

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,

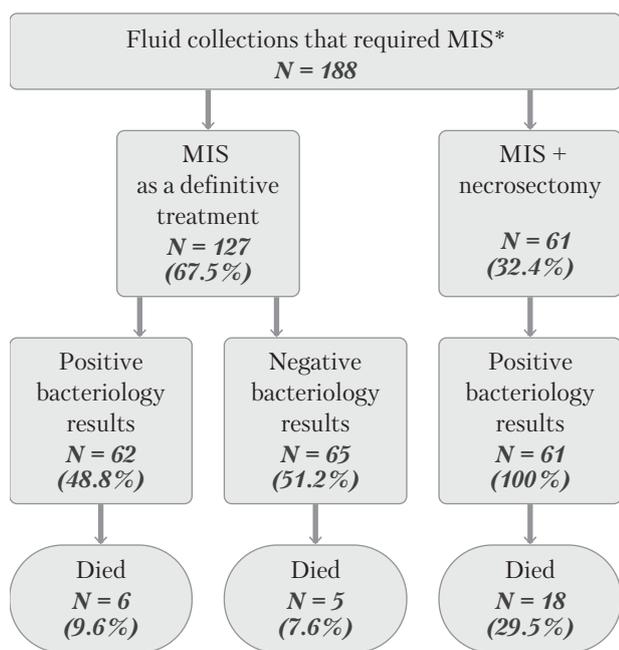


Figure. **Treatment outcomes for ANP patients with local complications requiring ultrasound-guided minimally invasive correction of fluid accumulations in the retroperitoneal tissue**

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 ($> 400,000/\text{mm}^3$ or $< 150,000/\text{mm}^3$) 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 $> 400,000/\text{mm}^3$ or $< 150,000/\text{mm}^3$ (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.

