction. | 2.76 | Strong |
| 9.3. We recommend using the open method for insertion of the first trocar during laparoscopy for bowel obstruction. | 2.80 | Strong |
| 9.4. We suggest bridging therapy in the form of stoma or stent implantation (after considering the pros and cons for each method) and postponed laparoscopic surgery in the group of patients with high surgical risk and obstruction caused by a neoplastic or inflammatory bowel tumor. | 2.48 | Strong |
| 9.5. We suggest resection with primary anastomosis in the group of patients with colonic obstruction caused by a malignant or inflammatory tumor and at low risk of complications. | 2.60 | Strong |

**Table I.** Cont.

| Recommendation | Rating | Strength of the recommendation |
|---|---|---|
| **10. Diverticulitis of the large intestine** | | |
| 10.1. We recommend assessing the stage of the disease in computed tomography of the abdomen and pelvis with contrast in patients with suspected acute complicated diverticulitis selected for surgical treatment. | 2.96 | Strong |
| 10.2. Hinchey I and II: We suggest percutaneous drainage in patients with acute diverticulitis and an abscess > 3 cm. If percutaneous drainage is not possible, we recommend laparoscopic drainage. | 2.80 | Strong |
| 10.3. Hinchey III: We recommend surgery for patients with acute diverticulitis and diffuse peritonitis. We suggest laparoscopic surgery at this stage of the disease, provided that it is performed by or under the supervision of an experienced surgeon. In a selected group of patients, an adequate operation is lavage and drainage of the peritoneal cavity. | 2.68 | Strong |
| 10.4. Hinchey IV: We recommend open surgical treatment or conversion to laparotomy in patients with acute diverticulitis and diffuse fecal peritonitis. In selected cases of hemodynamically stable patients, laparoscopic surgery can be performed by a surgeon experienced in this technique. | 2.49 | Strong |
| **11. Laparoscopy in pregnancy** | | |
| 11.1. Laparoscopy is a safe access in any trimester of pregnancy if surgical intervention is indicated. | 2.48 | Strong |
| 11.2. We recommend positioning the patient in the 2nd and 3rd trimesters on the left side or partially on the left side to minimize pressure on the inferior vena cava. | 2.80 | Strong |
| 11.3. In the first trimester of pregnancy, we recommend choosing the technique of inserting the first trocar based on the surgeon's experience. The trocar can be safely inserted using the open technique, trocar techniques with optics or after insufflation with a Veress needle. | 2.68 | Strong |
| 11.4. During the 2nd and 3rd trimesters, we recommend creating a pneumoperitoneum using the open technique. | 2.60 | Strong |
| 11.5. We recommend adjusting the intra-abdominal pressure according to the condition of the patient and the well-being of the fetus in close cooperation with the anesthesiologist. With peritoneal insufflation of $CO_2$ BPs down to 15 mm Hg is safe for most pregnant patients. | 2.68 | Strong |
| **12. Laparoscopy in the treatment of postoperative complications** | | |
| 12.1. We suggest laparoscopic reoperation after both open and laparoscopic surgery, if this access allows safe and adequate management of the complication. | 2.68 | Strong |
| 12.2. We suggest laparoscopic reoperation within 48 h of the primary surgery. The difficulty of revision increases with time after surgery. | 2.52 | Strong |
| 12.3. We suggest using a large diameter (10 mm) suction tube to remove clots from the peritoneal cavity. | 2.83 | Strong |
| 12.4. We suggest that laparoscopic reoperation in surgical complications should be performed by an experienced surgeon and, if possible, there should be intraoperative consultation with another experienced surgeon. | 2.96 | Strong |

fact that laparoscopic appendectomy in this group is associated with lower mortality and overall number of complications, shorter hospitalization, and lower treatment costs. Currently, all available studies support an absolute benefit of laparoscopic appendectomy over open appendectomy, especially in older adults with acute appendicitis [17–21]. Southgate *et al.* in a meta-analysis of 15,000 patients over 60 years of age found that laparoscopic appendectomy significantly reduced mortality (OR = 0.24;

95% CI: 0.15–0.37), postoperative complications (OR = 0.61; 95% CI: 0.50–0.73) and length of hospital stay (MD = –0.51 days; 95% CI: –0.64 to –0.37) compared to open-label [22].

Dasari *et al*., in a systematic review of the literature based on seven retrospective cohort studies and one randomized study, found that laparoscopy in obese patients was associated with lower perioperative mortality, lower rates of complications, including surgical site infection, and shorter hospital stay compared to open operations [23].

An analysis of the ACS NSQIP pediatric patient database (American College of Surgeons National Surgical Quality Improvement) showed that obesity is not an independent risk factor for postoperative complications in laparoscopic appendicitis. Despite the prolongation of the operative time, obesity did not increase the risk of postoperative complications within 30 days after surgery [24]. Katar *et al.* presented a comparison of the technique of open and laparoscopic appendectomy in patients with a BMI over 40 kg/m$^2$. The minimally invasive procedure shortened hospitalization time and reduced the risk of surgical site infection [25].

The use of the laparoscopic technique seems to be significantly more beneficial than the open method in obese patients operated on due to appendicitis. Laparoscopy makes it possible to reduce the percentage of both complications and postoperative mortality, and to shorten operative time and hospitalization.

