

1 (8) | 2024

GENERAL SURGERY

ЗАГАЛЬНА ХІРУРГІЯ

Modern endovascular treatment strategies in the management of postpancreatectomy haemorrhage in patients with pancreatic cancer

A differentiated approach to comprehensive surgical treatment of combined combat thermomechanical injuries

Single-stage laparoscopic treatment of a cholecystoduodenal fistula with perforated small bowel ileus and fibrinous purulent peritonitis



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РЯТУЄ ЖИТТЯ

Пробіотична антисептика
для обробки ран та опіків

Проект «Неопалимі», фотограф Марта Сирко



Внесено до Державного реєстру дезінфекційних засобів МОЗ України наказ
№ 604 від 26.04.2022

Засіб антисептичний «Аредерма» спрей для шкіри

Склад засобу діюча речовина в 1 мл: *Bacillus spp.* > 5 x 10⁷ КУО/мл; Дидецилдиметиламоніум хлорид 0,1%; Призначення засобу. Комбінований антисептичний засіб з пробіотиками «Аредерма» готовий до використання, для місцевого застосування з потужною протизапальною, протимікробною та репаративною дією. Застосовується для:

- ранових поверхонь будь-якого походження;
- антисептичної обробки шкіри та м'яких тканин, особливо при хірургічних інфекціях;
- антисептичної обробки поверхневих опіків;

- зниження бактеріального навантаження опікової поверхні на всіх етапах комплексного місцевого лікування;

- оптимізації запального процесу опікової поверхні, що - забезпечує епітелізацію поверхневих опіків у встановлені терміни. Спектр антимікробної дії: Засіб «Аредерма» володіє антимікробною активністю у відношенні до грамнегативних і грампозитивних бактерій (включаючи збудники госпітальних інфекцій, мікобактерій туберкульозу, кишкових інфекцій), вірусів (поліомієліт, ентеровіруси, грип, парагрип, пташиний грип, коронавіруси, SARS, «атипічна пневмонія» гепатити А, В, С і ВІЛ-інфекції), патогенних грибів роду Кандіда, Трихофітон. Дія засобу базується на антагоністичних властивостях пробіотичних бактерій *Bacillus spp.* по відношенню до ІПНМД. *Bacillus spp.* здатні утворювати пробіотичну біоплівку і запобігати утворенню патогенних біоплівок. Завдяки цій властивості має пролонговану дію не менше 24 годин. Виробник - ТОВ «СІРІОН», 49107, Україна, м. Дніпро, проспект Гагаріна, буд. 119, прим. 4, 24.

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Група компаній «УКРТЕХМЕД» та «УКРТЕХМЕД ІННОВЕЙШН» є українськими виробниками та новаторами в області розробки та виготовлення медичних виробів з історією понад 29 років. У виробничій діяльності наших підприємств ми використовуємо досягнення у сфері традиційно-інноваційних та інформаційно-енергетичних технологій.

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ПОВ'ЯЗКИ МОЖУТЬ БУТИ НАСИЧЕНІ ДОПОМІЖНИМИ ЛІКАРСЬКИМИ ЗАСОБАМИ

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- новокаїном
- димексидом
- метилурацилом
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ПЕРЕВАГИ «АРМА-ГЕЛЬ+»

01 Знеболюють та охолоджують

Завдяки додатковим компонентам знеболюють та охолоджують у місцях опіку та отриманої рани

02 Прості у використанні

Розмір та властивості дозволяють використовувати гідрогелеві пов'язки пацієнтам самостійно - без допомоги медперсоналу

03 Швидке загоєння, захист від бактерій

Технологія виготовлення пов'язок дозволяє суттєво прискорити загоєння ушкодженої поверхні шкіри

04 Сертифіковані в Україні

Продукція відповідає вимогам техрегламенту та має сертифікат відповідності державним стандартам

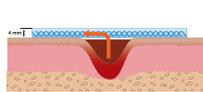
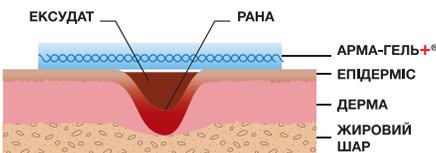
05 Не пристають до рани та еластичні

Гідрогелева основа та конструкція пов'язок забезпечує безболісне їх знімання - пов'язки не пристають до рани

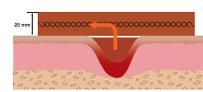
06 Рекомендовані лікарями

За результатом практичного використання та отриманих результатів «АРМА-ГЕЛЬ+» рекомендують практикуючі лікарі країни

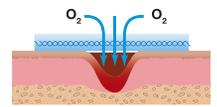
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МАКСИМАЛЬНО СОРБУЮЧІ ВЛАСТИВОСТІ



ЛЕГКО МОДЕЛУЄТЬСЯ В РАНИ



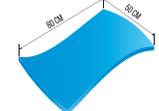
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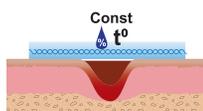
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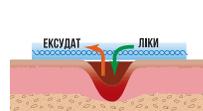
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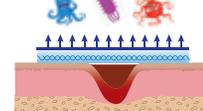
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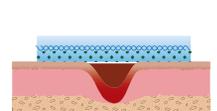
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- ДО УВАГИ АВТОРІВ

Hnat Mykhailovych Matyashin: the difficult path of a soldier, surgeon, scientist, and teacher

The life and professional path of Professor Hnat Mykhailovych Matyashin: a scientist and surgeon, Doctor of Medical Sciences, Honoured Scientist of the Ukrainian SSR, Honoured Doctor of the Ukrainian SSR, Chief Surgeon of the Ministry of Health of the Ukrainian SSR, Head of the Department of Faculty Surgery of the Kyiv Medical Institute.

To reach the goal a person needs only one thing. Go.

Honore de Balzac



Hnat Mykhailovych Matyashin was born on November 11, 1925, in the village of Andreyevka, Selidiv district, Donetsk region. He was a descendant and successor of one of the oldest medical dynasties. His parents were doctors, and his great-grandfather and grandfather on his father's side were paramedics. H. M. Matyashin grew up in a healthy, friendly family atmosphere where human dignity was respected, work was valued, and books were loved. Throughout his lifetime, he adhered to his parents' teachings regarding the moral superiority of principles, the ability to take on the responsibilities of others, the values of democracy, and faithfulness to one's word.

After finishing high school, Hnat Mykhailovych entered the Arkhangelsk Medical Institute. However, he quickly realised that his real mission was to serve

as his Motherland's defender, as there was World War II. He transferred to the machine-gun school and in 1943, as an eighteen-year-old young man, he received his baptism of fire, first as a soldier and then as a machine-gun platoon commander and tank landing platoon commander. Hnat Mykhailovych took part in battles during the fording of the Dnieper at the Bukryn and Lyutizh bridgeheads for Kyiv, Fastiv, and Zhytomyr. For his courage and bravery, he was awarded the Order of the Red Star. During the war, H. M. Matyashin was wounded twice. After the second wound received under Proskurov in 1944, which appeared to be very severe (a blind shrapnel wound of the spine with subsequent osteomyelitis), H. M. Matyashin was demobilised. He had to be treated for a long time. Hnat Mykhailovych underwent 16 difficult operations for osteomyelitis of the spine. In 1945, H. M. Matyashin entered the Donetsk Medical Institute, from which he graduated in 1950. It was at the institute that Hnat Mykhailovych began to demonstrate that special style of intensity and ardour that marked his behaviour in later life.

From 1952 to 1964, Hnat Mykhailovych worked at the department of general surgery of the Donetsk Medical Institute (the head of the department was Professor O. I. Charugin), having progressed from a clinical resident to the head of the department (1964). In 1956, he defended his candidate's thesis, and in 1964, his doctoral thesis. During that period, he actively mastered one of the most difficult sections of surgery — reconstructive operations on the esophagus. And here H. M. Matyashin's will and extraordinary determination were manifested, which led him to the peak of professional skill. Hnat Mykhailovych becomes a well-known surgeon and scientist and gains significant authority in the medical community.

In 1968, H. M. Matyashin was elected head of the Department of Faculty Surgery of the Kyiv Medical Institute. Having assumed the leadership of one of the oldest, most honourable, academic clinics in the country, Hnat Mykhailovych not only continued the glorious traditions of his predecessors with honour, but also managed to find new ways for the further development of these traditions.

Gathering a team around him, H. M. Matyashin, year after year, expanded the scope of the clinic's creative and scientific research activities. The period of 1968–1979 can be considered the most fruitful for Hnat Mykhailovych. During this time, more than 100 scientific studies were published, including 5 monographs. He trained 20 candidates (27 in total) and 5 doctors of medical sciences. H. M. Matyashin gave a lot of effort and time to the reconstruction of the clinic, its equipment, the organisation of work in new conditions, the implementation of novel techniques and methods of diagnosis and treatment, and the organisation of the pedagogical process.

After the completion of the reconstruction of the clinic (in just 2 years), Hnat Mykhailovych said the prophetic words: «The reconstruction of the clinic will remain a good memory of my existence». So, simply put, once and for all!

However, the activity of H. M. Matyashin was not limited only to the interests of the clinic. He was actively engaged in social activities. In 1970, Hnat Mykhailovych was appointed chief surgeon of the Ministry of Health of the Ukrainian SSR, and since 1976 he had been an honorary member of the International Society of Surgeons. In these positions, he gained great authority, and the wider surgical community treated him with deep respect. H. M. Matyashin's bust, created by the renowned sculptor M. K. Vronsky, was placed in the lobby of the Department of Faculty at the Kyiv Medical Institute as a tribute to his outstanding achievements.

Hnat Mykhailovych died prematurely, yet he died as he should have, till the very end, fulfilling his professional duty. I left to stay forever! H. M. Matyashin died in his office as the chief surgeon of the Ministry of Health of Ukraine at 10 o'clock in the morning on October 30, 1979, before reaching the age of 54, in the presence of the members of the commission, which consisted of 15 professors from all regions of the USSR, who checked the state of surgical care in Ukraine and gave a positive evaluation of its organisation.

The funeral of Hnat Mykhailovych took place on November 2, 1979, at the Baikovo cemetery.

H. M. Matyashin stood out for his generosity and kindness. He was a faithful friend, a wise adviser, and if necessary, a fair judge. Hnat Mykhailovych never

felt lonely. He liked to repeat that those who are lonely live only by themselves and for themselves, and he claimed that contact with the thoughts of others causes mental work, whatever that thought may be. H. M. Matyashin established the proctology centre from the beginning. During that period, there was no differentiation between a general physician and a proctologist, and there was no official definition for the centre, as well as a lack of technical and instrumental equipment. He solved these problems at the level of the City Department of Health and the Ministry of Health of Ukraine in a short period of time. It was more difficult to train doctors, and he also solved that problem successfully, as evidenced by the high reputation of the centre and its recognition in Europe. Throughout its existence, the centre has published five doctoral dissertations, approximately 20 candidate's theses, six monographs, 23 methodological recommendations, and information sheets. Additionally, the centre has successfully organised the first four congresses of coloproctologists with international participation. The centre also performs operative interventions at a technologically advanced level, achieving outcomes comparable to those in Europe.

Hnat Mykhailovych analysed the works written by the scientific staff, revised them, engaged in discussions about facts and ideas, provided constructive criticism tactfully, and smiled when he was satisfied. The visits to the teacher to discuss their works, despite their strictly professional nature, were a remarkable experience for engaging in profound dialogue with the ideal representation of a doctor — a clinician, a scientist, as he portrayed himself.

Hnat Mykhailovych was a passionate lover of books. When he had a few free hours and could read, he picked up a book, having a sense of anticipation for a reading retreat. He had been attracted to books since a young age and possessed both innate and educated intelligence.

His deep respect for the memory of his predecessors was impressive. H. M. Matyashin requested that a monument honouring V. A. Karavaev be preserved. Hnat Mykhailovych initiated the department's tradition of cleaning up the established memorial sites of its personnel at least twice a year.

H. M. Matyashin often provided consultations for the most difficult patients in Kyiv, including Feofania, as well as regional and university centres in Vinnytsia, Poltava, Kharkiv, and Dnipropetrovsk.

Hnat Mykhailovych did not tolerate standardised procedures in clinical work, in diagnostic frameworks, or in patient interaction. He was a master at individual diagnosis. He consistently identified

distinctions and unique nuances of disease symptoms, which he skillfully used for precise diagnosis.

Diagnoses were made quickly. He recognised the characteristics of the illness immediately. He was rarely mistaken in his diagnoses. He was well-versed in physical examination techniques and X-ray diagnostics. Courage enabled him to agree to complicated operations. The work of a surgeon always gave him a sense of fulfilment.

H. M. Matyashin had statesmanlike thinking, outstanding organisational skills, high professionalism, and business acumen.

Hnat Mykhailovych became famous for his exceptional abilities as a surgeon, teacher, scientist, and organiser, as well as his high morality, social participation, and dedication to public service. H. M. Matyashin received the Order of the Red Banner of Labour in recognition of his labour activities and

the honorary title of Honoured Scientist of the Ukrainian SSR. H. M. Matyashin once said: «Everything I did and am doing is the result of the fact that I wanted and want to be a good doctor and surgeon». Impressive words! He served as a role model for both young and experienced doctors.

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Матяшин Гнат Михайлович — тяжкий шлях солдата, лікаря-хірурга, вченого, педагога

Висвітлено життєвий та професійний шлях професора Гната Михайловича Матяшина — вченого-хірурга, доктора медичних наук, заслуженого діяча науки УРСР, заслуженого лікаря УРСР, головного хірурга МОЗ УРСР, завідувача кафедри факультетської хірургії Київського медичного інституту.

Modern endovascular treatment strategies in the management of postpancreatectomy haemorrhage in patients with pancreatic cancer

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OBJECTIVE — to determine the occurrence and management of postpancreatectomy haemorrhage in pancreatic cancer patients, as well as to identify effective treatment strategies to improve patient outcomes.

MATERIALS AND METHODS. From January 2010 to December 2022, 878 patients who underwent radical pancreatic resections for malignant tumours were retrospectively analysed.

Patients were divided into two groups. The main group consisted of 500 patients who were treated in the clinic from 2016 to 2022. In the main group, postpancreatectomy haemorrhage occurred in 31 (6.2%) patients. These patients were treated according to our diagnostic and treatment algorithm, using endovascular techniques as the first step of treatment. The comparison group consisted of 378 patients who were treated in our department from 2010 to 2015. In the comparison group, postpancreatectomy haemorrhage occurred in 20 (5.3%) patients. These patients were treated according to standard approaches. The definition of postpancreatectomy haemorrhage proposed by the International Study Group of Pancreatic Surgery was used in our research.

RESULTS. Out of 31 patients in the main group, 16 (51.6%) had endovascular embolisation. A total of 10 patients underwent endovascular occlusion, whereas 5 patients experienced cessation of bleeding with the use of a stent graft. Angiography did not detect the cause of bleeding in 3 (9.7%) individuals in the main group. They underwent laparotomy with subsequent haemostasis. 11 (35.5%) patients underwent open surgical interventions. In the main group, one (3.2%) patient died due to the emergence of infectious complications after laparotomy and subsequent haemostasis. 2 (10%) patients underwent endovascular haemostasis, while 15 (75%) patients underwent relaparotomy with haemostasis. In the comparison group, 6 (30%) patients died after open relaparotomies.

CONCLUSIONS. The initial course of action for managing postpancreatectomy haemorrhage involves the implementation of endovascular techniques, wherein stent grafts are used to address bleeding originating from the main blood vessel. The application of advanced treatment strategies that optimised the use of minimally invasive endovascular techniques resulted in a notable decrease in the mortality rate associated with postpancreatectomy bleeding from 30% to 3.2% ($\chi^2=7.3$, $p=0.006$). Ensuring 24/7 access to endovascular treatment, which can be provided exclusively in high-volume centres, is imperative for improving the treatment outcomes of patients with pancreatic and periampullary cancer.

KEYWORDS

postpancreatectomy haemorrhage, endovascular techniques, endovascular embolisation, stent graft.

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Despite improvements in the perioperative care of patients with pancreatic cancer and advances in operative techniques aimed at improving the results of treatment for patients with pancreatic cancer, the level of postoperative complications after pancreatic resections remains high.

Pancreatic resections are demanding surgery, and despite the decrease in mortality rate to 5 % in highly specialised centres, the number of postoperative complications is one of the highest in abdominal surgery and reaches up to 60 %, even in experienced world centres [6, 8–10, 14, 19].

Postpancreatectomy haemorrhage (PPH) is a critical, life-threatening complication that can occur in approximately 10 % of patients [6]. It is the main cause of death after pancreatic resections and is associated with a high mortality rate, ranging from 30 % to 50 % [11, 18].

In 2007, the International Study Group of Pancreatic Surgery (ISGPS) published guidelines to standardise definitions of PPH, allowing for better management of this life-threatening complication.

The ISGPS determines PPH based on three parameters: onset, location, and severity. Onset is classified as early (within 24 hours after surgery) or late (occurring 24 hours after surgery). Localization helps differentiate between intraluminal and extraluminal bleeding. According to the degree of severity, bleeding is divided into two categories: moderate and severe.

There are 3 degrees of postpancreatectomy haemorrhage, depending on the time of onset and severity.

Grade A (early, moderate severity): minor blood loss in which there are practically no changes in the patient's clinical condition and which do not require invasive interventions.

Grade B (early severe bleeding or late moderate bleeding) rarely threatens the patient's life and requires computed tomography (CT), angiography (AG), and esophagofibro-gastroduodenoscopy (EFGDS) with subsequent medical interventions: endoscopic haemostasis, vascular embolization, or relaparotomy (only in case of severe early bleeding).

Grade C (late bleeding, severe degree) threatens the patient's life and requires CT, EFGDS, and medical interventions (endoscopy, angiography, surgical management of bleeding) [18].

Early postpancreatectomy bleeding is associated with technical failures, intraoperative complications, and problems with haemostasis or coagulopathy. In case of early PPH, conservative treatment is recommended. If it is ineffective, immediate reoperation is necessary [1–3, 11, 18].

Late PPH is often associated with other complications after pancreatectomy, such as a postoperative pancreatic fistula. A haemorrhage can occur due to postoperative fluid collection, which can lead to the erosion of blood vessels and bleeding. Additionally, infectious complications or abdominal abscesses can also be the cause of PPH [1–3, 6, 11, 18]. Among all the causes of postpancreatectomy bleeding, pancreatic fistulas are the most common. Recent studies have confirmed that 80 % of patients with postpancreatectomy haemorrhage develop postoperative pancreatic fistulas [4, 5, 7, 12, 13, 15, 16, 20]. They are not only an independent risk factor for the occurrence of late PPH, but their presence also increases bleeding-related mortality by 17 times [15].

Postpancreatectomy haemorrhage requires careful clinical monitoring and urgent treatment. Patients with late bleeding should be treated with minimally invasive endovascular procedures, with angiography as the first option. Recent advancements in endovascular treatment of PPH, including covered stents and embolization techniques, have contributed to a reduced mortality rate. Timely diagnosis and correct treatment can prevent serious and fatal consequences. A multidisciplinary team of experts is essential to ensuring the best treatment 24 hours a day. In our study, we used the definition of PPH developed by the International Study Group of Pancreatic Surgery [18].

OBJECTIVE – to determine the occurrence and management of postpancreatectomy haemorrhage in pancreatic cancer patients, as well as to identify effective treatment strategies to improve patient outcomes.

Materials and methods

We retrospectively analysed the results of surgical treatment for 878 patients with pancreatic and periampullary cancer who were radically operated on from January 2010 to December 2022 in the Department of Pancreatic and Bile Ducts Surgery at Shalimov's National Scientific Centre of Surgery and Transplantation. All medical records were reviewed and retrospectively analysed. All patients were operated on by a single surgical team under the direction of the Head of the Department. Of these patients, 497 were men (56.6 %) and 381 were women (43.4 %). The patients' average age was 56.8 ± 9.3 years, ranging from 27 to 82 years.

51 patients (5.8 %) experienced postpancreatectomy haemorrhage. Haemorrhage occurred in 42 patients (5.9 %) after pancreatoduodenectomy (PDE), 8 patients (5.6 %) after distal pancreatic resection

(DPR), including one patient after the modified Appleby procedure, and one patient (4.3 %) after a total pancreatoduodenectomy (TPE). Out of the patients who experienced postpancreatectomy haemorrhage, 7 patients (13.7 %) died.

Prior to 2016, the treatment of PPH often involved reoperation with subsequent haemostasis and surgical treatment of other complications. Since 2016, there have been notable changes in our techniques, leading to the development of appropriate strategies for the management of PPH. Patients with grade A PPH receive conservative therapy. In situations of grade B PPH (early severe bleeding), surgical intervention is used if conservative treatment proves ineffective. If a patient has late-grade B PPH and is hemodynamically stable, angiography is the first-line treatment option for diagnosis, followed by endovascular intervention to control bleeding. Reoperation is performed if the patient is hemodynamically unstable or if the initial endovascular intervention is unsuccessful.

To develop an optimal treatment strategy for PPH, we analysed patient treatment results over different periods.

The study included 878 patients who received treatment in our department between 2010 and 2022. Patients were divided into two groups. Of these, 500 patients were treated according to our diagnostic and treatment algorithm, while the remaining 378 patients were treated using standard approaches. The two groups were comparable in terms of age, disease stage, ASA status, the presence of concomitant pathology, and degrees of PPH, according to ISGPS.

In the main group, we performed diagnostic angiography before beginning endovascular treatment for PPH.

If the patient's general condition allowed, we performed a multidetector CT before angiography to identify the source of bleeding and evaluate the arterial anatomy. In accordance with our strategy, a CT scan is a necessary component of the diagnostic algorithm for patients experiencing PPH, provided that the patient is in a stable hemodynamic state. CT scans not only allow for the identification of the probable source of bleeding and the determination of blood vessel anatomy, but they also enable the diagnosis of other postoperative complications, such as parapancreatic and other fluid collections, which may not have been previously detected by postoperative ultrasound. If a CT scan showed an arterial aneurysm or active extravasation of contrast agent, we diagnosed bleeding. In such cases, we immediately performed angiography. If angiography revealed bleeding, we proceeded with endovascular treatment. This involved either endovascular occlusion

of the blood vessel that was the source of bleeding or endovascular stenting. Endovascular stenting was used to manage bleeding from the main blood vessels, such as the common hepatic artery, right and left hepatic arteries, or superior mesenteric artery (SMA).

Open surgical interventions were performed if endovascular treatment of PPH was technically impossible, or if bleeding could not be stopped using endovascular techniques, or if the patient was hemodynamically unstable.

Results and discussion

Postpancreatectomy haemorrhage occurred in 31 (6.2 %) patients in the main group and in 20 (5.0 %) patients in the comparison group. We identified the degrees of postpancreatectomy haemorrhage according to the ISGPS classification. In the main group, PPH occurred in 27 (6.25 %) patients after PDE and in 4 (5.6 %) patients after DPR. In the comparison group, PPH occurred in 15 (5.1 %) patients after PDE, in 4 (5.7 %) patients after DPR, and in one (7.1 %) patient after TPE.

In the main group, PPH grade A occurred in 4 patients, grade B in 13 patients, grade C in 14 patients. As for the comparison group, PPH grade A occurred in 2 patients, grade B in 3 patients, and grade C in 15 patients.

Postpancreatectomy haemorrhage grade A occurred in 4 patients in the main group, which was stopped conservatively. In the main group, 19 (61.3 %) out of 31 patients underwent angiography as the first stage of treatment. Haemorrhage was diagnosed in 16 (84.2 %) out of 19 patients, requiring endovascular haemostasis. In 3 (15.8 %) patients, the source of bleeding was not found. These patients underwent laparotomy with subsequent cessation of bleeding.

In the main group, 16 (51.6 %) out of 31 patients underwent endovascular treatment for bleeding. Endovascular occlusion was performed in 11 patients: splenic artery (SA) occlusion in 6 patients, dorsal pancreatic artery occlusion in 2 patients, branches of the SMA in 2 patients, and gastroduodenal artery (GDA) occlusion in one patient.

In case of haemorrhage from major blood vessels such as the common hepatic artery and the right and left hepatic arteries, endovascular embolization might not be possible due to severe ischemic complications. In such cases, endovascular stenting was performed, which allowed for the closure of the blood vessel defect without disturbing blood flow. The bleeding was successfully stopped in five patients using a stent graft.

After PDE, a stent graft was placed into the common hepatic artery of two patients in order to prevent bleeding from the gastroduodenal artery stump. In addition, a stent graft was used to close the arterial defect in a patient who was experiencing bleeding from the common hepatic artery (refer to Figs. 1, 2).

Two patients underwent PDE and subsequently received a stent graft in the right hepatic artery. In one case, a patient experienced post-operative bleeding during angiography, and extravasation from the right hepatic artery was diagnosed. The right hepatic artery departed from the SMA via a separate trunk. Due to the high risk of ischemic complications, embolization of the right hepatic artery was

deemed dangerous. Following the diagnosis and detection of extravasation, the patient underwent angiography, and a stent graft was promptly installed in the right hepatic artery (refer to Figs. 3, 4). Subsequent control angiography confirmed the cessation of bleeding (refer to Figs. 5, 6).

No complications were observed after the placement of stent grafts. Postpancreatectomy haemorrhage was successfully stopped in all cases without any further ischemic complications.

Only one case (5.6 %) experienced complications after endovascular bleeding, where the patient developed a splenic abscess. The abscess was treated using minimally invasive techniques, including



Figure 1. Angiography with detection of the zone of extravasation from the gastroduodenal artery stump



Figure 2. Control angiography with confirmation of bleeding cessation after placement of a stent graft in the common hepatic artery



Figure 3. CT angiography with detection of the zone of extravasation from the right hepatic artery, which originates from the superior mesenteric artery

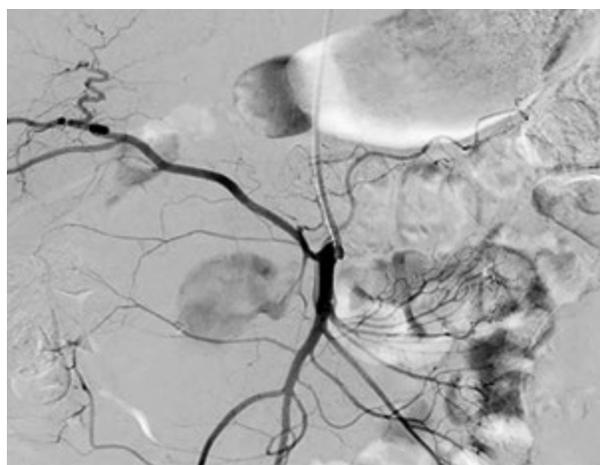


Figure 4. Angiography with detection of the zone of extravasation from the right hepatic artery

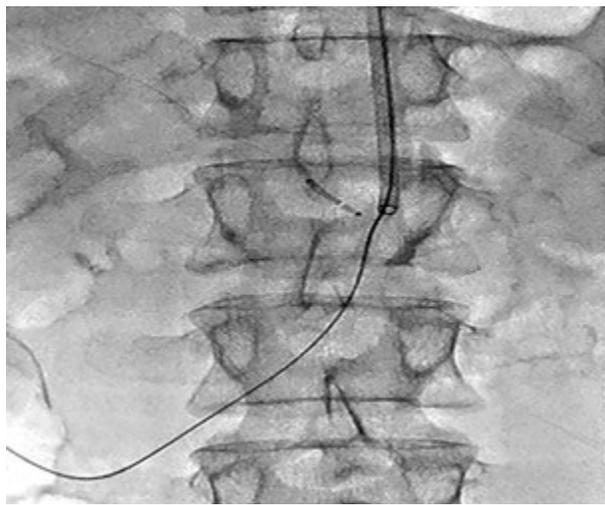


Figure 5. **Placement of a stent graft in the right hepatic artery**

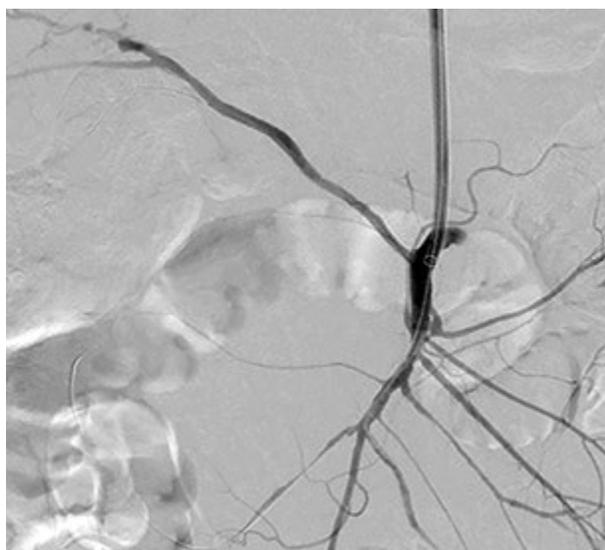


Figure 6. **Control angiography with confirmation of bleeding cessation**

punctures and abscess remediation under ultrasound control. Bleeding was successfully stopped in all patients after endovascular treatment.

13 (35.5%) patients underwent open surgical interventions in the main group, with successful cessation of bleeding in all cases. Two (18.2%) patients experienced a recurrence of bleeding, leading to TPE in one case. During relaparotomy, bleeding from the pancreatojejunostomy was diagnosed in one patient, which was stopped intraoperatively. However, bleeding recurred one day after the procedure. The patient underwent urgent surgery to perform a separation of the pancreatojejunostomy and establish external drainage of the main pancreatic duct.

In the main group, only one patient (3.2%) died after undergoing a No-touch PDE. During the

postoperative period, the patient developed postoperative pancreatitis with infected parapancreatic clusters. On the 9th day after the operation, intra-abdominal bleeding occurred, and an urgent relaparotomy was performed. The bleeding was stopped, and a TPE with splenectomy was completed. Finally, an autoarterial prosthetic replacement of the common hepatic artery with a stump of the SA was performed. On the first postoperative day after relaparotomy, thrombosis of the arterial anastomosis occurred. Urgent, repeated surgical intervention was performed, including thrombectomy and sanitation of the abdominal cavity. Vacuum-assisted bandages were then placed and replaced repeatedly, and the abdominal cavity was resanitized and drained. Unfortunately, the patient died.

In the comparison group, bleeding occurred in 20 (5.3%) patients. Of these, 2 (10%) patients experienced post-pancreatectomy bleeding, which was managed conservatively. Additionally, 3 patients experienced PPH, with one case being gastrointestinal bleeding that was resolved through endoscopic intervention. Endovascular occlusion of the SA was performed in 2 (10%) patients.

15 patients (75%) underwent repeated surgical interventions to stop bleeding. Eventually, bleeding was successfully stopped in all cases. In the comparison group of 20 patients, 6 (30%) died due to the development of additional purulent-septic complications. The overall mortality rate for bleeding was 13.7% (7 out of 51).

Following laparotomy to stop bleeding, 26.9% of patients (7 out of 26) died due to septic complications, including one patient in the main group and six patients in the comparison group.

The application of endovascular techniques for haemostasis did not result in any mortality. Due to our diagnostic and treatment strategies, which extensively use endovascular methods to diagnose and stop bleeding, we have managed to reduce PPH mortality in the main group to 3.2%. However, the mortality rate in the control group was 30% ($\chi^2 = 7.3$; $p = 0.006$).

Postpancreatectomy haemorrhage is a life-threatening complication with high mortality rates, even in high-volume centres. It requires immediate and timely treatment. Despite improvements in surgical techniques and the development of modern equipment, postoperative complications, including PPH, have a high incidence even in high-volume centres.

A systematic review by T. A. Maccabe et al. analysed the management of PPH stratified by the ISGPS score. The review included 62 studies conducted between 2008 and 2020, which reported on 10775 pancreatic resections. Bleeding occurred in

608 patients, representing 5.4% of cases [2]. According to data from the world's leading clinics, PPH after PD may occur in as many as 6–8% of patients, according to the Mayo Clinic [2]. The Pancreas Institute in Verona reported that PPH occurred in 6.8% of patients undergoing pancreatic resections [5]. Ageo Central Hospital in Japan published data indicating that PPH after PDE occurred in 8.3% of patients [7].

According to our data, PPH was observed in 5.8% of patients. Our findings are comparable. Among those who experienced bleeding, 7 patients died, resulting in a mortality rate of 13.7%.

A review by A. Floortje van Oosten and F. Jasmijn Smits analysed data from 14 studies involving 467 patients who experienced postoperative haemorrhage after pancreatic resections between February 2007 and July 2018. According to their findings, PPH occurred in 3% – 16% of patients [6]. The overall mortality rate was 21%, significantly greater than ours [1].

