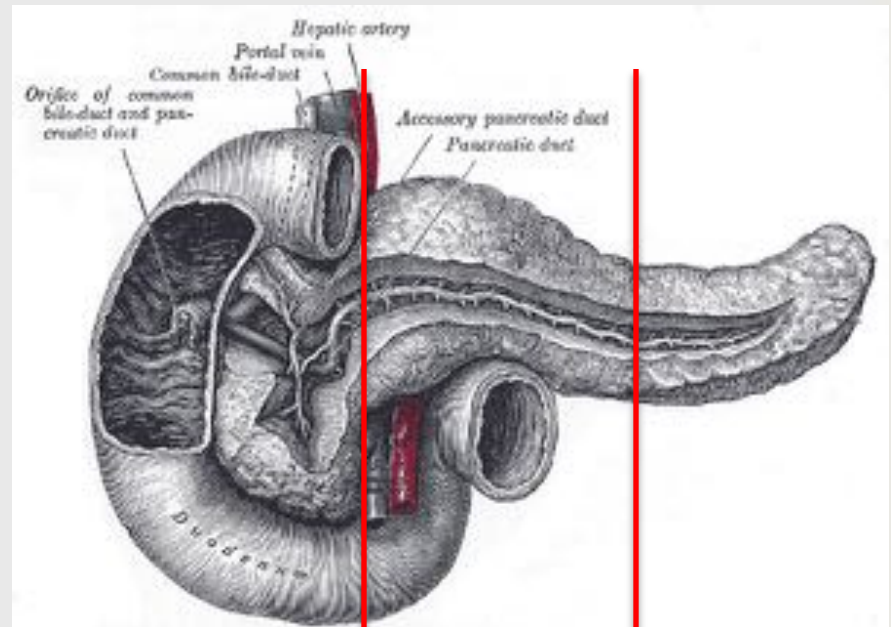
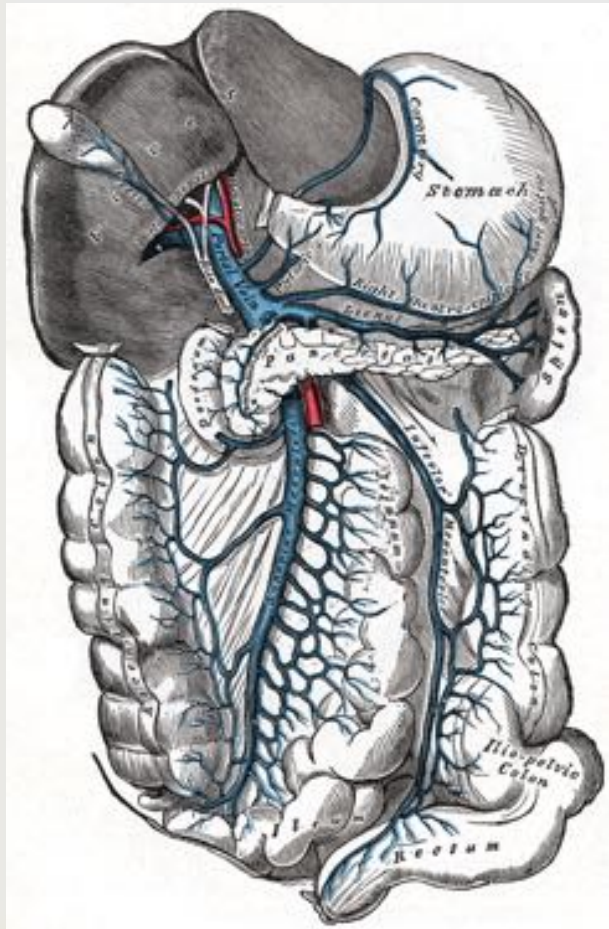


Surgical Management of Pancreatic Diseases



Kenneth K.W. Lee, M.D.
Jane and Carl Citron Professor of Surgery
Department of Surgery
University of Pittsburgh School of Medicine

Pancreatic Anatomy

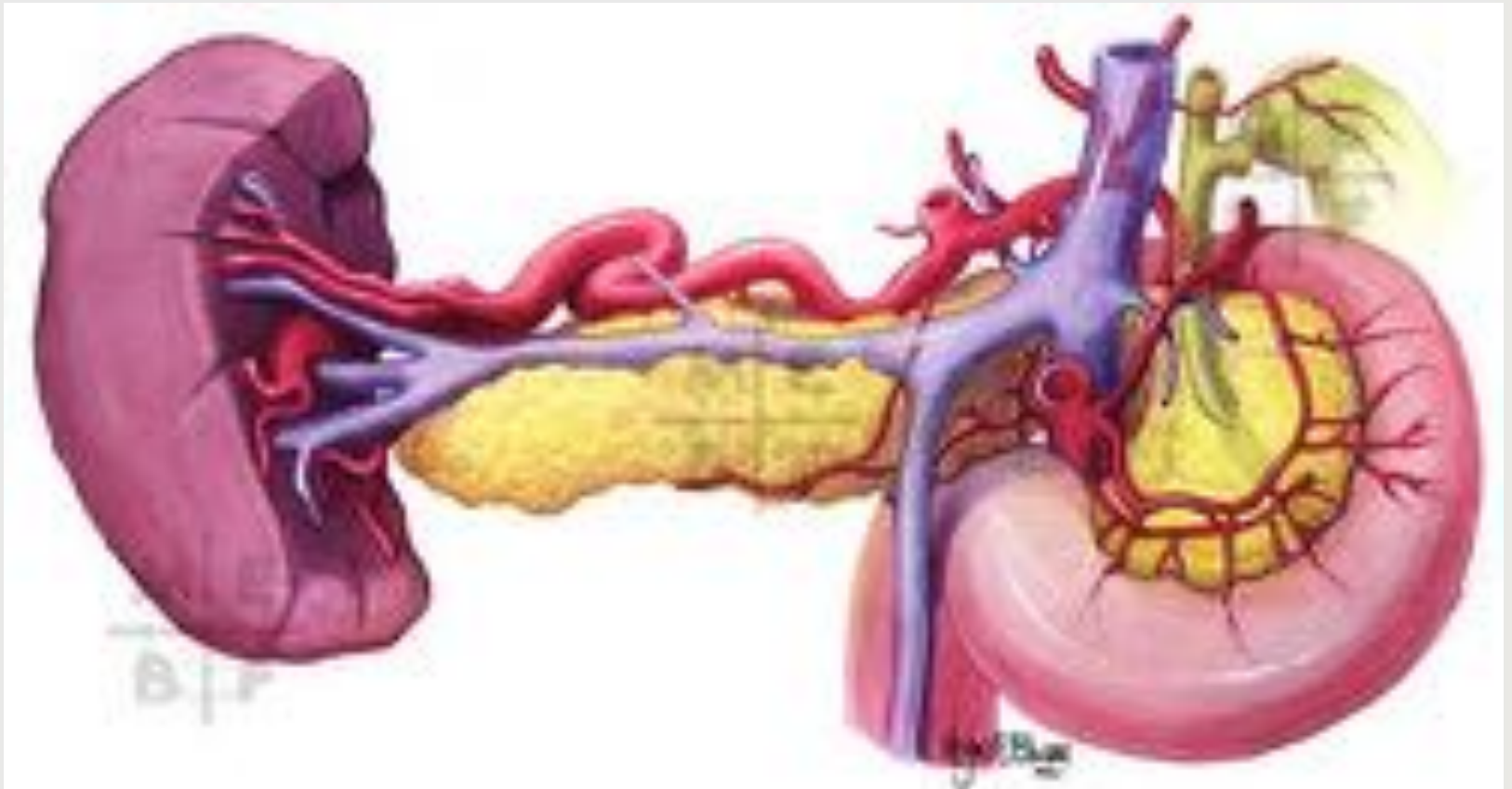


HEAD

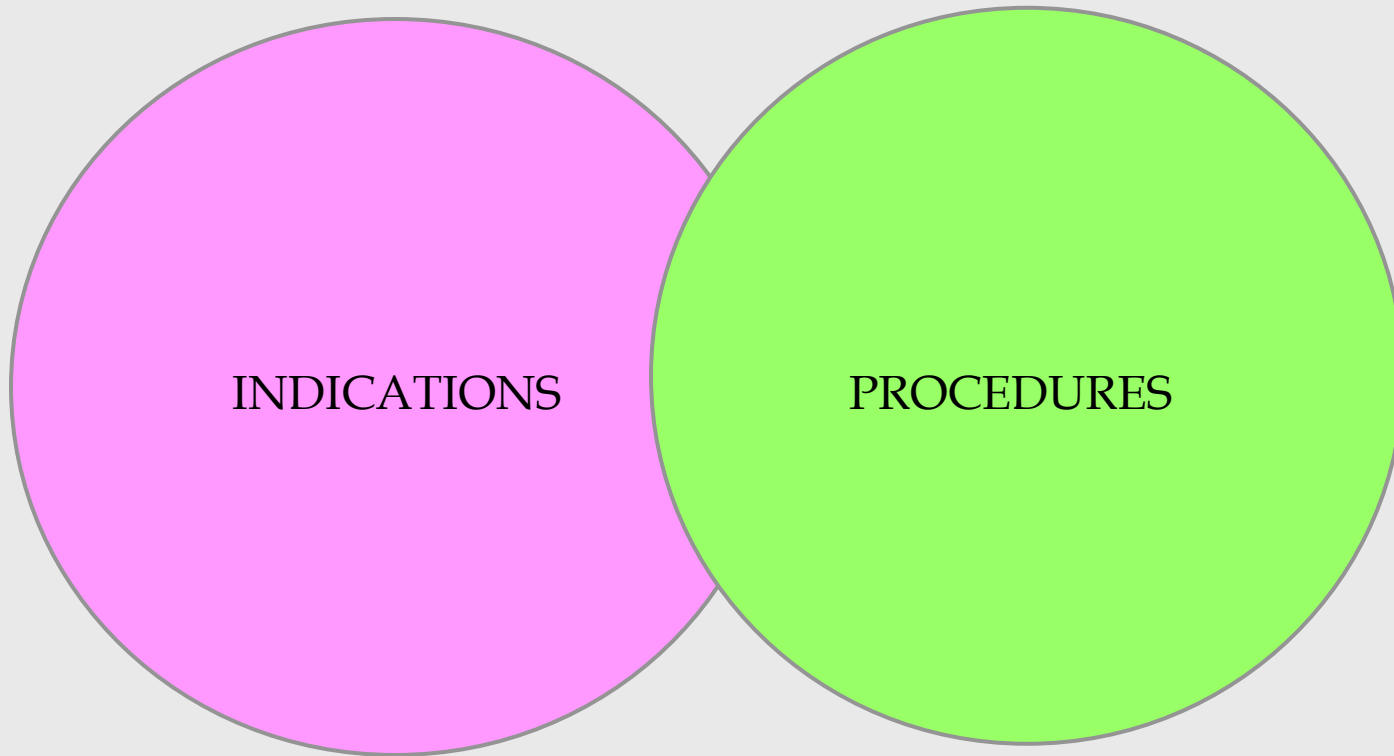
BODY

TAIL

Pancreatic Anatomy



Surgical Procedures



Indications for Surgery



- **Neoplasms with malignant risk - RESECTION**
 - Pancreatic ductal adenocarcinoma (PDA) and other malignancies
 - Abnormalities with potential for development of PDA (e.g. IPMN, mucinous cystadenoma)
 - Pancreatic (neuro)endocrine tumors
 - Indeterminate masses
- **Benign but symptomatic masses - RESECTION**
 - Microcystic (serous) cystadenoma