6.2. We do not recommend routine peritoneal irrigation during laparoscopic appendicitis.

Routine peritoneal lavage has no advantage over suction alone, both in terms of the incidence of intra-abdominal abscesses and surgical wound infection in patients who have not developed diffuse purulent peritonitis. Siotos *et al.* in a meta-analysis based on five randomized trials including a total of 2,511 patients after laparoscopic appendectomy found that the use of peritoneal lavage led to longer operative time (MD = 7.16 min; 95% CI: 3.23–11.09; $p < 0.001$), but did not reduce the incidence of intra-abdominal abscesses (OR = 2.39; 95% CI: 0.49–11.74; $p = 0.28$) in both adults and children [26]. Similar conclusions were reached in the meta-analysis by Hajibandeh *et al*., including three prospective randomized analyses. The authors found that peritoneal lavage during laparoscopic appendectomy had no significant advantage over simple suctioning of the liquid content. The incidence of intra-abdominal abscesses, surgical site infections and hospital stay were similar in both groups [27]. In a meta-analysis published in 2021 by Burini *et al.* on the basis of nine prospective randomized studies covering 5,315 patients after laparoscopic appendectomy, the authors unequivocally stated that peritoneal lavage after appendectomy does not bring any benefits, but it is associated with prolonged surgery time [28].

6.3. We recommend simple closure of the appendix stump (with ligature, snare, metal or polymer clip). Routine use of appendectomy stump sutures has no additional benefit.

A review by Mannu *et al.* of the Cochrane database of 850 laparoscopic appendectomy patients compared the mechanical closure of the appendix stump (clips, stapler, and electrocoagulation) to its ligation (endoloop, Roeder loop, or other intra-abdominal techniques). There were no differences in the incidence of complications (OR = 0.97; 95% CI: 0.27–3.50), both intra- and post-operatively; however, the use of mechanical stump closure methods reduced the time of surgery compared to ligature placement (MD = –9.04 min, 95% CI: –12.97 to –5.11) [29].

Antoniou *et al*., in a meta-analysis of over 5,000 laparoscopic appendectomies from 43 RCTs, concluded that stump ligation (suture or endoloop) in minimally invasive removal of the appendix has an advantage over other methods of mechanical provision of the stump (e.g. clip) in terms of the risk of infection of the surgical site [30].

Knight *et al.* in a meta-analysis of ten studies covering a total of 702 patients after laparoscopic appendectomy ascertained that the use of polymer clips is the cheapest method of appendage stump supply, but does not significantly reduce the duration of surgery or the length of hospitalization [31].

Qian *et al*., in a meta-analysis of 2,634 laparoscopic appendectomies from eleven prospective randomized trials, compared simple ligation versus stump appendectomy. The risk of complications was similar in both groups, but in the group of patients with simple ligation alone, there was shorter operative time (MD = 8.72 min; 95% CI: 6.87–10.56; $p < 0.00001$), shorter postoperative obstruction

(MD = 2.02; 95% CI: 1.36–3.01; $p$ = 0.0005) and faster recovery (MD = 0.30; 95% CI: 0.11–0.48; $p$ = 0.002) [32].

6.4. We do not recommend routine peritoneal drainage after laparoscopic surgery for uncomplicated or perforated appendicitis in adults without abscess or purulent peritonitis.

In a Cochrane review of six prospective randomized trials involving 521 laparoscopic appendectomies, Li *et al.* assessed the effectiveness of drainage after appendectomy. They concluded that there was currently insufficient evidence that the use of drainage reduces the incidence of intra-abdominal abscesses or surgical site infections. Routine drainage, on the other hand, is associated with a higher incidence of general complications in the postoperative course and increases the length of hospital stay, but the authors emphasized that the included data were of very low scientific quality [33].

Schlottmann *et al.*, based on a retrospective analysis of 1,300 laparoscopic appendectomies, found that the use of drains compared to no drains during surgery for complicated appendicitis did not reduce the risk of abscesses (14.25% vs. 8.9%, $p$ = ns), but only prolonged hospitalization time (5.2 vs. 2.9 days, $p$ = 0.001) [34]. Fujishiro *et al.* based on a Japanese registry of 1,762 pediatric appendectomies, determined that routine drainage after laparoscopic appendectomy for complicated inflammation does not bring any additional benefits and may adversely affect infection prevention [35].

6.5. We suggest laparoscopic appendectomy in each trimester of pregnancy for patients with suspected appendicitis.

Despite the fact that laparoscopic appendectomy in pregnant women with acute appendicitis is performed more and more often worldwide, many publications still highlight the controversies regarding the safety of this access for the fetus [36, 37]. Winter *et al.* emphasize that the low strength of evidence in the available studies is the result of the analysis of heterogeneous groups of patients, because usually surgeons are more likely to use laparoscopic access in the first trimester of pregnancy and the open method in the third trimester [38].

A 2019 meta-analysis of 801 studies by Lee *et al.* revealed no difference in the impact on miscarriage rates between laparoscopic and open appendectomy (OR = 1.163; 95% CI: 0.68–1.99; $p$ = 0.581) [39]. There was also no statistically significant difference in terms of preterm birth (OR = 0.76; 95% CI: 0.51–1.15). At the same time, it was found that after laparoscopic appendectomy, hospital stay was shorter (MD = –1.01 days; 95% CI: –1.61 to –0.41) and there were fewer wound infections (OR = 0.40; 95% CI: 0.21–0.76) compared to open appendectomy. Similar results were reported by Cheng *et al.* in an analysis of 859 pregnant women treated for acute appendicitis [40]. In addition, this study showed that surgical management in this group of patients is the preferred method of management compared to conservative treatment, and due to the fact that both laparoscopic and open appendectomy are comparable in terms of maternal and fetal safety, laparoscopic access should be preferred due to lower risk of wound infection and shorter hospital stay.

