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ЗАГАЛЬНА ХІРУРГІЯ

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ДО УВАГИ АВТОРІВ

The life and work of Borys Horodynskyi: contribution to medical science and education

The article focuses on the life and professional accomplishments of Borys Mykhailovych Horodynskyi (1887–1969), an outstanding Ukrainian surgeon, teacher, and scientist. His path from a student at St. Volodymyr University in Kyiv to a leading specialist in general and military field surgery is highlighted. The article explores the main stages of his career, including his work in Kyiv clinics, participation in World War I, management of the surgical departments at the Second Kyiv Medical Institute, and evacuation to Chelyabinsk during World War II. His contributions to the development and implementation of asepsis and antiseptic procedures, abdominal surgery, and treatment of purulent diseases are particularly noteworthy. The educational endeavours of Borys Horodynskyi, his influence on the formation of a new generation of doctors, as well as the circumstances of his dismissal during the 1953 «doctors' case», are elucidated. We analyse his legacy in Ukrainian medicine, specifically regarding his scientific research, the training of specialists, and the organization of surgical education. The article emphasizes Horodynskyi's significance as a pivotal figure in 20th-century Ukrainian medicine, with his name engraved in the history of national surgery and medical science.



Borys Mykhailovych Horodynskyi was born in 1887 in the city of Haisyn, Podolsk province (today – the city of Haisyn, Vinnytsia region), in the family of an official. He studied at the Nemyriv gymnasium, after which, in 1907, he entered the Medical Faculty of St. Volodymyr University, which he graduated from with honours in 1913 and received the specialty of a doctor.

As a student, he became deeply interested in surgery and worked in the clinic of Professor Dobromyslov, where he wrote his first scientific work.

Between 1913 and 1914, after his successful graduation from the Medical Faculty of St. Volodymyr University, Borys Mykhailovych began to work

under the guidance of Professor M. B. Yukelson who was his teacher and mentor for many years.

In 1914, with the outbreak of World War I, B. M. Horodynskyi was mobilized into the tsarist army, where he served as the senior regimental doctor of the 405th regiment until 1918. After his service, he returned to his «native» hospital, where he worked as an «assistant to the surgical department» from 1918 to 1923. Then he became the head of the surgical department, which he headed until 1934.

Along with knowledge and surgical skills, young Borys acquired meticulousness from his teacher which he demonstrated through various surgical techniques, systematic organization of surgical procedures, and adherence to the principles of clinical documentation.

In 1931, the Kiev Industrial Medical Institute was established on the basis of the First Kyiv Soviet Hospital, which was subsequently transformed into a full-fledged educational medical institution, the Second Kyiv Medical Institute, in 1936. In that year, B. M. Horodynskyi received the titles of Privatdozent at the Kyiv Psychoneurological Institute and Associate Professor in the Department of General Surgery at the Second Kyiv Medical Institute.

In 1934, Borys Mykhailovych was appointed as the Professor of the Department of Propaedeutic Surgery, which he founded himself. In 1936, he received the title of Candidate of Medical Sciences for the entirety of his achievements without defending a candidate dissertation.

B. M. Horodynskyi's principal tenet was, «There is no minor or major in surgery». His practical endeavours mainly involved surgery of the abdominal cavity organs and the management of purulent pathologies affecting soft tissues, bones, and joints. During this period, Borys Mykhailovych cultivated a definitive intolerance to non-compliance with the norms of asepsis and antiseptics. According to his colleagues who worked under his leadership, he required his fellow workers to strictly adhere to the principles of asepsis and antiseptics.

In 1937, the Council of Professors of the Second Kyiv Medical Institute appointed B. M. Horodynskyi as professor and head of the Department of Hospital Surgery, a position he held from 1937 to 1941. He served as the secretary of the Kyiv Surgical Society for many years and was elected deputy chairman of the regional Kyiv Surgical Society in 1937.

A significant milestone in Borys Mykhailovych's life was the year 1941, when World War II reached Ukraine. In August 1941, the Second Kyiv Medical Institute, along with the Kyiv Medical Institute, was evacuated to Kharkiv and subsequently to Chelyabinsk in October 1941. B. M. Horodynskyi was assigned as the head of the Department of General Surgery at the Kyiv United Medical Institute and concurrently served as the chief surgeon for evacuation hospitals in the Chelyabinsk region. Borys Mykhailovych headed the above-mentioned department until 1944.

In Chelyabinsk, B. M. Horodynskyi also ran the surgical department of Chelyabinsk City Hospital No. 1, which became the clinical base for the Kyiv United Medical Institute during its evacuation in Chelyabinsk.

During the first seven months of the war, 70 evacuation hospitals were deployed in the Chelyabinsk region, with 27,000 hospital beds and 11,000 medical personnel. At the time, the southern Urals experienced a critical shortage of highly qualified surgeons and medical staff. The shortage was caused by a lack of doctors and the need to send them to the front.

Another issue was the frequent placement of young, inexperienced individuals, who had only completed expedited medical courses, in evacuation hospitals without any practical experience. To address this issue, hospitals implemented measures to train doctors in the specific specialty required.

However, the whole process was complicated, since there were few specialists to provide a sufficient level of training for young doctors, including the lack of medical literature necessary for training. The evacuation of the Kiev United Medical Institute to the Chelyabinsk territory marked a dramatic improvement in the situation.

Borys Mykhailovych directly participated in the training and retraining of 136 military field surgery specialists and 230 doctors.

In 1944, after the liberation of Ukraine, the Kyiv Medical Institute returned from the city of Chelyabinsk to Kyiv. Due to the tenacious work of our compatriots, including B. M. Horodynskyi, the Chelyabinsk Medical Institute was established in 1944 at the Chelyabinsk First City Hospital, after the return of the Kyiv Medical Institute to the Motherland. The Chelyabinsk Medical Institute was founded with resources and personnel from the departments and clinics of the Kyiv United Medical Institute, who decided to stay there for various reasons.

The 1944 order for the restoration of the Kyiv Medical Institute stated: «to appoint Professor B. M. Horodynskyi as the head of the Department of General Surgery of the Sanitary and Hygienic Faculty». Currently, the department is referred to as the «Department of General Surgery No 2». The Kyiv Medical Institute was renamed as the National Medical University named after Academician O. O. Bogomolets.

During his tenure as department head, Borys Mykhailovych delivered courses in general, faculty, and hospital surgery, as well as military field surgery. During this period, the department developed methodologies for practical instruction on a number of topics within the general and faculty surgery curriculum. The instructional approach to surgery at the sanitary and hygienic faculty did not differ from that employed at other faculties of the university. The intended controversial scientific topics were not pursued by the department during this timeframe. However, the primary scientific domains of the department included rectal diseases and their surgical treatment, along with acute intestinal obstruction.

Four candidate dissertations were successfully defended under the leadership of B. M. Horodynskyi as the head of the department. He was the author of more than 50 scientific publications focused on the issues of purulent surgery, oncology, and abdominal surgery.

An exceptional characteristic of Borys Mykhailovych was his pedagogical approach and lecture delivery, which students remembered for a lifetime. His lectures were so remarkable that they were considered almost legendary among students. He served as an exemplary mentor for the young generation of doctors.

Regrettably, the infamous «doctors' case» – a criminal case against a group of prominent doctors – adversely impacted B. M. Horodynskyi's teaching and professional activities at the

department in 1953. Thus, on September 16, 1953, he was dismissed from his position as head of the department of surgery at the sanitary and hygienic faculty and reassigned to the role of associate professor within the same department. On July 26, 1955, he was dismissed from the associate professorship since he did not take part in the competition for the position. He dedicated the rest of his life to working at the Kyiv Regional Hospital, where he began his challenging yet illustrious journey as an outstanding Ukrainian surgeon. Borys Mykhailovych died in 1969.

Successes and failures shape an individual's personality, leading to the accumulation of invaluable life, professional, and practical experience. Individuals who are determined and self-assured have the capacity to identify appropriate answers

in challenging circumstances, leaving a significant impact and vital insights in the annals of our past for generations. It is crucial for us to preserve the memory of them, as these individuals set the highest standards, driving progress and influencing our future. One of such individuals was Borys Mykhailovych Horodynskyi. His life story serves as both a moral and professional benchmark for aspiring doctors and establishes the historical foundations of the medical profession.

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Життя і діяльність Бориса Городинського: внесок у медичну науку та освіту

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Стаття присвячена життю та професійній діяльності Бориса Михайловича Городинського (1887—1969) — видатного українського хірурга, педагога та науковця. Висвітлено його шлях від студента Київського університету Св. Володимира до провідного фахівця в галузі загальної та військово-польової хірургії. Розглянуто основні етапи його кар'єри, зокрема роботу в клініках Києва, участь у Першій світовій війні, завідування кафедрами хірургії в Другому Київському медичному інституті та евакуацію до Челябінська під час Другої світової війни. Особливу увагу приділено його внеску в розробку та впровадження методик асептики й антисептики, хірургії органів черевної порожнини та лікування гнійних захворювань. Висвітлено педагогічну діяльність Бориса Городинського, його вплив на формування нового покоління лікарів, а також обставини звільнення під час «справи лікарів» 1953 року. Проаналізовано його спадщину в українській медицині, зокрема наукові праці, підготовку спеціалістів та організацію хірургічної освіти. Стаття підкреслює значення Городинського як однієї з ключових постатей української медицини ХХ століття, чие ім'я закарбоване в історії вітчизняної хірургії та медичної науки.

Evaluation of different methods of endoscopic papillectomy for adenomas of the major duodenal papilla

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OBJECTIVE – to assess the outcomes of endoscopic papillectomy (EP) using standard techniques, as well as to develop and implement novel surgical intervention approaches.

MATERIALS AND METHODS. Between 2021 and 2024, the Department of Interventional Endoscopy at the National Cancer Institute performed EP for adenoma of the major duodenal papilla (MDP) on 19 patients, 10 women (52.63%) and 9 men (47.37%), aged 24 to 78 years, with a mean age of 45.6 years. We observed clinical signs of biliary obstruction and cholangitis in the majority of cases (2 (63.15 %)).

RESULTS. 10 patients (52.63%) with tumours <1.0 cm underwent the standard procedure of en-bloc loop resection (Group 1). To prevent intraoperative and postoperative complications, we developed and implemented a two-stage EP procedure in 6 (31.57%) cases (Group 2). In 3 (15.78%) patients with tumours ranging from 5.0 to 8.0 cm, the piecemeal approach was used to remove all fragments from the area of the neoplasm that reached into the intestinal lumen (Group 3). After a three-month follow-up, 2 patients (10.5%) from Group 3 had a recurrence of an adenoma of the MDP. Both cases required loop diathermy excision for recurrent neoplasms and stent removal. Routine tests at 3 and 6 months revealed no evidence of disease progression.

CONCLUSIONS. The topographic and anatomical characteristics of the MDP area determine the complexity of surgical interventions for patients with neoplasms. The novel EP approach minimizes the risks associated with both early and late postoperative complications. The outcomes achieved by employing EP in the treatment of patients with MDP adenomas support its recommendation as the primary approach at specialized centers.

KEYWORDS

endoscopic papillectomy, adenoma of the major duodenal papilla, endosonography.

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Among obstructive neoplasms of the major papilla of the duodenum, carcinomas account for 37.7%, adenomas for 19.6%, and other benign tumours for 42.7% [12]. Major duodenal papilla (MDP) adenomas may occur sporadically or be associated with ad-

enomatous polyposis syndromes (familial adenomatous polyposis and MUTYH-associated polyposis).

In the early stages of development, the disease is asymptomatic in 60.2–93.1% of cases [5, 8, 10]. As the tumour size increases, complications arise due to

impaired outflow of secretions from the ductal systems of the liver and pancreas: mechanical jaundice (7.1–26%), cholangitis (0.3–1.6%), pain syndrome (6.9–21.6%), acute pancreatitis (1.9–6.3%). Malignancy occurs in 15 to 30% of cases [2]. In rare cases, the first clinical manifestation of the disease may be duodenal intussusception.

The morphological analysis of tissues collected after tumour biopsy plays an essential role in establishing the diagnosis [2]. False-negative findings are reported in 16.7–30.2% of observations, whereas false-positives are observed in 12.5–38% [3, 9]. Endoscopic papillectomy (EP) is thus regarded as a variant of excisional biopsy [6].

Endoscopic ultrasonography (EUS) of the hepatopancreatoduodenal organs improves the accuracy of identifying MDP neoplasms, especially in the early stages (size <1 cm). EUS has a sensitivity close to 100% in detecting tumour-like MDP lesions. It is important for treatment strategy selection, enabling the assessment of the depth of the pathological process in the layers of the duodenal wall and detection of possible signs of regional lymphadenopathy [4].

Currently, the only recognized treatment for this group of patients is surgical excision of the MDP. A number of techniques are used for this, including transduodenal papillectomy and pancreaticoduodenal resection by laparotomic or laparoscopic access. However, due to a high incidence of complications (19.7–23.8%) and mortality (10.2%), as well as disease recurrence in 26.1–30.4% of patients, minimally invasive endoscopic approaches to removing MDP neoplasms are increasingly preferred. Furthermore, the precision of performing endoscopic procedures with high-resolution equipment contributes to a reduction in the frequency of postoperative adenoma recurrences.

Endoscopic papillectomy has lower rates of postoperative complications (4.2–7.4%), mortality (0.8–1.1%), and recurrence (14.7–18.2%) [10, 13]. To reduce the risk of recurrence, a combination of EP and tissue ablation therapy is used, which involves multipolar, laser, and argon plasma coagulation of the tumour bed, which is controlled endoscopically in the Narrow-band imaging (NBI) mode [7].

OBJECTIVE – to assess the outcomes of endoscopic papillectomy using standard techniques, as well as to develop and implement novel surgical intervention approaches.

Materials and methods

Between 2021 and 2024, the Department of Interventional Endoscopy at the National Cancer Institute performed EP for the MDP adenoma on 19 patients,

10 women (52.63%) and 9 men (47.37%), aged 24 to 78 years, with a mean age of 45.6 years. Biliary obstruction and cholangitis were the reasons for the examination in the majority of cases (2 (63.15%)): pain in the epigastric region after eating–5 (26.31%), intermittent hyperbilirubinemia without pain syndrome–6 (31.57%), periodic fever–3 (15.78%), and weight loss–6 (31.57%). In the remaining 7 patients (36.84%), the condition was asymptomatic and was discovered accidentally during screening exams and testing for concomitant disorders.

The diagnostic regimen for the patients encompassed duodenoscopy with biopsy, abdominal ultrasound, computed tomography of the abdominal cavity and retroperitoneal space, magnetic resonance cholangiopancreatography as indicated, endoscopic ultrasound of the hepatoduodenal region, complete blood count, biochemical blood analysis, coagulogram, urinalysis, and electrocardiogram.

The origin of the MDP neoplasm, its size, mobility, spread to surrounding tissues, and the existence of fluctuating symptoms in the intramural section of the common bile duct (CBD) were assessed endoscopically. We employed instrumental examination and palpation for this objective. Furthermore, we used the NBI mode as an adjunct diagnostic instrument during the endoscopic evaluation. The observed alterations in the pit pattern, as per Kudo and Tsuruta, align with II-IIIIL-IIIIS classifications. In the study, a tumour biopsy was conducted, the outcome of which served as a primary criterion for patient selection for endoscopic therapy (patients with malignant neoplasms were excluded from the research).

Ultrasound examination indicated biliary hypertension in all patients, dilation of the main pancreatic duct (MPD) in 5 (26.31%), gallbladder stones in 3 (15.78%), bile duct stones in 1 (5.26%), and a foreign body («retained» CBD drainage) in 1 (5.26%).

The evaluation of computed tomography is deemed essential for determining the existence of regional and distant metastases in MDP neoplasms, which also served as a criterion for eliminating patients from the research cohort.

MRCP was conducted in 6 individuals (31.57%), revealing endoscopic evidence of damage to the intramural segment of the CBD. In 2 cases (10.52%), the spread of tumour tissues to the distant regions of the CBD was verified.

The application of EUS, alongside the measurement of adenoma size, facilitated the assessment of tumour penetration into the duodenum wall and its extension into the CBD lumen. Out of the 4 cases (21.05%) of tumour invasion into the duodenal wall, 2 cases (10.52%) were confined to the submucosal layer (third echo layer), whereas 1 case

(5.26 %) extended to the muscular layer of the intestine (fourth echo layer). Notwithstanding this, the patients were presented with the option of endoscopic surgery due to the existence of significant concomitant disease and elevated anesthetic risks. In 2 cases (10.52 %), the MRCP results regarding the spread of tumour growths into the lumen of the distal CBD were confirmed by EUS.

Upon admission, persistent hyperbilirubinemia was noted in 5 patients (26.31 %), with a period ranging from 5 to 17 days and bilirubinemia levels between 170.7 and 349.5 $\mu\text{mol/l}$. The initial phase of their therapy was biliary decompression. Suprapapillary choledochoduodenostomy was conducted in all cases. In 3 (15.78 %) patients, it was supplemented by bile duct stenting, and in 1 (5.26 %), it involved the removal of a «retained» drainage and choledocholithoextraction.

The size of the MDP adenoma did not restrict the application of EP but was critical in determining the surgical approach: en-bloc or piecemeal technique.

For the execution of EP, the following instruments were used: Olympus TJF-190 duodenoscope, Evis Exera CLV-190 video processor, Extron 7 X-ray C-arm, ESG-300 electrosurgical unit, 23 G injection endoscopic needles, polypectomy loops measuring 10 to 34 mm in diameter, endoscopic I-knife, guides with a diameter of 0.35 mm, lateral papillotomes, plastic stents of 7 and 8.5 Fr, coagrasper, alligator forceps, hot biopsy forceps, a net for foreign body retrieval, Dormia basket, and 11 and 16 mm rotary hemostatic clips.

The procedure was conducted in the operating room under endotracheal anesthesia with the patient in a prone position. If required, the patient was repositioned to the left side throughout the surgery. CO_2 was used as the gas for insufflation.

During en-bloc loop resection of the MDP adenoma, hydrolifting of the duodenal mucosa around the papilla was previously performed in accordance with established and original papillectomy procedures.

The two-stage papillectomy technique we developed involves, in the initial stage, the dissection of the duodenal mucosa using a needle papillotome at a distance of 3–5 mm from the major papilla (within healthy tissues), followed by the exfoliation of the submucosal layer tissues down to its tubular structures (the CBD and pancreatic duct) (Fig. 1). The second stage involves the transection of the ducts using a diathermic endoloop. The use of a diathermic loop during the final stage of the procedure facilitated the coagulation of the wound surface to the necessary degree. This ensured the reliability of hemostasis while simultaneously reducing the duration of endoloop usage, thereby minimizing electrothermal damage to adjacent tissues, particularly the pancreatic head, which subsequently decreased the risk of postoperative pancreatitis [1].

For the same objective, in cases of substantial tumour sizes (>2.0 cm), the piecemeal approach was employed for the portion of the neoplasm that protruded most into the intestinal lumen. The residual tissue that originated from the intestinal wall was excised using one of the aforementioned techniques.

After the removal of the macropreparation and the establishment of hemostasis, we evaluated the possibility and feasibility of stenting the ductal systems. Plastic stents with diameters of 8.5 and 10 Fr were used for the draining of the CBD, while those with diameters of 5 and 7 Fr were employed for the MPD. In case of significant gaping in the CBD incision and free bile flow due to the CBD dilation caused by long-term biliary hypertension, drainage was not conducted. If 3–4 attempts at catheterization of the MPD were unsuccessful, stenting was deemed inadvisable to prevent unnecessary damage to the pancreas.

An inspection of the postoperative wound was conducted prior to the removal of the endoscope. Upon identification of defects in the duodenal wall extending to the muscular layer, closure was executed using hemostatic clips. In such instances (often involving big tumour sizes), the procedure concluded with the placement of a probe for enteral nutrition and a decompression nasogastric tube positioned beyond the duodenal-jejunal junction.

Postoperative pharmacological care comprised the administration of proton pump inhibitors, antispasmodics, analgesics, anti-inflammatory agents, antimicrobial medications, and, when appropriate, somatostatin analogues.

Dynamic monitoring encompassed controlled duodenoscopy and the removal of biliary and pancreatic stents after three months.

Results

The endoscopic surgical approach was selected based on the size of the MDP adenoma, the extent of duodenal wall, and the distal CBD involvement in the pathological process. Due to the complex topographic and anatomical relationships of organs and ductal structures in the parapapillary region, hydrolifting of the MDP and adjacent intestinal mucosa was employed in all cases during EP to enhance intervention accuracy and mitigate associated risks.

In 10 patients (52.63 %) with tumour diameters of <1.0 cm, the standard technique of en-bloc loop resection (Group 1) was employed (Fig. 2, 3) [10]. Larger tumour sizes result in a substantial volume of mucosal and submucosal layers being found in the excised loop, which significantly increases both the wound surface area and depth, hence adding to the risk of intestinal perforation upon exposure of the



Figure 1. **Dissection of the MDP mucosa with a needle papillotome around the MP (the initial stage of papillectomy)**



Figure 2. **MDP adenoma with a diameter of 0.9 cm**



Figure 3. **Condition after en-bloc loop resection of the MDP neoplasm**

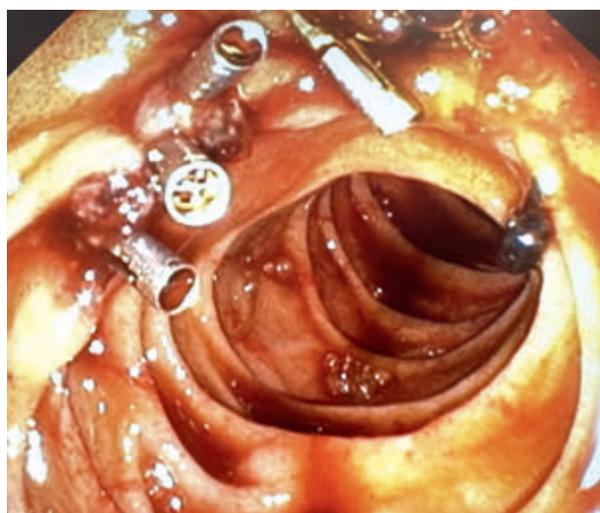


Figure 4. **Postoperative defect of the duodenum sutured using hemostatic clips**

muscle layer. This phenomenon is more frequently observed at the lower corner of the postoperative wound. To prevent intraoperative and postoperative complications, we designed and implemented a two-stage EP approach in 6 (31.57%) cases (Group 2). The rationale for employing this approach was the detection of a tumour size between 1.0 and 2.0 cm.

Due to prolonged electrothermal exposure to pancreatic tissue, en-bloc loop resection with neoplasms larger than 2.0 cm increases the risk of duodenal perforation and acute pancreatitis. The piecemeal technique was used on the portion of the tumour that spread the most into the intestinal lumen in 3 patients (15.78%) with tumour sizes ranging from 5.0 to 8.0 cm, necessitating the complete removal of all fragments (Group 3). The ability to observe the entire volume of tissues within the loop is limited by this approach. The intestinal wall layers adjacent to

the tumour are excised uncontrollably during the first stages of the procedure. In 3 (15.78%) cases where there was a risk of intraoperative and/or delayed intestinal perforation, the resulting defects required suturing with hemostatic clips (Fig. 4). Using the method we developed, the residual tumour component that directly protruded from the intestinal wall was successfully removed in 2 (10.5%) cases. When the tumour penetrated the intestinal muscle layer, the loop resection was not visually radical in one case (5.3%). Therefore, spray coagulation (power 32 W, third mode) was used to diathermoablate the residual tumour tissue in the wound.

In 2 patients (10.5%) from Group 3, previous investigations (MRCP) diagnosed the spread of tumour tissues to the distal portion of the CBD. After removing the primary neoplastic mass from the duodenum, we observed the protrusion of tumour

growths from the CBD lumen into the intestinal lumen. We conducted the excision using a diathermic loop and a coagrasper.

In Group 1, stenting of the MPD was not conducted, as small asymptomatic neoplasms did not result in ductal hypertension or dilation; nevertheless, stenting of the CBD was executed in 2 cases (10.5%). One patient (5.3%) who underwent the original procedure received stenting in both ductal systems, whereas two patients (10.5%) had stenting just in the CBD. Following EP by the piecemeal technique, stenting of both ductal systems was carried out in 2 patients (10.5%), while stenting of the CBD was conducted in 1 patient (5.3%).

A correlation was discovered between the size of the MDP adenoma and, as a result, the method of its endoscopic removal, as well as the volume of intraoperative measures that prevent complications (closure of incomplete intestinal wall defects with hemostatic clips and the installation of feeding and decompression probes). We did not apply decompression techniques for the stomach and duodenum in Group 1, as there were no intestinal wall defects that needed to be repaired. In Group 2, decompression of the stomach and duodenum was noted in 2 (10.5%) and 2 (10.5%) cases, respectively (33.3% of all patients in this group). All patients in Group 3 (tumour sizes >2.0 cm) had the marginal defects of the post-papiloscopic incision closed and both probes inserted.

The frequency of early postoperative complications in Group 1 was (Table): bleeding – 5.3% (stopped by conservative measures), pain syndrome that did not require the administration of narcotic analgesics – 15.8%, transient hyperamylasemia (up to 1100–1700 U/l for 2 days) – 10.5%. We detected no signs of acute postoperative pancreatitis. In Group 2, no clinically significant postoperative complications were registered. In Group 3, 1 (5.3%) case of bleeding that required the use of endoscopic hemostasis (clipping), 1 (5.3%) case of pain syndrome that required the administration of

narcotic analgesics, and 1 (5.3%) case of transient hyperamylasemia (up to 1300 U/l for 2 days) were observed in the postoperative period. No cases of duodenal perforation were registered.

All patients required basic postoperative care, including proton pump inhibitors, antispasmodics, analgesics, anti-inflammatories, and antibacterial medications. Somatostatin analogues were administered to 3 (15.8%) patients in Group 1, as well as all patients in Group 3.

During a three-month control trial, the MDP adenoma recurred in 2 (10.5%) patients from Group 3 with preoperatively confirmed tumour progression to the distal section of the gastrointestinal system (Fig. 5). In both patients, we used loop diathermy to remove the recurring neoplasms, as well as the biliary and pancreatic stents (Fig. 6). Tumour remains were recovered and removed using a polypectomy loop in 1 (5.3%) case during revision with a Fogarty balloon from the distal region of the CBD into the duodenal lumen. Both patients exhibited no evidence of disease progression during subsequent planned tests at 3 and 6 months (Fig. 7).

Discussion

The asymptomatic occurrence of MDP adenomas in the early stages of the disease accounts for the randomness and relative infrequency of their detection during screening assessments. Symptomatic MDP adenomas are mostly large, sometimes accompanied by complications or the involvement of surrounding organs and tissues in the disease process.

EUS is pivotal in determining the access and extent of surgical intervention for benign MDP neoplasms. This investigation facilitates the evaluation of the tumour's dimensions and the degree of its infiltration into the duodenal wall and the CBD [12].

Most experts agree that abdominal procedures are needed when an adenoma invades the muscular layer of the intestine and/or the distal parts of the

Table. Early postoperative complications

Complications	Grade*	Group 1	Group 2	Group 3
Pain syndrome that did not require the administration of analgesics	I	3 (15.8%)	0	0
Pain syndrome that required the administration of narcotic analgesics	II	0	0	1 (5.3%)
Bleeding that did not require hemotransfusion, endoscopic hemostasis, surgical intervention	I	1 (5.3%)	0	0
Bleeding that required endoscopic hemostasis	IIIa	0	0	1 (5.3%)
Transient hyperamylasemia	I	1 (5.3%)	0	1 (5.3%)

* Clavien-Dindo classification.



Figure 5. Recurrent MDP adenoma 3 months after removal of the primary tumour by the piecemeal technique

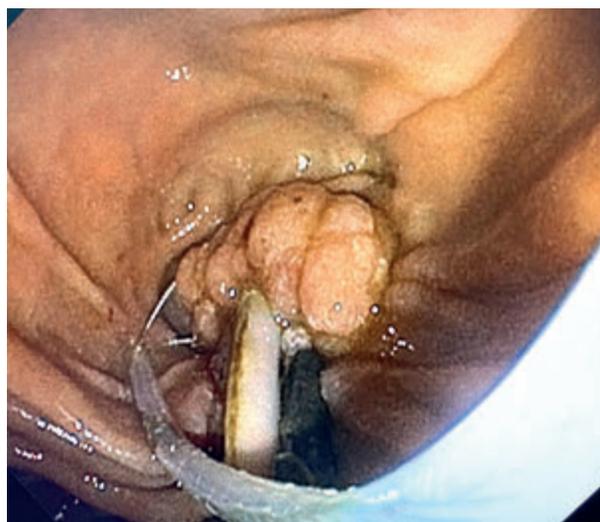


Figure 6. Diathermy loop resection of recurrent MDP adenoma and simultaneous removal of both stents



Figure 7. Control duodenoscopy 3 months after removal of recurrent MDP adenoma. No signs of prol. morbi were detected

CBD. However, EP may be possible if the adenoma is found on the intestinal mucosa and there is no evidence that it has spread to the CBD [2].

