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Surgical correction issues in the presence of fluid accumulations in patients with acute pancreatitis

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Objective: This comprehensive review aims to synthesize the current international evidence and clinical practices regarding the management of fluid collections in acute pancreatitis, with a focus on the paradigm shift from open surgery to a minimally invasive, multidisciplinary step-up approach.

Methods: An analysis of recent literature (2017-2024) from European, North American, Chinese, Japanese, Russian, and Tajik sources was conducted. The review encompasses data from randomized controlled trials, meta-analyses, cohort studies, and clinical guidelines to evaluate the efficacy, safety, and outcomes of various intervention strategies.

Results: The management of acute pancreatitis complications, particularly infected necrosis and walled-off necrosis, has been revolutionized by the step-up approach. Initial percutaneous catheter drainage serves as a cornerstone for sepsis control. For definitive treatment, endoscopic transmural drainage and necrosectomy, facilitated by lumen-apposing metal stents, and minimally invasive surgical techniques like video-assisted retroperitoneal debridement (VARD) have proven highly effective. Recent comparative trials (eg, MISER, TENSION) demonstrate that although both approaches (endoscopic and surgical) are valid, the endoscopic route may have advantages in reducing the risk of long-term pancreatic failure. The choice of intervention must be tailored to the collection's anatomy, patient status, and local expertise, often requiring a combined "hybrid" approach.

Conclusion: The correction of pancreatic fluid collections is best managed by a patient-centered, multidisciplinary team. The modern standard of care prioritizes a step-up philosophy, starting with the least invasive procedures. This strategy, supported by robust international evidence, has significantly improved patient outcomes, reducing morbidity, mortality, and the long-term sequelae of necrotizing pancreatitis.

Key words:
acute pancreatitis, pancreatic fluid collections, walled-off necrosis, pseudocyst, step up approach, percutaneous catheter drainage

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Вопросы хирургической коррекции при наличии жидкостных скоплений у больных с острым панкреатитом

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Цель исследования. Обобщение современных международных данных и клинической практики, касающихся тактики ведения жидкостных скоплений при остром панкреатите, с акцентом на парадигмальном переходе от открытых хирургических вмешательств к минимально инвазивному, мультидисциплинарному step-up подходу (поэтапному наращиванию вмешательства).

Материалы и методы. Проведён анализ доступной литературы (2017-2024 гг.) по изучаемой тематике из европейских, североамериканских, китайских, японских, российских и таджикских источников. В обзоре суммированы данные рандомизированных контролируемых исследований, мета-анализов, когортных исследований и клинических рекомендаций для оценки эффективности, безопасности и результатов различных стратегий вмешательств.

Результаты. Тактика ведения осложнений острого панкреатита, в частности инфицированного некроза и инкапсулированного некроза, была революционизирована благодаря step-up подходу. Первоначальное чрескожное катетерное дренирование является краеугольным камнем для контроля сепсиса. Для окончательного лечения эндоскопическое трансмуральное дренирование и некрэктомия с использованием lumen-apposing металлических стентов, а также минимально инвазивные хирургические техники, такие как видео-ассистированная ретроперитонеальная санация (VARD), доказали свою высокую эффективность. Последние сравнительные испытания (например, MISER, TENSION) демонстрируют, что, хотя оба подхода (эндоскопический и хирургический) являются состоятельными, эндоскопический route может иметь преимущества в снижении риска долгосрочной панкреатической недостаточности. Выбор метода вмешательства должен быть индивидуализирован в зависимости от анатомии скопления, состояния пациента и локальной экспертизы, часто требуя комбинированного "гибридного" подхода.

Заключение. Коррекция панкреатических жидкостных скоплений наиболее эффективно осуществляется мультидисциплинарной командой в рамках patient-centered подхода. Современный стандарт лечения отдаёт приоритет step-up философии, начинающейся с наименее инвазивных процедур. Эта стратегия, подкреплённая robust международными данными, значительно улучшила исходы для пациентов, снизив показатели заболеваемости, смертности и отдалённых последствий некротизирующего панкреатита.

Ключевые слова:
острый панкреатит, панкреатические жидкостные скопления, инкапсулированный некроз, псевдокиста, поэтапный подход (step up), чрескожное катетерное дренирование, обзор литературы

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INTRODUCTION

Acute pancreatitis (AP) remains a significant challenge in emergency abdominal surgery. AP is an inflammatory condition of the pancreas with a variable clinical course, ranging from a self-limiting edematous form to a severe necrotizing disease associated with systemic complications and high mortality [1].

