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PANCREATIC SURGERY - CANCER, CHRONIC PANCREATITIS, ACUTE PANCREATITIS, INNOVATIVE SURGICAL METHODS

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ABSTRACT

Pancreatic surgery is one of the most technically demanding fields of abdominal surgery due to the complex anatomy of the pancreas and its proximity to major vascular structures. Pancreatic cancer, often diagnosed at an advanced stage, carries a poor prognosis, and surgical resection combined with systemic therapy remains the only potentially curative option for a limited group of patients. Postoperative complications remain common despite advances in perioperative care.
Chronic pancreatitis leads to irreversible structural damage and severe pain, frequently requiring surgical intervention tailored to morphological changes. In acute pancreatitis, management focuses on early severity assessment, intensive supportive therapy, and minimally invasive treatment of complications. Ongoing development of modern techniques—including minimally invasive, robotic, and ablative procedures—has contributed to gradual improvement in outcomes and reduction of postoperative morbidity.

KEYWORDS

Pancreatic Surgery, Pancreatic Cancer, Chronic Pancreatitis, Acute Pancreatitis, Pancreaticoduodenectomy, Distal Pancreatectomy, Minimally Invasive Surgery, Robotic Surgery, Irreversible Electroporation, Mesopancreas, Postoperative Complications

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1. Introduction

The pancreas is a retroperitoneal organ closely related to major vascular and visceral structures, making surgical procedures within this region particularly challenging. Pancreatic diseases include malignant tumors, chronic inflammatory disorders, and acute inflammatory conditions, all of which may require complex multidisciplinary management.

Pancreatic cancer remains one of the most aggressive gastrointestinal malignancies, while chronic and acute pancreatitis continue to present significant therapeutic challenges. Advances in surgical techniques, perioperative management, and integration with systemic therapies have significantly influenced contemporary pancreatic surgery.

This paper presents current perspectives on surgical management of pancreatic diseases, with emphasis on modern operative strategies and their clinical implications.

2. Anatomy

The pancreas is an organ located in the retroperitoneal space of the abdominal cavity. Anatomically, it is divided into the head, which is embraced by the loop of the duodenum, the body, and the tail extending to the splenic hilum. The pancreas lies in close proximity to key vascular and visceral structures, such as the portal vein, aorta, inferior vena cava, liver, and duodenum. The superior mesenteric artery (SMA), responsible for supplying a significant portion of the intestine, also runs nearby — injury to this vessel may result in extensive gastrointestinal necrosis. (Wysocki 2021)

These complex anatomical relationships and the presence of major blood vessels make pancreatic surgery one of the most technically demanding fields of surgery. (Wysocki 2021; Mee Joo Kang and Sun-Whe Kim 2021).

Pancreatic cancer

Pancreatic cancer is characterized by diagnostic difficulties resulting from nonspecific clinical symptoms, such as epigastric pain, weight loss, and general weakness. In some patients, obstructive jaundice occurs and may initially be misinterpreted as an inflammatory condition. (Wysocki 2021)

Surgical resection combined with systemic therapy currently represents the only treatment offering a chance to prolong survival. Unfortunately, only approximately one-fifth of patients meet the criteria for surgical treatment. The remaining patients receive palliative therapy. (Wysocki 2021; Mee Joo Kang and Sun-Whe Kim 2021)

The most technically demanding and oncologically critical step of pancreaticoduodenectomy is the dissection of the pancreatic head from the superior mesenteric artery. In order to assess resectability early and avoid irreversible transection of the pancreas, “artery-first” (SMA-first) techniques have been developed, involving early exposure and control of the artery. In patients with borderline resectable or locally advanced tumors, particularly after neoadjuvant therapy, the so-called “TRIANGLE” operation is used. This procedure involves radical removal of tissues surrounding the major vessels while preserving arterial continuity. Despite advances in surgery, pancreatic cancer is still most frequently diagnosed at a stage that precludes effective resection. (Masiak-Segit et al. 2018)

Compared with other gastrointestinal malignancies, surgical treatment of pancreatic cancer is associated with a higher risk of perioperative complications and poorer long-term prognosis. (Mee Joo Kang and Sun-Whe Kim 2021; Joliat 2023)

The most common early complications after pancreatectomy include pancreatic fistula, hemorrhage, delayed gastric emptying, and infectious complications. In the long term, both exocrine and endocrine pancreatic insufficiency may occur, leading to diabetes and problems with digestion and nutrition. Available data suggest that preoperative biliary stenting may be associated with a higher risk of postoperative wound

infection. Therefore, its routine use is not recommended in patients eligible for direct surgical treatment. (Mee Joo Kang and Sun-Whe Kim 2021; Joliat 2023; Andrén-Sandberg et al. 2011)

