Review

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Diffuse Appendicular Peritonitis: Laparoscopic vs Open Access — Viewpoint from Aside

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ABSTRACT The perforative acute appendicitis with the development of diffuse peritonitis increases the incidence of postoperative complications to 47%, and mortality to 3%. Mortality in the case of the development of diffuse purulent peritonitis makes 4.5-58%, and it can exceed 70% in severe forms of diffuse peritonitis with the development of infectious-toxic shock and multiple organ failure.

National Clinical Guidelines for acute appendicitis with diffuse peritonitis allow for appendectomy from both the median and laparoscopic access in the absence of general contraindications to the creation of pneumoperitoneum. However, despite the proven advantages of laparoscopic appendectomy, there are opponents of its use in diffuse forms of appendicular peritonitis.

An increased number of postoperative abscesses with a minimally invasive approach has been reported in literature; however, recent randomized studies refute this fact. There is also evidence that the laparoscopic method for appendicular peritonitis often leads to a lengthening of the operation time and higher operating costs, but at the same time there is a decrease in postoperative pain syndrome, a reduction in the length of inpatient treatment and early social and labor rehabilitation, which leads to an overall decrease in hospital costs.

Thus, to date, there is no generally accepted opinion about the advisability of laparoscopic access for appendicular peritonitis. At the moment, the presence of diffuse peritonitis is the most common intraoperative reason for refusing a minimally invasive surgical treatment. However, there is a tendency to trying to standardize indications and contraindications, which was the objective of our literature review.

Keywords: laparoscopy, appendicular peritonitis, peritoneal lavage, antibiotic therapy

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IAI – intra-abdominal infection scale
LA – laparoscopic appendectomy
MPI – Mannheim Peritonitis Index
OA – open appendectomy
PIA – Peritonitis Index Altona
SAS – Surgical Apgar Score
SIRS – Systemic Inflammatory Response Syndrome
SSI – surgical site infection

Acute appendicitis is the most common acute surgical disease and, despite the fact that there is a significant reduction in its share in urgent practice (from 40.3% in 2000 to 24.8% in 2019); it still ranks first in terms of incidence and operational activity. In 2019, the overall lethality rate for this condition in Russia was 0.13%, of which 0.12% was postoperative [1-3]. The perforated acute appendicitis form with the development of advanced peritonitis increases the incidence of postoperative complications to 47%, and the postoperative lethality to 3% [4, 5].

Destructive appendicitis, according to national clinical guidelines, leads to the development of appendicular peritonitis in more than 20% of cases. The overall lethality rate in the case of widespread diffuse purulent peritonitis is 4.5-58%, and in severe forms with the development of sepsis and multiple organ failure, it reaches 70% or more [6-8].

In various Russian and foreign clinical guidelines, the "gold standard" for differential diagnosis of urgent abdominal pathology, including suspected appendicular peritonitis, is the diagnostic laparoscopy. This approach is effective and safe, associated only with minimal surgical trauma and reduces the incidence of intraabdominal and wound complications in the absence of contraindications to its use, the absolute one being a high operational and anesthetic risk on ASA V Physical Status Classification System [9-18]. However, in a number of hospitals, median laparotomy is considered the leading approach for the treatment of disseminated forms of appendicular peritonitis. The choice of this access is interpreted by its proven safety and efficacy, as well as the potential of making surgical intervention for a shorter time [19-22].

The main principles in the treatment of patients with advanced peritonitis were developed by the German surgeon M. Kirschner at the end of the XX century. The main postulate has been the control of the infection source: elimination of the peritonitis source; intraoperative cleansing and drainage of the abdominal cavity; intestinal decompression - nasointestinal intubation of the intestine in a state of paresis; selection of an adequate option for completing the primary surgery and further management of the patient [9, 23].

To predict the results of appendicular peritonitis treatment, various assessment scales have been proposed in the literature; they include intraoperative characteristics of lesion severity grade and the extent of the process. Predictor that can be used include: P-POSSUM, the Mannheim Peritonitis Index (MPI), Peritonitis Index Altona (PIA and PIA II), and the WSI, Intra-Abdominal Infection (IAI) Scale from the WISS study.

Also, do not forget about domestically developed scales and systems for assessing the severity of peritonitis: the abdominal cavity index and the abdominal organs severity degree assessed by the number of bacteria in 1 ml of exudate, the peritonitis classification by the stage of the course [24-27].

The P-POSSUM score calculates the risk of surgical morbidity and mortality; it can be used to help making a well-grounded decision about surgery. It is more complete than the Surgical Apgar Score (SAS), which is calculated on the basis of 3 parameters and uses exclusively intraoperative parameters. The P-POSSUM score preoperative parameters. The predicted risk by the P-POSSUM system correlates well with the observed mortality and morbidity rates ($p<0.001$). The MPI assessment is well-suited for intraoperative assessment and selection of surgical access for appendicular peritonitis. [30, 31].