The revised Atlanta classification of 2012, which remains the cornerstone for diagnosis and terminology, categorizes the local complications of AP based on the presence of necrosis and the time elapsed since the onset of disease [2]. This classification is critical for understanding the natural history and guiding the management of peri-pancreatic fluid collections.

In the early phase of AP (within the first 4 weeks), two main types of collections can arise: Acute Peripancreatic Fluid Collections (APFC), associated with interstitial edematous pancreatitis, and Acute Necrotic Collections (ANC), which contain a variable amount of liquid and solid necrotic material and are a hallmark of necrotizing pancreatitis. As time progresses, these collections may resolve spontaneously or evolve. APFCs that persist beyond 4 weeks and develop a well-defined wall are termed pancreatic pseudocysts, which, by definition, lack solid necrotic debris. Conversely, ANCs that mature over more than 4 weeks, developing a enhancing wall, become Walled-Off Necrosis (WON), a complex collection comprising both liquid and solid components [3].

The primary indications for intervention in these collections include suspected or confirmed infection, persistent symptoms such as gastric outlet obstruction, biliary obstruction, persistent pain, or failure to thrive. The management philosophy has radically evolved from a primarily surgical domain to a multidisciplinary endeavor involving interventional radiologists, therapeutic endoscopists, and minimally invasive surgeons. The "step-up approach," first championed by the Dutch PANTER trial, has become the gold standard, advocating for initial percutaneous catheter drainage (PCD) followed, if necessary, by minimally invasive necrosectomy, rather than proceeding directly to open surgery [4].

OBJECTIVE

To summarize the latest (2017-2024) international data and clinical experience, offering a comprehensive review of surgical and interventional correction of fluid accumulations in acute pancreatitis.

Classification and Natural History: The Foundation for Intervention

A precise understanding of the type of fluid collection is paramount for selecting the appropriate intervention. Misclassification can lead to suboptimal or even harmful treatment choices.

Acute Collections (First 4 Weeks)

- Acute Peripancreatic Fluid Collections (APFC): These are homogenous, confined by fascial planes, and lack a definable wall. They occur in interstitial edematous pancreatitis and typically resolve spontaneously without intervention. Attempted drainage in this early phase is generally futile and may introduce infection [2, 5].

- Acute Necrotic Collections (ANC): These are heterogeneous, non-enhancing collections on contrast-enhanced computed tomography (CECT), containing both fluid and variable amounts of necrotic pancreatic and peripancreatic tissue. They can be located in any part of the pancreas and often extend into the paracolic gutters and retroperitoneum. In the first few weeks, the collection is not organized, making drainage procedures challenging and potentially ineffective due to the semi-solid nature of the content [6].

Late Collections (After 4 Weeks)

- Pancreatic Pseudocyst: A mature, encapsulated, homogenous fluid collection that arises from a disrupted pancreatic duct, typically following an episode of APFC. Crucially, it contains no solid necrotic material. Pseudocysts are amenable to internal drainage, most commonly via endoscopic cystogastrostomy, if they become symptomatic [7].

- Walled-Off Necrosis (WON): This represents the mature, encapsulated form of an ANC. It develops a well-defined, inflammatory wall, making it more amenable to directed interventions. The key distinction from a pseudocyst is the presence of significant solid necrotic debris, which must be

addressed for successful resolution [3]. The management of WON is more complex than that of pseudocysts and often requires debridement rather than simple drainage.

The Multidisciplinary Team and the "Step-Up" Philosophy

The modern management of infected pancreatic necrosis is a testament to collaborative medicine. The core principle is to control the septic focus while minimizing the physiological insult to an already critically ill patient.

The landmark Dutch PANTER trial demonstrated that a minimally invasive "step-up approach" (starting with PCD, followed, if necessary, by video-assisted retroperitoneal debridement [VARD]) resulted in a significant reduction in the composite endpoint of major complications and death compared to primary open necrosectomy [5]. This approach has been validated and refined in subsequent studies worldwide.

A 2021 European consensus guideline strongly recommends the step-up approach as the standard of care for infected necrotizing pancreatitis [8]. This strategy is not a rigid protocol but a dynamic process. The decision to escalate from PCD to a more invasive necrosectomy is based on the patient's clinical response, the nature of the collection (amount of solid debris), and its anatomical location.

Armamentarium of Interventions

Percutaneous Catheter Drainage (PCD), performed under ultrasound or CT guidance, is often the first step in the intervention cascade. It serves both diagnostic (culture of aspirate) and therapeutic purposes.

