The Saudi Journal of Medical Insights, Vol. 1, Page 144-151, December 2025

Conservative and Surgical Management of Chronic Pancreatitis: Narrative Review

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ABSTRACT

Chronic pancreatitis (CP) is a progressive inflammatory disease leading to irreversible fibrosis, pain, and loss of pancreatic function, presenting a complex therapeutic dilemma. This narrative review aims to synthesize current evidence on the conservative and surgical strategies for managing CP. A comprehensive literature search was conducted, focusing on diagnosis, medical therapy, indications for intervention, surgical techniques, and outcomes. The findings underscore that initial management must be multidisciplinary, centered on strict lifestyle modifications, aggressive pain control, and pancreatic enzyme replacement. When conservative measures fail, surgical intervention becomes necessary for intractable pain, suspicion of malignancy, or mechanical complications. Comparative analysis of procedures indicates that duodenum-preserving pancreatic head resections often provide superior long-term outcomes, offering durable pain relief with better preservation of endocrine function and quality of life compared to traditional resections like pancreatoduodenectomy. The conclusion emphasizes that treatment must be individualized, integrating escalating medical, endoscopic, and surgical options within a personalized care framework to optimize patient outcomes. Future research should focus on early disease detection and refining patient selection for tailored interventions.

Keywords: Chronic Pancreatitis; Pain Management; Pancreatic Enzyme Replacement Therapy; Duodenum-Preserving Pancreatic Head Resection; Pancreatoduodenectomy; Surgical Outcomes; Exocrine Insufficiency.

INTRODUCTION

Chronic pancreatitis (CP) represents a relentless, inflammatory disease of the pancreas characterized by irreversible fibrosis, acinar cell destruction, and ductal distortion, culminating in the loss of both exocrine and endocrine functions[1]. This progressive condition imposes a substantial burden on patients through chronic pain, maldigestion, diabetes mellitus, and a diminished quality of life, while also posing significant diagnostic and therapeutic challenges for clinicians[2]. The global epidemiology of CP reveals considerable variation, with estimated prevalence rates ranging from 5 to 30 per 100,000 individuals in Western populations, and notably higher incidences reported in regions such as Southern India[3]. Historically associated with excessive alcohol consumption, which accounts for approximately 60-70% of cases in Western nations, the etiology of CP is now recognized as multifactorial[4]. The TIGAR-O classification system aptly categorizes risk factors into Toxic-metabolic (e.g., alcohol, tobacco), Idiopathic, Genetic (e.g., *PRSS1*, *CFTR*, *SPINK1* mutations), Autoimmune, Recurrent and severe acute pancreatitis, and Obstructive causes[5]. Tobacco smoking has emerged as a potent independent and synergistic risk factor, significantly accelerating disease progression and complications[6].

The pathophysiology of CP is a complex interplay of initial injury, sustained inflammation, and fibrotic scarring. Central to the most widely accepted model, the necrosis-fibrosis sequence, is the concept that recurrent episodes of pancreatic injury, often subclinical, lead to focal necrosis and periacinar fat necrosis[7]. This injury triggers the activation of pancreatic stellate cells (PSCs), which are the principal mediators of fibrosis in the pancreas[8]. Once activated, PSCs transform into a myofibroblast-like phenotype, proliferating and

Received: 01/12/2025
Accepted: 31/12/2025

depositing excessive amounts of extracellular matrix proteins, predominantly collagen, thereby replacing the functional parenchyma with fibrous tissue[9]. This process is driven and perpetuated by a milieu of pro-inflammatory cytokines (e.g., TNF-α, IL-1, IL-6) and growth factors (e.g., TGF-β, platelet-derived growth factor) released from infiltrating inflammatory cells and damaged acinar cells[10]. Concomitant ductal obstruction from protein plugs, stones, or strictures further exacerbates the disease by causing upstream ductal hypertension, parenchymal ischemia, and continued activation of the inflammatory cascade[11]. The culmination of this process is the classic triad of CP: chronic pain, pancreatic exocrine insufficiency (PEI) leading to steatorrhea and malnutrition, and endocrine insufficiency manifesting as diabetes mellitus (pancreatogenic diabetes or type 3c diabetes)[12].