Indications for Surgery



- **Complications/sequelae of acute pancreatitis**
 - Infected or symptomatic necrosis
 - Pseudocysts
 - Causes of pancreatitis (e.g. cholelithiasis)

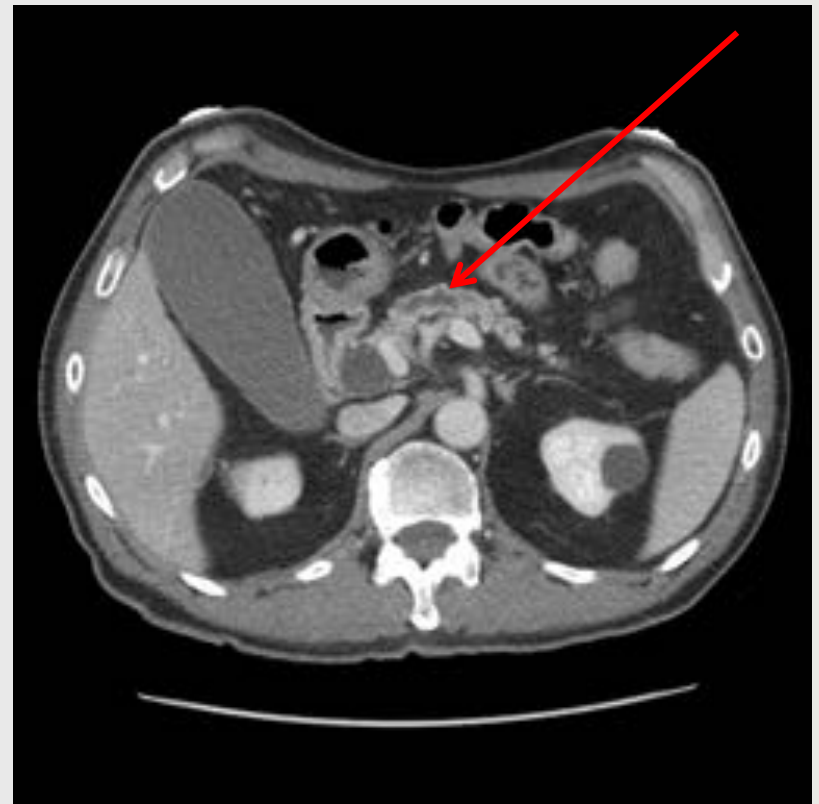
- **Complications/prevention of chronic pancreatitis**
 - Resection of “tumorous” enlargement of the pancreas
 - Ductal drainage procedures
 - Resection and autoislet transplantation

Surgical Procedures



- Resection
 - Partial
 - Head (pancreaticoduodenectomy or Whipple procedure)
 - Body (central or middle pancreatectomy)
 - Tail (distal or left pancreatectomy +/- splenectomy)
 - Enucleation
 - Total +/- autoislet transplantation
- Drainage
 - Pancreatic duct (Puestow-type procedure)
 - Pseudocyst/Walled-off necrosis
- Debridement

Pancreatic Head Cancer



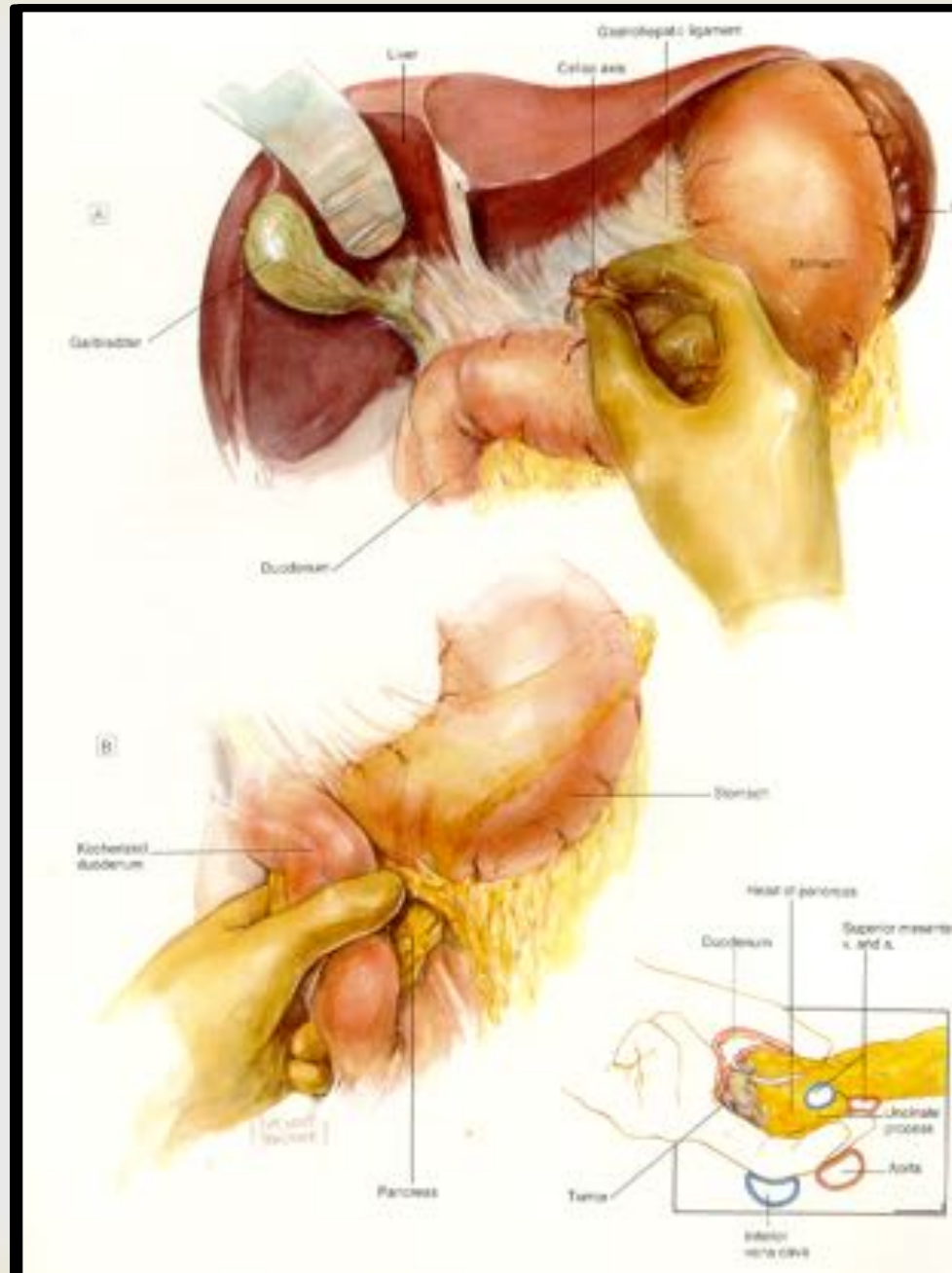
Resection Procedures



∞ Pancreaticoduodenectomy (Whipple Procedure)



<https://www.bcm.edu/healthcare/care-centers/pancreas-center/procedures/whipple-procedure>





