EXPERIENCE IN SURGICAL TREATMENT OF ENTEROATMOSPHERIC FISTULAS IN THE LATE PERIOD OF POSTOPERATIVE PERITONITIS

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ABSTRACT

Background. *Enteroatmospheric fistulas (EAF) that occur during the use of the "open abdomen" surgical tactics are a complex surgical pathology with a high mortality rate.*

The aim. *To assess the effectiveness of treatment of various forms of enteroatmospheric fistulas in patients with postoperative peritonitis using vacuum aspiration technology.*

Methods. *We assessed the results of the surgical treatment of 46 patients with EAF in the late course of postoperative peritonitis (PP). Three clinical and morphological groups were distinguished: group 1 (n = 24) – EAF in small wounds of the anterior abdominal wall; group 2 (n = 15) – EAF opening into limited cavities; group 3 (n = 7) – EAF opening into laparostoma wounds. In group 1, a fistula was formed using continuous aspiration devices or VAC systems. In group 2, we used continuous aspiration of intestinal contents from the cavity. In group 3, laparostoma was treated using vacuum devices with isolation of the intestinal fistula and simulation of a floating enterostoma.*

Results. *Group 3 of patients with EAF was characterized by a high flow rate (1224.2 ± 210.3 ml), duration of treatment (87.3 ± 12.5 day), extensive laparostoma (335.4 ± 14.3 cm^2), high mortality rate (57.1 %). The best results of treatment were obtained in groups 1 and 2. The flow rate was 675.8 ± 154.3 and 541.3 ± 114.1 ml, the duration of treatment was 2 or 3 times less (37.7 ± 6.1 and 26.4 ± 5.2 days), the mortality rate was 8.3 % and 6.7 % respectively.*

Conclusion. *EAF that occur when using the "open abdomen" surgical tactics due to the impossibility of their isolation in extensive wounds of the anterior abdominal wall are complicated clinical and morphological forms. For their treatment, it is advisable to use VAC systems, aimed at the treatment of both the anterior abdominal wall wound itself and the intestinal fistula opening into it for its gradual extraterritorialization by modeling a floating enterostoma in a vacuum device.*

Key words: *postoperative peritonitis, enteroatmospheric fistula, aspiration, vacuum therapy, enterostoma*

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ОПЫТ ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ НЕСФОРМИРОВАННЫХ ТОНКОКИШЕЧНЫХ СВИЩЕЙ В ОТДАЛЁННОМ ПЕРИОДЕ ТЕЧЕНИЯ ПОСЛЕОПЕРАЦИОННОГО ПЕРИТОНИТА

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РЕЗЮМЕ

Обоснование. *Несформированные тонкокишечные свищи (НТКС), возникающие в ходе использования тактики «открытый живот», являются сложной хирургической патологией с высокой летальностью.*
Цель исследования. *Оценить эффективность лечения различных форм несформированных тонкокишечных свищей у больных послеоперационным перитонитом при использовании технологии вакуумной аспирации.*
Методы. *Проведена оценка результатов хирургического лечения 46 больных с НТКС в периоде позднего течения послеоперационного перитонита (ПП). Выделены три клинико-морфологические группы: 1-я группа (n = 24) – НТКС в небольших ранах передней брюшной стенки; 2-я группа (n = 15) – НТКС, открывающиеся в ограниченные полости; 3-я группа (n = 7) – НТКС, открывающиеся в лапаростомные раны. В 1-й группе формировали свищ с помощью аппаратов непрерывной аспирации или VAC-систем. Во 2-й группе использовалась непрерывная аспирация кишечного содержимого из полости. В 3-й группе с помощью вакуумных устройств проводилось лечение лапаростомы с изоляцией кишечного свища и моделированием плавающей энтеростомы.*
Результаты. *3-я группа больных с НТКС отличалась высоким дебитом (1224,2 ± 210,3 мл), длительностью лечения (87,3 ± 12,5 койко-дней), обширностью лапаростомы (335,4 ± 14,3 см^2), высокой летальностью (57,1 %). Лучшие результаты лечения получены в 1-й и 2-й группах. Дебит составил 675,8 ± 154,3 и 541,3 ± 114,1 мл, срок лечения был в 2–3 раза меньше (37,7 ± 6,1 и 26,4 ± 5,2 дня), летальность – 8,3 % и 6,7 % соответственно.*
Заключение. *НТКС, возникающие при использовании тактики «открытый живот» вследствие невозможности их изоляции в обширных ранах передней брюшной стенки, являются сложными клинико-морфологическими формами. Для их лечения целесообразны VAC-системы, направленные на лечение как самой раны передней брюшной стенки, так и открывающегося в неё кишечного свища для его постепенной экстерриторизации путём моделирования в вакуумном устройстве плавающей энтеростомы.*

Ключевые слова: *послеоперационный перитонит, несформированные тонкокишечные свищи, аспирация, вакуумная терапия, энтеростома*