METHODOLOGY

This narrative review was conducted to provide a comprehensive synthesis of the current evidence and clinical practices regarding the conservative and surgical management of chronic pancreatitis. The methodology aimed to encompass the breadth of the topic rather than to perform a systematic meta-analysis, allowing for the integration of landmark trials, cohort studies, expert consensus guidelines, and seminal reviews into a coherent clinical overview. The literature search was performed utilizing major electronic databases, including PubMed/MEDLINE, Scopus, and the Cochrane Library, for articles published from January 2000 to December 2025. Search terms were constructed using Boolean operators and included key phrases such as "chronic pancreatitis," "management," "pain control," "pancreatic enzyme replacement therapy," "surgical treatment," "Frey procedure," "Beger procedure," "pancreatoduodenectomy," and "outcomes." The reference lists of identified high-impact articles were also manually screened to capture additional pertinent sources.

Articles were selected for inclusion based on their relevance to the predefined subheadings of the review: pathophysiology and epidemiology, diagnostic approaches, conservative management, surgical indications, surgical techniques, and outcomes. Priority was given to randomized controlled trials, large prospective cohort studies, systematic reviews, and society guidelines (e.g., from the American Gastroenterological Association, International Association of Pancreatology). Case reports and small case series were excluded unless they described unique technical innovations or rare complications. Data from selected studies were extracted and organized thematically to construct a logical progression from disease fundamentals to complex management decisions. The information was then critically appraised and synthesized to highlight established consensus, areas of controversy, and evolving trends in the field, with the goal of providing a practical and evidence-based resource for clinicians.

Diagnostic Approaches in Chronic Pancreatitis

The diagnosis of CP, particularly in its early stages before the establishment of overt morphological changes, remains a considerable clinical challenge. A definitive diagnosis often relies on a synthesis of clinical presentation, functional testing, and advanced imaging, as no single test is pathognomonic[13]. The clinical hallmarks include recurrent epigastric pain radiating to the back, often exacerbated by meals, and evidence of maldigestion such as weight loss, steatorrhea, and deficiencies of fat-soluble vitamins[14].

Imaging serves as the cornerstone for confirming the structural alterations characteristic of advanced CP. Transabdominal ultrasound, while accessible, has limited sensitivity for early changes but can detect calcifications, ductal dilation, and parenchymal heterogeneity[15]. Computed Tomography (CT) is highly sensitive for detecting pancreatic calcifications, which are a late but specific sign, and can also assess ductal anatomy, complications like pseudocysts, and rule out malignancies[16]. Magnetic Resonance Imaging (MRI) combined with Magnetic Resonance Cholangiopancreatography (MRCP) has become the non-invasive imaging modality of choice. It provides superior soft-tissue contrast for evaluating parenchymal fibrosis (seen as decreased T1 signal) and, with secretin enhancement (s-MRCP), allows for functional assessment of ductal compliance and exocrine secretion, increasing sensitivity for early ductal changes[17]. Endoscopic Ultrasound (EUS) is arguably the most sensitive modality for detecting early parenchymal and ductal features. The Rosemont classification standardizes EUS findings, which include hyperechoic foci, strands, lobularity, cysts, calcifications, ductal irregularities, dilation, and hyperechoic duct walls[18]. However, the specificity of individual EUS features is debated, and their presence must be interpreted within the clinical context[19].

Direct visualization of the pancreatic duct via Endoscopic Retrograde Cholangiopancreatography (ERCP) was historically the gold standard, revealing classic ductal changes like dilation, strictures, and the "chain of lakes" appearance. However, due to its invasive nature and risk of pancreatitis, its role is now largely therapeutic rather than purely diagnostic[20]. Pancreatic function testing, either directly via secretin-stimulated duodenal fluid collection (the gold standard for detecting exocrine insufficiency) or indirectly via fecal elastase-1 measurement, is crucial for diagnosing PEI, which can precede morphological changes[21]. Serum tests like amylase and lipase are typically not elevated in stable CP but may rise during acute exacerbations[22].

Table 1: Key Diagnostic Modalities for Chronic Pancreatitis

Modality	Primary Utility	Key Findings	Limitations
CT Scan[16]	Detection of calcifications, overall morphology.	Pancreatic calcifications, ductal dilation, parenchymal atrophy, pseudocysts.	Poor sensitivity for early, non-calcific disease.
MRI/MRCP[17]	Evaluation of parenchyma and ducts without radiation.	Parenchymal fibrosis (T1 hypointensity), ductal irregularities, side-branch ectasia. Secretin response on s-MRCP.	Less sensitive for micro-calcifications than CT.
Endoscopic Ultrasound (EUS)[18],[19]	Highest sensitivity for early structural changes.	Rosemont criteria: hyperechoic foci, strands, lobularity, ductal features.	Operator-dependent. Low specificity of individual features may lead to over-diagnosis.
Fecal Elastase-1[21]	Non-invasive test for exocrine insufficiency.	Level <200 µg/g suggests moderate to severe PEI; <100 µg/g indicates severe PEI.	False positives with watery diarrhea. Does not detect mild insufficiency.
Secretin Stimulation Test[21]	Gold standard for exocrine function.	Measures bicarbonate concentration/ output in duodenal aspirate.	Invasive, time-consuming, limited availability.