Locally Advanced Pancreatic Head Cancer

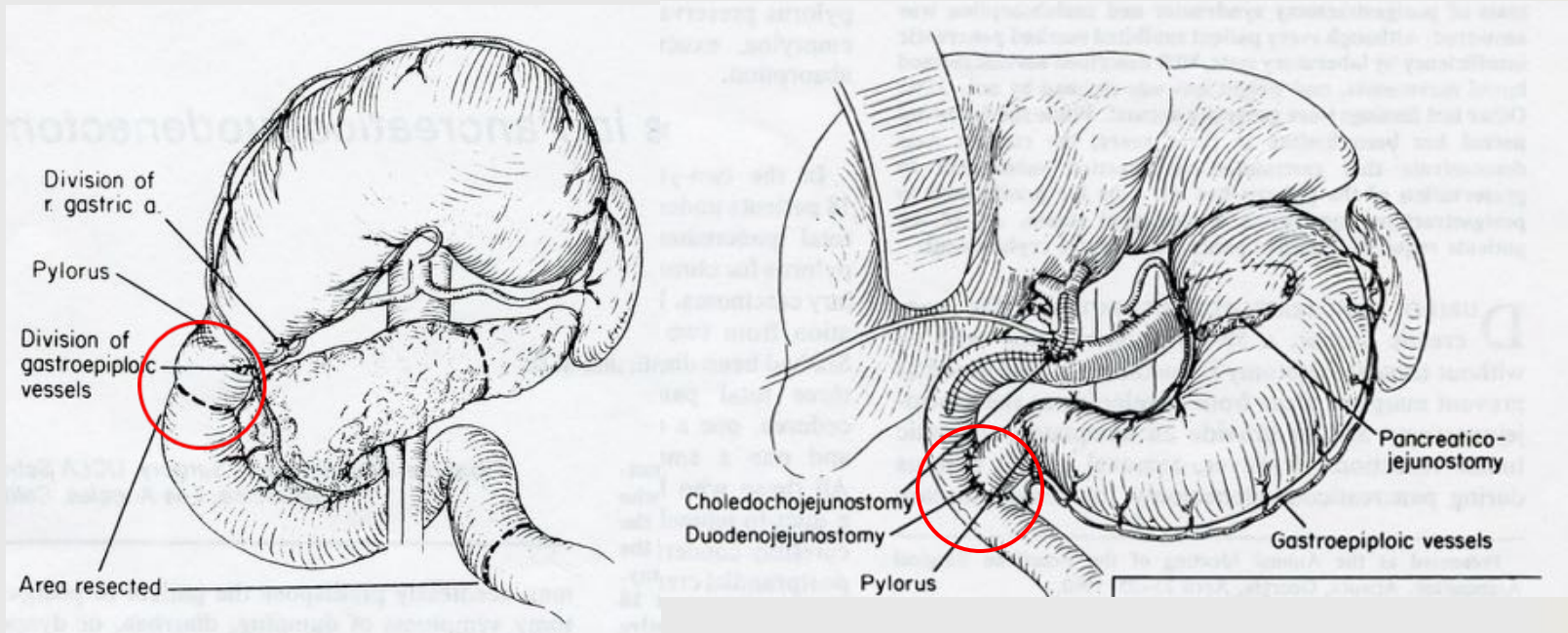




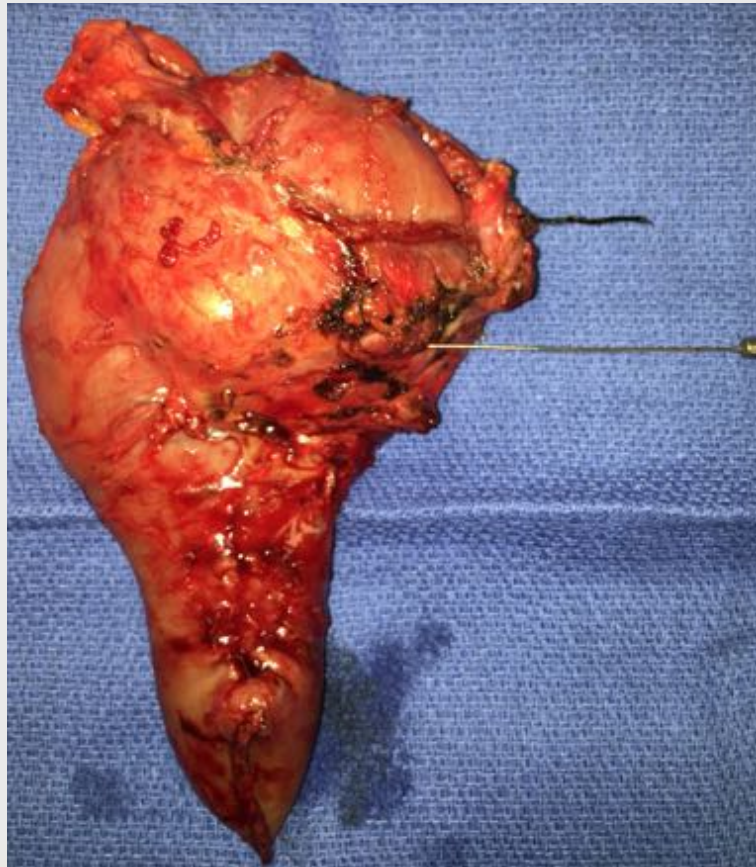
Resection Procedures



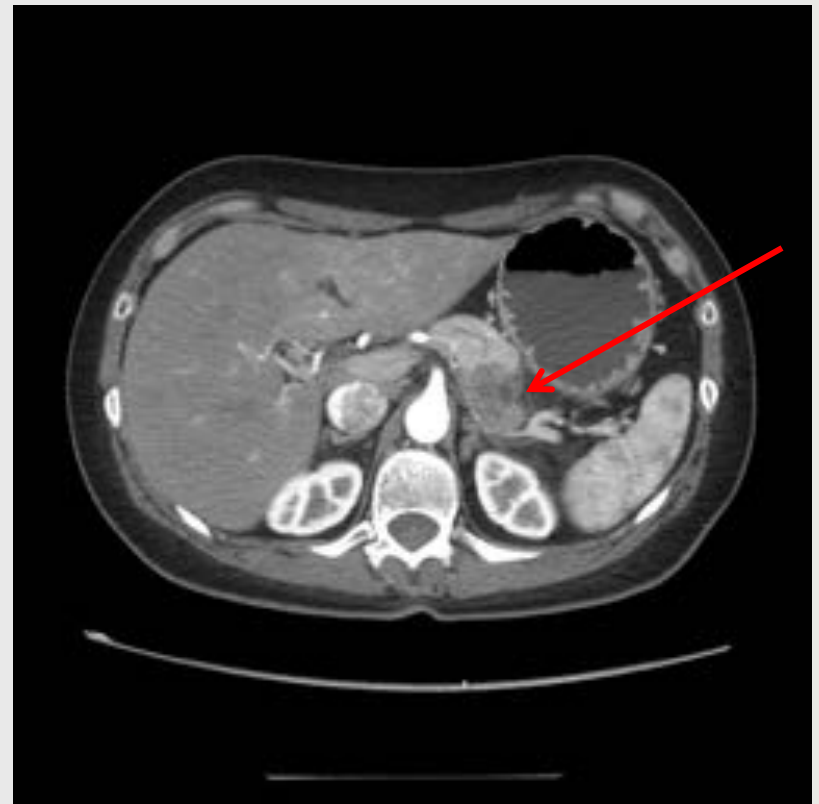
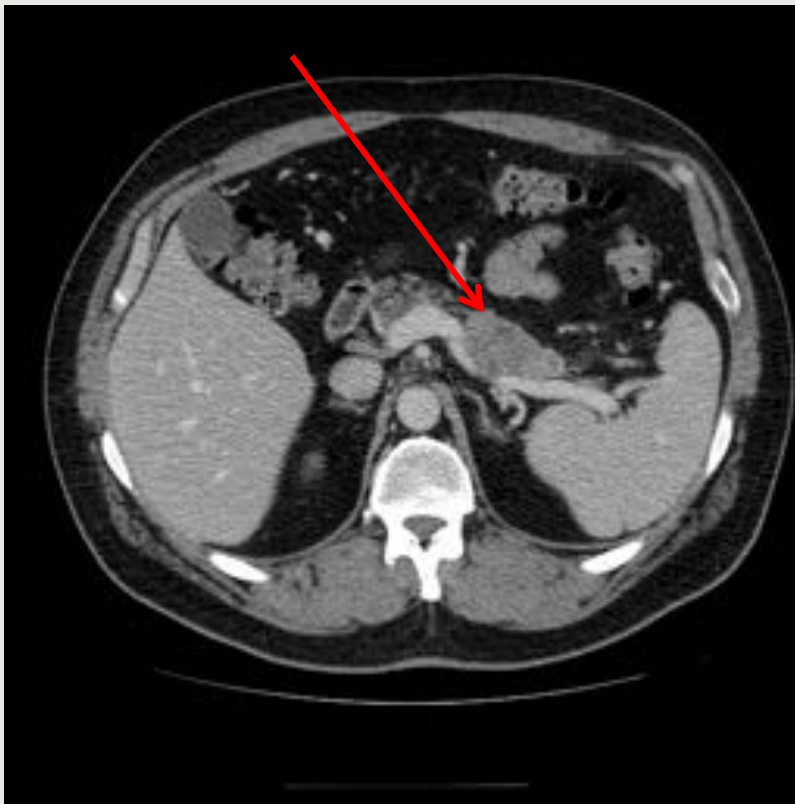
Pylorus Preserving Pancreaticoduodenectomy Procedure (“modified Whipple procedure”)