The original EP approach facilitated a reduction in postoperative bleeding incidence compared to conventional loop resection of the MDP, due to the sequential electrocoagulation of vessels adjacent to the neoplasm during tumour excision.

Our study indicates that in operated patients of Group 3, with neoplasms exceeding 2.0 cm, early postoperative complications were more prevalent than in patients from Group 1 and Group 2

(neoplasm size < 2.0 cm). This is ascribed to an increased extent of tissue damage and prolonged exposure to high temperatures during electrocoagulation affecting adjacent tissues and organs, including the pancreas. To mitigate these adverse traumatic consequences during the excision of large adenomas, we recommend using the piecemeal approach.

We concur with certain authors that stenting of the MPD does not significantly influence the occurrence of acute pancreatitis in the postoperative phase. This problem arose in just 1 case (5.26%), when the stent was placed in the MPD following tumour excision with the piecemeal approach. The traumatic nature of tumour excision, due to its dimensions and spread, in this case probably contributed to the development of acute pancreatitis.

In our study, the recurrence rate of MDP adenomas after EP was 10.5%, necessitating further endoscopic excision of the tumour at scheduled follow-up examinations of patients.

The limited traumatic impact of EP and the reduced incidence of postoperative complications enable us to regard the suggested procedure as a priority for the excision of MDP adenomas [2, 8].

Conclusions

The topographic and anatomical characteristics of the MDP area determine the complexity of surgical interventions for patients with neoplasms. The novel EP approach minimizes the risks associated with both early and late postoperative complications. The outcomes achieved by employing EP in the treatment of patients with MDP adenomas support its recommendation as the primary approach at specialized centers.

DECLARATION OF INTERESTS

The authors declare the absence of a conflict of interest and their own financial interest in the preparation of the manuscript.

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AUTHORS CONTRIBUTIONS

All authors made an equal contribution to this work.

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Оцінка різних методів ендоскопічної папілектомії при аденомах великого дуоденального сосочка

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Мета — оцінити результати виконання ендоскопічної папілектомії з використанням відомих методик, розробити та впровадити оригінальні технології оперативних втручань.

Матеріали та методи. З 2021 до 2024 р. у відділі інтервенційної ендоскопії ДНП «Національний інститут раку» ендоскопічну папілектомію з приводу аденоми великого дуоденального сосочка (ВДС) проведено 19 пацієнтам (10 (52,63%) жінок та 9 (47,47%) чоловіків) віком від 24 до 78 років (середній вік — 45,6 року). У більшості випадків (2 (63,15%)) мали місце клінічні вияви білярної обструкції та холангіту.

Результати. У 10 (52,63%) хворих при розмірах новоутворення <1,0 см використовували загальноприйнятну методику петлевої резекції єдиним блоком (перша група). Для запобігання виникненню інтраопераційних та післяопераційних ускладнень нами розроблений та в 6 (31,57%) випадках застосований двохетапний метод ендоскопічної папілектомії (друга група). У 3 (15,78%) пацієнтів із розміром пухлини від 5,0 до 8,0 см використано методику фрагментації частини новоутворення, що найбільш виступає в просвіт кишки, з обов'язковим видаленням усіх фрагментів (третья група). Рецидив аденоми ВДС при контрольному дослідженні через 3 міс виявлено в 2 (10,5%) пацієнтів третьої групи. В обох випадках виконано петлеву діатермоексцизію рецидивних новоутворень і видалення стентів. При планових обстеженнях через 3 та 6 міс ознак продовження захворювання в обох випадках не зареєстровано.

Висновки. Топографо-анатомічні особливості ділянки ВДС зумовлюють складність хірургічного лікування пацієнтів з його новоутвореннями. Розроблена оригінальна методика ендоскопічної папілектомії дає змогу знизити ризики виникнення ранніх та пізніх післяопераційних ускладнень. Отримані результати застосування ендоскопічної папілектомії в лікуванні пацієнтів з аденомами ВДС дають змогу пропонувати даний метод як основний в експертних центрах.

Ключові слова: ендоскопічна папілектомія, аденома великого дуоденального сосочка, ендосонографія.

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Treatment of combat injuries to major arteries with extensive soft tissue defects

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OBJECTIVE – to enhance the treatment outcomes of combat injuries to the lower extremities with damage to major arteries and extensive soft tissue defects by preventing complications and implementing an improved surgical algorithm.

MATERIALS AND METHODS. The study was conducted on a cohort of patients with gunshot and explosive wounds in the femoropopliteal segment of the lower extremities, affecting the major arteries. These patients sustained injuries during combat operations and received treatment at the National Military Medical Clinical Center «Main Military Clinical Hospital» between 2014 and 2024. The cohort was divided into two groups. The main group (n=29) included patients who underwent treatment using an improved surgical algorithm that involved selective use of methods for extra-anatomic revascularization, ligation of the major arteries (in cases of complications in the reconstruction zone), and active application of rotational fasciocutaneous and muscle flaps to close soft tissue defects in the vascular reconstruction zone. The comparison group (n=41) included patients who received treatment using standard methods that involved staged surgical debridement, NPWT, and staged wound closure. All patients were males aged between 23 and 57, with gunshot wounds to the lower extremities that caused damage to major arteries and extensive soft tissue defects.

RESULTS. The improved surgical algorithm focused on patients with extensive soft tissue defects in the area of the reconstructed artery (> 100 cm²), often accompanied by Gustilo-Anderson grade IIIC gunshot fractures. The treatment strategy included the following key components: 1) Early wound closure using rotational fasciocutaneous and muscle flaps to ensure reliable coverage of the neurovascular bundle. 2) Extra-anatomic bypass for complications such as erosion, thrombosis, or progression of infection in the reconstructed artery. 3) Ligation of major arteries followed by active monitoring of limb viability and delayed revascularization when feasible in cases of extra-anatomic vascular restoration failure. The main group (treated using the improved algorithm) had a significantly higher limb preservation rate than the comparison group (treated with conventional methods), with 82.8% limb preservation and 17.2% amputations versus 53.7% limb preservation and 46.3% amputations, respectively. Statistical analysis using the χ^2 -test and Fisher's exact test confirmed the statistical significance of the improved surgical algorithm in amputation reduction rates (χ^2 -test 5.16, p=0.023; Fisher's exact test p=0.02).

CONCLUSIONS. The implementation of an improved surgical algorithm for the treatment of gunshot wounds to major arteries in the lower extremities, accompanied by extensive soft tissue defects, significantly reduced the amputation rate in our study, from 46.3% to 17.2% (p=0.02).

KEYWORDS

gunshot wounds, gunshot and explosive injuries to the arteries of the lower extremities, extra-anatomical bypass surgery, revascularisation of the lower extremities, amputation, limb loss, limb preservation.

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In modern warfare, the incidence of injuries involving major vascular damage has significantly increased compared to armed conflicts of the first half and middle of the 20th century [4, 8, 22]. According to numerous studies and reports, as well as our

observations [4, 7, 10, 11, 22], most combat-related vascular injuries affect the lower extremity arteries, specifically the femoropopliteal segment. While limb salvage rates have improved significantly since previous wars, primarily due to successful arterial repair

at the second level of medical care [11, 22], successful revascularization does not guarantee a complication-free recovery for these severely injured patients. Various authors report complications in reconstructed arteries occurring in 6–30 % of cases [1, 3]. In comparison, secondary amputations after arterial reconstruction for combat-related injuries range from 8.5 % to 38 % [2, 4, 6], with the highest failure rates occurring in the femoropopliteal segment [4, 6]. Among early complications following revascularization for gunshot wounds to the lower limbs, arterial reconstruction failure leading to hemorrhage poses a direct threat to the patient's life, especially at the third and fourth levels of medical care [22]. Additional severe complications include thrombosis in the reconstructed artery and progressive necrosis of muscle groups despite maintained arterial perfusion, which may necessitate timely amputation to prevent acute renal failure [6, 7, 9, 10, 11].

Early research focused on the widespread use of the Mangled Extremity Severity Score (MESS), which was introduced in 1990 to assess extremity injuries and guide amputation decisions. This score initially suggested a near-certain probability of amputation when reaching 7 points or higher. However, recent studies and the European Society for Vascular Surgery (ESVS) 2025 Clinical Practice Guidelines on the Management of Vascular Trauma highlight that advancements in medical technology have diminished MESS's predictive accuracy for amputation [13]. Improvements in vascular reconstruction techniques, enhanced anesthesia and resuscitation protocols, principles of damage control surgery, and advanced fracture fixation methods have all contributed to this development [12]. The primary risk factors for limb loss in combat trauma, as noted by most authors, include the extent of soft tissue damage, the presence of associated gunshot fractures, the severity of compartment syndrome, and the time frame from injury to revascularization [2, 3, 8, 10]. This study aims to focus on this particularly challenging category of injured patients and improve treatment outcomes despite several adverse prognostic factors.

OBJECTIVE – to enhance the treatment outcomes of combat injuries to the lower extremities with damage to major arteries and extensive soft tissue defects by preventing complications and implementing an improved surgical algorithm.

Materials and methods

We analyzed 209 medical records of patients treated at the National Military Medical Clinical Center «Main Military Clinical Hospital» for lower

extremity combat injuries between 2014 and 2024. A cohort of 70 patients was identified as having damage to major arteries in the iliac and femoropopliteal segments, as well as extensive soft tissue defects and associated injuries. Patients were divided into two groups. The main group (Group O) included 29 patients who underwent treatment using an improved surgical algorithm. The comparison group (Group P) included 41 patients who received treatment using standard methods such as repeated staged surgical debridement, NPWT (negative pressure wound therapy), and staged wound closure.

The improved surgical algorithm for treating gunshot and explosive wounds to major arteries with extensive soft tissue defects included (Fig. 1):

1. Prompt use of rotational fasciocutaneous and muscle flaps to cover soft tissue defects in vascular reconstruction areas without viable muscles;
2. Implementation of methods for extra-anatomic revascularization to address complications or substantial contamination in initially reconstructed vessels in original vascular bundle sites.

3. Ligation of the major artery followed by dynamic limb monitoring when extra-anatomic revascularization was not feasible due to complications or its imminent risk. The major artery supply was progressively restored if ischemic tolerance persisted after the active infection was treated. For cases of extensive soft tissue necrosis, especially those involving muscle loss, amputation was recommended.

All patients in the study cohort were males aged between 23 and 57 years. The mean age in the main group was 37.4 ± 11.4 years, while in the comparison group, it was 34.2 ± 8.0 years ($p > 0.05$), indicating no statistically significant difference in age between the groups.

The study included patients with injuries extending from the external iliac artery to the tibioperoneal trunk. All patients presented with extensive soft tissue defects ($> 100 \text{ cm}^2$) or Gustilo-Anderson grade IIIC gunshot fractures [10]. The soft tissue defects were deep, involving fascia, muscle, and bone tissue. In the main group, 26 patients had mine-blast or blast injuries, while 3 patients sustained gunshot bullet wounds. In the comparison group, 34 patients had mine-explosion injuries, and 7 had gunshot bullet wounds ($p > 0.05$).

All wounded individuals received staged medical care. At the second level of care (Role II), 70 % ($n = 49$) of patients had primary reconstructive arterial surgery. At the third level (Role III), 20 % ($n = 14$) underwent primary surgery on major arteries. At the fourth level (Role IV), 10 % ($n = 7$) had primary arterial reconstruction. The latter cases were associated with combat operations taking

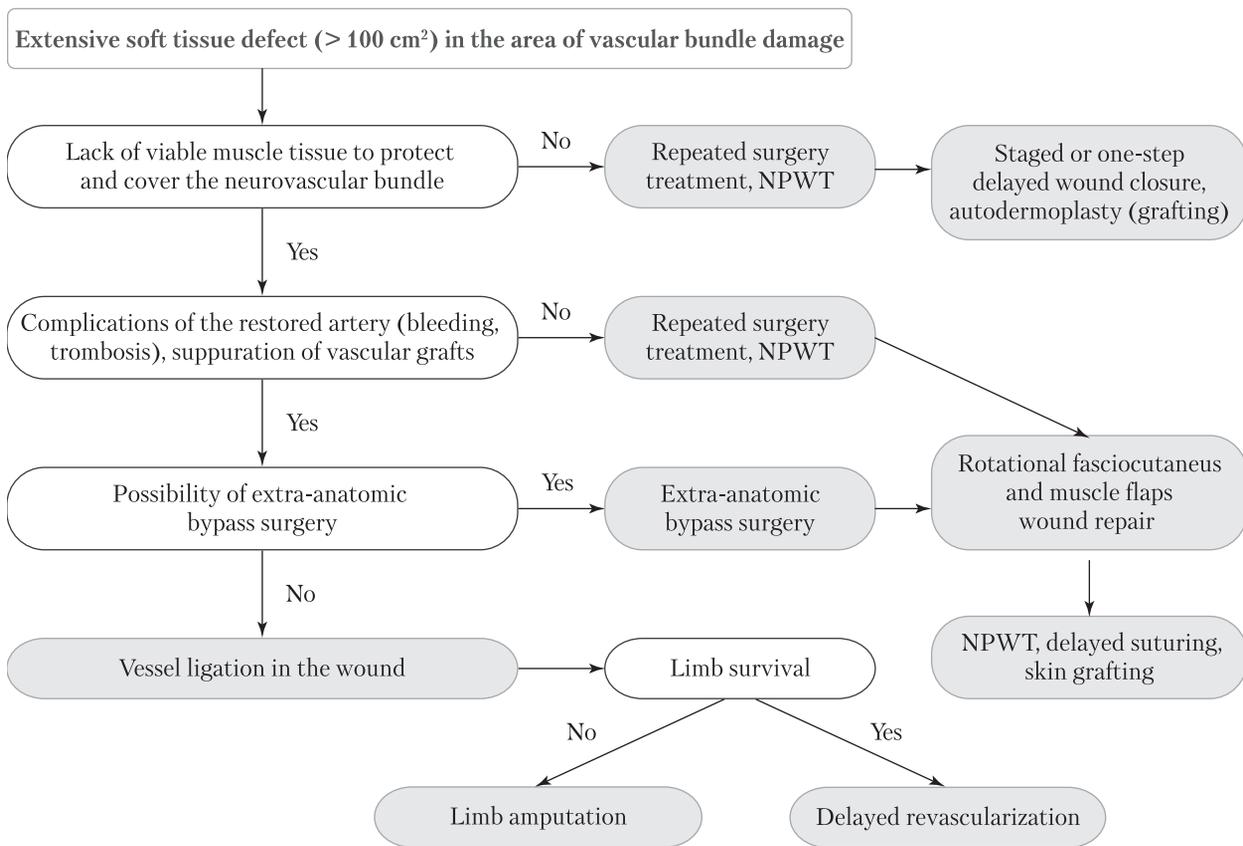


Figure 1. **Improved surgical algorithm for treating gunshot and explosive wounds to major arteries with extensive soft tissue defects**

place near Role IV medical facilities, which provided both second and third-level care. All repeated surgeries on major arteries and reconstructive-plastic interventions were conducted in Role IV medical facilities.

The most frequently affected area was the femoral segment (51 %, n = 36), followed by the popliteal segment (44 %, n = 31) and the external iliac artery (4 %, n = 3).

The study assessed both relative and absolute indicators of injury characteristics, primary and repeated surgical interventions, and treatment outcomes in both groups. The primary outcome measures were limb preservation (positive outcome) and amputation (negative outcome).

Statistical analysis was conducted using IBM SPSS Statistics, Version 22. Descriptive statistics were calculated. Mean values were presented as $M \pm SD$, while relative values were expressed as n (%). A comparison of mean values of quantitative variables was performed using the Mann-Whitney U test or Student's t-test, depending on data distribution. A comparison of relative values was carried out using Pearson's χ^2 test and Fisher's exact test. The null hypothesis was rejected at $p < 0.05$.

Results

The study groups did not statistically differ in terms of the characteristics of gunshot wounds to the lower extremities involving major arteries ($p = 1.0$). The most common associated injuries were major venous damage and gunshot fractures (Table 1).

Table 1. **Characteristics of gunshot and explosive wounds of the lower extremities with damage to the arteries in the main and comparison groups**

Characteristic	Group M (n = 29)	Group C (n = 41)
Concomitant gunshot bone fracture in the area of injury	20 (69.0 %)	27 (65.9 %)
Concomitant damage to the main veins	24 (82.8 %)	34 (82.3 %)
Concomitant damage to the sciatic nerve or its branches	15 (51.7 %)	20 (48.8 %)
Compartment syndrome	26 (89.7 %)	37 (90.2 %)
Acute kidney injury	11 (37.9 %)	13 (31.7 %)
Multiple injury	10 (34.5 %)	16 (39.0 %)

All $p > 0.05$.

There were no significant differences in the primary surgical interventions between the two groups. The most common method for restoring the integrity of the damaged vessel was suturing the defect in the artery. Other methods of revascularization were end-to-end anastomosis and autogenous vein graft repair of the damaged artery. Prosthetic PTFE grafting was not a priority method for revascularization in the femoropopliteal segment. It was primarily used in cases where a suitable great saphenous vein was unavailable or for iliofemoral reconstructions [5, 16].

It is important to note that all patients underwent fasciotomy of the lower leg compartments during the primary arterial reconstruction stage (Table 2).

The structure of secondary surgical interventions varied considerably between the two groups. In the main group (Group M), extra-anatomic bypass was performed in 8 (27.6%) patients, whereas no such cases were observed in the comparison group (Group C) ($p=0.0014$). Additionally, wound reconstruction using muscle flaps, PFAP flaps (Profunda Femoris Artery Perforator), and autografting, was performed significantly more frequently in the main group (Table 3).

At the fourth level (Role 2) of care, additional fasciotomy was performed in 6 cases (20%) in the main group and in 14 cases (34%) in the comparison group.

The early closure of exposed arteries in gunshot wounds with viable muscle is well justified, as it directly influences the integrity of the vascular suture [11, 13, 16]. However, within the first week post-injury, achieving such an outcome is often challenging due to extensive wound contamination and the necessity for staged surgical debridement to remove devitalized tissues (Table 4).

Comparison of treatment approaches

Thus, the treatment of patients in the main group differed significantly from that in the comparison group. In the main group, wound closure was performed using rotational muscle flaps (Fig. 2) or fasciocutaneous flaps when an extensive tissue defect was present and it was impossible to cover the vascular bundle with viable muscles after a series of repeated staged surgical debridement combined with NPWT and targeted antibiotic therapy to reduce infection.

Management of complications and extra-anatomic bypass

When it was not possible to rapidly control the infection within the wound or in cases of complications arising from the reconstructed vessels (Fig. 3), the method of extra-anatomic bypass (Fig. 4, 5) was applied to restore blood supply to the limb. This was followed by subsequent staged surgical debridement and closure of the wound defect.

Table 2. **Characteristics of primary surgical interventions**

Type of intervention	Group M (n = 29)	Group C (n = 41)
Autogenous interposition vein grafting	8 (27.6%)	8 (19.5%)
PTFE- grafting	2 (6.9%)	3 (7.3%)
Arterial suture	9 (31.0%)	15 (36.6%)
End-to-end anastomosis	8 (27.6%)	12 (29.3%)
Main artery ligation	2 (7.00%)	3 (7.3%)
Fasciotomy of the lower leg	29 (100.0%)	41 (100.0%)
Bone fracture fixation	20 (69.0%)	27 (65.9%)

All $p > 0.05$.

Table 3. **Characteristics of secondary surgical interventions**

Type of intervention	Group M (n = 29)	Group C (n = 41)
Autogenous interposition vein grafting	5 (17.2%)	12 (29.3%)
Extra-anatomic bypass	8 (27.6%)	0*
M. gracilis rotation flap	6 (20.7%)	2 (4.9%)
M. gastrocnemius rotation flap	5 (17.2%)	0*
M. sartorius rotation flap	4 (13.8%)	0*
PFAP- flap	2 (6.9%)	0
Main artery ligation	6 (20.7%)	8 (19.5%)
Staged repeated surgery treatment, NPWT	29 (100.0%)	41 (100.0%)
Wound suturing	11 (37.9%)	20 (48.8%)
Skin grafting	17 (58.6%)	11 (26.8%)*
Additional fasciotomies	6 (20.7%)	14 (34.1%)

The difference from the group M is statistically significant ($p < 0.05$).

Table 4. **The terms of reconstructive and plastic interventions in the wounded patients from the main group**

Intervention	Time since injury, days		
	4–7	8–11	12–15
Gastrocnemius muscle flap	–	4	1
Gracilis muscle flap	2	3	1
Sartorius muscle flap	1	1	2
PFAP-flap		1	1

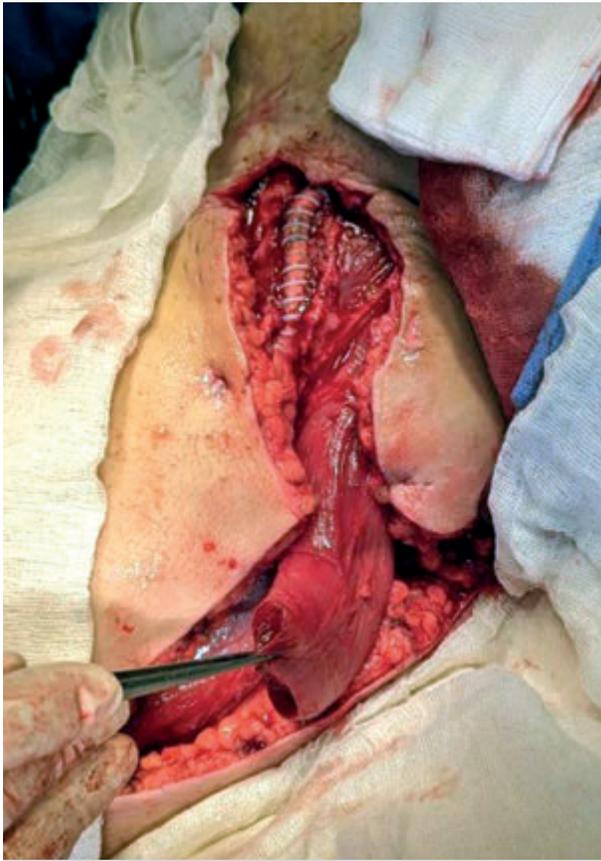


Figure 2. Coverage of the iliofemoral PTFE-graft in the upper third of the right thigh with a *m. gracilis* flap



Figure 3. Erosive bleeding after primary reconstruction from the SFA suture area. The wounded patient sustained an explosive shrapnel injury to the right thigh, causing damage to both the superficial femoral artery and vein. The patient presented with hectic fever, elevated C-reactive protein levels (190–230 mg/L), and a significant left shift in the leukocyte formula. Extensive necrosis of the adductor muscles and partial involvement of *m. vastus intermedius* were observed in the wound. The artery was exposed and unprotected, located within a purulent-necrotic focus

Illustrative case and vascular reconstruction technique

For example, Fig. 5 illustrates a treatment stage for a patient in the main group. In this case, a combined injury involving the sigmoid colon and external iliac artery was managed with an extra-anatomic crossover iliofemoral PTFE bypass to prevent contamination of the vascular reconstruction site.

When extra-anatomic bypass was technically unfeasible or in cases of complications involving the reconstructed vessel (Fig. 6, 7) and progressive necrotic-infectious processes in the affected zone, ligation of the major artery (typically the superficial femoral artery in the upper and middle thirds of the thigh) was performed.

Management of arterial ligation and ischemic complications

Surgical interventions involving ligation of major arteries in the femoral segment required careful post-operative monitoring of the patient's condition. If the limb exhibited good tolerance to ischemia, vascular reconstruction was performed on a delayed basis following wound decontamination or even complete healing. However, if ischemia of the distal muscle groups progressed – evidenced by elevated creatine phosphokinase (CPK) levels, increased pain syndrome, and signs of ischemic neuropathy – a decision was made to proceed with limb amputation.

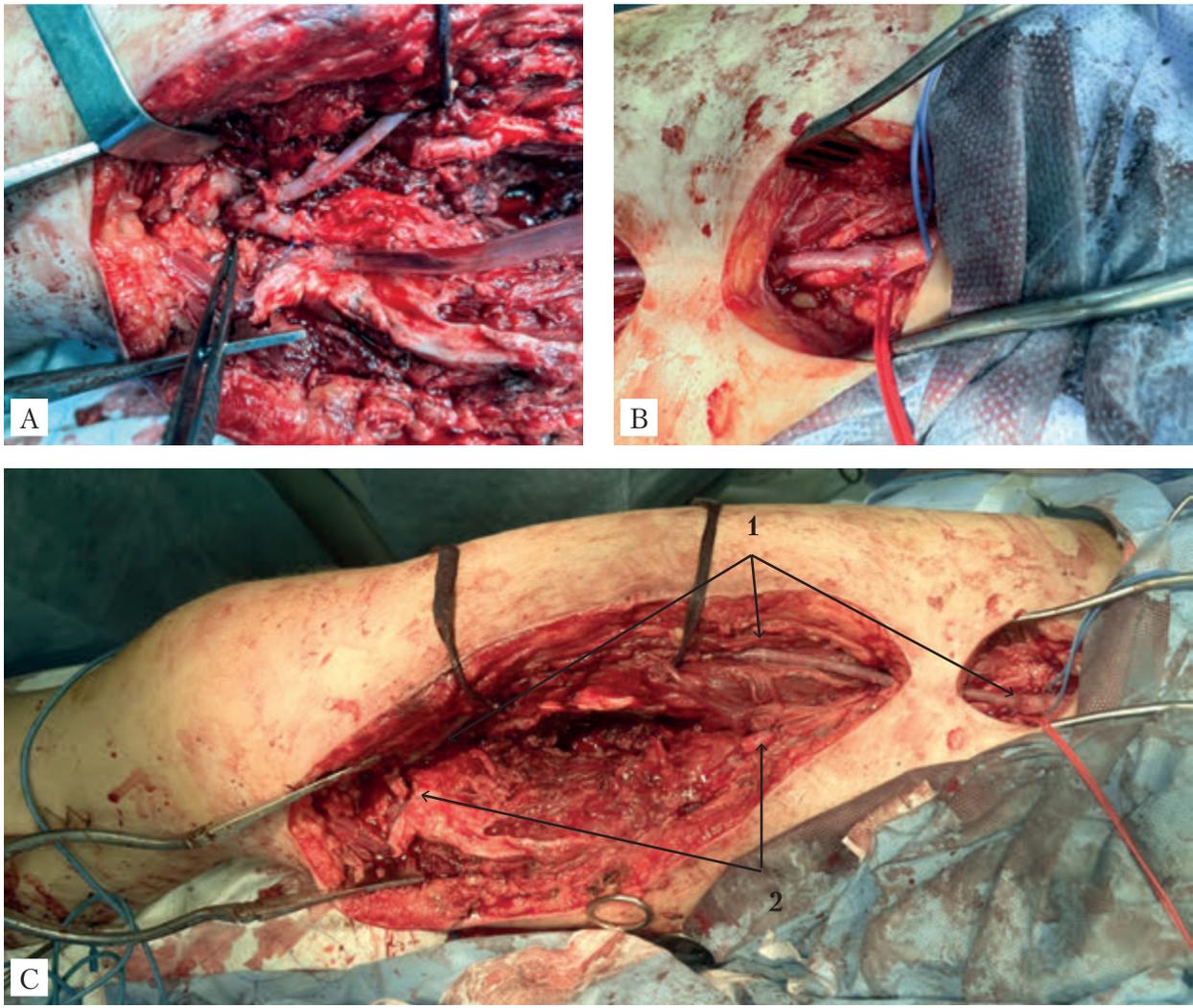


Figure 4. **Restoration of blood flow in the extremity via extra-anatomic femoropopliteal bypass using autogenous vein graft through the space between the rectus femoris and vastus intermedius muscles. The purulent-necrotic area is centrally located after debridement and preparation for NPWT system application. Distal, above the knee (A), and proximal (B) anastomoses. Extra-anatomic femoro-politeal bypass (C): 1 – femoropopliteal bypass; 2 – stumps of the ligated superficial femoral artery**

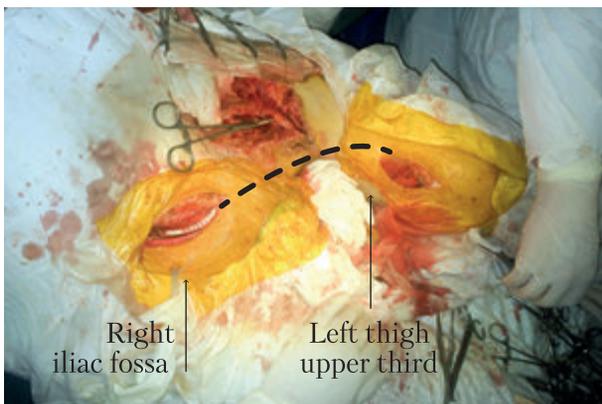


Figure 5. **Injury to the left iliac fossa with damage to the external iliac artery, combined with a penetrating abdominal wound involving the sigmoid colon. Due to failure of the primary ilio-femoral bypass, extra-anatomic crossover ilio-femoral PTFE-bypass was performed from right to left to achieve revascularization.**

Comparison group treatment approach

Patients in the comparison group were managed using staged repeated surgical debridement with NPWT and subsequent staged wound closure. Complications associated with vascular reconstruction, such as erosive bleeding, thrombosis, and progression of necrotic-infectious processes, were treated through repeated arterial defect suturing, bypass with autogenous vein grafts (interposition), thrombectomy, or arterial ligation with continued monitoring. In cases of progressive limb ischemia or recurrent vascular graft erosions, amputation was performed.