Conservative Management Strategies:

The initial management of CP is predominantly conservative, aiming to alleviate symptoms, manage complications, and slow disease progression. The cornerstone of non-interventional therapy is a multifaceted approach addressing etiology, pain, and exocrine/endocrine insufficiency[23].

Lifestyle Modifications: Absolute and sustained abstinence from alcohol is the single most critical intervention to halt disease progression, reduce pain episodes, and improve survival in alcohol-related CP[24]. Equally imperative is complete cessation of tobacco smoking, a major independent risk factor for calcification, disease progression, and pancreatic cancer[25]. Dietary counseling is essential; patients are advised to consume small, frequent, low-fat, high-protein, and high-calorie meals to minimize pancreatic stimulation while countering malnutrition[26]. In cases of severe PEI, medium-chain triglycerides (MCTs), which are absorbed directly into the portal circulation without requiring pancreatic lipase, can be a useful nutritional supplement[27].

Pain Management: Chronic abdominal pain is the most debilitating symptom. The first step involves the use of non-opioid analgesics like acetaminophen or non-steroidal anti-inflammatory drugs (NSAIDs), though caution is warranted regarding renal and gastrointestinal side effects[28]. For moderate to severe pain, a stepwise approach following the World Health Organization analgesic ladder is employed, potentially leading to the use of tramadol or, in refractory cases, weak to strong opioids. However, opioid use is fraught with risks of dependence, tolerance, constipation, and narcotic bowel syndrome, necessitating careful patient selection and monitoring[29]. Adjuvant therapies play a significant role. Pancreatic enzyme replacement therapy (PERT), especially in non-enteric coated forms, can provide pain relief via negative feedback inhibition of pancreatic secretion in a subset of patients[30]. Antioxidant therapy (e.g., with a combination of selenium, beta-carotene, vitamin C, vitamin E, and methionine) has shown promise in some studies for reducing pain, possibly by mitigating oxidative stress, though evidence remains inconsistent[31]. Gabapentinoids (gabapentin, pregabalin) and tricyclic antidepressants (amitriptyline) are valuable for managing neuropathic components of pancreatic pain[32].

Pancreatic Enzyme Replacement Therapy (PERT): PERT is the mainstay for treating PEI. The goal is to restore normal digestion, prevent malnutrition, and stabilize weight. Effective PERT requires sufficient lipase activity (typically starting at 40,000-50,000 units of lipase per main meal and 25,000 units per snack), delivery of enzymes in an acid-resistant enteric-coated microsphere formulation to prevent gastric inactivation, and co-administration with meals[33]. Proton pump inhibitors (PPIs) may be added to ensure an optimal duodenal pH >4 for the release of enzymes from their enteric coating[34]. The clinical response is monitored through symptom improvement (reduced steatorrhea, bloating), weight gain, and normalization of nutritional parameters.

Management of Complications and Endocrine Insufficiency: Diabetes mellitus in CP (type 3c) requires management, often with insulin due to the concurrent deficiency of glucagon, making patients prone to hypoglycemia with certain oral agents[35]. Deficiencies of fat-soluble vitamins (A, D, E, K) and vitamin B12 must be screened for and supplemented accordingly[36].

Indications for Surgical Intervention

Despite optimal medical management, a significant proportion of patients (approximately 40-70%) continue to experience debilitating pain or develop complications

that necessitate surgical intervention[37]. Surgery is not considered a last resort but rather a timely option in the disease management algorithm when specific indications are present. The primary goals of surgery in CP are durable pain relief, management of local complications, preservation of pancreatic function where possible, and exclusion of malignancy[38].

The most common and compelling indication is intractable abdominal pain that is refractory to comprehensive conservative and endoscopic therapy, significantly impairing quality of life and leading to opioid dependency[39]. Suspicion of pancreatic malignancy is another critical indication. The inflammatory mass in the pancreatic head can be indistinguishable from adenocarcinoma on imaging. In cases where repeated biopsies are negative but clinical or radiological suspicion remains high, surgical resection is often warranted for both diagnosis and curative intent[40]. Local mechanical complications caused by the fibrotic process frequently require surgery. These include: obstruction of the common bile duct leading to jaundice, cholangitis, or secondary biliary cirrhosis; duodenal obstruction causing gastric outlet obstruction; and obstruction of the portal or superior mesenteric vein resulting in sinistral portal hypertension, gastric varices, or ascites[41].