No significant association has been found between tumor size or the diameter of the main pancreatic duct (Wirsung duct) assessed on preoperative computed tomography and the occurrence of clinically significant postoperative complications or pancreatic fistulas ($p>0.05$). Length of hospital stay shows a strong positive correlation with the severity of complications according to the Clavien–Dindo classification ($R=0.81$; $p<0.01$). The severity of postoperative complications is also influenced by a higher ASA score, the extent of surgery performed, intraoperative blood loss, and soft pancreatic parenchyma texture. (Molasy 2023)

Early initiation of enteral nutrition via a jejunal tube contributes to a reduction in complications after pancreaticoduodenectomy. The literature emphasizes that standard lymphadenectomy is usually sufficient during this procedure, whereas vascular resections (portal vein and superior mesenteric vein) and resections of adjacent organs should be reserved for selected cases.

A significant place in current analyses is occupied by IPMN (Intraductal Papillary Mucinous Neoplasm), which is divided into main duct and branch duct types. Surgical treatment is recommended in cases involving the main duct and in branch duct lesions larger than 3 cm. Smaller tumors (<3 cm) are indications for resection if clinical symptoms or worrisome features coexist, such as lymph node enlargement, elevated CA 19-9 levels, or newly diagnosed or worsening diabetes. A positive surgical margin and certain histopathological IPMN subtypes are considered risk factors for recurrence. (Lampe & Kuśnierz 2011)

Therefore, contemporary surgical strategies focus not only on oncological radicality but also on minimizing postoperative complications. (Mee Joo Kang and Sun-Whe Kim 2021; Gaëtan-Romain Joliat 2023)

Chronic pancreatitis

Chronic pancreatitis (CP) is a progressive inflammatory disease leading to fibrosis and permanent structural changes of the pancreas. The inflammatory process results in significant complications, including chronic debilitating pain and impairment of both exocrine and endocrine pancreatic function. The incidence of CP varies by region; in European populations, it is estimated at approximately 5 cases per 100,000 individuals. (Beyer et al. 2020; Hart & Conwell 2020)

Long-term outcomes of surgical pancreatic duct drainage procedures are unsatisfactory because they do not eliminate the inflammatory mass in the pancreatic head, which is considered the main source of pain in CP. Pain is the most burdensome symptom and may vary depending on the degree of organ damage. Two types of pain are distinguished: type A – episodic, with long asymptomatic periods, usually manageable conservatively; and type B – constant, with severe exacerbations associated with complications such as pseudocysts or impaired pancreatic juice outflow. (Kemper et al. 2018; Machicado et al. 2017)

The choice of surgical method depends primarily on the location and extent of morphological changes. Procedures involving anastomosis of the pancreatic duct with the jejunum are indicated in patients with chronic pain and dilatation of the main duct, aiming to preserve as much pancreatic parenchyma as possible. However, the inflammatory process often concentrates in the pancreatic head, making drainage alone insufficient. Currently, drainage is considered appropriate only in isolated ductal changes without an inflammatory mass in the pancreatic head. In properly selected patients, pain reduction of 60–70% can be achieved with low perioperative mortality. (Usenko et al. 2023)

The main goals of CP therapy remain sustained pain relief, elimination of complications, and improvement in quality of life. The best outcomes are achieved through a multidisciplinary approach involving radiologists, pain specialists, gastroenterologists, and surgeons. Endoscopic treatment may be beneficial in early stages; however, in advanced CP, surgery provides better and more durable results than interventional methods.

In patients without enlargement of the pancreatic head, drainage procedures are safe and provide short-term improvement, although their long-term effectiveness may be limited. In the presence of an inflammatory mass in the pancreatic head, duodenum- and pylorus-preserving procedures currently represent the standard of care for patients with pain refractory to conservative treatment. (Kňazovický et al. 2023)

Acute pancreatitis

A key element in the early management of acute pancreatitis (AP) is assessment of disease severity, primarily based on the degree of organ failure, as well as prompt initiation of intensive fluid therapy aimed at stabilizing hemodynamic parameters. Accurate determination of the etiology is essential to reduce the risk of recurrence.

Based on currently available data, it is not possible to clearly define the optimal timing of surgical intervention in severe AP, regardless of the technique used (open, minimally invasive, or endoscopic).