It is important to note that both groups initially received empirical antibiotic therapy, which was later adjusted to targeted antibacterial treatment based on bacteriological culture results. The spectrum of wound infection pathogens did not show significant differences between groups ($p > 0.05$, Table 5).



Figure 6. Erosive bleeding in a patient with an extensive soft tissue defect and a gunshot comminuted femoral fracture on day 8 of treatment following thrombectomy of the superficial femoral artery for post-traumatic thrombosis. NPWT was applied. The hemorrhage occurred due to arterial erosion in the setting of inflammatory changes, distal to the arteriotomy site. Direct compression was applied at the projection of the common femoral artery

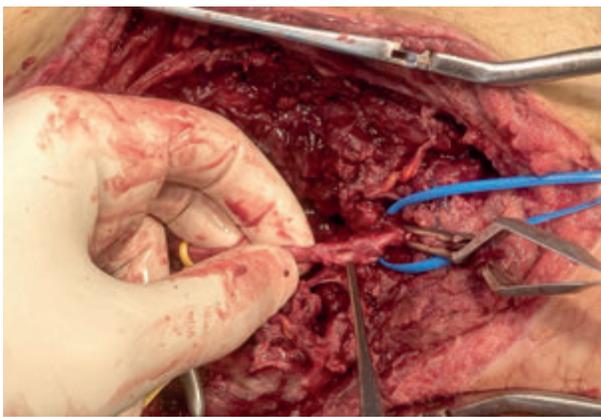


Figure 7. The forceps indicate the site of vascular suture rupture

Complications associated with vascular reconstruction

Wounds characterized by extensive soft tissue defects and gunshot fractures carry a high risk of complications involving reconstructed vessels [1, 3, 7, 9]. In both study groups, cases of erosive hemorrhages were observed, resulting from either suture line failure, arterial wall destruction, or graft erosion. Additionally, thrombosis of the reconstructed arterial segment and suppuration of the vascular bundle area were reported.

Table 5. Characteristics of wounded patients depending on the predominant wound microflora

Microorganism	Group M (n = 29)	Group C (n = 41)
<i>Klebsiella pneumoniae</i>	17 (58.6%)	28 (68.3%)
<i>Acinetobacter</i> spp., <i>baumanii</i>	10 (34.5%)	21 (51.2%)
<i>Proteus mirabilis</i>	4 (13.8%)	8 (19.5%)
<i>Staphylococcus aureus</i>	4 (13.8%)	1 (2.4%)
<i>Enterococcus faecium</i>	5 (17.2%)	6 (14.6%)
<i>Pseudomonas aeruginosa</i>	9 (31.0%)	17 (41.4%)
<i>Staphylococcus haemolyticus</i> (в крові)	5 (17.2%)	3 (7.3%)
<i>E. coli</i>	6 (20.7%)	5 (12.2%)

All $p > 0.05$.

Table 6. Complications of the restored arteries

Complications	Group M (n = 29)	Group C (n = 41)
Erosive bleeding	5 (17.2%)	6 (14.6%)
Reconstruction segment thrombosis	3 (10.3%)	7 (17.1%)
Infection, suppuration in the area of restored vessels	11 (37.9%)	19 (46.3%)

All $p > 0.05$.

There were no significant differences in the complication spectrum between Group M and Group C (Table 6).

Complications of vascular reconstruction

In the main group (Group M), the complications associated with reconstructed arteries were as follows: erosive bleeding – 5 cases (see Fig. 6), thrombosis of the reconstructed segment – 3 cases, and infection (suppuration) in the vascular reconstruction area – 11 cases. In the comparison group (Group C), the complications associated with reconstructed arteries were as follows: erosive bleeding – 6 cases, thrombosis of the reconstructed segment – 7 cases (Fig. 8), and infection and suppuration in the reconstructed vascular area – 19 cases.

Secondary amputations peaked in both groups during the second week of treatment (Table 7).

Treatment Outcomes and Statistical Analysis

The treatment outcomes in the main and comparison groups exhibited significant differences (Table 8).

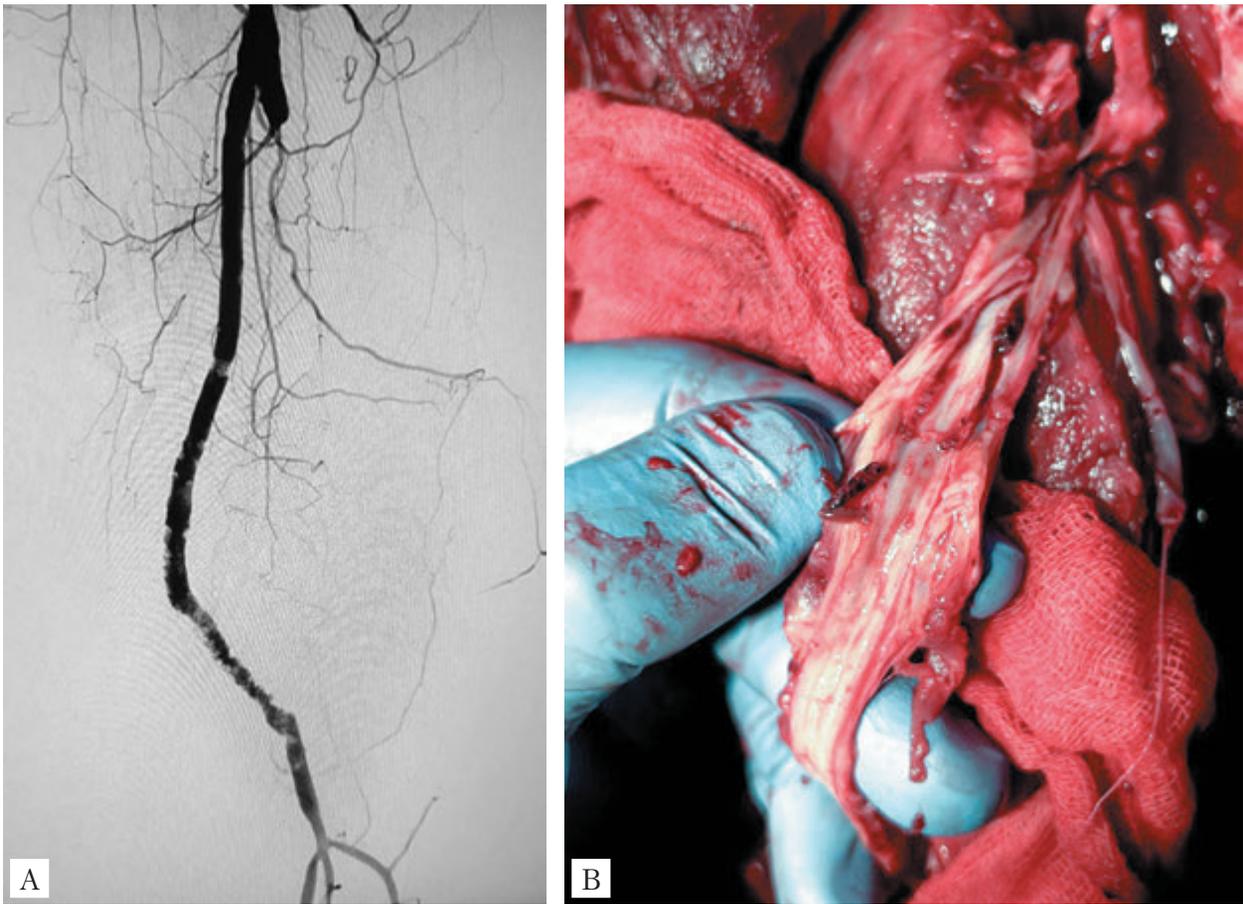


Figure 8. Recurrent thrombosis of the femoropopliteal bypass using an autogenous vein graft in a patient with an explosive shrapnel wound to the left lower limb involving injury to the distal portion of the superficial femoral artery. Chronology of secondary surgical interventions: 1) GSV graft thrombectomy, 2) re-bypass procedure, 3) thrombectomy, 4) revision of tibial arteries, 5) amputation at the mid-thigh level. Angiographic picture GSV graft thrombosis (A). Longitudinally dissected autogenous vein graft with thrombotic masses (B)

Table 7. Terms of amputations

Group	Time since injury, days			
	3–6	7–10	11–14	15–20
Main	–	3	2	–
Comparison	2	8	7	2

Table 8. Treatment outcomes in the groups

Treatment outcome	Group M (n = 29)	Group C (n = 41)
Limb preservation	24 (82.8%)	22 (53.7%)*
Amputation (within 4 weeks from the start of treatment)	5 (17.2%)	19 (46.3%)*
Referred to the orthopedic department after wound healing to change the method of bone fixation	14 (48.3%)	15 (36.6%)

The difference from the group M is statistically significant (p < 0.05).

The limb preservation rate was significantly higher in the main group, with 17.2% amputations and 82.8% limb salvage, compared to the comparison group, where 46.3% of patients required amputations, leaving only 53.7% with preserved limbs. Statistical analysis using the χ^2 test and Fisher's exact test demonstrated the statistical significance of the improved surgical algorithm in reducing amputation rates ($\chi^2 = 5.16$; $p = 0.023$; Fisher's exact test, $p = 0.02$).

Discussion

The wounded patients in this study cohort were characterized by extensive soft tissue defects and gunshot fractures. Numerous studies analyzing predictors of poor outcomes in vascular trauma have highlighted the presence of extensive soft tissue defects and concomitant fractures as key factors contributing to higher secondary amputation rates [1, 2, 7, 10]. This study aimed to improve treatment outcomes specifically for this high-risk patient category.

Lauren T. Greer et al. conducted a single-center study on vascular graft failures in combat casualties transferred to a tertiary hospital in the continental United States. The study included patients who had undergone limb vascular reconstruction in Iraq or Afghanistan and later experienced graft rupture. Among 10 secondary complications, 4 (40%) cases were erosive hemorrhages, which the authors associated with concomitant gunshot fractures, soft tissue defects, and infection [2].

The original MESS (Mangled Extremity Severity Score) study (1990) concluded that a score above 7 strongly predicted the need for amputation. All patients in our study cohort had MESS scores exceeding 7. However, recent studies have shown that advancements in technology have reduced the accuracy of MESS in predicting amputations. This improvement is attributed to modern vascular reconstruction techniques, enhanced resuscitation and anesthesia protocols, and advanced fracture fixation methods [12]. Other studies suggest that while MESS is useful for outcome prediction, it is not sufficiently precise to be relied upon exclusively [11]. Our findings support this view, as all patients in our cohort exceeded a MESS score of 7. We aimed to demonstrate the technical possibilities of limb preservation, following careful evaluation of the patient's general condition and the functional capacity of the preserved limb in the future.

According to literature data, the most common early complications in the treatment of gunshot wounds to the lower limbs with arterial injuries are recurrent thrombosis in the reconstructed segment, accounting for 72–80% of vascular graft complications [2, 4, 6]. Bleeding due to graft or anastomosis failure are the second most frequent complication. Our study, however, found a higher proportion of secondary hemorrhages (48% thrombosis vs. 52% bleedings). The higher rate of hemorrhages may be attributed to infection activity and wound necrosis expansion rather than purely surgical technique limitations. The first one can be both a consequence of imperfect surgical technique and progression of the infectious process in the wound. Secondary bleeding can be caused exclusively by the progression of infection activity and the expansion of necrosis in the radial tissue displacement area produced by the temporary cavity.

In our study cohort, the overall amputation rate was 34%, with 66% of limbs preserved. However, it is essential to note that our cohort consisted exclusively of severe injuries with extensive tissue loss and associated trauma. In contrast, Amila Sanjiva Ratnayake et al. analyzed risk factors for failed arterial reconstruction based on data from 129 combat

casualties in Sri Lanka, reporting an amputation rate of 20% following failed vascular reconstruction [1]. Similarly, Robert B. Laverty et al. studied vascular reconstruction outcomes in military trauma, describing secondary amputations in 23% of patients who had undergone femoropopliteal segment vascular repair [6].

Difficulties in treating these patients arise at the stage when the infectious process actively progresses within the wound, and the vascular bundle or graft is either surrounded by infected tissues or completely exposed over a large area, with no viable tissue available for coverage. This condition significantly increases the risk of multiple complications.

An effective strategy for limb salvage in cases of early complications (such as thrombosis and erosive bleeding) is extra-anatomic bypass. This technique involves placing the vascular graft and anastomoses within relatively healthy tissues, away from necrotic zones [2, 4, 13, 15]. This method is particularly justified in cases where the graft cannot be covered with viable tissues, either due to initial massive soft tissue loss or subsequent extensive necrectomies during wound debridement. Furthermore, placing a graft within the original vascular bundle site becomes impossible when infection-induced hemorrhage develops at the reconstruction site [13, 14]. In such cases, extra-anatomic bypass remains the only viable option for limb salvage [13, 14].

According to David Feliciano, the indications for extra-anatomic shunting in vascular trauma include: 1) extensive soft tissue loss over the injured vessel, 2) incisional infection with blowout of an underlying vascular repair, and 3) simultaneous infections in soft tissue and underlying native vessel secondary to injection of illicit drugs.

For lower limb explosive and gunshot wounds with major arterial injuries, the most commonly performed extra-anatomic bypass procedures include 1) crossover femoro-femoral bypass, 2) ilio-femoral bypass (see Fig. 6, 8), 3) ilio-popliteal bypass through the obturator foramen or lacuna musculorum, 4) femoro-anterior tibial (or peroneal) bypass along the lateral leg surface, and 5) femoropopliteal bypass between the quadriceps muscle layers (see Fig. 5) [13, 14].

However, not all vascular injuries can be managed with extra-anatomic bypass. Extensive soft tissue defects in the popliteal fossa, which prevent coverage of the exposed vascular reconstruction site, pose a major challenge. In such cases, immediate wound closure with musculocutaneous or muscle flaps may prevent limb loss, but only if infection control is concurrently achieved. Conversely, David Feliciano warns against over-reliance on plastic surgery

techniques in such complex injuries, particularly in cases of gunshot wounds or severe infections from illicit intravenous drug use. The combination of extensive vascular damage, soft tissue loss, and deep muscle cavitation complicates reconstruction. Feliciano notes that rotational muscle flaps may be ineffective due to multiple metallic foreign bodies, local edema, and large wound cavities [22].

Limb amputation in cases of vascular reconstruction failure should only be considered after thorough revision of the major arteries, muscle compartments, and the patient's overall condition, particularly when multiple injuries are present [8, 11, 12]. If severe vascular complications render safe revascularization impossible and fasciotomy reveals extensive muscle necrosis, amputation may be required. However, if muscle viability persists and some tissue responsiveness remains, limb salvage should be attempted through continued staged treatment.

In cases of complex polytrauma, such as chest, abdominal, pelvic, or severe cranial injuries, life-saving interventions must take priority over limb preservation. In such scenarios, timely amputation of a severely damaged limb may improve the overall prognosis and redirect trauma recovery towards survival.

Conclusions

The implementation of an improved surgical algorithm for the treatment of gunshot injuries to major arteries in the lower extremities, accompanied by extensive soft tissue defects, significantly reduced the amputation rate in our study, from 46.3 % to 17.2 % ($p = 0.02$).

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

Conception and design — K. V. Gumeniuk; data collection, critical revision of the article, analysis and interpretation of data, drafting the article — M. V. Shchepetov.

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Лікування вогнепальних поранень магістральних артерій із масивними дефектами м'яких тканин

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Мета — поліпшити результати лікування вогнепальних поранень нижніх кінцівок із ушкодженням магістральних артерій і масивними дефектами м'яких тканин шляхом профілактики ускладнень та впровадження активної хірургічної тактики за вдосконаленим алгоритмом.

Матеріали та методи. Проведено аналіз когорти пацієнтів із вогнепальними пораненнями стегново-підколінного сегмента нижніх кінцівок із пошкодженням магістральних артерій і великим дефектом м'яких тканин, які отримали поранення в результаті бойових дій та проходили лікування в Національному військово-медичному клінічному центрі «Головний військовий клінічний госпіталь» у 2014—2024 рр. Пацієнтів розподілили на дві групи. В основній групі (n = 29) пацієнтів лікували з використанням удосконаленого хірургічного алгоритму (з вибірковою застосуванням екстраанатомічних методів відновлення кровотоку, перев'язки магістральних артерій (зона реконструкції яких мала ускладнення) і активним використанням ротаційних шкірно-фасціальних та м'язових клаптів для закриття дефектів м'яких тканин у зоні судинної реконструкції), у групі порівняння (n = 41) пацієнти отримували лікування за стандартною методикою (етапні хірургічні обробки, NPWT-терапія, етапне ушивання ран). Усі пацієнти — чоловіки віком від 23 до 57 років.

Результати. Основними принципами вдосконаленого алгоритму є відбір пацієнтів із масивним дефектом м'яких тканин у зоні відновленої артерії (> 100 см²), зокрема із супутнім вогнепальним переломом кістки ІІІс типу за класифікацією Gustilo-Anderson, якомога раніше закриття рани з використанням ротаційних шкірно-фасціальних і м'язових клаптів, що забезпечує надійне укріплення судинно-нервового пучка, при ускладненнях у відновленій артерії (арозія, тромбоз, прогресування інфекційного процесу) — застосування методів екстраанатомічного шунтування, за неможливості екстраанатомічного відновлення кровопостачання — перев'язка магістральної артерії з динамічним спостереженням за станом кінцівки і пацієнта. При задовільній толерантності до ішемії після завершення активного інфекційного процесу — відтерміноване відновлення магістрального кровопостачання, при прогресуванні ішемії на тлі лігваної артерії та загибелі м'язів — ампутація кінцівки. Установлено, що частота збереження кінцівки була значно вищою в основній групі: 17,2% ампутацій і 82,8% збережених кінцівок, тоді як у групі порівняння — 46,3 та 53,7% відповідно. Статистичний аналіз отриманих даних виявив статистичну значущість удосконаленого алгоритму лікування цієї когорти поранених для збереження кінцівок ($\chi^2 = 5,16$; $p = 0,023$, точний тест Фішера $p = 0,02$).

Висновки. Упровадження вдосконаленого хірургічного алгоритму в лікування вогнепальних поранень магістральних артерій нижніх кінцівок із масивними дефектами м'яких тканин дало змогу знизити частоту ампутацій при цих тяжких видах бойової травми з 46,3 до 17,2% ($p = 0,02$).

Ключові слова: вогнепальні поранення, вогнепальні та вибухові пошкодження артерій нижніх кінцівок, екстраанатомічне шунтування, реваскуляризація нижніх кінцівок, ампутація, втрата кінцівок, збереження кінцівок.

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Non-contrast MRI and surgical concordance in fistula-in-ano

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Fistula-in-ano is an abnormal connection between the anal canal or rectum and the perianal skin, often resulting from infection in the anal glands. While clinical examination provides some insights, MR fistulogram is essential for detailed assessment and reducing recurrence rates after surgery.

OBJECTIVE – to compare and correlate the pre-operative non-contrast MR fistulogram findings with surgical findings, focusing on concordance rates for fistula type, craniocaudal extent of tracts, number and clock position of internal and external openings, and presence of complicating features like secondary tracts, supralelevator extension, presence and location of abscesses.

MATERIALS AND METHODS. We retrospectively analysed 236 patients with fistula-in-ano who underwent both MR fistulogram and subsequent surgery within a span of 1 month over one year. MRI scans were reviewed by an experienced radiologist blinded to surgical findings. Parameters assessed included fistula type (Parks, St. James, simple vs. complex), number and clock position of internal and external openings, craniocaudal level of internal openings, puborectalis involvement, secondary tracts, presence of secondary tracts, and location of abscess, if any. Concordance between MRI and surgical findings was evaluated using percentage agreement and weighted kappa coefficients.

RESULTS. Our study cohort had a mean age of 41.7 years, with the majority being men (89%) and cryptoglandular etiology (93.6%). Transsphincteric fistula was the most common type (64%). Complex fistulas were seen in 63.6%. Secondary tracts, abscesses, or multiple tracts were seen in 45%, 30.5%, and 11%, respectively. There was almost perfect agreement between MRI and surgical findings in identifying fistula type, clock position of internal and external openings, secondary tracts, and location of abscesses ($\kappa=0.98, 0.93, 0.94, 0.88$ and 0.98 , respectively), substantial agreement for the craniocaudal level of internal opening ($\kappa=0.72$), and only moderate agreement for the number of internal and external openings ($\kappa=0.56$ and 0.51 , respectively).

CONCLUSIONS. Non-contrast MR fistulogram, with its excellent soft tissue resolution, accurately depicts the type of fistula-in-ano, localises the internal and external openings, and identifies the presence of any complicating features with almost perfect agreement between MRI and surgical findings.

KEYWORDS

fistula-in-ano, perianal fistula, cryptoglandular fistula, MR fistulogram, complex fistula, Parks classification, St. James University Hospital classification.

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Fistula-in-ano is a pathological communication between two epithelialized surfaces, specifically the anal canal or rectum with the perianal skin, and the fistulous tract itself lined by granulation tissue [2, 21]. The prevalence of fistula-in-ano is estimated to be approximately 0.01% in the general population, with a higher incidence in young adults and a greater occurrence in males than females [5]. The anal

glands, located within the intersphincteric space, open into the anal crypts at the level of the dentate line [8]. Infection or obstruction of these glands is believed to be the primary etiological factor in the development of most cryptoglandular fistulas [10]. Once an infection establishes itself within the anal gland, it can spread through the path of least resistance, either forming an abscess or piercing through

the surrounding tissues to create a fistula [22]. This process is influenced by various immunological, microbiological, and host factors. Rarely, secondary causes such as Crohn's disease, tuberculosis, pelvic infections, trauma, diverticulitis, anorectal cancer, or radiation therapy can also lead to fistula formation [12]. The most frequent clinical manifestation of fistula-in-ano involves perianal discharge accompanied by pain, swelling, and inflammation in the affected region [5]. Parks classification categorizes fistula into four main types based on its relationship to the anal sphincter: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric [13]. The St. James University Hospital classification system further categorizes fistula based on anatomical landmarks, secondary extensions, and abscess formation, and it is more useful for describing the level of complexity of fistula-in-ano [12]. The precise preoperative assessment of fistula characteristics, including the location of the internal opening, the course and extent of the fistulous tract, and the presence of any associated abscesses or secondary extensions, is paramount for effective surgical management and prevention of fistula recurrence [17]. Clinical examination, including digital rectal examination and probing of the external opening may provide some anatomical detail about the fistula; however, it is often incomplete due to significant patient discomfort and may necessitate examination under anaesthesia (EUA) for better assessment. Imaging is frequently necessary to fully delineate the anatomy and associated complications of fistula-in-ano, with the exception of low uncomplicated fistulas [9, 18]. Magnetic resonance imaging (MRI)/MR fistulogram has emerged as the preferred non-invasive modality for evaluating complex perianal fistulas due to its superior soft-tissue resolution, multiplanar capabilities, and ability to detect subtle inflammatory changes and fluid collections as well as delineate complex fistula anatomy [5, 18]. Despite advancements in medical understanding and surgical techniques, the management of fistula-in-ano remains a formidable challenge, primarily because of the complex anal sphincter anatomy and the need to preserve sphincter function in order to prevent postoperative faecal incontinence [14]. MRI aids in assessing prognosis, particularly concerning the post-operative faecal incontinence by assessing the length of sphincter involved and monitoring treatment progress, including resolution or recurrence of the fistula [6].

Several studies have shown that MRI accurately detects the primary tract and presence of abscesses, with reasonably high sensitivity and specificity [9, 20]. However, we did not come across any large population study in English literature

with a head-to-head comparison between surgical findings and MRI, taking into consideration several MRI findings in patients with fistula-in-ano. Through this study, we aim to provide additional insight into the reliability of non-contrast MRI for accurate depiction of the number, clock position, and distance from the anal verge of the internal and external openings, secondary tracts, and presence and location of abscesses with respect to the anal sphincter and levator ani muscle.

OBJECTIVE. Through this large-volume retrospective observational study, we aim to compare and correlate the preoperative non-contrast MR fistulogram findings with surgical findings, focusing on concordance rates for fistula type, craniocaudal extent of tracts, number and clock position of internal and external openings, and presence of complicating features like secondary tracts, supralelevator extension, and presence and location of abscesses.

Materials and methods

We retrospectively reviewed all consecutive MRI scans done in the department of Radiology in our institution over the course of one year for patients with clinically apparent perianal fistulous disease who underwent surgery for the same within 1 month after the MRI scan (n = 236). Their demographic, clinical, and surgical details were obtained from electronic medical records (EMR) by the abdominal radiology fellow; MRI scans were reviewed on our PACS (Picture Archiving and Communication System) database by an experienced abdominal radiologist who was blinded to the operative findings. Patients who either did not undergo surgery after the MRI or those who underwent surgery more than a month after the MRI and had no fistula on imaging were excluded from analysis.

The MRI scans were performed on either a Philips 1.5-Tesla Ingenia S or a PHILIPS 3-Tesla Ingenia Elition X scanner using body or phased-array coils, without the use of intravenous paramagnetic contrast agents or instillation contrast into the fistulous tracts. No patient preparation was required prior to the scan. T2-weighted high-resolution MRI sequences, with and without fat suppression, using small field of view in sagittal, oblique axial, and oblique coronal planes with respect to the anal canal axis were used to document the MRI findings in a structured proforma. The detailed list of our MR fistulogram protocol is in Table 1.

Operative/surgical findings were considered as the gold standard to assess the accuracy of the following MRI parameters: 1. Fistula Type: Classified using both the Parks classification [13] and

Table 1. MR fistulogram sequences

MRI sequences	Slice thickness, mm		Slice gap, mm		TR/TE, ms		Flip angle, degree		Field of view, cm	
	1.5T	3T	1.5T	3T	1.5T	3T	1.5T	3T	1.5T	3T
T2 STIR axial	4	3.7	0	0.4	5300/75	5100/80	90	90	22×22	23×23
T2 STIR coronal	4	3.5	0	0.4	2200/60	5000/80	90	90	20×20	25×25
T2 STIR sagittal	4	4	0	0.4	2200/60	4700/80	90	90	20×20	25×25
3D T2 FS axial	2	1.2	0	0	1300/200	1500/152	90	90	34×34	28×28
DWI axial	4	4	0	0.8	4000/105	4900/79	90	90	26×26	24×24
T2 TSE axial	4	3.7	0	0.4	3600/100	4600/100	90	90	20×20	23×23
T2 TSE coronal	4	3.5	0.5	0.4	5300/100	4600/100	90	90	20×20	25×25
T2 TSE sagittal	4	3	0	0.3	3100/110	3600/100	90	90	20×20	25×25
T1 3D mDIXON	2	2.5	0	0	5900/0	4900/0	10	10	35×35	32×32

St. James University Hospital classification [12] systems 2. Internal Openings: Number and clock position, and craniocaudal level (low anal canal, mid anal canal, high anal canal or rectum) 3. External openings: Number and clock position. Additional MRI parameters assessed were: 4. Puborectalis sling involvement 5. Secondary tracts/extensions 6. The presence and location of fluid collections 7. Involvement of adjacent organs (urinary bladder, urethra, external genitalia, etc.). There was missing data in a few patients, as their surgical notes did not include information regarding some of the fistula parameters that we were trying to assess. The concordance rate in such instances was calculated by including only those patients with paired data available. We also documented the presence of any other compelling evidence of co-existing inflammatory bowel disease from the patient's EMR or other available imaging from PACS and any evidence of tuberculosis from the histopathological examination of the excised fistulous tract, when available. In patients with two or more fistulous tracts, the highest grade of St. James classification applicable to the patient was assigned; the rest of the details of each fistulous tract were documented separately. In cases where the internal opening was not visually apparent in the anal mucosa, its location was inferred based on the clock position and craniocaudal level where the fistulous tract penetrated the internal sphincter. Clock positions of the internal and external openings from MRI and surgery were considered concordant when they matched or were within one clock hour of each other. Every attempt was made to document the same details assessed during the surgery; however, in the event of one

or more missing details in the operative notes, the same parameter was excluded from analysis. When internal openings were not visible during the surgery, hydrogen peroxide was injected into the tract via the external opening to assist in identification. For the purpose of our study, the craniocaudal level of internal opening was categorized as low anal canal when the opening was seen at or below the inferior edge of the internal sphincter. The rest of the upper anal canal was arbitrarily divided into equal upper and mid thirds in order to be able to compare MRI and clinical findings. Clinically, the level of internal opening was documented as 'low' when it was at or below the dentate line. Above the level of the dentate line, the anal canal was arbitrarily divided into equal upper and mid thirds – equated to 'high' and 'mid' anal canal on MRI. Patients were also broadly grouped into simple and complex fistulas in this study, the latter characterized by the presence of one or more of the following features: high transsphincteric tract, involvement of puborectalis, supralelevator extension or rectal involvement, associated fluid collections, multiple fistulous tracts, involvement of > 30 % of the anal sphincter complex, coexisting tuberculosis, or Crohn's disease.