REFERENCES

1. МОЗ України. Гострий панкреатит: клінічна настанова, заснована на доказах. Київ, 2020. 75 с. [Електронний ресурс]. Режим доступу: https://moz.gov.ua/uploads/1/12-acute_pancreatitis_guideline_2020.pdf.
2. Сусак ЯМ, Ткаченко ОА, Згржебловська ЛВ, Березенко ІМ, Дирда ОО. Алгоритм лікування пацієнтів з гострим некротичним панкреатитом в умовах спеціалізованого відділення багатопрофільної лікарні. *Radiation Diagnostics, Radiation Therapy*. 2016;(3):60-68. - Режим доступу: http://nbuv.gov.ua/UJRN/Ildt_2016_3_10.
3. Baron TH, DiMaio CJ, Wang AY, Morgan KA. American Gastroenterological Association Clinical Practice Update: Management of Pancreatic Necrosis. *Gastroenterology*. 2020 Jan;158(1):67-75.e1. doi: 10.1053/j.gastro.2019.07.064. Epub 2019 Aug 31. PMID: 31479658.
4. Baron TH. Drainage for Infected Pancreatic Necrosis — Is the Waiting the Hardest Part? *N Engl J Med*. 2021 Oct 7;385(15):1433-1435. doi: 10.1056/NEJMe2110313. PMID: 34614334.
5. Bruennler T, Langgartner J, Lang S, Wrede CE, Klebl F, Zierhut S, Siebig S, Mandraka F, Rockmann F, Salzberger B, Feuerbach S, Schoelmerich J, Hamer OW. Outcome of patients with acute, necrotizing pancreatitis requiring drainage-does drainage size matter? *World J Gastroenterol*. 2008 Feb 7;14(5):725-30. doi: 10.3748/wjg.14.725. PMID: 18205262; PMCID: PMC2683999.
6. Delattre JF, Levy Chazal N, Lubrano D, Flament JB. Place du drainage percutané échoguidé dans le traitement chirurgical de la pancréatite aiguë grave [Percutaneous ultrasound-guided drainage in the surgical treatment of acute severe pancreatitis]. *Ann Chir*. 2004 Nov;129(9):497-502. French. doi: 10.1016/j.anchir.2004.09.006. PMID: 15556578.
7. Freeny PC, Hauptmann E, Althaus SJ, Traverso LW, Sinanan M. Percutaneous CT-guided catheter drainage of infected acute necrotizing pancreatitis: techniques and results. *AJR Am J Roentgenol*. 1998 Apr;170(4):969-75. doi: 10.2214/ajr.170.4.9530046. PMID: 9530046.
8. Goodchild G, Chouhan M, Johnson GJ. Practical guide to the management of acute pancreatitis. *Frontline Gastroenterol*. 2019 Jul;10(3):292-299. doi: 10.1136/flgastro-2018-101102. Epub 2019 Mar 2. PMID: 31288253; PMCID: PMC6583768.
9. Hollemans RA, Bakker OJ, Boermeester MA, Bollen TL, Bosscha K, Bruno MJ, Buskens E, Dejong CH, van Duijvendijk P, van Eijck CH, Fockens P, van Goor H, van Grevenstein WM, van der Harst E, Heisterkamp J, Hesselink EJ, Hofker S, Houdijk AP, Karsten T, Kruyt PM, van Laarhoven CJ, Laméris JS, van Leeuwen MS, Manusama ER, Molenaar IQ, Nieuwenhuijs VB, van Ramshorst B, Roos D, Rosman C, Schaapherder AF, van der Schelling GP, Timmer R, Verdonk RC, de Wit RJ, Gooszen HG, Besselink MG, van Santvoort HC, Dutch Pancreatitis Study Group. Superiority of Step-up Approach vs Open Necrosectomy in Long-term Follow-up of Patients With Necrotizing Pancreatitis. *Gastroenterology*. 2019 Mar;156(4):1016-1026. doi: 10.1053/j.gastro.2018.10.045. Epub 2018 Nov 2. PMID: 30391468.
10. Horvath K, Freeny P, Escallon J, Heagerty P, Komstock B, Glickerman DJ, Bulger E, Sinanan M, Langdale L, Kolokythas O, Andrews RT. Safety and efficacy of video-assisted retroperitoneal debridement for infected pancreatic collections: a multicenter, prospective, single-arm phase 2 study. *Arch Surg*. 2010 Sep;145(9):817-25. doi: 10.1001/archsurg.2010.178. PMID: 20855750.
11. Huang Y, Badurdeen DS. Acute Pancreatitis Review. *Turk J Gastroenterol*. 2023 Aug;34(8):795-801. doi: 10.5152/tjg.2023.23175. PMID: 37404118; PMCID: PMC10544623.
12. Iannuzzi JP, King JA, Leong JH, Quan J, Windsor JW, Tanyingoh D, Coward S, Forbes N, Heitman SJ, Shaheen AA, Swain M, Buie M, Underwood FE, Kaplan GG. Global Incidence of Acute Pancreatitis Is Increasing Over Time: A Systematic Review and Meta-Analysis. *Gastroenterology*. 2022 Jan;162(1):122-134. doi: 10.1053/j.gastro.2021.09.043. Epub 2021 Sep 25. PMID: 34571026.
13. Leonard-Murali S, Lezotte J, Kalu R, Blyden DJ, Patton JH, Johnson JL, Gupta AH. Necrotizing pancreatitis: A review for the acute care surgeon. *Am J Surg*. 2021 May;221(5):927-934. doi: 10.1016/j.amjsurg.2020.08.027. Epub 2020 Aug 26. PMID: 32878690; PMCID: PMC8650167.
14. Leppäniemi A, Tolonen M, Tarasconi A, Segovia-Lohse H, Gambellini E, Kirkpatrick AW, Ball CG, Parry N, Sartelli M, Wolbrink D, van Goor H, Baiocchi G, Ansaloni L, Biffl W, Coccolini F, Di Saverio S, Kluger Y, Moore E, Catena F. 2019 WSES guidelines for the management of severe acute pancreatitis. *World J Emerg Surg*. 2019 Jun 13;14:27. doi: 10.1186/s13017-019-0247-0. PMID: 31210778; PMCID: PMC6567462.
15. Navalho M, Pires F, Duarte A, Gonçalves A, Alexandrino P, Távora I. Percutaneous drainage of infected pancreatic fluid collections in critically ill patients: correlation with C-reactive protein values. *Clin Imaging*. 2006 Mar-Apr;30(2):114-9. doi: 10.1016/j.clinimag.2005.09.026. PMID: 16500542.
16. Papachristou GI, Muddana V, Yadav D, O'Connell M, Sanders MK, Slivka A, Whitcomb DC. Comparison of BISAP, Ranson's, APACHE-II, and CTSI scores in predicting organ failure, complications, and mortality in acute pancreatitis. *Am J Gastroenterol*. 2010 Feb;105(2):435-41; quiz 442. doi: 10.1038/ajg.2009.622. Epub 2009 Oct 27. PMID: 19861954.
17. Raraty MG, Halloran CM, Dodd S, Ghaneh P, Connor S, Evans J, Sutton R, Neoptolemos JP. Minimal access retroperitoneal pancreatic necrosectomy: improvement in morbidity and mortality with a less invasive approach. *Ann Surg*. 2010 May;251(5):787-93. doi: 10.1097/SLA.0b013e3181d96c53. PMID: 20395850.
18. Segal D, Mortelet KJ, Banks PA, Silverman SG. Acute necrotizing pancreatitis: role of CT-guided percutaneous catheter drainage. *Abdom Imaging*. 2007 May-Jun;32(3):351-61. doi: 10.1007/s00261-007-9221-5. PMID: 17502982.
19. Shenvi S, Gupta R, Kang M, Khullar M, Rana SS, Singh R, Bhasin DK. Timing of surgical intervention in patients of infected necrotizing pancreatitis not responding to percutaneous catheter drainage. *Pancreatol*. 2016 Sep-Oct;16(5):778-87. doi: 10.1016/j.pan.2016.08.006. Epub 2016 Aug 13. PMID: 27592206.