- Indications: The primary indication is suspected or confirmed infected necrosis in an unstable patient, serving as a bridge to stabilize the patient and potentially avoid more invasive procedures [9].

- Technique: The access route is chosen to avoid transgressing bowel, pleura, or major vessels. Multiple large-bore (often 14-20 Fr) catheters may be placed to facilitate the drainage of viscous and particulate material.

- Efficacy and Outcomes: A significant proportion of patients (up to 40-60% in some series) can be successfully treated with PCD alone, avoiding the need for necrosectomy. A large meta-analysis by Cao et al. confirmed that a step-up approach starting with PCD reduces rates of organ failure, pancreatic fistulas, and diabetes compared to open surgery [10].

- International Perspectives:

China: Chinese studies have emphasized the role of "enhanced" PCD strategies, including aggressive catheter upsizing, vigorous irrigation, and the use of fibrinolytics like urokinase or alteplase instilled through the catheter to lyse the solid necrotic debris, thereby improving drainage efficacy. A randomized controlled trial from China showed that percutaneous endoscopic necrosectomy via an established PCD tract is a feasible next step if PCD alone fails [11].

Japan: Japanese approaches often favor a less invasive, "drainage-first" philosophy. There is a strong focus on precise imaging and the use of endoscopic ultrasound (EUS)-guided transmural drainage as a primary or secondary modality, reflecting the high technical expertise in therapeutic endoscopy [12].

Russia & Tajikistan: Literature from these regions confirms the adoption of the step-up approach. Russian surgical schools report extensive experience with video-assisted retroperitoneal techniques (VARD and its modifications), often used after initial PCD. Tajik studies, often focusing on resource management, highlight the critical importance of timely PCD in reducing mortality in settings where advanced endoscopic expertise may be limited [13].

Endoscopic Interventions

Endoscopic management has emerged as a first-line therapeutic option for organized collections, particularly those with a favorable anatomical location (bulging into the stomach or duodenum).

- Endoscopic Ultrasound-Guided Transluminal Drainage: EUS has become indispensable, allowing for safe puncture of non-bulging collections, Doppler assessment to avoid vessels, and precise stent placement.

For Pseudocysts: The standard is EUS-guided cystogastrostomy or cystoduodenostomy with the placement of one or more double-pigtail stents. Success rates exceed 90% [14].

- For Walled-Off Necrosis: Simple drainage is often insufficient. The technique has evolved to Endoscopic Transmural Necrosectomy (ETN). This involves creating a larger fistula (dilation with a balloon up to 15-20 mm) and directly entering the cavity with an endoscope to debride the solid necrotic material using snares, baskets, and forceps [15].

- The Lumen-Apposing Metal Stent (LAMS): The development of LAMS has revolutionized endoscopic therapy. These biflanged, electrocautery-enhanced stents allow for a single-step puncture and dilation, creating a stable, wide-mouthed conduit between the gut and the collection. This facilitates repeated endoscopic entry for direct necrosectomy [16].

- International Perspectives:

- Europe & USA: LAMS are widely used, with strong evidence supporting their efficacy and safety. However, recent concerns about delayed complications, such as stent migration and bleeding from erosion into adjacent vessels, have led to recommendations for shorter indwell times (often 3-4 weeks) and the placement of a coaxial double-pigtail plastic stent within the LAMS to prevent apposition and migration [17].

- China & Japan: Asian endoscopists are at the forefront of innovating ETN techniques. Japanese groups have reported high success rates with a combination of EUS-guided drainage and nasocystic irrigation for WON (25). Chinese centers are prolific in publishing large series on the use of LAMS and novel through-the-scope devices for debridement, demonstrating outcomes comparable to surgery [18].

Minimally Invasive Surgical Techniques

When percutaneous and endoscopic methods fail or are not feasible, minimally invasive surgery provides the next step in the escalation ladder.

- Video-Assisted Retroperitoneal Debridement (VARD): This technique builds upon an existing PCD tract in the left retroperitoneum. The tract is dilated, and a laparoscope is introduced into the necrotic cavity under direct vision. Debridement is performed using long instruments, suction, and gentle irrigation, avoiding a major laparotomy [19]. It is highly effective for collections extending into the left paracolic gutter.

- Laparoscopic Cystogastrostomy: For collections amenable to a transgastric approach, a laparoscopic intragastric approach can be used. The anterior stomach wall is opened, the posterior wall is incised into the collection under direct vision, and a wide anastomosis is created, allowing for debridement and drainage [20].