Statistical Analysis: Continuous and categorical data were described in terms of mean, frequencies (number of cases), and relative frequencies (percentages), as appropriate. MRI accuracy in predicting fistula type, number, clock position, and the craniocaudal level of internal opening was expressed as percentage concordance with surgical findings and also measured using the weighted kappa coefficient (κ) with a 95 % confidence interval (CI). The degree of agreement was classified as slight agreement

Table 2. **Demographics and clinico-radiological profile (n = 236)**

Indicator	Value
Age, years (mean (min–max))	41.7 (7–78)
Male	211 (89%)
Female	25 (11%)
Etiology of fistula	
Cryptoglandular	221 (93.6%)
Crohn's disease	5 (2.1%)
Tuberculosis*	4 (1.7%)
Trauma	4 (1.7%)
Immunosuppression (bone marrow transplant)	2 (0.8%)
Recurrent fistula	56 (23.7%)
Single fistula	211 (89.4%)
Multiple fistula	25 (10.6%)
2 tracts	23
3 tracts	1
4 tracts	1
Secondary tracts (information is available for 186 patients)	84 (45.2%)
Abscess	
Ischioanal fossa	36
Intersphincteric	25
Supralelevator	11

* Confirmed on histopathology of the excised fistulous tracts.

($0.01 \leq \kappa \leq 0.20$), fair ($0.21 \leq \kappa \leq 0.40$), moderate ($0.41 \leq \kappa \leq 0.60$), substantial ($0.61 \leq \kappa \leq 0.80$), or almost perfect ($\kappa \geq 0.81$). All the analyses were performed using the statistical package IBM SPSS 23.0 (SPSS, USA).

Results and discussion

A total of 423 MR fistulograms were performed in our Radiology department over 1 year for evaluation of perianal fistula. After excluding patients with duplicated imaging ($n = 19$), those who did not undergo surgery in our institute ($n = 127$), underwent surgery more than a month after MRI ($n = 14$), or had no fistula or alternate diagnosis on MRI ($n = 27$), a total of 236 patients were included in our final analysis with a mean age of 41.7 years and the majority being males (211, 89%), which is consistent with available literature [15, 20, 22]. The demographic and clinico-radiological profile of these patients is given in Table 2.

The overwhelming majority of our study patients were thought to have cryptoglandular perianal

fistula; etiology was attributable to tuberculosis or Crohn's disease (Fig. 1) in less than 4% of subjects, consistent with previous reports [16]. Despite the majority of our patients having cryptoglandular fistulas (93.6%), more than half had complex fistulas (63.6%) (Fig. 2). This is somewhat higher than the reported prevalence of complex fistulas in other studies [4, 9, 22] which can be explained by the referral bias in a tertiary care setting like our institution, which tends to attract a higher proportion of complex cases. Approximately a quarter of our patients (23.7%) had a history of prior fistula surgery and were presenting with recurrent perianal disease.

The most common type of fistula seen on both MRI and surgery was transsphincteric followed by intersphincteric types, and St James Grade III followed by Grade IV fistula (Table 3). Although intersphincteric fistula is the most frequently encountered in clinical practice, [12] transsphincteric fistula remains the predominant type identified on MRI, reflecting the inherent selection bias in all imaging-based studies, especially in a tertiary referral care centre [2, 14].

Abscess associated with perianal fistula was seen in 72 patients (30.5%), half of whom were in the ischioanal fossa. Puborectalis muscle involvement was observed in 54 patients (22.8%). Ten patients had fistulous tracts extending into adjacent organs, including the urethra ($n = 1$), penile shaft ($n = 2$), scrotum ($n = 4$), prostate ($n = 1$), vagina ($n = 1$), and inguinal region ($n = 1$).

Identification of fistula location and associated complications before surgery is crucial for appropriate surgical management and to minimize recurrence [11]. In our study, MRI accurately depicted the primary fistulous tract (both Parks type & St. James grade), clock position of internal and external openings, and presence of secondary tracts and abscesses with almost perfect agreement (κ ranging from 0.88 to 0.98) between MRI and surgical findings (Tables 3, 4). There was substantial statistical agreement ($\kappa = 0.72$) between MRI and surgical findings for the craniocaudal level of internal opening as well. Despite a reasonably high concordance ($> 70\%$) between MRI and surgery in identifying the number of internal and external openings, there was only moderate statistical agreement ($\kappa = 0.51–0.56$). This could be explained by the fact that one cannot always visualise the sinus opening itself on the skin or mucosa despite accurately localising the fistulous tract on MRI due to inflammation and swelling. In some long-term fistulas, the internal opening may be cicatrized, making its identification very challenging on MRI [19]. Moreover, when an internal opening is not directly visualised on MRI, its location may



Figure 1. 21-year-old woman with fistulizing Crohn's disease and complex branching high trans-sphincteric fistula. T2w axial MR images above the level of puborectalis (A), upper anal canal (B) and lower anal canal (C) demonstrating a nearly circumferential fluid tract/collection (black arrows) encircling the outer aspect of the anal sphincter complex and involving external sphincter muscle fibers, extending from the 1 to 8 o'clock position (A, B) at the upper anal canal and puborectalis level and from the 10 to 6 o'clock position at the lower anal canal level (C). Few blind-ending branching tracts are seen at 11 and 1 o'clock positions (white arrows in C). Craniocaudal extent of the tract and the external opening in the left gluteal region are well depicted in the T2w coronal image (D). The horseshoe-like extensions of the tract around the anal canal are depicted in the coronal T2w images at the level of the low anal canal (white arrow in D) and upper anal canal (white arrow in E). Sagittal CT image (F) of the same woman showing small bowel involvement by Crohn's disease with thickened and clumped ileal loops in the pelvis and ileovaginal fistula (black arrow) resulting in air in the vaginal lumen (*). She underwent EUA with drainage of collection and seton insertion and received antibiotics followed by Biologics

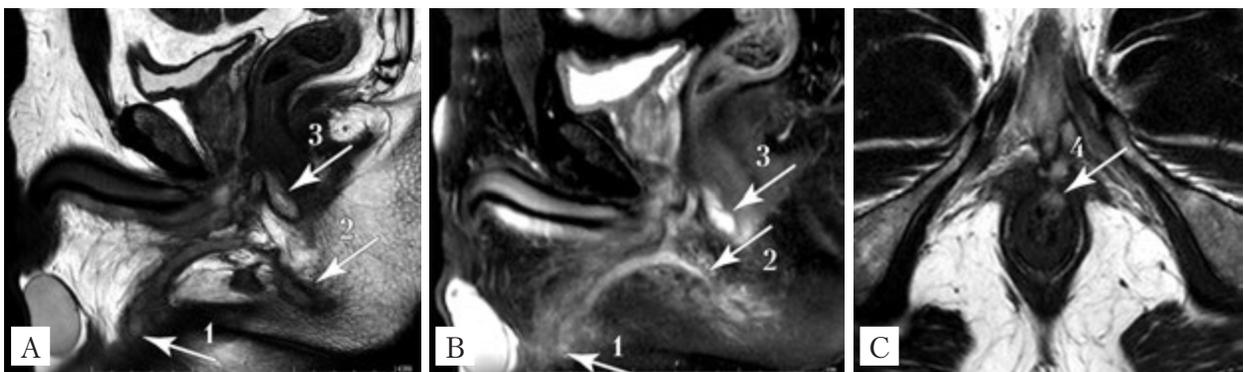


Figure 2. 36-year-old man with a complex branching anterior fistula-in-ano. T2w (A) and T2 Fat suppressed (B) sagittal MRI depicting the long anterior tract leading to the external opening in the scrotum (1), its branches in the perineum (2), and an anterior intersphincteric abscess (3). T2w axial MRI (C) depicts the defect in the internal sphincter with a potential internal opening (4) at the 12 o'clock position of the upper anal canal. Examination under anaesthesia showed a high anterior intersphincteric fistula with an external opening at the 1 o'clock position at the base of the scrotum, an internal opening at the 12 o'clock position 3 cm above the anal verge, and an intersphincteric abscess, which was drained along with partial fistulectomy and seton insertion

Table 3. MR and surgical classification of perianal fistula

Indicator	MRI	Surgery	Concordance	κ (95% CI)
Parks (n = 264)				
Intersphincteric	70 (26.5%)	67 (25.3%)	98.9%	0.97 (0.95–1)
Transsphincteric	169 (64%)	172 (65.1%)		
Suprasphincteric	13 (4.9%)	13 (4.9%)		
Extrasphincteric	12 (4.5%)	12 (4.5%)		
St James (n = 236)				
Grade I	43 (18.2%)	41 (17.3%)	98.7%	0.98 (0.96–1)
Grade II	16 (6.8%)	15 (6.3%)		
Grade III	83 (35.1%)	85 (36%)		
Grade IV	69 (29.2%)	70 (29.6%)		
Grade V	25 (10.5%)	25 (10.5%)		
Simple	86 (36.4%)	83 (35.1%)	98.7%	0.98 (0.96–1)
Complex	150 (63.6%)	153 (64.8%)		

Table 4. Concordance/agreement between MRI and surgical findings

Index	Patients with surgical and MRI details available	Concordance	κ (95% CI)
Number of external openings	232	166 (71.6%)	0.51 (0.4–0.62)
Clock position of external opening	205	173 (84.4%)	0.94 (0.91–0.97)
Number of internal openings	226	171 (75.7%)	0.56 (0.45–0.66)
Clock position of internal opening	187	156 (83.4%)	0.93 (0.88–0.96)
Level of internal openings	169	139 (82.2%)	0.72 (0.63–0.81)
Secondary tracts	186	175 (94%)	0.88 (0.81–0.94)
Abscess	236	233 (98.7%)	0.98 (0.96–1)

be inferred based on where the tract is seen involving the internal sphincter (as explained in the Methodology section); this is an indirect and less reliable way of assessment compared to the real-time visualisation of the internal or external openings during surgical exploration and taking advantage of hydrogen peroxide injection into the tract to assist in the identification of the internal opening.

We acknowledge the limitations in our study, including its retrospective nature, which may have resulted in missing data. In our institute we do not routinely administer I. V. Gadolinium for MRI, which arguably may have the advantage of identifying some secondary tracts and tiny abscesses that may be missed on non-contrast MR fistulogram [1, 3, 7].

Advantages of our study include a large sample size with a high proportion of complex fistulae and head-to-head comparison between multiple findings documented both on MR fistulogram and

surgical notes. We identified the MRI parameters that are highly reliable or concordant with surgery and listed some parameters that are less reliably depicted on MRI. Specifically, the ability of MRI to visualize soft tissues and delineate the course of fistulas and associated extensions makes it a valuable tool for surgical planning. For example, identifying supralelevator extensions preoperatively is crucial, as these can be easily missed during EUA [10].

Our head-to-head comparison between MR fistulogram and surgical findings helps highlight the reliability of preoperative MRI in depicting the morphology of complex fistulas. Most importantly, there was complete concordance between MRI features and surgical findings in terms of classifying the type of sphincter involvement, detecting abscesses, and identifying supralelevator extension.

MRI is highly effective in classifying sphincter involvement, detecting abscesses, and identifying

suprlevator extensions in anal fistulas. Studies have shown that MRI has a high sensitivity and specificity for identifying these features, often outperforming physical examination under anaesthesia.

Conclusions

Non-contrast MR fistulogram, with its excellent soft tissue resolution, accurately depicts the type of fistula-in-ano, the clock position of internal and external openings, the presence of any complicating features including secondary tracts, and the presence and location of abscesses with almost perfect agreement between MRI and surgical findings.

DECLARATION OF INTERESTS

The authors declare no conflicts of interest.

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ETHICS APPROVAL AND WRITTEN INFORMED CONSENT STATEMENTS

Ethical approval was waived by the Ethics Committee of Asian Institute of Gastroenterology, AIG Hospitals in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.

Patient Informed Consent: Not applicable; patient informed consent was waived as this is a retrospective study.

AUTHORS CONTRIBUTIONS

S. Naidu: data collection and interpretation, statistical analysis, drafting the article; T. Putta: conception and design, data interpretation, critical revision of the article.

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Відповідність між МРТ без контрастування та результатами інтраопераційної оцінки при норицях прямої кишки

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Нориця прямої кишки – це аномальне сполучення між анальним каналом або прямою кишкою та шкірою періанальної ділянки, яке здебільшого виникає внаслідок інфікування анальних залоз. Клінічне обстеження дає певну інформацію, але магнітно-резонансна фістулографія є необхідною для детальної візуалізації та зменшення частоти післяопераційних рецидивів.

Мета — оцінити відповідність між результатами доопераційної магнітно-резонансної фістулографії без контрастування та оцінкою інтраопераційно з урахуванням типу нориці, внутрішнього та зовнішнього отворів, краніокаудального рівня внутрішніх отворів, наявності вторинних ходів і локалізації вторинних абсцесів.

Матеріали та методи. Ретроспективно проаналізовано дані 236 пацієнтів із норицями, яким було виконано магнітно-резонансну фістулографію та подальше хірургічне лікування з інтервалом від 1 міс до 1 року. Магнітно-резонансні фістулограми були розглянуті досвідченим радіологом, який не був поінформований щодо результатів хірургічного лікування. Оцінювали такі параметри: тип нориці (за класифікаціями Паркса, лікарні Сент-Джеймса – проста чи складна), кількість і розташування внутрішніх та зовнішніх отворів, краніокаудальний рівень внутрішніх отворів та залучення лобково-прямокишкового м'яза, а також (за наявності) вторинні ходи й локалізацію абсцесів. Відповідність між результатами МРТ та оцінкою інтраопераційно визначали за допомогою відсотка узгодженості та коефіцієнта κ .

Результати. Середній вік пацієнтів дослідної групи становив 41,7 року, більшість із них були чоловіками (89%), етіологія – криптогенною (93,6%). Найпоширенішим типом нориці була транссфінктерна нориця (64%). Складні нориці спостерігалися у 63,6% пацієнтів, вторинні нориці, абсцеси або множинні нориці – у 45%, 30,5% та 11% відповідно. Установлено майже повну відповідність між результатами магнітно-резонансної фістулографії та оцінкою інтраопераційно щодо визначення типу нориці, розташування внутрішнього та зовнішнього отворів за умовним циферблатом, наявності вторинних ходів і локалізації абсцесів (κ 0,98, 0,93, 0,94, 0,88 та 0,98 відповідно), значну відповідність для краніокаудального рівня внутрішнього отвору ($\kappa = 0,72$) та помірну відповідність – щодо кількості внутрішніх та зовнішніх отворів ($\kappa = 0,56$ та 0,51 відповідно).

Висновки. Магнітно-резонансна фістулографія без контрастування забезпечує відмінну роздільну здатність м'яких тканин, точно відображує тип нориці прямої кишки, локалізацію внутрішніх та зовнішніх отворів, а також дає змогу визначити наявність будь-яких ускладнень із майже повною відповідністю між даними МРТ та результатами оцінки інтраопераційно.

Ключові слова: нориця прямої кишки, періанальна нориця, криптогландулярна нориця, магнітно-резонансна фістулографія, складна нориця, класифікація Паркса, класифікація Лікарні Святого Джеймса.

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Ultrasound-guided percutaneous surgical techniques as a definitive treatment for acute infected necrotizing pancreatitis

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OBJECTIVE – to identify clinical, laboratory, and imaging predictors for open necrosectomy in patients with acute infected necrotizing pancreatitis (AINP).

MATERIALS AND METHODS. A retrospective cohort study involving 188 patients with local AINP complications was conducted in a specialized surgical department from 2018 to 2023. All patients had ultrasound-guided percutaneous drainage. Patients were divided into two groups based on the effectiveness of ultrasound-guided minimally invasive surgery (MIS): those receiving ultrasound-guided MIS as a definitive treatment and those undergoing ultrasound-guided MIS combined with open necrosectomy. Clinical severity, CT index, comorbidities, laboratory parameters, and bacteriological culture results were analyzed. Statistical significance was assessed using the t-test, χ^2 test, and odds ratio (OR).

RESULTS. Ultrasound-guided MIS was an effective definitive treatment in 127 (67.5%) patients. Open surgery was required for 61 (32.4%) patients. Statistically significant risk factors for resorting to open surgery included a dense tissue component in the drainage area (OR=0.08), hemorrhagic effusion (OR=0.07), hypoalbuminemia (OR=0.09), anemia (OR=0.16), platelet abnormalities (OR=0.13), and early laparotomy (OR=0.09). Mortality in the ultrasound-guided MIS group was 9.6%, whereas in the open surgery group it was 29.5% ($p < 0.05$).

CONCLUSIONS. Ultrasound-guided minimally invasive drainage procedures are an effective and safe treatment for the majority of patients with infected necrotizing pancreatitis. The identified clinical and laboratory predictors serve as indications for open surgery.

KEYWORDS

acute necrotizing pancreatitis, infected necrosis, percutaneous drainage, ultrasound guidance, minimally invasive surgery.

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Acute necrotizing pancreatitis (ANP) poses a significant challenge to healthcare systems in the United States and Europe, as the incidence of affected individuals is steadily rising, accompanied by numerous complications and high mortality rates [13]. Approximately 300,000 individuals are admitted to emergency departments in the United States annually due to acute pancreatitis [11]. From 1964 to 2016, North America and Europe observed an annual increase of about 3% in this disease [11, 12]. The incidence of acute pancreatitis in Ukraine is 6.70–6.95 per 10,000 individuals. In the last two decades, acute pancreatitis has consistently ranked second in prevalence among

acute surgical pathologies of the abdominal cavity, with an overall mortality rate ranging from 4.5% to 15.0% [1]. Many clinics around the world report that 10 to 20% of patients with acute pancreatitis experience pancreatic necrosis, which represents a significant challenge in modern emergency pancreatology [8, 14]. Infection of necrotic foci in the pancreas and retroperitoneal region occurs in 40 to 70% of patients, correlating with a mortality rate of up to 20% [23].

The introduction of ultrasound-guided minimally invasive surgery (MIS) has greatly influenced the management of acute necrotizing pancreatitis, allowing the deferral of traditional open surgery.

The fourth week of the disease is considered optimal for initiating surgical intervention, typically conducted during the phase of walled-off necrosis (WON) [9].

In 2010, the PANTER study findings revealed certain advantages of a step-up strategy for the surgical management of patients with ANP prior to laparotomy. The research demonstrated a decrease in complication rates, including organ failure, from 40% to 12%, and a reduction in the mortality rate from 19% to 16% [22]. A follow-up of 73 patients over 86 months confirmed the advantages of the step-up approach [11].

To reduce the surgical risk in necrotizing pancreatitis, the implementation of minimally invasive surgical techniques is widely supported, including video-assisted endoscopic surgery, ultrasound-guided puncture drainage, minimal access surgery, and endoscopic interventions [12]. A systematic review of 11 studies assessing the effectiveness of minimally invasive drainage as the primary treatment for necrotizing pancreatitis revealed that 55.7% of patients benefited from this approach without necessitating supplementary open necrosectomy.

Numerous literature sources presently emphasize the choice of method, type, and timing of surgical intervention in the context of infectious complications of necrotizing pancreatitis, along with the determination of the appropriate timing for open surgery [14]. It is advised that in cases of confirmed infected pancreatic necrosis, open surgery should be deferred for at least 4 weeks after the onset of acute pancreatitis [15].

Upon analyzing the literature, it can be stated that traditional open necrotectomies have been overshadowed by minimally invasive techniques. The effectiveness of the latter has been demonstrated through randomized controlled trials. The advantages of minimally invasive necrotectomies include lower complication rates, cost effectiveness, and reduced mortality. Literature indicates that 35–55% of patients with infected localized necrosis can be effectively managed only using transcutaneous or endoscopic drainage [12, 14].

Table 1. **Distribution of patients with ANP who required ultrasound-guided MIS due to local complications, by severity**

Severity	MIS* (n = 127)	MIS + necrosectomy (n = 61)	Total (n = 188)
Moderate	102 (80.3%)	48 (78.7%)	150 (79.7%)
Severe	25 (19.7%)	13 (21.3%)	38 (20.2%)

The difference between the groups is statistically insignificant ($p = 0.09$; χ^2 criterion).

Our study identified risk factors that may necessitate an additional treatment stage for purulent-necrotic processes in patients with acute infected necrotizing pancreatitis.

OBJECTIVE – to identify clinical, laboratory, and visual predictors for open necrosectomy in patients with acute necrotizing pancreatitis complicated by purulent-necrotic processes in the retroperitoneal tissue.

Materials and methods

An analytical retrospective cohort study was conducted. Between 2018 and 2023, 188 patients with local ANP complications received treatment in the Specialized Hepatopancreatobiliary Department of the Kyiv City Clinical Hospital of Emergency Medicine, specifically in the Department of Surgery No. 2. Local complications manifested as fluid accumulations in the omental bursa and retroperitoneal space, requiring ultrasound-guided MIS.

The study included 86 (45.7%) women and 102 (54.3%) men aged 18 to 73 years.

The patients were divided into two groups. The first group consisted of 127 patients who underwent ultrasound-guided MIS as a definitive treatment. In contrast, the second group comprised 61 patients who received ultrasound-guided MIS supplemented with necrosectomy if the initial treatment proved unsatisfactory.

An analysis of odds ratios was conducted for several binary characteristics, calculating the OR, 95% confidence interval (CI), and p-value.

On admission to the emergency department, patients were examined in accordance with the standard of care for patients with urgent surgical conditions of the abdominal cavity (Order of the Ministry of Health of Ukraine No. 297 of 02.04.2010) [1]. All patients were subjected to clinical blood and urine tests, biochemical tests, blood coagulation system tests, and endotoxemia markers. Abdominal ultrasound, chest and abdominal radiography, esophagogastroduodenoscopy, spiral computed tomography, morphological analysis of pancreatic samples obtained intraoperatively, and bacteriological analysis of effusion from the abdominal cavity and retroperitoneal region were among the instrumental examinations.

The severity of ANP in patients with local complications was assessed using widely accepted scales based on the Atlanta classification, which was revised in 2012 (Table 1).

169 (89.9%) patients with moderate to severe acute necrotizing pancreatitis required hospitalization in the general intensive care unit (ICU). The remaining 19 (10.1%) patients were admitted to

the ICU after 19.0 ± 4.3 hours of hospitalization due to unsuccessful conservative therapy and increased intoxication. The characteristics of the patients are given in Table 2.

In the early stage of the disease, patients with ANP in the ICU received care in accordance with the therapeutic guidelines and protocols of the Kyiv City Clinical Hospital of Emergency Medicine [1].

All patients with ANP and local complications, including acute post-necrotic fluid accumulations in different parts of the retroperitoneal tissue (left and right paracolic spaces, omental bursa, pelvic tissue, parapancreatic fluid collections, and mesentery of the transverse mesocolon), were treated according to a step-up approach. Initially, ultrasound-guided MIS was performed. Two techniques were

Table 2. Characteristics of patients with ANP

Indicator	MIS (n = 127)	MIS + necrosectomy (n = 61)	p
Age, years (M ± SD)	43.6 ± 5.1	45.2 ± 7.3	0.074*
Body mass index, kg/m ² (M ± SD)	24.2 ± 2.0	26.5 ± 3.4	0.001*
Severity of the condition on admission (Bisap score, M ± SD)	3.1 ± 1.1	4.5 ± 1.0	0.001*
Etiology			
Biliary	11 (8.6%)	2 (3.2%)	0.304#
Alimentary	91 (71.7%)	49 (80.3%)	
Idiopathic	25 (19.7%)	10 (16.4%)	
CT severity index			
< 50 %	109 (85.8%)	46 (75.4%)	0.079#
> 50 %	18 (14.2%)	15 (24.6%)	
Time from diagnosis to ultrasound-guided MIS in the retroperitoneal region and omental bursa, days (M ± SD)	22.1 ± 4.5	16.4 ± 4.1	0.001*
Comorbidities			
Cardiopathology	14 (11.02%)	11 (80.03%)	0.185#
Lung pathology	8 (6.3%)	9 (14.8%)	0.058#
Kidney pathology	6 (4.7%)	8 (13.1%)	0.040#
Bacteriological culture result			
Positive	43 (33.9%)	61 (100%)	0.001#
Negative	84 (66.1%)	0	
Microbiology, infected forms			
<i>E. coli</i>	21 (48.8%)	42 (68.9%)	0.001#
<i>Klebsiella pneumoniae</i>	5 (11.6%)	6 (9.8%)	0.107#
<i>Acinetobacter</i> spp.	4 (3.1%)	2 (3.3%)	0.962#
<i>Pseudomonas aureginosa</i>	6 (4.7%)	5 (8.2%)	0.342#
Microbial associations	7 (16.3%)	6 (9.8%)	0.274#
One-time minimally invasive drainage	55 (43.3%)	10 (16.4%)	0.000#
Two or more repeated minimally invasive drainages	72 (56.7%)	51 (83.6%)	0.000#
Number of drained peritoneal areas (M ± SD)	2.3 ± 1.0	3.1 ± 2.0	0.182&
Complications of minimally invasive drainage techniques			
Bleeding	3 (2.7%)	7 (11.5%)	0.014#
Perforation of a hollow organ	5 (3.9%)	1 (1.6%)	0.665#
Length of hospital stay, days	53 (36–70)	88 (61–114)	0.000&
Mortality	12 (10.3%)	18 (29.5%)	0.000#

Note. * t-test; # χ^2 test (Fisher's exact test for $n < 5$); & Mann-Whitney test.

employed for ultrasound-guided MIS: the two-stage Seldinger technique and the trocar technique.

After detecting fluid accumulation in the retroperitoneal region, the Seldinger technique involved inserting an 18G Chiba needle into the target area with ultrasound guidance. After fluid aspiration, the outer sheath was advanced, and the core wire was removed. A guidewire of 0.035 or 0.038 inches was inserted into the needle's inner lumen, creating a ring within the cavity. The outer sheath was removed above the guidewire, and the canal was gradually dilated from 9 to 16 Fr. In patients undergoing the two-stage Seldinger technique, standard dilators were used in 2 Fr increments up to the final catheter size. The chosen catheter was advanced over the guidewire, ensuring all side holes were within the cavity before the guidewire was removed. A drainage bag was attached to the catheter. This technique allows maneuvering the guidewire accurately until the catheter is introduced. The disadvantages include a longer procedure time than in the trocar technique, guidewire kinking issues, and fluid leakage around the guidewire during needle or dilator withdrawal. For the two-stage drainage employing the Seldinger technique, 9–20 Fr direct drains were used.

The trocar technique involved mounting the catheter on a stylet or trocar without dilation. As a rule, the one-stage trocar technique was performed with 9–12 Fr pigtail catheters (Cook Medical USA, Balton Poland, Kamed Ukraine). After localizing the cavity and administering local anesthesia, the catheter was inserted into the fluid accumulation. The pigtail was deployed after being properly placed for fluid aspiration and ultrasound visualization, and the drainage bag was attached to the catheter. The benefits of this technique include faster catheter placement due to fewer steps and less fluid leaking along the canal.

All patients with acute pancreatitis exhibiting local complications required ultrasound-guided minimally invasive percutaneous drainage for fluid collections in the retroperitoneal compartments during the initial therapy phase. Two-stage drainage with the Seldinger technique was employed in 62 patients (32.9%), while one-step catheter placement using the trocar approach was performed in 31 patients (16.5%). In the remaining cases, the approaches for drainage catheter placement involved a combination of Seldinger drainage and trocar (one-step placement), contingent upon the clinical circumstances and anatomical location of the fluid accumulation inside the retroperitoneal compartments.

In 22 patients (11.7%), damage to a segment of the retroperitoneal tissue was identified. In 19 cases,

a post-necrotic fluid collection was observed in the left paracolic gutter, while in the remaining cases, it was located in the parapancreatic tissue adjacent to the omental bursa. In 48 (25.5%) patients, damage was identified in two retroperitoneal areas. In these cases, postnecrotic fluid accumulations were noted in the left paracolic gutter, the omental bursa, and the retroperitoneal tissue within the small pelvis. Damage to three retroperitoneal areas was noted in 87 (46.2%) patients, with postnecrotic fluid collections found in the parapancreatic tissue, right and left paracolic gutters, omental bursa, and retroperitoneal tissue within the small pelvis. In 31 (16.4%) patients, damage to over three retroperitoneal tissue compartments was discovered.