Pylorus Preserving Pancreaticoduodenectomy



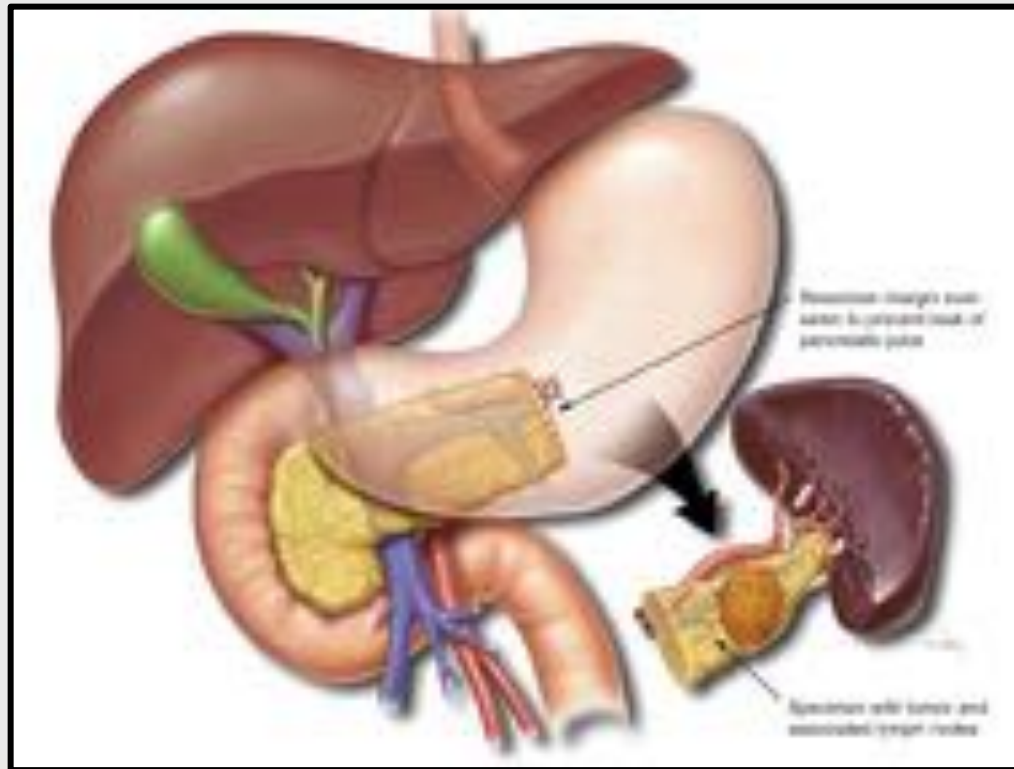
Pancreatic Tail Mass



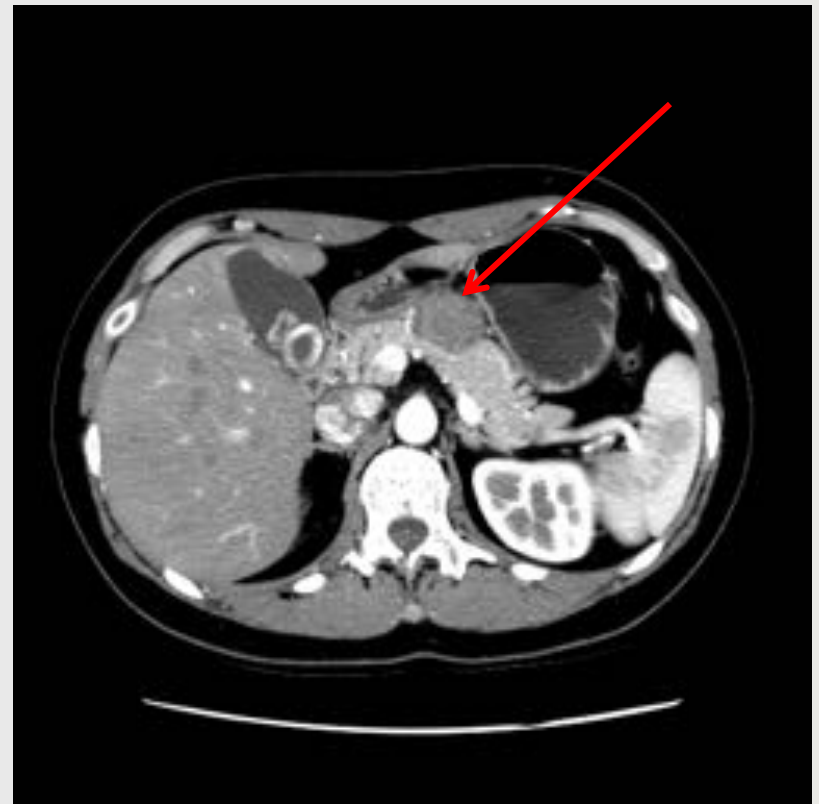
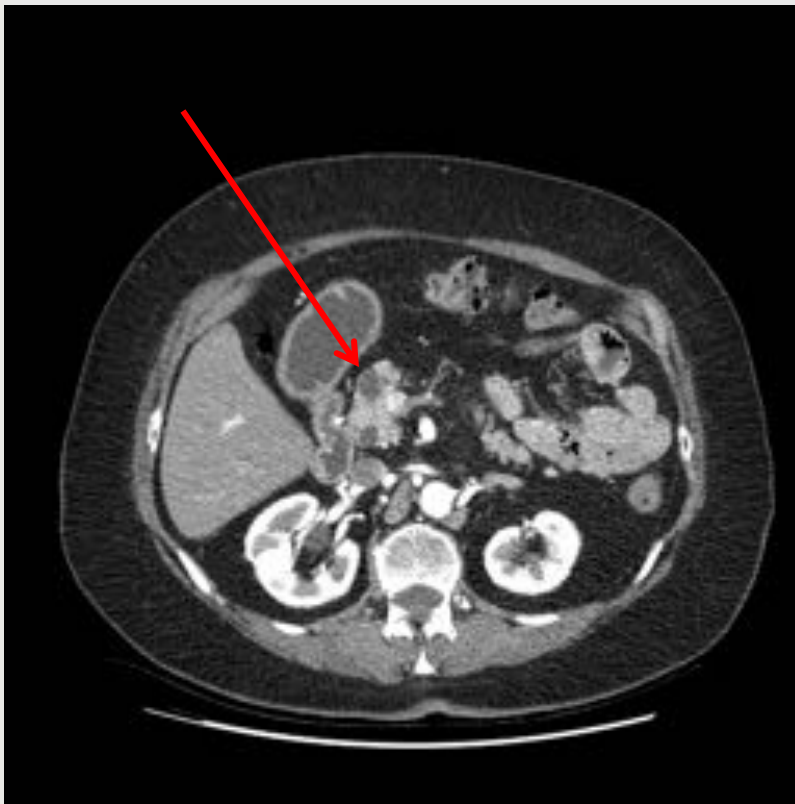
Resection Procedures



Distal pancreatectomy +/- splenectomy



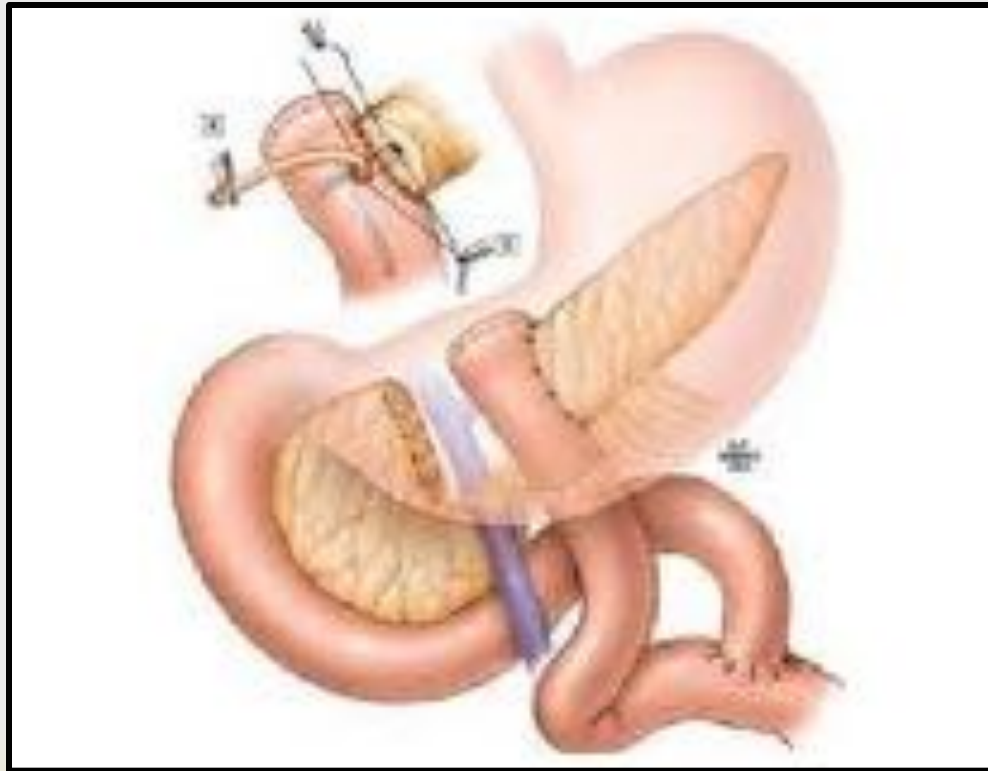
Mid-Pancreas Mass



Resection Procedures



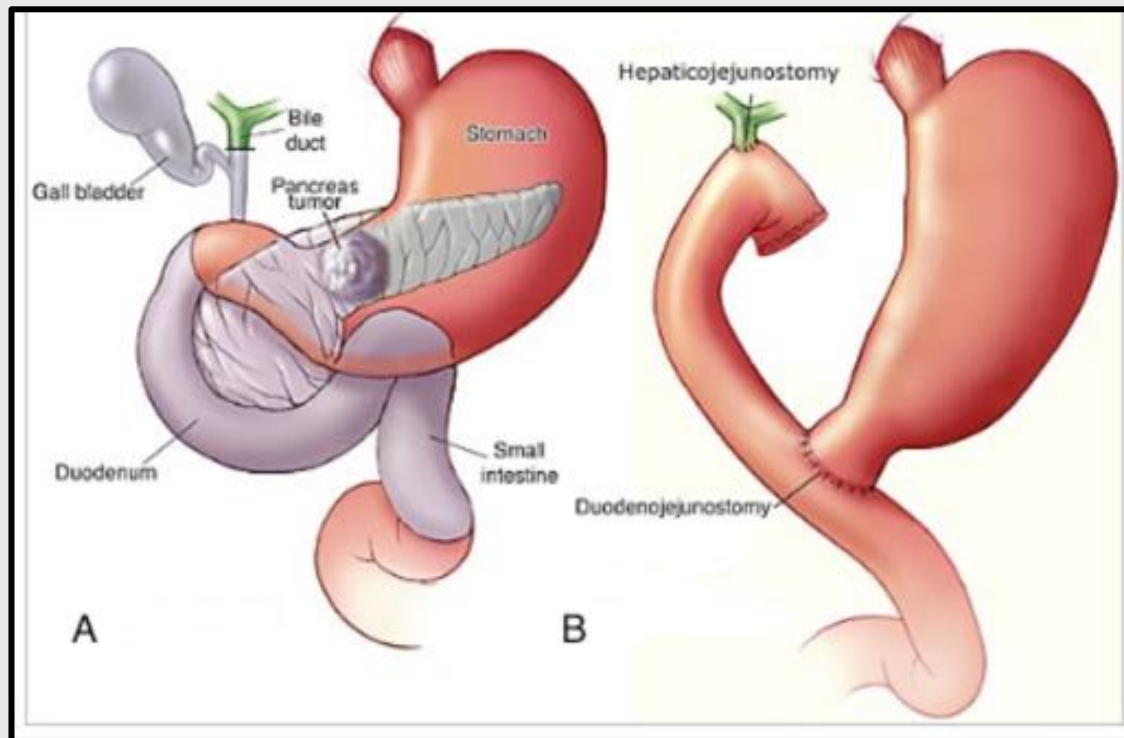
Central (middle) pancreatectomy



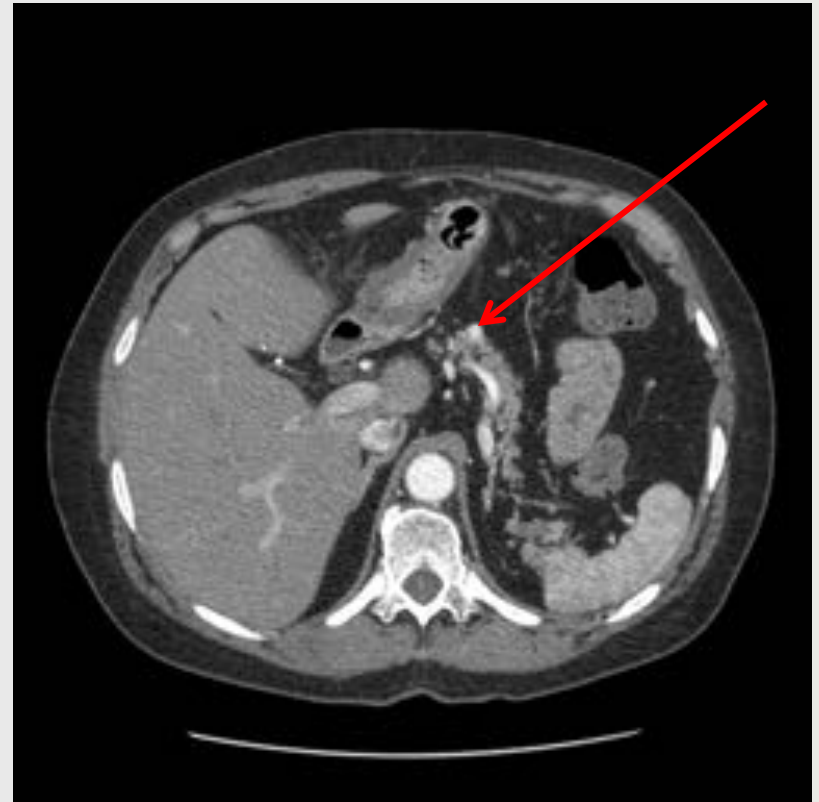
Resection Procedures



Total pancreatectomy (+/- autoislet transplantation)