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OBJECTIVES

To date, the problem of postoperative peritonitis (PP) continues to be one of the most important issues of practical surgery, because, despite all the recent achievements, it is the direct cause of death in 50–86 % of patients after abdominal surgery [1, 2]. The main strategy for surgical treatment of PP is currently semi-open (semi-closed) techniques, including "scheduled" and "open abdomen" (laparostomy) relaparotomies [3–7]. Along with the positive aspects, the use of open abdominal management undoubtedly leads to the development of various kinds of complications such as eventration, decreased protein, electrolytes, loss of integrity and structure of the anterior abdominal wall and the development of enteroatmospheric fistulas (EAFs), which constitute the main problem of postoperative peritonitis. The generalized EAF incidence using open abdominal tactics ranges from 1.5 % to 7 5% [8, 9]. Incidence of high EAF, including against the background of widespread peritonitis, is characterized by high mortality – from 19 % to 67 %. Lethal causes are attributed to fluid loss and electrolyte imbalance, protein loss, nutrient deficiencies, infection and sepsis [10]. There are two directions of surgical tactics in modern surgery of intestinal fistulas: radical surgical intervention in the acute period of the disease [11] and purely conservative treatment aimed at the fistula formation and its conversion into a chronic one [12]. However, the main and problematic issues in EAF treatment remain tactical approaches in cases of their late occurrence, especially at the time of their discovery in the laparostoma wounds – when active inflammation in the abdominal cavity has already ended. Such localization of fistula in the world literature is usually designated by the term "enteroatmospheric fistula", which implies an opening in the gastrointestinal tract of the open abdominal cavity without blocking it with tissues of the anterior abdominal wall [13]. The frequency rate of these fistulas increases with the duration of treatment of the patient with open abdomen and directly correlates with the number of repeated abdominal sanations, as well as with anastomotic dehiscence, intestinal ischemia, degree of distal intestinal obstruction, and adhesions [14–16].

In this regard, one of the most important components of the complex treatment of unformed intestinal fistulas are measures aimed at minimizing intestinal chyme loss [17–19]. It is difficult and sometimes impossible to reliably obturate an unformed intestinal fistula. As a rule, obturation of unformed intestinal fistulas with localizations on eventrated, protruding into the wound and covered with granulation loops does not lead to permanent success, but on the contrary, only increases the size of the fistula [20]. The best results in the treatment of patients with EAFs have been obtained using the active-aspiration system, but even here there are a number of difficulties associated with difficult to correct loss of chyme and severe destruction of abdominal wall tissue in the area of the fistula [21, 22]. The recently proposed method of vacuum therapy opens new perspectives in the treatment of patients with EAFs, first of all, allowing rapid sanation of the purulent-destructive process in the wound around the intestinal fistula, as well as promoting its rapid localization and formation [23–25].

Thus, methods of unformed intestinal fistula treatment continue to be developed and improved, including negative pressure therapy of fistula wounds, fistula obturation, use of surgical stents, etc. However, there is still no single universal method that can be applied to the treatment of certain unformed intestinal fistulas due to the peculiarities of their course. Therefore, there should be an individualized approach for each patient, depending on the clinical and morphologic form of EAFs, the level of fistula, features of development, nature and number of losses.

MATERIALS AND METHODS

Over the last 30 years, more than 350 patients with postoperative peritonitis have been treated in the clinic of hospital surgery on the basis of the purulent surgery department of the Barnaul Regional Clinical Hospital, in the treatment of which active surgical tactics of programmed abdominal cavity sanation, including the use of "open abdomen" technologies with temporary and final closure of the laparostoma wound were used. Bogota bags, negative pressure vacuum devices, and early dermal-aponeurotic sutures were used for this purpose. A total of 46 cases of unformed intestinal fistulas of the middle parts of the small intestine and ileum, opening in 3 different positions and arising after the use of the "open abdomen" technique were included in this study: on the eventrated loops of intestine in the midline wound; EAFs opening into the wound of the anterior abdominal wall; EAFs opening into the localized cavities (Table 1) (Atamanov V.V., 1985). In groups 1 and 2, patients with single incomplete intestinal fistulas prevailed, with a moderate flow rate of intestinal losses (from 200 to 400 ml per day), whereas in group 3, 4 out of 7 patients had multiple and complete enteric fistulas, and their flow rate always remained high – more than 800 ml per day [26]. The exclusion criteria included patients with unformed duodenal fistulas and colonic fistulas.

Among the patients with EAFs, 32 (69.6 %) were predominantly male. The mean age was 57.3 ± 2.6 years. All patients underwent from 2 to 5 scheduled abdominal cavity sanations for severe postoperative peritonitis. The time to fistula opening from the last surgical intervention was 12.4 ± 3.5 days. The major surgical diseases after treatment of which EAFs opened are summarized in Table 2.

In groups 1 and 2, patients with a moderate degree of protein-energy malnutrition dominated, and in group 3, the severity of these disorders was severe. Nutrition was carried out in a combined method.

TABLE 1
CLINICAL AND MORPHOLOGICAL FORMS OF ENTEROATMOSPHERIC FISTULAS

Groups	Clinical and morphological form of EAFs	*n*	%
Group 1	Fistula opening into anterior abdominal wall wounds	24	52.2
Group 2	Fistula opening into a localized purulent cavity	15	32.6
Group 3	Fistula on eventrated loops of bowel in a laparostoma wound	7	15.2
Total		46	100

There were no significant manifestations of organ dysfunction in the groups of patients with EAFs. Surgical treatment of unformed enteroatmospheric fistulas in all three groups involved the use of different variants of vacuum aspiration.