Results

Ultrasound-guided percutaneous MIS was used as the final stage of surgical treatment in 127 (67.5%) patients. Bacteriological findings indicated fluid collections in 62 (48.8%) patients. Between 2 and 5 drainages were used, progressively increasing the diameter to 20 Fr with the implementation of flowing drainage. The application of ultrasound-guided percutaneous minimally invasive surgical techniques for the definitive draining of fluid collections with positive bacteriological culture results led to a fatal outcome in 6 (9.6%) patients (Figure).

In 65 (51.2%) patients with ANP who underwent minimally invasive interventions, culture findings were negative after fine-needle aspiration for fluid accumulation in the retroperitoneal tissue. The indications for puncture and drainage of fluid collections in the retroperitoneal spaces and the omental bursa during the sterile course of ANP included progressive infiltration of the retroperitoneal space with pancreatic exudate, severe pain syndrome, compression of adjacent organs, and the onset of abdominal compartment syndrome. In 8 cases, diagnostic puncture of the fluid accumulation in the retroperitoneal tissue and the omental bursa yielded a cloudy hemorrhagic exudate with necrotic tissue content. In 3 cases, purulent material devoid of odor was recovered. These 11 cases were identified as instances of infected ANP, and the negative microbiological culture results could be attributed to a laboratory error. The remaining patients had a sterile course of ANP. In patients with negative bacteriological culture results, good outcomes were observed in 60 (92.3%) individuals following the drainage of fluid collections. The indications for the use of ultrasound-guided MIS in the sterile course of ANP included the progressive spread of pancreatic exudate within the retroperitoneal space,

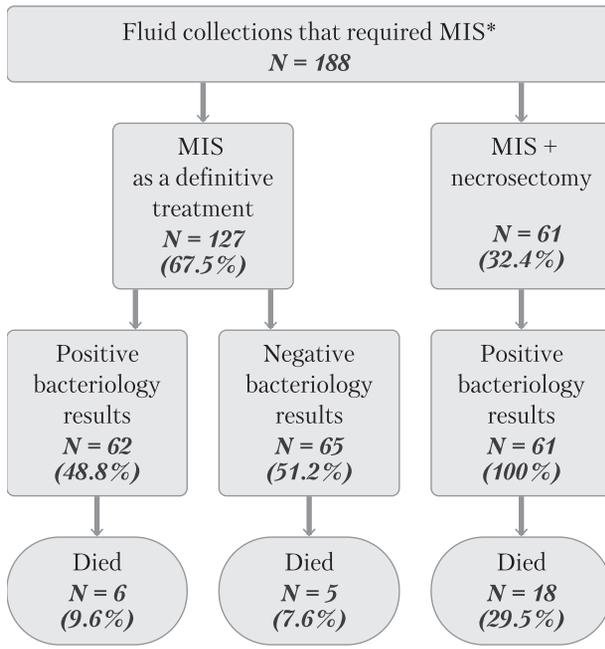


Figure. Treatment outcomes for ANP patients with local complications requiring ultrasound-guided minimally invasive correction of fluid accumulations in the retroperitoneal tissue

accompanied by symptoms of intoxication, the onset of compartment syndrome, and the compression of adjacent organs and tissues resulting in pain syndrome. The mortality rate was 7.6% (5 cases). The cause of mortality was a concomitant pathology that substantially exacerbated the progression of the primary disease.

In 61 (34.2%) patients, ultrasound-guided minimally invasive techniques for local complications of ANP were ineffective. In these patients, open

surgical treatment approaches were employed after an average of 24 ± 3 days, which included open necrosectomy with end-to-end draining of the necrotic areas in the retroperitoneal tissue and pancreatic bed. Ultrasound-guided minimally invasive procedures as the initial stage of surgical treatment for patients with local complications of ANP and subsequent open necrosectomy resulted in 18 (29.5%) fatal outcomes and 43 (70.4%) recoveries. We identified the factors that influenced the choice and scope of surgical techniques for patients with infectious complications of ANP (Table 3).

When analyzing the obtained indicators, it was found that the presence of a number of clinical and laboratory indicators is statistically significantly associated with an increased probability of the need for laparotomic necrosectomy after minimally invasive surgery (MIS).

In particular, a dense tissue component in the drainage area 10 ± 3 days after ultrasound-guided MIS significantly increased the probability of transition to open surgery (OR 0.08; 95% CI 0.03–0.20; p < 0.001). A similar association was established for hemorrhagic effusion in the abdominal cavity during laparocentesis (OR 0.07; 95% CI 0.03–0.18; p < 0.001).

Platelet counts outside the reference range (> 400,000/mm³ or < 150,000/mm³) were also significantly associated with the need for a more aggressive surgical approach (OR 0.13; 95% CI 0.05–0.36; p < 0.001). Similar results were obtained for low albumin values (less than 55 g/l) – OR 0.09 (95% CI 0.03–0.29; p < 0.001), as well as hemoglobin (less than 110 g/l) – OR 0.16 (95% CI 0.07–0.39; p < 0.001).

Table 3. Factors influencing the choice of surgical techniques for patients with infected necrotizing pancreatitis

Factor	MIS as a definitive treatment for infectious complications (n = 62)	MIS + necrosectomy (n = 61)	OR (95% CI)
Presence of a dense tissue component in the drainage area 10 ± 3 days after ultrasound-guided MIS	9 (14.5%)	41 (67.2%)	0.08 (0.03–0.20)
Diagnostic laparotomy within the first 7 days of the disease	1 (1.6%)	9 (10.1%)	0.09 (0.01–0.77)
Platelet counts > 400,000/mm ³ or < 150,000/mm ³ (at the time of MIS)	6 (9.6%)	27 (44.7%)	0.13 (0.05–0.36)
Albumin levels < 55 g/l (at the time of MIS)	4 (6.5%)	26 (29.2%)	0.09 (0.03–0.29)
Hemoglobin values < 110 g/l (at the time of MIS)	9 (14.5%)	31 (34.8%)	0.16 (0.07–0.39)
Presence of hemorrhagic effusion in the abdominal cavity during laparocentesis	8 (12.9%)	41 (46.1%)	0.07 (0.03–0.18)

Note. The difference between the groups is statistically significant (p < 0.05) for all factors.

In addition, performing diagnostic laparotomy in the first 7 days from the onset of the disease also turned out to be a statistically significant prognostic factor for resorting to open surgery (OR 0.09; 95 % CI 0.01–0.77; $p = 0.008$).

OR values below 1 in all cases indicate that the identified factors were more common in patients who required open necrosectomy. It allows us to consider them as predictors of lower effectiveness of MIS as a definitive treatment.

The obtained results emphasize the importance of a comprehensive assessment of patients' condition for choosing the optimal treatment strategy.

Discussion

Percutaneous puncture-drainage techniques are generally accepted in the management of ANP and can be used as a definitive solution, eliminating the need for traditional open surgeries. P.C. Freeny et al. [7] first described a homogeneous group of 34 patients who received only ultrasound-guided percutaneous treatment for infected necrotizing pancreatitis. They recorded clinical success in 47 % of cases.

The analysis revealed 3 cohort studies that described ultrasound-guided percutaneous drainage for infected necrotizing pancreatitis [6, 15, 25].

J. F. Delattre et al. [6] used percutaneous drainage in 42 patients with infectious complications of ANP. Positive dynamics were noted in 16 % of patients, and mortality was 17 %. M. Navalho et al. [15] performed ultrasound-guided percutaneous drainage of infected fluid accumulations in 30 patients. In 63 % of those patients, minimally invasive percutaneous drainage was used as a definitive treatment with positive dynamics. E. Zerem et al. [25] published the results of a study of the largest cohort of patients with infectious complications of pancreatic necrosis who underwent ultrasound-guided drainage. In 58 of 69 cases, percutaneous drainage had a positive effect. The remaining patients required open surgery. The mortality rate was 8.7 %. This result can be explained, at least in part, by the careful technique of performing manipulations, constant sanitation of drains to fragment the necrotic tissue component, and frequent manipulations with catheters since proper percutaneous drainage requires regular replacement.

Modern treatment of necrotic pancreatitis involves the so-called «step-up» approach. Ultrasound-guided percutaneous techniques are usually used as a first step and are often considered a temporary method to control sepsis and delay open surgery. However, ultrasound-guided minimally invasive percutaneous techniques are frequently the only necessary and definitive treatment in this

patient population. In a study by H. C. van Santvoort et al. [22], ultrasound-guided percutaneous drainage was the definitive treatment in approximately one-third of patients with infected necrosis.

The literature reviewed does not provide clear criteria for predicting which patients with infected necrotizing pancreatitis may benefit from percutaneous drainage. K. Horvath et al. [10] found that a 75 % reduction in the size of the collector at 10–14 days after percutaneous puncture and drainage was 100 % accurate in predicting the success of percutaneous drainage.

In our study, 67.5 % of patients required only percutaneous drainage. In 48.8 % of cases, percutaneous drainage was used as a definitive treatment for infected post-necrotic fluid collections in different areas of the retroperitoneal tissue.

Infection of necrotic foci in the pancreas and retroperitoneal space occurs in 40 to 70 % of patients, which is associated with a mortality of up to 20 % [22]. In our study, positive bacteriological cultures were collected in 53.3 % of patients with ANP-related local complications. According to D. R. J. Wolbrink et al. [24], negative bacteriological results are recorded in 12–25 % of cases, complicating the diagnosis of infected necrosis. In our study, false-negative culture results were recorded in 13.1 % of cases.

The most common complications of percutaneous catheter drainage include bleeding, internal organ perforation, and drainage dislocation [21]. The course of pancreatic necrosis, rather than the drainage itself, may cause bleeding sometimes (6.2 %) [9, 23]. Intestinal fistula formation may result from the spread of inflammation or unintentional injury to the intestine during percutaneous drainage [22]. After minimally invasive percutaneous interventions, we observed a complication in two patients: catheter displacement into the colon. In 3 (3.5 %) cases, bleeding caused by retroperitoneal vascular erosion was treated conservatively.

Ultrasound-guided percutaneous drainage for ANP-related infectious complications is a low-risk technique. We recorded complications associated with percutaneous drainage in 17.8 % of cases, which we attribute to good patient selection, careful assessment and planning before the treatment, medical staff experience, and proper drain management. Percutaneous techniques also shorten hospital stays, resulting in decreased rates of nosocomial infections and overall treatment costs [7, 20]. In our study, the average hospital stay for patients with acute infected necrotizing pancreatitis who had minimally invasive percutaneous treatment was 53 days. Necrosectomy led to a lengthier stay

in the surgical hospital (mean 88 days, $p < 0.05$). In our investigation, using ultrasound-guided minimally invasive techniques as a definitive treatment for infected retroperitoneal fluid masses resulted in a 9.6% death rate, compared to 29.5% after open surgery for infected necrotizing pancreatitis ($p < 0.05$).

Conclusions

The presence of a dense necrotic tissue component in the drainage after 10 ± 3 days (OR 0.08; $p < 0.001$), hemorrhagic effusion in the abdominal cavity (OR 0.07; $p < 0.001$), and diagnostic laparotomy within the first 7 days of the disease (OR 0.09; $p = 0.008$) are correlated with a markedly higher probability of undergoing open necrosectomy.

Platelet deviations (OR 0.13; $p < 0.001$), hypoalbuminemia (OR 0.09; $p < 0.001$), and anemia (OR 0.16; $p < 0.001$) significantly increase the risk of resorting to open surgery in acute necrotizing pancreatitis complicated by purulent-necrotic processes in the retroperitoneal tissue.

DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could influence the work presented in this manuscript.

AUTHORS CONTRIBUTIONS

Y.M. Susak: study concept, literature review, and data analysis; O. O. Dyrda: study design, literature review, patient selection, performance of ultrasound-guided minimally invasive procedures.

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Транскутантні хірургічні технології під ультразвуковим контролем як остаточний метод лікування в пацієнтів із гострим інфікованим некротичним панкреатитом

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Мета — визначити клінічні, лабораторні та візуалізаційні предиктори необхідності виконання відкритої некрсеквестрэктомії в пацієнтів із гострим інфікованим некротичним панкреатитом.

Матеріали та методи. Проведено ретроспективне когортне дослідження 188 пацієнтів із локальними ускладненнями гострого інфікованого некротичного панкреатиту, які проходили лікування в спеціалізованому хірургічному відділенні в період з 2018 до 2023 р. Усім пацієнтам проведено черезшкірне дренивання під ультразвуковою навігацією. Залежно від ефективності малоінвазивного втручання (МІНВ) пацієнтів розподілили на дві групи: МІНВ як остаточне лікування та МІНВ + відкрита некрсеквестрэктомія. Аналізували клінічне тяжкість, КТ-індекс, супутні хвороби, лабораторні показники та результати бактеріологічного посіву. Статистичну значущість оцінювали за t-критерієм, χ^2 і відношенням шансів (ВШ).

Результати. МІНВ було ефективним остаточним методом лікування в 127 (67,5%) пацієнтів. Потреба у відкритій операції виникла в 61 (32,4%) пацієнта. Статистично значущими чинниками підвищеного ризику переходу до відкритої хірургії були: щільний тканинний компонент у зоні дренивання (ВШ 0,08), геморагічний випіт (ВШ 0,07), гіпоальбумінемія (ВШ 0,09), анемія (ВШ 0,16), зміна рівня тромбоцитів (ВШ 0,13), рання лапаротомія (ВШ 0,09). Летальність у групі МІНВ становила 9,6%, у групі з відкритим втручанням — 29,5% ($p < 0,05$).

Висновки. Малоінвазивні методи дренивання під ультразвуковим контролем є ефективним і безпечним методом лікування в більшості пацієнтів з інфікованим некротичним панкреатитом. Виявлені клініко-лабораторні предиктори дають змогу прогнозувати необхідність відкритого оперативного втручання.

Ключові слова: гострий некротичний панкреатит, інфікований некроз, черезшкірне дренивання, ультразвукова навігація, малоінвазивна хірургія.

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Clinical and anamnestic characteristics of patients with different subtypes of chronic slow transit constipation

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In recent years, chronic slow transit constipation (CSTC) continued to be an actual clinical challenge due to its high prevalence, multifactorial pathogenesis, and the limited efficacy of current therapeutic strategies. The literature still lacks clear evidence regarding the correlation between the clinical manifestations of CSTC and specific histological alterations within the intestinal wall.

OBJECTIVE – to identify the clinical course in peculiarities in patients with CSTC depending on the histological subtype of the colonic wall.

MATERIALS AND METHODS. The study included 107 patients diagnosed with chronic slow-transit constipation (STC group) who underwent evaluation and surgical treatment at the clinical departments of Bogomolets National Medical University between 2011 and 2023. The diagnosis of STC was established according to the Rome IV criteria.

RESULTS. The Cajal subtype was associated with the youngest age of disease onset (8.67 ± 5.08 years), the longest duration of symptoms (25.24 ± 11.18 years), and the highest prevalence of family history (90.5%). This subtype had the lowest average body mass index 20.4 ± 2.3 kg/m². The neuropathic subtype was observed in the oldest patients (52.45 ± 13.61 years) and had a later onset of symptoms compared to other variants. It was characterized by a significantly shorter interval between defecations (8.1 ± 2.5 days). The inflammatory myopathic subtype was accompanied by the most pronounced pain syndrome (4.8 ± 1.4 points on the scale) compared to other subtypes, thereby confirming the role of inflammation in the development of abdominal pain. The dystrophic myopathic subtype was associated with the highest body mass index 25.7 ± 4.3 kg/m² and the longest interval between defecations (12.4 ± 5.5 days), indicating slow transit and muscle layer degeneration. Patients with late onset of symptoms and no need for manual assistance during defecation were more likely to have a histologically intact subtype.

CONCLUSIONS. The clinical course in surgically treated patients with CSTC, resistant to conservative therapy, is heterogeneous and significantly varies depending on the histological subtype of the bowel wall, indicating different pathophysiological mechanisms of constipation in different patients. The cajal, neuropathic, myopathic dystrophic, and inflammatory subtypes have clinical differences in the age of disease onset, symptom duration, interval between defecations, pain intensity, and body mass index. Morphological stratification of CSTC based on histological subtypes may provide valuable prognostic and therapeutic information, helping to individualize treatment strategies for patients with severe forms of constipation.

KEYWORDS

chronic slow transit constipation, histological subtype of the colonic wall.

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Chronic slow transit constipation (CSTC) is one of the main forms of chronic idiopathic constipation accompanied by a significant reduction in patients' quality of life and often requires a complex differential

approach for diagnosis and treatment [2, 4, 14, 16]. In recent years, CSTC has remained a relevant clinical concern due to its high prevalence, multifactorial pathogenesis, and the limited efficacy of current

therapeutic strategies [2, 8]. In case conservative long-term treatment fails, surgery is often considered, as highlighted in modern literature [15, 18].

Despite advances in the morphological study of the colon, the clinical significance of various histological subtypes of the colonic wall in patients with CSTC remains insufficiently defined [7]. The literature still lacks clear evidence regarding the correlation between the clinical manifestations of CSTC and specific histological alterations within the intestinal wall [7, 8]. The abovementioned requires further research focused on morphofunctional characteristics of the colonic wall in slow-transit forms of constipation and their potential impact on the clinical course of the disease.

OBJECTIVE – to identify the clinical course peculiarities in patients with CSTC depending on the histological subtype of colonic wall.

Materials and methods

The study included 107 patients diagnosed with chronic slow-transit constipation (STC group), who underwent evaluation and surgical treatment at the clinical departments of Bogomolets National Medical University between 2011 and 2023. The diagnosis of STC was established according to the Rome IV criteria [1].

Inclusion criteria:

- Age over 18 years
- CSTC that does not respond or poorly responds to modern conservative treatment methods for at least 6 months
- Low quality of life
- Consent for surgical treatment
- Consent to complete the QoL questionnaire

Exclusion criteria:

- Age under 18 years
- Severe comorbidities
- Patients with mental disorders
- Pregnancy
- Oncological diseases
- Harmful habits
- Refusal to complete the QoL questionnaire
- Proctogenic constipation
- Irritable bowel syndrome and/or constipation of secondary specific etiology (associated with an underlying condition)
- Drug-induced constipation

The majority of patients were female – 102 (95.3%). The mean age was 43.1 ± 13.6 years, and the mean body mass index (BMI) was 22.9 ± 4.5 kg/m².

The histological and immunological examination of samples was conducted and included the appendix,

ileum, cecum, colon, and sigmoid colon. Samples were taken from all sections of the colon and appendix for our study: at least three sections of the entire thickness of the colon in the transverse and longitudinal projection, at least 2 cm long. The tissue was fixed in 10% buffered formalin, wired in alcohol, and embedded in paraffin after collection. Serial sections were stained with the hematoxylin-eosin method. Also, an immunohistochemical study with the Polyclonal Ra a-Hu CD 117, c-kit (DAKO, Denmark) antibody was performed on the paraffin blocks using the imaging EnVision™ FLEX System to detect Cajal cells.

Pathohistological study

A microscopic examination was carried out using an Olympus CX23 microscope with a nozzle. Morphometric measurements were performed with the Olympus Stream software. The histological examination helped evaluate the intestinal wall structure. The architectonics of the glands and the cellular stroma composition in the mucous membrane were described.

The total muscle layer thickness was evaluated, the ratio of thickness and layer's number, the presence of lymphoid cell infiltration, the presence or absence of cytoplasmic inclusions in smooth myocytes, and their relative size were all estimated.

Meissner's plexuses were identified between the outer and inner muscle layers according to typical histological features. The glial cells were determined by their size, the presence of large vesicular nuclei, and Nissl substance. Their approximate number was calculated, and additional characteristics, including the presence or absence of dystrophic changes and lymphoid infiltrates, were assessed [7].

Patients were divided into four groups depending on the histological subtype of the colonic wall.

The myopathic type was observed in 59 (55.1%), patients with the myopathic-dystrophic subtype prevailing in 47 (43.9%) cases. The neuropathic type of constipation was diagnosed in 20 (18.7%) patients, while constipation associated with interstitial cells of Cajal pathology was found in 21 (19.6%) patients. In 7 (6.5%) patients, no histological or immunohistochemical abnormalities were registered; therefore, this subgroup was classified as «histologically intact type».

Patients with the Cajal-associated type were significantly younger than those with the myopathic ($p = 0.006$) and neuropathic ($p < 0.001$) types. Conversely, patients with the neuropathic subtype were significantly older compared to those with the myopathic form ($p = 0.003$) [7].

The distribution of the different histological subtypes is presented in Table 1.

Table 1. Frequency of various histological changes subtypes in patients with CSTC

Main variant of histological changes	Number of patients	Age, years Mean \pm SD (mediana)
Myopathic variant	59 (55.1%)	43.1 \pm 12.7 (43.0)
Inflammatory	12 (20.3%)	36.9 \pm 8.5 (34.5)
Dystrophic	47 (79.7%)	43.7 \pm 12.8 (44.0)
Pathology of Cajal cells	21 (19.6%)	33.9 \pm 10.3 (35.0)
Neuropathic	20 (18.7%)	52.5 \pm 13.5 (54.0)
Histologically intact	7 (6.5%)	49.2 \pm 14.8 (43.5)

Before visiting the clinic, all patients were continuously undergoing courses of conservative therapy, which gradually became less effective over time. They used a high-fiber diet in 103 (96.3%) cases, pharmacological agents in 107 (100.0%), and cleansing enemas in 92 (85.9%).

29 (27.1%) patients underwent subtotal colectomy, 57 (53.3%) underwent total colectomy, and 21 (19.6%) underwent colectomy with low rectal resection. Open surgery was performed in 70 (65.4%) patients, while laparoscopic access – in 37 (34.6%) patients.

The duration of symptoms before surgery ranged from 1 to 50 years, with a mean of 21.0 ± 14.0 years. The impact of histological subtype of colonic wall on the clinical course in patients with CSTC was assessed retrospectively by comparing the histological findings of resected colonic specimens following colectomy with preoperative questionnaire data and medical history.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 22. Descriptive statistics were calculated. Data normality was assessed using the Shapiro-Wilk test. Mean values were presented as $M \pm SD$. Categorical data were expressed as counts (%). The comparison of mean values for quantitative variables was performed using the Wilcoxon-Mann-Whitney. Comparisons of relative frequencies were performed using Pearson's chi-square test. The null hypothesis of equality of variables was rejected at $p < 0.05$.

Results

The mean age of patients with the histologically intact subtype was 49.3 ± 13.92 years; for those with the myopathic dystrophic subtype – 48.68 ± 11.69 years; and for those with the myopathic inflammatory subtype – 36.92 ± 8.32 years. The highest mean age was observed in patients with the neuropathic

subtype – 52.45 ± 13.61 years. The youngest age was found in patients with the Cajal subtype – 33.9 ± 8.7 years, which was significantly lower compared to the histologically intact subtype ($p = 0.026$), myopathic dystrophic subtype ($p < 0.001$), and neuropathic subtype ($p < 0.001$). Furthermore, the age in the myopathic inflammatory subtype was significantly lower than in the neuropathic subtype ($p = 0.003$) and the myopathic dystrophic subtype ($p = 0.019$).

Among the 107 patients, there were 6 men and 101 women. The groups did not differ statistically in terms of the male-to-female ratio ($p = 0.826$). No significant difference was found in the male-to-female ratio between subtypes, as shown in Table 2.

The mean BMI for the Cajal subtype was 20.395 ± 2.29 kg/m² (14.8–24.1 kg/m²), for the histologically intact subtype it was 23.26 ± 3.98 kg/m² (17.3–27.7 kg/m²), for the myopathic inflammatory subtype it was 22.14 ± 3.49 kg/m² (18.7–31.2 kg/m²), and for the neuropathic subtype it was 23.08 ± 3.28 kg/m² (18.0–30.1 kg/m²). The highest BMI was observed in patients with the myopathic dystrophic subtype – 25.66 ± 4.34 kg/m² (19.8–41.1 kg/m²), which was significantly higher than the Cajal subtype ($p < 0.001$) and the myopathic inflammatory subtype ($p = 0.042$). The BMI in patients with the Cajal subtype was significantly lower than in those with myopathic dystrophic ($p < 0.001$) and neuropathic ($p = 0.023$) subtypes.

The mean age of disease onset in patients with the myopathic dystrophic subtype was 29.96 ± 8.67 years (16–58 years); in those with the histologically intact subtype, it was 37 ± 16.79 years (14–61 years); in the myopathic inflammatory subtype, it was 31.17 ± 9.05 years (16–45 years); in the Cajal subtype, it was 8.67 ± 5.08 years (2–19 years); and in the neuropathic subtype, it was 31.9 ± 13.8 years (10–65 years). The Cajal subtype differed significantly from the myopathic inflammatory subtype ($p < 0.001$), the histologically intact subtype

Table 2. Distribution of patients by sex according to the main histological subtypes of constipation

Subtype of constipation	Female	Male	Total
Histologically intact	7 (100.0%)	0	7
Myopathic dystrophic	45 (95.7%)	2 (4.3%)	47
Myopathic inflammatory	11 (91.7%)	1 (8.3%)	12
Cajal	20 (95.2%)	1 (4.8%)	21
Neuropathic	18 (90.0%)	2 (10.0%)	20
Total	101 (94.4%)	6 (5.6%)	107

p=0.826.

Table 3. Stool type according to the Wexner scale based on the histological subtype of constipation

Subtype of constipation	Type 1	Type 2	Type 3	Type 4	Type 5	Total
Histologically intact	2 (28.6%)	3 (42.9%)	2 (28.6%)	0	0	7
Myopathic dystrophic	34 (72.3%)	11 (23.4%)	0	2 (4.3%)	0	47
Myopathic inflammatory	6 (50.0%)	1 (8.3%)	4 (33.3%)	0	1 (8.3%)	12
Cajal	15 (71.4%)	6 (28.6%)	0	0	0	21
Neuropathic	12 (60.0%)	6 (30.0%)	2 (10.0%)	0	0	20
Total	69 (64.5%)	27 (25.2%)	8 (7.5%)	2 (1.9%)	1 (0.9%)	107

p=0.003.

($p < 0.001$), and the neuropathic subtype ($p < 0.001$) in terms of the mean age of disease onset.

The mean duration of the disease in patients with the histologically intact subtype was 12.29 ± 6.67 years (5–25 years); in patients with the myopathic dystrophic subtype, it was 18.72 ± 7.97 years (5–36 years); in the myopathic inflammatory subtype, it was 5.75 ± 2.01 years (3–10 years); and in the neuropathic subtype, it was 20.55 ± 2.4 years (6–46 years). The longest disease duration was observed in patients with the Cajal subtype— 25.24 ± 11.18 years (3–51 years), which was significantly longer than in the histologically intact subtype ($p = 0.001$), the myopathic inflammatory subtype ($p < 0.001$), and the myopathic dystrophic subtype ($p = 0.059$). Additionally, the neuropathic histological subtype had a significantly longer disease duration compared to the myopathic inflammatory subtype ($p < 0.001$).

The stool type was assessed using the Wexner scale in all patients with STC [9].

In patients with the Cajal subtype, two stool subtypes were observed: 1 – in 71.4% and 2 – in 28.6%. In patients with the histologically intact subtype, three stool subtypes were registered: 1 – in 28.6%, 2 – in 42.9%, and 3 – in 28.6%. In patients with the myopathic dystrophic subtype, three stool subtypes were

found: 1 – in 72.3%, 2 – in 23.4%, and 4 – in 4.3%. In patients with the myopathic inflammatory subtype, stool type 1 was present in 50% of patients, types 2 and 4 in 8.3%, and type 3 in 33.3%. The neuropathic subtype included 60% of patients with stool type 1, 30% with type 2, and 10% with type 3. The distribution of different stool subtypes differed significantly between the groups ($p = 0.003$), as shown in Table 3.

The mean interval between bowel movements in the neuropathic subtype significantly differed from the myopathic dystrophic subtype ($p = 0.005$) and the Cajal subtype ($p = 0.038$). Due to the small number of patients with the histologically intact subtype ($n = 7$), we cannot compare the mean interval of 7.7 days between bowel movements with those in other histological subtypes to determine the percentage of differences, as shown in Table 4.

The highest heredity was observed in 50.5% of patients with CSTC: in 90.5% of patients with the Cajal subtype, in 55% with the neuropathic subtype, in 46.8% with the myopathic dystrophic subtype, in 14.3% with the histologically intact subtype, and the lowest – in 8.3% with the myopathic inflammatory subtype, as shown in Table 5.