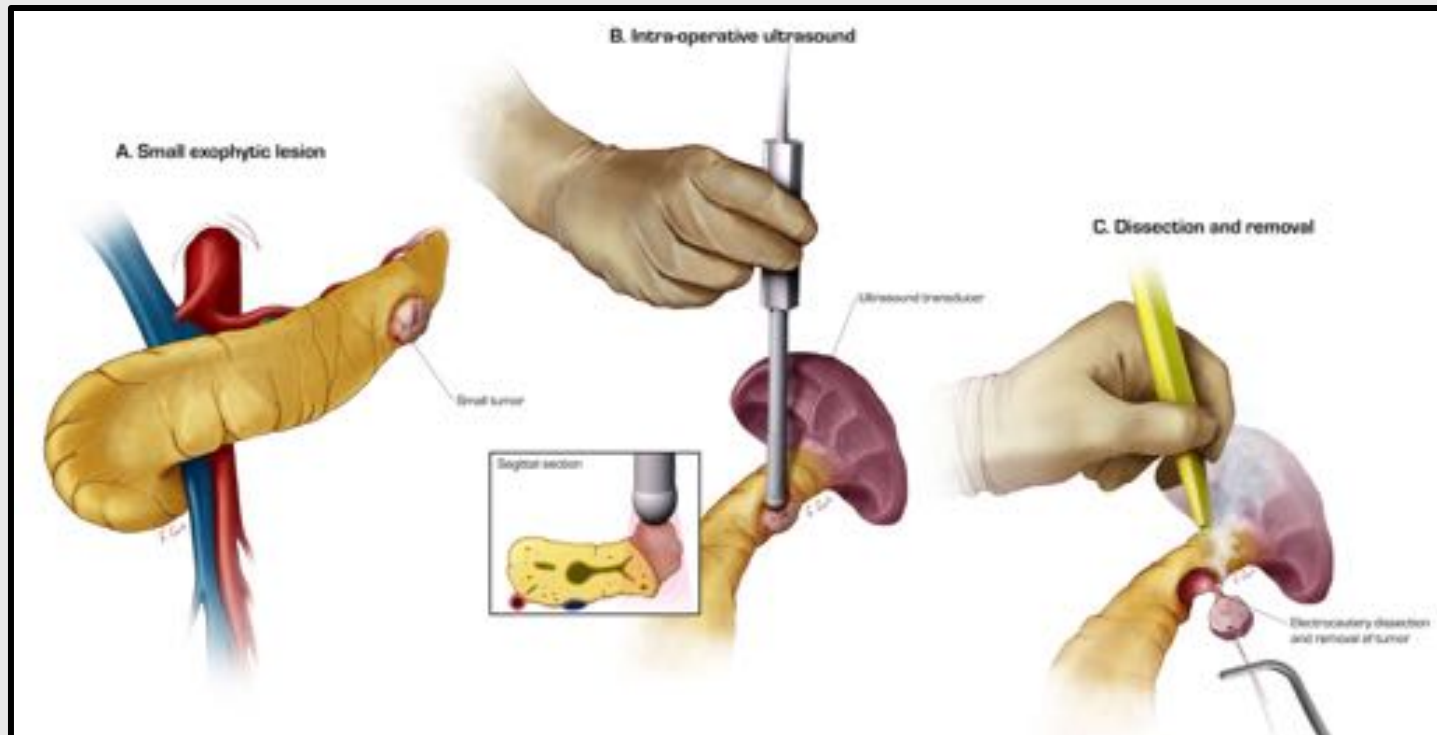
Pancreatic Endocrine Tumors

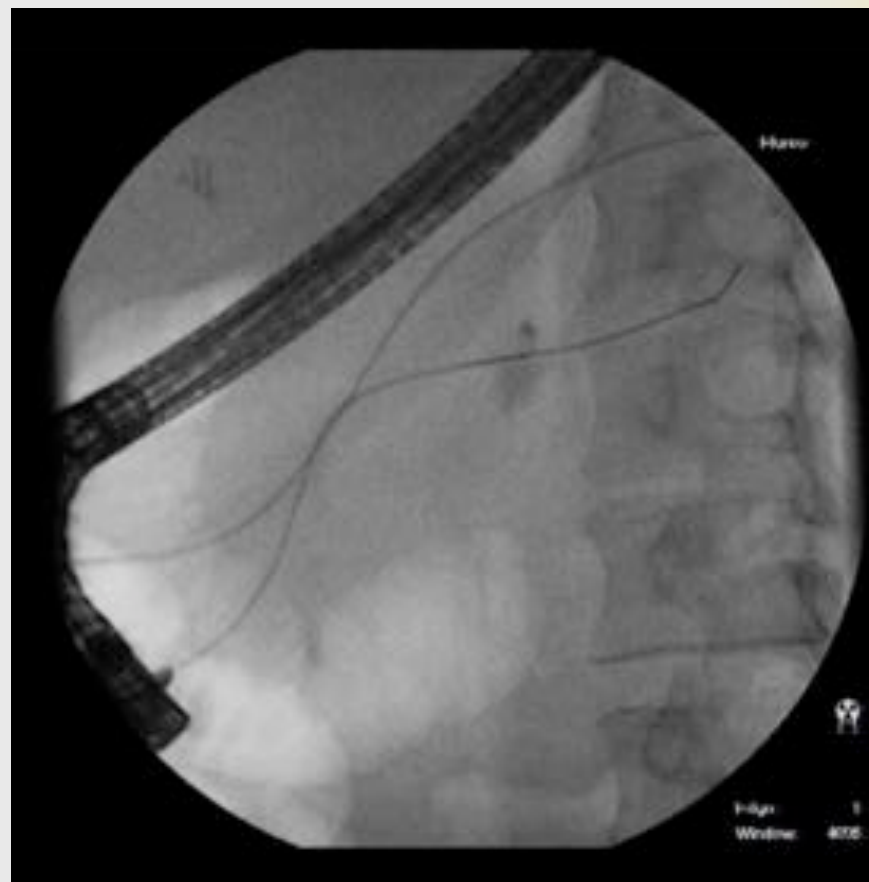
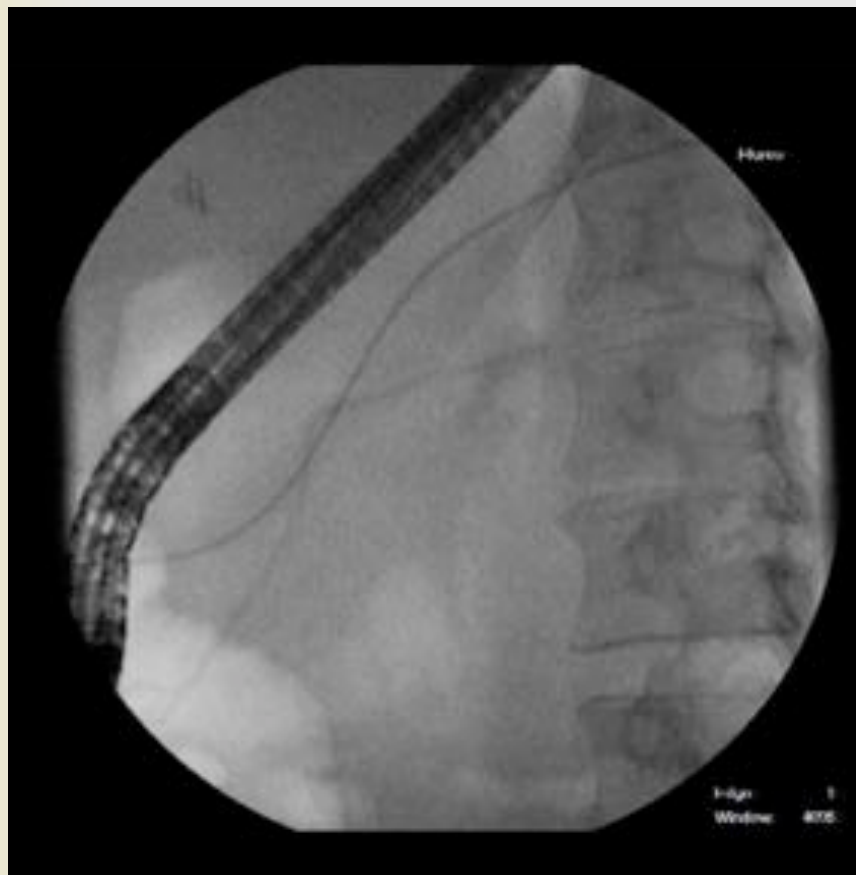