A study by the Mayo Clinic, published by Kengo Asai, revealed that the majority of PPH cases have an arterial origin. Global studies have shown that early bleeding is commonly detected from the surface of the pancreas and pancreaticojejunal anastomoses (41.2% and 23.6%, respectively), while late bleeding is more frequently observed from the gastroduodenal artery, common hepatic artery (27.4% and 21.4%, respectively), and pancreaticojejunal anastomoses [1, 2]. Late bleeding is usually arterial, with aneurysms present in one-third of patients with PPH, according to Pierpaolo Biondetti [1].

In our study, there were no early PPHs. All bleedings were late and occurred as early as 2–38 days.

Late bleeding is commonly associated with the erosion of blood vessels due to pancreatic fistulas, parapancreatic fluid collection, infectious complications, or intra-abdominal abscesses [1, 20]. Pancreatic fistula is identified as the primary cause of late postoperative haemorrhage. Recent studies have shown that 80% of patients with bleeding have a pancreatic fistula. Postoperative pancreatic fistula is a reliable risk factor for postoperative bleeding and increases bleeding-associated mortality by 17 times [15]. According to our data, out of 51 patients with PPH, 44 (86.3%) experienced bleeding in conjunction with a postoperative pancreatic fistula and associated infectious complications.

It is important to consider problems with pancreaticojejunostomy when observing postoperative intraluminal bleeding, not just ulcers in the gastrointestinal tract. Bleeding can occur from the cut surface of the pancreas due to pancreaticojejunostomy failure, which may result in bleeding

through drains or into the gastrointestinal tract. Hemobilia may occur when a pseudoaneurysm is formed after erosion of the common hepatic artery, leading to leakage into the biliary tract. Mortality rates associated with this complication can range from 35% to 50% [15].

When encountering intraluminal gastrointestinal bleeding, it is important to consider not only gastrointestinal ulcers and bleeding from gastroenteroanastomosis but also potential issues with pancreaticojejunostomy.

Intraabdominal bleeding can also be caused by venous bleeding, including bleeding from varicose veins associated with portal thrombosis. Bleeding may also occur from the portal vein, superior mesenteric vein, or their branches. It is important to differentiate between arterial and venous bleeding, as endovascular bleeding control is ineffective for external bleeding. In cases of venous bleeding, the main method of treatment is laparotomy with bleeding control. This ensures effective management of the condition. According to our findings, three patients in the main group experienced postoperative venous bleeding, which originated in the portal or superior mesenteric veins. All of these individuals underwent a relaparotomy to stop the bleeding. In terms of localization, our data reveal that the pancreaticojejunostomy, common hepatic, or right hepatic artery are the most prevalent sites of bleeding. This is linked to the development of postoperative pancreatogenic complications, including postoperative pancreatic fistulas.

Pancreatoduodenectomy is known to be one of the most complex abdominal surgeries [3]. Postpancreatectomy haemorrhage showed more than a 6-fold increase in mortality when compared to those not affected, with 64% and 35% of them requiring one or multiple interventions, respectively [3]. Reoperation in patients with late PPH is frequently associated with a significant mortality rate [3]. Postoperative adhesions and inflammation, particularly in patients with postoperative pancreatic fistula and other complications, make surgery challenging.

According to our findings, all patients who died from postpancreatectomy haemorrhage underwent reoperation during the first stage of treatment.

In terms of global data on reducing mortality in patients with PPH, the only effective measure is the use of minimally invasive endovascular techniques in the early stages of PPH management. This requires the availability of interventional radiology with angiography within 24 hours, 7 days a week [1–3, 10–12, 15, 18].

A previous meta-analysis has demonstrated that surgical interventions for PPH are associated with

higher rates of morbidity and mortality compared to interventional radiologic approaches, which have shown improved success rates [7]. According to reports, endovascular stenting for PPH has a success rate of between 82 % and 100 %, but due to the high rates of re-bleeding, which range from 7 % to 30 %, careful selection is necessary [7].

According to the research, endovascular techniques are effective in achieving haemostasis in 80–100 % of patients, with significantly lower mortality rates compared to surgical interventions. Roulin et al. reported a significant increase in mortality rates after laparotomies compared to endovascular haemostasis, with mortality rates of 22 % and 47 %, respectively, thus supporting the use of endovascular interventions [16]. Based on our data, endovascular haemostasis was effective in 83.3 % of patients. Out of the 18 patients who underwent angiography, 18 (85.7 %) achieved effective endovascular haemostasis.

Open surgery is considered an alternative approach for treating PPH. However, it is recommended that relaparotomy be performed urgently as the first stage only in patients with massive bleeding and unstable hemodynamics, as well as in patients with pancreatic fistulas who require a TPE or when angiography is unavailable for any reason [10, 18, 19]. A total of 11 patients (35.5 %) in the main group and 15 patients (75.0 %) in the comparative group underwent reoperations as part of our study.

Interventional radiology management with endovascular embolization may not always be safe. Embolization of the hepatic artery can be extremely dangerous and may lead to irreversible, life-threatening consequences. Ischemic complications occur in 30–66 % of cases after embolization of the common hepatic artery (CHA), according to the literature. Occlusion of the CHA can lead to cholangitis, liver abscesses, and fatal liver failure [1]. We did not perform embolization of the CHA, left or right hepatic artery in these patients.

Embolizing the stump of the GDA separately is usually impossible due to its small length. Hur et al. reported that bleeding recurrence is experienced by 100 % of patients, which may also originate from another segment of the common hepatic artery. Angiography is often considered the primary procedure for treating bleeding from the GDA, or common hepatic artery, followed by stent graft placement. It is important to note that subjective evaluations have been excluded from this analysis. While the literature describes complications such as stent thrombosis, dislocation, and recurrence of bleeding, there may also be infectious complications associated with parapancreatic infectious collection near the

stent [12, 13, 15, 16]. However, no complications related to stent placement or subsequent bleeding recurrences were observed.

The selection of a treatment method for late bleeding is dependent on the patient's clinical condition. The initial step in treatment is to evaluate the patient's hemodynamic stability. Urgent reoperation is recommended for unstable patients. These patients typically experience severe bleeding, such as active arterial and pancreaticojejunostomy bleeding. Emergency laparotomy is the only life-saving option [4, 5, 12, 13, 15, 16, 20].

The selection of a surgical technique is crucial for emergency procedures, and minimally invasive surgery is often the optimal choice. Performing a TPE can be technically challenging due to altered anatomy, postoperative adhesion processes, and inflammatory changes. This is especially true when bleeding occurs in the presence of a postoperative pancreatic fistula, which can lead to septic complications. According to some authors, special pancreatic drainage is recommended instead of a complete TPE [5].

Due to the significant trauma associated with laparotomy, surgery is not the primary option for hemodynamically stable patients.

Some authors recommend angiographic examination for patients experiencing sentinel bleeding, but in many cases, the source of the bleeding cannot be identified, likely due to its intermittent nature. Angiography has the highest sensitivity as soon as sentinel bleeding is observed. MDCT angiography can reveal the cause, nature, and location of bleeding, providing valuable information for further treatment [15].

If the source of bleeding cannot be determined after the initial diagnosis, it is recommended to perform diagnostic angiography of the abdominal trunk and SMA. This study may reveal direct signs of bleeding, such as active contrast extravasation, or indirect signs, such as spasm or vessel contouring. Diagnostic angiography may be limited in cases of diffuse, venous, or periodic bleeding [4, 12, 13, 15, 16, 20].

In summary, late PPH is a significant complication of pancreatic surgery, with the pancreaticojejunal anastomosis being the most frequent site of bleeding. The mortality rate is high due to diagnostic challenges and sudden onset of bleeding. To achieve low mortality rates, pancreatic resections should only be conducted in highly specialised medical institutions that allow for rapid detection and appropriate management, including round-the-clock availability of endovascular procedures to stop bleeding [5, 7, 10, 17].

Conclusions

The initial course of action for managing postpancreatectomy haemorrhage involves the implementation of endovascular techniques, wherein stent grafts are used to address bleeding originating from the main blood vessel.

The application of advanced treatment strategies that optimised the use of minimally invasive endovascular techniques resulted in a notable decrease in the mortality rate associated with postpancreatectomy bleeding from 30 % to 3.2 % ($\chi^2 = 7.3$; $p = 0.006$).

Ensuring 24/7 access to endovascular treatment, which can be provided exclusively in high-volume centres, is imperative for improving the treatment outcomes of patients with pancreatic and periampullary cancer.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

V.M. Kopchak, L.O. Pererva, V.A. Kondratiuk, I.V. Khomiak, O.V. Duvalko: conceptualization, methodology, writing review and editing; L.O. Pererva, I.A. Mazanovych, V.V. Khanenko, V.I. Trachuk, P.A. Azadov: formal analysis, investigation, writing, original draft preparation; L.O. Pererva: statistical analysis; V.M. Kopchak: supervision. All authors have read and approved the final manuscript.

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Сучасна тактика з використанням ендovasкулярних методик в лікуванні постпанкреатектомічних кровотеч у хворих зі злоякісними пухлинами підшлункової залози

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Мета — оцінити частоту виникнення та результати лікування постпанкреатектомічних кровотеч у пацієнтів зі злоякісними пухлинами підшлункової залози та розробити оптимальні стратегії в лікувальній тактиці для поліпшення результатів лікування.

Матеріали та методи. Ретроспективно проаналізовано результати лікування в період із січня 2010 до грудня 2022 року 878 пацієнтів, які перенесли радикальні резекції підшлункової залози з приводу її злоякісних пухлин. Пацієнтів розподілили на дві групи. В основній групі 500 хворих перебували на лікуванні в клініці в період з 2016 до 2022 р. У цій групі постпанкреатектомічна кровотеча виникла в 31 (6,2%) хворого. Лікування пацієнтів проводили за розробленим нами алгоритмом діагностики та лікування з пріоритетним застосуванням ендovasкулярних методів на першому етапі лікування. У групі порівняння 378 пацієнтів перебували на лікуванні в період із 2010 до 2015 р. У цій групі постпанкреатектомічна кровотеча виникла у 20 (5%) хворих. Пацієнтів лікували згідно зі стандартними підходами. Постпанкреатектомічні кровотечі визначали відповідно до International Study Group of Pancreatic Surgery.

Результати. Ендovasкулярну емболізацію виконано у 16 (51,6%) пацієнтів основної групи, ендovasкулярну оклюзію — 11, кровотечу зупинено за допомогою стент-графту в 5 пацієнтів. У 3 (9,7%) хворих джерело кровотечі за даними ангіографії не виявлено, їм виконали лапаротомію з подальшим гемостазом. Відкриті оперативні втручання проведено 11 (35,5%) хворим. В основній групі 1 (3,2%) хворий помер після лапаротомії з гемостазом від розвитку інфекційних ускладнень. У групі порівняння ендovasкулярний гемостаз виконано 2 (10,0%) хворим, гемостаз за допомогою ендоскопії — 1 (5,0%), релапаротомію з подальшим гемостазом — 15 (75,0%). У цій групі 6 (30%) пацієнтів померли після відкритих релапаротомій.

Висновки. Ендovasкулярні методи постпанкреатектомічної кровотечі необхідно застосовувати на першому етапі лікування з установленням стент-графтів при кровотечі з магістральних судин. Летальність при постпанкреатектомічних кровотечах статистично значущо знизилася з 30,0 до 3,2% ($\chi^2=7,3$; $p=0,006$) завдяки застосуванню нової лікувальної тактики, що передбачає максимальне використання малоінвазивних ендovasкулярних методик. Для поліпшення лікування хворих зі злоякісними пухлинами підшлункової залози та періампулярної зони з постпанкреатектомічною кровотечею необхідний постійний доступ до ендovasкулярних методик із можливістю проводити ендovasкулярні втручання в режимі 24/7, що можливо у високоспеціалізованих центрах.

Ключові слова: постпанкреатектомічна кровотеча, ендovasкулярні методики, ендovasкулярна емболізація, стент-графт.

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A differentiated approach to comprehensive surgical treatment of combined combat thermomechanical injuries

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In recent years, there has been a notable increase in the incidence of thermomechanical injuries, which frequently manifest as a combination of various types of damage. The majority of these injuries require long-term treatment and result in the development of decompensated (critical) conditions during the early stages, with a substantial death rate ranging from 75% to 80%.

OBJECTIVE — to improve the results of surgery for combined combat thermomechanical injuries by developing and implementing a differentiated surgical approach that incorporates the assessment of injury severity within the context of medical support.

MATERIALS AND METHODS. A retrospective-prospective study was carried out to determine the effectiveness of medical care provided for wounded individuals with combined combat thermomechanical injuries sustained during combat operations between 2017 and 2023. The study included a cohort of 97 wounded individuals, who were subsequently divided into two separate clinical groups. The main group (n=56) underwent treatment according to a differentiated surgical approach that included the assessment of the severity of the patient's condition using the admission trauma scale (AdTS) and the perfusion index (PI). The control group (n=41) received treatment based on established protocols using conventional treatment approaches for combined combat thermomechanical injuries without considering prioritisation.

RESULTS. A differentiated surgical strategy for managing combined combat thermomechanical injuries, which included an objective assessment of injury severity using the AdTS and the perfusion index (PI), allowed for a notable decrease in the occurrence of late purulent-septic complications as well as a significant reduction in the mortality rate in the main group to 21.4%, compared to 38.8% in the control group (p=0.038). This was related to a decrease in the frequency of fatal outcomes among individuals with serious injuries: 21.2% in the main group, 37.0% in the control group (p=0.013). Furthermore, surgical treatment improved anatomical and functional outcomes in the main group compared to the control group. Group 1 had a higher specific weight of favourable outcomes $52.0 \pm 14.2\%$ and a lower specific weight of unsatisfactory outcomes (17.6), [8.7;28.7]%, compared to group 2 $20.6 \pm 13.4\%$ and $47.3 \pm 14.7\%$. The difference was statistically significant at p=0.001.

CONCLUSIONS. The implementation of a differentiated surgical approach with an objective assessment of injury severity resulted in a reduction in mortality from 7.3% to 1.8%, specific weight of amputations from 34.2% to 8.9%, and contractures from 26.8% to 10.5% (p<0.05). Early vacuum therapy in the surgical treatment of combined combat thermomechanical injuries reduced treatment time and allowed for early reconstructive and restorative operations, leading to better functional outcomes. The specific weight of favourable outcomes increased from 20.6% to 52.0%, while the relative number of unsatisfactory outcomes decreased from 47.3% to 17.6% (p<0.05).

KEYWORDS

combined combat thermomechanical injury, perfusion index, syndrome of mutual aggravation of injuries.

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In recent years, there has been a notable increase in the incidence of thermomechanical injuries. They frequently manifest as a combination of various types of damage, primarily affecting people of working age and resulting in severe conditions. The majority of these injuries require long-term treatment and result in the development of decompensated (critical) conditions during the early stages, with a substantial death rate ranging from 75 % to 80 % [3, 9, 7].

It should be noted that combined combat thermomechanical injury, which differs from civilian injury and is a separate category of mine-explosive injuries, includes a combination of burns received as a result of the action of a flame of incendiary material, the explosion of shells, missiles, and bombs as well as mechanical injuries caused by the impact of a shock wave or various projectiles (for example, bullets, shrapnel, or mine-explosive injuries). In the spectrum of all explosive injuries, combined combat thermomechanical trauma accounts for approximately 69–75 % [8, 14].

Modern explosives used in combat operations and causing combined combat thermomechanical injuries can be classified into high-order explosives and low-order explosives. High-order explosives have a significant supersonic pressure wave known as a blast wave or shock wave. Low-order explosives have a subsonic explosion and lack a high-order blast wave. In addition to the blast wave, the explosion can cause a shock wave. A shock wave is a stream of superheated air that can interact with people and objects and cause injury or damage [2].

Burn shock and traumatic shock are more severe in cases of extensive mechanical injuries and deep thermal burns compared to isolated mechanical injuries and thermal burns. These types of shock result from hemodiscirculatory disorders and occur due to blood and plasma loss. Burn wounds and carbon monoxide poisoning involving the respiratory tract aggravate the clinical manifestations of shock due to the development of all forms of hypoxia (circulatory, hypoxic, tissue, and mixed). Bleeding from damaged vessels and organs and loss of plasma and lymph in injured and burned tissues lead to hypovolemia, hemodynamic disorders, and impaired oxygen transport. More than 85 % of burn and traumatic shock patients have serious acid-base balance disorders of the blood and lymph, hemo- and lymphodynamics, metabolic processes, and functional abnormalities in the liver and kidneys. If no medical assistance is provided, the risk of death increases dramatically [16].

Some studies focus on the correlation between thermal injuries and the development of burn disease and a non-specific systemic inflammatory response syndrome (SIRS). Their findings indicate that a superficial burn of 15 % of the body surface

is associated with the syndrome of mutual aggravation, which is characterised by more severe clinical signs of shock and a high incidence of purulent-septic complications in the post-shock period [1, 15].

In modern literature, there is no consensus on the appropriate indications, contraindications, and management strategies for burn shock and traumatic shock, as well as the treatment of their combined manifestation in the presence of the syndrome of mutual aggravation. This lack of agreement extends to several aspects of medical support, including modern resuscitation measures, differentiated surgical treatment, support during transportation, and subsequent restorative treatment of combined combat thermomechanical injuries. These factors have prompted further research under the current conditions of combat operations [4].

OBJECTIVE — to improve the results of surgery for combined combat thermomechanical injuries by developing and implementing a differentiated surgical approach that incorporates the assessment of injury severity within the context of medical support.

Materials and methods

A retrospective-prospective study was carried out to determine the effectiveness of medical care provided for wounded individuals with combined combat thermomechanical injuries sustained during combat operations between 2017 and 2023. The study was conducted at the injury clinic of the National Military and Medical Clinical Centre «The Main Military Clinical Hospital» (Kyiv), the burn department of Kyiv City Clinical Hospital No. 2, and the orthopaedic and traumatology department of Kyiv City Clinical Hospital No. 8. A total of 376 case histories were analysed. The study included a cohort of 97 wounded individuals, who were subsequently divided into two separate clinical groups. The main group (n = 56) underwent treatment according to a differentiated surgical approach that included the assessment of the severity of the patient's condition using the AdTS, the perfusion index (PI), and modern methods of treatment. The control group (n = 41) received treatment based on established protocols using conventional treatment approaches for combined combat thermomechanical injuries without assessing injury severity or considering prioritisation.

After receiving first aid at level I care, the injured were transported to level II care. In the first hour after the injury, we admitted 11 (19.6 %) and 8 (19.5 %) individuals; in the second hour, 29 (51.8 %) and 23 (56.1 %) individuals; and between 2 and 24 hours, 16 (28.6 %) and 10 (24.4 %) individuals (Table 1).

Table 1. Admission time for level I care

Admission time	Group 1 (n = 56)	Group 2 (n = 41)
Up to 1 hour	11 (19,6%)	8 (19,5%)
From 1 to 2 hours	29 (51,8%)	23 (56,1%)
From 2 to 3 hours	7 (12,5%)	5 (12,2%)
From 3 to 6 hours	5 (8,9%)	3 (7,3%)
After 6 hours	1 (1,8%)	0
Unknown	3 (5,4%)	2 (4,9%)

All of the wounded individuals had multiple and combined mine-explosive injuries. The most commonly diagnosed injuries in Group 1 and Group 2 were upper limb injuries, with 32 (57.1%) and 24 (58.5%) cases, respectively, and lower limb injuries, with 24 (42.9%) and 17 (41.5%) cases, respectively.

Based on the type of wound tract, 159 wounds were penetrating, and 58 wounds were perforating. No statistically significant difference was found among the comparison groups in terms of the trajectory of the wound tract ($p > 0.05$ for both groups). The comparison groups were comparable (Table 2).

With regard to the depth of burn wounds, the IIa degree group suffered the most injuries, with 25 (43.9%) and 18 (43.9%), respectively (Table 3).

The extent of anatomical damage, anatomical and functional severity of injury, general clinical indicators, biochemical findings, coagulograms, as well as

Table 2. Distribution of the types of wound tract in comparison groups

Type of wound tract	Group 1 (n = 56)	Group 2 (n = 41)	Significance of the difference
Penetrating	96 (72,7%)	64 (74,4%)	$\chi^2 = 0,076$ $p = 0,783$
Perforating	36 (27,3%)	22 (25,6%)	
Total	132	86	

Table 3. The degree of burns in combined combat thermomechanical injuries in the study groups

Degree of burn	Group 1 (n = 56)	Group 2 (n = 41)	Significance of the difference
IIa	25 (43,9%)	18 (43,9%)	$\chi^2 = 0,873$ $p = 0,647$
IIb	14 (24,6%)	13 (31,7%)	
III	16 (31,6%)	10 (24,4%)	

respiratory and circulatory disorders, were assessed before, during, and after conservative and operative treatment within the context of medical support.

Correlation analysis revealed a reliable relationship between the anatomical and functional assessment of injury severity according to the PTS (Polytrauma-Schlüssel) and the value of PI in the wounded individuals both on admission (Spearman correlation coefficient $r = -0.61$; $p = 0.01$) and in the first 1–3 days after injury ($r = -0.62$; $p < 0.001$). At the same time, the relationship between the score assessment of injury severity on the PTS scale and the AdTS was less pronounced ($r = +0.31$; $p = 0.095$).

The collected statistical information was analysed and processed using the Statistica 8.0 and Microsoft Excel 2021 programmes. The study focused on the assessment of the absolute (m) and frequency (p) characteristics of indicators for qualitative parameters as well as average values for quantitative data (arithmetic mean \bar{X}) and their variability (mean square deviation σ). Pearson's Chi-square (χ^2) test was used to compare the group frequency of a specific parameter.

Results

In the study groups, surgical treatment of combined combat thermomechanical injuries was approached differently. In the main group, it included an objective assessment of injury severity using the AdTS and the perfusion index (PI), life-saving measures aimed at reducing the volume, duration, and traumatic impact of the first operation at level II care, and the final restoration of damaged organs and structures after stabilising vital bodily functions during the second operation at levels III and IV care.

On admission of a wounded person with a severe and extremely severe injury to level II care, first of all, anti-shock measures were performed according to damage control tactics, aimed at combating three main life-threatening conditions: coagulopathy, hypothermia, and acidosis. The concept of damage control, in addition to the specified triad, includes the «two hit theory» («first hit» — systemic inflammatory response, «second hit» — blood loss, shock, reaction to surgical intervention).

Individuals with non-severe combined combat thermomechanical injuries received comprehensive surgical care in the dressing room or operating room, depending on their needs. In situations of severe and extremely severe injuries, the scope of surgical care was reduced in accordance with DCS. The medical procedures started in the anti-shock ward, and after stabilising the patient's condition, they were transferred to the operating room. In situations of

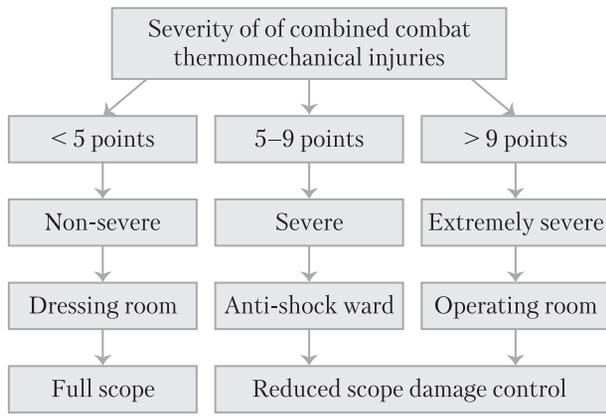


Figure 1. **A differentiated approach to the surgical treatment of combined combat thermomechanical injuries**

extremely severe injuries, a full scope of surgical treatment was provided in the operating room (Fig. 1).

Based on the assessment of injury severity using the AdTS and the value of the perfusion index, the place, scope, and sequence of diagnostic procedures were determined to identify the main clinical and laboratory indicators of homeostasis, integral indicators, single heart output, the coefficient of integral vascular tonicity, the rate of respiratory tension, the rate of tone stabilisation of blood vessels, indicators of the severity of respiratory and circulatory disorders, and indicators of SpO₂ and heart rate.

The full scope of surgical intervention for combined combat thermomechanical injuries included the following procedures: primary surgical treatment of gunshot wounds to stop external bleeding; preventive and curative fasciotomy of the muscle and fascial compartments of the damaged limb segment; limb amputation when necessary; stabilisation of bone fragments using a rod apparatus for external fixation; necrotomy; early necrectomy of the burned tissue; and, in cases of burns involving more than 40% of the body area, staged necrectomy. The

reduced scope of surgical intervention included the following procedures: cessation of external bleeding, therapeutic fasciotomy, necrotomy for circular burns of the trunk and limbs, and stabilisation of bone fragments using a rod apparatus for external fixation.

At the next level of care, further comprehensive management of combined combat thermomechanical injuries included vacuum-assisted closure treatment (VAC-technique) for burn wounds, during which negative pressure was applied to a white foam dressing when available (Fig. 2), which made it possible to maintain constant temperature in the wound, reduce bacterial insemination, decrease edema, reduce intercellular pressure, stimulate the formation of granulation tissue, and reduce the wound surface area.

Irrigation-oxygen vacuum therapy was also used to reduce the risk of the progression of anaerobic infection. It included the application of an antiseptic solution along with oxygen. An oxygen concentrator was administered to treat the wound with negative pressure and constant insufflation with oxygen without the threat of depressurization of the wound due to the adjustment of the dosed supply of oxygen to the wound (Fig. 3).

The implementation of a differentiated surgical approach with an objective assessment of injury severity resulted in a reduction in mortality from 7.3% to 1.8%, specific weight of amputations from 34.2% to 8.9%, and contractures from 26.8% to 10.5% (p < 0.05). Furthermore, it reduced the treatment period and allowed for the conversion of the osteosynthesis method at level IV care, which improved the functional outcomes of treatment: the specific weight of favourable outcomes increased from 28.6% to 51.0%, and the relative number of unsatisfactory outcomes decreased from 39.3% to 17.6% (p < 0.05) (Table 4).

A notable decrease in the occurrence of late purulent-septic complications led to a significant reduction in the mortality rate in the main group to 21.4%



Figure 2. **Wounded D.: treatment of burn wounds with a white foam dressing**



Figure 3. **Wounded K.: the condition after surgical treatment and installation of an irrigation-oxygen vacuum system**

compared to 38.8% in the control group ($p = 0.038$). This was related to a decrease in the frequency of fatal outcomes among individuals with serious injuries: 21.2% in the main group, 37.0% in the control group ($p = 0.013$). The mortality rate directly depended on the development of burn shock and traumatic shock, which were more severe than in cases of isolated mechanical injuries and thermal burns. Endotoxemia occurred due to the absorption of decomposition products from injured and ischemic tissues, leading to the formation of toxic substances inside

the body. It contributed to the syndrome of mutual aggravation, which had more severe clinical signs of shock and a significant number of purulent-septic complications in the post-shock period.

Furthermore, surgical treatment improved anatomical and functional outcomes in the main group compared to the control group. Group 1 had a higher specific weight of favourable outcomes (52.0%) and a lower specific weight of unsatisfactory outcomes (17.6%), compared to group 2 (20.6%) and (47.3%) (Table 5).

Table 4. **Analysis of the specific weight of amputated limbs at the level of the thigh in comparison groups**

Indicator	Group 1 (n = 56)	Group 2 (n = 41)
Amputation	6 (8,9%)	14 (34,2%)
Limbs saved	50 (91,1%)	27 (65,8%)

Table 5. **Analysis of the quality of treatment of the wounded according to the scale of anatomical and functional outcomes of Mathis–Luboshits–Schwartzberg**

Functional outcomes	Group 1 (n = 56)	Group 2 (n = 41)
Good	27 (52,0%)	8 (20,6%)
Satisfactory	20 (30,4%)	14 (32,1%)
Unsatisfactory	9 (17,6%)	19 (47,3%)

Clinical case

Wounded D., 34 years old. Mine-explosive injury (10.06.23). Combined injury. Gunshot shrapnel wound of the left lower limb with a gunshot multifragmentary fracture of the femur, tibia, and foot on the left. Thermal burns of the left lower limb IIa and IIb degree, amounting to 11% and 5% body area respectively.

The condition of the wounded was assessed as severe, according to the AdTS of 8 points and the PI of 3.7. In the operating room, primary surgical treatment of gunshot wounds of the left lower limb with fasciotomy, installation of a rod apparatus for external fixation on the left lower limb (segment: thigh, lower leg, foot), and toileting of the burn surface were performed (Fig. 4). After stabilisation of the condition, evacuation to the next level of care.

At level III care, the surgical intervention was carried out as a result of the non-viability of the limb. The procedure included the amputation of the left lower limb at the level of the middle third

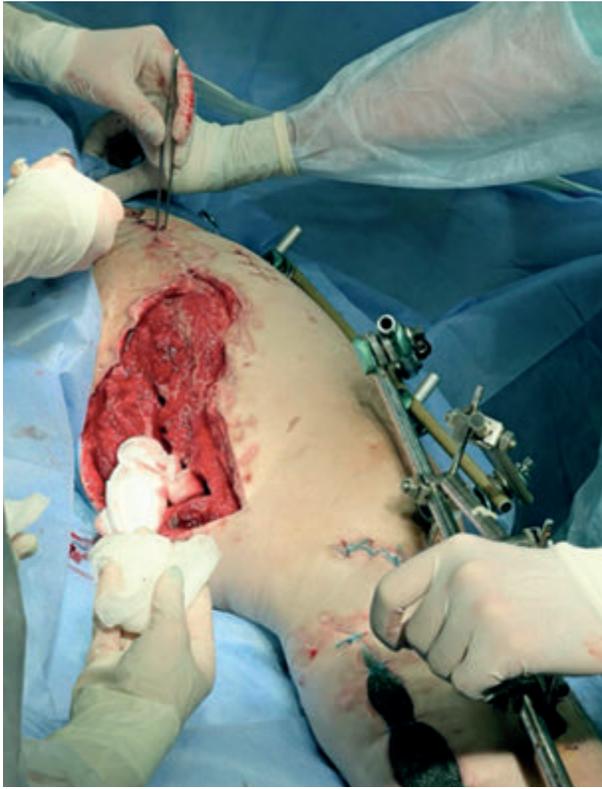


Figure 4. Wounded D.: during surgical procedure

of the thigh, followed by the formation of a stump. The postoperative period was uneventful. After the healing of the stump, the fragments of the upper third of the left femur continued to be displaced, making it impossible to begin limb prosthetics with further rehabilitation. For this purpose, the intramedullary osteosynthesis of the left femur was conducted using the PFNA (Fig. 5).

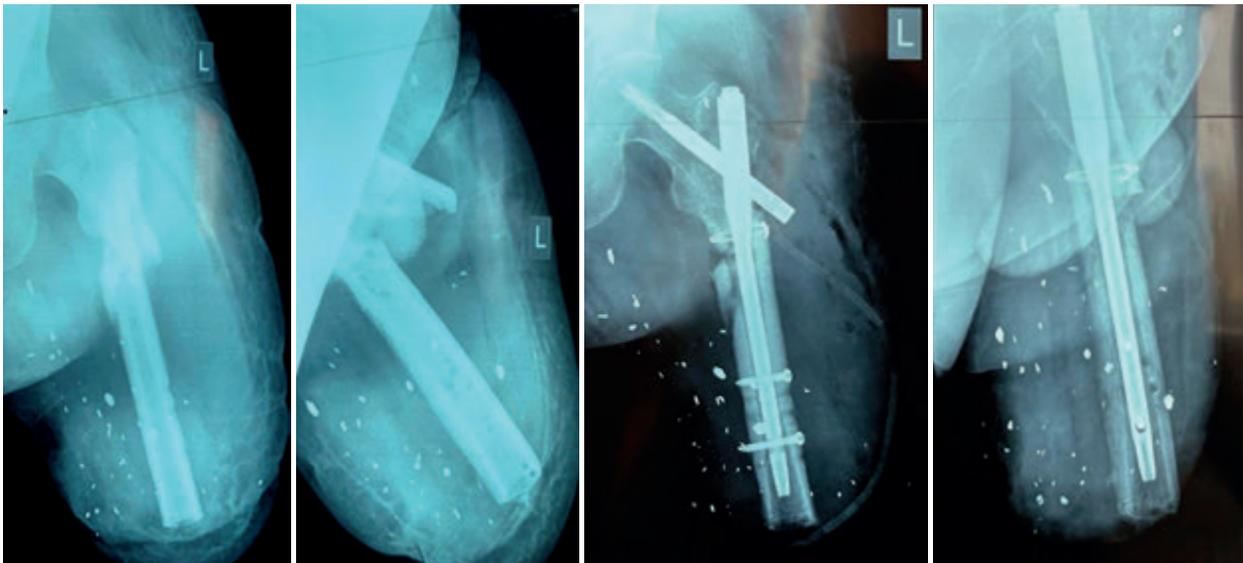


Figure 5. Wounded D.: intramedullary osteosynthesis of the left femur using the PFNA

The postoperative period was without complications. Early rehabilitation was started, and sutures were removed on the 10th day (Fig. 6). The total period of treatment at all levels of care was 47 days.