In a systematic review published in 2021, Zhang *et al.* opined that, due to the higher incidence – as was still suggested in some publications – of miscarriages after laparoscopic appendectomies (OR = 1.93; 95% CI: 1.39–2.69; $p$ < 0.0001), with a similar percentage of preterm births (OR = 0.80; 95% CI: 0.48–1.34; $p$ = 0.40) compared to the open method, the final choice of the method of surgical access should be preceded by explaining to the patient all advantages and disadvantages of both accesses, and the operation should be carried out with particular attention and care [41].

## 7. Acute mesenteric ischemia

7.1. We suggest exploratory laparoscopy when other non-invasive tests cannot exclude the suspicion of acute mesenteric ischemia (AMI).

Patients with acute mesenteric ischemia constitute a small percentage of patients requiring emergency surgical intervention (less than 1% of all cases). However, due to the very high mortality rate (up to 80%), this disease is still a serious diagnostic and therapeutic challenge [42, 43].

The gold standard in the diagnosis of AMI is currently computed tomography angiography (angio-CT), with a sensitivity of 90% and a specificity of 100% [44]. Diagnostics is supplemented with laboratory tests (white blood count, lactate and D-dimers) [45–47].

If AMI is suspected, urgent surgical intervention is required after the patient's general condition has been adequately balanced. The aim of the surgical procedure is to assess the vitality of the intestines, and in the case of finding ischemia, an attempt to restore proper blood supply (revascularization). If intraoperative necrosis of a segment of the intestine is found, resection is necessary. Laparoscopic techniques are of limited use in AMI. At present, there are no published randomized controlled trials comparing the use of laparoscopy versus open surgery. Most recommendations for the use of laparoscopic techniques are based on small case series and expert opinion. It is believed that the use of laparoscopy is justified when clinical symptoms and the results of imaging and laboratory tests do not allow a proper diagnosis to be established [48]. Then laparoscopy may be a valuable diagnostic option. With less trauma compared to laparotomy, patients benefit from diagnostic laparoscopy. In addition, in some patients it is possible to confirm a diagnosis other than AMI. It should be emphasized that the use of laparoscopy as a diagnostic method should be preceded by prior noninvasive tests.

7.2. We suggest "second-look" exploratory laparoscopy in case of doubt about the proper blood supply to the intestine. Indocyanine green (ICG) imaging may be useful intraoperatively.

Deciding on the extent of resection may not be easy due to the difficulty in identifying the extent of ischemia and the potential risk of extending this extent after surgery [45]. If during exploratory laparoscopy there are doubts as to the blood supply to the intestines, indocyanine green imaging can be used in centers that have such technology [49–51]. In doubtful situations, a second look into the abdominal cavity is recommended. Due to the number of advantages of this approach, second-look laparoscopy should be considered [52]. No studies have been published to clearly determine whether this procedure should be implemented as planned in all patients or only in selected cases [53]. Bedside laparoscopy in the intensive care unit has also been described as safe [48].

7.3. We do not recommend laparoscopy in hemodynamically unstable patients or in cases where the use of this approach would result in a significantly prolonged or postponed procedure.

In the group of patients who are hemodynamically unstable, usually as a result of septic shock or in cases where the use of laparoscopic techniques would be associated with a significantly prolonged or postponed procedure, laparotomy access should be considered first [54]. In a situation where revascularization is necessary, conversion and continuation of the procedure from the classic access are required [55].

## 8. Abdominal injuries

Despite a number of advantages of laparoscopy, there is no consensus on the use of laparoscopy in the management of abdominal injuries. EAES recommends the use of laparoscopy in selected patients with blunt and penetrating abdominal trauma as a diagnostic and therapeutic tool. The low percentage of missed injuries, shorter hospital stay, faster recovery and lower costs make it an attractive and safe alternative to classic trauma laparotomy [56, 57]. Despite these benefits, such a procedure has a number of limitations.

8.1. We do not recommend laparoscopy in patients with hemodynamically unstable abdominal injuries, gastroschisis, penetrating injuries to the anus and vagina, serious multi-organ injuries, or symptoms of diffuse peritonitis.

Hemodynamic instability and shock are generally considered contraindications to laparoscopy. Evisceration, due to the essence of this pathology, makes it impossible to perform laparoscopy. In the case of penetrating injuries of the anus or vagina, laparoscopic access has limited ability to inspect the organs in this area. Multi-organ injuries were also considered as limiting factors [56, 58].

8.2. We recommend laparoscopy in hemodynamically stable patients with blunt and penetrating abdominal injuries requiring further investigation. Such a procedure reduces the number of diagnostic laparotomies.

Laparoscopy can be performed safely in hemodynamically stable patients with abdominal trauma, reducing the number of non-therapeutic laparotomies. Compared to laparotomy, it may be a less invasive method of direct examination of the peritoneal cavity and its contents, after both blunt and penetrating injuries.

The most common indications include the following clinical situations:
- assessment of peritoneal integrity in suspected penetrating injury,
- suspected gastrointestinal injury,
- suspected damage to the diaphragm,
- free fluid of unknown source/suspected mesenteric injury,
- "unclear belly" – when there is a significant discrepancy between the clinical examination and imaging studies [56, 59].

For minor bowel injuries, laparoscopic evaluation may be associated with a higher rate of missed lesion site, so great care should be taken in assessing the organs [60].