20. Solanki R, Thumma V, Sastry RA, Bheerappa N. The role of image guided percutaneous drainage in multidisciplinary management of necrotizing pancreatitis. *Trop Gastroenterol*. 2013 Jan-Mar;34(1):25-30. doi: 10.7869/tg.2012.87. PMID: 23923371.
21. Van Grinsven J, van Dijk SM, Dijkgraaf MG, Boermeester MA, Bollen TL, Bruno MJ, van Brunschot S, Dejong CH, van Eijck CH, van Lienden KP, Boerma D, van Duijvendijk P, Hadithi M, Haveman JW, van der Hulst RW, Jansen JM, Lips DJ, Manusama ER, Molenaar IQ, van der Peet DL, Poen AC, Quispel R, Schaapherder AF, Schoon EJ, Schwartz MP, Seerden TC, Spanier BWM, Straathof JW, Venneman NG, van de Vrie W, Witteman BJ, van Goor H, Fockens P, van Santvoort HC, Besselink MG; Dutch Pancreatitis Study Group. Postponed or immediate drainage of infected necrotizing pancreatitis (POINTER trial): study protocol for a randomized controlled trial. *Trials*. 2019 Apr 25;20(1):239. doi: 10.1186/s13063-019-3315-6. PMID: 31023380; PMCID: PMC6482524.
22. Van Santvoort HC, Besselink MG, Bakker OJ, Hofker HS, Boermeester MA, Dejong CH, van Goor H, Schaapherder AF, van Eijck CH, Bollen TL, van Ramshorst B, Nieuwenhuijs VB, Timmer R, Laméris JS, Kruij PM, Manusama ER, van der Harst E, van der Schelling GP, Karsten T, Hesselink EJ, van Laarhoven CJ, Rosman C, Bosscha K, de Wit RJ, Houdijk AP, van Leeuwen MS, Buskens E, Gooszen HG; Dutch Pancreatitis Study Group. A step-up approach or open necrosectomy for necrotizing pancreatitis. *N Engl J Med*. 2010 Apr 22;362(16):1491-502. doi: 10.1056/NEJMoa0908821. PMID: 20410514.
23. Werge M, Novovic S, Schmidt PN, Gluud LL. Infection increases mortality in necrotizing pancreatitis: A systematic review and meta-analysis. *Pancreatology*. 2016 Sep-Oct;16(5):698-707. doi: 10.1016/j.pan.2016.07.004. Epub 2016 Jul 9. PMID: 27449605.
24. Wolbrink DRJ, Kolwijck E, Ten Oever J, Horvath KD, Bouwense SAW, Schouten JA. Management of infected pancreatic necrosis in the intensive care unit: a narrative review. *Clin Microbiol Infect*. 2020 Jan;26(1):18-25. doi: 10.1016/j.cmi.2019.06.017. Epub 2019 Jun 22. PMID: 31238118.
25. Zerem E, Imamović G, Sušić A, Haračić B. Step-up approach to infected necrotising pancreatitis: a 20-year experience of percutaneous drainage in a single centre. *Dig Liver Dis*. 2011 Jun;43(6):478-83. doi: 10.1016/j.dld.2011.02.020. Epub 2011 Apr 8. PMID: 21478061.

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 некрсеквестректомії 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 некрсеквестректомія. 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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