When using laparoscopic access for appendicular peritonitis, various authors have investigated the following aspects of surgical intervention: the method of treatment of the appendix stump; timing o surgery, the frequency of access conversion, as well as cleansing and drainage stage. A number of literature sources indicate that the use of endoscopic loops (Endoloops) is as safe and effective as the use of suturing devices in terms of the development of stump failures and differences in surgical site infection (SSI) and intra-abdominal infection (IAA). It should be noted that earlier studies initially reported the benefits of routine use of endo-staplers to reduce the number of complications and surgery duration. However, a subsequent analysis of the treatment results showed no differences in the incidence of intra-and postoperative complications and the duration of inpatient treatment when comparing the above two methods. Although the mechanical treatment of the stump shortened the surgery duration, it did not affect the length of inpatient treatment, the pain intensity, the timing of activation and resolution of postoperative bowel paresis, as well as the duration of antibacterial therapy.

We also conducted a study comparing the results of forming one or two ligatures on the appendix stump: there were no significant differences in the number of postoperative complications between these methods. For the perforated form of appendicitis in appendicular peritonitis, the use of Endoloops is safer (the IAA development made 12.7% after laparoscopic appendectomy [LA], 50% after open appendectomy [OA]).

Thus, there are no significant advantages in using an end-stapler compared to endoloops for the treatment of the appendix stump. In this regard, the ligature technique may be preferable to reduce financial costs when the appropriate skills and the operator learning curve are available [32-42].

To analyze the frequency of conversion of LA to OA, a number of studies were reviewed, in which parameter made 11.3% (333 patients). The reasons for conversion were presented only in 193 patients (57.9%). These include: technical difficulties during appendectomy, including those related to the infiltrative process in the surgical area (n = 50), necrosis with the perforation at the appendix base (n = 43), inability to visualize the appendix base (n = 36), widespread diffuse peritonitis (n = 33), appendicular infiltrate (n = 15), inability to complete revision and manipulation in the abdominal cavity (n = 5,), surgeon's decision (n = 4), technical difficulties associated with endosurgical equipment (n = 3), others (n = 4).

The results of this study demonstrate significant advantages of performing LA in appendicular peritonitis compared to OA (similar frequency of IAA occurrence, a significant reduction in the incidence of wound infection, respiratory complications, intestinal obstruction, LOS, and overall mortality after LA).[43].

Some literature sources report that the use of carbon dioxide to create a pneumoperitoneum increases the risk of developing cardiovascular comorbidities in elderly patients. However, a number of studies that collectively analyzed the results of treatment of more than 250,000 patients over the age of 65, with comorbid conditions and various forms of appendicular peritonitis, proved that performing LA reduced LOS, the number of postoperative complications and mortality by reducing the number of extraabdominal complications associated with decompensation of concomitant diseases [20, 44-48].

Intraoperative lavage for advanced appendicular peritonitis, according to most studies, does not provide significant benefits in terms of IAA prevention compared to simple aspiration. Meanwhile, it increases the total surgery duration by an average of 15-20 minutes, the IAA incidence to 18.3-47.6% versus 12-19.1%, the duration of antibacterial therapy and LOS due to the increased formation of postoperative abscesses. According to studies, that is due to the dissemination of purulent contents in the abdominal cavity, while cleansing solutions worsen the ability of white blood cells to bacteria phagocytosis and reduce the concentration of local inflammatory mediators, which contributes to stronger bacteria adhesion to the peritoneum. Meanwhile, there is evidence that aspiration of residual fluid after peritoneal lavage by means of abdominal drainage on the first day after surgery can reduce the IAA incidence in case of inadequate primary cleansing [39, 50-55].

According to the overwhelming majority of authors, the abdominal cavity drainage in advanced appendicular peritonitis is mandatory. However, a number of investigators report that routine drainage in certain forms (local and disseminated serous peritonitis) leads to a longer surgery duration, LOS, SSI without reducing the IAA incidence (total number of complications without drainage was 7.7% vs. 18.5%, $p = 0.01$; 4.2 days without drainage vs. 7.3 days, $p<0.0001$). Other investigators have noted a tendency to a longer persistence of postoperative intestinal paresis for a longer time in the presence of drainage in the abdominal cavity. The World Society for Emergency Surgery (WSES) in the given clinical recommendations noted that routine drainage after appendectomy for perforated and appendicular peritonitis (local and disseminated serous forms) does not prevent the development of intra-abdominal abscesses, but only prolongs an inpatient treatment. However, according to the 2018 Russian National Guidelines "Abdominal Surgical Infection", the abdominal drainage is mandatory for any form of appendicular peritonitis [39, 50, 52, 56].

An important stage in the treatment of appendicular peritonitis is rational antibacterial therapy, which is a key factor in preventing the development of postoperative complications. In the recent years, the indications for the use of antibacterial drugs in patients undergoing appendectomy, the duration and frequency of their use have been actively discussed [57-60].

Broad-spectrum antibiotics, administered 30 minutes before surgery in a single dose, reduce the number of postoperative complications such as SSI and IAA. Perioperative antibiotic therapy exceeded the placebo effect in preventing SSI and POIAA by 2.4 times without significant differences in the nature of the inflammatory process in the appendix [61].