Resection Procedures



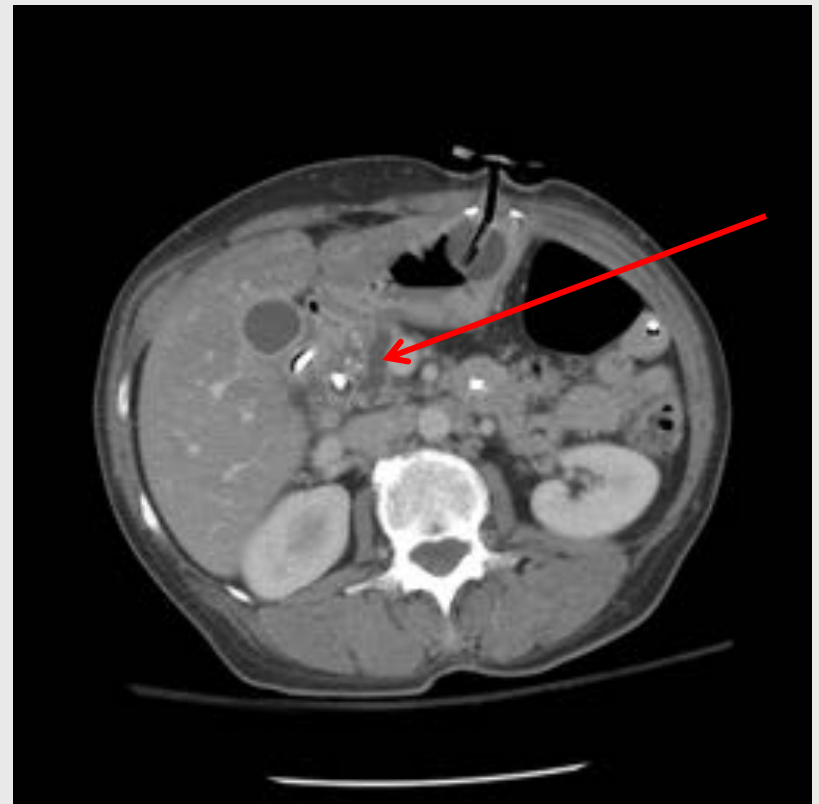
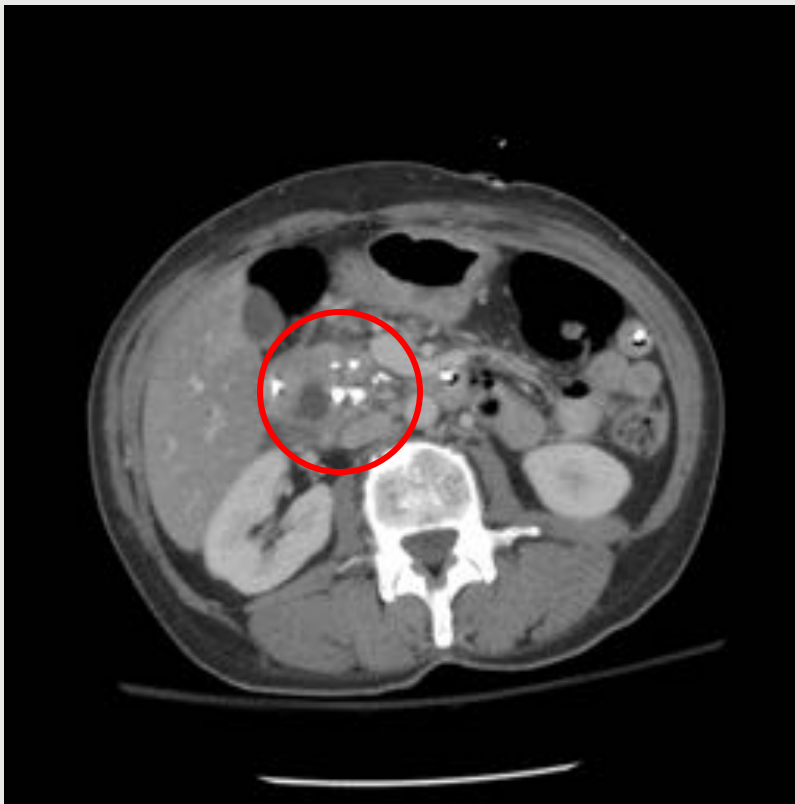
Enucleation



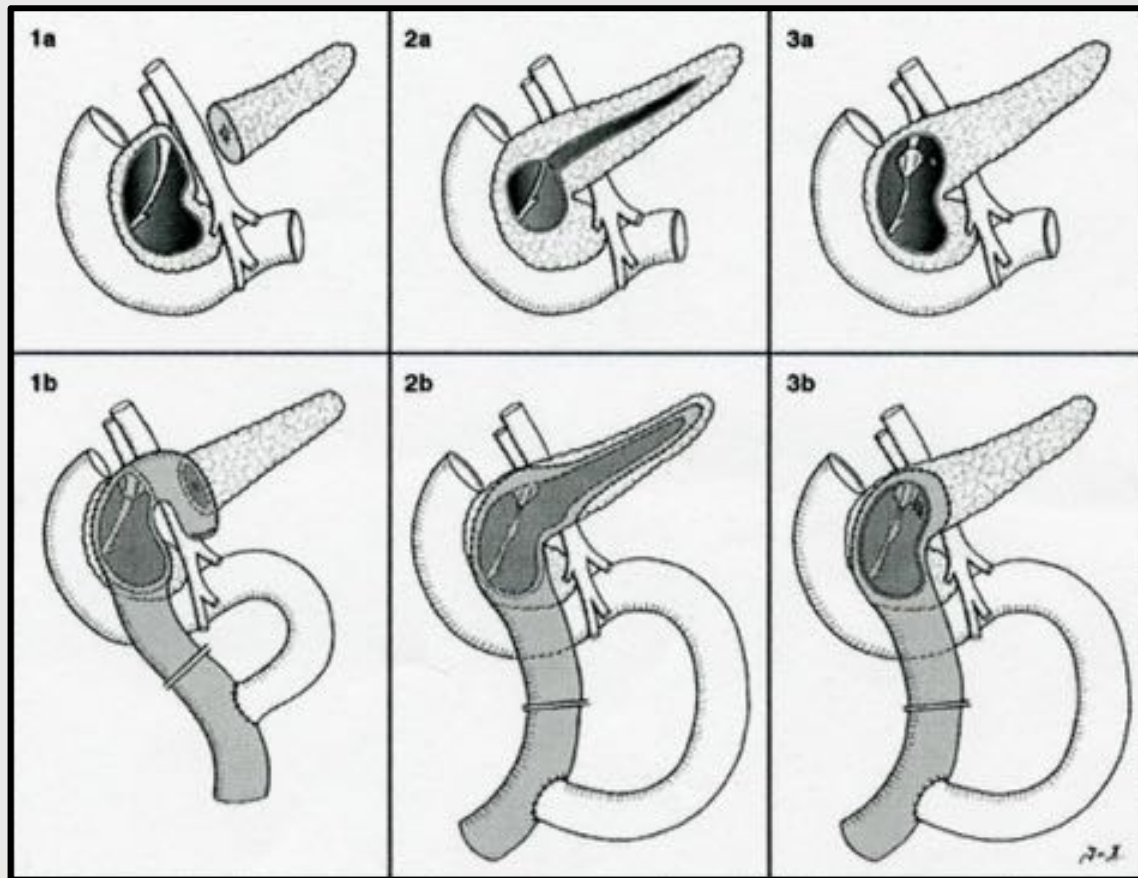




Chronic Pancreatitis



Duodenum-Sparing Procedures

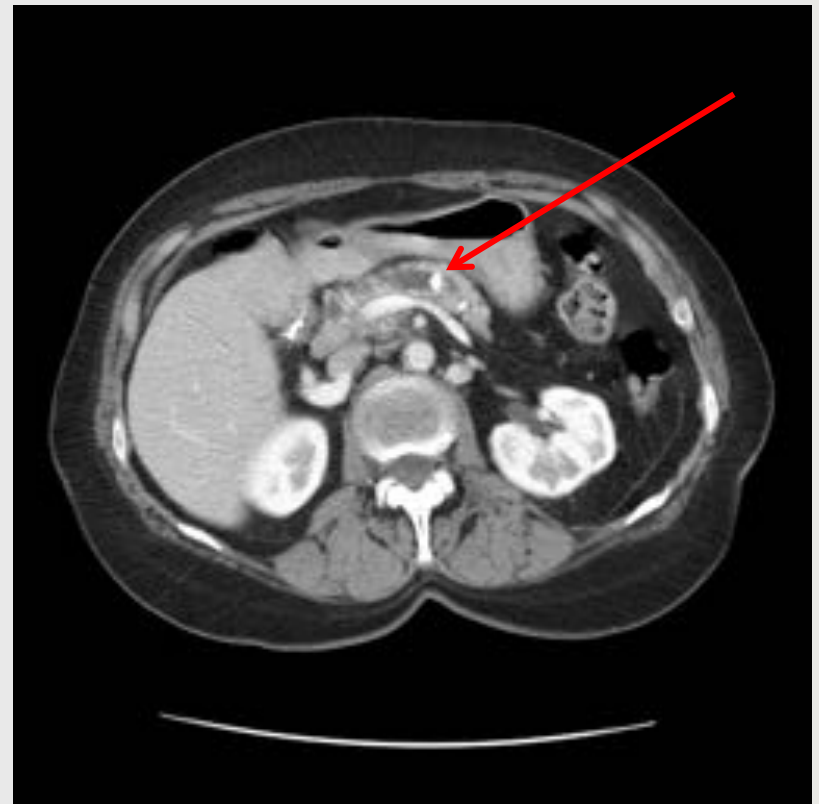
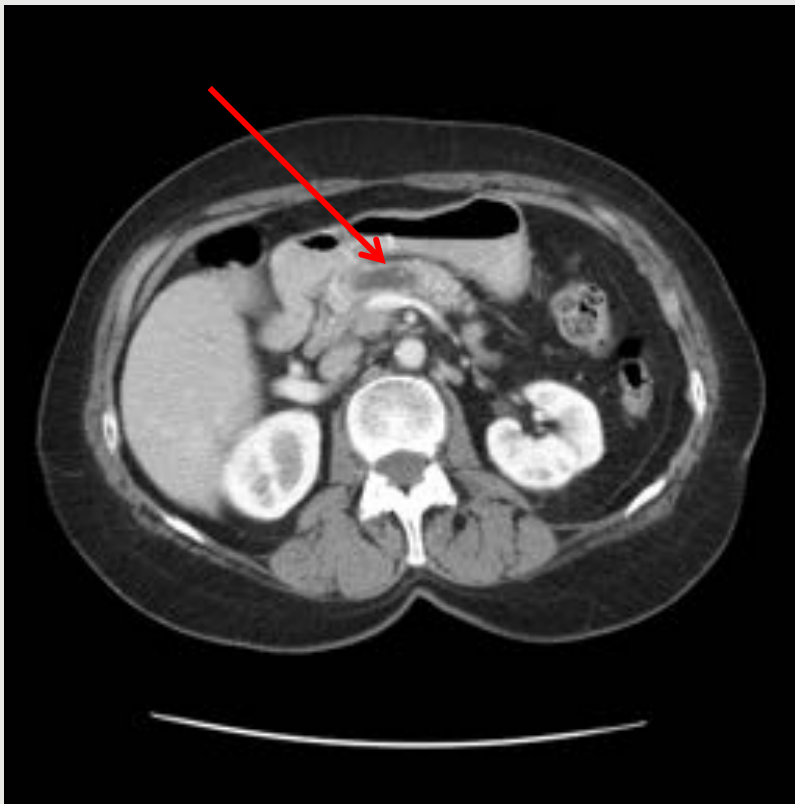