8.3. We suggest laparoscopic repair in patients with abdominal trauma where it can be performed in accordance with general surgical principles.

After the stage of laparoscopic diagnostics, one can proceed to therapeutic laparoscopy. The experience and skills of the surgeon, as well as the training of other personnel and access to the required equipment, are key factors in the successful implementation of laparoscopy in the routine management of injuries [56]. Bleeding from minor injuries to the liver or spleen can be effectively controlled with laparoscopy. Diaphragmatic injuries and stabbing puncture wounds of the gastrointestinal tract can be treated with both manual and mechanical sutures [60, 61].

## 9. Bowel obstruction

Intestinal obstruction – an acute surgical disease – in most cases is caused by an obstruction at the level of the small intestine, and in 75% of cases it is caused by postoperative adhesions [62–68]. Obstruction at the level of the large intestine is 4–5 times less frequent than at the level of the small intestine and is usually caused by a malignant or inflammatory tumor (together about 70%), followed by colonic volvulus or adhesions [69].

Minimally invasive techniques are also applicable in the treatment of obstruction, although the experience of centers and available literature in this area are limited. Many publications mention a number of advantages of this technique compared to open access, 36 including the reduction of the frequency of surgical site infections, eventrations, the formation of new intestinal adhesions or postoperative hernias. Reduction in postoperative pain, faster recovery of bowel function, shortening of hospitalization time and even reduction in postoperative mortality are also reported [63, 70–76]. Reduction of surgical trauma seems to be particularly beneficial in the group of elderly patients [77].

Most studies concern the use of minimally invasive techniques in the treatment of adhesion obstruction. Parallel to the advantages mentioned above, there is a noticeable higher percentage of intestinal resections compared to classical operations (53.5% vs. 43.4%), as well as the need for conversion in about 21–40% of cases, despite the extensive experience of operators [62, 78–81]. There are also data in the literature showing no advantage of laparoscopic operations of small bowel adhesion over open ones, with a comparable percentage of adverse events [82].

9.1. We recommend careful pre-operative assessment of the feasibility of laparoscopic surgery, taking into account the benefits and risks of the procedure.

The key to safe and successful laparoscopic surgery in all cases of intestinal obstruction is careful patient selection, taking into account the established cause of the disease and knowledge of the requirements and limitations of the method. During the procedure itself, a particularly gentle technique of manipulating the intestinal loops and dissection, controlled traction and the use of only atraumatic instruments are required. The decision to use the laparoscopic technique must take into account the cause, severity of the obstruction and the general condition of the patient. An important element is the history of numerous laparotomies (especially due to adhesion obstruction), radiotherapy and duration of symptoms. In addition to the assessment of the general condition, the physical examination should also include e.g. the presence of hernias and signs of obstruction complications. The occurrence of symptoms of diffuse peritonitis indicating ischemia or bowel perforation prompts open surgery. Circulatory or respiratory failure, which may intensify secondary to the development of pneumoperitoneum, is an absolute contraindication to laparoscopy [65, 83–85].

The main challenge in laparoscopic operations in patients with obstruction is the significant dilatation of the intestinal loops and, consequently, the reduction of the working space, which makes it difficult

to expose the surgical field. In addition, the fragility of the intestinal wall, exacerbated by distension, increases the risk of iatrogenic injuries during trocar insertion, dissection and manipulation of intestinal loops [72, 85–87]. The reported incidence of intraoperative bowel injury with dissection of adhesions is 6.3–26.9% of cases [88–90]. Moreover, difficulties with exposure and the presence of massive adhesions may additionally contribute to the delay in the diagnosis of the resulting damage to the intestinal wall [87]. In the face of such demanding intraoperative conditions, for the safety of the patient, in the absence of adequate exposure, it is necessary to decide on early replacement of the open laparoscopic technique.

Patients who have had an appendectomy in the past, with a single intestinal adhesion or with a history of no more than 2 laparotomies, have the greatest chances for a successful laparoscopic procedure [76, 86, 91]. A particularly high percentage of failures is seen in patients after operations due to adhesion obstruction, midline laparotomy and after irradiation of the pelvic organs [81, 92].

The effectiveness of the operation of intestinal obstruction caused by a foreign body in the small intestine, described in small groups, suggests the usefulness of minimally invasive surgery also in this area [93, 94].

Large intestine obstruction was a contraindication to laparoscopic procedures for a long time. Currently, these operations are acceptable, but they are still performed in a small percentage of cases, in carefully selected patients with moderate symptoms of obstruction and often after bowel decompression [95, 96].

A necessary condition for the operator, regardless of the cause of obstruction, is to have extensive experience in elective laparoscopic operations of the intestine and stomach [81, 97, 98].

**9.2. We recommend a contrast-enhanced computed tomography (CT) scan of the abdomen and pelvis for preoperative assessment of the severity and cause of obstruction.**

Preoperative assessment of the cause and location of the obstruction, its severity and the presence of complications is necessary to determine the indications for surgical treatment and to plan the intervention itself.

Physical examination allows accurate diagnosis of strangulation in less than half of cases, and therefore imaging is necessary [99]. Despite the presence of pathognomonic signs of obstruction in a certain percentage of abdominal X-rays, this classic examination shows sensitivity and specificity of 70% for this diagnosis [100, 101]. Information about the cause of the disease and about complications other than perforation of the intestine is obtained only to a limited extent. Supplementing the examination with an oral supply of a water-soluble contrast agent has therapeutic and additionally prognostic significance; it proves the ineffectiveness of conservative management in the absence of contrast transfer to the colon after 24 h [102–105].