Regarding heredity, the Cajal subtype significantly differed from the myopathic inflammatory

Table 4. **Interval between bowel movements in patients with STC in different histological subtypes**

Subtype of constipation	Interval between bowel movements, days Mean \pm SD (min–max)
Histologically intact	7.7 \pm 3.7 (5.0–14.0)
Myopathic dystrophic	12.4 \pm 5.5 (4.0–30.0)
Myopathic inflammatory	9.3 \pm 3.0 (5.0–14.0)
Cajal	12.2 \pm 4.3 (7.0–22.0)
Neuropathic	8.1 \pm 2.5 (5.0–14.0)

Table 5. **Heredity in different histological subtypes of CSTC**

Subtype of constipation	Heredity	Total
Histologically intact	1 (14.3%)	7
Myopathic dystrophic	22 (46.8%)	47
Myopathic inflammatory	1 (8.3%)	12
Cajal	19 (90.5%)	21
Neuropathic	11 (55.0%)	20
Total	54 (50.5%)	107

Table 6. **The need for manual assistance (in > 1/4 cases of defecation) before surgery depending on the histological subtype of CSTC**

Subtype of constipation	Need for manual assistance	Total
Histologically intact	0	7
Myopathic dystrophic	7 (14.9%)	47
Myopathic inflammatory	2 (16.7%)	12
Cajal	1 (4.8%)	21
Neuropathic	2 (10.0%)	20
Total	12 (11.2%)	107

subtype ($p = 0.0001$), the myopathic dystrophic subtype ($p = 0.001$), the neuropathic subtype ($p = 0.01$), and the histologically intact subtype ($p = 0.0001$). The myopathic inflammatory subtype also had significant differences compared to the neuropathic subtype ($p = 0.008$) and the myopathic dystrophic subtype ($p = 0.015$).

Table 7. **Pain intensity in patients with CSTC depending on the histological subtype**

Subtype of constipation	Intensity of pain, score Mean \pm SD (min–max)
Histologically intact	2.9 \pm 0.9 (2.0–4.0)
Myopathic dystrophic	3.2 \pm 1.4 (1.0–6.0)
Myopathic inflammatory	4.8 \pm 1.4 (3.0–7.0)
Cajal	2.8 \pm 1.3 (1.0–5.0)
Neuropathic	2.6 \pm 1.1 (1.0–5.0)

Table 8. **Presence of pain (intensity > 3 points) in patients with CSTC**

Subtype of constipation	Pain	Total
Histologically intact	2 (28.6%)	7
Myopathic dystrophic	23 (48.9%)	47
Myopathic inflammatory	9 (75.0%)	12
Cajal	7 (33.3%)	21
Neuropathic	4 (20.0%)	20
Total	45 (42.1%)	107

12 (11.2%) patients of 107 required manual assistance in all subtypes except the histologically intact subtype, as shown in Table 6. No significant differences were found between subtypes in the frequency of «manual assistance» ($p = 0.594$), although it was more frequent in patients with the myopathic subtype.

All patients experienced abdominal pain within 30 days prior to their admission to the clinic. The intensity of pain was assessed using the visual analog scale (VAS), ranging from 0 to 10, as shown in Table 7. Significant differences in the mean pain score were observed when comparing the myopathic inflammatory subtype with the histologically intact subtype ($p = 0.022$), the myopathic dystrophic subtype ($p = 0.002$), the Cajal subtype ($p < 0.001$), and the neuropathic subtype ($p < 0.001$).

Additionally, patients were categorized based on the presence of pain with an intensity greater than 3 points on the visual analog pain scale, as shown in Table 8. Significant statistical differences were observed between the groups regarding the percentage of patients with pain greater than three points ($p = 0.022$), due to the high percentage of

such patients in the myopathic inflammatory subtype (75 %) and the myopathic dystrophic subtype (48.9 %), and the lower percentage in the neuropathic subtype (20 %) and the histologically intact subtype (28.6 %).

Discussion

Despite the current classifications for constipation based on etiology and morphological characteristics [6], there is a lack of data in modern literature regarding the relationship between the clinical manifestations of CSTC and the histological structure of the colonic wall.

The wide range of potential pathophysiological mechanisms in CSTC, including affected neuromuscular transmission, degeneration of intramural nerve plexuses, Cajal cell pathology, and others, leads to the variability of the clinical picture of the disease [3, 6, 17]. As a result, patients with CSTC may have a wide spectrum of symptoms, from ineffective defecation to severe abdominal pain, and as a consequence, reduced quality of life [4, 5, 12]. However, attempts to clearly link specific symptoms with certain morphological or etiological factors are currently limited [6]. One of the primary reasons for this is the difficulty in obtaining histological samples due to the invasive nature of full-thickness colon biopsy, which remained the only method to assess changes in the deeper layers of the colonic wall, including the muscle layer and enteric nervous system. This diagnostic method is particularly important in studying slow-transit constipation, as it allows us to detect structural changes not only in nerve plexuses but also in the muscle layer of the bowel, potentially correlating with clinical manifestations of the disease. According to recent studies, full-thickness biopsy may prove to be a promising tool for the stratification of patients with chronic forms of constipation, including slow-transit types [10, 11, 13]. Despite its high diagnostic value, full-thickness biopsy is still applied sparingly due to the associated risks and the lack of standardized interpretation of morphological changes in different forms of constipation [6]. All the abovementioned factors create significant barriers for studying the morphofunctional basis of clinical heterogeneity in CSTC. Therefore, we performed a retrospective evaluation of clinical manifestations depending on the histological subtype of the bowel wall in patients with CSTC. The results of colon histological examinations in patients after colectomy were compared with anamnesis and preoperative questionnaire data.

The clinical manifestations of CSTC are heterogeneous and depend on the etiology of constipation,

i.e., the histological subtype. In particular, the Cajal subtype was observed in the youngest patients, with an average age of 33.9 ± 8.7 years, the highest heredity (90.5 %), and the lowest BMI (20.395 ± 2.29 kg/m²) among all patients with CSTC. The Cajal subtype was characterized by an earlier onset of the disease – 8.67 ± 5.08 (2–19) years ($p < 0.001$) – as well as the longest disease duration – 25.24 ± 11.18 years ($p < 0.001$) – at the time of surgery. The shortest disease duration was observed in patients with the myopathic inflammatory subtype – 5.75 ± 2.01 (3–10) years, which was significantly shorter than in the myopathic dystrophic, Cajal, and neuropathic histological subtypes, all $p < 0.01$. In contrast to the Cajal subtype, the oldest average age at surgery was found in patients with the neuropathic histological subtype – 52.45 ± 13.61 years. Thus, patients with the neuropathic and histologically intact subtypes of CSTC had a significantly later onset of the disease compared to the Cajal subtype – 31.9 ± 13.82 (10–65) years and 37 ± 16.79 (14–61) years, respectively, $p < 0.001$. Patients with the neuropathic subtype had a relatively shorter average interval between bowel movements – 8.1 ± 2.5 days, which was significantly different from the myopathic dystrophic subtype ($p = 0.005$) and the Cajal subtype ($p = 0.038$). Regarding pain intensity, a significantly higher average score was noted in the myopathic inflammatory subtype – 4.8 ± 1.4 (3–7) points – compared to the histologically intact ($p = 0.022$), myopathic dystrophic ($p = 0.002$), Cajal ($p < 0.001$), and neuropathic ($p < 0.001$) subtypes. According to pain intensity greater than three points, statistical differences were observed between the groups ($p = 0.022$) due to the higher percentage of such patients in the myopathic inflammatory subtype (75 %) and the myopathic dystrophic subtype (48.9 %), compared to the lower percentage in the neuropathic subtype (20 %) and histologically intact (28.6 %). The highest BMI was observed in the myopathic dystrophic subtype – 25.66 ± 4.34 kg/m² (19.8–41.1 kg/m²), which was significantly higher than for the Cajal subtype ($p < 0.001$) and the myopathic inflammatory subtype ($p = 0.042$). The largest average interval between bowel movements was found in patients with the myopathic dystrophic (12.4 ± 5.5 days) and Cajal (12.2 ± 4.3 days) subtypes, and these significantly differed from the neuropathic subtype, $p = 0.005$ and $p = 0.038$, respectively. Among the 107 patients with CSTC, 12 individuals (11.2 %) required manual assistance in all subtypes except the histologically intact one.

This study has certain limitations, as it only includes patients with CSTC resistant to conservative

therapy who had undergone surgery. Consequently, the results should be interpreted carefully when applying them to the wider population of STC patients.

Conclusions

The clinical course in surgically treated patients with CSTC, resistant to conservative therapy, is heterogeneous and significantly varies depending on the histological subtype of the bowel wall, indicating different pathophysiological mechanisms of constipation in different patients.

The Cajal, neuropathic, myopathic dystrophic, and inflammatory subtypes have clinical differences in the age of disease onset, symptom duration, interval between defecations, pain intensity, and BMI.

Morphological stratification of CSTC based on histological subtypes may provide valuable prognostic and therapeutic information, helping to individualize treatment strategies for patients with severe forms of constipation.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

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AUTHORS CONTRIBUTIONS

Concept and design – I. M. Leschyshyn, R. V. Gonza; data collection and analysis – I. M. Leschyshyn, O. I. Okhotska, P. L. Byk, R. V. Gonza; statistical analysis – I. M. Leschyshyn, L. Y. Markulan, P. L. Byk; drafting the article – I. M. Leschyshyn, L. Y. Markulan; critical revision of the article – I. M. Leschyshyn, O. I. Okhotska.

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Клініко-анамнестичні характеристики хворих за різних підтипів хронічних повільно-транзитних запорів

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Останніми роками хронічний повільнотранзитний запор (ХПТЗ) залишається актуальною клінічною проблемою через високу поширеність, багатофакторний патогенез та обмежену ефективність терапевтичних стратегій. У літературі досі бракує чітких доказів взаємозв'язку між клінічними виявами ХПТЗ і специфічними гістологічними змінами в стінці кишки.

Мета — виявити особливості клініко-анамнестичних характеристик пацієнтів із ХПТЗ залежно від гістологічного підтипу стінки товстої кишки.

Матеріали та методи. У дослідження було залучено 107 пацієнтів із діагнозом ХПТЗ, які проходили обстеження та хірургічне лікування на клінічній базі Національного медичного університету імені О. О. Богомольця в період із 2011 до 2023 р. Діагноз ХПТЗ установлювали згідно з Римськими критеріями IV.

Результати. Кахальний підтип асоціювався з наймолодшим віком початку захворювання ($(8,67 \pm 5,08)$ року), найбільшою тривалістю симптомів ($(25,24 \pm 11,18)$ року) і частотою сімейного анамнезу (90,5%), найменшим середнім індексом маси тіла ($(20,4 \pm 2,3)$ кг/м²). Нейропатичний підтип спостерігався в старших пацієнтів ($(52,45 \pm 13,61)$ року) і мав пізніший початок симптомів порівняно з іншими варіантами. Його характерною ознакою був найкоротший інтервал між дефекаціями ($(8,1 \pm 2,5)$ дня). Запальний міопатичний підтип супроводжувався найвиразнішим больовим синдромом ($(4,8 \pm 1,4)$ бала за візуальною аналоговою шкалою) порівняно з іншими підтипами, що підтверджує роль запалення у формуванні абдомінального болю. Міопатичний дистрофічний підтип асоціювався з найбільшим індексом маси тіла ($(25,7 \pm 4,3)$ кг/м²) та інтервалом між дефекаціями ($(12,4 \pm 5,5)$ дня), що вказує на повільний транзит у поєднанні з морфологічною дегенерацією м'язового шару. Інтактний підтип найчастіше виявляли в пацієнтів із пізнім початком симптомів і відсутністю потреби в ручній допомозі під час дефекації.

Висновки. Клініко-анамнестичні характеристики прооперованих пацієнтів із ХПТЗ, резистентних до консервативної терапії, є гетерогенним і суттєво варіює залежно від гістологічного підтипу стінки кишки, що свідчить про різні патофізіологічні механізми запору. Кахальний, нейропатичний, міопатичний дистрофічний і запальний гістологічні підтипи відрізняються за віком початку захворювання, тривалістю симптомів, інтервалом між дефекаціями, інтенсивністю болю та індексом маси тіла. Морфологічна стратифікація ХПТЗ за гістологічними підтипами може надати цінну прогностичну та терапевтичну інформацію, що сприятиме індивідуалізації лікувальних стратегій для пацієнтів із тяжкими формами запору.

Ключові слова: хронічний повільнотранзитний запор, гістологічний підтип стінки товстої кишки, запор.

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Endoscopic transluminal necrosectomy in patients with acute infected necrotizing pancreatitis. Experience of a specialized center

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Over the past decades, the treatment of acute infected necrotizing pancreatitis (AINP) has significantly improved due to a better understanding of the disease pathogenesis and the implementation of minimally invasive technologies. Endoscopic transluminal interventions occupy an important place among these techniques and continue to evolve, both technically and tactically.

OBJECTIVE – to evaluate the results of ETN in the treatment of patients with acute infected necrotizing pancreatitis (AINP) and summarize the experience of our department, including technical and tactical aspects of the procedure.

MATERIALS AND METHODS. The study included 28 patients: 15 (53.6%) men and 13 (46.4%) women with a mean age of 52.6 ± 12.5 years, who underwent ETN between 2021 and 2024 due to a limited peri-/pancreatic necrotic collection in direct contact with the stomach and/or duodenum. AINP of moderate severity was diagnosed in 19 (67.9%) patients, and a severe course – in 9 (32.1%). The mean size of the walled-off pancreatic necrosis (WON) was 109.6 ± 32.9 mm. ETN outcomes were assessed as complete, partial, or no clinical success.

RESULTS. The first ETN session was performed on average on day 36.2 ± 16.1 (range: 22 to 86 days) from the onset of the disease. A total of 48 ETN sessions were performed, from 1 to 4 per patient, most often a single session in 14 (50.0%) patients. The intervals between subsequent sessions were mostly 6–7 days. Continuous lavage of the WON cavity was performed in 17 (60.7%) patients. The duration of each procedure ranged from 60 to 90 minutes. The rate of intraoperative complications was 3.6% ($n = 1$, profuse bleeding). Complete clinical success was achieved in 18 (64.3%) patients, partial success – in 8 (28.6%), and no clinical success – in 2 (7.1%) patients. Overall, 25 (89.3%) patients recovered, and the mortality rate was 10.7% (3 cases).

CONCLUSIONS. In 64.3% of cases, ETN can be the main treatment method in AINP when the indications for the procedure are observed. In 28.6% of patients, it serves as a transitional stage before more invasive surgical procedures. Performing ETN with subsequent continuous lavage of the WON cavity increases the likelihood of achieving complete clinical success by 2.26 times compared to patients without lavage (RR 2.26; 95% CI 1.01–5.10; $p = 0.0485$).

KEYWORDS

acute pancreatitis, acute infected necrotizing pancreatitis, walled-off pancreatic necrosis, endoscopic transluminal necrosectomy, direct endoscopic necrosectomy.

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Acute pancreatitis (AP) typically manifests as an edematous type with a relatively mild, self-limiting course that is managed with supportive therapy and is associated with few long-term consequences [2]. As a progression of acute edematous pancreatitis, acute peripancreatic or pancreatic fluid collection may sometimes persist and develop into a pseudocyst after 4 or more weeks, resulting in pain syndrome and requiring drainage.

Acute necrotizing pancreatitis (ANP), as the severe form of AP, develops in 10–20% of cases and is characterized by prolonged hospitalization, organ failure, infection, the need for intensive care and surgical interventions, complications, repeated hospitalizations, and long-term adverse outcomes. Mortality in ANP varies from 11% to 39%, depending on the presence of infection in the necrotic area [3].

Acute necrotic collection, which develops during ANP, usually persists and transforms into walled-off necrosis (WON) within 3–4 weeks. WON is characterized by the presence of a capsule and a mixture of fluid and necrotic debris. The wall of WON consists of an infiltration zone of immunocompetent cells, fibrin deposits, and the walls of adjacent organs surrounding the cavity.

Surgical treatment options for complicated forms of AP include percutaneous, endoscopic transluminal, laparoscopic, and open surgical interventions [3, 12]. Currently, minimally invasive techniques are the primary method of surgical management in ANP, as they significantly reduce mortality and complication rates and often help avoid or postpone open surgery [4].

Over the past 20 years, new minimally invasive techniques have emerged, including video-assisted retroperitoneal debridement (VARD) and endoscopic transluminal necrosectomy (ETN), which are considered among the most favorable approaches. In the English-language literature, ETN is also referred to as direct endoscopic necrosectomy (DEN), endoscopic transgastric necrosectomy, and endoscopic peroral necrosectomy.

The optimal intervention strategy for patients with suspected or confirmed infected necrotizing pancreatitis (INP) includes percutaneous drainage of the necrotic collection under imaging guidance (ultrasound or CT) or endoscopic transluminal drainage with subsequent endoscopic or surgical necrosectomy, if necessary [11].

The first direct endoscopic necrosectomy was described in 2000 by Seifert in three patients with infected WON who were in a critical condition and unsuitable for open surgery [8]. The researchers introduced a gastroscope transgastrically directly into the necrotic cavity and removed necrotic tissue using a basket designed for bile stone extraction. Since then, ETN has been increasingly used in Western countries and, since 2021, has been successfully implemented in our clinical practice.

OBJECTIVE – to evaluate the results of ETN in the treatment of patients with acute infected necrotizing pancreatitis (AIP) and summarize the experience of our department, including technical and tactical aspects of the procedure.

Materials and methods

The study included 28 patients: 15 (53.6 %) men and 13 (46.4 %) women, with a mean age of 52.6 ± 12.5 years, who underwent ETN for AIP in our medical institution between 2021 and 2024.

Diagnostic methods included general and biochemical blood tests, microbiological analysis,

ultrasound examination, esophagogastroduodenoscopy (EGD), contrast-enhanced computed tomography (CT) of the abdomen, or magnetic resonance imaging (MRI) of the abdomen. Given the complexity of the pathology, patient management was multidisciplinary, involving surgeons, endoscopists, anesthesiologists-intensivists, radiologists, interventional ultrasound specialists, and other related specialists (in some cases – internists, cardiologists, endocrinologists, and psychiatrists).

The indications for endoscopic transluminal intervention included:

- A walled-off necrotic peripancreatic/pancreatic collection (WON), which, according to CT or MRI data, was in direct contact with the stomach and/or duodenum.
- Disease duration of ≥ 4 weeks (28 days) from the first pain episode.
- Extrinsic compression of the stomach and/or duodenum identified by EGD.

Endoscopic Intervention

Patients underwent endoscopic treatment of necrotizing pancreatitis, which included the following technical and tactical aspects:

- A duodenoscope Olympus TJF-150 was used for transluminal access and drainage, and if direct necrosectomy was needed, a gastroscope Olympus GIF-Q150 with a distal transparent cap was employed.
- The procedures were performed under general anesthesia with endotracheal intubation to protect the airway from potential aspiration of infected WON content.
- The patient was placed in the supine position during the procedure to provide the most accurate positioning of the WON relative to the stomach/duodenum based on pre-procedural imaging (CT or MRI).
- The access point to the WON cavity (Fig. 1) was the site of the greatest bulging into the gastric lumen, usually along the posterior wall in the middle or lower third of the stomach body (in one case – in the upper third of the stomach body). In one patient, access to the WON cavity was achieved through an existing cystic duodenal fistula with a diameter of 1 mm along the inferior wall of the duodenal bulb, through which pus and necrotic debris were discharged.
- Access to the WON cavity was mainly created using an Optimos cystotome (TaeWoong Medical, South Korea) or a needle papillotome in the «blend» and «coagulation» modes of the electro-surgical unit to prevent bleeding, followed by the insertion of a guidewire. Subsequently, the created fistulous tract was dilated using the endo-balloon with a length of 50 mm and a diameter of 15–20 mm,

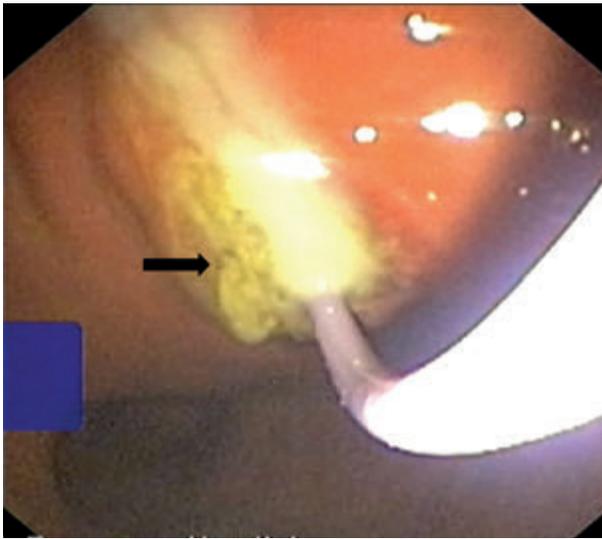


Figure 1. Access to the walled-off necrosis (WON) cavity indicated by the arrow

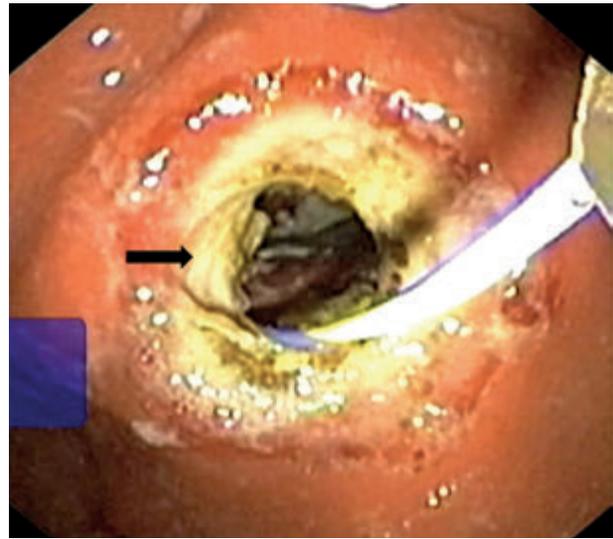


Figure 3. View of the created transluminal fistulous tract, indicated by the arrow

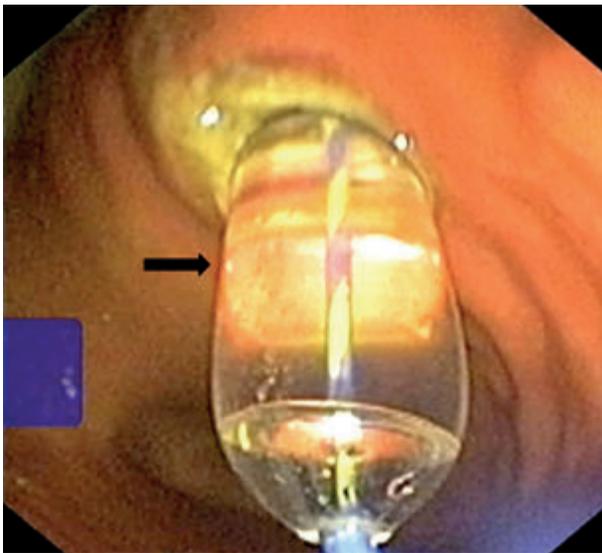


Figure 2. Dilation of the created fistulous tract using a dilation endo-balloon, indicated by the arrow

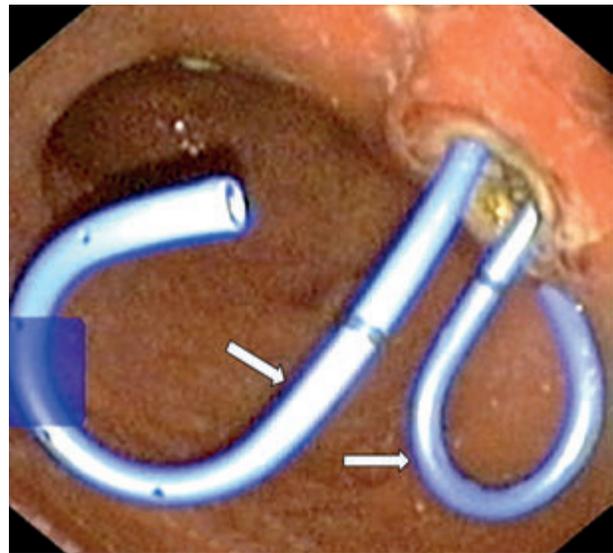


Figure 4. Transluminally placed plastic double-pigtail stents, viewed within the stomach cavity (indicated by arrows)

maintaining balloon inflation for 5–10 min to prevent bleeding (Fig. 2, 3).

- The contents of the WON cavity were collected for bacteriological examination.

- Subsequently, over the guidewire, 1–2 plastic double-pigtail stents (length 50 mm between loops, diameter 10 French) were placed (Fig. 4). The presence of at least one transluminal stent prior to direct endoscopic necrosectomy facilitates identification of the newly created fistula, which may be difficult to visualize between the gastric folds, particularly due to the presence of pus and debris from the WON cavity within the stomach. The placement of two transluminal stents ensures

better long-term patency and lumen support for the fistulous tract compared to a single stent.

- A gastroscope with a distal cap was advanced into the WON cavity alongside the stents. To improve visualization and wash out pus and debris, the WON cavity was initially irrigated abundantly through the endoscope's working channel with a 1% hydrogen peroxide solution, followed by aspiration of the contents. During a single necrosectomy session, cavity irrigation was performed several times to enhance the removal of necrotic debris and improve visualization. The average volume of irrigation solution used during one procedure ranged from 200 to 400 ml, depending on the cavity size.

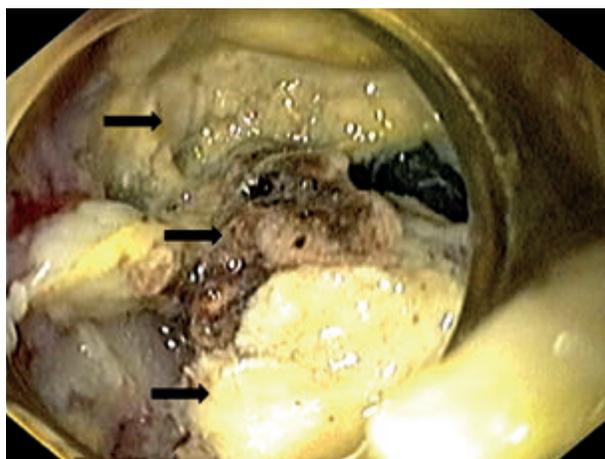


Figure 5. Necrotic debris in the WON cavity during initial access (indicated by arrows)

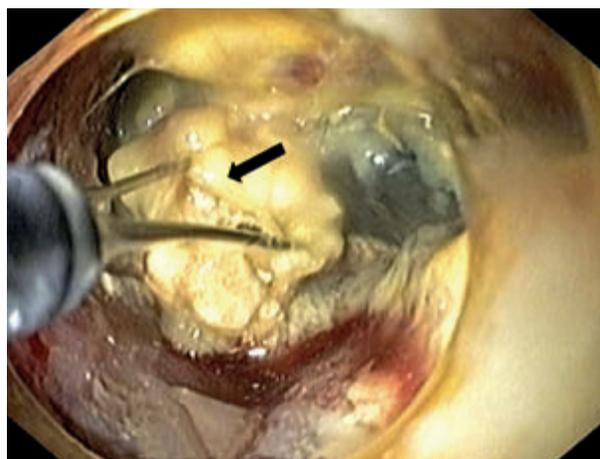


Figure 6. Endoscopic transluminal necrosectomy, view inside the WON cavity (indicated by arrow)



Figure 7. View of the WON cavity after complete necrosectomy and lavage

- Direct endoscopic necrosectomy (Fig. 5–7) through the created fistulous tract between the stomach/duodenum cavity and the WON cavity was performed using an endoscopic tripod (grasper). Necrotic sequestra lying freely within the cavity were removed and fragmented.

- During necrosectomy, aggressive removal of necrotic tissue with inadvertent capture of viable structures was avoided in order to prevent profuse bleeding; tightly adherent necrotic fragments were left for the next session to allow spontaneous detachment into the WON cavity.

- After each session, the presence of unremoved dense necrotic fragments in the WON cavity at the time of procedure completion was recorded in the surgical protocol to guide further treatment strategy and determine the need for additional sessions.

- To improve the conditions for cavity debridement between sessions, the principle of continuous

lavage was applied. In patients with pre-existing percutaneous drainage of the WON cavity, antiseptic solutions were introduced through the drain, allowing pus and debris to be evacuated through the created transluminal fistula into the stomach. In patients where endoscopic intervention was the primary method of decompression, a 7 Fr transnasal catheter was placed into the WON cavity through the created fistula at the end of endoscopic session, enabling drip or intermittent irrigation.

- During the subsequent endoscopic necrosectomy session, if necessary, the fistula was re-dilated using a 15–20 mm dilation balloon; the stents remained in place.

- The decision to proceed with open surgical treatment was individualized by a multidisciplinary team of surgeons and endoscopists in cases of the patient's lack of significant improvement and the presence of a large volume of residual necrotic debris within the WON cavity.

Criteria for treatment effectiveness

The effectiveness of treatment using ETN was assessed based on the degree of clinical success, which was defined as complete, partial, or no clinical success. Obtaining access to the WON cavity determined the technical success of the procedure.

The main criterion for complete clinical success of ETN was the patient's discharge in satisfactory condition with no need for additional surgical interventions for necrosectomy or complications. Other criteria for complete treatment effectiveness at the time of discharge included:

- absence or significant reduction of symptoms associated with the primary disease (abdominal pain, hyperthermia, signs of compartment syndrome, including nausea, vomiting, digestive disorders);

- according to imaging studies (ultrasound, contrast-enhanced CT, or MRI), the absence of fluid collections or the presence of a cystic cavity < 3 cm that did not require surgical intervention.