TABLE 2
PRIMARY DISEASES CAUSED THE DEVELOPMENT OF POSTOPERATIVE PERITONITIS AND UNFORMED ENTEROATMOSPHERIC FISTULAS

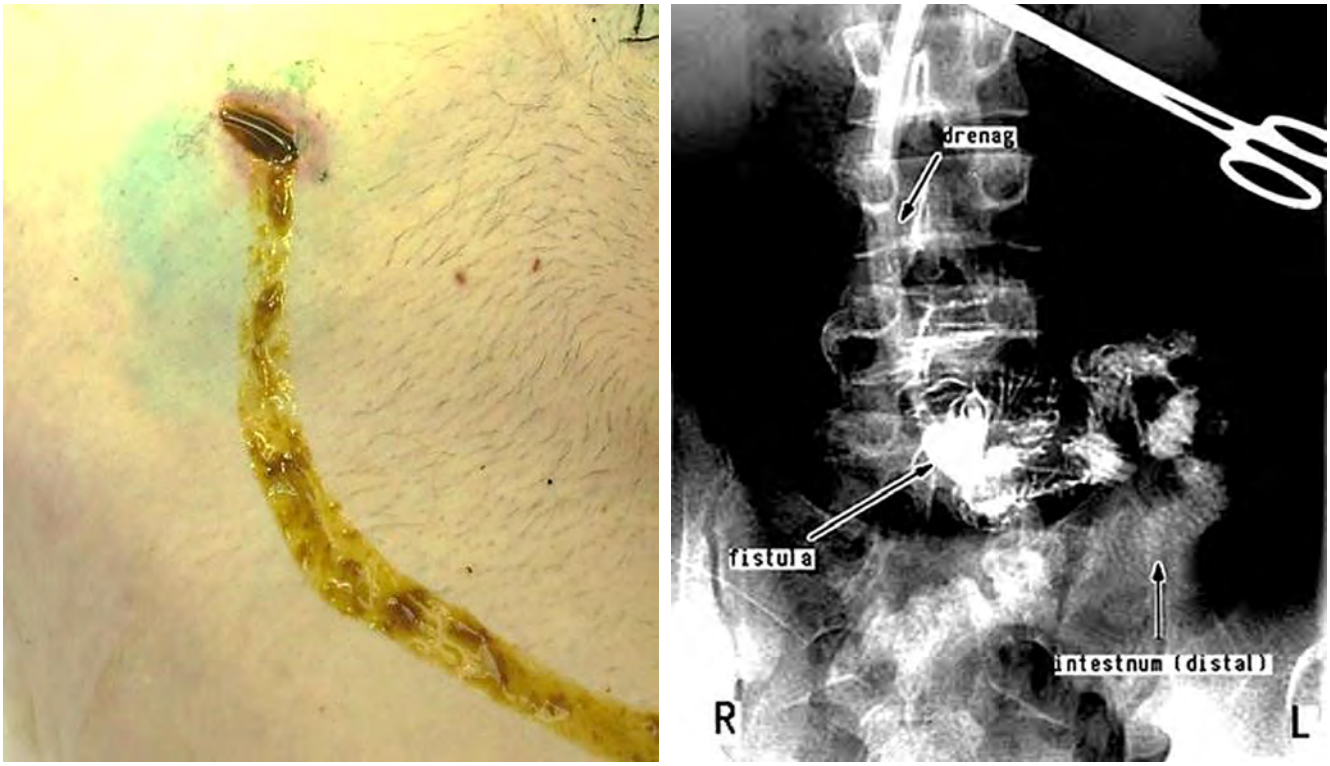
Diagnosis	*n*	%
Acute adhesive intestinal obstruction	27	58.7
Pancreonecrosis	8	17.4
Closed abdominal trauma with damage to the small intestine	5	10.9
Colon cancer	3	6.5
Incarcerated hernia	2	4.3
Acute mesenteric ischemia	1	2.2
Total	46	100

The opening of EAF into the wounds of the anterior abdominal wall ($n = 24$) occurred late in the course of peritonitis due to arrosion of the intestinal loop in a small laparostoma wound of the anterior abdominal wall in the presence of its purulent-necrotic changes with subsequent skin dermatitis due to irritation by intestinal enzymes. Continuous aspiration was used at local localization of the inflammatory process within the wound of the anterior abdominal wall and in the presence of enteroatmospheric fistulas, which was determined by the preservation of intestinal passage, small amount of small intestinal secretion, as well as the study data of barium passage through the small intestine and colon. The treatment algorithm consisted in clearing and reducing the purulent cavity where the intestinal fistula had opened, draining its contents outside the wound and reducing the phenomena of contact enzymatic dermatitis. The first stage of surgical treatment was necrectomy with secondary surgical treatment of the wound and skin suturing of its edges. This helped to reduce the size of the wound around the fistula and seal the single-lumen drainage (Fig. 1a). The continuous aspiration apparatus OP-01, creating negative pressure with a discharge range of 0.01–0.05 kgf/cm^2, was connected to it (Fig. 1b). In some cases, a modern vacuum system was simply applied to a laparostoma wound with a fistula. Aspiration devices were changed once every 3 days. All efforts were made to minimize the fistula wound by aspiration, additional secondary sutures and adapting it to the subsequent fixation of the colostomy bag.

Clinical EAF manifestations in the group 2 with fistulas opening into purulent cavities ($n = 15$), as a rule, occurred against the background of perforation of the intestinal loop in a localized purulent cavity, most often

a ***b***

FIG. 1.
EAF opening into localized wounds of the anterior abdominal wall: ***a*** *– drainage in the postoperative wound and adaptation of the colostomy bag;* ***b*** *– device for continuous aspiration from a wound with a fistula*



a ***b***

FIG. 2.
EAF opening into a localized cavity: ***a*** *– intestinal contents leakage into the drainage wound of the right iliac region;* ***b*** *– fistulography (contrast of the distal loops of the small intestine, no contrast streaks)*

a *b*

FIG. 3.

*Open abdomen: **a** – view of the abdominal cavity ("frozen abdomen") 30 days after using the "open abdomen" technique (**1** – EAF of the transverse colon; **2** – functioning complete fistula of the small intestine; **3** – ileostomy); **b** – formation of a VAC system for the healing of a laparostoma with isolation of the EAF at the left edge of the laparostoma in a hole cut over the fistula in a polyurethane sponge for subsequent fixation of a two-piece colostomy bag on it [22]*

in the pelvic cavity; they were characterized by the flow of intestinal contents into the drainage wound (Fig. 2a) with no signs of widespread peritonitis and insignificant inflammatory changes. Preserved intestinal passage was recorded clinically and by enterography; in addition, no contrast streaks on fistulography implied the presence of a localized intestinal fistula (Fig. 2b). This facilitated conservative treatment using also continuous aspiration aimed at forming a tubular fistula.