The highest efficiency in the assessment of small bowel obstruction (approximately 90%) is achieved with CT with intravenous contrast. In addition to identifying the cause, multiplanar imaging allows one to trace dilated loops of the intestine and determine its location. Thanks to the high accuracy in assessing the features of intestinal ischemia, the presence of fluid and air in the peritoneal cavity and the symptoms of a closed loop, the test shows the greatest usefulness in determining indications for surgical treatment [106–112]. In clinical practice, the lack of wall enhancement after contrast administration is of the greatest importance for confirming intestinal ischemia. At the same time, the lack of fluid within the mesentery precludes strangulation with high probability [113].

Using the developed criteria, it is also possible to distinguish single from multiple adhesions, which allows for an approximate assessment of the risk of intestinal ischemia and iatrogenic injuries during surgery [114]. In the group of patients designated for a conservative treatment trial, oral administration of 100 ml of a water-soluble contrast agent before the examination is another indication. Control of the distribution of the contrast agent in the intestines is recommended after 4–24 h, using a plain abdominal image [114].

In colorectal tumor obstruction, contrast-enhanced CT also has the highest sensitivity and specificity in confirming and localizing the baseline lesion [96, 115, 116]. At the same time, it allows one to obtain additional information on the stage of the cancer and the presence of metastases in the liver, which influences therapeutic decisions [116].

In the diagnosis of less common causes of obstruction, such as torsion of the colon, CT again

proves its usefulness and confirms the diagnosis with almost 100% sensitivity and over 90% specificity [117, 118].

9.3. We recommend using the open method for insertion of the first trocar during laparoscopy for bowel obstruction.

At least half of the injuries to the intestines and blood vessels that occur during laparoscopic surgery take place before dissection begins, at the stage of insertion of the Veress needle, the first trocar and the creation of a pneumoperitoneum. The total rate of these events is 1.1/1000 performed operations [119]. We do not have data specific to surgery for intestinal obstruction; however, due to the significant dilatation of the intestines and the presence of post-operative adhesions, the natural consequence is that there is an increased likelihood of injury [120–122].

Meta-analyses comparing various methods of access to the peritoneal cavity during laparoscopic surgery have not shown any superiority. Due to the low quality of the evidence, the superiority or better safety profile of the open technique compared to the closed technique has not been confirmed. However, a reduction in the risk of damage to the larger network was noted when using the open method. A comparison of closed techniques showed a higher rate of pneumothorax failure with the Veress needle compared to direct trocar insertion [123].

Among the methods used to access the peritoneal cavity, insertion of a blunt trocar under visual control through the incision of the fascia and peritoneum (Hasson's method) seems to be the safest in the case of obstruction. In studies evaluating the usefulness of laparoscopy in the treatment of adhesion obstruction, the most commonly used technique for introducing the first trocar is the open method in the umbilical region. In the case of the presence of a scar in the midline or suspicion of adhesions in this area based on CT, the authors usually accessed the peritoneal cavity in the right or left abdomen [75, 81, 91, 124–126].

9.4. We suggest bridging therapy in the form of stoma or stent implantation (after considering the pros and cons for each method) and postponed laparoscopic surgery in the group of patients with high surgical risk and obstruction caused by a neoplastic or inflammatory bowel tumor.

Both the emergence of a stoma and the implantation of a self-expanding stent (SEMS – self-expandable metallic stent) allow for temporary bowel decompression with minimal surgical trauma. Both methods are justified in patients with a high risk of surgical and general complications, when urgent bowel decompression is indicated. Postponing extensive surgery in patients in a severe general condition or with advanced obstruction allows for improvement of their general condition, required nutritional preparation, supplementation of diagnostics and, as a result, effective and safe laparoscopic bowel resection. Such management is applicable mainly to patients with obstruction caused by a tumor of the left half of the colon and rectum [127–131].

As a bridge to elective surgery, SEMS and stoma creation offer better short-term and long-term outcomes compared to emergency resection. The difference concerns primarily the percentage of primary anastomoses, as well as postoperative complications, perioperative mortality and long-term results of treatment [96, 132, 133]. Maintaining high efficiency of the method requires extensive experience from the endoscopist. Due to the limited access to SEMS in Poland, the method of bridging therapy that is more often used is the creation of a loop stoma. At this stage of treatment, the choice of the emerging segment of the intestine is not without significance. In the case of tumors of the distal colon and rectum, extraction above the integument of the proximal part of the transverse colon, and not the sigmoid colon, may be easier due to its greater mobility. An additional advantage of this solution is the possibility of further use of the previously formed stoma as a protective one after tumor resection [134].

Creating a loop ileostomy in obstructions caused by a tumor of the right colon is not a commonly recommended method. Due to the risk of secondary water and electrolyte disturbances, loop ileostomy has limited therapeutic significance and may only be considered in patients with the highest surgical risk, in whom such a procedure will limit the surgical trauma [96].

There are also considerations in the literature regarding the possible impact of implanted stents on the tumor itself and the potential impact on long-term prognosis. Compared to the results of histopathological examinations of primary resected tumors, a higher percentage of tumor ulcerations, perineural invasion and lymph node metastases was

confirmed in postoperative preparations after prior stent implantation [135]. What is more, in almost 30% of cases microscopic features of perforation of the intestinal wall are visible, which theoretically increases the risk of local recurrence and septic complications [136]. Despite these reports, at present, the negative impact of SEMS on the long-term results of oncological treatment does not outweigh the benefits of obtaining time to prepare the patient for surgery and the use of the laparoscopic technique [137, 138].