Discussion

The management of combined combat thermomechanical injuries at all levels of care is a challenging issue that requires complex and well-considered decisions to be made over a period of time [5, 13]. The proposed differentiated approach makes it possible to reduce the time for assessing the severity of combined combat thermomechanical injuries using the AdTS and the perfusion index (PI), whose prognostic value is not inferior even to the widespread PTS [10]. However, their application is technically simpler and does not require significant costs, in contrast to other prognostic methods of assessing the severity of combined combat thermomechanical injuries [6].

The application of the AdTS and the PI increases the effectiveness of treatment and minimises the risk of complications resulting from both full-scope and reduced-scope surgical interventions. This approach mitigates the impact of misclassifying combined combat thermomechanical injuries as either traumatic injuries or burns [11] and takes into account the syndrome of mutual aggravation. This syndrome involves two or more anatomical and functional systems of the body and is characterised by the simultaneous action of several diverse pathophysiological processes on the body. The dominance of one pathological process over another depends on the mechanism of injury. It is



Figure 6. **Wounded D.: early and late postoperative period**

characterised by a significant and rapid impairment of the autoregulation of the inflammatory process, resulting in a competitive interaction between pro-inflammatory and anti-inflammatory cytokines, leading to irreversible changes such as multiple organ failure, sepsis, and the death of the wounded.

The development and implementation of modern approaches to comprehensive surgical treatment of combined combat thermomechanical injuries as well as their impact on various aspects of traumas and burns, including the wound process, remain relevant. In contrast to conventional methods of surgical treatment, the application of the VAC technique (irrigation-oxygen vacuum therapy) in the management of burn wounds allows us to reduce the risk of complications and the treatment period, effectively control the wound process, and maximally preserve the functionality and aesthetics of burn skin defects with subsequent early plastic surgery, rehabilitation, and restoration of motor activity, which contributes to a higher quality of life [12].

Conclusions

The implementation of a differentiated surgical approach with an objective assessment of injury severity resulted in a reduction in mortality from 7.3% to 1.8%, specific weight of amputations from 34.2% to 8.9%, and contractures from 26.8% to 10.5% ($p < 0.05$).

Early vacuum therapy in the surgical treatment of combined combat thermomechanical injuries reduced treatment time and allowed for early reconstructive and restorative operations, leading to better functional outcomes. The specific weight of favourable outcomes increased from 20.6% to 52.0%, while the relative number of unsatisfactory outcomes decreased from 47.3% to 17.6% ($p < 0.05$).

DECLARATION OF INTERESTS

The authors declare no potential conflicts of interest.

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ETHICS APPROVAL AND WRITTEN

INFORMED CONSENTS STATEMENTS

The study was conducted in accordance with the Helsinki Declaration of Ethics. The study protocol was approved by the ethics committee of the Ukrainian Military Medical Academy.

AUTHORS CONTRIBUTIONS

S. O. Korol: idea, design, formalisation, conclusions; I. P. Palii: materials and methods, design, data processing, statistics.

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Диференційована хірургічна тактика в комплексному лікуванні поранених із бойовою комбінованою термомеханічною травмою

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Термомеханічні ушкодження часто є комбінованим видом уражень. Більшість цих ушкоджень потребують тривалого лікування та призводять до розвитку декомпенсованих (критичних) станів у ранні терміни після поранення з високою летальністю (75—80%).

Мета — поліпшити результати хірургічного лікування поранених із бойовою комбінованою термомеханічною травмою (БКТМТ) шляхом розробки та впровадження диференційованої хірургічної тактики з урахуванням оцінки тяжкості на рівнях медичного забезпечення.

Матеріали та методи. Для оцінки ефективності надання медичної допомоги пораненим із БКТМТ під час бойових дій за період із 2017 до 2023 р. проведено ретроспективно-перспективне дослідження. Пацієнтів ($n=97$) розподілили на дві групи. В основній групі ($n=56$) лікування проводили за диференційованою хірургічною тактикою з урахуванням тяжкості стану пораненого за шкалою оцінки тяжкості травми AdTS та величиною перфузійного індексу (ПІ). Контрольну групу ($n=41$) лікували загальноприйнятими методами без урахування пріоритетів.

Результати. Диференційована хірургічна тактика надання хірургічної допомоги пораненим із БКТМТ з об'єктивною оцінкою тяжкості травми за шкалою AdTS та ПІ дала змогу зменшити кількість пізніх гнійно-септичних ускладнень, що сприяло зменшенню кількості летальних наслідків в основній групі до 21,4%, тоді як у контрольній групі таких випадків було 38,8% ($p=0,038$). Це зумовлено зменшенням частоти летальних наслідків у поранених із тяжкою травмою: в основній групі — 21,2%, у контрольній групі — 37,0% ($p<0,05$). Анатомо-функціональні результати лікування в основній групі були кращими, ніж у контрольній групі. В основній групі зафіксовано більшу частоту добрих результатів — 52,0 і 20,6% відповідно і меншу частоту незадовільних — 17,6 та 47,3% ($p<0,05$).

Висновки. Упровадження диференційованої хірургічної тактики з урахуванням тяжкості травми дало змогу зменшити рівень летальності з 7,3 до 1,8%, частку ампутацій — з 34,2 до 8,9%, кількість контрактур — з 26,8 до 10,5% ($p<0,05$). Застосування ранньої вакуумної терапії при хірургічному лікуванні у пацієнтів із БКТМТ дало змогу скоротити тривалість лікування та провести в ранні терміни реконструктивно-відновні операції, що поліпшило функціональні результати лікування: частка добрих результатів збільшилася з 20,6 до 52,0%, а незадовільних — зменшилася з 47,3 до 17,6% ($p<0,05$).

Ключові слова: бойова комбінована термомеханічна травма, перфузійний індекс, синдром взаємного обтяження.

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Surgical rehabilitation of patients with Crohn's disease

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OBJECTIVE — to enhance the outcomes of surgical rehabilitation for patients with Crohn's disease through the improvement and implementation of organisational measures as well as general and specialised surgical strategies.

MATERIALS AND METHODS. The study focused on the development of organisational measures as well as general and specialised surgical rehabilitation procedures for Crohn's disease. The research was conducted to determine the scope of radical surgical interventions for complications resulting from segmental lesions with extensive damage to the intestinal tract. The study also aimed to develop methods of restorative, reconstructive and restorative operations that would reduce the frequency of postoperative complications, disease recurrence, digestive disorders in the intestinal tract, malabsorption, and anal incontinence. Additionally, the study aimed to improve the functional outcomes and quality of life for operated patients.

RESULTS. A total of 53 patients with Crohn's disease — 28 (52.8%) men and 25 (47.2%) women — were operated on using specially designed surgical rehabilitation techniques. The patients undergoing surgery ranged in age from 19 to 45. 32 (60.4%) patients had segmental resections, while 21 (39.6%) had extensive resections. 8 (15.1%) patients underwent restorative operations, while 40 (75.4%) had reconstructive operations. A lifelong ileostomy was formed in 5 (9.4%) patients. Postoperative complications were observed in 12 (22.6%) patients, and disease relapses in 5 (9.4%) patients. One (1.8%) patient died after surgery. Positive functional outcomes, including improved digestion in the intestinal tract, normal absorption, and preservation of anal retention, were noted following restorative and reconstructive-restorative operations.

CONCLUSIONS. Organisational measures as well as general and specialised surgical rehabilitation strategies for Crohn's disease allowed for more effective diagnosis and treatment of postoperative complications, better prevention of disease recurrence, improved digestion in the intestinal tract, normalised absorption processes, and preservation of anal retention. Following the implementation of specially designed surgical rehabilitation techniques, 20.7% and 1.8% of patients experienced early and late postoperative complications, respectively. Additionally, there were occurrences of postoperative mortality in 1.8% of patients and relapses in 9.4%. Severe forms of reflux ileitis, postcolectomy syndrome, and secondary anal incontinence syndrome were not observed.

KEYWORDS

Crohn's disease, surgical treatment, rehabilitation.

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The concept of surgical rehabilitation includes a set of surgical measures aimed at surgical treatment of the disease, its complications, achievement of an uncomplicated course of the postoperative period, favourable short-term and long-term functional outcomes, quality of life, and sufficient social and labour adaptation of operated patients [20]. The implementation of these rehabilitation factors in patients with Crohn's disease is extremely important when performing radical, restorative, and, especially, reconstructive and restorative surgical interventions [12, 15, 16, 20, 21].

Surgical rehabilitation of patients with Crohn's disease is an extremely important and complex problem. The challenges in dealing with this problem are evident in the substantial number and severity of complications associated with the underlying disease, postoperative complications, relapses, and even the reluctance of some authors to perform reconstructive and restorative operations, despite the significance of these rehabilitation measures [10, 16–18].

In order to effectively implement these provisions, it is imperative to improve, and in some cases,

modify, the methodological approach to choosing the scope of radical, restorative and, especially, reconstructive and restorative surgical interventions. This includes the use of monitoring techniques to assess the overall health of operated patients throughout their lifetimes, and the timely addressing of any identified disorders [12, 18, 20–22].

OBJECTIVE – to enhance the outcomes of surgical rehabilitation for patients with Crohn’s disease through the improvement and implementation of organisational measures as well as general and specialised surgical strategies.

Materials and methods

The components of surgical rehabilitation for Crohn’s disease include a set of organisational measures, general and specialised surgical strategies aimed at determining appropriate indications for surgical treatment, developing and implementing new diagnostic and treatment methods for postoperative complications, preventing relapses, improving digestion and absorption in the intestinal tract, and preserving anal retention.

The organisational measures encompassed the identification of indications, patient preparation for surgery, appropriate support based on the clinical course of the disease, assessment of the anatomical lesions in the intestinal tract, determination of the scope of the radical surgical stage and the method of its completion, and evaluation of the risk of postoperative complications.

General surgical rehabilitation strategies were aimed at performing radical and restorative stages of surgery, prognostication, prevention, diagnosis, and treatment of complications in the early and late postoperative periods. To ensure timely diagnosis of early postoperative complications, continuous monitoring of the operated patients was provided, as well as staged monitoring in the late postoperative period to detect late complications and possible recurrence of the disease.

Specialised surgical rehabilitation strategies were aimed at reducing the risk or preventing the recurrence of the disease in the anatomical parts of the intestinal tract that remained after the radical stage of surgery. They largely depended on the characteristics of the clinical course of Crohn’s disease, the sites and extent of the intestinal tract lesion, the scope of the radical surgical stage, and the method of performing the restorative or reconstructive-restorative stages of surgery.

The radical stage of surgical interventions for Crohn’s disease with acute complications, such as bleeding into the intestinal lumen and extensive

peritonitis, involved performing an obstructive bowel resection, which depended on the extent of the lesion and was completed with the formation of an ileostomy. The rehabilitation measures for these patients included prescribing anti-relapse therapy and creating a retention ileostomy without a reservoir to improve digestion and absorption in the intestinal tract [2].

In the presence of chronic complications, in particular stricture, paracolic inflammatory infiltrate, internal or external intestinal fistulae, and colon cancer, which most often occurred at the site of segmental lesions, resection of the lesions was performed. The radical stage of surgical intervention was aimed at eliminating only the complications of the disease. In the presence of colon cancer, the radical stage of surgery was performed in accordance with generally accepted oncological standards.

Large-scale surgical interventions (colectomy, colectomy with low resection of the rectum, ultra-low resection of the rectum, and mucosectomy of the surgical anal canal) were performed in cases of subtotal or total colon involvement with existing complications and irreversible morphological changes in its wall. These surgical interventions were complemented by resection of the terminal part of the small intestine in cases of its lesion and a high predicted risk of disease recurrence.

An important general surgical rehabilitation measure was the restorative stage of surgery, which included forming an intestinal anastomosis. Small intestinal and intermucosal anastomoses were created by the end-to-end type using a single-row inverted intestinal suture without capturing the mucous membrane in the suture [4].

Reconstructive-restorative operations, as a special measure of surgical rehabilitation, involved the creation of appropriate anatomical and functional structures that were used after the removal of functionally important parts of the intestinal tract: the ileocecal junction, colon, and rectum.

When removing the ileocecal junction, as well as after performing a right-sided hemicolectomy, an ileoascendicular anastomosis or ileotransverse anastomosis was formed, with the reproduction of the anatomical relationship between the segments of the small intestine and colon like the removed ileocecal junction [5].

After colectomy, the continuity of the intestinal tract was restored by forming an end-to-side ileorectal anastomosis with an excess of the small intestine’s adductor and creating a bend in the small intestine in front of the anastomosis site with serous-muscle sutures. This contributed to a physiological delay in the advancement of the contents

and improved digestion and absorption [6]. After a colectomy with low resection of the rectum, which involved the preservation of only the lower ampullary section of the rectum, an ileorectal anastomosis was formed using a circular stapler. After colectomy with ultra-low resection of the rectum by mucosectomy of the surgical anal canal, as well as after the specified volume of the radical stage of surgery supplemented by forced resection of the terminal part of the small intestine, an ileo-endoanal anastomosis was formed [1]. After each of these radical operations, appropriate pelvic small bowel reservoir structures were created to prevent the occurrence of severe forms of postcolectomy syndrome [3, 7].

Staged monitoring in the late postoperative period involved the performance of clinical, laboratory, and instrumental methods of examination of the patient, which were carried out 1, 3, 6, and 12 months after the end of surgical treatment, and then once a year, taking into account the peculiarities of performing radical and reconstructive and restorative stages of surgical intervention aimed at determining the functional results of surgical treatment, timely diagnosis of late postoperative complications, disease recurrence, and correction of diagnosed pathological conditions. At the same time, standard clinical and biochemical laboratory tests and special methods, including proctological examination, irrigography, colonoileoscopy, CT, or MRI of abdominal organs, were used. Anoproctoscopy, anoreservoirscopy, reservoirography, CT, or MRI enteroreservoirography were prescribed according to indications. The assessment of functional results, the presence of late postoperative complications, and disease recurrence is given in the period up to 3 years from the time of completion of all stages of surgical treatment.

Results

From 2011 to 2020, using specially designed surgical rehabilitation techniques at the Coloproctological Centre of Ukraine, the main clinical base of the Department of Surgery No. 1 of Bogomolets National Medical University, the authors operated on 53 patients with Crohn's disease, including 28 (52.8%) men and 25 (47.2%) women. The age of the operated patients ranged from 19 to 45 years. The features of damage to the anatomical parts of the intestinal tract in patients with Crohn's disease are presented in Table 1.

These findings indicate that the vast majority of patients had segmental lesions of the terminal area of the small intestine and anatomical sections of the right half of the large intestine, accompanied by

ileocolitis, cecoileitis, and ileitis. In a much smaller number of patients, the disease affected only the colon (segmental and total colitis), as well as the colon and the terminal part of the small intestine (total colitis and terminal ileitis). The complications of Crohn's disease are presented in Table 2.

Extensive peritonitis in all patients occurred as a result of perforation of the colon wall and intestinal bleeding into the lumen of the terminal area of the small intestine and the right sections of the colon. Internal intestinal fistulas most often arose between the terminal area of the small intestine, proximal to the stricture, and the left anatomical sections of the

Table 1. Features of intestinal damage in Crohn's disease

Extent of the lesion	Number of patients (n = 53)
Segmental ileocolitis	17 (32.1%)
Cecoileitis	8 (15.1%)
Segmental ileitis	4 (7.5%)
Segmental colitis	3 (5.7%)
Total colitis	6 (11.3%)
Total colitis and terminal ileitis	9 (16.9%)

Table 2. Complications of Crohn's disease

Diagnosis of complications	Number of complications (n = 76)
Acute complications	
Common peritonitis	5 (9.4%)
Intestinal bleeding	4 (7.5%)
Chronic complications	
Internal intestinal fistulas	11 (20.7%)
External intestinal fistulas	9 (16.9%)
Paracolic infiltrates	7 (13.2%)
Stricture of the small intestine	7 (13.2%)
Colon stricture	6 (11.3%)
Colon cancer	3 (5.7%)
Hormone dependence and hormone resistance	16 (30.2%)
Extraintestinal manifestations of the disease	14 (26.4%)

Note. 7 (13.2%) patients were diagnosed with 2 complications, 2 (5.7%) – with 3 ones.

colon, in particular the sigmoid and descending colon, as well as between the loops of the jejunum and duodenum, the bladder. External intestinal fistulas mainly opened on the front abdominal wall in the right iliac region and on the perineum, which led to the destruction of the rectal sphincters. Strictures of the small and, especially, the large intestine were often tubular and sufficiently long, which made it impossible to perform a colonoileoscopy, to visualise the mucous areas of the intestinal canal proximal to the stricture, and to perform stricturoplasty.

Associated diseases such as obesity, diabetes, duodenal ulcers, chronic urinary tract infections, and essential thrombocytopenia were diagnosed in 11 (20.7%) patients.

According to the prevalence of the pathological process and existing complications, the following radical surgical interventions were performed, as presented in Table 3.

In general, segmental resections of the intestinal canal, namely, resection of the terminal part of the small intestine, right-sided hemicolectomy, resection of the ileocecal junction, and resection of the colon, were performed in 33 (62.3%) patients, and extensive resections in 20 (37.7%).

It should be noted that in 11 patients with internal fistulas, the scope of the radical stage of surgical intervention had to be expanded to include sectoral resections of the walls of other hollow organs, specifically the sigmoid colon, duodenum, and bladder, depending on the location of the internal fistula openings. In 9 (16.9%) patients with acute complications (peritonitis, bleeding), regardless

of the severity of the general condition, obstructive surgical interventions were performed, which ended with the formation of an ileostomy and rectal stump. In 3 (5.7%) patients, colectomy with rectal extirpation was performed. The remaining 8 (15.1%) patients underwent primary reconstructive surgery involving the formation of an intestinal anastomosis, including 4 patients with a small intestinal anastomosis and 4 patients with an inter-anal anastomosis.

Primary reconstructive and restorative operations involving the formation of appropriate anatomical and functional structures and anastomoses were performed in 32 (60.3%) patients: small-bowel – in 25 (47.1%), pelvic small-bowel – in 7 (13.2%). In 6 patients, after obstructive type operations, in 14–18 months after stabilisation of the general condition, topical anti-inflammatory therapy in the area of the rectal stump and secondary reconstructive and restorative operations were performed. In three of them, the rectal stump was preserved, and an ileorectal anastomosis was formed with a corresponding small intestinal reservoir structure. This operation was possible only if there were no inflammatory changes in the rectal stump. The other 4 patients underwent resection of the rectal stump and mucosectomy of the surgical anal canal due to inflammatory changes in the mucous membrane of the rectum. In this way, the radical stage of surgical treatment was completed for this category of patients. After that, an appropriate pelvic small bowel reservoir and ileo-anal anastomosis were formed. In two patients, the second stage of surgical treatment involved extirpation of the rectal stump due to the aggressive course of the disease in the rectal stump, the consequent external fistulae, and purulent lesions in the pararectal tissue. Thus, restorative surgical interventions were performed in 8 (15.1%) patients, reconstructive-restorative – in 40 (75.4%), including primary – in 36 (67.9%), and secondary – in 4 (7.5%). In addition, in 5 (9.4%) patients, surgical treatment was completed with the formation of a lifelong ileostomy.

Postoperative complications occurred in 12 (22.6%) patients, early complications in 11 (20.7%), and late complications in 1 (1.8%). Early postoperative complications occurred in patients operated on urgently due to acute complications of the disease: progressive peritonitis – in 3 (5.7%), failure of rectal stump sutures – in 2 (3.8%), postoperative wound suppuration – in 3 (5.7%), and *pneumonia* – in 3 (5.7%). These complications were treated in accordance with modern standards. Postoperative mortality occurred in 1 (1.8%) patient due to multiorgan failure against the background

Table 3. **Radical surgeries for Crohn's disease**

Scope of the radical operation	Number of operations (n = 53)
Resection of the terminal part of the small intestine	4 (7.5%)
Right-sided hemicolectomy	17 (32.1%)
Resection of the ileocecal junction	8 (15.1%)
Resection of the colon	4 (7.5%)
Colectomy with resection of the rectum	5 (9.4%)
Colectomy with resection of the terminal part of the small intestine and resection of the rectum	5 (9.4%)
Colectomy ultralow rectal resection, mucosectomy of the surgical anal canal	7 (13.2%)
Colectomy, extirpation of the rectum	3 (5.7%)
Colectomy, rectal extirpation	2 (3.8%)

of aggressive progressive peritonitis. In the late postoperative period, most of the operated patients received anti-relapse therapy in accordance with modern requirements. However, 5 (9.4 %) patients experienced disease recurrence: two in the terminal area of the small intestine proximal to the anastomosis, two in the area of the rectum stump after the formation of ileorectal anastomoses, and one in the area of the small intestinal reservoir. It should be noted that patients with relapses did not sufficiently adhere to clear recommendations regarding the prescribed anti-relapse treatment. In one (1.8 %) patient, against the background of recurrence in the pelvic small bowel reservoir, an external fistula was formed in the area of the pelvic small bowel 4 months after completion of all stages of surgical treatment, which opened into the perineum. Conservative treatment aimed at fistula healing within 3 months was ineffective. In this regard, the anal canal stump with the ileo-anal anastomosis and part of the pelvic small bowel reservoir with the existing internal fistula opening were extirpated. The operation was completed with the formation of a lifelong ileostomy. In most patients, after removal of functionally important parts of the colon, in particular the ileocecal junction, colon, ileum, and rectum, and mucosectomy of the surgical anal canal, formation of appropriate anatomical and functional structures and anastomoses, except for patients with recurrent disease and a lifelong ileostomy, the frequency of bowel movements was 3–5 times a day, which corresponded to the permissible limit of the physiological frequency of bowel movements in a healthy person. There was also a satisfactory course of intestinal digestion and absorption, as indicated by the presence of a mushy, sometimes thick, consistency of the stool, a small amount of it within 300–450 grams per day, and no body weight deficit. Almost all patients did not have cases of anal incontinence, which indicated a satisfactory function of anal retention. The satisfactory functional results of surgical treatment for patients with Crohn's disease contributed to a significant improvement in their quality of life.

Discussion

The main goal of surgical rehabilitation of patients with Crohn's disease was to preserve or restore their body image by preventing the formation or elimination of an enterostomy on the anterior abdominal wall, reducing the number of postoperative complications and relapses, providing favourable conditions for the implementation of the main functions of the intestinal tract: digestion, absorption, and

anal retention, and thus preventing or reducing the degree of disability, and improving the quality of life. The complexity of the problem required a systematic approach to its solution through the implementation of organisational measures, and general and specialised surgical strategies.

Taking into account the presence of a constantly existing high risk of disease recurrence, the risk of complications in the area of this recurrence, and the need for repeated surgical interventions in this regard, the organ-preserving principle of choosing the scope of radical surgery was followed. This principle provided for the removal of only the part of the intestinal canal with an existing complication or complications. Thus, operations in the presence of local complications were radical only in relation to the complication but not to Crohn's disease. However, in the case of total colon involvement, a reconstructive and restorative procedure is required. To prevent severe post-colectomy syndrome, a small bowel reservoir is created in the pelvic area using ileorectal or ileo-endoanal anastomosis. In this situation, the authors state that the organ-preserving principle loses its fundamental importance. This approach to the choice of a radical stage of surgical intervention in Crohn's disease is due to the attempt to minimise the risk of relapse after performing sufficiently complex reconstructive and restorative operations. In such cases, it becomes necessary to expand the radical surgical intervention by removing those areas of the intestinal canal where the probability of recurrence of Crohn's disease is highest. These areas include the mucous membrane of the surgical anal canal and the ampulla of the terminal section of the small intestine, which is usually less than 15 cm long. That is why colectomy with ultra-low anterior resection of the rectum was supplemented with mucosectomy of the surgical anal canal and removal of the small bowel ampulla. Removal of typical sites of Crohn's disease recurrence significantly reduced the risk of its occurrence.

Our research shows that the technical aspects of connecting the segments of the intestinal tract during the formation of interintestinal anastomoses and small intestinal reservoir structures are crucial for surgical rehabilitation. The use of a single-row inverted intestinal suture without capturing the mucous membrane in the formation of small-intestinal, small-intestinal-analogue, and inter-analogue anastomoses prevented its injury, penetration of infection into the thickness of the submucosa and other layers of the intestinal wall, and the resulting chronic productive inflammation inherent in Crohn's disease.

The reconstructive and restorative stages of surgical intervention were considered possible only if

there was a low risk of disease recurrence. The criteria for a low risk of recurrence included Crohn's disease affecting only the colon, chronic recurrent, intermittent variants of its course, and the absence of acute complications in the history. To prevent the recurrence of Crohn's disease during the formation of pelvic small intestinal reservoir structures, methods of atraumatic formation were used. The peculiarity of this measure was the refusal to create anatomical containers like classical reservoir structures. Instead, functional structures were created using serous-muscular sutures, which included anatomical bends of the terminal part of the small intestine. This eliminated the need to cross and suture the walls of the small intestine and the presence of a wound surface in the formed reservoir. The functionality of the reservoir was to physiologically delay the movement of the contents, and increase the duration of contact of the chyme with the surface of the small intestinal mucosa, thus improving the course of intestinal digestion and absorption. The rehabilitation effect of these functional small intestinal reservoir structures was due to a reduction in the risk of complications of healing of the small intestinal reservoir and ileo-endoanal anastomosis, and the severity of post-colectomy syndrome due to the use of a new methodological approach to the formation of pelvic small intestinal reservoirs and techniques for their formation.

A mandatory rehabilitation measure aimed at reducing the risk of complications of the healing of the formed pelvic small intestinal reservoir structure was its temporary disconnection from the flow of chyme with a protective (diverting) loop ileostomy, which was «closed» no earlier than 2–3 months after the healing of the pelvic reservoir and ileo-endoanal anastomosis.

Among the measures of surgical rehabilitation for Crohn's disease, which are the subject of discussion in modern available literary sources, the peculiarities of performing radical and reconstructive and restorative surgical interventions should be highlighted. The majority of authors adhere to a single, well-founded point of view regarding the performance of segmental resections for local lesions of the intestinal canal based on the fact that it is impossible to cure Crohn's disease surgically [8, 17]. In this regard, the selection of the scope of radical surgery for local lesions was minimal [8, 17]. Most authors use a similar principle in case of subtotal or total damage to the colon, trying to reduce the amount of resection. At the same time, preference is given to colectomy or proximal subtotal resection of the colon and the formation of ileorectal or ileosigmoid anastomoses [8, 13, 14, 18, 21]. Less trauma,

slightly better functional results, and preservation of sexual function [17] serve as the motivation for performing these radical operations. However, the authors do not take into account the fact that over the next 5–10 years, 80–89% of patients will experience relapses and severe irreversible changes in the remaining parts of the colon (sigmoid and rectum) [8, 17, 21]. The most frequent complications in such cases are external fistulas that open into the perineum, inflammatory infiltrates, and rectal cancer [17]. The presence of these complications requires the removal of the sigmoid colon and rectum and the removal of a lifelong ileostomy [17, 18]. The main reason for refusing to perform a larger volume of radical surgery for the available indications, in particular, colectomy with ultra-low anterior resection, mucosectomy of the surgical anal canal, and formation of the «J pouch» of the small intestinal pelvic reservoir, is considered to be a significant risk of complications in the range of 24–35% due to the formation of the specified reservoir and reservoir-anal anastomosis, and relapse in the formed reservoir in 54% despite more favourable functional results [9, 11, 17, 19].

Taking into account the stated circumstances, the authors of the article worked out and used a fundamentally different methodical approach to the choice of radical, restorative and reconstructive-restorative stages of surgical intervention, including in the case of total involvement of the colon with Crohn's disease. The essence of this approach is to perform not limited but rather radical surgical intervention in the case of a total lesion of the large intestine using the author's atraumatic method of applying a single-row everted intestinal suture, which does not injure the mucous membrane and does not lead to a decrease in the lumen of the intestinal canal, using the principle of atraumatic formation of the pelvic small intestinal reservoir. The introduction of a new methodical approach to the surgical treatment of Crohn's disease led to the absence of recurrences in the areas of anastomoses formed with the help of a manual intestinal suture, which contributed to the occurrence of a significantly lower number of complications in the early – 20.7% and late – 1.8% postoperative periods, postoperative mortality – 1.8%, relapses of the disease – 9.4%, prevention of severe forms of reflux ileitis, post-colectomy syndromes, and secondary anal incontinence syndrome.

An obligatory rehabilitation measure aimed at reducing the risk of complications of healing of the formed pelvic small intestinal reservoir structure was its temporary disconnection from the chyme flow by a protecting (diverting) loop ileostomy,

which was «closed» no earlier than 2 months after the healing of the pelvic reservoir and ileoendoanal anastomosis. Thus, the use of a system of organisational, general and specialised surgical strategies for the rehabilitation of patients operated on for Crohn's disease aimed at selecting clear, timely indications for surgical treatment, ensuring the implementation of radical, restorative, reconstructive and restorative stages of surgical interventions, prevention, diagnosis, treatment of postoperative complications, and recurrence of the disease allowed to reduce the number of these postoperative complications, cases of postoperative mortality, and recurrence of the disease.

The future prospects for research are enhancing the techniques used in surgical treatment for Crohn's disease.

Conclusions

Organisational measures as well as general and specialised surgical rehabilitation strategies for Crohn's disease allowed for more effective diagnosis and treatment of postoperative complications, better prevention of disease recurrence, improved digestion in the intestinal tract, normalised absorption processes, and preservation of anal retention.

Following the implementation of specially designed surgical rehabilitation techniques, 20.7% and 1.8% of patients experienced early and late postoperative complications, respectively. Additionally, there were occurrences of postoperative mortality in 1.8% of patients and relapses in 9.4%. Severe forms of reflux ileitis, postcolectomy syndrome, and secondary anal incontinence syndrome were not observed.

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The authors declare that they have no conflicts of interest.

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AUTHORS CONTRIBUTIONS

O. I. Poyda: research concept and design, manuscript editing, final approval of the manuscript. V. M. Melnyk: data collection, data analysis and interpretation, writing the manuscript.

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Хірургічна реабілітація пацієнтів при хворобі Крона

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Мета — поліпшити результати хірургічної реабілітації пацієнтів при хворобі Крона шляхом розробки та вдосконалення організаційних, загальнохірургічних і спеціальних хірургічних заходів.

Матеріали та методи. Опрацьовані організаційні, загальнохірургічні та спеціальні хірургічні заходи реабілітації при хворобі Крона кишкового каналу. Визначено обсяги виконання радикальних хірургічних втручань при ускладненнях у ділянках сегментарних уражень і на тлі обширних уражень кишкового каналу, розроблено способи виконання відновних та реконструктивно-відновних операцій, спрямовані на зниження частоти виникнення післяопераційних ускладнень, рецидивів захворювання, порушення функцій кишкового травлення, всмоктування, анального тримання, поліпшення функціональних результатів та якості життя прооперованих пацієнтів.

Результати. Із використанням опрацьованих заходів хірургічної реабілітації прооперовано 53 пацієнти із хворобою Крона кишкового каналу, з них 28 (52,8%) чоловіків і 25 (47,2%) жінок. Вік пацієнтів становив 19—45 років. Сегментарні резекції виконано 32 (60,4%) пацієнтам, великі — 21 (39,6%), відновні операції — 8 (15,1%), реконструктивно-відновні — 40 (75,4%). Довічну ілеостому сформовано 5 (9,4%) пацієнтам. Післяопераційні ускладнення виникли у 12 (22,6%) пацієнтів, рецидиви захворювання — у 5 (9,4%). Зареєстровано 1 (1,8%) випадок післяопераційної летальності. Після відновних і реконструктивно-відновних операцій відзначено сприятливі функціональні результати — поліпшення функцій кишкового травлення та всмоктування, збереження анального тримання.

Висновки. Опрацьовані організаційні, загальнохірургічні та спеціальні заходи хірургічної реабілітації при хворобі Крона дали змогу поліпшити діагностику, лікування післяопераційних ускладнень і рецидивів захворювання, поліпшити функції кишкового травлення та всмоктування, зберегти функцію анального тримання. Ранні післяопераційні ускладнення виникли у 20,7% пацієнтів, пізні — у 1,8%, рецидиви захворювання — у 9,4%. Не зафіксовано жодного випадку тяжких форм рефлюкс-ілеїту, постколектомічного синдрому, синдрому вторинної анальної інконтиненції. Післяопераційна летальність — 1,8%.