When the patient was admitted after ultrasound examination of the abdominal cavity and fistulography in the surgical dressing room, the purulent cavity was revised, its size was determined, and the depth of intestinal fistula opening was investigated. Subsequently, a double-lumen drainage up to 1.5 cm in diameter was placed along the course of the wound channel towards the intestinal fistula. Formation of a impermeable cavity around the drain was achieved by applying secondary skin sutures. Aspiration was performed using a negative pressure apparatus (OP-01). When the flow rate of intestinal contents decreased, the drain was gradually replaced with a smaller diameter and removed. Daily instillations of Betadine solution were performed in the formed tubular drainage passage and gauze strips with Levomekol ointment were placed. According to the fistula localization, high enteric fistulas were noted in 3 patients, low enteric fistulas – in 12 patients.

The most problematic group of patients ($n = 7$) were patients with EAF opening on eventrated bowel loops. The occurrence of these intestinal fistulas also occurred late in the course of PP, when the "open abdomen" technique was used, and was due to perforation of intestinal loops that were in a rough infiltrative-adhesive process – "frozen abdomen" (Fig. 3a, b).

As already mentioned, according to the classification of M. Björck et al. [13], these EAFs belong to enteroatmospheric fistulas arising in the middle of the laparostoma. Usually such an intestinal fistula occurs in the presence of tight adhesions in the "frozen" abdominal cavity, it lacks a formed fistulous passage, and there is lateralization and retraction of the edges of the anterior abdominal wall, which makes it impossible to spontaneously close or seal it. Drying of intestinal loops and microtraumatization during abdominal sanations were the most important causes of these fistulas. The intestinal contents coming out of such a fistula were difficult to control, especially if the fistula was high (proximal), with a high flow rate, lead-

ing to multiple local complications (irritation, maceration, erosion, abdominal streaks, infection). In this situation, it was of high importance to clarify the level and anatomic location of the fistula in order to properly quantify fluid and electrolyte losses, and to use enterography to determine the total length of the remaining intestine and the maximum length of proximal intestine available for absorption. A hole was formed in the polyurethane sponge that was used for vacuum therapy of the laparostoma over the intestinal fistula (Fig. 3b), through which a soft round plastic pad with a diameter of 4–5 cm was placed on the fistula. Fixation of the sponge was performed with a patch. The two-piece colostomy bag was placed over a mouth of a fistula in the sponge. From above, the wound was sealed with adhesive films and an aspiration device was placed in the center. Small negative pressure (–80 mmHg) was created in the wound using the RENASYS GO device (Smith & Nephew, UK). Vacuum devices were changed once every 3–5 days. As a result, a directed collection of intestinal contents into the colostomy bag was gradually performed, and as the laparostoma was reduced, an enterostoma was formed.

STUDY RESULTS

In group 1 patients with EAF opening into purulent wounds of the anterior abdominal wall, the flow rate of intestinal contents ranged from 300 to 600 mL and averaged 675 ± 154.3 mL. The wound size reached 64.2 ± 9.8 cm^2. Continuous aspiration of intestinal contents in most cases contributed to intestinal passage improvement, reduction of flow rate from the fistula to 100–120 mL per day and motor adaptation of patients. Gradual wound reduction with secondary-delayed sutures allowed the intestinal fistula to continue to be managed conservatively. Reducing the size of the wound with intestinal fistula to 25 cm^2 in diameter made it possible to fit a colostomy bag with the widest opening (80–100 mm), which could be replaced by the patients themselves in the future.

The duration of aspiration was 25.7 ± 4.6 days and the mean hospital bed-day was 37.7 ± 6.1 days. Among the complications, 1 patient had arterial bleeding in the area of the fistula hole, 2 patients had abscess formation under the anterior abdominal wall, and 3 patients had transition of incomplete intestinal fistula to a complete one. In general, the process of further formation of such EAFs amounted to 2.5–3 months with subsequent planned surgical treatment of the formed enterostoma (resection of the fistula-bearing intestinal loop).

The main direction of surgical treatment in the group 2 of patients with EAFs was also the gradual formation of a tubular intestinal fistula due to continuous aspiration of intestinal contents, wound exudate (contents of the abscess cavity) from the sealed cavity formed from the wound edges above the fistula opening. Intestinal secretions aspirated from the cavity did not interfere with the healing processes. Against the background of vacuum-collaboration of the cavity, the defect in the intestinal wall decreased due to filling of the purulent cavity with granulation tissue, and the drainage tube served as a skeleton for the formation of a connective tissue fistulous passage, followed by a tubular fistula over the defect in the intestinal wall (Fig. 4).

FIG. 4.
Formation of a tubular incomplete enteric fistula in the drainage wound of the left iliac region 3 weeks after continuous aspiration (the area of the wound has small manifestations of enzymatic dermatitis)

The duration of continuous aspiration was 19.4 ± 2.37 days, and the intestinal loss rate was 541.3 ± 114.1 mL. Due to the treatment 11 (73.3 %) out of 15 patients had a tubular enteric fistula with minimal flow rate (up to 20–30 mL), and in 3 (30 %) there was an independent closure of intestinal fistulas on the day 30–40. The mean bed day was 26.4 ± 5.2 days. Lethality was 6.7 % (1 patient); the cause of death was decompensation of cardiac activity.