**9.5. We suggest resection with primary anastomosis in the group of patients with colonic obstruction caused by a malignant or inflammatory tumor and at low risk of complications.**

Bowel resection with anastomosis is the preferred option for uncomplicated, moderately severe intestinal obstructions associated with benign and malignant colon tumors in the absence of other risk factors [96]. Primary anastomosis eliminates the need for subsequent operations and improves the patient's quality of life. With rates of anastomotic leaks similar to those reported after elective procedures, such a procedure is beneficial [97, 139–142]. During procedures using the open technique, in conditions without advanced occlusion, primary anastomosis, according to the literature, is performed in about 70% of cases alone or in combination with a protective stoma [143]. Creating a stoma is supposed to reduce the rate of anastomotic leaks, but a number of studies do not confirm this assumption [96].

In the past, colon obstruction was considered an absolute contraindication to laparoscopic surgery. Over the years, with the growing experience of operators and increasing technical capabilities, the method began to be accepted also in this area. With proper selection of patients and maintaining high standards and safety rules in specialized centers, laparoscopic resections of the large intestine make it possible to achieve long-term results not different from those obtained with open surgery [95, 97, 144, 145].

Laparoscopic resection of the colon is an attractive method of treatment not only in cases of obstruction caused by a neoplastic tumor, but also inflammatory, in the course of diverticular disease and inflammatory bowel disease [95, 97, 146].

For the feasibility and safety of the operation, the severity of the obstruction and the surgeon's sufficiently extensive experience in laparoscopic procedures are of fundamental importance, manifested, among other attributes, by manual dexterity and knowledge of various operational tactics. In order to reduce the risk of iatrogenic damage, in the face of increasing intraoperative difficulties, the key is the ability not to postpone the decision to convert the procedure to the classical technique [95, 144].

## 10. Diverticulitis of the large intestine

Conservative management is the basic treatment of diverticulitis. Surgical treatment has a place in selected cases of treatment of complications of diverticulitis and ineffective conservative management. The diverticulitis treatment strategy is based on the E classification by Hinchey *et al.* published in 1978 and then adapted to the description of computed tomography images [147]. We are currently using the 2015 modification proposed by Kaiser *et al.* [148] (Table II).

**Table II.** Hinchey classification modified by Kaiser

| Clinical stage | Image in CT |
|---|---|
| 0. Clinically mild diverticulitis | Diverticula with thickening of the colon wall |
| Ia. Limited pancolitis or limited phlegmon | Changes in pericolic tissues |
| Ib. Pericolic or mesenteric abscess | Lesions of grade Ia and pericolic or mesenteric abscess |
| II. Pelvic abscess, distant intraabdominal or retroperitoneal abscess | Lesions of grade Ia and distant abscess, usually in the pelvis |
| III. Diffuse purulent peritonitis | Free fluid or air in the abdomen, pneumoperitoneum, thickening of the peritoneum |
| IV. Diffuse fecal peritonitis | As above |

10.1. We recommend assessing the stage of the disease in computed tomography of the abdomen and pelvis with contrast in patients with suspected acute complicated diverticulitis selected for surgical treatment.

Abdominal and pelvic CT has high sensitivity and specificity in the diagnosis of diverticulitis and is the imaging test of choice in patients with suspected diverticulitis. CT confirms the diagnosis of the disease and determines its form [149]. If CT is unavailable or contraindicated (contrast allergy, pregnancy), magnetic resonance imaging or ultrasound should be performed [150, 151].

10.2. Hinchey I and II: We suggest percutaneous drainage in patients with acute diverticulitis and an abscess > 3 cm. If percutaneous drainage is not possible, we recommend laparoscopic drainage.

Patients with small abscesses, the diameter of which does not exceed 3 cm, should be treated conservatively with systemic antibiotic therapy. In the absence of treatment progress, percutaneous drainage of the abscess is recommended, especially in patients with an abscess diameter exceeding 3 cm [152, 153]. In a situation where there is no technical possibility to perform percutaneous drainage or drainage is ineffective, surgical treatment should be considered. In selected patients, laparoscopic drainage of the abscess is sufficient [154].

10.3. Hinchey III: We recommend surgery for patients with acute diverticulitis and diffuse peritonitis. We suggest laparoscopic surgery at this stage of the disease, provided that it is performed by or under the supervision of an experienced surgeon. In a selected group of patients, an adequate operation is lavage and drainage of the peritoneal cavity [155].

In patients with purulent peritonitis, surgical treatment consisting in resection of the affected section of the large intestine is the treatment of choice. The operation can be performed laparoscopically, and the choice of surgical technique depends on the surgeon's experience and assessment of the clinical situation [156]. The use of the laparoscopic technique shortens the hospital stay and reduces the number of perioperative complications compared to open procedures [157]. During laparoscopy, the decision to perform Hartmann surgery or resection with primary anastomosis is based on the risk of anastomotic leakage, similarly to open surgery. Laparoscopic peritoneal lavage and drainage is an alternative to resection and, in selected patients, avoids stoma and shortens hospital stay [158]. However, it should be remembered that this approach in less experienced surgeons carries an increased risk of reoperation due to the presence of intra-abdominal abscesses and missed bowel perforations [159].