The partial clinical success of ETN was defined as a decrease in pain syndrome, resolution of gastric and/or duodenal obstruction symptoms, and reduction of hyperthermia, but without significant improvement in the patient's condition, requiring open surgery within the step-up approach.

No clinical success was achieved in fatal cases, regardless of whether open surgery was performed within the step-up approach.

The procedure was technically successful when direct transmural access to the WON cavity was established, enabling subsequent dilation of the fistula created with an endo-balloon, stent placement, and the advancement of the endoscope into the WON cavity, regardless of the final clinical treatment result.

The complications were divided into two groups: those directly associated with necrosectomy (intraoperative) and those related to the disease course requiring surgical intervention (peritonitis, fistulas, and others).

Statistical analysis of the obtained data was performed using the IBM SPSS Statistics 22 software package. Descriptive statistics were used. Quantitative data are presented as arithmetic mean (M) ± standard deviation (SD), and for qualitative characteristics – absolute values (n) and percentages were used. Correlation analysis was performed using Spearman's rank correlation. The chi-square (χ^2) one-sample test assessed the correspondence between the observed and expected frequencies in categorical data. A comparison of quantitative variables was performed using the Mann–Whitney U test. The null hypothesis of variable equality was rejected at $p < 0.05$.

Results

Among 28 patients with ANP, 13 (46.4 %) were admitted directly to the specialized department, while 15 (53.6 %) were transferred from other hospitals or units. 23 (82.1 %) patients experienced primary hospitalization due to ANP, while 5 (17.9 %) underwent re-hospitalization, with $p = 0.001$. In most patients – 15 individuals (53.6 %; $p = 0.004$) – the duration of the disease history exceeded 72 hours upon admission.

Among the etiological factors of ANP, gallstone disease and alcohol consumption played a leading role in 92.9 % of cases ($p < 0.001$). According to the Atlanta Classification 2012 [2], moderate severity ANP was diagnosed in 19 (67.9 %) patients, while

severe disease was recorded in 9 (32.1 %) patients ($p = 0.089$) (Table 1).

The initial session of ETN was performed on average at 36.2 ± 16.1 days (ranging from 22 to 86 days) after the first onset of symptoms. Among patients experiencing their first episode of ANP, the interval to ETN was 33.9 ± 12.9 days (22–80 days). For those who were rehospitalized, the interval was 47.0 ± 25.5 days (29–86 days), with no statistically significant difference ($p = 0.489$). In one case, ETN was performed as a «last resort» surgery on day 22 of the disease, earlier than the typically recommended ≥ 4 -week interval for endoscopic transluminal interventions.

In the area of fluid/necrotic pancreatic collection, percutaneous drainage using a 9–12 Fr pigtail catheter under ultrasound guidance was performed in 14 patients (60.9%) on average by the 7th day from disease onset (range: 5–9 days), or, if necessary, at later stages of the disease. Furthermore, 15 (53.6 %)

Table 1. **Clinical characteristics of the studied patients (n = 28)**

Parameter	Value
Male	15 (53.6 %)
Fmale	13 (46.4 %)
Age, years (mean ± SD (min–max))	52.6 ± 12.5 (33–77)
Time to admission	
< 6 hours	5 (17.9 %)
6–24 hours	6 (21.4 %)
24–72 hours	2 (7.1 %)
> 72 hours	15 (53.6 %)
Hospitalization status	
First-time admission	23 (82.1 %)
Readmission	5 (17.9 %)
Etiology of pancreatitis	
Gallstone disease	15 (53.6 %)
Alcohol	11 (39.3 %)
Hypertriglyceridemia	1 (3.6 %)
Tumor (ampullary adenoma)	1 (3.6 %)
Severity of acute pancreatitis [2]	
Moderate	19 (67.9 %)
Severe	9 (32.1 %)
Patients without adequate initial management of acute pancreatitis	
Transferred from another department or hospital*	15 (53.6 %)

Note. *1 of 15 patients remained at home for about a month from the onset of the disease before being admitted to the clinic.

patients underwent abdominal cavity drainage due to pancreatic ascites, and 8 (28.6%) patients had pleural cavity drainage for exudative pleuritis.

Before surgical intervention, patients exhibited fever (96.4%), infection (positive bacteriological culture from WON aspirate) (96.4%), abdominal pain (89.3%), severe general weakness (78.6%), signs of systemic inflammatory response syndrome (SIRS) (67.9%), gastric outlet obstruction/vomiting (60.7%), pancreatic ascites (53.6%), nausea and loss of appetite (50.0%), sleep disturbances (46.4%), splenoportal thrombosis (28.6%), and pleural effusion (28.6%) (Fig. 8).

The average size of the WON was 109.6 ± 32.9 mm (Fig. 9), as assessed using imaging techniques such as contrast-enhanced abdominal CT (less frequently,

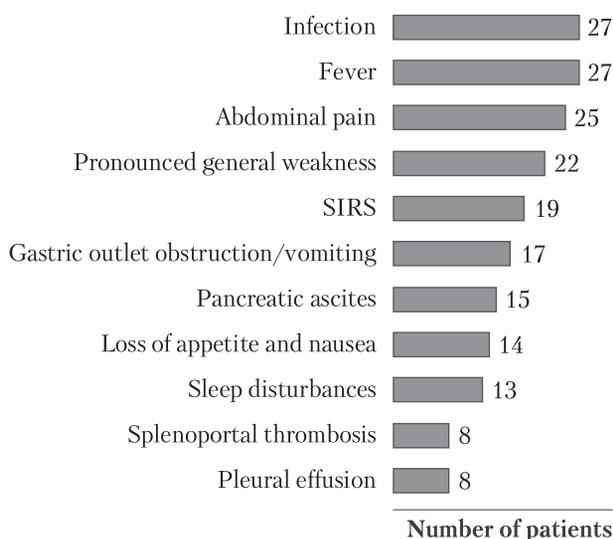


Figure 8. Primary conditions and symptoms in patients with walled-off necrosis at the time of endoscopic transluminal necrosectomy (n = 28)

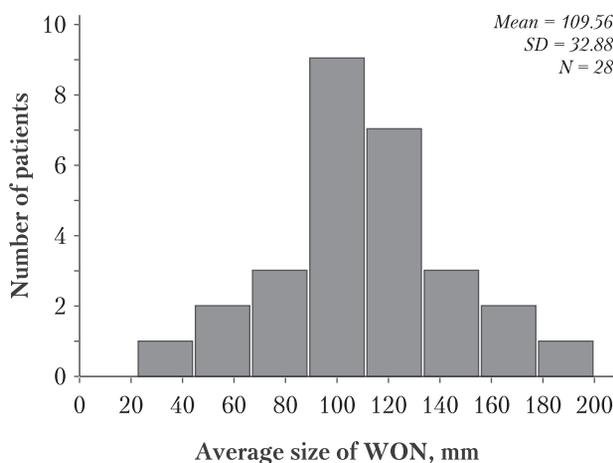


Figure 9. Distribution of patients according to the average size of the walled-off necrosis (WON)

abdominal MRI). Specifically, two maximum dimensions of the cavity (conventionally referred to as width and length) were measured separately in the axial and frontal planes; the four obtained measurements were then summed and divided by four.

A total of 48 endoscopic transluminal sessions were performed, most commonly one per patient (Table 2).

The average intervals between consecutive sessions (1–2, 2–3, 3–4) did not show statistically significant differences (Table 3).

Continuous lavage of the WON was performed in 17 (60.7%) patients, including percutaneous lavage through an existing drain in 10 (58.8%) patients and transnasal drainage installed endoscopically during the ETN session (and reinstalled on the subsequent sessions) in 7 (41.2%) patients. Lavage was carried out three times a day, either fractionally or by drip. The antiseptics used included 1% hydrogen peroxide solution and/or 1% betadine solution; the volume of irrigation solution was 200–400 ml per day.

The procedure was considered technically successful in 28 (100.0%) patients. One patient experienced gastric wall bleeding during the first session, which was stopped by balloon tamponade. No complications requiring surgical intervention were observed.

After performing ETN alone, complete clinical success was attained in 18 (64.3%) patients, while 8 (28.6%) patients presented with partial clinical success. No clinical success was recorded in 2 (7.1%) patients. Among patients with partial clinical success, one patient died after open surgical intervention.

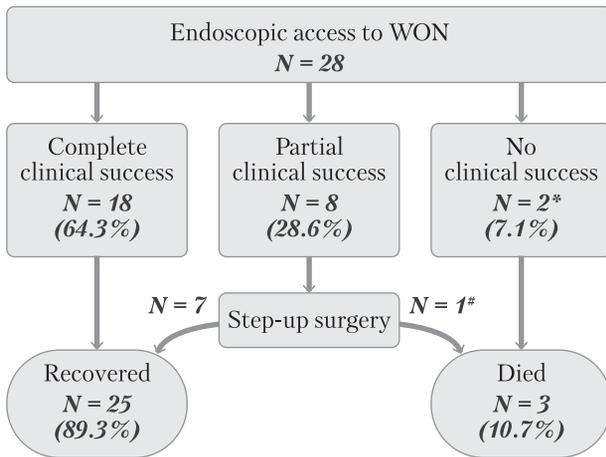
Table 2. Distribution of patients by number of sessions (n = 28)

Number of sessions	Number of patients
1	14 (50.0%)
2	10 (35.7%)
3	2 (7.1%)
4	2 (7.1%)

Table 3. Average intersession intervals during treatment, days

Sessions	Mean ± SD	Min–max
1st–2nd (n = 16)	7.0 ± 2.2	4–14
2nd–3rd (n = 4)	6.5 ± 1.0	6–8
3rd–4th (n = 2)	6.5 ± 0.7	9–7

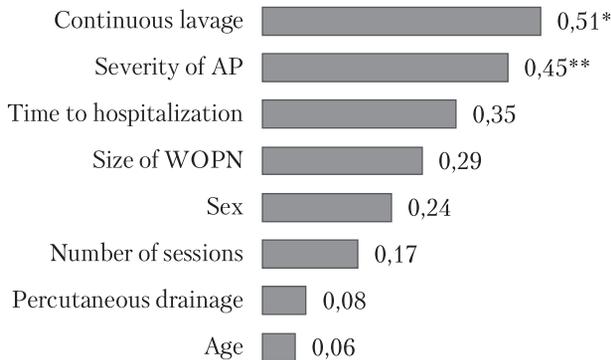
Note. No statistically significant differences were found between intervals (p > 0.05).



* One patient was transferred from another department and was in critical condition before the procedure, with signs of multiple organ failure; the other patient had stayed at home for about a month from disease onset until admission to the clinic and was of advanced age (77 years).

Fatal case due to progression of multiple organ failure; the WON cavity was of giant size (mean size – 185 mm) with extensive necrotic tissue; the patient was transferred from another department.

Figure 10. Flowchart of treatment outcomes in patients from the study



Statistical significance: * p = 0.006; ** p = 0.017.

Figure 11. Correlation between the effectiveness of ETN and several parameters

Thus, a total of 25 (89.3%) patients recovered, and mortality was noted in 3 (10.7%) cases (Fig. 10).

Achieving complete clinical success or complete+partial clinical success necessitated 1 to 4 sessions (Table 4).

Complete clinical success was achieved within 1–2 sessions in 15 patients, which accounted for 53.6% of the total number (n = 28) of treated patients. Complete+partial clinical success was achieved within 1–2 sessions in 21 patients (75.0%). The mean length of hospital stay was 56.2 ± 27.2 days (ranging from 19 to 113 days).

Table 4. Number of ETN sessions in patients with complete and complete+partial clinical success

Number of sessions	Number of patients
Complete clinical success (n = 18)	
1	8 (44.4%)
2	7 (38.9%)
3	1 (5.6%)
4	2 (11.1%)
Complete + partial clinical success (n = 25)	
1	12 (48.0%)
2	9 (36.0%)
3	2 (8.0%)
4	2 (8.0%)

Table 5. Frequency of achieving complete clinical success depending on the use of continuous lavage for WON

Continuous lavage	Complete clinical success		Total
	Yes	No	
Yes	14 (82.4%)	3 (17.6%)	17 (100.0%)
No	4 (36.4%)	7 (63.6%)	11 (100.0%)
Total	18 (64.3%)	10 (35.7%)	28 (100.0%)

Correlation analysis of the relationship between ETN effectiveness and several clinical parameters revealed significant correlations only for the severity of the patient’s condition at admission and the use of continuous WON cavity lavage (Fig. 11).

Among the 17 patients who underwent continuous lavage of the WON cavity, complete clinical success was achieved in 14 (82.4%), but only 4 (36.4%) of the 11 patients who did not receive continuous lavage obtained the same outcome (p = 0.013; Table 5).

Thus, performing ETN followed by continuous lavage of the WON cavity increased the likelihood of achieving complete clinical success by 2.26 times compared to patients who did not undergo lavage (RR = 2.26; 95% CI 1.01–5.10; p = 0.0485).

Discussion

Currently, the management of acute necrotizing pancreatitis is based on the following key principles: priority of minimally invasive interventions, the «step-up» approach, delayed interventions, and multidisciplinary management.

The choice of surgical strategy in ANP is made according to the internationally recognized «step-up approach», taking into account the timing of disease onset and the dynamics of the clinical course. This strategy involves a gradual transition from less invasive methods to more invasive procedures to minimize surgical trauma to the patient. Unlike open necrosectomy, the essence of the «step-up» approach lies primarily in controlling the infectious focus and alleviating sepsis symptoms, rather than in the complete removal of infected necrotic tissue [10]. There is convincing clinical evidence that the «step-up» strategy significantly reduces the number of complications, adverse long-term outcomes, and mortality in patients with ANP [4, 10], allowing for avoidance or postponement of surgical necrosectomy [4, 11].

Endoscopic transluminal interventions for ANP in Western countries have already occupied a significant niche among minimally invasive techniques and are being used with increasing frequency [1].

Despite the high effectiveness of this method, clinicians face several unresolved issues, such as determining the optimal frequency of interventions; choosing the endoscopic debridement strategy – initial endoscopic drainage alone or immediate endoscopic necrosectomy; selecting stents – plastic or self-expanding metal stents; developing innovative tools for necrosectomy; ensuring continuous lavage of the WON cavity with antiseptic or antibiotic solutions; and establishing criteria for transitioning to more invasive procedures. Currently, these aspects are addressed on an individual basis, relying on the experience and technical capabilities of a particular medical center, which highlights the need for further research.

Among the debatable issues is the performance of endoscopic transluminal access without an endoscopic ultrasound (EUS). The WON cavity compresses the wall of the stomach or duodenum in approximately 50–60 % of ANP cases, 4–6 weeks after the onset of the disease [4]. During diagnostic upper gastrointestinal endoscopy, an area of external compression or bulging into the lumen of the stomach or duodenum is usually visualized. Moreover, this site frequently displays inflammatory infiltration, indicating the WON's cavity direct attachment to the hollow organ's wall. In such cases, endoscopic transluminal interventions can be performed at the site of bulging without using of EUS as long as there are no signs of significant portal hypertension [5–7, 12]. It should also be noted that interventions through the greater and lesser curvatures of the stomach should be avoided due to the presence of large vessels in these areas, which may lead to fatal bleeding. Using an

ultrasound endoscope to create access is preferable, as this device allows access to the WON cavity in up to 100 % of cases, even if typical bulging into the gastric lumen is absent, provided that the cavity is within the EUS visualization range [1].

Our study demonstrates that adherence to the indications (direct contact of the WON cavity with the stomach or duodenum according to CT/MRI data, external compression of the stomach/duodenum according to EGD findings, disease duration ≥ 4 weeks), as well as the patient's supine position during the procedure, allows for safe endoscopic transluminal interventions without EUS, with a minimal complication rate and 100 % technical success of accessing the cavity. For convenience during the procedure in the supine position, we used a 15 cm footrest for the endoscopist.

For better evacuation of purulent-necrotic contents from the WON cavity, it is crucial to create adequate access to the cavity. Plastic stents with a diameter of 10 French, which are considered the standard, become rapidly occluded with debris, and the evacuation of purulent-necrotic material occurs mainly through the space between the stents. Therefore, during the first intervention, transluminal drainage with plastic stents alone is insufficient. A fistula should be created using a dilation balloon up to 20 mm. In addition, during the initial procedure, endoscopic entry into the WON cavity is mandatory for the assessment of cavity size, the amount of necrotic debris, and its consistency – which will help determine the need for subsequent sessions.

According to our experience, soft-consistency necrotic masses can be removed by lavage; however, in most cases, dense sticky necrotic debris is present. It must be fragmented and removed using an endoscopic tripod (or other tools) into the lumen of the hollow organ over several sessions.

Performing daily continuous lavage of the WON cavity after establishing endoscopic access significantly improves treatment outcomes in these patients and may reduce the number of endoscopic sessions required.

The duration of a single ETN session should be limited. Prolonged necrosectomy sessions in patients under anesthesia and mechanical ventilation, weakened by a long-lasting intra-abdominal infectious-toxic process, may together exert significant pathophysiological stress on the patient's body. Based on our experience, the optimal duration of a single ETN session should be 60–90 minutes, which has also been reported in previous original studies [7].

Important factors predicting the clinical success of ETN include the size of the WON cavity and the extent of necrotic process spreading into paracolic

spaces [6]. Among the patients in our study, there was one female patient with necrosis spreading into the left paracolic gutter. In this case, complete clinical success was achieved after two ETN sessions combined with the placement of a «competing» percutaneous drain under ultrasound guidance into the left paracolic space, with active lavage through it.

A large WON size and extensive necrotic tissue, with paracolic extension of the necrotic process observed during endoscopic assessment, may indicate the need to transition to more invasive surgical intervention. However, the decisive factors in such situations are the general condition of the patient, the clinical response to transluminal intervention, and the expertise of the selected center.

Our findings confirm that ETN is an effective treatment method for acute infected necrotizing pancreatitis when the indications for the procedure are observed, demonstrating a low complication rate (3.6%, n = 1, bleeding) and mortality (10.7%, n = 3). When indicated, this technique, in combination with percutaneous drainage, can serve as the primary method for complete WON debridement in most cases (64.3%). In 28.6% of patients, it may be used as an intermediate stage before transitioning to more invasive surgical procedures.

The study has certain limitations due to the relatively small number of patients included and its single-center design.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

ETHICS APPROVAL AND WRITTEN INFORMED CONSENT STATEMENTS

The study was conducted in accordance with the Helsinki Declaration of Ethics. The study protocol was approved by the ethics committee of Bogomolets National Medical University (protocol number of topic approval).

AUTHORS CONTRIBUTIONS

N. V. Puzyr: investigation, statistical analysis, writing of the manuscript; Y. M. Susak: conceptualization, methodology, editing.

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Ендоскопічна транслюмінальна некроектомія у пацієнтів з гострим інфікованим некротичним панкреатитом. Досвід спеціалізованого відділення

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За останні десятиліття лікування гострого інфікованого некротичного панкреатиту (ГНП) суттєво покращилося завдяки поглибленню розуміння механізмів перебігу захворювання та впровадженню малоінвазивних технологій. Ендоскопічні транслюмінальні втручання посідають важливе місце серед цих методик і продовжують удосконалюватися як з технічної, так і з тактичної точки зору.

Мета — оцінити результати ендоскопічної транслюмінальної некроектомії у пацієнтів з ГНП та узагальнити досвід спеціалізованого відділення.

Матеріали та методи. В дослідження увійшло 28 пацієнтів: 15 (53,6%) чоловіків та 13 (46,4%) жінок, з середнім віком ($52,6 \pm 12,5$) року, яким протягом 2021—2024 років виконано ендоскопічну транслюмінальну некроектомію (ЕТН) з приводу обмеженого некротичного пері-/панкреатичного скупчення (ОНС), яке безпосередньо контактувало з шлунком та/або дванадцятипалою кишкою. ГНП середнього ступеня тяжкості мали 19 (67,9%) пацієнтів, тяжкий перебіг — 9 (32,1%). Середній розмір ОНС становив $109,6 \pm 32,9$ мм. Результати ЕТН оцінювали як повний, частковий або відсутній клінічний успіх.

Результати. Перша сесія ЕТН виконана в середньому на $36,2 \pm 16,1$ добу (від 22 до 86 діб) від першого приступу захворювання. Всього виконано 48 ендоскопічних транслюмінальних сесій, від 1 до 4, найчастіше — одну на одного пацієнта у 14 (50,0%). Інтервали між послідовними сесіями найчастіше становили 6—7 діб. Проточний лаваж ОНС здійснено 17 (60,7%) хворим.

Тривалість маніпуляції становила від 60 хв. до 90 хв. Рівень інтраопераційних ускладнень становив 3,6% (профузна кровотеча). Повного клінічного успіху досягнуто у 18 (64,3%) пацієнтів, часткового — у 8 (28,6%), у 2 (7,1%) клінічного успіху не зафіксовано. Загалом одужало 25 (89,3%) пацієнтів, летальність становила 3 випадки (10,7%).

Висновки. ЕТН при ГНП при дотриманні показів може бути основним методом лікування у 64,3% пацієнтів, а також у частини пацієнтів (28,6%) — як перехідний етап до більш інвазивних операцій. Виконання ЕТН з подальшим застосуванням проточного лаважу порожнини ОНС підвищує ймовірність досягнення повного клінічного успіху у 2,26 рази порівняно з пацієнтами, яким такий лаваж не проводився ($RR = 2,26$; 95% ДІ 1,01—5,10; $p = 0,0485$).

Ключові слова: гострий панкреатит, гострий інфікований некротичний панкреатит, обмежене некротичне скупчення, ендоскопічна транслюмінальна некроектомія, пряма ендоскопічна некроектомія.

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Indocyanine green lymphography as a method for the diagnostics and management of a chylous ascites. Clinical case

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Chylous ascites is an uncommon complication following invasive procedures, occurring in fewer than 5 % of cases. Most patients with low output lymphorrhea respond favourably to conservative management. However, in cases of persistent lymphatic leakage, surgical intervention may be warranted.

CASE PRESENTATION. A 42-year-old male developed lymphorrhea following ultrasound-guided percutaneous drainage of a large perisplenic hematoma and hemoperitoneum. Despite repeated drainage of ascitic fluid (performed three times) and conservative therapy, including dietary modifications, the patient exhibited persistent chylous ascites that necessitated surgical intervention. A total of five abdominal computed tomography (CT) scans and two magnetic resonance imaging (MRI) studies failed to identify the site of lymphatic leakage. The patient was admitted to Riga East Clinical University Hospital, where additional CT and MRI imaging of the abdomen was performed. Surgical treatment was scheduled. During laparotomy, intraoperative fluorescence lymphography was employed using near-infrared imaging with indocyanine green (ICG) injection. Lymphatic leakage was identified in the vicinity of the left diaphragmatic crus. Approximately three minutes after paraaortic administration of ICG, intact lymphatic vessels became visible, and within five minutes, the precise site of leakage was localized via fluorescence-guided extravasation. The leaking lymphatic vessel was coagulated and sealed using a TachoSil® hemostatic patch. A surgical drain was placed adjacent to the repair site for postoperative monitoring. No recurrence of chylous ascites was observed during a four-month follow-up period. Intraoperative identification of lymphatic leakage remains challenging due to the small calibre of lymphatic vessels and the low-pressure flow of lymph, which is often imperceptible to the unaided eye. Fluorescence-guided lymphography using ICG significantly enhances intraoperative visualization of compromised lymphatic structures. In cases of refractory chylous ascites, surgical management incorporating this technique appears to be both safe and effective.

CONCLUSIONS. This case highlights the successful surgical management of refractory chylous ascites utilizing intraoperative indocyanine green fluorescence lymphography, which enabled precise identification and closure of the lymphatic leakage site.

KEYWORDS

fluorescence guided surgery, indocyanine green, lymphography, lymphorrhea, lymphatic leakage, chylous ascites, image guided surgery, fluorescence lymphography, acute pancreatitis.

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Chylous ascites is an uncommon clinical condition, with incidence rates varying depending on patient population and clinical context. It is most frequently associated with disorders that disrupt lymphatic flow, such as lymphomas, malignancies, or infections involving the lymphatic

system. Overall, chylous ascites accounts for less than 1 % of all ascites cases, including those due to cirrhosis and malignancy. In cirrhotic patients, the incidence ranges from 0.5 % to 1.0 %, while in malignancy-associated ascites it can reach up to 6.7 % [26].

Although lymphatic leaks are relatively rare, they can pose considerable clinical challenges. For instance, the incidence of lymphatic leakage following pancreatic resections is approximately 2.6% [17], while in gynaecological surgeries involving pelvic and/or para-aortic lymph node dissection, the rate is around 0.17% [20]. The management of such leaks is often complex and requires multimodal approaches. Traditional non-invasive and minimally invasive methods include percutaneous drainage and aspiration. More targeted techniques, such as lymphatic vessel ligation and sclerotherapy, may also be employed [14]. Given the higher incidence of lymphatic injury in vascular surgery – reported in up to 18% of arterial procedures – microsurgical interventions, including lymphatic-lymphatic and lymphatic-venous anastomoses, are increasingly utilized in managing lymphatic leakage and associated lymphedema [24].

We present the case of a patient who developed high output lymphorrhea and refractory chylous ascites following acute pancreatitis complicated by a large perisplenic hematoma and hemoperitoneum. After undergoing endovascular embolization of the splenic artery and percutaneous drainage via ultrasound-guided pigtail catheter placement, the patient developed persistent chylous ascites. Definitive treatment was ultimately achieved using intraoperative fluorescence-guided lymphography.

Case presentation

A 42-year-old male was admitted to Riga East Clinical University Hospital with persistent high-output chylous ascites and lymphorrhea. These symptoms developed following abdominal hemorrhage due to ruptured splenic artery pseudoaneurysm complicated with a large perisplenic and intra-abdominal hematoma, which had been managed previously with ultrasound-guided drainage using a pigtail catheter.

This event resulted in chronic chylous ascites that persisted over a seven-month period. Prior to his referral to our institution, the patient was managed conservatively in one of largest hospitals in United Kingdom. Treatment included strict dietary modifications intended to reduce lymph production. During this time, he underwent three therapeutic paracenteses, five computed tomography (CT) scans, and two magnetic resonance imaging (MRI) examinations for the detection of possible lymphatic duct leakage. Ascitic fluid analysis showed markedly elevated triglyceride levels (16 mmol/L), low protein content, and no evidence of infection—findings consistent with chylous ascites.

The initial episode occurred on July 1, 2024, when the patient presented to a regional hospital

in the UK with acute abdominal pain, generalized weakness, and dyspnoea. Laboratory investigations revealed severe anaemia (haemoglobin 5.1 g/dL), necessitating transfusion of five units of packed red blood cells. CT angiography demonstrated a splenic artery pseudoaneurysm, a large perisplenic and epigastric hematoma, hemoperitoneum, and multiple pancreatic pseudocysts. On July 2, the patient underwent endovascular embolization of the splenic artery. He was transferred from the intensive care unit (ICU) to the surgical ward on July 3.

Follow-up abdominal CT on July 15 showed no significant progression of the intra-abdominal hematoma. On July 18, ultrasound-guided percutaneous drainage of the epigastric hematoma was performed, yielding 300 mL of haemorrhagic fluid. A subsequent CT scan on July 20 revealed a marked reduction in the size of the haemorrhagic collection. The drainage catheter was removed on July 26, and the patient was discharged two days later.

The first signs of ascites appeared four months after the initial intervention. In November 2024, the patient underwent the first ultrasound-guided percutaneous drainage procedure due to progressive abdominal distension and discomfort. Approximately 8 litres of milky white ascitic fluid were drained. A second drainage procedure was performed one month later, yielding 11 litres of similar fluid. Despite additional CT and MRI imaging, the site of lymphatic leakage could not be localized. A third drainage was performed on January 21, 2025, shortly before the patient travelled to Latvia for further evaluation.

Upon admission to Riga East Clinical University Hospital on January 28, 2025, the patient reported mild abdominal pain, controlled with tramadol. He also described constitutional symptoms, including a 10 kg weight loss over six months. On physical examination, he was 184 cm tall and weighed 71 kg, reflecting a significant catabolic state. Persistent high output lymphorrhea was observed, with daily drainage volumes ranging from 800 to 1200 mL. Repeated CT imaging of the abdomen was performed but failed to identify the precise site of lymphatic leakage. MRI revealed mild fibrotic changes in retroperitoneal adipose tissue and a linear structure adjacent to the splenic vein, near the left diaphragmatic crus (Fig. 1). Although suggestive, these findings did not definitively confirm the location of the lymphatic leak. Due to the patient's deteriorating clinical condition—including severe malnutrition, chronic pain, ongoing protein and electrolyte losses, and increased risk of life-threatening complications—a multidisciplinary decision was made to proceed with surgical intervention. Since preoperative



Figure 1. MRI findings (arrow) – linear structure at the projection of the splenic vein close to the left pedicle of the diaphragm

lymphangiography was not feasible, intraoperative fluorescence-assisted lymphography with indocyanine green (ICG) was selected to enable real-time localization of the lymphatic leak and guide definitive surgical repair.