In the group 3, treatment of extensive medial wound with negative pressure technique based on modern VAC systems was used. Considering that the laparostoma itself with intestinal fistula is also a wound, using vacuum aspiration, we also tried to reduce it. But the main challenge was to get the intestinal chyme outside the laparostoma wound. Generally, extra-territorialization of an intestinal fistula in this setting has been difficult,

but a floating stoma [27, 28] has been used in the construction, with the primary goal of forming a manageable fistula with collection of intestinal secretions separately into a colostomy bag in the laparostoma wound (Fig. 5). The mean size of the laparostoma wound where fistulas were opened was 335.4 ± 14.3 cm^2. The intestinal contents rate in group 3 EAF was 1224.2 ± 210.3 mL. Fistula formation time was 87.3 ± 12.5 days.

FIG. 5.
EAF opening into a vast laparostoma wound: extra-territorialization of the EAF at the left edge of the laparostoma wound with the installation of a colostomy bag on an enterostoma modeled in the VAC device (floating stoma) and on an ileostomy. Test of vacuum aspiration from a laparostoma (negative pressure – 120 mm Hg with its subsequent decrease to – 80 mm Hg)

Among the complications of the treatment period, arterial bleeding was noted in 2 patients, and in 2 observations – the appearance of additional intestinal fistulas in the laparostoma wound. In this group of patients, nutritional support was the most difficult task given the most commonly reported proximal location of the fistula and the large intestinal loss rate. Almost always the unformed intestinal fistula in the laparostoma was complete. It has been found that enteral nutrition can sometimes increase the flow rate of intestinal contents from EAF. Difficulties in enteral nutrition were noted when the driving small intestine was observed to be shorter than 75 cm according to enterography. However, combined nutrition with correction of the secretory function of the upper gastrointestinal tract was performed in these patients.

DISCUSSION

Given that the most important causes of unformed enteroatmospheric fistula formation in group 3 seem to be drying of the intestinal loops in contact with the external environment and microtrauma [29], all possible actions that could prevent them should be taken during treatment: 1) minimizing any rough or direct contact between the intestinal loops and the devices used for temporary abdominal closure (tissues, sponges, films); 2) avoiding prosthetic meshes, as they may cause perforation of the intestinal wall, leading to the formation of intestinal fistulas; 3) preventing drying of the intestinal loops; 4) early definitive closure of the abdomen; and 5) planning and performing dressing changes in the operating room. In addition, we should take into account the alteration of blood flow in the intestinal wall noted by us in earlier publications, leading to full blood flow in the mucous membrane of the small intestine [30]. It is caused not only by fixation and compression of intestinal loops in the wound of the anterior abdominal wall, but also by dysmetabolism associated with translocation of microflora into the intestinal wall. Therefore, we believe that the most important element in improving prognosis is the preservation of intestinal passage by enteral administration of nutrient mixtures and fractional enteral nutrition.

Treatment of the most difficult clinical and morphologic forms of unformed enteroatmospheric fistulas opening into extensive wounds of the anterior abdominal wall should be aimed at complete isolation of the fistula from the remaining open laparostoma wound; maximum atraumaticity of the materials used both for the fistula itself and for the underlying intestinal loops to avoid the occurrence of additional holes in the intestinal wall; ensuring the possibility of collection and quantification of intestinal losses, speed and ease of structures used change; protection of the surrounding tissues from the aggressive action of chyme; infection treatment and prevention.

CONCLUSION

Despite treatment, 7 (15.2 %) patients with EAFs died. The highest mortality was recorded in the group with EAFs opening into extensive laparostoma wounds – 4 (57.1 %) patients. Overall, the treatment results of patients with EAFs are summarized in Table 3.

The cause of a large number of fatal outcomes in group 3 was significant poorly managed intestinal losses in the presence of informed enteroatmospheric fistulas; repeated perforations of intestinal loops in the laparostoma. This group of patients with EAFs also differed in the duration of treatment, which was 2–3 months, resulting in the need not just to localize the intestinal fistula, but also to reduce the extensive laparostoma wound. In group 1,

TABLE 3
RESULTS OF TREATMENT OF PATIENTS WITH EAF

Parameters	Group 1 (n = 24)	Group 2 (n = 15)	Group 3 (n = 7)	p
Intestinal losses (ml)	675.8 ± 154.3	541.3 ± 114.1	1224.2 ± 210.3	$p_{1-2} > 0.05$ $p_{1-3} < 0.05$ $p_{2-3} < 0.01$
Wound size with intestinal fistula (cm^2)	64.2 ± 9.8 cm^2	12.5 ± 6.7	335.4 ± 14.3	$p_{1-2} < 0.01$ $p_{1-3} < 0.01$ $p_{2-3} < 0.0001$
Duration of aspiration (days)	25.7 ± 4.6	19.4 ± 2.3	67.3 ± 7.5	$p_{1-2} > 0.05$ $p_{1-3} < 0.001$ $p_{2-3} < 0.001$
Bed day (days)	37.7 ± 6.1	26.4 ± 5.2	87.3 ± 12.5	$p_{1-2} > 0.05$ $p_{1-3} < 0.01$ $p_{2-3} < 0.001$
Patients died, n (%)	2 (8.3)	1 (6.7)	4 (57.1)	$p_{1-2} > 0.05$ $p_{1-3} < 0.05$ $p_{2-3} < 0.05$

Note. p – statistical significance of differences between groups.

2 (8.3 %) patients died and in group 2, 1 (6.7 %) patient died. Death occurred as a result of the development of purulent-septic complications, formation of complete intestinal fistulas with the development of severe protein-energy malnutrition.

CONCLUSIONS

The use of "open abdomen" surgical tactics in patients with postoperative peritonitis is often accompanied by the opening of unformed enteroatmospheric fistulas. The most challenging clinical and morphologic forms among them are complete EAFs occurring in extensive laparostoma wounds, which are difficult to isolate in the stiff granulation tissue of vast wounds of the anterior abdominal wall, resulting in new perforations and total skin dermatitis. EAFs that open into small anterior abdominal wall wounds and localized purulent cavities while maintaining passage downstream of the fistula can be effectively treated conservatively with a variety of continuous aspiration options. In case of EAF in large laparostoma wounds, it is advisable to use VAC-systems aimed at treating both the wound of the anterior abdominal wall and the intestinal fistula opening into it with the aim of its gradual exteriorization by simulating a floating enterostoma in the device.