10.4. Hinchey IV: We recommend open surgical treatment or conversion to laparotomy in patients with acute diverticulitis and diffuse fecal peritonitis. In selected cases of hemodynamically stable patients, laparoscopic surgery can be performed by a surgeon experienced in this technique.

Patients with diffuse fecal peritonitis accompanied by septic shock (hemodynamically unstable) should be operated on openly. The aim of the operation is to control the source of infection as soon as possible and stabilize the patient's condition. In this group of patients, the procedure of choice is the Hartmann procedure. In the case of hemodynamically stable patients, the choice of surgical technique depends on the surgeon's experience and assessment of the clinical situation, as in recommendation 10.3. [160, 161].

## 11. Laparoscopy in pregnancy

Laparoscopic surgery can be safely performed in pregnant patients in every trimester. Pregnancy should not be considered a contraindication to laparoscopic procedures. The mother's condition should take precedence in deciding whether surgery is necessary. Proper treatment of the mother usually benefits both the mother and the fetus.

Since the risk of fetal complications, including premature birth or spontaneous abortion, is greatly increased by maternal deterioration, emergency surgery should always be performed without undue delay, as in non-pregnant patients [162, 163].

The factor limiting the use of laparoscopy, of primary importance, should be the awareness of the surgeon's own capabilities and limitations. The surgeon should be skilled in advanced laparoscopic techniques. Surgical interventions during pregnancy should minimize the risk to the fetus and ensure the safety of the mother.

11.1. Laparoscopy is a safe access in any trimester of pregnancy if surgical intervention is indicated.

It is recommended to avoid surgery during pregnancy, which can be postponed until after delivery. In view of the need for urgent procedures, it was preferred to perform them in the second trimester, if possible, to minimize the risk of spontaneous abortion and premature delivery. These recommendations are not supported by good evidence quality. Studies indicate that pregnant patients can safely undergo laparoscopic surgery in any trimester without any increased risk to the mother or fetus [164]. Importantly, postponing necessary surgery until delivery has been shown to increase both maternal and fetal complications in some cases [165, 166].

11.2. We recommend positioning the patient in the 2nd and 3rd trimesters on the left side or partially on the left side to minimize pressure on the inferior vena cava.

When the pregnant patient is in the supine position, the uterus puts pressure on the inferior vena cava, resulting in reduced venous return to the heart, leading to reduced cardiac output with associated maternal hypotension and reduced placental perfusion during surgery. Placing the patient in the left-sided position will move the uterus away from the vena cava, improving venous return and cardiac output. If abdominal access is difficult in the full position, a partial left lateral recumbent position may be used [167]. Pregnant patients in the first trimester do not require repositioning because the small size of the uterus does not adversely affect venous return.

11.3. In the first trimester of pregnancy, we recommend choosing the technique of inserting the first trocar based on the surgeon's experience. The trocar can be safely inserted using the open technique, trocar techniques with optics or after insufflation with a Veress needle.

The fear of using closed-access techniques (Veress needle or optic trocar) is largely based on the potentially higher risk of uterine trauma. Since intra-abdominal anatomy is changed in the second and third trimesters, the position of the trocar should be changed from the standard configuration to account for the increased size of the uterus to improve access safety. If the initial abdominal access site is aligned with the fundal height and the abdominal wall is elevated during trocar insertion, both the open technique and the Veress needle can be used safely and effectively. An initial subcostal access to the abdomen using an open or closed technique is recommended to avoid interference with the uterus [166–168]. Ultrasound-guided trocar placement has been described in the literature as an additional safeguard against uterine injury [168].

Closed pneumoperitoneum can be safely performed (up to 16 weeks of gestation) by inserting a Verres needle in the left upper quadrant of the abdomen [167, 168]. Port placement in the first trimester of pregnancy is similar to that used for most laparoscopic procedures in non-pregnant patients.

11.4. During the 2nd and 3rd trimesters, we recommend creating a pneumoperitoneum using the open technique.

The location of the primary port depends on the indications for laparoscopic surgery, so the incision should be planned with particular care. The remaining ports should be introduced in an orderly manner, strictly adhering to generally accepted laparoscopic principles, with the position of the ports more cephalad.

The size of the abdomen, in the second half of pregnancy, allows the ports to be placed on the same side of the uterus. Using the one-sided (ipsilateral) method, the table is usually tilted on the contralateral side, which moves the uterus to the side and additionally frees up the operating field [167–169].

11.5. We recommend adjusting the intra-abdominal pressure according to the condition of the patient and the well-being of the fetus in close cooperation with the anesthesiologist. With peritoneal insufflation of $CO_2$, blood pressure up to 15 mm Hg is safe for most pregnant patients.

The pregnant patient's diaphragm is displaced upwards by the growing fetus, resulting in a reduction in functional residual capacity. Some authors recommend keeping intra-abdominal inspiratory pressure below 12 mm Hg to avoid deterioration of lung physiology [164]. During laparoscopy, a pressure of 15 mm Hg was used in pregnant patients with no adverse results for the patient or her fetus [169]. There have been no published data indicating the harmful effects of pneumoperitoneum $CO_2$ on human fetuses [167].

## 12. Laparoscopy in the treatment of postoperative complications

Until recently, postoperative complications requiring reoperation were treated only with the open technique. More and more publications indicate that in the hands of an experienced surgeon, laparoscopy can be not only effective, but also safe and may offer fewer complications than open surgery. Postoperative trauma is less after minimally invasive procedures, especially if it is a re-operation in a short time. However, it should be emphasized that each reoperation, especially laparoscopic, is a major challenge and should be performed by an experienced team.