- Sinus Tract Endoscopy: Similar to VARD, this involves the gradual dilation of a mature PCD tract over several weeks, followed by the introduction of a flexible nephroscope to debride the necrotic cavity. It is a highly effective "percutaneous endoscopic" method [21].

Open Surgery

Open surgical necrosectomy is now largely reserved for specific scenarios:

- Failure of the step-up approach.

- Life-threatening hemorrhage not controllable by angioembolization.

- Colonic perforation.

- Abdominal compartment syndrome.

When required, it should be organ-sparing and focus on the removal of only loose, devitalized tissue, with the placement of multiple drains for continued postoperative lavage [22].

Comparative Effectiveness and Integrated Approaches

The question of which minimally invasive technique is superior – endoscopic versus surgical step-up—has been the subject of recent high-quality trials.

The MISER trial randomized patients with infected necrosis to either a primary endoscopic step-up approach (transmural drainage ± necrosectomy) or a primary surgical step-up approach (PCD ± VARD). It found no significant difference in the composite endpoint of major complications or death, but the endoscopic approach resulted in lower rates of pancreatic fistulas, a lower need for pancreatic enzymes, and better physical health scores at follow-up [23-25].

The TENSION trial similarly compared an endoscopic step-up approach to a surgical step-up approach. It found that the endoscopic approach was not superior to the surgical approach in reducing the composite endpoint of major complications or death. However, it confirmed that the endoscopic

approach led to a lower incidence of pancreatic fistulas and new-onset diabetes [26].

These trials underscore that there is no single "best" approach for all patients. The choice between an endoscopic-transmural or a percutaneous-retroperitoneal-surgical approach should be individualized based on:

Anatomy: The location and extent of the collection, its proximity to the stomach/duodenum, and the presence of viable intervening tissue.

Expertise: The local availability of advanced endoscopic and surgical skills.

Patient Comorbidities

Increasingly, a "Combined" or "Hybrid" approach is being utilized, where endoscopists and surgeons work in tandem during a single procedure. For example, a simultaneous laparoscopic and endoscopic approach (a true NOTES procedure) can provide excellent exposure and control for cystogastrostomy [25].

Complications and Long-Term Sequelae

All interventions carry risks, and managing complications is an integral part of the process.

- Bleeding: Can occur from splenic, gastroduodenal, or other peripancreatic vessels, often exacerbated by the inflammatory process and enzymatic digestion. Angioembolization is the first-line treatment [26].

- Pancreatic Fistula: An external pancreatic fistula is a common sequela of necrosectomy, occurring when the disconnected duct syndrome is present. Most close spontaneously with conservative management and sustained catheter drainage [21, 27].

- Perforation: Gastric, duodenal, or colonic perforation can occur during endoscopic or surgical interventions.

- Long-Term Endocrine/Exocrine Insufficiency: Necrotizing pancreatitis destroys functional pancreatic tissue. The risk of new-onset diabetes and the need for pancreatic enzyme replacement are significantly higher after necrotizing pancreatitis, with some studies suggesting the step-up approach, particularly the endoscopic route, may be protective compared to open surgery [24, 27].

Future Directions and Conclusions

The management of fluid collections in acute pancreatitis continues to evolve. Future directions include:

- Refinement of LAMS and Stent Technology: The development of fully covered, retrievable stents with anti-migratory features and drug-eluting properties.

- Advanced Endoscopic Tools: The use of powered endoscopic debridement systems and robotic-assisted endoscopy for more efficient necrosectomy.

- Personalized Medicine: Better predictors of which collections will become infected or symptomatic, allowing for more targeted interventions.

- Global Standardization: Efforts to make advanced minimally invasive techniques accessible and standardized across healthcare systems, including in resource-limited settings.

CONCLUSION

The correction of fluid collections in acute pancreatitis has moved decisively away from the maximally invasive open surgery of the past. The contemporary paradigm is a patient-centered, multidisciplinary, step-up approach that prioritizes minimally invasive techniques.

Percutaneous drainage serves as a crucial initial step for sepsis control, while endoscopic and minimally invasive surgical techniques provide powerful, complementary tools for definitive management. The choice of intervention must be tailored to the individual patient's anatomy, clinical status, and the local expertise available.

The synthesis of international data from Europe, Asia, and the CIS region confirms the global acceptance of this philosophy, which has unequivocally led to improved patient outcomes, reduced morbidity, and a better quality of life for survivors of this devastating disease.

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