Conflict of interest
The authors of this article declare the absence of a conflict of interest.

REFERENCES

1. Bassetti M, Eckmann C, Giacobbe DR, Sartelli M, Montravers P. Post-operative abdominal infections: epidemiology, operational definitions, and outcomes. *Intensive Care Med*. 2020; 46(2): 163-172. doi: 10.1007/s00134-019-05841-5

2. Sartelli M, Coccolini F, Kluger Y, Agastra E, Abu-Zidan FM, et al. WSES/GAIS/SIS-E/WSIS/AAST global clinical pathways for patients with intra-abdominal infections. *World J Emerg Surg*. 2021; 16(1): 49. doi: 10.1186/s13017-021-00387-8

3. Sigua BV, Zemlyanoy VP, Kotkov PA, Ignatenko VA. Comparison of the effectiveness of planned and «on-demand» relaparotomies in patients with secondary diffuse peritonitis (review

of literature). *Grekov's Bulletin of Surgery.* 2021; 180(6): 96-104. (In Russ.). doi: 10.24884/0042-4625-2021-180-6-96-104

4. Avakimyan VA, Karipidi GK, Avakimyan SV, Aluhanyan OA, Potyagajlo EG, Marchenko NV, et al. Programmed relaparotomy in the treatment of general purulent peritonitis. *Kuban Scientific Medical Bulletin.* 2017; (6): 12-16. (In Russ.). doi: 10.25207/1608-6228-2017-24-6-12-16

5. Vachev AN, Koryttsev VK, Sherbatenko VYu, Skupchenko SS, Krasnoslobodtsev AM. Indications for the programmed remedial relaparotomies in diffuse peritonitis. *Grekov's Bulletin of Surgery.* 2019; 178(5): 89-94. (In Russ.). doi: 10.24884/0042-4625-2019-178-5-89-94

6. Scriba MF, Laing GL, Bruce JL, Sartorius B, Clarke DL. The role of planned and on-demand relaparotomy in the developing world. *World J Surg*. 2016; 40(7): 1558-1564. doi: 10.1007/s00268-015-3379-8

7. Coccolini F, Montori G, Ceresoli M, Catena F, Moore EE, Ivatury R, et al. The role of open abdomen in non-trauma patient: WSES consensus paper. *World J Emerg Surg*. 2017; 12(1): 39. doi: 10.1186/s13017-017-0146-1

8. Di Saverio S, Tarasconi A, Inaba K, Navsaria P, Coccolini F, Costa Navarro D, et al. Open abdomen with concomitant enteroatmospheric fistula: Attempt to rationalize the approach to a surgical nightmare and proposal of a clinical algorithm. *J Am Coll Surg*. 2015; 220: 23-33. doi: 10.1016/j.jamcollsurg.2014.11.020

9. Ramsay PT, Mejia VA. Management of enteroatmospheric fistulae in the open abdomen. *Am Surg*. 2010; 76: 637-639

10. Prichayudh S, Sriussadaporn S, Samorn P, Pak-Art R, Sriussadaporn S, Kritayakirana K, et al. Management of open abdomen with an absorbable mesh closure. *Surg Today*. 2011; 41(1): 72-82. doi: 10.1007/s00595-009-4202-7

11. Grigoryev EG, Kogan AS. *Surgery for severe purulent processes.* Novosibirsk: Nauka; 2000. (In Russ.).

12. Krieger AG, Kubyshkin VA, Berelavichus SV, Gorin DS, Caldarov AR, Gogiya BSh, et al. Surgical treatment of patients with enteric fistulae. *Pirogov Russian Journal of Surgery*. 2015; 12: 86-95. (In Russ.).

13. Björck M, Kirkpatrick AW, Cheatham M, Kaplan M, Leppäniemi A, De Waele JJ. Amended classification of the open abdomen. *Scand J Surg.* 2016; 105(1): 5-10. doi: 10.1177/1457496916631853

14. Marinis A, Gkiokas G, Argyra E, Fragulidis G, Polymeneas G, Voros D. "Enteroatmospheric fistulae" – gastrointestinal openings in the open abdomen: A review and recent proposal of a surgical technique. *Scand J Surg*. 2013; 102(2): 61-68. doi: 10.1177/1457496913482252

15. Bradley MJ, Dubose JJ, Scalea TM, Holcomb JB, Shrestha B, Okoye O, et al. Independent predictors of enteric fistula and abdominal sepsis after damage control laparotomy: Results from the prospective AAST Open Abdomen registry. *JAMA Surg*. 2013; 148(10): 947-954. doi: 10.1001/jamasurg.2013.2514

16. Becker HP, Willms A, Schwab R. Small bowel fistulas and the open abdomen. *Scand J Surg*. 2007; 96: 263-271. doi: 10.1177/145749690709600402

17. Terzi C, Egeli T, Canda AE, Arslan NC. Management of enteroatmospheric fistulae. *Int Wound J*. 2014; 11(1): 17-21. doi: 10.1111/iwj.12288

18. Kirshtein B, Mizrahi S. Vacuum-assisted management of enteroatmospheric fistula within the open abdomen. *Am Surg.* 2014; 80: 209-210.