Surgical Management

Under general endotracheal anaesthesia, an upper midline laparotomy was performed following three consecutive rounds of surgical site preparation using antiseptic disinfectant solution. Upon entry into the peritoneal cavity, a large volume of white, milky chylous fluid was encountered (Fig. 2).

Complete evacuation was achieved using suction and copious warm saline irrigation. Dense adhesions between intestinal loops and the abdominal wall were meticulously dissected using a LigaSure device to minimize tissue trauma and haemorrhage, thereby improving exposure and access to



Figure 2. White, milky content known as chylous ascites

retroperitoneal structures. The abdominal cavity was irrigated until the effluent was macroscopically clear. Subsequently, the mesenteric root was exposed to facilitate intraoperative lymphatic mapping. Indocyanine green (ICG) dye at a concentration of 2.5 mg/mL was injected (1 mL) into three retroperitoneal sites. Near-infrared fluorescence imaging was initiated one-minute post-injection. Although several small-calibre, intact lymphatic vessels were visualized, no obvious leakage site was initially observed, prompting an extension of the surgical field. The lesser sac was accessed via division of the gastrocolic ligament. Significant venous engorgement along the gastroepiploic arcade was noted, suggesting portal hypertension. Careful dissection toward the left diaphragmatic crus—corresponding to a suspicious area previously identified on MRI was performed. During this stage, a lysed, haemorrhagic splenic cyst was encountered and evacuated. To improve visualization, an additional 7.5 mg of ICG dye (1 mL per injection) was administered into three para-aortic locations. Repeat fluorescence lymphography revealed focal extravasation of the dye, indicating active lymphatic leakage. The identified site was thoroughly irrigated with 0.9% sodium chloride solution. Following field clearance, ICG lymphography was repeated to confirm the leakage site. Targeted coagulation of the leaking vessel was performed using monopolar electrocautery. Haemostasis and lymphostasis were reinforced by applying a 10 × 5 cm TachoSil® fibrin sealant patch over the treated area with gentle compression (Fig. 3, 4). A drainage tube was positioned adjacent to the repair site for postoperative monitoring. Final irrigation was completed, and the abdomen was closed in anatomical layers using non-absorbable sutures for fascia and absorbable sutures for skin.

The intraoperative and early postoperative courses were uneventful, classified as Clavien-Dindo Grade I.

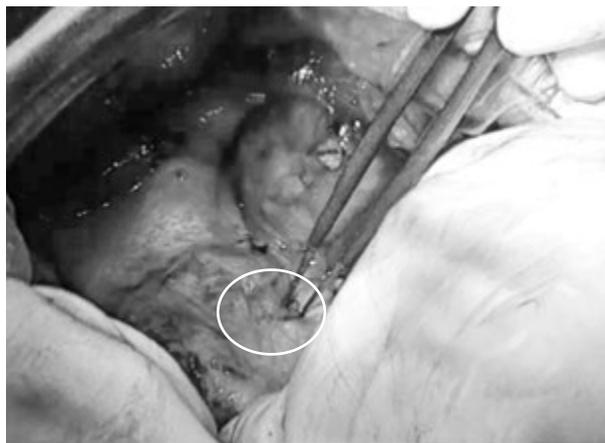


Figure 3. **Fluorescence lymphography, electrocoagulation knife coagulation of the damaged area**



Figure 4. **Fluorescence lymphography, visualization of the damaged area**

No chylous drainage was observed over the first three postoperative days, and the drain was removed accordingly. The patient was discharged on postoperative day four in stable condition with appropriate outpatient follow-up. No recurrence of lymphatic leakage or ascites was observed during subsequent evaluations during the period from March to June.

Discussion

Chylous ascites refers to the pathological accumulation of triglyceride-rich, milky-appearing lymphatic fluid in the peritoneal cavity, typically resulting from traumatic disruption of lymphatic vessels. The condition was first described in the literature in 1912 [4]. Common etiologies include trauma, lymphatic obstruction with consecutive rupture, malignant infiltration of the cisterna chyli, disruption of retroperitoneal lymphatic pathways or the thoracic duct, and elevated peritoneal lymphatic pressure [7]. Loss of chyle from the lymphatic system compromises nutritional, immunological, and fluid balance. Key complications include severe protein depletion, electrolyte imbalance, immunosuppression, and dehydration. These complications are particularly pronounced in high output lymphorrhea (> 1000 mL/day) [21], and thus necessitate early diagnosis and timely intervention to mitigate morbidity and preserve quality of life. Conservative therapy remains the first-line approach and includes dietary modification (low-fat, high-protein, MCT-enriched diet), total parenteral nutrition, and pharmacologic agents such as somatostatin or octreotide. However, resolution is only achieved in approximately 62 % of patients treated conservatively [1], highlighting the importance of timely surgical referral in refractory cases. The intraoperative identification of lymphatic injury is technically challenging due to the microscopic size of lymphatic vessels. While the thoracic duct measures 2–5 mm in diameter [23], most abdominal lymphatics are < 1 mm and capillaries range from 10–60 μm [19], making them difficult to visualize intraoperatively without adjunctive tools. Patients with postoperative lymphatic leakage often present with non-specific symptoms—progressive abdominal distension, dyspnoea, fatigue, malnutrition, and hypoalbuminemia [5]. Diagnostic evaluation includes biochemical analysis of ascitic or drainage fluid (appearance, triglyceride concentration), imaging (CT, MRI), lymphangiography, lymphoscintigraphy, and diagnostic paracentesis [12]. Lymphatic injuries, although rare, may occur even after minimally invasive procedures. Reported incidences range from 2.6 % in left colectomies to 9.6 % in right colectomies [18, 27], reflecting proximity of key lymphatic structures to retroperitoneal dissection planes. Surgical intervention is generally reserved for cases unresponsive to conservative therapy. Standard operative strategies include laparotomy or laparoscopy with identification and ligation of the leaking lymphatic channel, often augmented by haemostatic sealants (e.g., fibrin glue, oxidized cellulose) [6, 8]. Preoperative localization improves success rates to nearly 97 % [18], but guidelines for

management when the site remains unidentified are lacking. In this case, intraoperative ICG fluorescence lymphography was used successfully to localize and treat a persistent lymphatic leak when conventional imaging failed. Although only a few cases employing this technique have been reported, ICG lymphography offers clear advantages by providing real-time visualization of lymphatic flow and allowing precise targeting of the leak.

Conclusions

Chylous ascites remains a rare but challenging complication, particularly in patients with high output lymphorrhea refractory to conservative management. Surgical intervention is often required, yet intraoperative identification of the leaking lymphatic vessel is frequently impeded by the anatomical complexity and extremely small size of the lymphatic system. This case highlights the clinical utility of intraoperative ICG fluorescence lymphography as an effective diagnostic and therapeutic adjunct in the surgical treatment of chylous ascites. By enabling real-time visualization of lymphatic structures and extravasation, ICG lymphography facilitates accurate localization and targeted intervention, significantly improving outcomes. Only a limited number of such cases have been described in the literature, emphasizing the need for broader clinical experience and research. Further studies are needed to establish standardized protocols for ICG use in lymphatic surgery and to evaluate its long-term efficacy in the management of chylous ascites. Nonetheless, this case exemplifies the value of innovative intraoperative techniques in resolving complex surgical dilemmas and advancing patient care.

DECLARATION OF INTERESTS

The authors declare that they have no conflict of interests.

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ETHICS APPROVAL AND WRITTEN INFORMED CONSENT STATEMENTS

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

AUTHORS CONTRIBUTIONS

Acquisition of data – J. Pāvulāns, S. Lūkina, R. Laguns, V. Lobarevs, H. Plaudis; drafting the article – J. Pāvulāns, S. Lūkina, H. Plaudis; critical revision of the article – J. Pāvulāns, H. Plaudis.

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Лімфографія з індоціаніном зеленим як метод діагностики та лікування гілозивного асцити. Клінічний випадок

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Хільозний асцит є рідкісним ускладненням після інвазивних процедур, що трапляється менш ніж у 5% випадків. Більшість пацієнтів із низьким рівнем лімфорей добре реагують на консервативне лікування, але у випадках, коли витік лімфи триває, може знадобитися хірургічне втручання.

Клінічний випадок. Описано випадок 42-річного чоловіка, який отримав пошкодження лімфатичної судини після черезшкірного дренивання великої периспленічної гематоми та гемоперитонеуму під контролем УЗД. Попри багаторазове дренивання (тричі) та консервативну терапію (зміна дієти), у пацієнта спостерігався стійкий хільозний асцит, що потребував хірургічного втручання. Загалом було проведено п'ять комп'ютерних томографій (КТ) черевної порожнини та дві магнітно-резонансні томографії (МРТ), проте місце витоку лімфи виявити не вдалося. Пацієнта було госпіталізовано до Ризької Східної клінічної університетської лікарні, де було проведено додаткові КТ та МРТ черевної порожнини та заплановано хірургічне лікування. Під час лапаротомії була застосована інтраопераційна флюоресцентна лімфографія з введенням індоціаніну зеленого в ближньому інфрачервоному діапазоні. Витік лімфи було виявлено в ділянці лівої ніжки діафрагми. Приблизно через три хвилини після параортального введення індоціаніну зеленого стали видимими інтактні лімфатичні судини, а протягом п'яти хвилин за допомогою флюоресцентно-керованої екстравазації точне місце витоку лімфи було локалізовано. Пошкоджена судина була коагульована та герметизована за допомогою гемостатичної губки TachoSil. У ділянці втручання було встановлено хірургічний дренаж для післяопераційного контролю. Протягом чотиримісячного періоду спостереження рецидивів хільозного асцити не спостерігалось. Інтраопераційне визначення витоку лімфи залишається складним завданням через малий калібр лімфатичних судин і витік лімфи під низьким тиском, що робить процес непомітним для неозброєного ока. Використання інтраопераційної флюоресцентної лімфографії з індоціаніном зеленим може значно полегшити виявлення пошкоджених лімфатичних структур. У випадках стійкого хільозного асцити хірургічне лікування із застосуванням цієї методики є безпечним та ефективним.

Висновки. Наведений випадок демонструє успішне хірургічне лікування стійкого хільозного асцити з використанням інтраопераційної флюоресцентної лімфографії з введенням індоціанінового зеленого для точного визначення місця витоку лімфи та його закриття.

Ключові слова: флюоресцентно-асистована хірургія, індоціанін зелений, лімфографія, лімфорей, витік лімфи, хільозний асцит, хірургія під візуалізаційним контролем, флюоресцентна лімфографія, гострий панкреатит.

FOR CITATION

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A rare case of complicated hernioplasty and reconstruction of the gastroesophageal junction: multistage treatment with a positive outcome

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This clinical case presents the complex and multistage management of a 48-year-old woman with a recurrent hiatal hernia following previous laparoscopic surgical treatment. The initial surgery was complicated by technical errors, leading to early recurrence of the hernia. Subsequent laparoscopic reintervention included mesh-reinforced hernioplasty and revision fundoplication. However, the postoperative course was complicated by the development of acute gastric fundus ischemia and necrosis, which necessitated urgent atypical wedge resection of the stomach. Despite initial recovery, the patient later developed further complications, including a mesh-related gastric ulceration and the formation of a chronic inflammatory infiltrate in the upper abdominal cavity. These adverse events required a relaparotomy, complete mesh removal, proximal gastrectomy, and complex gastrointestinal reconstruction using the double-tract method. The management of this case illustrates several critical challenges: the risk of ischemic complications following fundoplication, the long-term sequelae of mesh implantation at the gastroesophageal junction, and the technical considerations necessary for successful reconstruction after proximal gastrectomy. Special attention was paid to minimizing postoperative reflux, preserving nutritional function, and ensuring a high quality of life. This clinical case highlights the importance of careful patient selection, meticulous surgical technique, and the necessity for early recognition and management of postoperative complications. Through a stepwise, multidisciplinary surgical approach, a positive long-term outcome was achieved, with the patient demonstrating good tolerance to a regular diet, no signs of reflux, and satisfactory functional recovery.

KEYWORDS

hiatal hernia, fundoplication, surgical complications, double-track reconstruction, gastric necrosis, mesh erosion.

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Hiatal hernia is a prevalent condition that can present with heartburn, postprandial discomfort, and epigastric pain. When conservative therapy fails, surgical intervention becomes necessary. Laparoscopic cruroplasty remains the standard surgical approach for controlling reflux symptoms rather than for repairing

the hernia itself. However, postoperative complications, including hernia recurrence, gastric necrosis, and mesh-related erosion, may significantly impair outcomes and require complex reoperations.

The presented case is of particular clinical interest due to the rare combination of gastric fundus

necrosis and mesh erosion into the gastric lumen, following laparoscopic hiatal hernia repair and fundoplication. These complications underscore the importance of meticulous surgical technique, proper selection of mesh material, and vigilant postoperative surveillance.

According to published data, the recurrence rate of hiatal hernia after primary laparoscopic surgery ranges between 10 % and 30 %, depending on technical factors and patient-specific risks. Complications such as ischemic damage to the gastric fundus or mesh-related erosion are rare but life-threatening, often necessitating urgent intervention and reconstructive procedures.

Clinical case

In 2016, a 48-year-old female patient began experiencing heartburn and discomfort in the epigastric region. Conservative management provided only partial symptom relief. In 2020, she underwent laparoscopic Nissen fundoplication at a local clinic. No concurrent cruroplasty was documented. One month postoperatively, she experienced a recurrence of heartburn and discomfort. Imaging and endoscopic evaluation confirmed a recurrent hiatal hernia. However, no surgical revision was pursued over the next three years due to the moderate severity of her symptoms.

In February 2023, the patient presented to the National Cancer Institute (NCI) with worsening symptoms, including severe heartburn, regurgitation, and epigastric pain. Diagnostics, including esophagogastroduodenoscopy (EGD) and contrast-enhanced computed tomography (CT), identified a large sliding hiatal hernia (type I) with significant anatomical disruption. (Status post-surgical treatment for hiatal hernia. At the level of the diaphragmatic segment, the esophageal lumen was dilated up to 18.7 mm, and the esophageal wall thickness measured 13.7 mm. At the gastroesophageal junction, the gastric wall prolapsed towards the left and superiorly, measuring up to 23.0 × 15.6 mm.) Conservative management was deemed ineffective, and redo laparoscopic surgery was indicated to prevent progressive esophageal damage.

The surgical team opted for laparoscopic hernioplasty with synthetic mesh reinforcement. Intraoperatively, technical errors from the initial fundoplication were revealed: inadequate mobilization of the gastric fundus and excessive tension on the Dor's fundoplication wrap (Fig. 1). The hernia defect measured approximately 3 cm, and the hernia sac contained both the gastric cardia and proximal body without signs of incarceration.

A complete takedown of the previous fundoplication was performed, followed by refashioning a new 360-degree wrap. A 12-cm Symbotex composite mesh was applied after posterior cruroplasty using non-absorbable sutures with moderate tension.

The laparoscopic view reveals anatomical disarrangement and improper fixation of the gastric wrap. These findings confirmed the cause of early hiatal hernia recurrence and justified the need for surgical revision.

Three hours postoperatively, the patient was transferred to a specialized department. After 23 hours, her condition acutely deteriorated, exhibiting clinical signs of hollow organ perforation, including severe abdominal pain, tachycardia, and signs of peritonitis.

An emergency laparotomy, performed approximately 24 hours after the initial surgery, revealed diffuse fibrinous peritonitis and a large area of gastric fundus necrosis. The gastric fundus and greater curvature were severely ischemic, flaccid, and cyanotic. A necrotic perforated ulcer of the gastric fundus was visualized, characterized by necrotic, undermined («lip-like») edges, measuring up to 7 cm in diameter. Resection of the greater curvature of the stomach was performed using surgical staplers, with additional peritonization of the staple line. A nasogastric tube was placed for gastric decompression. Intraoperative endoscopy was conducted to assess staple line integrity: the stomach was airtight, and resection was performed within healthy tissue margins.

The postoperative course was uneventful, and the patient was discharged in satisfactory condition on postoperative day 5.

Over the next six months, the patient remained asymptomatic. However, in August 2024, she began experiencing postprandial discomfort and periodic nausea, which gradually worsened, but she did not

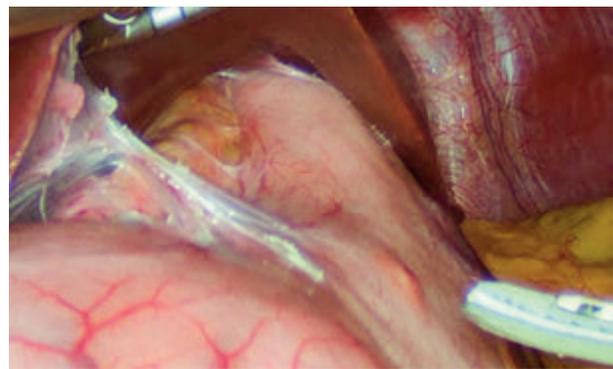


Figure 1. **Intraoperative image during redo hernioplasty demonstrating technical failure of the previous fundoplication**

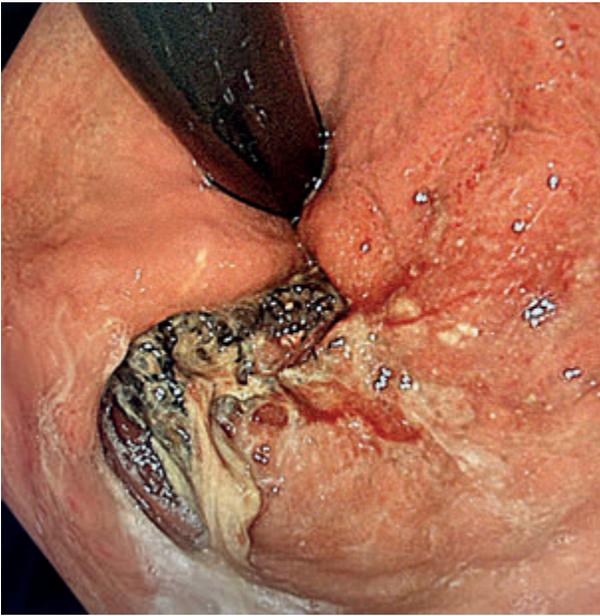


Figure 2. Endoscopic image showing mesh-induced pressure necrosis penetrating into the gastric lumen

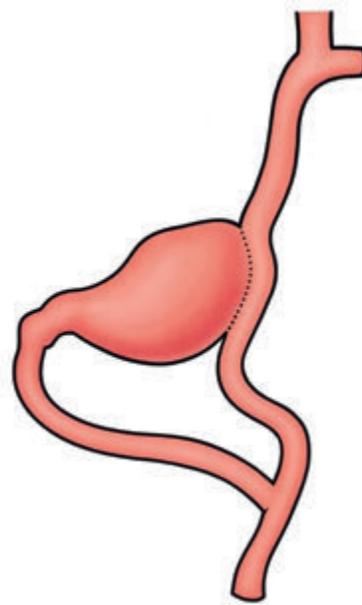


Figure 3. Diagram of the upper gastrointestinal tract after proximal gastrectomy with double-track reconstruction

seek medical help. By September 2024, the pain intensity reached 8 out of 10 on the visual analog scale after eating, prompting her readmission to the NCI.

Repeat EGD revealed a deep mucosal defect on the gastric staple line, with evidence of mesh erosion into the gastric lumen (Fig. 2).

Contrast-enhanced CT confirmed the absence of gastrointestinal perforation or extraluminal leakage.

A deep ulcerative defect is visible at the site of prior hernioplasty, consistent with mesh erosion. The lesion is characterized by necrotic margins and inflammatory changes in the surrounding mucosa. This finding was critical in confirming the diagnosis and planning for surgical intervention in the presented clinical case.

In September 2024, a planned relaparotomy was performed. Intraoperatively, dense adhesions were encountered, and the mesh was found to have eroded into the gastric remnant. A chronic inflammatory infiltrate involving the mesh and surrounding tissues was present. Proximal gastrectomy was performed with complete removal of the mesh and resection of the involved gastric segment.

Reconstruction was achieved using the double-track method: a Roux-en-Y esophagojejunostomy with an additional side-to-side gastrojejunostomy between the gastric remnant and the Roux limb, approximately 15 cm distal to the esophagojejunostomy (Fig. 3).

Postoperative recovery was uncomplicated, and the patient was discharged on postoperative day 7. As of the last follow-up in April 2025, the patient remained asymptomatic, tolerating a regular diet without significant weight loss or reflux symptoms.

Discussion

Hiatal hernia repair combined with laparoscopic fundoplication is a widely accepted method to manage symptomatic gastroesophageal reflux disease (GERD). However, fundoplication alone does not correct the anatomical defect of the hiatal hernia. Recurrence of hiatal hernia after repair ranges from 2% to 30%, according to various studies [3, 6, 13, 15, 19], depending on the quality of the initial surgical technique, hernia size, and patient factors such as obesity.

Most anatomical recurrent cases are asymptomatic or mildly symptomatic, but approximately 3–6% require surgical reintervention [14]. In this case, technical deficiencies during the initial fundoplication likely contributed to early hernia recurrence.

In the late postoperative period, our patient developed a complication – mesh erosion into the stomach, which clinically manifested as pain and symptoms of gastric dysfunction. Such complications related to mesh placement have been reported both after primary and revisional surgeries. The main mechanisms of mesh erosion include chronic inflammation, mechanical pressure on the gastric wall, and impaired mesh integration [1].

According to recent literature, prevention strategies for mesh erosion involve proper mesh positioning, minimizing direct contact between the mesh and the esophageal or gastric mucosa, and covering the mesh with adjacent tissues such as the hernia sac whenever possible [1]. Despite these precautions, mesh erosion remains a significant clinical problem, particularly after revisional surgeries [11].

Li et al. demonstrated that the esophagus is the most frequent site of erosion (50%), followed by the stomach (25%) and the gastroesophageal junction (23%) [11]. Mesh erosion typically occurs within two years after surgery and may necessitate complex reoperations, including distal esophageal or partial gastric resections. The type of mesh material (e.g., polytetrafluoroethylene [PTFE] or polypropylene) and the technical aspects of implantation play critical roles in determining the risk of erosion [11].

The choice of mesh material has a notable impact on outcomes. According to Lima et al., biosynthetic meshes may offer a lower risk of long-term complications compared to permanent synthetic meshes [12]. Although biosynthetic materials such as BIO-A or Phasix ST can reduce foreign body reactions and decrease the likelihood of erosion, direct contact between the mesh and gastrointestinal structures still carries a risk of serious complications [12].

Furthermore, a network meta-analysis by Rausa et al. demonstrated that nonabsorbable meshes were associated with lower hernia recurrence rates but higher risks of long-term complications such as erosion and migration, compared to absorbable meshes [17]. Therefore, when choosing the type of prosthesis, surgeons must balance the lower risk of anatomical recurrence against the higher probability of severe mesh-related complications.

In our case, given the evidence of mesh erosion into the stomach, the surgical team performed complete mesh removal, proximal gastrectomy, and double-track reconstruction to restore gastrointestinal continuity and minimize the risk of further complications.

During Nissen fundoplication, the gastric fundus is mobilized, wrapped around the esophagus, and sutured to form a cuff [10]. This process involves ligating short gastric vessels within the gastro-splenic ligament. Consequently, the blood supply to the gastric fundus relies solely on the right and left gastric arteries, providing limited perfusion in this area. Gastric fundus necrosis is a rare complication arising from impaired perfusion due to damage or ligation of its short vessels during surgery.

The development of gastric fundus necrosis post-operatively is a rare but life-threatening complication. Several mechanisms may contribute to this outcome:

1. **Vascular Damage:** Ligation of short vessels during the initial operation significantly reduces blood flow to the gastric fundus. Subsequent trauma to intramural vessels during revision surgery may exacerbate ischemia.

2. **Hypoxia and Secondary Inflammation:** Re-fundoplication and tissue tension during reconstruction mechanically disrupt microcirculation.

Impaired blood flow triggers hypoxia and a cascade of secondary inflammatory processes, leading to cell death, granulation tissue growth, and transmural damage.

Early recognition of ischemic complications is crucial for preventing severe outcomes.

To minimize the risk of necrosis in clinical practice:

- Damage to the vascular network during primary surgery should be minimized.
- Excessive tissue tension during cuff formation should be avoided.

Proximal gastrectomy and double-track reconstruction

Patients undergoing proximal gastrectomy often report heartburn, postprandial discomfort, and dumping syndrome [2]. In this case, double-track reconstruction was chosen after proximal gastrectomy, justified by several key factors:

Physiological advantages

Double-track reconstruction enhances (see Fig. 3) the patient's quality of life, preventing significant digestive disturbances such as gastric juice reflux, dumping syndrome, or anemia.

Double-track reconstruction is performed after standard Roux-en-Y reconstruction, adding a side-to-side anastomosis between the distal stomach and the Roux limb.

The image illustrates the anatomical configuration following resection of the upper third of the stomach, preserving the gastric remnant and continuity with the small intestine.

This approach provides two parallel pathways for food passage:

Direct passage to the distal small intestine via the jejunojejunostomy loop, minimizing gastric stasis and reflux.

Slower transit through the preserved stomach segment, allowing physiological digestion [23].

This partially preserves gastric digestive functions and improves nutrient absorption, particularly for iron, calcium, and B vitamins [4].

Long-term outcomes

Studies show that patients undergoing double-track reconstruction demonstrate:

- Lower rates of dumping syndrome.
- Better tolerance of solid food.
- Less pronounced weight disturbances compared to classical reconstruction.

These factors are especially important for this patient, who did not have oncological pathology, as the therapy aimed to treat complications and restore normal digestive function [16].

Reflux prevention

In cases requiring proximal gastrectomy for non-oncological conditions, double-track reconstruction effectively prevents severe gastroesophageal reflux, a common complication of standard esophagogastronomy.

Quality of life

The patient's recovery without significant dietary restrictions or postoperative complications (e.g., systemic inflammatory response, infections, or impaired transit) confirms the effectiveness of the chosen approach. High quality of life, minimal dietary limitations, and a return to normal daily activities underscore the benefits of double-track reconstruction.

Thus, the choice of double-track reconstruction was based on balancing surgical radicality, complication prevention, and patient optimization.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

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ETHICS APPROVAL AND WRITTEN INFORMED CONSENT STATEMENTS

The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from the patient for publication of clinical details and images.

AUTHORS CONTRIBUTIONS

Y. Kondratskyi: conceptualization, surgery, supervision; N. Koval: surgical assistance, manuscript writing, data collection; A. Kolesnyk, Y. Shudrak, O. Dobrzanskiy, M. Pepenin: surgical assistance, data acquisition; V. Turchak, A. Horodetskyi, Y. Svichkar, I. Ukrainets, E. Kozak: postoperative care, literature review.

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Рідкісний випадок ускладненої герніопластики та реконструкції гастроєзофагеального переходу: багатоетапне лікування з позитивним результатом

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У статті представлено клінічний випадок складного та багатоступеневого лікування 48-річної жінки з рецидивною грижею стравохідного отвору діафрагми після попереднього лапароскопічного хірургічного втручання. Первинна операція була ускладнена технічними помилками, що призвело до раннього рецидиву грижі. Повторне лапароскопічне втручання включало герніопластику із застосуванням сітчастого імплантанта та ревізійну фундоплікацію. Однак у післяопераційному періоді розвинулося гостре ішемічне ураження та некроз дна шлунка, що потребувало термінової атипової резекції шлунка клиноподібної форми. Попри початкове одужання, у пацієнтки згодом виникли додаткові ускладнення, зокрема утворення виразкового дефекту, спричиненого сіткою, та формування хронічного запального інфільтрату у верхньому відділі черевної порожнини. Ці стани потребували повторної лапаротомії, повного видалення сітки, проксимальної гастректомії та складної реконструкції шлунково-кишкового тракту за методом подвійного тракту. Представлений випадок демонструє низку критичних аспектів: ризик ішемічних ускладнень після фундоплікації, віддалені наслідки імплантації сітки в ділянці гастроєзофагеального переходу та технічні особливості успішної реконструкції після проксимальної гастректомії. Особливу увагу було приділено мінімізації післяопераційного рефлюксу, збереженню харчової функції та забезпеченню високої якості життя. Цей клінічний випадок підкреслює важливість ретельного відбору пацієнтів, досконалої хірургічної техніки та своєчасного виявлення й корекції післяопераційних ускладнень. Завдяки поетапному, мультидисциплінарному підходу до лікування було досягнуто позитивного віддаленого результату: пацієнтка добре переносила звичний раціон, не мала ознак рефлюксу та продемонструвала задовільне функціональне відновлення.

Ключові слова: хіатальна грижа, фундоплікація, хірургічні ускладнення, реконструкція за методом double-tract, некроз шлунка, пролежень від сітки.

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