Ключові слова: хвороба Крона, хірургічне лікування, реабілітація.

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Minimally invasive techniques for surgical treatment of sacrococcygeal pilonidal disease

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Sacrococcygeal pilonidal disease (SPD) is a common disease that affects mainly young men and leads to a decrease in their quality of life and a long-term loss of working capacity. According to the available statistical data, the disease prevalence in Europe and North America ranges from 26 to 40 cases per 100,000 people.

OBJECTIVE — to determine the effectiveness of minimally invasive techniques for surgical treatment of chronic and recurrent forms of SPD.

MATERIALS AND METHODS. The study included 23 patients with SPD. It was clinical prospective, with a follow-up period of 18 months. The evaluation criteria were defined as recurrences, the frequency of postoperative complications, the severity of the pain syndrome, the patient's self-assessment of the cosmetic effect, the duration of hospitalisation, and the duration of surgery.

The results. The recurrence rate during the 18 months of observation was 39.1%. The overall frequency of postoperative complications was 21.7%. The median duration of surgery was 20 (CI 95% 15–25) minutes, and the median duration of hospitalisation was 2 (CI 95% 1–3) days. The median score of the pain syndrome according to the modified visual analogue scale was 5 (CI 95% 4–5) points on the 0th postoperative day, 3 (CI 95% 3–4) points on the third postoperative day, and 2 (CI 95% 2–2) points on the fifth postoperative day. The cosmetic effect of surgical intervention was rated as rather dissatisfied (17.4%), rather satisfied (52.2%), and completely satisfied (30.4%).

CONCLUSIONS. Minimally invasive techniques are effective for the surgical treatment of chronic and recurrent forms of sacrococcygeal pilonidal disease, reducing both the inpatient period and the surgery duration. Minimally invasive surgical treatment for chronic and recurrent forms of sacrococcygeal pilonidal disease has been observed to cause a moderate pain syndrome in the early postoperative period while contributing to satisfactory cosmetic results in the remote period. The surgical treatment of chronic and recurrent forms of sacrococcygeal pilonidal disease with minimally invasive techniques has been found to result in a relatively high recurrence rate (39.1% over 18 months of follow-up).

KEYWORDS

pilonidal disease, pilonidal cyst, sacrococcygeal area, minimally invasive techniques, recurrences.

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Sacrococcygeal pilonidal disease (SPD) is a common disease that mainly affects young men and leads to a decrease in the quality of life of such patients and a loss of work capacity for a long time [3, 12]. According to available statistical data, the prevalence of the disease in European and North American countries ranges from 26 to 40 cases per 100,000 people [8]. Most often, the onset of the disease occurs at the age of 16–30 years. However, the disease can also affect children and elderly patients. Males are approximately three to four times more likely to develop SPD than females. Apart from the sacrococcygeal area, other locations, such as

the interdigital spaces of the upper limbs, the periumbilical area, and the front surface of the chest, rarely exhibit pilonidal disease (PD). Male sex, young age (16–35 years old), increased body mass index (BMI), belonging to specific ethnic groups, increased hair growth, anatomical features of the buttock area, and a low level of personal hygiene are factors that sharply increase the risk of SPD [11].

Today, a generally accepted point of view is that SPD is an acquired disease. The leading theory that confirms the acquired mechanism of etio-morphogenesis of SPD is the follicular-retention theory (FRT). According to theory, the primary underlying

factor in SPD is the proliferation of hair follicles in the sacrococcygeal area. This, together with the dysfunction of the sebaceous and sweat glands, triggers inflammation in the follicle area. The pump-like effect caused by the movement of the buttocks during walking and the shape of the gluteal cleft contribute to the migration of hairs from other locations of the body (primarily adjacent) to the bottom of the gluteal cleft. Next, these hairs and dirt particles fall into retention cavities formed at the site of local follicular inflammation. In the future, such a cavity will increase in size, and the migration of hairs will continue within the boundary of the formed cavity. The shape of the hair and the presence of microscopic, unidirectional notches help to fix the hair in the formed cavity. The next stage is the development of a reaction to a foreign body (hair) and the attachment of an infection, which further contributes to the formation of a cyst or abscess [13].

SPD is divided into three fundamentally distinct forms: pilonidal abscess (PA), symptomatic pilonidal cyst (SPC), and asymptomatic pilonidal cyst (APC). The principle of distribution of these forms is based on the differentiation of clinical diagnostic and treatment approaches for such patients.

Most often, SPD requires differential diagnosis with other diseases affecting the sacrococcygeal and perianal areas: hidradenitis suppurativa, perianal manifestations of Crohn's disease, furunculosis, pararectal fistulas and abscesses, presacral tumours, and specific infections [1, 6].

The proper management of SPD remains a subject of debate, despite the extensive body of research undertaken, the existence of clinical treatment guidelines, and the international guidelines provided by leading professional associations [8, 14].

OBJECTIVE — to determine the effectiveness of minimally invasive techniques for surgical treatment of chronic and recurrent sacrococcygeal pilonidal disease.

Materials and methods

The study was conducted at the clinical base of the Department of Surgery with a course of emergency and vascular surgery at Bogomolets National Medical University during 2020–2024. The study was clinical prospective. The inclusion criteria were defined as:

- the age of the patient of any gender is ≥ 18 years;
- the presence of a chronic or recurrent form of SPD.

The exclusion criteria were defined as:

- the presence of concomitant endocrine pathology (diabetes mellitus 1 and 2 types, diseases of the adrenal glands or brain accompanied by hypercorticism);

- body mass index is > 35 kg/m²;
- organ transplantation in the anamnesis;
- history of taking immunosuppressive drugs during the last calendar year;
- congenital or acquired immunodeficiency syndrome of any genesis;
- the presence of bedsores and other defects of the sacrococcygeal area associated with the patient's long-term supine position;
- traumatic injury in the anamnesis, which led to a marked change in the anatomical configuration of the sacrococcygeal area;
- patients with an acute form (abscess) of SPD.

The study's evaluation criteria were the recurrence rate, frequency of postoperative complications, severity of pain syndrome (visual analogue scale of pain), patient self-assessment of the cosmetic effect, inpatient period, and duration of surgical intervention.

The follow-up period was 18 months. The study included 23 patients: 18 (78.3%) males and 5 (21.7%) females. The average age of the patients was 27 ± 7.2 years. The average BMI was 26 ± 2.5 kg/m². 15 (65.2%) patients were permanent smokers, and 8 (34.8%) did not smoke. A total of 10 (43.5%) patients had surgical interventions due to SPD (a recurrent form of the disease). Within the scope of the study, 3 (13%) patients were treated with the pit-picking technique, 9 (39.1%) patients with the Moshe Gips technique, and 11 (47.8%) patients with the Bascom-1 technique.

Statistical data processing was performed in the statistical packages PRIZM (GraphPad Software, 8.3.0) and IBM SPSS Statistics 22. We performed descriptive statistics. Measures of central tendency are presented as the mean ($M \pm SD$) or median (Me). The Kaplan-Meier method was used to determine the cumulative frequency of events.

Results

The obtained results indicate that the surgical treatment of chronic and recurrent forms of SPD with minimally invasive techniques resulted in nine recurrences (two in the first three months, two patients in the period from 3 to 6 months, three in the period from 6 to 12 months, and two in the period from 12 to 18 months). Thus, the cumulative frequency of recurrences during 18 months of observation was 39.1% (Fig. 1).

At the same time, the cumulative frequency of SPD recurrence in the first three months was 9.5% (2 patients), the first six months — 19.04% (4 patients), the first year — 23.8% (7 patients), and the first 18 months — 39.1% (9 patients).

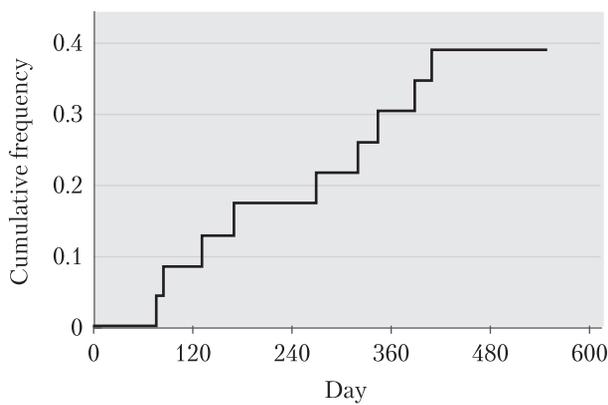


Figure 1. **Cumulative frequency of SPD recurrence during the follow-up period**

The total frequency of postoperative complications was 21.7% ($n = 5$), including seroma at 60% ($n = 3$), hematoma at 20% ($n = 1$), and surgical site infections at 20% ($n = 1$).

The median duration of surgery was 20 (CI 95% 15–25) minutes, and the median duration of the inpatient period was 2 (CI 95% 1–3) days (1 day for 7 patients, 2 days for 9 patients, and 3 days for 7 patients).

The median score of the pain syndrome according to the modified visual analogue scale was 5 (CI 95% 4–5) points on the 0th postoperative day, 3 (CI 95% 3–4) points on the 3rd postoperative day, and 2 (CI 95% 2–2) points on the 5th postoperative day (Fig. 2).

The patient self-assessment of the cosmetic effect was rated as completely dissatisfied (0%), rather dissatisfied (17.4%), rather satisfied (52.2%) and completely satisfied (30.4%) (Table).

Discussion

Surgical and non-surgical approaches are the current options for treating SPD. Non-surgical methods include local hair removal and the insertion of chemical agents into the cyst cavity. Surgical methods are classified into the following groups: a) excisional methods with primary (tensional) wound closure; b) excisional techniques without primary closure of the wound (or with its partial closure); c) minimally invasive methods without excision (various variations of the «pit-picking technique», curettage of the cyst cavity with or without the use of different surgical energies, endoscopic methods – EP-SiT, laser methods); c) excisional techniques with non-tension (flap) wound closure (Bascom cleft-lift procedure, Karydakias flap procedure) [9, 10].

In the 1980s, Bascom included economic excision of the primary fistula sinuses in his modification of the minimally invasive surgical procedure for SPD

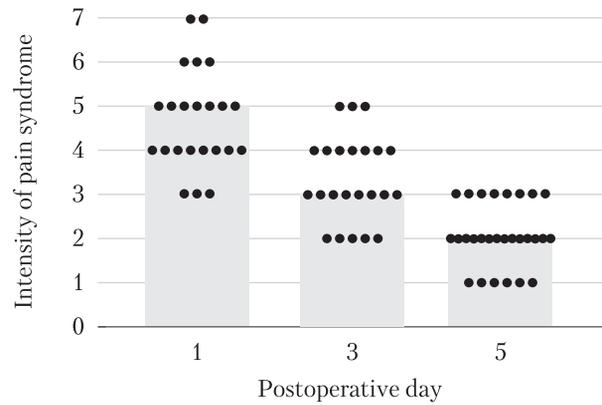


Figure 2. **Median intensity of pain syndrome**

Table. **Patient self-assessment of the cosmetic effect (n = 23)**

Patient self-assessment	Number of patients
Completely satisfied	7 (30.4%)
Rather satisfied	12 (52.2%)
Rather dissatisfied	4 (17.4%)
Completely dissatisfied	0

management that Lord and Millar had first developed 20 years earlier. Today, there are different definitions for this modification: Bascom-I procedure or Bascom «pit-pick and drain». The author's original description of the technique involves excising the primary fistula sinuses using small diamond-shaped incisions. The cavity of the pilonidal cyst is drained through a large lateral incision, which is later left open for healing by secondary tension. Generally, a lateral incision is made at the site of the secondary fistula opening (if it is present). Additionally, curettage or subcutaneous excision of the secondary fistula is performed [7] (Figs. 3, 4).

According to the results of the Dole study, published in 2022, the recurrence rate within five years after the procedure was 62% [4].

Koskinen's (2022) study concluded that patients who underwent Bascom-1 surgery experienced fewer postoperative complications (9.4% vs. 36.2%, $p = 0.002$) and had a shorter rehabilitation duration (median 14 days vs. 21 days, $p < 0.001$) compared to those who were treated using flap methods. A follow-up study of patients with a mean duration of 9.3 years (range, 5.4–10.6) revealed a statistically significant increase in recurrence rates after the Bascom procedure compared to the alternative technique (50.9% vs. 10.3%, HR 6, 65; $p < 0.001$) [9].

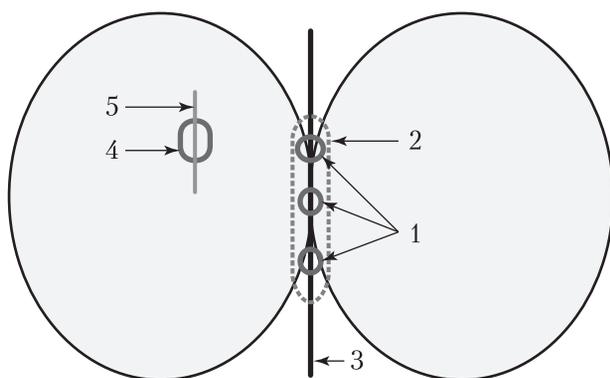


Figure 3. **Plan-scheme of Bascom-1 procedure:** 1) primary fistula openings; 2) borders of the pilonidal cyst cavity; 3) the bottom of the gluteal cleft; 4) secondary fistula opening; 5) lateral incision line



Figure 4. **The appearance of the operating field after the Bascom-1 procedure**

In 2008, Gips published a scientific report introducing the modification of the «pit-picking technique». Instead of a scalpel for the excision of primary fistula passages, he proposed using special circular skin trephines, which were used to excise the affected areas and curettage of the cyst cavity. A total of 1358 patients with SPD participated in the study, mostly men (84.3%) with an average age of 20.9 ± 3.6 years. Postoperative infection, secondary bleeding, and early recurrence rates were 1.5%, 0.2%, and 4.4%, respectively. Complete healing was observed within 3.4 ± 1.9 weeks in patients with complete postoperative follow-up. The recurrence rate after one year was 6.5%; after five years, 13.2%; and after ten years, 16.2%. The average time to recurrence was 2.7 ± 2.6 years after surgery. The

estimated disease-free probability was 93.5% after one year and 86.5% after five years [5].

A DiCastro study from 2016 revealed that all 2347 SPD patients underwent surgical intervention using the Gips method. 1714 men (73%) and 633 women (27%) participated in the study, and the average age of the patients was 19 years. After observation, the recurrence rate was 5.8%. There were 102 cases of clinically significant postoperative complications (4.3%) [2].

Conclusions

Minimally invasive techniques are effective for the surgical treatment of chronic and recurrent forms of sacrococcygeal pilonidal disease, reducing both the inpatient period and the surgery duration.

Minimally invasive surgical treatment for chronic and recurrent forms of sacrococcygeal pilonidal disease has been observed to cause a moderate pain syndrome in the early postoperative period while contributing to satisfactory cosmetic results in the remote period.

The surgical treatment of chronic and recurrent forms of sacrococcygeal pilonidal disease with minimally invasive methods has been found to result in a relatively high recurrence rate (39.1% over 18 months of follow-up).

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest in this regard research, including financial, personal, authorship, or other nature, that could affect the research and its results presented in this article.

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AUTHORS CONTRIBUTIONS

D. Y. Dubenko, R. V. Honza: research concept and design; D. Y. Dubenko: acquisition of data, analysis and interpretation of data, drafting the article.

ETHICS APPROVAL AND WRITTEN

INFORMED CONSENTS STATEMENTS

The Commission on Bioethical Expertise and Ethics of Scientific Research at the Bogomolets National Medical University concluded that the mentioned research does not contain an increased risk for the research subjects and was planned with existing bioethical norms and scientific standards regarding the conduct of clinical research involving patients (November 26, 2020, No. 139)

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Використання малоінвазивних методик для хірургічного лікування пілонідальної хвороби крижово-куприкової ділянки

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Пілонідальна хвороба крижово-куприкової ділянки є поширеним захворюванням, що вражає переважно чоловіків молодого віку та призводить до зниження якості життя пацієнтів і тривалої непрацездатності. Згідно зі статистичними даними, поширеність захворювання в країнах Європи та Північної Америки становить від 26 до 40 випадків на 100 тис. населення.

Мета — визначити ефективність застосування малоінвазивних методик для хірургічного лікування хронічної та рецидивної форми пілонідальної хвороби крижово-куприкової ділянки.

Матеріали та методи. Проведено клінічне проспективне дослідження з періодом спостереження 18 міс. У дослідження було залучено 23 пацієнти із пілонідальною хворобою крижово-куприкової ділянки. Критерії оцінки ефективності методики: частота рецидивів і післяопераційних ускладнень, тяжкість більшого синдрому, самооцінка пацієнтами косметичного ефекту, тривалість госпіталізації та оперативного втручання.

Результати. Частота рецидивів за 18 міс спостереження становила 39,1 %, загальна частота післяопераційних ускладнень — 21,7 %. Медіана тривалості оперативного втручання — 20 хв (95 % довірчий інтервал (ДІ) 15—25 хв), медіана тривалості госпіталізації — 2 доби (95 % ДІ 1—3 доби). Медіана оцінки більшого синдрому за модифікованою візуальною аналоговою шкалою — 5 балів (95 % ДІ 4—5 балів) у 0 післяопераційну добу, 3 бали (95 % ДІ 3—4 бали) — на 3-тю післяопераційну добу, 2 бали (95 % ДІ 2—2 бали) — на 5-ту. Косметичним ефектом оперативного втручання були скоріше незадоволені 17,4 % пацієнтів, скоріше задоволені — 52,2 %, повністю задоволені — 30,4 %.

Висновки. Використання малоінвазивних методик для хірургічного лікування хронічної та рецидивної форм пілонідальної хвороби крижово-куприкової ділянки є ефективним, сприяє зменшенню терміну перебування пацієнта в стаціонарі та тривалості оперативного втручання, зменшенню більшого синдрому в ранній післяопераційний період і задовільним косметичним результатам у віддалений період хірургічного лікування, але спричиняє велику кількість рецидивів (39,1 % за 18 міс спостереження).

Ключові слова: пілонідальна хвороба, пілонідальна кіста, крижово-куприкова ділянка, малоінвазивні методики, рецидиви.

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Management of rare complications in obese patients after laparoscopic gastric bypass

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The complications resulting from laparoscopic gastric bypass can be categorised into two main groups: early (within 30 days after surgery) and late (after 30 days following surgery). Bleeding, marginal ulcers, and failure of the suture line occur most often. Stenosis of the anastomotic areas, adhesive small bowel obstruction, incarceration of Petersen's space hernia, gastrogastic fistula, and hemobezoar-induced small bowel obstruction are less often observed.

OBJECTIVE — to improve the management of rare complications in obese patients after laparoscopic gastric bypass.

MATERIALS AND METHODS. The study includes a retrospective analysis of patients who underwent laparoscopic gastric bypass in the Department of General Surgery No. 2 at Bogomolets National Medical University from 2011 to 2023. Patients aged 25 to 59 who met the IFSO criteria for obesity participated in the research. The minimum observation period was 12 months. All patients underwent a laparoscopic Roux-en-Y Gastric Bypass.

RESULTS. The study included a cohort of 348 patients who underwent laparoscopic gastric bypass. The majority of them were female, including 189 individuals (54.3%). A total of 6 patients (1.72%) were identified with rare problems, consisting of 2 women and 4 men. Two patients were diagnosed with acute small bowel obstruction caused by a hemobezoar, one patient with gastrogastic fistula, one patient with acute adhesive small bowel obstruction, one patient with a marginal ulcer of the «large» stomach complicated by perforation, and one patient with a pinched Petersen's space hernia. All complications were class IIIb, according to the Clavien-Dindo classification, and required surgical treatment. In the early period, 3 (50%) cases were diagnosed: acute adhesive small bowel obstruction (2 days postoperatively) and acute small bowel obstruction caused by a hemobezoar (2–3 days postoperatively).

CONCLUSIONS. We found that the incidence of rare complications among obese individuals after laparoscopic gastric bypass was 1.72%. Specifically, 1.14% of patients experienced small bowel obstruction, 0.29% had a marginal ulcer of the «large» stomach complicated by perforation, and 0.29% had a pinched Petersen's space hernia. Each case of a rare complication requires an individual approach to its management.

KEYWORDS

rare complication, gastric bypass, hemobezoar, marginal ulcer, gastrogastic fistula, Petersen's space hernia, bleeding.

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Laparoscopic gastric bypass (LGB) is considered the «gold standard» of surgical treatment for obesity due to its long-term effect and lower level of complications compared to other methods [22].

The complications resulting from laparoscopic gastric bypass can be categorised into two main groups: early (within 30 days after surgery) and late (after 30 days). Bleeding, marginal ulcers, and failure of the suture line occur most often. Stenosis of the anastomotic areas, adhesive small bowel obstruction, incarceration of Petersen's space hernia, gastrogastic fistula, and hemobezoar-induced small bowel obstruction are less often observed.

Petersen's space hernia is a late, rare complication of laparoscopic gastric bypass, with an incidence of 1–5% [17,11]. It occurs on average 3 months after surgery. Risk factors include a significant decrease in body weight, male gender, and the extraduodenal location of the alimentary loop [3].

Gastrogastic fistula is the formation of an unnatural connection between the «small» and «large» stomachs, occurring in 1.5–6.0% of patients. The main reasons are incomplete transection of the stomach, ingress of fatty tissue during transection of the stomach between the branches, insufficiency of gastroenteroanastomosis, displacement of the

stomach after surgery, formation of marginal ulcers, and complications of their penetration [6].

Hemobezoar-induced small bowel obstruction is a very rare complication after laparoscopic gastric bypass, occurring in 0–0.5%, most often 2–5 days after surgery, as a result of bleeding from the suture line of the large stomach [13].

OBJECTIVE – to improve the management of rare complications in obese patients after laparoscopic gastric bypass.

Materials and methods

The study includes a retrospective analysis of 348 patients who underwent laparoscopic gastric bypass in the Department of General Surgery No. 2 at Bogomolets National Medical University from 2011 to 2023. Patients aged 25 to 59 who met the IFSO (International Federation for the Surgery of Obesity and Metabolic Disorders) criteria participated in the research. The majority of them were female, including 189 individuals (54.3%). The average age was 44.81 years (25–59 years), and the average body mass index was 45.43 kg/m² (41.21–59.41 kg/m²). The minimum observation period was 12 months.

Preoperative examination included: complete blood count, complete urinalysis, biochemical blood count (total protein, alaninaminotransferase, aspartataminotransferase, total bilirubin with fractions, urea, creatinine), coagulogram, blood group and rhesus, electrocardiography, video esophagogastroduodenoscopy, echocardiography, chest X-ray cavity, ultrasound of the abdominal cavity organs, consultation of a cardiologist and pulmonologist, spirometry, ultrasound of the vessels of the lower extremities, glycosylated hemoglobin (Hb1Ac), blood C-peptide, blood thyroid-stimulating hormone test, adrenocorticotrophic hormone blood test, cortisol blood test, acid-base blood test, blood analysis for electrolytes (K, Na, Cl, Ca).

All patients underwent a laparoscopic Roux-en-Y Gastric Bypass. Until 2019, the small intestine was transected with a stapling-cutting device with a staple height of 3.6 mm to perform laparoscopic gastric bypass, but it has since been switched to the Tri Staple technology using the EGIA60AVM (staple heights: 2 mm, 2.5 mm, 3 mm) at a distance of 50 cm from the ligament of Treitz. Until 2019, a stapling-cutting device with a staple height of 4.1 mm was used to construct a «small» stomach with a volume of 20–30 ml, but it has since been switched to Tri Staple technology using EGIA60AMT (staple heights: 3 mm, 3.5 mm, and 4 mm).

A side-to-side antero-colic gastroenteroanastomosis was performed between the «small» stomach

and the alimentary loop of the small intestine. Until 2019, the back lip of the anastomosis was formed with the help of a stapling-cutting device with a staple height of 3.6 mm. It has since been switched to Tri Staple technology using EGIA60AVM (staple heights: 2 mm, 2.5 mm, 3 mm). The anterior lip of the anastomosis was formed with the help of a continuous suture using an atraumatic suture material (Vicril 3/0). After applying the anastomoses, a pneumatic test was performed to determine their tightness. The length of the alimentary loop was 150 cm, and the biliopancreatic loop was 50 cm. Petersen's space was not sutured. Statistical analysis was performed using SPSS 18.0.

Results

A total of 6 patients (1.72%) were identified with rare problems, consisting of 2 women and 4 men. Two patients were diagnosed with acute small bowel obstruction caused by a hemobezoar, one patient with gastrogastic fistula, one patient with acute adhesive small bowel obstruction, one patient with a marginal ulcer of the «large» stomach complicated by perforation, and one patient with a pinched Petersen's space hernia. All complications were class IIIb, according to the Clavien-Dindo classification, and required surgical treatment. In the early period, 3 (50%) cases were diagnosed: acute adhesive small bowel obstruction (7 days postoperatively) and acute small bowel obstruction caused by a hemobezoar (2–3 days postoperatively).

Among the 6 cases of complications, 4 (1.14%) had a clinical pattern of small bowel obstruction and were manifested by nausea, vomiting, abdominal distension, and a lack of bowel movements. In all cases, we performed a computer tomography of the abdominal cavity with intravenous enhancement for diagnostic purposes. Treatment included urgent surgical intervention. Patients with acute small bowel obstruction caused by a hemobezoar underwent relaparoscopy with enterotomy and removal of a blood clot, mandatory gastrotomy of the «large» stomach with mechanical stopping of bleeding, and removal of a blood clot from the «large» stomach, which filled the entire lumen. The period of stay in the hospital after surgery was 4–5 days. In the case of acute adhesion or small bowel obstruction, relaparoscopy with viscerolysis was performed. Strangulation of Petersen's space hernia occurred six months after laparoscopic gastric bypass. A relaparoscopy was performed with a resection of the necrotic intestine and the imposition of an entero-enteroanastomosis. The period of stay in the hospital was 7 days.

A marginal ulcer of the «large» stomach complicated by perforation occurred six months after laparoscopic gastric bypass. A laparotomy was performed with the removal of the «large» stomach. Hospital stay was 7 days.

A gastrogastic fistula developed in the patient 18 months after laparoscopic gastric bypass on the background of a marginal ulcer complicated by penetration, which led to the formation of a common mouth between the «large» and «small» stomachs. Clinically, it was accompanied by an increase in body weight, nausea, and pain in the epigastric area. The patient underwent laparoscopic intervention with resection of the «large» and «small» stomachs with gastroenteroanastomosis, and the formation of a new gastroenteroanastomosis. The postoperative period in the hospital was 5 days.

Discussion

The study confirmed the low frequency of detection of the indicated complications, which, due to the severity of the condition (Clavien-Dindo III), required rapid diagnosis and urgent surgical treatment.

Strangulation of Petersen's space hernia was diagnosed in one patient (0.28%), which is statistically lower than the world data. For comparison, in the study of A. Iannelli, Petersen hernia entrapment was diagnosed in 2.51–4.75% of cases, and the average follow-up time was 24.19 months after laparoscopic gastric bypass [15]. According to V. Ende et al., this rate was 4.8%, but the mean follow-up time was 36.1 months [12]. All 348 operated patients did not have suturing of the mesenteric defect. This did not cause an increase in the number of pinched Petersen's space hernias. Compared to other studies, D. Muir et al. found that with the closure of mesenteric defects, the rate of pinched Petersen's space hernias was 2.0% [18]. A meta-analysis by Q.-L. Wu et al. found no difference in the occurrence of small bowel obstruction due to Petersen's space hernia entrapment between groups with and without closure of mesenteric defects [23].

In our study, the alimentary loop was located in the antecolic position in all patients, which had a significant impact on the occurrence of internal hernias. The postcolic location of the alimentary loop has a worse prognosis due to the formation of an additional mesenteric defect. In a study by A. B. Al Harakeh et al., in the group with an antecolic location of the alimentary loop, entrapment of Petersen's space hernia occurred in 1.4% of cases, and with a postcolic location of the alimentary loop in 5.2% [1]. According to a study by F. Nuytens et al., the closure of the mesenteric defect in the antecolic

location of the alimentary loop compared to not-closure does not affect the occurrence of a pinched internal Petersen's space hernia (4.8% and 5.5%), but at the same time significantly increases the number of small bowel obstructions due to adhesions (4.8% and 1.7%). Therefore, the optimal option is the antecolic location of the alimentary loop without closing the mesenteric defect [20].

Acute small bowel obstruction caused by a hemobezoar is a very rare complication resulting from laparoscopic gastric bypass. From 2011 to 2019, 2 (1.12%) of 179 patients experienced bleeding from the suture line of the «large» stomach. According to global data, this indicator ranges from 0.05% to 1.9% [5]. All cases reported up to 2019 used the stapling-cutting device with a staple height of 3.6 mm for gastric transection. After starting to use the Tri Staple stapling device in 2019 (staple heights: 3 mm, 3.5 mm, 4 mm), no new cases of «large» stomach bleeding complicated by acute hemobezoar-induced small bowel obstruction have been recorded. Based on single cases found, or a small series of cases, D. T. Hess et al. (2021) described 38 patients with hemobezoar-induced small bowel obstruction [14]. Treatment tactics included relaparoscopy with enterotomy and removal of a blood clot from the area of the entero-enteroanastomosis, and gastrotomy of the «large» stomach with removal of a blood clot that filled the entire lumen, because in all cases the source was bleeding from the suture line of the large stomach. An intraoperative inspection of the anastomotic suture lines was mandatory due to the high risk of their failure, as an increase in intraluminal pressure occurs due to the presence of an obstruction in the form of a blood clot. Recurrences of bleeding after surgery, infectious complications, and failures of anastomotic suture lines were not detected. In other research, nine patients underwent resection of an entero-enteroanastomosis and gastrostomy for decompression. However, due to a high complication rate of 44.4%, compared to enterotomy and removal of a blood clot and gastrotomy with hemostasis, where this indicator is 27.2%, such approach is not recommended [5].

Marginal ulcers occur in 3–35% of patients after laparoscopic gastric bypass [8]. Marginal ulcers of the «large» stomach complicated by perforations occur quite rarely, up to 0.3% [16]. According to O. Bacoer-Ouzillou et al., in 71.4% of cases, marginal ulcers occur in the area of gastroenteroanastomosis. [4] In the study of D. E. Azagury et al., 50% of marginal ulcers occur in the area of the gastroenteroanastomosis, 40% in the alimentary loop, and 10% in the area of the «small» stomach [2]. G. Plitzko et al.'s review from 2021 details 54 cases of gastric

and duodenal ulcers, with a perforation in the gastric region complicating 34 % of these cases [21]. Gastrogastric fistula was diagnosed in one (0.28 %) patient, although according to global data, the frequency of occurrence is up to 6 % [19]. The term of occurrence was 18 months. According to global data, the average time of occurrence is 28 months (22–62) [7]. The cause is a marginal ulcer, which is complicated by penetration and the formation of a joint between the «large» and «small» stomachs. According to various data, about 60 % of patients with gastrogastric fistulas have a history of marginal ulcers or incompetence [7]. Since 28–61 % of marginal ulcers are asymptomatic [10], we recommend performing prophylactic VEGS 6, 12, and 24 months after laparoscopic gastric bypass to cover the period during which the development of marginal ulcers and their complications are possible. One of the first manifestations of the occurrence of gastrogastric fistula is an increase in body weight. Therefore, gastroscopy should be performed in the absence of a decrease in body weight or its increase after laparoscopic gastric bypass. Marginal ulcers of the «large» stomach complicated by perforation and marginal ulcers complicated by penetration with the formation of a gastrogastric fistula were recorded in the period 2011–2019, when patients were prescribed a regimen of proton pump inhibitors at a dose of 20 mg twice a day for 30 days. Due to the emergence of studies on the increase in the entry of hydrochloric acid into the lumen of the small intestine and the activation of pepsin in the lumen of the small intestine within 6 months after laparoscopic gastric bypass [9]. Since 2019, we have been prescribing proton pump inhibitors at a dose of 20 mg twice a day for 6 months. No new cases of marginal ulcers were recorded. The observation period was 12 months.

Conclusions

We found that the incidence of rare complications among obese individuals after laparoscopic gastric bypass was 1.72 %. Specifically, 1.14 % of patients experienced small bowel obstruction, 0.29 % had a marginal ulcer of the «large» stomach complicated by perforation, and 0.29 % had a pinched Petersen's space hernia.

Each case of a rare complication requires an individual approach to its management, and their prevention includes the use of stapling devices with Tri Staple technology and proton pump inhibitors at a dose of 20 mg twice times a day for 6 months.

The influence of non-closure of the mesenteric defect and the antecolic location of the alimentary loop on the occurrence of an incarcerated Petersen's space hernia requires further study.