Beger

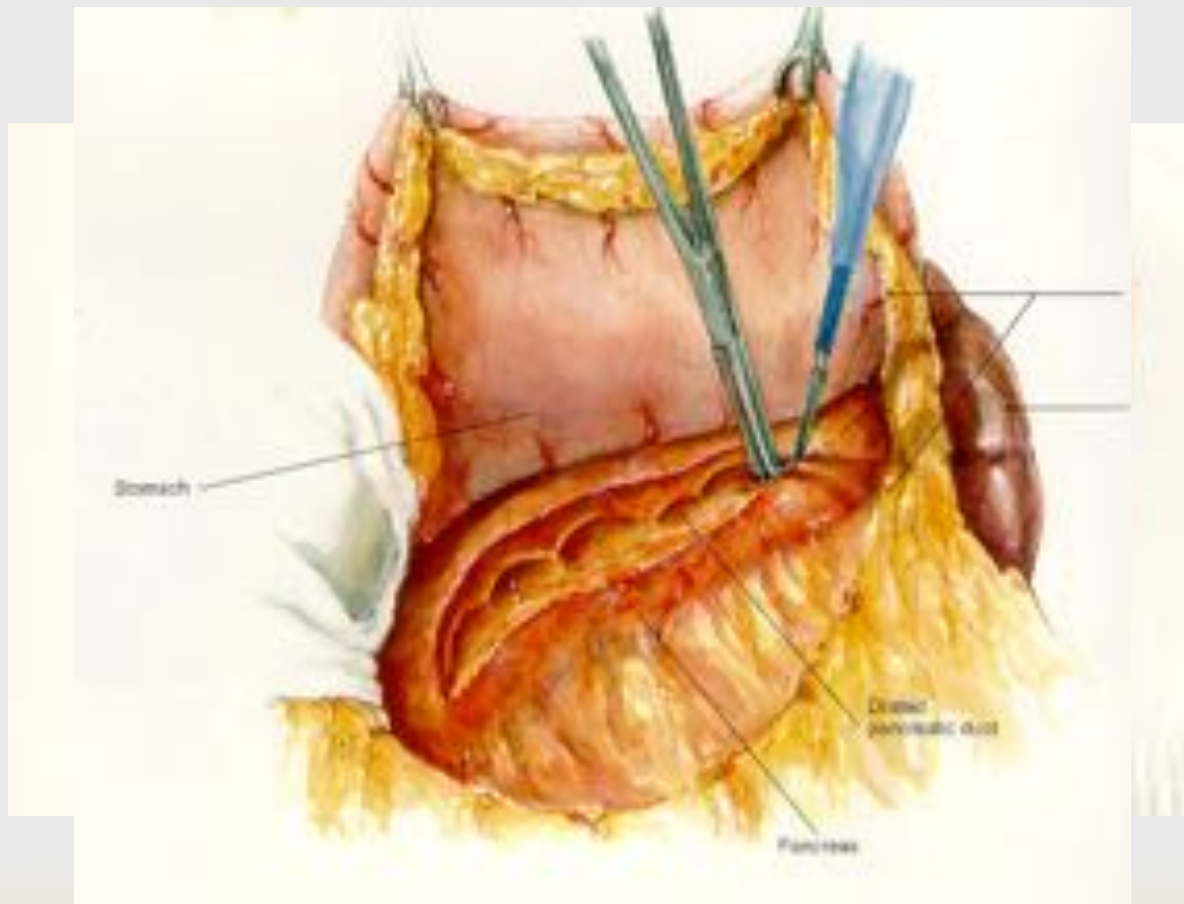
Frey

Bern

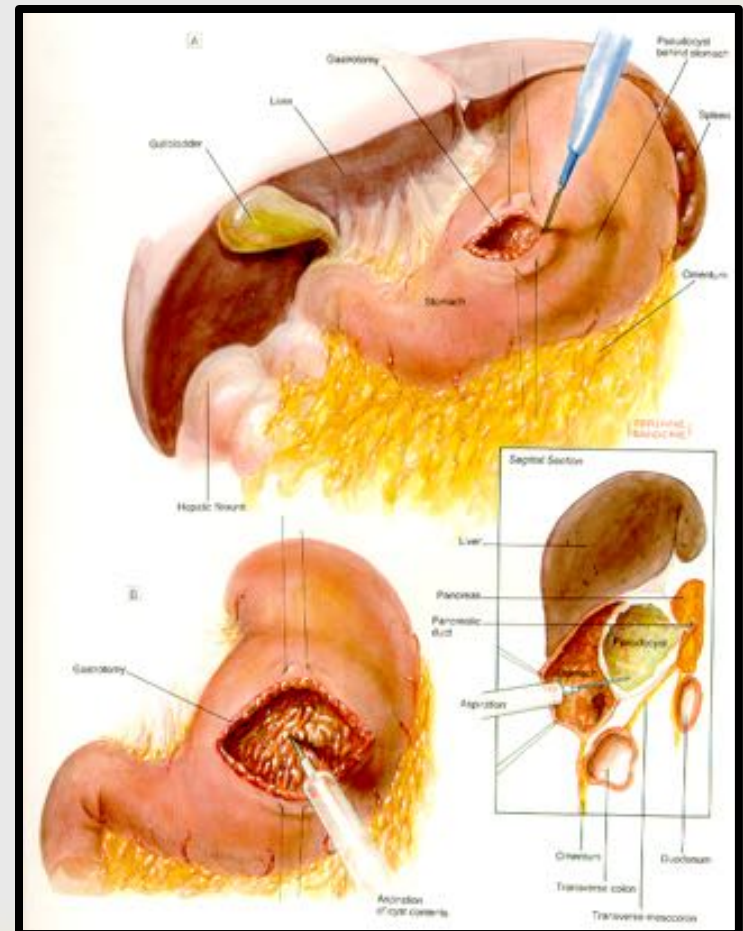
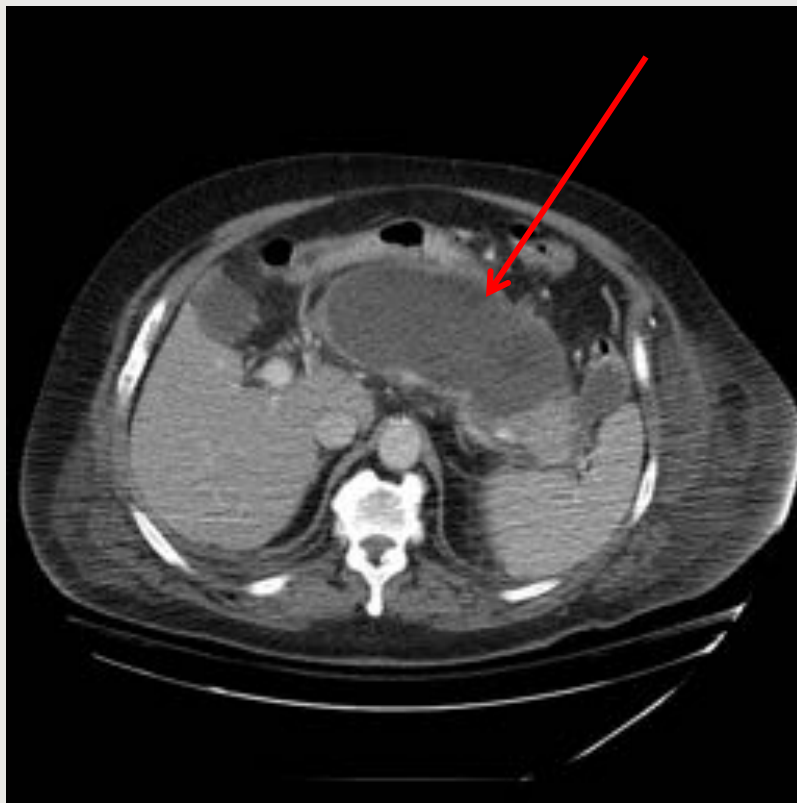
Dilated Pancreatic Duct