12.1. We suggest laparoscopic reoperation after both open and laparoscopic surgery, if this access allows safe and adequate management of the complication.

In the study by Nielsen *et al*., the complication rate after emergency laparoscopy was not higher than after open surgery [170]. On the other hand, in the publication of Agrusa *et al*., analyzing 75 laparoscopic reoperations, effective treatment was demonstrated in 88%. Conversion to classical surgery was necessary in 12%. Only 3 out of 63 laparoscopically reoperated patients required a third operation [171].

Reoperations can be performed laparoscopically also after procedures on the large intestine. According to O'Riordan *et al*., 5% of patients required reoperation, half of which were successfully performed laparoscopically. These were operations for small bowel obstruction in 3 patients and diagnostic laparoscopy in the case of unconfirmed suspicion of leakage in 2 patients [172]. In a retrospective study by Vennix *et al.* on reoperation for anastomotic leak after colorectal surgery, the majority of patients after primary laparoscopic surgery were reoperated laparoscopically (67% of cases) [173].

In a meta-analysis of the results of 9 studies due to complications of laparoscopic colorectal surgery, it was found that laparoscopy is associated with a significantly shorter hospital stay and lower risk of death. The majority of reinterventions (64% of cases) were due to anastomotic leak and consisted of stoma extraction with or without anastomosis repair or re-anastomosis [174].

In bariatric surgery, which is currently performed almost exclusively laparoscopically, relaparoscopy seems to be the preferred method of treating complications [175]. In a multicenter retrospective study on early complications (up to 30 days) after gastric bypass and sleeve gastrectomy procedures, 31 out of 33 reoperations were performed laparoscopically, of which 2 required conversion to the classical technique [175]. The authors concluded that relaparoscopy is an effective and safe method of treating complications after bariatric surgery [176]. Laparoscopy shows the highest diagnostic value when an internal hernia is suspected [177]. Nimeri *et al.* demonstrated the advantage of laparoscopy over computed tomography in the diagnosis of internal hernias after Roux-en-Y gastric bypass. Simultaneous treatment of this complication with laparoscopic technique was possible. Only 4% of patients required conversion to classical surgery. It is worth remembering that internal hernia is also possible after gastrectomy and other types of surgery.

Ramakrishnan *et al*. demonstrated that TAPP is a safe and useful option for the treatment of complications of minimally invasive inguinal hernia surgery: recurrence, mesh infection, pubic osteomyelitis due to takers [178]. 95% of 49 procedures were successfully performed laparoscopically without significant intraoperative problems and with minimal postoperative morbidity.

Also complications after laparoscopic cholecystectomy can be treated laparoscopically. Dexter *et al.* performed 12 out of 13 laparoscopic reoperations, finding a slight bile leak in 6, subdiaphragmatic hematoma in 1, damage to the small intestine in 1, acute pancreatitis in 1, and no cause of postoperative pain in 2. All patients were reoperated on within 7 days after primary laparoscopic cholecystectomy [179].

Complications of laparoscopic appendectomy may also be an indication for reintervention. Casas *et al.* performed 41 relaparoscopies after appendectomies, finding diffuse peritonitis (36%), intra-abdominal abscess (27%), and appendicitis in 12% of cases. 85% of reoperations were completed laparoscopically, while 15% required conversion. On the other hand, 7% of laparoscopically reoperated patients required additional percutaneous drainage, and 5% of reoperations required laparotomy. All patients in this group had diffuse peritonitis during the reoperation [180].

12.2. We suggest laparoscopic reoperation within 48 h of the primary surgery. The difficulty of revision increases with time after surgery.

In the case of postoperative complications, it is very important to diagnose them early and not to postpone their treatment. Researchers from Israel found that in a group of 37 patients who were re-operated within 48 h, the mortality rate was 2.7% lower than in patients who underwent reintervention after 48 h (10%). Patients operated on early also had fewer complications and shorter stay in the hospital. 65% of reoperations were completed laparoscopically. The others were converted to a classic operation [181].

12.3. We suggest using a large diameter (10 mm) suction tube to remove clots from the peritoneal cavity.

The prognosis of postoperative hemorrhage depends on early diagnosis, preoperative correction of coagulation disorders, early revision decision, and knowledge of the most common bleeding sites [182]. Laparoscopic reoperation is effective in managing bleeding after both minor and major surgery [179, 183, 184]. The use of a suction device with a larger diameter (10 mm) facilitates the removal of organizing clots, but requires skillful use in order not to lose the stability of the pneumoperitoneum [185].

12.4. We suggest that laparoscopic reoperation in surgical complications should be performed by an experienced surgeon and, if possible, there should be intraoperative consultation with another experienced surgeon.

During the laparoscopic treatment of complications, it is beneficial to have the operator performing the original operation and an independent, laparoscopically experienced surgeon. Do not hesitate to insert additional trocars or convert to open surgery if necessary. An experienced surgeon may attempt to treat postoperative complications using the laparoscopic technique. This reduces surgical trauma and the risk of wound infection, may shorten hospital stays, and reduce the risk of complications, including death. Laparoscopy seems to be particularly beneficial in the treatment of complications after laparoscopic operations.

## Conclusions

Laparoscopy is the preferred method of surgical treatment in the emergency room, assuming the appropriate experience of the surgeon performing the operation and observing the safety rules, including the rules of conversion to laparotomy. The authors hope that the guidelines will be helpful in the daily practice of emergency room surgeons.

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