DECLARATION OF INTERESTS

The author declares that they have no conflicts of interest.

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ETHICS APPROVAL AND WRITTEN

INFORMED CONSENTS STATEMENTS

In this study, the authors adhered to the Ethical Principles for Medical Research Involving Human Subjects outlined in the WMA Declaration of Helsinki and current Ukrainian regulations. The study protocol was approved by the ethics committee of Bogomolets National Medical University. Written informed consent was obtained from all the patients.

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Менеджмент маргінальних виразок у пацієнтів з ожирінням після лапароскопічного шунтування шлунка

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Виділяють дві групи ускладнень унаслідок лапароскопічного шунтування шлунка — ранні (упродовж 30 днів після операції) та пізні (пізніше 30-ї доби). Найчастіше виникають кровотечі, маргінальні виразки та неспроможності лінії швів, рідше — стеноз ділянок анастомозів, спайкова кишкова непрохідність, защемлення грижі Петерсена, гастро-гастро нориця, кишкова непрохідність гемобезоаром.

Мета — поліпшити менеджмент рідкісних ускладнень після лапароскопічного шунтування шлунка у пацієнтів з ожирінням.

Матеріали та методи. Проведено ретроспективний аналіз даних 348 пацієнтів з ожирінням відповідно до критеріїв IFSO, яким виконано лапароскопічне шунтування шлунка в період з 2011 до 2023 р. на базі кафедри загальної хірургії № 2 Національного медичного університету імені О. О. Богомольця. Вік пацієнтів — від 25 до 59 років, середній вік — 44,81 року. Серед пацієнтів переважали жінки (189 (54,3 %)). Середня величина індексу маси тіла — 45,43 кг/м² (41,21 — 59,41 кг/м²). Мінімальний період спостереження — 12 міс.

Результати. Рідкісні ускладнення діагностовано у 6 (1,72 %) пацієнтів (у 2 жінок, та 4 чоловіків): у 2 — гостру тонкокишкову непрохідність гемобезоаром, по одному випадку гастро-гастро нориці, гострої спайкової непрохідності, маргінальної виразки «великого» шлунка, ускладненої перфорацією, та защемленої грижі Петерсена.

Висновки. У пацієнтів з ожирінням після лапароскопічного шунтування шлунка частота рідкісних ускладнень становила 1,72 %: кишкової непрохідності — 1,14 %, маргінальної виразки «великого» шлунка, ускладненої перфорацією, — 0,29 %, защемленої грижі Петерсена — 0,29 %. Кожен випадок рідкісного ускладнення потребує індивідуального підходу до його менеджменту.

Ключові слова: рідкісне ускладнення, шунтування шлунка, гемобезоар, маргінальна виразка, гастро-гастро нориця, грижа Петерсена, кровотеча.

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Changes in the antibiotic-resistant properties of pathogenic microorganisms in patients with purulent-necrotic wounds against the background of type 2 diabetes when using a probiotic antiseptic

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Antibiotic resistance remains a serious problem, leading to millions of deaths every year. The increasing prevalence of type 2 diabetes mellitus (T2DM) is contributing to the continued spread of this problem. Ukraine, like other countries, feels the consequences of this problem. Over the past ten years, the number of patients with T2DM has doubled, and diabetes is already the cause of disability and death for thousands of people. Complications of T2DM, such as diabetic foot syndrome, often require surgery and antibacterial therapy. New research shows the prospects of using probiotic antiseptics based on lactic acid bacteria of the genus *Bacillus* in the treatment of wounds, which may open new opportunities to combat this problem and improve treatment outcomes.

OBJECTIVE — to analyse changes in the antibiotic-resistant properties of pathogenic microorganisms in patients with purulent-necrotic wounds in type 2 diabetes mellitus.

MATERIALS AND METHODS. The study, which was conducted at the Department of General Surgery No. 2 of Bogomolets National Medical University in Kyiv City Clinical Hospital No. 3, included 229 patients with purulent-necrotic wounds and type II diabetes. A total of 229 patients were randomly divided into two groups, with one group receiving probiotic antiseptics and the other traditional chemical antiseptics, with subsequent analysis focusing on changes in antibiotic-resistant properties against *P. aeruginosa* and *K. pneumoniae*. Antibiotic-resistant properties were evaluated through microbiological examination, revealing significant changes in resistance patterns among patients treated with probiotic antiseptics compared to those using traditional chemical antiseptics, assessed using statistical methods including the Student's t-test and Wilcoxon W-test.

RESULTS. When the first subgroups were compared on the first day, there was no statistically significant difference in the levels of *P. aeruginosa* wound contamination ($p=0.671$). On the seventh day, there was a statistically significant difference between contamination levels ($p<0.05$) and the emergence of sensitivity to reserve antibiotics ($p<0.05$). On the 14th day, there was a statistically significant difference between contamination levels ($p<0.05$) and the emergence of sensitivity to reserve antibiotics ($p<0.05$).

CONCLUSIONS. Probiotic antiseptics have a statistically significant advantage over chemical antiseptics in terms of reducing contamination and emergence of antibiotic sensitivity in patients with purulent-necrotic wounds in type 2 diabetes mellitus.

KEYWORDS

type 2 diabetes mellitus, antibiotics, antibiotic resistance, *Bacillus subtilis*, *Klebsiella*, *Pseudomonas*.

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The problem of antibiotic resistance arose as a result of the uncontrolled use of antibiotics around the world, especially without clear medical indications. According to global statistics, antibiotic resistance causes the death of at least 1.27 million individuals annually and was associated with approximately 5 million deaths in 2019 [4]. The constant increase in the number of patients with type 2 diabetes mellitus (T2DM) is a factor contributing to the spread of this problem. The global population of T2DM patients reached 532 million people in 2021, and it is predicted to increase to 700 million people by 2045. Diabetes is currently on the scale of a pandemic [5].

Ukraine does not remain aloof from this problem. Over the past 10 years, the incidence of T2DM in the country has doubled. Diabetes mellitus causes more than 3% of the primary disability in the working population of Ukraine. The constant increase in the number of patients with T2DM leads to an increase in the mortality rate from complications of this disease [1].

One of the most common complications of diabetes is diabetic foot syndrome (DFS), which occurs in 6–11% of patients with T2DM, and 40–70% of them require surgical treatment with the use of antibacterial drugs. About 30% of hospitalisations are associated with fatal complications of T2DM [5].

As the number of patients with T2DM increases, so does the number of purulent-necrotic complications in the extremities. About 40% of patients experience relapses of such processes during the first year after treatment, and in patients with a long course of the disease, these complications acquire antibiotic-resistant properties [2].

In Ukraine, the problem of antibiotic resistance, when more than 80% of strains of intra-hospital infections have antibiotic resistance, including reserve antibiotics, is acutely relevant. Taking into account the rising incidence of T2DM and related complications, the problem of discovering and developing new antimicrobial agents for the treatment of this category of patients is becoming increasingly urgent [9].

The latest studies in the field of prevention of the emergence of antibiotic-resistant strains indicate the importance of finding new and effective methods of combating this problem. Probiotic antiseptics, which rely on lactic acid bacteria from the genus *Bacillus*, are one of the promising approaches in this field [3].

Lactic acid bacteria of the genus *Bacillus* are particularly interesting from the point of view of their potential role in the fight against antibiotic-resistant strains. They are characterized by high resistance to mutations and the ability to produce enzymes that contribute to the dissolution of the cell walls of other bacteria that share the same ecological niche. This ability of *Bacillus* helps to reduce the population of

antibiotic-resistant bacteria as well as preserve the diversity of microorganisms and the normal microbiome of the skin and mucous membranes [6, 7].

Probiotic antiseptics, based on the use of *Bacillus*, create favourable conditions for the development of «beneficial» microorganisms that compete for nutrition and space with antibiotic-resistant strains. This allows for a reduction in the level of colonisation of wounds by microorganisms, which can become a source of antibiotic resistance. Moreover, probiotic antiseptics can promote active tissue regeneration and reduce infectious complications, which helps maintain an optimal wound environment for faster healing.

Considering this, the use of probiotic antiseptics can be a promising strategy in the prevention of antibiotic resistance and wound complications, especially in patients with purulent-necrotic processes such as diabetic foot syndrome. Additional clinical studies and clinical trials are needed to confirm the efficacy and safety of this approach, but it may open up new avenues for combating antibiotic-resistant infections and improving patient outcomes [8].

OBJECTIVE — to analyse changes in the antibiotic-resistant properties of pathogenic microorganisms in patients with purulent-necrotic wounds in type 2 diabetes mellitus.

Materials and methods

This study was conducted at the clinical base of the Department of General Surgery No. 2 of the Bogomolets National Medical University in the Kyiv City Clinical Hospital No. 3. The criteria for inclusion in the study were: men and women, aged 18 to 75 years; the presence of purulent-necrotic wounds of various localizations; and (against) T2DM. The study involved 229 patients, randomly divided into two groups. In the research group, probiotic antiseptics served as the primary method of local treatment for purulent necrotic wounds in 118 patients. In the control group, traditional chemical antiseptics were used for the treatment of purulent-necrotic wounds in 111 patients. We selected patients whose microbiological examination detected *P. aeruginosa* and *K. pneumoniae* to compare changes in antibiotic-resistant properties in both groups. Among the first group, 33 patients (Research Subgroup 1) and 37 patients (Research Subgroup 2) were selected, respectively. Among the second group, 32 patients (Control subgroup 1) and 34 patients (Control subgroup 2) were included in the study, respectively. The difference in indicators was compared at 1.7 and 14 days of treatment.

The distribution of patients is presented in Table.

Table. Characteristics of patients included in the study

Indicator	Control group	Experimental group
Age, years	52.8 ± 6.1	52.6 ± 6.7
Female	37 (52.8%)	35 (51.4%)
Male	33 (47.2%)	33 (48.6%)
Upper extremity lesions	20 (28.5%)	18 (26.4%)
Lower extremity lesions	44 (62.8%)	46 (67.6%)
Other body parts	6 (8.7%)	4 (5.9%)
Duration of type 2 diabetes, years	9.6	9.4
Glycosylated hemoglobin, %	6.9 ± 0.62	6.8 ± 0.58
Prior administration of antibacterial agents, days	54.3 ± 8.3	55.1 ± 7.9
Number of co-morbid conditions	2.7	2.8
IL-6, pg/mL	36.8 ± 7.3	35.9 ± 8.5
TNF- α , pg/mL	18.2 ± 1.01	17.8 ± 1.03
CRP, mg/L	49.7 ± 9.2	52.4 ± 8.8

The difference between the control group and the experimental group is statistically insignificant ($p > 0.05$) for all indicators.

The above data indicate that the control and experimental groups are comparable to each other ($p > 0.05$).

The use of probiotic antiseptics included the use of a combination of antiseptics based on lactic acid bacteria (LAC), which are non-pathogenic for humans.

To clear the skin around the wound, a gel was used, the composition of which included: ethyl alcohol – 60.0%, 2-propanol 5.0%, *Bacillus megaterium* < 5%, *B. subtilis* – 5.0%, enzymes 5–10%. To clean the wound, a gel was used, the composition of which included: purified water, anionic surfactant 5–15%, amphoteric surfactant, nonionic surfactant, ethoxylated alcohols, sodium chloride, enzymes, *Bacillus megaterium*, *B. subtilis*, citric acid, and preservative. For the final stage of wound treatment, 2–3 doses of spray were used, which included *Bacillus subtilis* > $5 \cdot 10^7$ CFU/ml, *B. megaterium* > $5 \cdot 10^7$ CFU/ml, didecyldimethylammonium chloride 0.1%.

The main mechanism of action of probiotic antiseptics is to create antagonism in the wound between the LAC and pathogenic microorganisms that cause and maintain the wound process. The application of the spray results in the creation of *Bacillus subtilis* colonies that form a biofilm. It prevents the

penetration of other pathogenic microorganisms into the wound (nosocomial infection) and inhibits their multiplication.

The control group used antiseptics based on octenidine dihydrochloride (0.001%) and 2-phenoxyethanol (2.0%) or antiseptics based on decamethoxine.

All patients underwent correction of concomitant pathology treatment, which took place with the participation of specialists, symptomatic treatment, and empiric (at the beginning of treatment) antibiotic therapy, and etiologic – after determining antibiotic sensitivity, daily debridement with wound dressing, and control of laboratory parameters.

The collection of material for microbiological research was carried out before debridement on the 1st, 7th, and 14th days of treatment. The analysis of changes in antibiotic resistance properties to the following antibiotics was carried out: amikacin, amoxicillin-clavulanic acid, gentamicin, imipenem, meropenem, norfloxacin, moxifloxacin, cefazolin, cefepime, cefotaxime, ceftazidime, ceftriaxone, ciprofloxacin, levofloxacin, cefuroxime, nitrofurantoin, chloramphenicol, aztreonam, piperacillin-tazobactam, tobramycin, and aztreonam.

The analysis of changes in antibiotic-resistant properties in patients with purulent-necrotic wounds against the background of T2DM was carried out using the IBM SPSS Statistics Base software (version 28). Results that had statistical significance were determined at a value of $p < 0.05$. Quantitative data were expressed as the arithmetic mean \pm standard deviation (SD). To check the normality of the data distribution, the Chi-square test was used, while a value of $p > 0.05$ was considered an indicator of compliance with a normal distribution. The Student's t-test for related and unrelated samples was used to compare data that corresponded to a normal distribution. In cases where data were not normally distributed, analysis was performed using the Wilcoxon W-test for related and unrelated samples. The analysis of cytogram types and their changes was carried out using Fisher's exact method, which made it possible to compare the frequency of symptoms.

The study adhered to modern bioethics principles. The Bioethics Commission of Bogomolets National Medical University approved the research design. As the study was conducted in compliance with bioethical norms and biostatistical standards, it did not jeopardise the patient's health. Before the start of the study, all patients gave their informed consent for participation and the further use and publication of their data. All medical devices were registered and received permission for use in Ukraine.

Results

When analysing the changes in the antibiotic-resistant properties (ARC) in Research Subgroup 1, it was found that on the first day, in 24 patients, the degree of contamination was 10^6 CFU, and in 9 patients, the degree of contamination exceeded 10^6 CFU. All patients received *P. aeruginosa*, exhibiting resistance to conventional antibiotics and reserve antibiotics. On the 7th day, it was found that the degree of wound contamination in all patients did not exceed 10^6 CFU, and in 12 patients, it was 10^4 CFU. The appearance of sensitivity to reserve antibiotics was also detected in 18 patients ($p < 0.001$). On the 14th day, the level of contamination above 10^3 CFU was not observed in this subgroup of patients, which indicated a low level of contamination, and *P. aeruginosa* was not detected in 18 patients ($p < 0.001$). When analysing the antibiotic charts, it was found that sensitivity to conventional antibiotics appeared in all patients, and antibiotic resistance to reserve antibiotics disappeared (Fig. 1).

When analysing the changes in the properties of ARC in Research Subgroup 2, it was found that on the first day, in 31 patients, the degree of contamination was 10^6 CFU, and in 6 patients, the degree of contamination exceeded 10^6 CFU. All patients received *K. pneumoniae*, exhibiting resistance to conventional antibiotics and reserve antibiotics. On the 7th day, it was found that the degree of wound contamination in all patients did not exceed 10^6 CFU, and in 12 patients, it was 10^4 CFU. The appearance of sensitivity to reserve antibiotics was also detected in 18 patients ($p < 0.001$). On the 14th day, the level of contamination above 10^3 CFU was not observed in this subgroup of patients, which indicated a low level of contamination, and *P. aeruginosa* was not detected in 18 patients. When analysing the antibiotic charts, it was found that sensitivity to conventional antibiotics appeared in all patients, and antibiotic resistance to reserve antibiotics disappeared (Fig. 2).

When analysing the changes in the properties of ARC in Control Subgroup 1, it was found that on the first day, in 26 patients, the degree of contamination was 10^6 CFU, and in 6 patients, the degree of contamination exceeded 10^6 CFU. All patients received *P. aeruginosa*, exhibiting resistance to conventional antibiotics and reserve antibiotics. On the 7th day, it was found that the degree of wound contamination in 6 patients did not exceed 10^6 CFU; in other patients, the level of contamination remained above 10^6 CFU. The appearance of sensitivity to reserve antibiotics was revealed in 7 patients ($p < 0.001$). On the 14th day, in this subgroup of patients, the

preservation of the level of contamination above 10^6 CFU was noted in 7 patients, which indicated the preservation of ARC properties, and in 25 patients, *P. aeruginosa* was detected but without antibiotic-resistant properties. During the analysis of antibioticograms, it was found that the patients in this subgroup had a high level of contamination and ABD properties.

When analysing the changes in ARC properties in Control Subgroup 2, it was found that on the first day, in 24 patients, the degree of contamination was 10^6 CFU, and in 10 patients, the degree of contamination exceeded 10^6 CFU. All patients received *K. pneumoniae*, exhibiting resistance to

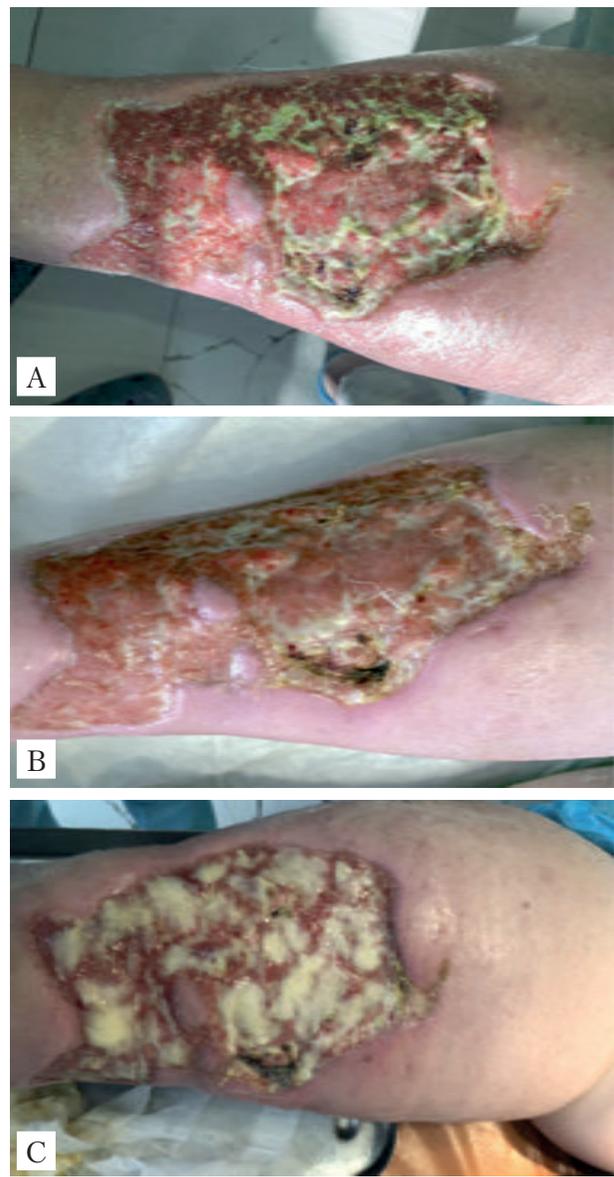


Figure 1. Dynamics of macroscopic changes in the wound of Patient N., 58 years old: 1st day of using probiotic antiseptic (A); 7th day in the hospital (B); 8th day in the hospital, secondary surgical treatment, autodermplasty according to Thirsch (C)

conventional antibiotics and reserve antibiotics. On the 7th day, it was found that the degree of wound contamination in 8 patients did not exceed 10^6 CFU; in other patients, the level of contamination remained above 10^6 CFU. The appearance of sensitivity to reserve antibiotics was revealed in 9 patients ($p = 0.286$). On the 14th day, in this subgroup of patients, the preservation of the level of contamination above 10^6 CFU was noted in 5 patients, which indicated the preservation of ARC properties, and in 29 patients, *K. pneumoniae* was detected but without antibiotic-resistant properties ($p < 0.001$). Although statistical significance was found when comparing patients between the 1st and 14th days of the study, the patients in this subgroup had a high level of contamination and ARC properties.

When the first subgroups (control and experimental groups) were compared on the first day, there was no statistically significant difference in the levels of *P. aeruginosa* wound contamination ($p = 0.671$). On the seventh day, there was a statistically significant difference between contamination

levels ($p < 0.001$) and the emergence of sensitivity to reserve antibiotics ($p < 0.001$). On the 14th day, there was a statistically significant difference between contamination levels ($p < 0.001$) and the emergence of sensitivity to reserve antibiotics ($p < 0.001$).

When the second subgroups (control and experimental groups) were compared on the first day, there was no statistically significant difference in the levels of *K. pneumoniae* wound contamination ($p = 0.462$). On the seventh day, there was a statistically significant difference between contamination levels ($p < 0.001$) and the emergence of sensitivity to reserve antibiotics ($p < 0.001$). On the 14th day, there was a statistically significant difference between contamination levels ($p < 0.001$) and the emergence of sensitivity to reserve antibiotics ($p < 0.001$).

Considering the aforementioned findings, it can be concluded that the use of probiotic antiseptics has a positive effect on reducing the level of contamination with antibiotic-resistant strains of bacteria and promoting the emergence of antibiotic sensitivity when compared to the use of traditional antiseptics.

Discussion

The alarming surge in antibiotic resistance underscores the urgency of exploring alternative antimicrobial approaches. The World Health Organisation and Public Health Centre of Ukraine highlight the criticality of addressing antibiotic resistance, particularly in the context of T2DM-related complications [1, 5]. The exponential growth in T2DM cases, as evidenced by global projections, mandates proactive interventions to curtail the ensuing burden on healthcare systems [2, 9]. Analysing global data, S. Demir et al. found that more than 1.27 million people die annually [4] from the emergence of antibiotic-resistant properties in pathogens. The research data of K. Al-Rubeaan and P. Zhang indicate that patients with purulent-necrotic complications have a high frequency of purulent-necrotic complications in T2DM and frequent relapses, tissue trophic disorders, and impaired repair processes, which in our opinion is the main factor in the occurrence of antibiotic-resistant properties of pathogens persisting in wounds [3, 7]. That is why, in our study, we decided to combine the two problems and find options for preventing the development of antibiotic-resistant properties in causative agents of purulent-necrotic wounds in patients with T2DM. After conducting a review of the literature and searching for alternative methods of preventing the development



Figure 2. Dynamics of macroscopic changes in the wound of Patient Yu., 51 years old: 1st (A) and 5th (B) day of using probiotic antiseptic

of antibiotic-resistant properties in pathogens and treating patients with existing antibiotic-resistant pathogens, we found an alternative method of treatment, including probiotic antiseptics. S. W. Lee's studies indicate persistent properties in the environment and the displacement of pathogenic microflora from nutrient media, winning the fight for nutrients [6]. After analysing changes in antibiotic-resistant properties in K. W.K. Tang materials, it was decided to conduct a study of changes in antibiotic-resistant properties in patients with T2DM and purulent-necrotic wounds through the use of probiotic antiseptics [8]. When performing this study, four subgroups were selected in which *P. aeruginosa* and *K. pneumoniae* had pronounced antibiotic-resistant properties. These pathogens caused long-lasting inflammation in patients with purulent-necrotic wounds in T2DM. The results obtained by us indicate that patients from the research group (to whom probiotic antiseptics were applied) had better clinical results of treatment, more often the disappearance of antibiotic-resistant properties and generally cleaning of wounds from antibiotic-resistant pathogens ($p < 0.001$). That is why probiotic antiseptics can be a promising method to combat antibiotic resistance, but this direction requires a better study of all aspects of the effect on bacteria and changes in wounds in various concomitant conditions and pathologies.

Conclusions

Local use of probiotic antiseptics has been found to have a faster, statistically significant positive impact on reducing ARC properties in T2DM patients with purulent-necrotic wounds ($p < 0.001$).

Probiotic antiseptics accelerate the disappearance of ARC properties in T2DM patients with purulent-necrotic wounds, compared to chemical antiseptics ($p < 0.001$).

Probiotic antiseptics have the potential to become a new approach to local treatment for T2DM patients with purulent-necrotic wounds, as well as to rapidly overcome ARC and accelerate the healing of purulent-necrotic wounds.

More research is needed to expand the potential of using probiotic antiseptics for the prevention of wound infection, treatment of wounds in different areas, and burns. However, our preliminary findings provide us with optimism for positive results in the future.

DECLARATION OF INTERESTS

The authors declare no conflicts of interest.

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AUTHORS CONTRIBUTIONS

Conception and design — O. Y. Ioffe, O. P. Stetsenko; data collection, critical revision of the article — Y. P. Tsyura; analysis and interpretation of data — S. L. Kindzer, M. S. Kryvopustov, Y. P. Tsyura, Y. S. Prykhodko; drafting the article — S. L. Kindzer, M. S. Kryvopustov, Y. S. Prykhodko.

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Зміни антибіотикорезистентних властивостей патогенних мікроорганізмів у пацієнтів із гнійно-некротичними ранами на тлі цукрового діабету 2 типу при використанні пробіотичної антисептики

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Стійкість до антибіотиків залишається серйозною проблемою, яка щороку призводить до мільйонів смертей. Зростання поширеності цукрового діабету (ЦД) 2 типу поглиблює цю проблему. Україна, як і інші країни, відчуває наслідки цієї проблеми. За останніх 10 років кількість хворих на ЦД 2 типу зростає вдвічі, ЦД є причиною інвалідності та смерті тисяч людей. Ускладнення ЦД 2 типу, такі як синдром діабетичної стопи, часто потребують хірургічного втручання та проведення антибактеріальної терапії. Дослідження виявили перспективність використання пробіотичних антисептиків на основі молочнокислих бактерій роду *Bacillus* при лікуванні ран, що може відкрити нові можливості для боротьби з цією проблемою та поліпшення результатів лікування.

Мета — проаналізувати зміни антибіотикорезистентних властивостей патогенних мікроорганізмів у хворих на гнійно-некротичні рани при ЦД 2 типу.

Матеріали та методи. У дослідження, проведене на базі кафедри загальної хірургії № 2 Національного медичного університету імені О. О. Богомольця — у Київській міській клінічній лікарні № 3, було залучено 229 пацієнтів із гнійно-некротичними ранами та ЦД 2 типу, яких випадковим чином розподілили на дві групи, одна з яких отримувала пробіотичні антисептики, а друга — традиційні хімічні антисептики. Проведено аналіз змін антибіотикорезистентних властивостей *P. aeruginosa* та *K. pneumoniae*. Стійкість до антибіотиків оцінювали за допомогою мікробіологічного дослідження. Виявлено значні зміни в моделях резистентності серед пацієнтів, які отримували пробіотичні антисептики, порівняно з тими, хто використовував традиційні хімічні антисептики. Отримані дані оцінювали за допомогою статистичних методів, зокрема з використанням t-критерію Стьюдента та W-критерію Вілкоксона.

Результати. У 1-шу добу між групами не виявлено статистично значущої різниці за рівнем контамінації ран *P. aeruginosa* ($p=0,671$), на 7-му добу зафіксовано статистично значущу різницю за рівнем контамінації ($p<0,05$) та появою чутливості до антибіотиків резервного ряду ($p<0,05$), на 14-ту добу також установлено статистично значущу різницю за цими показниками ($p<0,05$).

Висновки. При застосуванні пробіотичних антисептиків порівняно з хімічними виявлено статистично значущу різницю щодо зниження рівня контамінації та появи антибіотикочутливості в пацієнтів із гнійно-некротичними ранами при ЦД 2 типу.

Ключові слова: цукровий діабет 2 типу, антибіотики, антибіотикорезистентність, *Bacillus subtilis*, *Klebsiella*, *Pseudomonas*.

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Choledochoscopy in the laparoscopic treatment of patients with choledocholithiasis: a single-centre study

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Choledochoscopy is a minimally invasive procedure used for laparoscopic bile duct exploration and the removal of bile duct stones. However, there is insufficient information available about its advantages in diagnosing choledocholithiasis and its role in laparoscopic choledocholithoextraction.

OBJECTIVE — to compare the diagnostic efficacy of imaging techniques and choledochoscopy in patients with choledocholithiasis and to evaluate the role of choledochoscopy in laparoscopic choledocholithoextraction.

MATERIALS AND METHODS. The study examined the results of 128 patients with calculous cholecystitis and choledocholithiasis who had laparoscopic choledocholithoextraction in combination with choledochoscopy. We assessed the sensitivity and specificity of ultrasound, CT, and MRI in the diagnosis of choledocholithiasis, as well as the efficacy of one-stage treatment of calculous cholecystitis and choledocholithiasis using choledochoscopy and laparoscopic choledocholithoextraction.

RESULTS. Imaging techniques demonstrated limited sensitivity and specificity in determining the diameter and number of common bile duct stones. A total of 89 (69.5%) patients achieved complete bile duct clearance after blind laparoscopic choledocholithoextraction: 86 (81.1%) had choledochotomy, and 3 (13.6%) underwent transcystic common bile duct exploration. The combination of choledochoscopy and laparoscopic choledocholithoextraction ensured the complete removal of bile duct stones in 97.6% of patients.

CONCLUSIONS. The imaging techniques used for determining the number of common bile duct stones in choledocholithiasis had sensitivity and specificity rates of 41.4% and 92.7% for ultrasound, 72.7% and 83.3% for CT, and 86.7% and 60.9% for MRI, respectively. A total of 89 (69.5%) patients achieved complete bile duct clearance after blind laparoscopic choledocholithoextraction: 86 (81.1%) had choledochotomy, and 3 (13.6%) underwent transcystic common bile duct exploration. Choledochoscopy was required for laparoscopic choledocholithoextraction in 18.9% of choledochotomy patients and in 86.4% of those who underwent transcystic common bile duct exploration. Choledochoscopy demonstrated an overall bile duct stone clearance rate of 97.6%.

KEYWORDS

choledocholithiasis, choledochoscopy, choledocholithoextraction, mechanical jaundice.

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Choledocholithiasis, or the presence of common bile duct stones, is the most frequent complication of gallstone disease, amounting to 5–33% [4, 5, 16]. Today, there are two main approaches to the treatment of calculous cholecystitis with concomitant choledocholithiasis: two-stage treatment, including endoscopic retrograde cholangiopancreatography (ERCP) with papillosphincterotomy (EPST) and laparoscopic cholecystectomy (LCE), which

is performed either in the first or second stage, and one-stage treatment, including laparoscopic choledocholithotomy with choledochoscopy, lithoextraction, and subsequent LCE [4, 5, 8, 9].

According to research, in 85–90% of cases, calculous cholecystitis with concomitant choledocholithiasis can be successfully treated in two stages [6, 8, 12]. First and foremost, this is due to almost 50 years of ERCP development, as well as the

establishment and standardization of endoscopic procedures in the majority of medical institutions around the world [1, 8, 33]. Despite a number of obvious advantages, the one-stage approach is still not the most popular [8, 12, 19]. These advantages include reducing the length of hospital stays, preserving the sphincter apparatus of the major duodenal papilla, and lowering the overall cost of treatment [3, 7]. An important reason for the selection of a one-stage approach is found in the use of intraoperative choledochoscopy, which offers a higher level of precision in diagnosing choledocholithiasis compared to preoperative techniques while also facilitating complete lithoextraction. However, this particular aspect of the problem has received insufficient research attention.

Both approaches successfully achieve their goal of eliminating bile duct stones, but the choice of the treatment strategy remains a subject of debate.

OBJECTIVE – to compare the diagnostic efficacy of imaging techniques and choledochoscopy in patients with choledocholithiasis and to evaluate the role of choledochoscopy in laparoscopic choledocholithoextraction.

Materials and methods

The study examined the results of 128 patients with calculous cholecystitis and choledocholithiasis who underwent treatment between 2019 and 2023 in the Department of Surgery No. 2 (a specialised department for the treatment of hepatopancreatobiliary diseases) at the Kyiv City Clinical Hospital of Emergency Medical Care, which is a clinical base of the Department of Surgery with the Course of Emergency and Vascular Surgery at Bogomolets National Medical University.

All patients had single-stage laparoscopic choledocholithoextraction with choledochoscopy and cholecystectomy. In 22 (17.2 %) patients, choledocholithoextraction and choledochoscopy were conducted through the cystic duct, while the remaining 106 (82.8 %) had choledocholithotomy, lithoextraction, and choledochoscopy.

The screening method for choledocholithiasis-complicated gallstone disease was an abdominal ultrasound. Imaging techniques were employed to address diagnostic difficulties in patients. Specifically, 23 (18.0 %) patients underwent contrast-enhanced computed tomography, and 38 (29.7 %) patients underwent magnetic resonance cholangiopancreatography.