19. Ribeiro-Junior MAF, Yeh DD, Augusto SS, Elias YGB, Néder PR, Costa CTK, et al. The role of fistuloclysis in the treatment of patients with enteroatmospheric fistulas. *ABCD Arq Bras Cir Dig*. 2021; 34(2): e1605. doi: 10.1590/0102-672020210002e1605

20. Kanshin NN. *Unformed intestinal fistulas and purulent peritonitis.* Moscow: Bioinformservis; 1999. (In Russ.).

21. Layec S, Seynhaeve E, Trivin F, Carsin-Mahe M, Dussaulx L, Picot D. Management of entero-atmospheric fistulas by chyme reinfusion: A retrospective study. *Clin Nutr*. 2020; 39(12): 3695-3702. doi: 10.1016/j.clnu.2020.03.030

22. Bobkiewicz A, Walczak D, Smoliński S, Kasprzyk T, Studniarek A, Borejsza-Wysocki M, et al. Management of enteroatmospheric fistula with negative pressure wound therapy in open abdomen treatment: A multicentre observational study. *Int Wound J*. 2017; 14: 255-264. doi: 10.1111/iwj.12597

23. Doday VA, Borisov DL, Terushkova ZI. Experience in vacuum therapy of incomplete intestinal fistula treatment. *Wounds and Wound Infections. The Prof. B.M. Kostyuchenok Journal.* 2016; 3(4): 24-33. (In Russ.). doi: 10.25199/2408-9613-2016-3-4-24-33

24. Tavusbay C, Genc H, Cin N, Kar H, Kamer E, Atahan K, et al. Use of a vacuum-assisted closure system for the management of enteroatmospheric fistulae. *Surg Today*. 2015; 45(9): 1102-1111. doi: 10.1007/s00595-014-1020-3

25. Giudicelli G, Rossetti A, Scarpa C, Buchs NC, Hompes R, Guy RJ, et al. Prognostic factors for enteroatmospheric fistula in open abdomen treated with negative pressure wound therapy: A multicentre experience. *J Gastrointest Surg*. 2017; 21(8): 1328-1334. doi: 10.1007/s11605-017-3453-7

26. Berry SM, Fischer JE. Classification and pathophysiology of enterocutaneous fistulas. *Surg Clin North Am*. 1996; 76(5): 1009-1018. doi: 10.1016/s0039-6109(05)70495-3

27. Huang J, Ren H, Jiang Yu, Wu X, Ren J. Technique advances in enteroatmospheric fistula isolation after open abdomen: A review and outlook. *Front Surg*. 2021; 7: 559443. doi: 10.3389/fsurg.2020.559443

28. Malgras B, Barbier O, Pasquier P. Floating stoma and abdominal negative-pressure therapy. *J Visc Surg*. 2017; 154(4): 310. doi: 10.1016/j.jviscsurg.2017.05.011

29. Mintziras I, Miligkos M, Bartsch DK. High risk of fistula formation in vacuum-assisted closure therapy in patients with open abdomen due to secondary peritonitis – A retrospective analysis. *Langenbecks Arch Surg*. 2016; 401(5): 619-625. doi: 10.1007/s00423-016-1443-y

30. Lubyanskiy VG, Zharikov AN. Basic pathogenetic mechanisms of acute intestinal perforation in patients with postoperative peritonitis. *Acta biomedica scientifica*. 2012; 4(86): 51-55. (In Russ.).

ЛИТЕРАТУРА

1. Bassetti M, Eckmann C, Giacobbe DR, Sartelli M, Montravers P. Post-operative abdominal infections: epidemiology, operational definitions, and outcomes. *Intensive Care Med*. 2020; 46(2): 163-172. doi: 10.1007/s00134-019-05841-5

2. Sartelli M, Coccolini F, Kluger Y, Agastra E, Abu-Zidan FM, et al. WSES/GAIS/SIS-E/WSIS/AAST global clinical pathways for patients with intra-abdominal infections. *World J Emerg Surg*. 2021; 16(1): 49. doi: 10.1186/s13017-021-00387-8

3. Сигуа Б.В., Земляной В.П., Котков П.А., Игнатенко В.А. Сравнение эффективности плановых релапаротомий и релапаротомий «по требованию» у больных распространенным вторичным перитонитом (обзор литературы). *Вестник хирургии имени И.И. Грекова*. 2021; 180(6): 96-104. doi: 10.24884/0042-4625-2021-180-6-96-104

4. Авакимян В.А., Карипиди Г.К., Авакимян С.В., Алуханян О.А., Потягайло Е.Г., Марченко Н.В., и др. Программированная релапаротомия в лечении разлитого гнойного перитонита. *Кубанский научный медицинский вестник*. 2017; (6): 12-16. doi: 10.25207/1608-6228-2017-24-6-12-16

5. Вачев А.Н., Корытцев В.К., Щербатенко В.Ю., Скупченко С.С., Краснослободцев А.М. Показания к программированным санационным релапаротомиям при распространенном перитоните. *Вестник хирургии имени И.И. Грекова*. 2019; 178(5): 89-94. doi: 10.24884/0042-4625-2019-178-5-89-94

6. Scriba MF, Laing GL, Bruce JL, Sartorius B, Clarke DL. The role of planned and on-demand relaparotomy in the developing world. *World J Surg*. 2016; 40(7): 1558-1564. doi: 10.1007/s00268-015-3379-8

7. Coccolini F, Montori G, Ceresoli M, Catena F, Moore EE, Ivatury R, et al. The role of open abdomen in non-trauma patient: WSES consensus paper. *World J Emerg Surg*. 2017; 12(1): 39. doi: 10.1186/s13017-017-0146-1

8. Di Saverio S, Tarasconi A, Inaba K, Navsaria P, Coccolini F, Costa Navarro D, et al. Open abdomen with concomitant enteroatmospheric fistula: Attempt to rationalize the approach to a surgical nightmare and proposal of a clinical algorithm. *J Am Coll Surg*. 2015; 220: 23-33. doi: 10.1016/j.jamcollsurg.2014.11.020

9. Ramsay PT, Mejia VA. Management of enteroatmospheric fistulae in the open abdomen. *Am Surg*. 2010; 76: 637-639

10. Prichayudh S, Sriussadaporn S, Samorn P, Pak-Art R, Sriussadaporn S, Kritayakirana K, et al. Management of open abdomen with an absorbable mesh closure. *Surg Today*. 2011; 41(1): 72-82. doi: 10.1007/s00595-009-4202-7

11. Григорьев Е.Г., Коган А.С. *Хирургия тяжелых гнойных процессов*. Новосибирск: Наука; 2000.