Meanwhile, the results after 3 – 5 days of antibacterial therapy in the study group were similar to those after a longer course of antibiotics (up to 10 days) in the control group: IAA was detected in 21.8% versus 32.7% in the control group [56-60, 62, 63]. Criteria for the sufficiency of antibacterial therapy include: no symptoms of a systemic inflammatory reaction (body temperature below 38° C and above 36° C, heart rate less than 90 beats/min, respiration rate less than 20 /min, white blood cells lower 129x 109/L or over 4 x 109/L with

the stab neutrophils count lower 10%), absent multiple organ failure and recovery of gastrointestinal function, if the cause of these was associated with infection.

The necessity and timing of repeated surgical intervention for appendicular peritonitis is currently the most debated issue. Most investigators recommend making a second surgical intervention in case of unfavorable clinical and instrumental findings within the first 6-12 hours after the initial intervention. However, recent studies have indicated the benefits in the form of reduced death rate if making these interventions at earlier timing (up to 6 hours) [65-70].

The surgical strategy for re-intervention in appendicular peritonitis includes both "re-operation on demand" and "programmed re-operation" in the time interval from 36 to 48 hours in the postoperative period. There have been a number of studies proving that a timely "on-demand" intervention, as opposed to a "planned" cleansing, is the only surgical option that reduces mortality in patients with persistent intra-abdominal sepsis after primary surgery [71-75].

Currently, most surgeons consider the tactics of performing rehabilitation laparoscopy "on demand" to be a priority. It can be indicated by a complex of parameters: systemic inflammatory response syndrome (SIRS), clinical findings of bowel obstruction or peritonitis, and high fever. A comparative analysis of this method with the tactics of percutaneous drainage for IAA and sanitizing relaparotomies yielded the following results: the mean time of SIRS resolution in the laparoscopic cleansing group (2.0±2.5 days) was shorter than that in percutaneous drainage (3.25±3.1 days), and open intervention (5.2±4.1 days); LOS was 7.0±4.8 days in laparoscopic cleansing, 10.1±6.9 days in percutaneous drainage, and 8.7±6.3 days in open access. The mean duration of intravenous antibiotic administration after the intervention was significantly longer in the percutaneous drainage group (11.3±14.3 days) than in the laparoscopic cleansing group (5.8±3.6 days). The frequency of repeated hospitalizations after percutaneous drainage was higher than in the laparoscopy group. Based on these data, we can conclude that early laparoscopic cleansing in postoperative peritonitis may be an alternative to non-surgical treatment and delayed intervention in IAA, and may have better results than percutaneous drainage or open intervention [76-80].

The use of laparoscopic access for appendicular peritonitis may be associated with a longer time of surgical intervention and a higher cost of surgery. At the same time, there are conflicting literature data on the efficacy and safety of laparoscopic access in advanced appendicular peritonitis in terms of the development of postoperative complications. According to a number of authors, laparoscopy does not lead to an increased duration of surgical treatment (74.6±19.6 min in the LA group; 82.2±24.7 min in the OA group, p=0.19), but contributes to relieving postoperative pain and accelerating the intestinal paresis resolution (2.7±0.9 days in LA; 3.7±1.1 days in OA), reduces LOS (6.4±2.8 days for LA; 8.9±4.8 days for OA), all of which ultimately lead to a decrease in total hospital and social expenses [81-85]. When analyzing the literature, we found that after endosurgical intervention, the similar IAA incidence and a lower SSI incidence were noted in minimally invasive access compared to open surgery (odds ratio [OR] 1.24, CI 95%; 0.84-1.84) [86-91].

The incidence of intestinal obstruction did not exceed 1.6% after LA, and was up to 7% after OA. These figures can be explained by less pronounced trauma to the loops of the small intestine and an earlier functional recovery of the gastrointestinal tract in laparoscopic access. At the same time, OA significantly increased the incidence of eventrations, which reached 4%. This figure is significant, as about 60% of patients in these studies with disseminated forms of appendicular peritonitis were operated on using a laparotomy access. A high incidence of postoperative ventral hernias (14.6%) was also noted after OA [46, 81, 82, 85, 92-97]. Based on these data (overall odds ratio 0.33 and 95% confidence interval 0.20 to 0.55), the SSI rate was shown to be significantly lower in LA than in OA, without any difference in the IAA incidence, the overall morbidity and mortality [98-102].

Based on this analysis, the indications for the use of laparoscopic access in appendicular peritonitis have been noted as actively expanding over the recent 20 years, and the laparoscopic access itself is becoming increasingly important in emergency surgery as a "gold standard" [103-106]. However, to date, there is no generally accepted opinion on such issues as indications for conversion in the disseminated form of peritonitis, some technical aspects of the operation and the tactics for postoperative patient management in complicated course. Thus, these unsolved problems should be the subject of further study by surgeons of emergency hospitals.

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