The research parameters included the diameter of the common bile duct, the maximum diameter of bile duct stones based on the findings of imaging tests

(ultrasound, CT, MRI) and intraoperative data (intraoperative measurement of the diameter of the choledochus was carried out using a tape measure (cm) immersed in the abdominal cavity, and the diameter of the removed bile duct stones was determined using a caliper), sensitivity and specificity of imaging tests and choledochoscopy in determining the number of bile duct stones, as well as a comparative assessment of the effectiveness of blind choledocholithoextraction, including bile duct stone clearance with lithoextraction during choledochoscopy, the frequency of postoperative complications according to the Clavien-Dindo classification [10], bed-day.

The main baseline characteristics of the patients are listed in Table 1.

Choledochoscopy was performed using Olympus CHF-V and Karl Storz fibrocholedochoscopes with a diameter of 5 mm and 3 mm, respectively. The operation was performed under general anaesthesia. A standard 4-port technique for laparoscopic cholecystectomy was used, and a separate port was placed in the projection of the common bile duct for choledochoscopy if choledocholithotomy was planned intraoperatively. The central part of the common bile duct was isolated, the cystic artery was ligated, a clip was applied to the proximal part of the d. cysticus, and the gallbladder was left and used for traction during manipulations on the common bile duct. A total of 106 (82.8 %) patients underwent choledocholithotomy with choledocholithoextraction and

Table 1. **Baseline characteristics of patients with gallstone disease and choledocholithiasis**

Indicator	Value
Male	46 (35,9%)
Female	82 (64,1%)
Age, years	60,04 ± 1,31 (17–93%)
Jaundice syndrome,	91 (71,1%)
Total bilirubin, µmol/L	87,6 ± 5,6 (10,5–365,8)
Direct bilirubin, µmol/L	39,8 ± 2,8 (1,3–146,6)
Cholangitis (moderate and severe)	57 (44,5%)
ASA I n (%)	40 (31,3%)
ASA II	74 (57,8%)
ASA III	14 (10,9%)
Difficult cholelithiasis*	60 (46,9%)

Note. Categorical variables are presented as the number of cases and percentage, while quantitative indicators are presented as $M \pm m$ (min–max)

* Difficult cholelithiasis was established according to the criteria described by Hyuk Oh C., Dong S. [17] and Yasuda I., Itoi T. [33].

choledochoscopy using a 5 mm Olympus CHF-V fibrocholedochoscope, and 22 (17.2%) patients underwent transcystic choledocholithoextraction and choledochoscopy using a 3 mm Karl Storz fibrocholedochoscope.

An incision of 15 to 30 mm was usually made in the central part of the common bile duct, after which choledocholithoextraction was performed using a Dormia basket without visualisation (blind choledocholithoextraction) (Fig. 1).

The ducts were cleaned with a 0.9% solution of sodium chloride heated to 37°C, which helped wash out small bile duct stones from the common bile duct to the outside. With the help of choledochoscopy, all accessible sections of the bile ducts were explored, including the ampulla of Vater (Fig. 2).

When bile duct stones were detected, we performed choledocholithoextraction. During the procedure, the Dormia baskets were used to remove them through the working channel of the fibrocholedochoscope (Fig. 3).

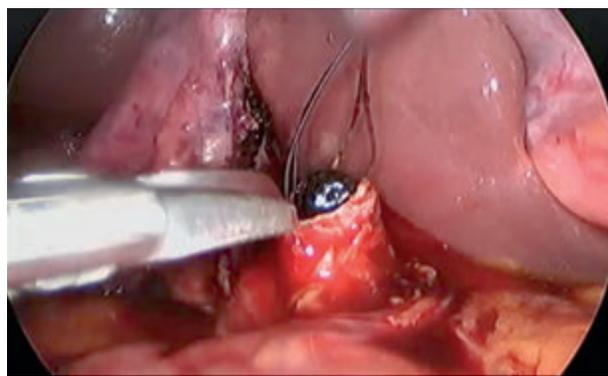


Figure 1. **Choledocholitotomy and mechanical choledocholithoextraction without visualisation**

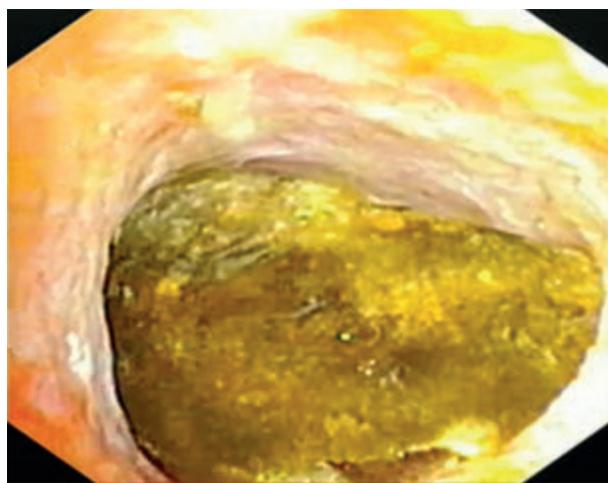


Figure 2. **A bile duct stone in the terminal section of the common bile duct (the ampulla of the major duodenal papilla)**

After choledocholithoextraction, all bile duct sections were explored using choledochoscopy. In the absence of bile duct stones, the incision was closed with knotted sutures (absorbable monofilament 4/0). Bile duct drainage was carried out in the presence of purulent cholangitis and microcholedocholithiasis. The next stage involved a cholecystectomy.

The study employs descriptive statistics and presents the data as the arithmetic mean \pm standard error ($M \pm m$). The mean values of two variables were compared using the Mann-Whitney U-test. The sensitivity and specificity of diagnostic techniques for choledocholithiasis were assessed using ROC analysis. IBM SPSS Statistics 22.0 was used to complete the calculations.

Results

According to anamnestic data, the majority of patients were admitted to the hospital 24 hours after the onset of the disease (pain syndrome). Thus, the condition lasted up to 6 hours in 4 (3.1%) patients, 7 to 24 hours in 16 (12.5%), and more than 24 hours in 108 (84.4%). Out of the total number of patients, 119 (93.0%) were hospitalised for the first time due to a diagnosis of choledocholithiasis, while 9 (7.0%) had repeated hospitalisation.

Following the diagnosis and preoperative preparation, all patients underwent surgery. Preoperative bed-day averaged 4.5 ± 0.2 days (from 1 day to 9 days) (Fig. 4).

The preoperative period was extended to manage the accompanying pathology and jaundice syndrome.

The operative intervention lasted an average of 115.0 ± 14.7 min.



Figure 3. **The stone captured with the Dormia basket in the distal section of the common bile duct during choledocholithoextraction**

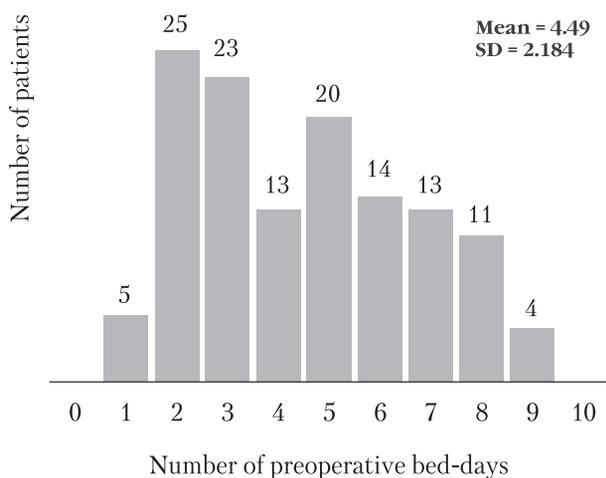
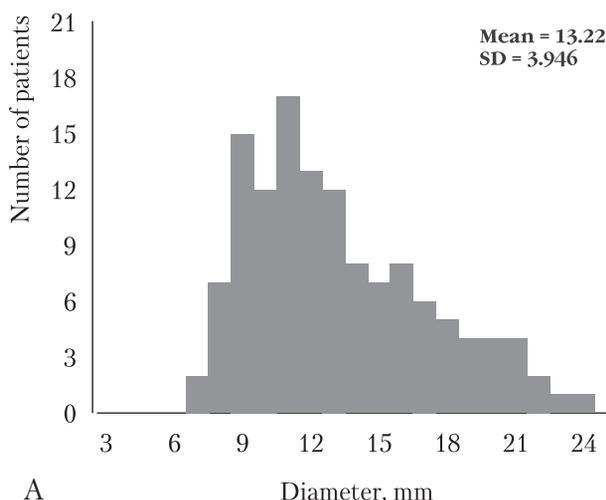
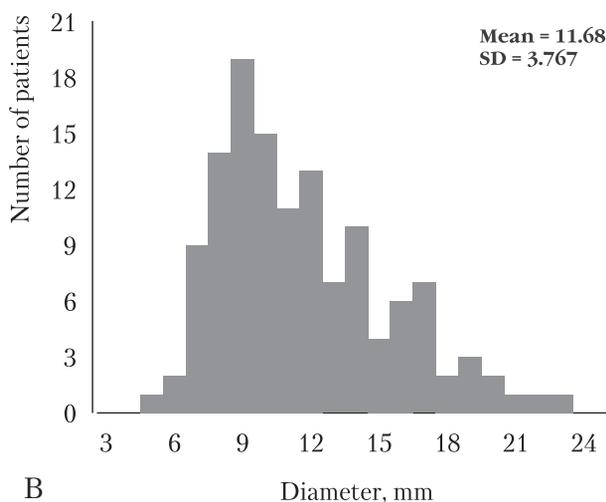


Figure 4. **Distribution of patients by preoperative bed-day**



A



B

Figure 5. **Distribution of patients based on the diameter of the common bile duct, as determined by intraoperative (A) and ultrasound (B) data**

According to intraoperative data, the average diameter of the common bile duct (choledochus) was 13.22 ± 0.35 mm (from 7 mm to 24 mm). According to ultrasound data, the diameter averaged 11.68 ± 0.33 mm (from 5 mm to 23 mm), $p = 0.003$, which was smaller compared to intraoperative findings (Fig. 5).

The error of measuring the diameter of the common bile duct using ultrasound compared with intraoperative data was from 0 mm to 5 mm, on average 1.54 ± 0.86 mm.

In 53 (41.4%) patients, the difference between ultrasound data and intraoperative measurement was 0 mm to 1 mm.

Patients who underwent CT had an average common bile duct diameter of 11.86 ± 0.96 mm, which did not statistically differ from the intraoperative average diameter of 12.39 ± 1.0 mm ($p = 0.712$). In 21 (91.3%) patients, the diameters of the common bile duct were found to be the same (a variation of 0 to 1 mm). In two cases, the common bile duct diameters were 2 mm smaller than those measured intraoperatively.

Patients who additionally underwent MRI had an average common bile duct diameter of 12.74 ± 0.67 mm, which did not statistically differ from the intraoperative average diameter of 13.0 ± 0.65 mm ($p = 0.774$). In 36 (94.7%) patients, the diameters of the common bile duct were found to be the same (a variation of 0 to 1 mm). In other cases, the common bile duct diameters were 2 mm smaller than those measured intraoperatively.

According to intraoperative findings, 45 (35.2%) patients had one common bile duct stone, 22 (17.1%) had two, and 61 (47.7%) had three or more (Fig. 6).

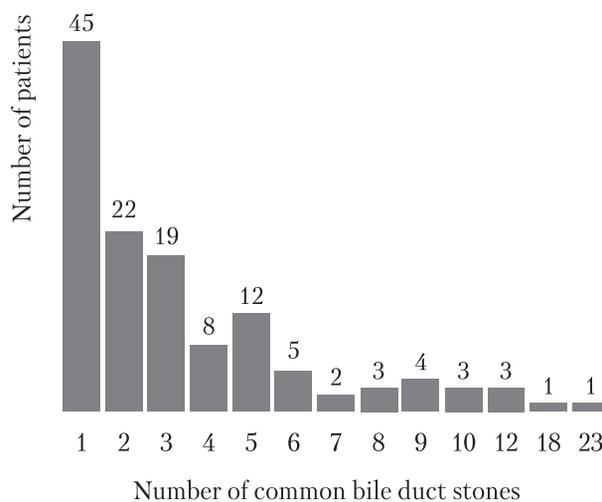


Figure 6. **The number of common bile duct stones according to choledochoscopy**

We compared the quantity of bile duct stones revealed intraoperatively and instrumentally. Ultrasound showed a considerably lower average number of bile duct stones (1.66 ± 0.13 versus 3.52 ± 0.31 ; $p = 0.001$). In 41 (32%) patients, both approaches showed an identical number of bile duct stones. In the other 87 (68.0%) cases, ultrasound reported a different number of bile duct stones than the actual number: 75 (58.6%) had fewer (by 1–22) bile duct stones, while 12 (9.4%) had more (by 1–4) bile duct stones. In general, ultrasound has a low diagnostic capacity for determining the exact number of bile duct stones: the area under the ROC curve is 0.675 (95% CI: 0.583–0.767), sensitivity is 41.4%, and specificity is 92.7% (Fig. 7).

Patients who additionally underwent CT had an average number of bile duct stones of 1.91 ± 0.25 , which did not statistically differ from the intraoperative average number of bile duct stones of 2.65 ± 0.46 ($p = 0.166$). In 12 (52.2%) patients, the number of bile duct stones was found to be the same. In the other 9 (39.1%) cases, CT diagnosed fewer (from 1 to 4) bile duct stones, and in 2 (8.7%) patients, more (from 1 to 2) bile duct stones.

In multiple choledocholithiasis, CT had 72.7% sensitivity, 83.3% specificity, and an area under the ROC curve of 0.754 (95% CI: 0.542–0.966) (Fig. 8).

Patients who additionally underwent MRI had an average number of bile duct stones of 3.08 ± 0.37 , which did not statistically differ from the intraoperative average number of bile duct stones of

3.97 ± 0.47 ($p = 0.142$). In 22 (57.9%) patients, the number of bile duct stones was found to be the same. In the other 13 (34.2%) cases, MRI diagnosed fewer (from 1 to 5) bile duct stones, and in 1 (5.3%) patient, more (by 1) bile duct stones.

In multiple choledocholithiasis, MRI had 86.7% sensitivity, 60.9% specificity, and an area under the ROC curve of 0.862 (95% CI: 0.747–0.978) (Fig. 9).

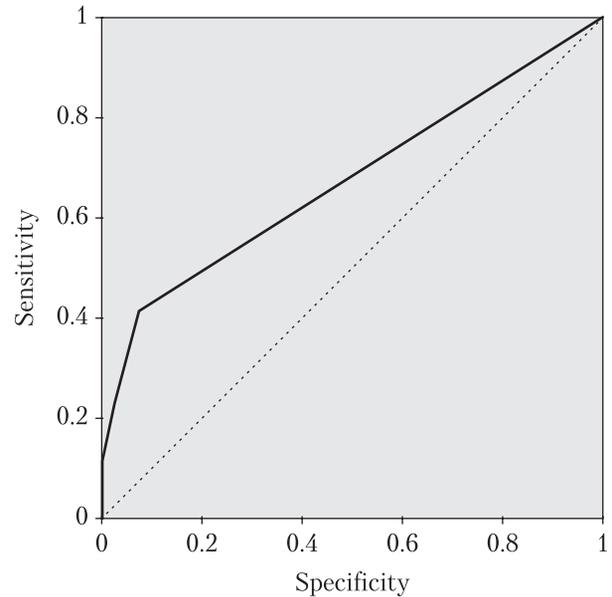


Figure 7. ROC curve for determining the number of bile duct stones in choledocholithiasis according to ultrasound data

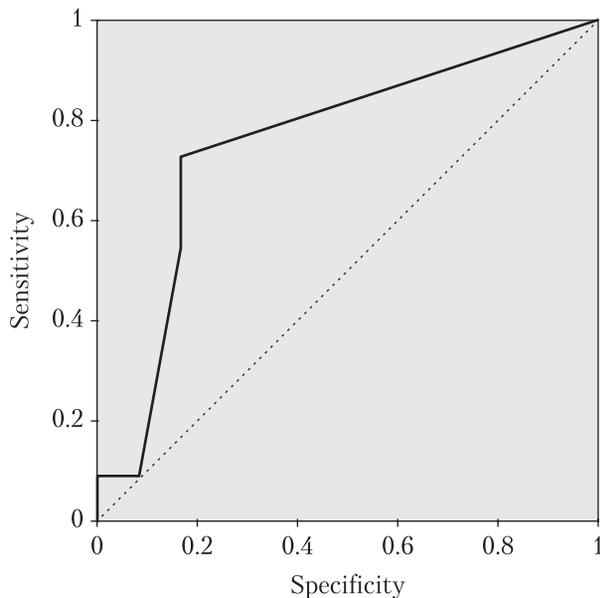


Figure 8. ROC curve for determining the number of bile duct stones in choledocholithiasis according to CT data

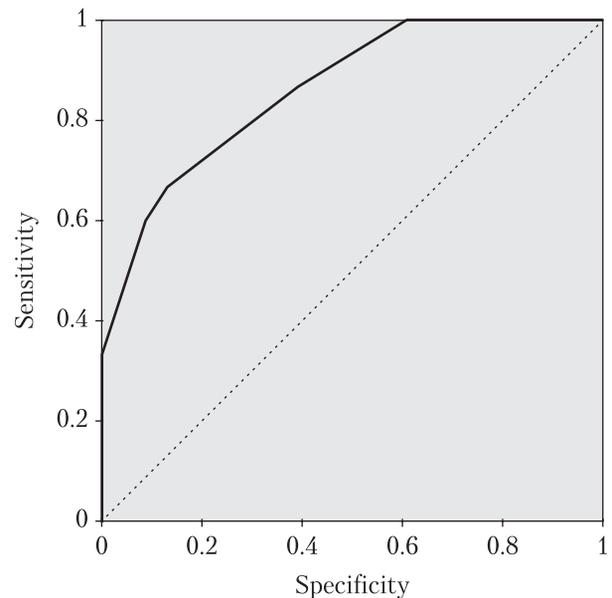


Figure 9. ROC curve for determining the number of bile duct stones in choledocholithiasis according to MRI data

Table 2. Average values of the maximum sizes of bile duct stones, depending on the diagnostic method, mm

Measurement method	n	Mean	SD	Min–Max	p*
Choledochoscopy	128	9,52	0,60	2–40	–
Ultrasound	128	8,05	0,95	2–120	0,192
CT	23	7,48	0,83	3–19	0,196
MRI	38	7,37	0,86	0–25	0,434

Note. * In relation to choledochoscopy. Differences in the average values of the maximum size of bile duct stones for choledochoscopy, CT, and MRI data were determined in patients who underwent two corresponding diagnostic procedures concurrently.

The diagnostic procedures used to measure the maximum size of bile duct stones revealed no statistical differences (Table 2).

A total of 89 (69.5%) patients achieved complete bile duct clearance after blind choledocholitho-extraction, which was subsequently confirmed by choledochoscopy: 86 (81.1%) had choledochotomy, and 3 (13.6%) underwent transcystic common bile duct exploration. In other cases, bile duct stones were removed using a Dormia basket, which was passed into the common bile duct through the working channel of the choledochoscope. Further extraction of bile duct stones was carried out under visual control.

Choledochoscopy was required for laparoscopic choledocholithoextraction in 20 (18.9%) choledochotomy cases and in 19 (86.4%) cases of transcystic common bile duct exploration. Choledochoscopy demonstrated an overall bile duct stone clearance rate of 97.6%.

In one case, the tight fixation of the bile duct stone in the area of the papilla of Vater prevented its removal during choledochotomy. In this case, we successfully applied the rendezvous method.

Although choledochoscopy allows us to correctly determine the completeness of stone removal, two patients returned to us within a year after the operation due to the presence of common bile duct stones. One patient had Caroli's disease whereas the other had a diverticulum of the common bile duct. Endoscopic papillosphincterotomy (EPST) was used in both cases to remove bile duct stones: three in a patient with Caroli's disease and two in a patient with a diverticulum of the common bile duct.

After choledocholithoextraction and choledochoscopy, external drainage of the common bile duct was performed in 15 (11.7%) patients: 11 (10.4%) had choledochotomy and 4 (18.2%) underwent

transcystic common bile duct exploration. Indications for external drainage in choledochotomy patients were cases of purulent cholangitis and/or biliary microcholedocholithiasis.

Postoperative complications were noted in 11 (8.6%) patients: grade II complications in 6 (4.7%) and grade III complications in 5 (3.9%).

The average postoperative bed-day was 8.2 ± 0.3 days, and the total bed-day was 12.7 ± 0.4 days.

There were no fatalities.

Discussion

Gallstone disease and its complications, such as calculous cholecystitis and choledocholithiasis, remain an urgent problem in abdominal surgery [7, 27, 32]. According to modern research, the incidence of common bile duct stones in patients with symptomatic gallstone disease varies widely and reaches 5–33%, depending on age [8, 13, 18]. The management of such patients requires the use of minimally invasive approaches, the reduction of surgical trauma, the reduction of bed-days and, accordingly, the cost of treatment [3, 23].

According to research, the frequency of complications arising from transpapillary interventions is 3.6–12%. Among them, the most common are acute pancreatitis, perforation of the duodenum, bleeding, and cholangitis [8, 25, 33]. Complications after EPST were recorded in 9.4–11.1% of cases [19, 27, 28].

Choledochoscopy combined with choledocholithoextraction and simultaneous cholecystectomy began to be used in the late 1990s. At first, access through the cystic duct was used, and later, choledocholithotomy was performed, which significantly expanded the possibilities of choledocholithoextraction [9, 15, 33].

Laparoscopic common bile duct exploration (LCBDE) is performed through the cystic duct and by choledochotomy, followed by primary sutures or drainage. In fact, applying primary sutures in comparison with drainage of the common bile duct is an obvious advantage for the patient [3, 19, 28]. The main disadvantages of drainage of the common bile duct are more prolonged hospitalisation, loss of bile, water-electrolyte disorders, additional discomfort for the patient, possible ascending infections of the biliary tract, etc. [3, 20, 26].

Considering these factors, the recommended procedures should be choledochoscopy and transcystic choledocholithoextraction, which is minimally traumatic as it does not require choledocholithotomy and allows for the avoidance of possible complications associated with drainage of the common bile

duct [19, 28]. However, this approach has many limitations: the size of the bile duct stone (< 6mm), the bile duct stone must be the same or smaller in diameter as the cystic duct, and the number of bile duct stones (< 5). Additionally, choledochoscopy and transcystic choledolithoextraction cannot be performed in the case of proximal choledocholithiasis, strictures of the common bile duct, acute angle between the cystic and common hepatic duct, or difficult choledocholithiasis [13]. Based on national and international data, fibrocholedochoscopes with a diameter of up to 3 mm are commonly used for performing choledochoscopy through the cystic duct. However, these devices have a smaller working channel, worse performance, and are prone to quick wear and fragility [3].

Taking into account the preoperative and intraoperative data, we used laparoscopic choledocholithotomy, lithoextraction, and choledochoscopy with a significantly higher frequency, namely in 106 (82.8%) cases, compared to laparoscopic choledolithoextraction and choledochoscopy through the cystic duct, which were used in 22 (17.2%) patients. Some international studies have reported comparable access ratios, specifically 65%/35% [3] and 76%/24% [15]. In cases where the primary choledochoscopy reveals the presence of a large common bile duct stone (≥ 15 mm), intrahepatic biliary stone, existing bile duct strictures (of any origin), a stone stuck in the terminal section of the common bile duct, or multiple choledocholithiasis (> 3 bile duct stones, size > 10 mm), it is recommended to conduct choledocholithotomy to explore the bile ducts [29].

The operative intervention lasted an average of 115.0 ± 14.7 min., which is consistent with other authors' results of 96 min [15] and 120 min [3].

A total of 89 (69.5%) patients achieved complete bile duct clearance after blind choledolithoextraction: 86 (81.1%) had choledochotomy, and 3 (13.6%) underwent transcystic common bile duct exploration.

Further extraction of bile duct stones was carried out under visual control. According to our findings, after choledochoscopy and choledolithoextraction, an overall bile duct stone clearance rate was 97.6%, which is consistent with the other authors' data of 93.6% [26] and 95% [3].

Some studies show the frequency of complications ranging from 7% to 12.5% [2, 3, 23, 25], which is consistent with our data: 8.6% (according to P. Clavien and D. Dindo).

The main complication was leakage of bile from the sutures of the common bile duct, which in our study was registered in 3.7% of cases, which is less

than the indicators cited by other authors of 9.5% [3]; 4.35% [18]; and 7.2% [23].

There were no strictures on the common bile duct and fatal consequences after a year of observation in our study, as in other authors' studies [19, 26, 29].

According to our data, the average length of stay in a hospital (bed-day) was quite significant and was 12.7 ± 0.4 days, while the world average is slightly lower at 10.7 [15], 12 [3], and 6 [26]. First of all, it can be explained by differences in patient discharge criteria.

Based on our experience, blind choledolithoextraction is effective in removing just 69.5% of stones. Therefore, information about the number of common bile duct stones and their characteristics plays an important role in preventing their incomplete removal. Unfortunately, imaging techniques such as ultrasound, CT, and MRI do not provide comprehensive information on this matter. Our findings show that, in relation to choledochoscopy, imaging tests used for determining the number of common bile duct stones in choledocholithiasis had sensitivity and specificity rates of 41.4% and 92.7% for ultrasound, 72.7% and 83.3% for CT, and 86.7% and 60.9% for MRI, respectively.

Considering the obtained data, the leading role in the diagnosis of choledocholithiasis belongs to choledochoscopy, due to which the risks of residual choledocholithiasis can be minimised.

Choledochoscopy provides visualisation of the extrahepatic bile ducts, the possibility of controlled removal of all bile duct stones, one-stage surgical treatment, preservation of the integrity of the papilla of Vater, and the absence of postoperative complications typical for transpapillary interventions.

Conclusions

The imaging techniques used for determining the number of common bile duct stones in choledocholithiasis had sensitivity and specificity rates of 41.4% and 92.7% for ultrasound, 72.7% and 83.3% for CT, and 86.7% and 60.9% for MRI, respectively.

A total of 89 (69.5%) patients achieved complete bile duct clearance after blind laparoscopic choledolithoextraction: 86 (81.1%) had choledochotomy, and 3 (13.6%) underwent transcystic common bile duct exploration.

Choledochoscopy was required for laparoscopic choledolithoextraction in 18.9% of choledochotomy patients and in 86.4% of those who underwent transcystic common bile duct exploration. Choledochoscopy demonstrated an overall bile duct stone clearance rate of 97.6%.

Our study is limited by its unicentricity.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

Conception and design: Y. M. Susak, M. V. Maksimenko; acquisition of data: L. Y. Markulan, V. V. Volkovetskii; drafting the article Y. M. Susak; critical revision of the article: L. Y. Markulan.

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Холедохоскопія в лапароскопічному лікуванні хворих із холедохолітіазом: досвід одного центру

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Лапароскопічна холедохоскопія (ЛХС) є одним із методів дослідження жовчних проток та дає змогу видалити конкременти. Інформації про її переваги для діагностики холедохолітіазу (ХЛ) та виконання лапароскопічної холедохолітоекстракції (ЛХЛЕ) недостатньо.

Мета — у хворих із ХЛ порівняти ефективність променевих методів діагностики і ЛХС та оцінити роль останньої в технології ЛХЛЕ.

Матеріали та методи. Проаналізовано результати лікування 128 хворих із калькульозним холециститом і ХЛ методом ЛХЛЕ з використанням ЛХС. Оцінювали чутливість і специфічність ультразвукового дослідження, комп'ютерної та магнітно-резонансної томографії щодо діагностики ХЛ, а також ефективність одноетапного лікування калькульозного холецистити у ХЛ із застосуванням ЛХС та ЛХЛЕ.

Результати. Установлено невисокі показники чутливості та специфічності променевих методів діагностики щодо діаметра загальної жовчної протоки та кількості конкрементів у ній. Очищено жовчні шляхи від конкрементів методом сліпого тролінгу в 69,5 % хворих: при холедохотомічному доступі — у 81,1 %, при доступі крізь міхурову протоку — у 13,6 %. Додаткове застосування ЛХС із ЛХЛЕ забезпечило повне видалення каменів у 97,6 % хворих.

Висновки. При холедохолітіазі чутливість і специфічність променевих методів діагностики кількості конкрементів у загальній жовчній протоці становить для ультразвукового дослідження 41,4 та 92,7 % відповідно, для комп'ютерної томографії — 72,7 і 83,3 %, для магнітно-резонансної томографії — 86,7 та 60,9 % відповідно. Холедохоскопія в складі лапароскопічної холедохолітоекстракції була потрібна 18,9 % хворим при застосуванні холедохотомічного доступу і 86,4 % — при доступі крізь міхурову протоку, забезпечила вісунність конкрементів у жовчних шляхах у 97,6 % пацієнтів.

Ключові слова: холедохолітіаз, холедохоскопія, холедохолітоекстракція, механічна жовтяниця.

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Single-stage laparoscopic treatment of a cholecystoduodenal fistula with perforated small bowel ileus and fibrinous purulent peritonitis. A single case study

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Gallstone ileus is a rare complication of recurrent cholecystitis and one of the rarest causes of mechanical bowel obstruction, with an increasing incidence in the elderly. We present a case of multiple small bowel perforations of the jejunum due to gallstone obstruction and the incidental finding of high-grade appendiceal mucinous neoplasia of the appendix. To our knowledge, this is the first such case to be described and completely resolved by a laparoscopic approach.

An 83-year-old woman presented to our emergency department with severe vomiting, constipation, and deterioration of her general condition. A computed tomography scan revealed thickening of the gallbladder with a continuous aerobe to the duodenum, a mechanical obstruction of the small intestine at the transition to the ileum, and a thickened and calcified appendix. Due to a high suspicion of gallbladder perforation with the formation of a bilio-duodenal fistula, the patient underwent an emergency exploratory laparoscopy, which revealed a small bowel perforation in three segments with marked local fibrinous, purulent, and stercoral peritonitis of the left hemiabdomen. The gallstone was retrieved through the perforated small bowel, and a partial small bowel resection and a cecal wedge resection were performed laparoscopically. Small bowel continuity was restored with an anisoperistaltic side-to-side jejuno-jejunostomy. The patient was discharged on postoperative day eight.

Despite advances in imaging, gallstone ileus remains a diagnostic challenge. Because the disease occurs predominantly in elderly patients, gallstone ileus remains associated with high morbidity and mortality. It remains unclear from the literature whether the optimal surgical management of bilioenteric fistula is best resolved by a single-stage or a two-stage approach.

KEYWORDS

cholecystolithiasis, cholecystoenteric fistula, gallstone ileus, small bowel perforation, Rigler's triad.

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Gallstone ileus is a rare complication of cholecystolithiasis and one of the rarest causes of mechanical ileus, with an increasing incidence in those over 65 years of age, with females predominating at a ratio of 4:1 to 16:1 [25, 32, 37]. The terminal ileum with 60% and the jejunum with 16% are described as the most common localization of the occluding calculus. Rarer stone locations are the stomach, duodenum (Bouveret syndrome), and colon [32].

Diagnosis is often delayed because symptoms can be intermittent, and supportive care can mask the disease. This, in addition to the fact that the disease often affects the elderly, is the reason for the increased morbidity and mortality, which are between 10 and 20% [3, 29]. A national review from the United States by Halabi et al. of 3286 cases of gallstone ileus found an overall mortality rate of 6.67%. In the case of partial small bowel resection, the mortality

rate was 12.87 %, almost three times higher than enterolithotomy alone (4.94 %) [3, 13, 29].

Gallstone ileus was first reported in 1654 by the Danish physician and anatomist Thomas Bartholin during autopsies. A systematic review was performed in 1890 by the Swiss surgeon Ludwig Georg Courvoisier, and the first detailed German-language collection of experienced case reports was published in 1902 by the German surgeon Dr. H. Karewski in the journal «Deutsche medizinische Wochenschrift» [9, 22, 35]. It is clear that this disease is not associated with a typical history or symptoms. The diagnosis is complex, and the indication for surgery is difficult to establish. Only the X-ray examination and the subsequent computed tomography (CT) diagnosis showed a high sensitivity and specificity for the presence of a gallstone ileus, which can be documented by Rigler's triad of aerobilia, small intestinal ileus, and ectopic gallstone [17, 18, 31, 39]. The need for surgery is easier to deduce from this, although the decision to treat the bilioenteric fistula at the same time is still under discussion [2, 13, 26, 28, 30].

Patient symptoms and clinical findings

An 83-year-old woman presented as an emergency because of torrential vomiting, constipation, and deterioration of her general condition. She reported no bowel movements and a loss of appetite for 5 days. She would only tolerate water and recurrent, sometimes foul-smelling vomiting. Last in the early morning hours. Abdominal pain was denied. Except for arterial hypertension, the initial diagnosis of diabetes mellitus (HbA1c 6.7 %) and medication with metoprolol, other diseases, and operations were denied.