12. Кригер А.Г., Кубышкин В.А., Берелавичус С.В., Горин Д.С., Калдаров А.Р., Гогия Б.Ш., и др. Хирургическое лечение больных с тонкокишечными свищами. *Хирургия. Журнал им. Н.И. Пирогова*. 2015; 12: 86-95.

13. Björck M, Kirkpatrick AW, Cheatham M, Kaplan M, Leppäniemi A, De Waele JJ. Amended classification of the open abdomen. *Scand J Surg*. 2016; 105(1): 5-10. doi: 10.1177/1457496916631853

14. Marinis A, Gkiokas G, Argyra E, Fragulidis G, Polymeneas G, Voros D. "Enteroatmospheric fistulae" – gastrointestinal openings in the open abdomen: A review and recent proposal of a surgical technique. *Scand J Surg*. 2013; 102(2): 61-68. doi: 10.1177/1457496913482252

15. Bradley MJ, Dubose JJ, Scalea TM, Holcomb JB, Shrestha B, Okoye O, et al. Independent predictors of enteric fistula and abdominal sepsis after damage control laparotomy: Results from the prospective AAST Open Abdomen registry. *JAMA Surg*. 2013; 148(10): 947-954. doi: 10.1001/jamasurg.2013.2514

16. Becker HP, Willms A, Schwab R. Small bowel fistulas and the open abdomen. *Scand J Surg*. 2007; 96: 263-271. doi: 10.1177/145749690709600402

17. Terzi C, Egeli T, Canda AE, Arslan NC. Management of enteroatmospheric fistulae. *Int Wound J*. 2014; 11(1): 17-21. doi: 10.1111/iwj.12288

18. Kirshtein B, Mizrahi S. Vacuum-assisted management of enteroatmospheric fistula within the open abdomen. *Am Surg*. 2014; 80: 209-210.

19. Ribeiro-Junior MAF, Yeh DD, Augusto SS, Elias YGB, Néder PR, Costa CTK, et al. The role of fistuloclysis in the treatment of patients with enteroatmospheric fistulas. *ABCD Arq Bras Cir Dig*. 2021; 34(2): e1605. doi: 10.1590/0102-672020210002e1605

20. Каншин Н.Н. *Несформированные кишечные свищи и гнойный перитонит*. М.: Биоинформсервис; 1999.

21. Layec S, Seynhaeve E, Trivin F, Carsin-Mahe M, Dussaulx L, Picot D. Management of entero-atmospheric fistulas by chyme reinfusion: A retrospective study. *Clin Nutr*. 2020; 39(12): 3695-3702. doi: 10.1016/j.clnu.2020.03.030

22. Bobkiewicz A, Walczak D, Smoliński S, Kasprzyk T, Studniarek A, Borejsza-Wysocki M, et al. Management of enteroatmospheric fistula with negative pressure wound therapy in open abdomen treatment: A multicentre observational study. *Int Wound J*. 2017; 14: 255-264. doi: 10.1111/iwj.12597

23. Додай В.А., Борисов Д.Л., Терюшкова Ж.И. Опыт применения вакуумной терапии в лечении наружных несформированных кишечных свищей. *Раны и раневые инфекции. Журнал им. проф. Б.М. Костючёнка*. 2016; 3(4): 24-33. doi: 10.25199/2408-9613-2016-3-4-24-33

24. Tavusbay C, Genc H, Cin N, Kar H, Kamer E, Atahan K, et al. Use of a vacuum-assisted closure system for the management of enteroatmospheric fistulae. *Surg Today*. 2015; 45(9): 1102-1111. doi: 10.1007/s00595-014-1020-3

25. Giudicelli G, Rossetti A, Scarpa C, Buchs NC, Hompes R, Guy RJ, et al. Prognostic factors for enteroatmospheric fistula in open abdomen treated with negative pressure wound therapy: A multicentre experience. *J Gastrointest Surg*. 2017; 21(8): 1328-1334. doi: 10.1007/s11605-017-3453-7

26. Berry SM, Fischer JE. Classification and pathophysiology of enterocutaneous fistulas. *Surg Clin North Am*. 1996; 76(5): 1009-1018. doi: 10.1016/s0039-6109(05)70495-3

27. Huang J, Ren H, Jiang Yu, Wu X, Ren J. Technique advances in enteroatmospheric fistula isolation after open abdomen: A review and outlook. *Front Surg*. 2021; 7: 559443. doi: 10.3389/fsurg.2020.559443

28. Malgras B, Barbier O, Pasquier P. Floating stoma and abdominal negative-pressure therapy. *J Visc Surg*. 2017; 154(4): 310. doi: 10.1016/j.jviscsurg.2017.05.011

29. Mintziras I, Miligkos M, Bartsch DK. High risk of fistula formation in vacuum-assisted closure therapy in patients with open abdomen due to secondary peritonitis – A retrospective analysis. *Langenbecks Arch Surg*. 2016; 401(5): 619-625. doi: 10.1007/s00423-016-1443-y

30. Лубянский В.Г., Жариков А.Н. Основные патогенетические механизмы развития острых перфораций кишечника у больных с послеоперационным перитонитом. *Acta biomedica scientifica*. 2012; 4(86): 51-55.

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