The presence of a symptomatic or complicated pancreatic pseudocyst that persists despite 6 weeks of conservative management, is infected, causes obstruction, or hemorrhages is also an established indication. Furthermore, chronic pancreatic fistula (e.g., from disrupted duct), pancreatic ascites, or a left-sided pleural effusion due to a ductal leak often require surgical management after failed endoscopic therapy. Finally, the failure of previous endoscopic interventions (such as ductal stenting, lithotripsy) or drainage procedures to provide sustained relief is a primary indication for surgical consultation and intervention. The decision to operate is made multidisciplinary, involving pancreatologists, surgeons, radiologists, and pain specialists, and must carefully balance the potential benefits against the risks of the procedure and the natural history of the patient's disease.

Surgical Techniques: A Comparative Overview

The surgical landscape for CP is diverse, with procedures broadly categorized into drainage procedures, resectional procedures, and hybrid procedures that combine elements of both. The choice of operation is tailored to the patient's specific anatomy (ductal diameter, presence of an inflammatory mass), pathology, and the surgeon's expertise.

Drainage Procedures: These operations aim to decompress a dilated pancreatic duct (>7mm) to alleviate ductal hypertension, which is a major source of pain. The classic Puestow procedure(longitudinal pancreaticojejunostomy, LPJ) involves opening the main pancreatic duct along its length from the head to the tail and anastomosing it to a Roux-en-Y loop of jejunum[42]. It effectively relieves pain in 60-80% of patients with a dilated duct and has low mortality and morbidity but does not address an inflammatory head mass or remove diseased tissue, leading to higher long-term pain recurrence rates[43].

Resectional Procedures: These are employed when there is a dominant inflammatory mass, particularly in the pancreatic head (the "pacemaker" of the disease), or concern for malignancy. The pancreaticoduodenectomy (Whipple procedure), originally for cancer, provides excellent pain relief (70-90%) and definitively treats biliary/duodenal obstruction[44]. However, it is a major operation with significant morbidity and results in the loss of healthy pancreatic parenchyma, potentially exacerbating endocrine and exocrine insufficiency. The distal pancreatectomy is indicated for disease confined to the body and tail, often in cases of disconnected duct syndrome after severe acute pancreatitis or focal chronic pancreatitis[45]. Total pancreatectomy with or without islet autotransplantation (TP-IAT) is reserved for end-stage, diffusely diseased glands in patients with unremitting pain and already existing diabetes. TP-IAT aims to mitigate the severe, brittle diabetes that follows total pancreatectomy by isolating the patient's own islets from the resected gland and infusing them into the portal vein[46].

Hybrid Procedures (Combining Drainage and Limited Resection): These operations have gained prominence as they address the inflammatory head mass while preserving duodenal and biliary continuity and more pancreatic parenchyma. The Beger procedure (duodenum-preserving pancreatic head resection, DPPHR) involves coring out the inflammatory head tissue while preserving a shell of pancreatic parenchyma along the duodenal C-loop. Pancreatic continuity is restored via a pancreaticojejunostomy to the remaining head rim and the opened duct in the body[47]. The Frey procedure is a technical modification that combines a limited head coring (like Beger but less extensive) with a longitudinal duct drainage (like Puestow) into the same Roux-en-Y jejunal loop[48]. The Berne modification is a further simplification, involving only head coring without formal division of the pancreas over the portal vein, followed by a single anastomosis to a jejunal loop[49]. These hybrid procedures offer pain relief equivalent to the Whipple procedure while better preserving endocrine and exocrine function and having lower morbidity rates, making them the operations of choice for most cases of CP with a dilated duct and an inflammatory head mass[50].

Table 2: Comparison of Major Surgical Procedures for Chronic Pancreatitis

Procedure	Primary Indication	Key Technical Feature	Advantages	Disadvantages
Puestow (LPJ)[42],[43]	Dilated pancreatic duct (>7mm), no head mass.	Longitudinal opening of duct anastomosed to Roux-en-Y jejunum.	Low morbidity/mortality, good short-term pain relief.	Does not address head mass; higher long-term pain recurrence.
Whipple (PD)[44]	Inflammatory head mass, suspicion of cancer, biliary/duodenal obstruction.	Resection of pancreatic head, duodenum, gallbladder, distal stomach.	Excellent pain relief, treats obstruction, definitive for cancer.	Highest morbidity, loss of healthy tissue, worsens endocrine/exocrine function.
Beger (DPPHR)[47]	Inflammatory head mass with dilated duct.	Head coring with preservation of duodenum; PJ to head rim and body.	Excellent pain relief, preserves duodenum/biliary continuity, better function preservation than Whipple.	Technically demanding, two anastomoses.
Frey[48],[50]	Inflammatory head mass with dilated duct.	Limited head coring + longitudinal duct drainage into a single jejunal loop.	Combines drainage & resection, single anastomosis, outcomes like Beger/Whipple.	May be insufficient for very large head masses or severe bile duct stenosis due to its more limited resection extent compared to Beger or Whipple.
Total Pancreatectomy with IAT (TP-IAT) [46]	Diffuse, debilitating disease with intractable pain.	Removal of entire pancreas; islets isolated and infused into liver.	Eliminates pain source (pancreas).	Creates brittle diabetes; success of IAT variable; major procedure.