On clinical examination, the abdomen was soft with slight tenderness in the left lower quadrant. There were no signs of guarding or peritonism. Auscultation revealed high-pitched bowel sounds.

Sonography showed the typical picture of a small bowel ileus with a dilated small bowel, the rope ladder phenomenon, and pendulum peristalsis. The wall of the gallbladder (GB) could not be completely delineated and was filled with concretions. The patient reported that GB stones had been known for years and had not caused any problems. Laboratory chemistry showed elevated C-reactive protein 147 mg/dl (< 5.0 mg/dL), and slightly elevated gamma glutamyl transferase 47 U/L (< 40 U/L) and alkaline phosphatase 142 U/L (35–104 U/L). Leukocytosis, hyperbilirubinemia, and elevated transaminases and lactate dehydrogenase were not observed. Elevated renal retention parameters were measured with creatinine of 1.37 mg/dL (< 0.9 mg/dL), urea of 140 mg/dL (< 50 mg/dL), and a reduced glomerular filtration rate of 36.9 ml/min (> 68 ml/min) consistent with chronic ileus.

A CT scan of the abdomen with intravenous contrast was performed because of a suspected mechanical ileus with elevated inflammatory blood parameters.

An inhomogeneously thickened, only partially filled GB with hypodense gallstones, presumably up to 2 cm in size, and intraluminal air collections («aerobilia») were found. A continuous transition to the duodenum was highly suspicious for a covered perforation with the formation of a bilio-duodenal fistula (Fig. 1). There was no free intra-abdominal air, no perivesical fluid collection.

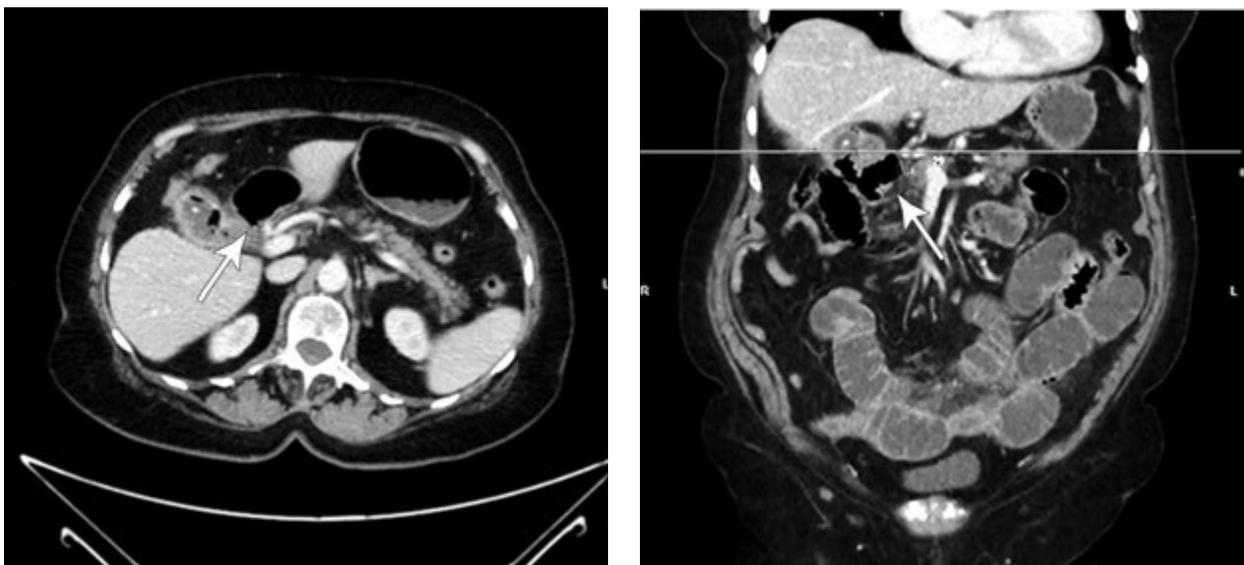


Figure 1. **Abdominal CT findings choleystoduodenal fistula** (cystoduodenal fistula and aerobilia are indicated by arrows)

Furthermore, there was an obstruction of the small intestine with a long segment of small intestine up to 3 cm wide («small intestinal ileus»). In the right mid-abdomen, not far from the right lower pole of the kidney, there was a jump in the caliber of the ileum with subsequent starvation bowel and a collapsed colonic frame (Fig. 2). In combination with the suspected perforation of the duodenum, there was at least the suspicion that a gallstone had passed through and was blocking the intestinal passage at this point («missing ectopic gallstone»). Unfortunately, the gallstones in this patient were barely radiopaque. Furthermore, a tumorous, calcifying mass

of the cecal pole or appendiceal base with a suspected mucocele differential diagnosis: cystadenocarcinoma was present (Fig. 3). An inflammatory correlate of the small intestine was not described. Thus, the CT image showed only two criteria of Rigler's triad; the ectopic GB stone could only be suspected indirectly. Despite the mild abdominal symptoms, we decided to perform exploratory laparoscopy due to increased inflammatory parameters and persistent inappetence with recurrent vomiting and lack of bowel movements. Antibiosis with ampicillin/sulbactam and metronidazole has already been initiated in the emergency room.

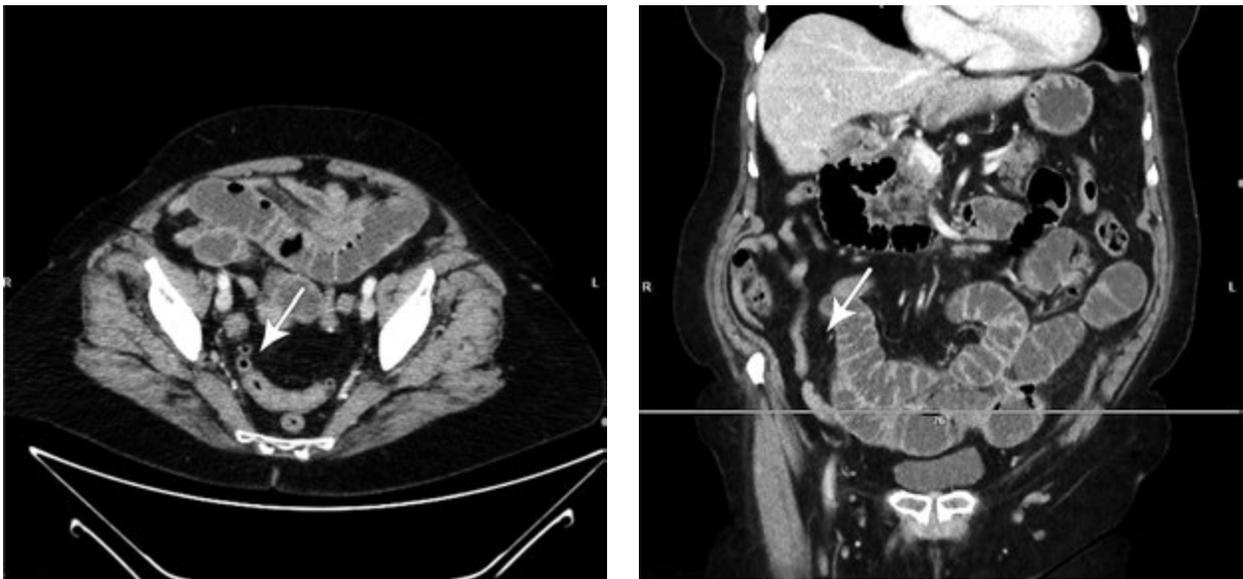


Figure 2. **Abdominal CT findings of small bowel ileus** (caliber leap of the proximal jejunum as indirect stone evidence, starvation bowel, small bowel ileus, and collapsed colonic frame are indicated by arrows)

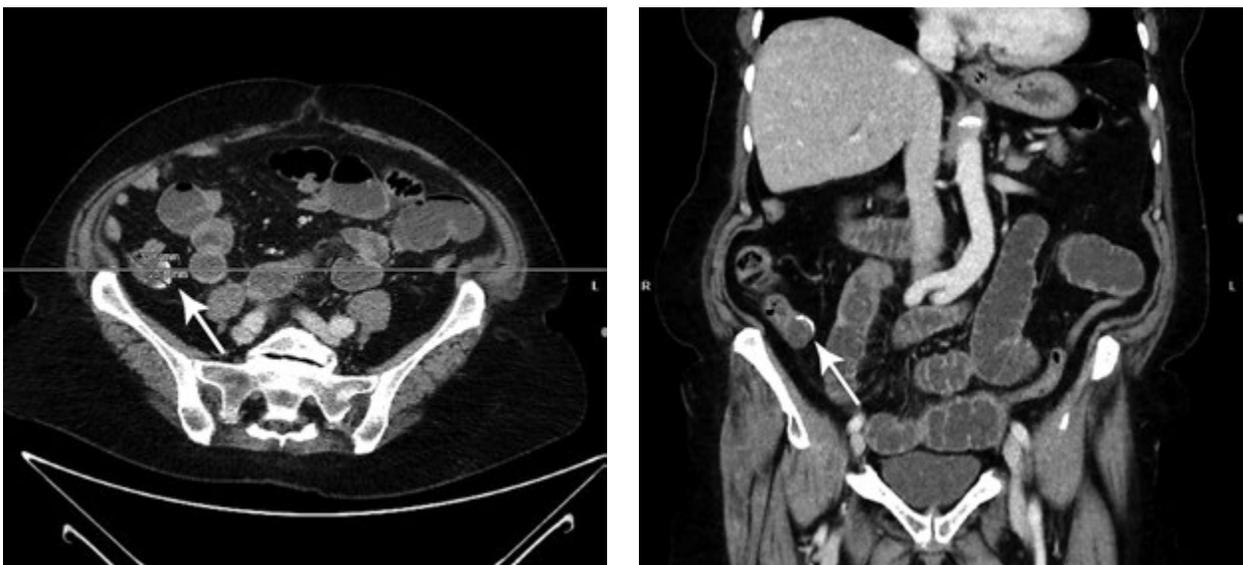


Figure 3. **Abdominal CT findings of suspicious appendiceal mass** (appendiceal mass are indicated by arrows)

Surgery and postoperative recovery

Intraoperatively, there was a small bowel perforation at three different sites within 15 cm with a marked localized fibrinous purulent incipient fecal peritonitis of the left hemiabdomen 160 cm from Treitz (Fig. 4–6). At first, no stone could be found. Only systematic instrumental palpation of the small intestine from the ileo-coecum to the ligament of Treitz revealed an occlusion of the distal jejunum with prestenotic dilatation by

a 2.0 × 2.5 cm GB stone 50 cm aboral to the devastating stone passage (Fig. 7). Resection of the coecum and extraction of the gallstone through the already perforated small bowel via minilaparotomy were followed by a partial small bowel resection of 30 cm of small bowel. Small bowel continuity was restored with an eaniso-peristaltic side-to-side jejunojunostomy. Extensive abdominal lavage and placement of a 24 Charrière drain in the left hemiabdomen were completed.

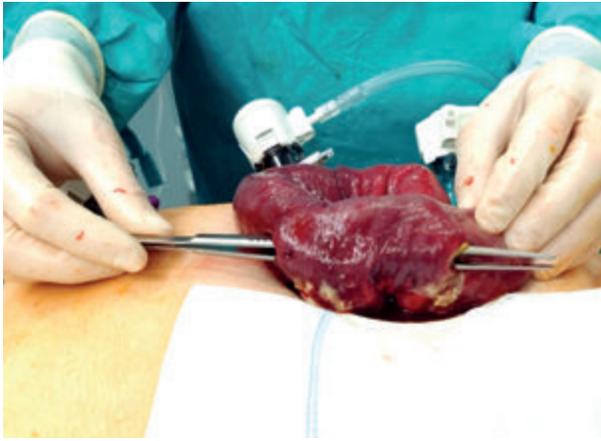


Figure 4. **Intraoperative finding of small bowel perforations** (surgical forceps in two perforation sites on the small intestine)



Figure 5. **Intraoperative finding small bowel perforation** (close-up perforation site is indicated by arrow)



Figure 6. **Third perforation site on opposite side with fibrinous purulent peritonitis** (surgical forceps in third perforation of the small intestine)



Figure 7. **Small ball with intraluminal gallstone 50cm after the last perforation of the small bowel** (specimen small bowel with gallstone 50 cm)

Because of the ileus, the patient remained in the intensive care unit for two days for monitoring and supportive therapy. The antibiotic therapy was in accordance with the antibiogram of *Raoultella ornithinolytica*, *Enterobacter cloacae* complex, *Atopodidium parvulum*, and *Streptococcus constellatus* cultured from the intra-abdominal specimen. The in-hospital esophagogastroduodenoscopy excluded a persistent enterobiliary fistula with normal mucosal findings up to the ligament of Treitz.

Pathology of the appendix revealed a high-grade appendiceal mucinous neoplasia pTis R0. The patient could be discharged on postoperative day 8 with an unremarkable course and a complete clinical recovery.

Discussion

The decision to perform a cholecystectomy should not be taken lightly, as the consequences of both having and not having the surgery can be severe and even fatal. In this particular case, the mortality rate is over 15 % due to the presence of ileus disease and a perforation of the small intestine resulting in purulent fibrinous peritonitis. Currently, health economics aims to reduce the number of cholecystectomies performed. However, pursuing this goal may lead us back to the 1990s, before the laparoscopic era, when procedures with fewer complications and shorter stays resulted in less hesitant indications for surgery. It is important to note that this approach carries a risk of significantly higher prevalence and associated morbidity and mortality from gallstone ileus, which can be triggered by recurrent, sometimes clinically occult, cholecystitis [4, 5, 16, 34, 36–38].

Gallstone ileus occurs in 0.15–1.5 % of cases with known cholelithiasis and is responsible for an obturation ileus in < 5 % of cases [13, 25, 29]

The recurrence rate is between 5–8 % [23] and occurs within 20–30 days in half of the cases [1, 10]. To our knowledge, only 13 cases with simultaneous small bowel perforation have been described in the literature [6, 12, 19–21, 24, 29, 33]. The enterolithotomy and repair of the perforation can rarely be solved laparoscopically. In our case, there was an unclear mass of the caecum and the base of the appendix, so an extensive median laparotomy would have been necessary. Therefore, in the case of overweight, we decided to first carry out the exploration laparoscopically, which is not undisputed, because a gallstone can easily be overlooked if there is no tactile possibility. Intraoperatively, there was devastating damage to the bowel due to the stone passage. Therefore, the decision to strive for a two-stage procedure was confirmed in order to get the

patient out of the life-threatening situation as quickly as possible. The one-stage procedure is associated with increased morbidity and mortality and is based on experience from a gallstone ileus alone and without small bowel perforation [13]. A single center analysis of 29 cases of cholecystenteric fistula with and without gallstone ileus from 2010 to 2021 showed a gallstone impact on the intestinal system in 12 cases, which led to an ileus. A small bowel perforation was not described in any case. Five patients underwent laparoscopic procedures, with three undergoing a laparoscopic enterolithotomy and two requiring conversion to an open enterolithotomy. An open procedure was chosen for the other 7 patients, and a one-stage procedure was performed in 4 cases, which was associated with an increased operating time, length of stay, and morbidity. There is no mortality in the patient pool. In the case of a cholecystoenteric fistula and gallstone ileus, the authors recommend first relieving intestinal obstruction and avoiding fistula closure until the patient is in better condition [14]. The working group of Gonzalez-Urquijo et al. came to the same conclusion; the significantly increased morbidity and mortality of the patients were decisive here [11]. The right procedure is still the subject of discussion today [15].

It is important to note that the persistence of a cholecystoenteric fistula carries the potential risk of retrograde cholecystitis and GB carcinoma [5, 7, 8, 38]. However, these are data from before the laparoscopic cholecystectomy era.

Nevertheless, in the majority of cases, there is a natural closure of the fistula opening, as was shown endoscopically in our case [27]. An increased carcinoma risk has not been described since then [1]. The relevant data was collected in the 1960s and 1970s. The number of cholecystectomies has increased significantly and therefore leads to such complications and malignant degeneration much less frequently. The question remains open as to whether the second treatment is actually necessary for our patient. Good surveillance of the patient and the high probability that she will survive the naturally healed fistula, along with an average current life expectancy of 83.4 years for women and another 9 years according to [1], the cohort life table in Germany, and the oldest documented patient being 76 years old when a recurrence occurred, most likely do not warrant repeat surgical intervention.

DECLARATION OF INTERESTS

All authors declare that there is no conflict of interest and that they have no financial ties to disclose.

ETHICS APPROVAL AND WRITTEN INFORMED CONSENTS STATEMENTS

Oral and written informed consent was obtained from the patient to publish the patient-related data in anonymized form.

AUTHORS CONTRIBUTIONS

C.R.D. Demtröder, M. Murnik: surgery, treatment, literature research, literature review and draft of the manuscript; D. Dajchin, U. Giger-Pabst: literature research, literature evaluation and critical revision of important contents of the manuscript.

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Одноетапне лапароскопічне лікування холецистодуоденальної фістули з перфорацією тонкої кишки та фібринозно-гнійним перитонітом. Дослідження окремого випадку

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Жовчнокам'яна кишкова непрохідність є рідкісним ускладненням холецистити, що рецидивує, та однією з найрідкісніших причин механічної кишкової непрохідності, яка частіше трапляється в осіб похилого віку. Описано випадок множинних перфорацій порожньої кишки внаслідок обструкції жовчними каменями і випадкового виявлення апендикулярної муцинозної неоплазії апендикса високого ступеня. Наскільки нам відомо, це перший описаний випадок досягнення повного одужання за допомогою лапароскопічного підходу.

Жінка, 83 роки, звернулася до нашого відділення швидкої медичної допомоги із сильним блюванням, запором, погіршенням загального стану. На комп'ютерних томограмах виявлено потовщення жовчного міхура, ураження, спричинені аеробною інфекцією до дванадцятипалої кишки, механічну непрохідність тонкої кишки в місці переходу в клубову, потовщений і кальцифікований апендикс. У зв'язку з високою підозрою на перфорацію жовчного міхура з утворенням жовчно-дуоденальної нориці хворій проведено екстрену експлораторну лапароскопію, яка виявила перфорацію тонкої кишки в трьох відділах з виразним локальним фібринозно-гнійним і каловим перитонітом лівої половини живота. Жовчний камінь було вилучено крізь перфоровану тонку кишку. Лапароскопічно виконано часткову резекцію тонкої кишки та клинову резекцію сліпої кишки. Безперервність тонкої кишки відновлено за допомогою анізоперистальтичної бічної єюноєюностомії. Хвору виписано на восьму добу після операції.

Попри прогрес у візуалізації, жовчнокам'яна кишкова непрохідність залишається діагностичною проблемою. Оскільки захворювання трапляється переважно в пацієнтів літнього віку, жовчнокам'яна кишкова непрохідність залишається пов'язаною з високою захворюваністю та смертністю. З джерел літератури не зрозуміло, який підхід є оптимальним для хірургічного лікування біліоентеральної нориці — одноетапний чи двохетапний.

Ключові слова: холецистолітаз, білідигестивна фистула (нориця), жовчнокам'яна кишкова непрохідність, перфорація тонкої кишки, тріада Рігlera.

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A clinical case of surgical treatment of appendiceal stump abscess

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In Ukraine, the share of patients with acute appendicitis is 89.1% of the total number of patients with acute surgical pathology. In modern surgical practice, early and late complications occupy the first place in the structure of acute surgical diseases of the abdominal organs, regardless of the age and gender of the patients, and the postoperative mortality is on average 0.15%. In the remote period after an appendectomy, despite the progress of modern surgery, a very rare complication known as inflammation of the stump of the appendix can occur.

The patient, 25 years old, turned to the department of purulent surgery with complaints of a «small wound» at the site of the postoperative scar in the right inguinal area and minor purulent discharge from it. Four months ago, in July, he was operated on for acute phlegmonous appendicitis. On November 1, after physical exertion, the wound reappeared, and on November 3, the patient independently sought a consultation at the reception department of the Clinical City Hospital No. 3. He was examined by a surgeon and hospitalized. During the revision of the wound, a tumor-like formation measuring 2.5 × 3.0 × 2.5 cm, as well as the parietal peritoneum, was revealed. Appendectomy was performed by the method of pouch ligation with drainage of the abdominal cavity through a separate contraperture with polyvinyl chloride drainage. After the operation, a diagnosis was established: abscess of the stump of the appendix, and external fistula of the anterior abdominal wall. The postoperative wound healed with primary tension, and the sutures were removed.

The diagnosis of appendicitis may be mistakenly excluded from the clinical search due to the presence of a postoperative scar after appendectomy. A clear clinical picture of acute appendicitis or the opening of a fistula at the site of a postoperative scar in the right iliac region indicates the need for a computer tomography of the abdominal organs with contrast to establish an accurate diagnosis and choose the correct treatment tactics. The only treatment for inflammation of the appendiceal stump is a complete appendectomy with appendix removal either by open or laparoscopic surgery, which should be performed urgently to avoid further complications.

KEYWORDS

appendectomy, stump appendicitis, intra-abdominal abscess, surgical treatment, diagnostics.

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In Ukraine, acute appendicitis (AP) accounts for 89.1% of the total number of patients with acute surgical pathology. In modern surgical practice, early and late complications take the first place in the structure of acute surgical diseases of the abdominal cavity, regardless of the age and gender of the patients, and the postoperative mortality rate is 0.15% on average [1, 2]. In the long run, following an appendectomy, despite the advancements in modern surgery rare and infrequent complication known as

inflammation of the appendiceal stump might occur. Few surgeons have ever encountered this in their practice. Even at the dawn of surgical treatment for acute appendicitis, surgeons of that time wrote about this pathology in their works. 48 clinical cases of this pathology have been reported in the contemporary medical research literature [3, 5, 6].

Postoperative complications present a challenge in abdominal surgery as they interfere with predicting the course and the surgical treatment of

abdominal emergencies. According to O. S. Balogun et al. (2019) [4], their number is 28.5 %, with such complications as suppuration of the surgical wound in 18.6 %, wound dehiscence in 15.2 %, and intra-abdominal abscess in 13.5 % of patients.

Clinical case

A 25 y.o. male patient presented to the Department of Purulent Surgery complaining of a «small wound» at the site of the postoperative scar in the right inguinal area and minor purulent discharge from it.

According to the anamnesis, he underwent surgery for acute phlegmonous appendicitis four months ago. The early postoperative period was uneventful. On the fifth day, he was discharged in satisfactory condition. The postoperative wound healed with primary tension, and the sutures were removed on the seventh day. The patient reported that two months after the surgical treatment, a «small wound» «opened» for no apparent reason at the site of the postoperative scar, and there was also minor purulent discharge from it. That was the cause of his appointment with the surgeon at the polyclinic. The ligature was removed during a wound revision procedure. A ligature fistula at the site of the postoperative scar was diagnosed. The application of dressings, drainage of the wound with an antiseptic Decametoxinum, and oral administration of Lefloxacin 500 mg promoted wound healing by secondary tension. On November 1, after physical exertion (playing football), the wound appeared again, and on November 3, the patient independently sought consultation with the Department of Purulent Surgery at Kyiv City Clinical Hospital No. 3, where he was examined by a surgeon and hospitalized.

On examination, from the side of the digestive organs, there is no pathology. Auscultation and percussion are unchanged. A digital rectal examination shows no pathology

The right inguinal area has a postoperative scar but no signs of perifocal inflammation. In the lower third, there is a fistula tract up to 0.1 cm with a minor purulent discharge. Skin hyperemia and edema is absent, as is pain syndrome during palpation, and there are no signs of peritoneal irritation. A ligature fistula at the site of the postoperative scar is initially diagnosed.

To prepare for the surgical procedure, the patient underwent clinical and laboratory examinations. CDC on November 3: HB – 148 g/l, glucose – 5.2 mmol/l, leukocytes – $6,7 \cdot 10^9/l$, rod cells – 4 %, segment cells – 70 %, eosinophils – 1 %, lymphocytes – 24 %, monocytes – 1 %.

According to the ultrasound of the abdominal cavity, in the right iliac region, in the projection of

the postoperative scar at a depth of up to 3.5 cm, a hyperechoic formation measuring 1×1.5 cm with clear contours is visualized. Free fluid is not detected. X-ray of the organs of the abdominal cavity with identification of the fistula tract with sodium amidotrizoate contrast: free gas and Kloiber's cups are not detected; an accumulation of contrast in the form of a «mace» is noted, with a high probability in the abdominal cavity in the right iliac fossa (Fig. 1).

Based on the results of the instrumental research methods, the patient was prescribed a CT scan with contrast enhancement to confirm or exclude the localization of the pathological process in the abdominal cavity and to determine the extent of the surgical treatment (Fig. 2).

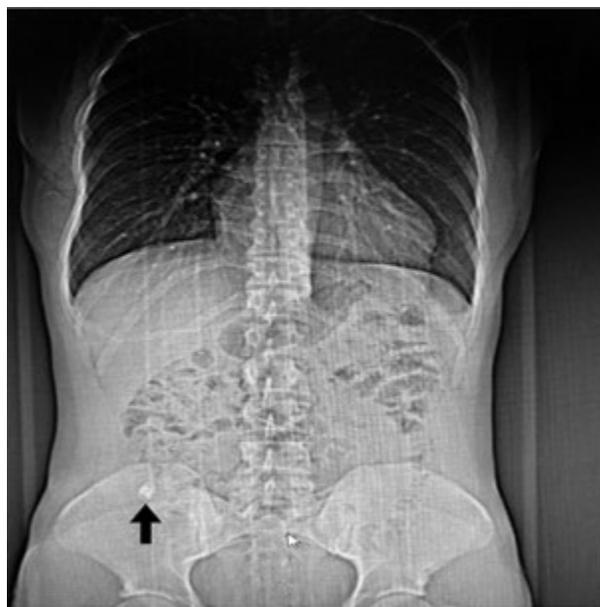


Figure 1. X-ray of the abdominal organs with fistula contrast with an iodine-containing radiopaque agent



Figure 2. CT of the organs of the abdominal cavity with contrast enhancement

The blue arrow in the photo indicates the skin defect and the external opening of the fistula. The red arrow in the photo indicates the accumulation of contrast in the right iliac fossa, and the radiologist's conclusion led the diagnosis of an abdominal abscess.

On November 4, the patient underwent surgical treatment following diagnostic procedures. After treatment of the operative field, the postoperative scar was excised together with the fistula tract to the aponeurosis. The abdominal cavity was opened in layers. The wound revision showed a tumor like formation measuring $2.5 \times 3.0 \times 2.5$ cm with even margins of a dense consistency fused with the dome of the cecum, and the parietal peritoneum was revealed too. As a result of the separation of the formation up to 3.5–4.0 cm, the appendiceal stump, which was located subserosally in the wall of the cecum, was found (Fig. 3).

Removal of the appendiceal stump was performed by the purse-string ligation method abdominal cavity drainage through a separate contraperture with polyvinyl chloride tube drainage.

After the surgery, a diagnosis was determined: an abscess of the appendiceal stump and an external fistula of the anterior abdominal wall.

Therapy was prescribed in the postoperative period for 3 days: Moxifloxacin 400 mg intravenously once a day; Enoxaparin sodium 0.3 subcutaneously once a day; Pantoprazole 40 mg intravenously once a day; and Dexketoprofen 50 mg IV 3 times a day. The drain was removed on the second day.

Treatment outcomes

The patient was discharged for outpatient treatment on the fifth day after the operation. On the eighth day, he was examined in the hospital; the postoperative wound healed with primary tension, and the stitches were removed. The patient had follow-up exams at 6 and 12 months post-surgery, including an abdominal cavity ultrasound (no pathology).

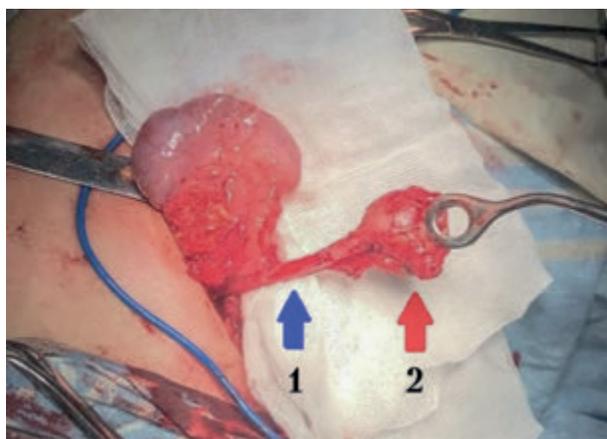


Figure 3. **Immobilized «long» appendiceal stump:**
1 — stump itself, 2 — stump abscess

Discussion

Although appendectomy is the most used and frequent surgical operation in the world, it still does not exclude the possibility of complications in the postoperative period [1, 2]. One of the rarest complications of this operation is the formation of an abscess of the appendix stump. According to Truty MJ, [8] the condition is accompanied by clinical appendicitis in patients with a history of appendectomy. This can lead the surgeon to make the wrong decision. After all, he is sure that the patient's appendix has already been removed. In the scientific medical literature, there is no clear definition of the etiology of the formation of an abscess in the stump of the appendix. According to Kurt E. Roberts [7], there are two main intraoperative factors for the occurrence of stump appendicitis: 1) incorrect identification of the appendix; 2) incomplete removal of the appendix, that is its resection. In general, the main hypotheses for the occurrence of this pathology are: less often — poor surgical technique (ignorance of the basic aspects of appendectomy), more often — the choice of incorrect patient management tactics (dense appendicular infiltrate, in which it is technically impossible to perform a full appendectomy). It is these two aspects, in our opinion, that encourage surgeons to perform resection of the appendix, which subsequently creates the risk of an abscess of the appendix stump. In most cases, patients have an acute appendicitis clinic, which allows for a better diagnosis of the patient's condition and a diagnosis of appendix stump abscess.

Authors such as Kurt E. Roberts et al. [7] suggest performing a CT scan of the abdominal wall and cavity to determine the exact size and location of the appendix or its stump.

The diagnosis of AP can be mistakenly excluded due to the presence of a postoperative scar after an appendectomy. A clear clinical pattern of acute appendicitis or a fistula opening at the site of the postoperative scar in the right iliac region directly indicates the need for a contrast-enhanced CT of the abdominal cavity. A full-scale appendectomy by open or laparoscopic surgery is the only method for managing an inflamed appendiceal stump.

Compliance with the basics of deontology, such as accurate medical recording and informing patients about intraoperative issues or difficulties, is also important for facilitating diagnosis and further treatment.

Conclusions

Inflammation of the «long» appendiceal stump remains a potential complication in the long run after appendectomy.

The diagnosis of AP can be mistakenly excluded due to the presence of a postoperative scar after an appendectomy. A clear clinical pattern of acute appendicitis or a fistula opening at the site of the postoperative scar in the right iliac region directly indicates the need for a contrast-enhanced CT of the abdominal cavity.

A full-scale appendectomy by open or laparoscopic surgery is the only method for managing an inflamed appendiceal stump.

DECLARATION OF INTERESTS

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AUTHORS CONTRIBUTIONS

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Опис клінічного випадку хірургічного лікування запалення кукси червоподібного відростка

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В Україні на частку пацієнтів з гострим апендицитом припадає 89,1% від загальної кількості хворих із гострою хірургічною патологією. У сучасній хірургічній практиці ранні та пізні ускладнення посідають перше місце в структурі гострих хірургічних захворювань органів черевної порожнини незалежно від віку та статі хворих, а післяопераційна летальність становить у середньому 0,15%. У віддалений період після апендектомії, незважаючи на прогрес сучасної хірургії, може виникнути дуже рідкісне ускладнення, відоме як запалення кукси червоподібного відростка.

Хворий, 25 років, звернувся до відділення гнійної хірургії зі скаргами на «дрібну ранку» на місці післяопераційного рубця в правій пахвинній ділянці та незначні гнійні виділення з неї. Чотири місяці тому, в липні, прооперований з приводу гострого флегмонозного апендициту. Першого листопада після фізичного навантаження рана виникла повторно, а 3 листопада пацієнт самостійно звернувся на консультацію до приймального відділення клінічної міської лікарні № 3. Оглянутий хірургом і госпіталізований. При ревізії рани виявлено пухлиноподібне утворення розміром 2,5 × 3,0 × 2,5 см, а також пристінкову очеревину. Апендектомію виконано методом кисетної перев'язки з дренажуванням черевної порожнини окремою контрапертурою з полівінілхлоридним дренажем. Після операції встановлено діагноз: абсцес кукси червоподібного відростка, зовнішня нориця передньої черевної стінки. Післяопераційна рана зажила первинним натягом, шви знято.