An undisputed indication for endoscopic retrograde cholangiopancreatography (ERCP) in patients with AP is concomitant cholangitis and obstruction of the common bile duct. A large meta-analysis of randomized controlled trials indicates that early ERCP in biliary AP with common bile duct obstruction is associated with improved treatment outcomes. (Sagar et al. 2023)

Experts of the Polish Society of Surgeons recommend initiating interventional treatment of local complications of AP with the least invasive methods, such as percutaneous or endoscopic drainage. The patient's condition should then be reassessed, and more extensive surgical procedures considered if necessary.

The optimal timing of the first intervention in necrotizing AP remains controversial. Some data support delaying intervention as long as possible — until clear demarcation of necrotic areas (usually after more than four weeks) — while applying appropriate antibiotic therapy according to the "step-up" strategy. On the other hand, there are reports suggesting benefits from earlier intervention immediately after confirmation of infected necrosis. (Szeliga et al. 2025)

3. Modern surgical techniques

3.1. Spleen-Preserving Distal Pancreatectomy

In classical distal pancreatic resection, simultaneous splenectomy was often performed, increasing the risk of infectious complications.

In response, the Warshaw technique was developed, involving preservation of the spleen with division of the splenic vessels. An alternative is the Kimura method, in which both the spleen and splenic vessels are preserved.

Comparative analyses indicate that the Kimura method is associated with a lower risk of splenic infarction and secondary splenectomy. However, the final choice of technique depends on anatomical conditions and surgical team experience. (Mee Joo Kang and Sun-Whe Kim 2021)

3.2. Modified Appleby Procedure

In cases of pancreatic body cancer infiltrating the celiac trunk, the modified Appleby procedure is applied. This involves distal pancreatectomy combined with resection of the celiac axis.

Preservation of hepatic and gastric perfusion is possible due to collateral circulation from the superior mesenteric artery.

In appropriately selected patients, this procedure combined with chemotherapy allows a median survival of approximately 18 months. (Mee Joo Kang and Sun-Whe Kim 2021, Pach 2021)

3.3. The Mesopancreas Concept

Based on principles used in colorectal surgery, the concept of the mesopancreas has been proposed.

It involves radical removal of soft tissues around the superior mesenteric artery during pancreaticoduodenectomy to improve resection margins and reduce local recurrence rates.

The effectiveness of this concept is currently being evaluated in clinical trials, including the Japanese MAPLE-PD project. (Mee Joo Kang and Sun-Whe Kim 2021)

3.4. Minimally Invasive and Robotic Surgery

In recent years, laparoscopic and robotic surgery for pancreatic diseases has developed dynamically. Minimally invasive techniques are associated with reduced blood loss, shorter hospital stay, and lower rates of infectious complications. Robotic systems provide high-resolution three-dimensional imaging, eliminate surgeon hand tremor, and improve ergonomics. Current results indicate comparable safety to open surgery, with potential improvement in oncological radicality.

Neoadjuvant therapy also plays an important role, particularly in borderline resectable and locally advanced cases. (Mee Joo Kang and Sun-Whe Kim 2021; Joliat 2023)

Summary

Surgical treatment of pancreatic cancer remains a major challenge due to anatomical conditions and late diagnosis.

However, technological progress, development of minimally invasive techniques, and integration of surgery with systemic therapy contribute to gradual improvement in treatment outcomes and reduction of postoperative complications. (Wysocki 2021; Mee Joo Kang and Sun-Whe Kim 2021)

Author's contribution:

Conceptualization: Aleksandra Romanowska, Paweł Arkadiusz Malmur, Weronika Biaduń-Mućko; Methodology: Weronika Biaduń-Mućko, Maria Wysieńska; Software: Paweł Arkadiusz Malmur, Kinga Rogowska-Borettini, Piotr Jóźwiak; Check: Weronika Biaduń-Mućko, Kinga Rogowska-Borettini, Maria Wysieńska; Formal analysis: Weronika Biaduń-Mućko, Adam Rybak, Kinga Rogowska-Borettini; Investigation: Aleksandra Romanowska, Paweł Arkadiusz Malmur, Piotr Jóźwiak; Resources: Paweł Arkadiusz Malmur; Data curation: Aleksandra Romanowska; Writing - rough preparation: Kinga Rogowska-Borettini, Aleksandra Romanowska, Piotr Jóźwiak; Writing - review and editing: Aleksandra Romanowska, Maria Wysieńska, Piotr Jóźwiak; Visualization: Adam Rybak, Paweł Arkadiusz Malmur; Supervision: Aleksandra Romanowska; Project administration: Maria Wysieńska, Adam Rybak, Paweł Arkadiusz Malmur, Weronika Biaduń-Mućko.

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