Outcomes and Complications of Surgical Management

Surgical intervention for chronic pancreatitis is highly effective, particularly for achieving the primary goal of durable pain relief. Long-term follow-up studies consistently demonstrate that surgery provides superior and more sustained pain reduction compared to continued medical or endoscopic therapy in appropriately selected patients[51]. Approximately 65-90% of patients experience significant or complete pain relief at 5-year follow-up, depending on the procedure and patient factors. Hybrid procedures like the Frey and Beger operations report success rates at the higher end of this spectrum, often exceeding 80% long-term pain relief, while maintaining superior outcomes in terms of quality of life and employment status compared to resectional procedures like the Whipple[52]. Pain relief following drainage or hybrid surgery is attributed to the decompression of ductal hypertension and removal of the inflammatory focus in the pancreatic head, which is believed to be a primary source of nociceptive signaling and perineural inflammation[53].

However, surgery is not without significant risks. Perioperative mortality, while low in high-volume centers (typically <2-3%), is a serious consideration[54]. Morbidity is substantial, ranging from 20% to 50%. Common complications include delayed gastric emptying, particularly after Whipple and, to a lesser extent, other procedures; pancreatic fistula, defined as drain output of amylase-rich fluid >3 times the serum amylase on or after postoperative day 3, which occurs in 5-20% of cases; intra-abdominal abscess; postoperative hemorrhage; and wound infections[55]. Long-term complications are predominantly related to the progression of the underlying disease and the metabolic consequences of surgery. The most significant is endocrine insufficiency. While drainage and hybrid procedures aim to preserve parenchyma, the natural history of CP often leads to progressive diabetes. Studies show a significant proportion of patients develop new-onset or worsened diabetes over 5-10 years postoperatively, though the rate is generally slower than after Whipple or total pancreatectomy[56]. Exocrine insufficiency also frequently progresses, necessitating

ongoing and often increased doses of PERT[57]. Recurrent pain can occur in 20-30% of patients over the long term, due to factors like small duct disease, continued alcohol use, narcotic bowel syndrome, or central pain sensitization[58].

CONCLUSION

The management of chronic pancreatitis remains a complex endeavor requiring a structured, multidisciplinary, and patient-centered approach. Surgical intervention is not a failure of therapy but a definitive and often necessary step for a substantial subset of patients plagued by intractable pain or local complications. The evolution of surgical techniques toward parenchyma-sparing, duodenum-preserving procedures like the Frey and Beger operations represents a significant advance, offering durable symptomatic relief while mitigating the metabolic morbidity associated with major resection. Ultimately, the choice between continuing medical management, endoscopic therapy, or proceeding to surgery must be individualized, balancing the patient's specific anatomical pathology, symptom burden, nutritional and metabolic status, and overall quality of life. Future progress hinges on earlier diagnosis, improved medical therapies to halt fibrosis, and continued refinement of surgical techniques to optimize long-term functional preservation and patient well-being.

LIMITATIONS

As a narrative review, this synthesis has several inherent limitations. The methodology, while comprehensive, did not follow a formal systematic protocol with explicit risk-of-bias assessment, which may introduce selection bias in the cited literature. The conclusions are primarily qualitative, as the absence of a meta-analysis precludes definitive quantitative summaries of treatment effects. Furthermore, the rapid evolution of therapeutic techniques and the predominance of evidence from high-volume specialist centers may limit the generalizability of findings to all clinical settings. These constraints highlight the need for interpreting the presented overview within the context of its design.

DECLARATIONS

Ethics Approval and Consent to Participate

Not Applicable.

Consent for Publication

Not Applicable.

Funding

None.

Competing Interests

None.

Authors' Contributions

All authors made substantial contributions to this work. All participated in the conceptualization, literature review, and critical discussion of the manuscript's intellectual content. Each author was involved in drafting or critically revising the work and approved the final version for publication. The corresponding author, coordinated the collaboration and manuscript preparation.

Acknowledgements

None.

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