Діагноз апендициту може бути помилково вилучений з клінічного пошуку через наявність післяопераційного рубця після апендектомії. Чітка клінічна картина гострого апендициту або відкриття нориці на місці післяопераційного рубця в правій здухвинній ділянці вказує на необхідність проведення комп'ютерної томографії органів черевної порожнини з контрастуванням для встановлення точного діагнозу та обрання правильної лікувальної тактики. Повноцінна, апендектомія з видаленням червоподібного відростка, апендектомія відкритим хірургічним шляхом або лапароскопічно є єдиним методом лікування запалення кукси червоподібного відростка та має проводитись в ургентному порядку для уникнення подальших ускладнень.

Ключові слова: апендектомія, абсцес кукси апендикса, внутрішньочеревний абсцес, хірургічне лікування, діагностика.

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Nutritional support in patients with acute pancreatitis. Review of published studies

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Acute pancreatitis is a common disease that occurs in 5–10% of patients with urgent pathology of the abdominal cavity. The most prevalent metabolic disorders affecting this group of patients are hypermetabolism and hypercatabolism syndromes, which are accompanied by excessive consumption of carbohydrates, fats, and amino acids, increased oxygen intake, and carbon dioxide production.

OBJECTIVE — to analyse the current state of the problem of nutritional support for patients with acute pancreatitis. The degree of nutritional disorders in patients with acute pancreatitis varies depending on the etiological factors and severity of the disease, necessitating a differential approach to their correction. Patients with acute pancreatitis experience disruption of the intestinal microflora due to the antibiotic therapy, nutrient and fiber deficiency, and lack of microbial antagonism. This disruption leads to excessive growth of bacteria, particularly gram-negative microflora. The effectiveness and safety of enteral tube feeding are determined by a complex of factors: the timing of recovery of peristalsis and the absorption function of the intestinal wall, the type of mixture, and the method of its administration. Restoration of intestinal absorption in patients with severe acute pancreatitis occurs on average 48 hours after the start of complex conservative therapy. The use of antifoatulents as part of a mixture for enteral nutrition allows to improve the laboratory indicators of blood serum and reduce the frequency of intestinal complications on the 7th day by 21.5% ($\chi^2=4.88$, 95% CI 2.3–39.5, $p=0.03$). Nasogastric nutritional support in patients with severe acute pancreatitis is safe and leads to a 25.8% reduction in the incidence of local infectious complications ($\chi^2=4.59$, 95% CI 2.43–45.53, $p=0.03$), length of hospital stay by 16 days ($p=0.04$), and deaths by 21.4% ($\chi^2=4.13$, 95% CI 0.81–39.68, $p=0.04$) in comparison with parenteral nutrition. Nutritional support should be started with nasogastric administration of a food mixture, and in case of complications (intolerance, aspiration, etc.), nasojejunal administration. Parenteral nutrition should be used if enteral nutrition is impossible or not tolerated.

KEYWORDS

acute pancreatitis, nutritional support, enteral nutrition, complications.

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Acute pancreatitis (AP) is a widespread disease that occurs in 5–10% of patients with urgent pathology of the abdominal cavity [39]. According to the revised classification of AP (Atlanta, 2012), which was proposed by the «Acute Pancreatitis Classification Working Group», three degrees of severity of the course of the disease are distinguished: moderate (mild), moderate and severe, while in the general structure of the disease, severe AP occupies from 10% to 20%, accompanied by a high risk of complications (up to 50%) and deaths (40–70%) [9, 11]. The most prevalent metabolic disorders affecting patients with AP are hypermetabolism and hypercatabolism syndromes, which are accompanied by excessive

consumption of carbohydrates, fats, and amino acids as energy substrates, a significant increase in oxygen intake and carbon dioxide production, and increased nitrogen loss with urine [21]. In turn, the goal of nutritional support in patients with AP is prevention of catabolic processes, correction of negative nitrogen balance, reduction of inflammation, and improvement of treatment results [61]. Despite the publication of a large number of studies devoted to the nutritional support of patients with AP, this topic remains debatable among practicing doctors, the vast majority of whom continue to adhere to the principle of the need for complete restriction of enteral nutrition (EN) (starvation) in this category of patients [13, 62].

OBJECTIVE – to analyse the current state of the problem of nutritional support for patients with acute pancreatitis.

The review of articles on AP published up to November 2023 in the PubMed, Web of Science, and EMBASE databases was carried out using the specific search terms «acute pancreatitis», «nutritional support», «enteral nutrition», and «complications». Qualitative and quantitative data were obtained through iterative interpretation of each article. This prevented the loss of potentially valuable information.

Pathophysiology of metabolic disorders in patients with acute pancreatitis

The occurrence of hypermetabolism and hypercatabolism syndromes in patients with AP is primarily associated with the release of pro-inflammatory cytokines, which leads to an increase in energy consumption and basic metabolism, which depend on both the severity of the course and the duration of the disease [21, 50]. Thus, in case of sepsis, as a complication of AP, in 80 % of patients there is an increase in protein catabolism and an increase in nutritional needs [47]. In turn, a long-term negative nitrogen balance leads to the deterioration of the course of AP and increases the risk of fatal cases [45].

Focusing on glucose metabolism in patients with AP, it should be noted that it is associated with both increased energy needs and damage to the cells of the islets of Langerhans. As a result of a complex metabolic reaction to the inflammatory process in the pancreas and surrounding tissues, endogenous glyconeogenesis increases [18]. In turn, exogenous glucose is an important source of energy, but it can only partially counteract the increase in glyconeogenesis and the destruction of proteins in response to inflammation. At the same time, the introduction of a large amount of glucose can cause an increase in oxygen consumption and carbon dioxide production and be one of the causes of acute respiratory failure. In addition, the occurrence of hyperglycemia is possible, which deepens metabolic disorders and is an aggravating factor in the risk of infectious complications [16, 34].

According to literature data, with the development of hypermetabolism syndrome in patients with AP, energy consumption can increase by 77–158 % [1]. When calculating nutritional support, it is recommended to take into account the following consumption norms [2]:

- energy consumption in the amount of 25–35 kcal/kg of body weight/day;
- consumption of carbohydrates – 3–6 g/kg of body weight/day (blood serum glucose concentration should not exceed 10 mmol/L);

- protein consumption – from 1.2 to 1.5 g/kg of body weight/day (requires correction in the development of acute kidney or liver failure);
- fat consumption – 2 g/kg of body weight/day (the blood serum triglyceride level should not exceed 12 mmol/L).

Pathogenetic features of the occurrence of purulent-septic complications in patients with acute pancreatitis and their connection with enteral nutrition

Special consideration should be given to the latest studies on the problem of infected necrotic foci and the development of the systemic inflammatory response syndrome (SIRS) in acute aseptic necrotic pancreatitis. Thus, microbial translocation from the lumen of the small intestine is considered to be one of the causes of infection of necrotic foci. This phenomenon was first described by Durwarding in 1881 [41]. In turn, R. Berg defines translocation as «the passage of viable bacteria and their toxins from the gastrointestinal tract through the mucous membrane to the surrounding tissues of the body (in the mesenteric lymph nodes, circulatory system, liver, and spleen)» [59]. There is also research devoted to the study of microbial translocation from the lumen of the small intestine in the etiopathogenesis of multiple organ failure syndrome (MODS) in critical conditions [29].

The main factors that ensure the barrier properties of the intestinal mucosa include an intact epithelial layer, the presence of lymphocytes, macrophages, and neutrophils produced in «Peyer's plaques» and located in the submucosal layer, and a normally functioning lymphoid tissue system associated with the intestine (gut-associated lymphoid tissue, or GALT) [65].

The barrier properties of the intestinal mucosa can be compromised due to the following factors [60, 66]:

- inadequate perfusion (microcirculation) and oxygenation of organs of the gastrointestinal tract;
- excessive bacterial growth;
- long-term lack of nutrients in the lumen of the gastrointestinal tract (enterocytes are fed directly from the chyme);
- impairment of local and general immunity.

These factors lead to the infection of necrotic foci and the development of purulent-septic complications, SIRS, and MODS [12]. The main causes of intestinal ischemic disorders in AP are: systemic toxic effects of inflammatory mediators (free peroxide radicals, cytokines, activated neutrophils), systemic intestinal blood supply disorders (arterial hypotension, centralization of blood circulation,

decreased cardiac output), microcirculation disorders due to excessive release of cytokines and vasoactive substances, and elastase activation (Fig. 1) [59]. Ischemia leads to anaerobic metabolism, acidosis, and a decrease in the energy reserves of cells, which leads to irreversible changes. These changes occur quickly, and on the 4th day after the onset of the disease, atrophy of the intestinal mucosa and lymphoid tissue develops [49]. Morphological examination of the intestinal mucosa reveals exfoliation of necrotic enterocytes and the formation of erosions and ulcers, i.e., inflammation of the mucosa, which aggravates the phenomenon of bacterial translocation. This is also facilitated by general immunosuppression, microcirculation disorders, and excessive bacterial contamination as a result of dysbacteriosis, which may worsen with the use of antibiotic therapy [56].

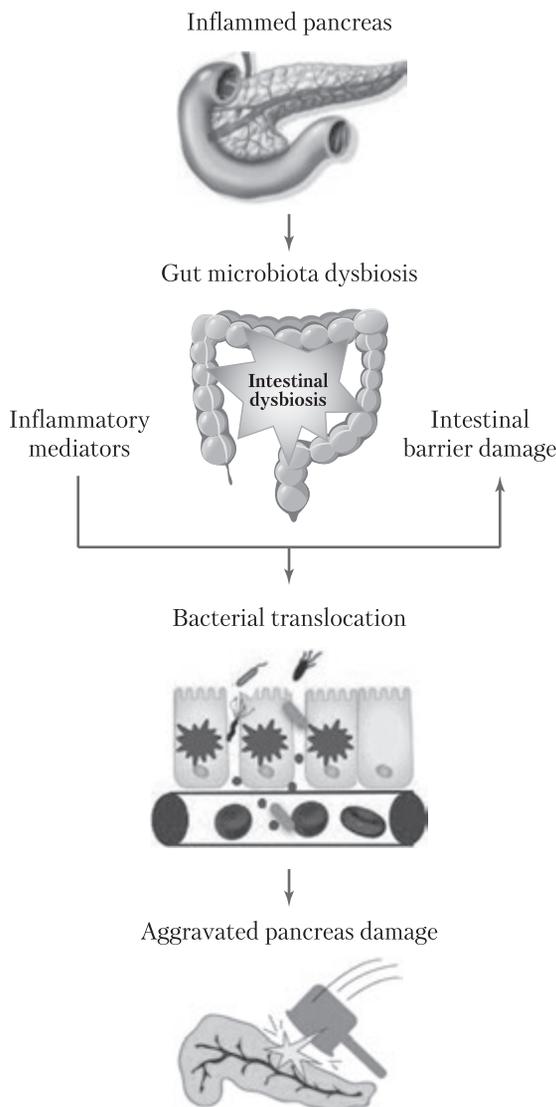


Figure 1. **The relationship between acute pancreatitis and gut microbiota** [28]

In inflammatory bowel diseases, there is an immunological imbalance characterised by increased production of pro-inflammatory cytokines (IL-6, IL-12) and decreased synthesis of anti-inflammatory cytokines (IL-4, IL-10, IL-11), resulting in an aggressive immune response to normal intestinal microflora [63].

The migration of bacteria through the intestinal wall is influenced by the number of microorganisms and the stability and competitiveness of the microflora. Normally, intestinal bacteria, together with the epithelium, form a natural protective barrier against exogenous microorganisms. With AP, the stable balance of the intestinal microflora is disrupted due to antibiotic therapy, a deficit of nutrients and fibre, and a lack of inter-microbial antagonism, leading to excessive bacterial growth and an advantage in the microbial population of gram-negative microflora [62]. This increases the risk of microbial translocation and the occurrence of purulent-septic complications [51].

In modern literature, there are many clinical studies according to which EN prevents degenerative changes in the intestinal mucosa, contributes to the normalisation of the immune response, and improves the state of the immune system as a whole [35]. As previously stated, fluid sequestration causes a reduction in the volume of circulating blood in patients with AP. In this case, intestinal ischemia occurs, which leads to a decrease in the energy potential of enterocytes and the activation of lipid peroxidation. The cells of the intestinal mucosa are deprived of energy substrates and the ability to maintain intercellular contacts. In turn, the entry of the nutrient mixture into the intestines increases both mesenteric blood circulation and the energy potential of enterocytes [36].

Thus, EN effectively restores the body's energy and plastic needs, is physiological, prevents atrophic processes, and improves the barrier characteristics of the intestinal mucosa.

Peculiarities of enteral nutrition in patients with acute pancreatitis

Although the administration of glucose, proteins, and lipids is a necessity for patients with AP, EN has long been considered dangerous because of possible stimulation and increased secretory activity of pancreatic cells. However, it has now been proven that the introduction of glucose or food mixtures containing amino acids and lipids into the small intestine is well tolerated by patients with AP and causes weak stimulation of pancreatic cells [44, 54].

It should be noted that the intravenous administration of carbohydrates, proteins, and fats also does not cause an increase in the secretory activity of pancreatic

cells, and in the case of the administration of protein hydrolyzate, the effect of their suppression occurs. However, with intravenous administration of glucose in patients with a severe course of AP, there is a risk of hyperglycemia due to insulin resistance, which is observed in patients with critical conditions [64].

The disadvantages of using parenteral nutrition in patients with AP are [26]:

- the need to transfuse large volumes of fluid, which is not always possible in elderly patients and in patients with severe concomitant (cardiovascular and pulmonary) pathology;
- patient's hypersensitivity to different components in the solutions for parenteral nutrition;
- the risk of phlebitis, thrombosis, embolism, and angioenic sepsis;
- the risk of developing hyper- and hypoosmolar conditions and aggravation of acid-alkaline balance disorders;
- trophic and degenerative changes in the intestines, suppression of normal flora, bacterial contamination.

Notwithstanding the aforementioned challenges in facilitating access for EN, the introduction of a food mixture into the gastrointestinal tract is currently regarded as the most justifiable course of action.

The effectiveness and safety of EN in patients with AP depend on a complex of factors: the type of mixture, the method of administration of the mixture, the timing of recovery of peristalsis, and the absorption function of the intestinal wall.

Depending on their composition and energy value, mixtures for EN are classified as [30]:

- standard isocaloric mixtures (correspond to daily needs under normal conditions with the preserved function of the gastrointestinal tract);
- hypercaloric mixtures (contain an increased number of proteins and energy with a limited amount of liquid);
- mixtures with increased protein content, enriched with trace elements, glutamine, arginine, and omega-3 fatty acids (indications for use are critical and immunodeficient states);
- mixtures with a low content of fats and carbohydrates, containing dietary fibres (prescribed for patients with diabetes);
- mixtures with high fat content and low carbohydrate content (prescribed for lung function disorders at the stage of decompensation);
- mixtures with a low content of aromatic amino acids and an increased content of amino acids with a branched chain (prescribed for liver failure);
- oligomeric mixtures containing dipeptides, tripeptides, and several amino acids (prescribed for disorders of the gastrointestinal tract);

- immunostimulating hypocaloric mixtures with increased glutamine content (prescribed in critical conditions).

Depending on their formula, polymer mixtures (containing elements of whole protein, partially split starch, triglycerides, vitamins, macro- and microelements) are distinguished from semi-elemental and elemental mixtures (containing short peptides, crystalline amino acids, dextrose, oligosaccharides, essential fatty acids, and medium-chain triglycerides) [46]. It should be noted that for the absorption of polymer mixtures, their enzymatic processing in the intestines is necessary, while semi-elemental and elemental ones are already pre-hydrolyzed. Thus, polymer mixtures include *Nutrilan* (Germany), *Nutrison* (Holland), *Nutren 1.0* (Switzerland), *Isocal* (Netherlands), and others (the osmolarity of the mixtures is 380 mosm/L, pH 6, 8). Semi-elemental and elemental include *Peptamen* (Switzerland), *Rebabilan* (USA), *Alfare2* (Switzerland), *Pepli-2000* (Netherlands), and others (the osmolarity of the mixtures is 315 mosm/L, pH 7.6) [3].

Numerous studies are currently comparing the effects of elemental, semi-elemental, and polymer mixtures used in the enteral nutrition of patients with AP [43]. As a rule, the authors prefer semi-elemental and elemental mixtures, explaining this by the fact that these mixtures cause less stimulation of the pancreas. This is due to the low fat content and the presence of free amino acids instead of intact proteins, which bind to free trypsin in the intestine and cause both a decreased level of trypsin and acidity in the stomach. However, according to the results of other studies, any type of food mixture introduced into the gastrointestinal tract causes a certain stimulation of the pancreas [37]. However, according to other publications, using polymer combinations rather than semi-elemental or elemental mixtures does not raise the risk of infectious complications or mortality in patients with AP [3, 4].

Some attention is paid to the gastrointestinal tract, where the food mixture is introduced. EN can be done through a tube inserted into the stomach, duodenum, or small intestine [7, 13]. There are also operative techniques for applying a gastro- or jejunostomy by an open or laparoscopic approach [53, 62]. It should be noted that probes with a large diameter can create significant discomfort for the patient, while probes with a small diameter often become impenetrable. Endoscopic techniques for inserting food probes have become popular in recent years. However, in the first 24 hours after endoscopic nasointestinal probe fitting, 15–25% of patients experience dislocation of the latter in the shunt [5]. There is also conflicting evidence regarding the

feasibility of nasogastric tube feeding. There are a number of contraindications to the nasogastric administration of food mixtures: the presence of large gastric residual volumes (over 500 mL/6 hours), abdominal pain or vomiting due to delayed gastric emptying, and the inability to meet the patient's energy needs within 72 hours from the start of enteral nutrition (< 70 % based on 25 kcal/kg of body weight during hospitalisation) [42, 43]. Some authors indicate that the introduction of a mixture for enteral nutrition into the stomach or duodenum leads to stimulation of pancreatic secretion and increases the risk of aspiration pneumonia (observed in 6–8 % of patients) [33] and respiratory failure (observed in 25.8 % of patients. The assessment was carried out according to the Marshall scale: $\text{PaO}_2/\text{FiO}_2 < 300$ mm Hg, score ≥ 2) [31].

Traditionally, it is believed that the introduction of the mixture into the cavity of the small intestine 20–120 cm distal to the ligament of Treitz does not cause a stimulating effect on the pancreas (it is possible to avoid the cerebral, gastric, and intestinal phases of secretion, but the synthesis of secretin and cholecystokinin-pancreozymin is inhibited [37, 38]. At the same time, the statement about creating «rest for the pancreas» in AP is currently being revised [52]. It has been suggested that despite inflammation and/or necrotic changes, the pancreas continues to produce enzymes in response to stimulation. However, animal studies in the experimental modelling of AP showed that the exocrine secretion of the pancreas is inhibited when inflammation occurs, even when stimulated by cholecystokinin [20]. Other studies indicate inhibition of trypsin synthesis in patients with AP, especially in the case of acute necrotizing pancreatitis, but the rate of appearance of newly synthesised trypsin remains unchanged [37, 38, 48].

Hence, the lack of deterioration in the health status of individuals with AP who are administered EN can be explained by the decreased pancreatic response to food mixtures and the reduced secretory response to basal indicators.

At the same time, there are studies that prove the absence of a reliable difference in the frequency of complications and deaths when using the nasogastric or nasojejunal method of introducing a mixture for nutrition in patients with AP [27].

In our clinic, a study was conducted comparing the effectiveness and safety of nasogastric feeding mixtures in patients with a severe course of AP [22]. According to the results of the study, it was established that the provision of nasogastric nutritional support in patients with a severe course of AP leads to a decrease in the frequency of local infectious complications by 25.8 % ($\chi^2 = 4.59$; 95 %

CI 2.43–45.53; $p = 0.03$), the duration of multiple organ failure by 3.1 days ($p < 0.001$), the duration of hospital stay by 16 days ($p = 0.04$), and deaths by 21.4 % ($\chi^2 = 4.13$; 95 % CI 0.81–39.68; $p = 0.04$) in comparison with parenteral nutrition. In addition, no significant difference was found between the frequency of occurrence of local infectious complications and deaths, the duration of MODS, and the length of stay of patients in the hospital when comparing nasogastric and enteral administration of food mixtures in patients with a severe course of AP.

There are also many studies devoted to the timing of the introduction of food mixtures in patients with AP. Thus, according to modern views, enteral nutrition should be started as early as possible (24–72 hours from the moment of hospitalisation) compared to parenteral nutrition [19]. Early onset of EN (up to 48 hours from the moment of hospitalisation) in patients with a severe course of AP is associated with a decrease in the frequency of infectious complications by 24 % and mortality by 32 % [18, 55]. However, today there are no clear criteria for the onset of EN in this category of patients. Thus, some authors emphasise that factors that indicate the possibility of starting the administration of enteral mixtures are the appearance of peristalsis and a decrease in intra-abdominal pressure below 10 mm Hg [10]. At the same time, it should be noted that restoration of intestinal absorption can occur at a later time, and this is dangerous due to the occurrence of a number of complications [40, 55]:

- disorders of the gastrointestinal tract in the form of nausea, vomiting, occurrence of gastroesophageal reflux, gastrointestinal bleeding, and increased pain (occurs in 30–38 % of patients);
- the occurrence of injuries of the upper parts of the gastrointestinal tract and respiratory tract with the development of rhinitis, pharyngitis, esophagitis, pulmonary aspiration, erosions and perforation of the esophagus, displacement, and obliteration of the feeding probe (2–10 %);
- occurrence of infectious complications in the form of parotitis, otitis, sinusitis, aspiration *pneumonia*, and microbial contamination (6–8 %);
- aggravation of metabolic disorders in the form of disturbances in the metabolism of calcium, magnesium, phosphorus, fluid balance, occurrence of hyperosmolar states, hyper- or hypoglycemia (10–15 %);
- occurrence of intestinal complications in the form of large residual volumes – 39 %, diarrhea – 14.7 %, flatulence – 13.2 %, vomiting – 12.2 %, regurgitation – 5.5 %.

Early use of EN in patients with AP can also cause the emergence of digestive and dynamic types of increased gas formation in the gastrointestinal tract

[58]. This is explained by the fact that the introduction of a mixture for nutrition can cause an imbalance between the bacteria that participate in the production of gases and their absorption. In turn, the combination of maldigestion and malabsorption syndromes and reflex suppression of intestinal motility against the background of AP lead to a disorder of gas transportation and absorption [15]. Liquid fecal masses, which are located in the intestines and contain various organic compounds consisting of proteins, fats, and carbohydrates, contribute to the formation of a large number of bubbles of various diameters, surrounded by mucus (foam). The bubbles cover the epithelial layer of the intestinal wall and lead to disorders of parietal digestion and the absorption of nutrients [8]. Therefore, determining and assessing the recovery of intestinal absorption can be one of the main criteria for the initiation of enteral tube feeding in patients with AP. There are known methods of assessing the recovery of intestinal absorption using labelled radioisotopes (Cu67-ceruloplasmin, Cr51-albumin) or by the level of absorption and secretion of disaccharides (lactulose/mannitol) that are not metabolised (in this case, the state of the urinary system should also be taken into account) [6]. The test using disaccharides is carried out as follows: 5.0 g of mannitol and 5.0 g of lactulose, dissolved in 100 ml of distilled water, are introduced into the probe. Urine is collected within 6 hours after administration of the mannitol and lactulose solutions. The analysis is carried out by the method of ion chromatography with a pulsed amperometric detector. Mannitol passes through the intestinal epithelium by passive transport. The average absorption rate is 14%. Lactulose, being a larger molecule, is, on the contrary, poorly absorbed in the intestines. The degree of its absorption is less than 1%. Therefore, the lactulose/mannitol ratio in urine is normally less than 0.03 [17].

There is also a way to assess the restoration of intestinal absorption by determining the fasting glucose level two hours after exercise (introduction of glucose into a feeding tube at a dose of 1 g/kg of the patient's body weight). An increase in the level of glucose in blood serum after 2 hours is a sign of restoration of intestinal absorption (restoration of the enzyme activity of intestinal disaccharidases) [14]. However, the use of this method is limited in the case of fluctuations in the level of glucose, which can be observed against the background of the course of AP and other accompanying pathologies (Itsenko-Cushing syndrome, diabetes, hyperthyroidism, acromegaly, etc.).

Due to the significant limitations and low efficiency of the aforementioned tests, which can

be attributed to a variety of factors, the search for objective criteria to initiate enteral tube feeding in patients with AP should be aimed at assessing the restoration of intestinal absorption.

We conducted a study, the purpose of which was to determine the timing of the recovery of intestinal absorption as one of the main criteria for the initiation of EN in patients with AP and to improve the results of the complex treatment of patients by preventing its complications [23]. It was found that in the vast majority of patients with AP (70.6% of patients in the main group and 69.7% of patients in the comparison group), recovery of intestinal absorption occurs on average 48 hours after the start of complex conservative therapy, so this time is optimal for the beginning of EN (Table).

To determine the beginning of intestinal absorption, we developed our own method using a 3% potassium iodide solution (the sensitivity is 87.36%, and the specificity is 81.5%). The method consists of determining the timing of restoration of intestinal absorption by recording excretion with saliva of potassium iodide 10 minutes after its enteral probe administration (20 ml of 3% solution). The transparent secretion taken into a test tube changes its colour to blue when the indicator – starch (2 ml of 10% solution) is added to it, in case of restoration of intestinal absorption.

As an alternative method for determining the beginning of intestinal absorption, a sample with disaccharides (lactulose or mannitol) that are not metabolised was used (introduction of disaccharides was carried out at the beginning of treatment, after 12, 24, 36, and 48 hours). When comparing the mean levels of lactulose/mannitol in the urine and their standard deviation in the main group and the comparison group at the beginning of treatment (0.042 ± 0.001 and 0.041 ± 0.001 ; $p = 0.64$ respectively), after 12 hours (0.040 ± 0.002

Table. **Terms of recovery of intestinal absorption in patients with severe acute pancreatitis depending on the duration of treatment**

Duration of treatment of the patient in the hospital	Restoration of intestinal absorption processes	
	Main group (n = 34)	Comparison group (n = 33)
12 hours	–	–
24 hours	3 (8.8%)	4 (12.1%)
36 hours	10 (29.4%)	9 (27.3%)
48 hours	24 (70.6%)	23 (69.7%)

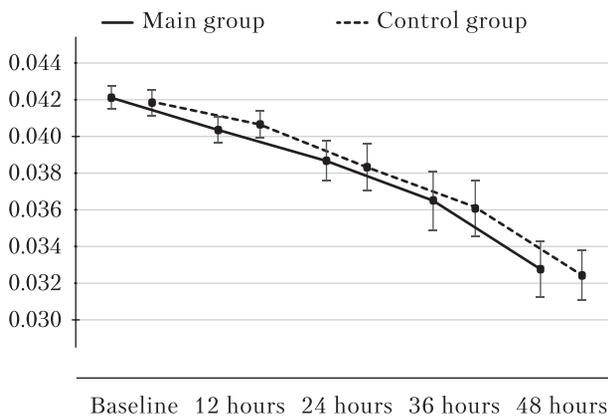


Figure 2. **Histogram of the ratio of lactulose/mannitol in the urine in the study groups**

and 0.041 ± 0.002 ; $p = 0.27$ respectively), 24 hours (0.039 ± 0.002 and 0.039 ± 0.003 ; $p = 0.92$ respectively), 36 hours (0.036 ± 0.003 and 0.037 ± 0.004 ; $p = 0.9$ respectively), 48 hours (0.033 ± 0.004 and 0.033 ± 0.004 ; $p = 0.9$ respectively), no significant difference was obtained (Fig. 2).

It should be noted that the protocols for providing assistance to patients with intestinal digestive disorders arising from the use of EN in the treatment of AP, as well as their prevention, are insufficiently developed. Activated charcoal, loperamide, etc. are used to reduce gas formation in the intestines [57]. However, the therapeutic effect of these drugs is insignificant, so this issue needs further study.

Therefore, nutritional support is an important component of therapy in patients with AP, the purpose of which is to ensure adequate caloric intake, modulate the response to oxidative stress, and counteract catabolic effects during the course of the disease. It should be noted that the degree of nutritional status disorders in patients with AP varies depending on the etiological factors and the severity of the disease and requires a differentiated approach to their correction. Currently, it is believed that with a mild course of AP, fasting does not affect the course and outcome of the disease, and this category of patients does not require the prescription of active nutritional support. Whereas with severe AP, adequate protein and energy supply is one of the key points of intensive therapy, the completeness of which affects the frequency of the development of complications, the duration of hospitalisation, and mortality [26]. In patients with AP, the optimal time to start nutritional support is 48 hours after hospitalisation, whereas one of the main criteria for initiating EN is the restoration of intestinal absorption. Nutritional support should be started with nasogastric administration

of a food mixture, and in case of complications (intolerance, aspiration, etc.), nasojejunal administration. At the same time, it is possible to use polymer, semi-elemental, and elemental mixtures. Parenteral nutrition should be used if enteral nutrition is impossible or not tolerated.

Conclusions

In the treatment of acute pancreatitis, nutritional support is an important component. It ensures adequate caloric intake, modulates the response to oxidative stress, and counteracts catabolic effects during the course of the disease.

The degree of nutritional disorders in patients with acute pancreatitis varies depending on the etiological factors and severity of the disease, necessitating a differential approach to their correction.

Restoration of intestinal absorption in patients with severe acute pancreatitis occurs on average 48 hours after the start of complex conservative therapy, which is the optimal time to initiate enteral nutrition.

Nasogastric nutritional support in patients with severe acute pancreatitis is safe and leads to a 25.8 % reduction in the incidence of local infectious complications ($\chi^2 = 4.59$; 95 % CI 2.43–45.53; $p = 0.03$), the duration of multiple organ failure by 3.1 days ($p < 0.001$), the length of stay in the hospital by 16 days ($p = 0.04$), and mortality by 21.4 % ($\chi^2 = 4.13$; 95 % CI 0.81–39.68; $p = 0.04$) compared to parenteral nutrition.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

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AUTHORS CONTRIBUTIONS

I. V. Kolosovych: conception and design; I. V. Hanol: collection, analysis and interpretation of data, drafting and revision of the manuscript.

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Нутритивна підтримка в пацієнтів із гострим панкреатитом. Огляд опублікованих досліджень

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Гострий панкреатит — поширене захворювання, що трапляється у 5—10% пацієнтів з ургентною патологією органів черевної порожнини. В основі розладів обмінних процесів, які виникають у цієї категорії пацієнтів, лежать синдроми гіперметаболізму та гіперкатаболізму, що супроводжуються підвищеними витратами вуглеводів, жирів і амінокислот, зростанням споживання кисню та продукції вуглекислого газу.

Мета — дослідити сучасний стан проблеми нутритивної підтримки пацієнтів із гострим панкреатитом.

Ступінь розладів харчового статусу в пацієнтів із гострим панкреатитом варіює залежно від етіологічних чинників і тяжкості захворювання та потребує диференційованого підходу до їхньої корекції. У хворих на гострий панкреатит спостерігається порушення балансу кишкової мікрофлори внаслідок прийому антибіотиків, нестачі поживних речовин, клітковини, а також відсутності мікробного антагонізму, що призводить до надлишкового бактеріального росту з переважанням грамнегативної мікрофлори в мікробній популяції. Ефективність і безпечність ентерального зондового харчування зумовлена комплексом чинників: термінами відновлення перистальтики і всмоктувальної функції кишкової стінки, типом суміші, способом її введення. Відновлення кишкової абсорбції у хворих на тяжкий гострий панкреатит відбувається в середньому через 48 год від початку комплексної консервативної терапії. Використання антифлатулентів у складі суміші для ентерального харчування дало змогу поліпшити лабораторні показники сироватки крові, зменшити частоту розвитку кишкових ускладнень на 7-му добу на 21,5% ($\chi^2=4,88$, 95% довірчий інтервал (ДІ) 2,3—39,5; $p=0,03$). Проведення назогастральної нутритивної підтримки в пацієнтів із тяжким перебігом гострого панкреатиту було безпечним та сприяло зниженню частоти виникнення локальних інфікованих ускладнень на 25,8% ($\chi^2=4,59$; 95% ДІ 2,43—45,53; $p=0,03$), тривалості перебування в стаціонарі на 16 діб ($p=0,04$) і рівня летальності на 21,4% ($\chi^2=4,13$; 95% ДІ 0,81—39,68; $p=0,04$) порівняно з парентеральним харчуванням. Нутритивну підтримку слід розпочинати з назогастрального введення харчової суміші, у разі виникнення ускладнень (непереносність, аспірація тощо) — з назоеюнального введення. Парентеральне харчування слід використовувати, якщо ентеральне харчування неможливе або не переноситься.

Ключові слова: гострий панкреатит, нутритивна підтримка, ентеральне харчування, ускладнення.

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