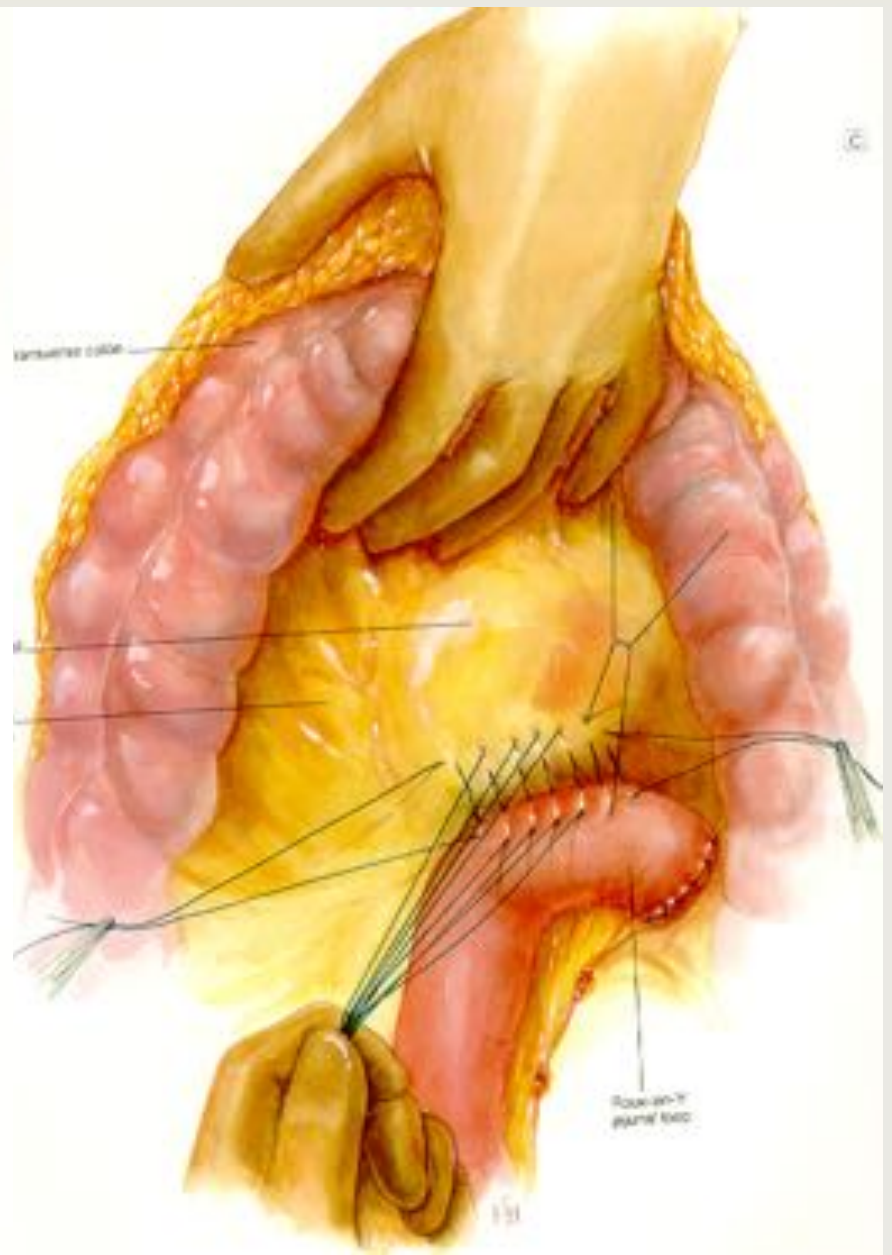


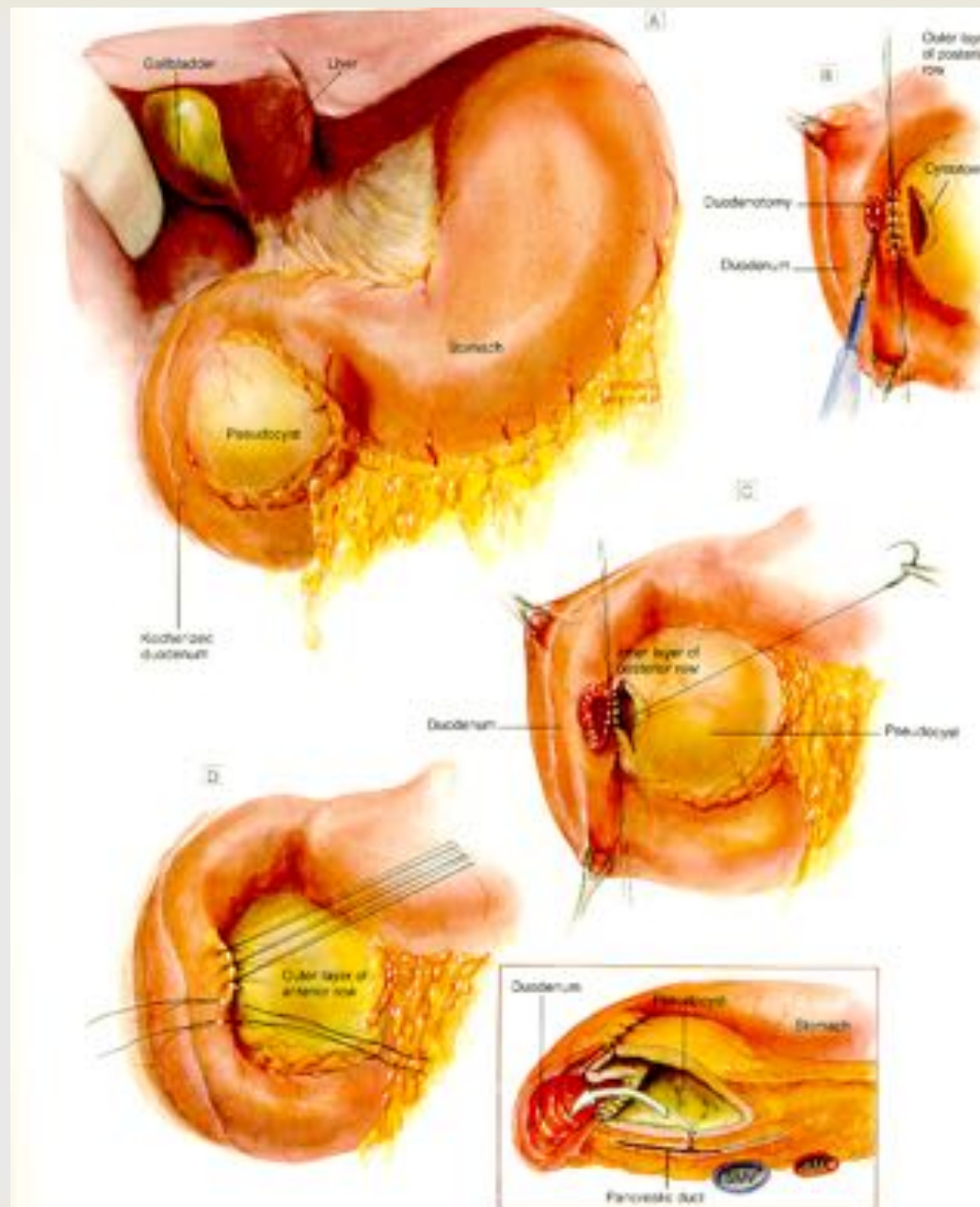
Ductal Drainage Procedures



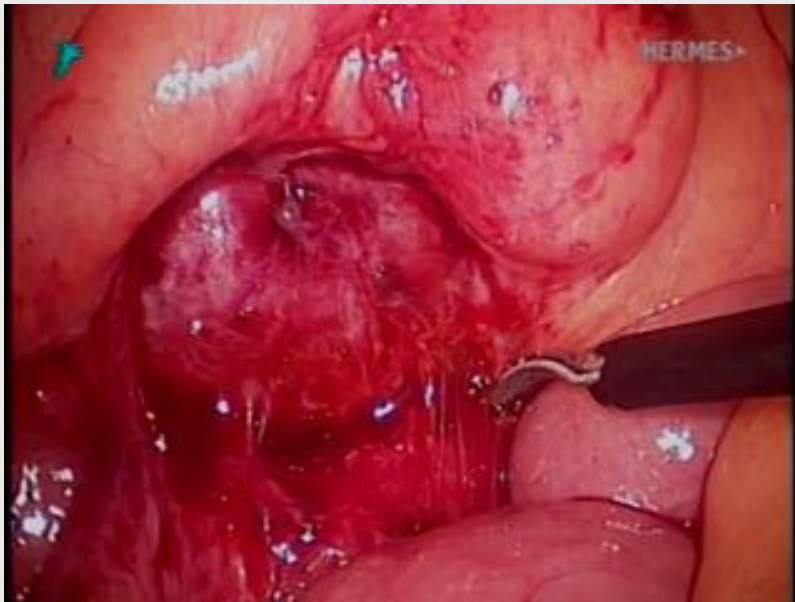
Pseudocyst Drainage



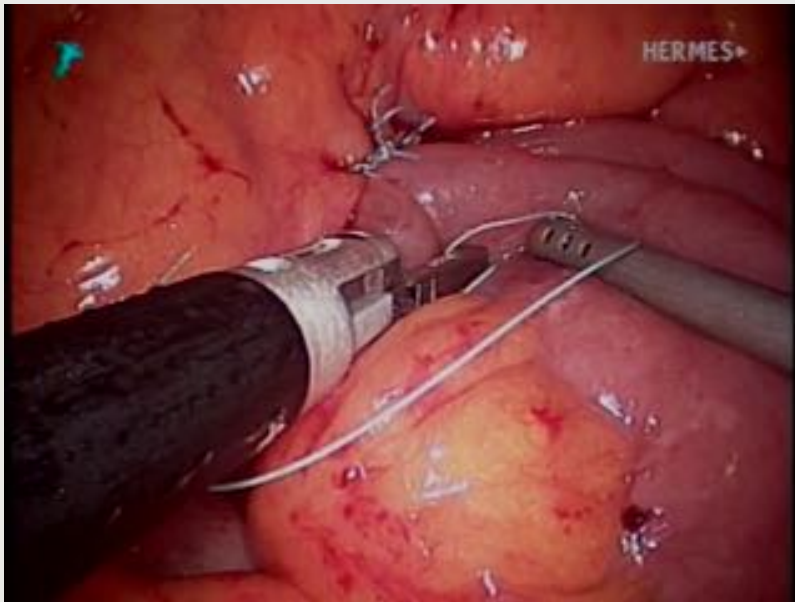




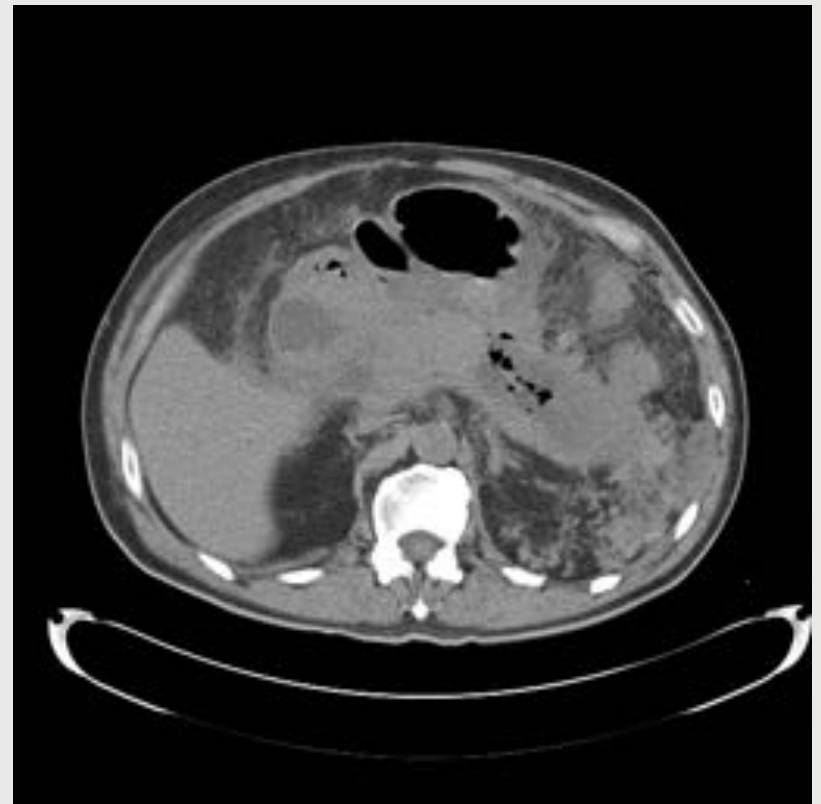
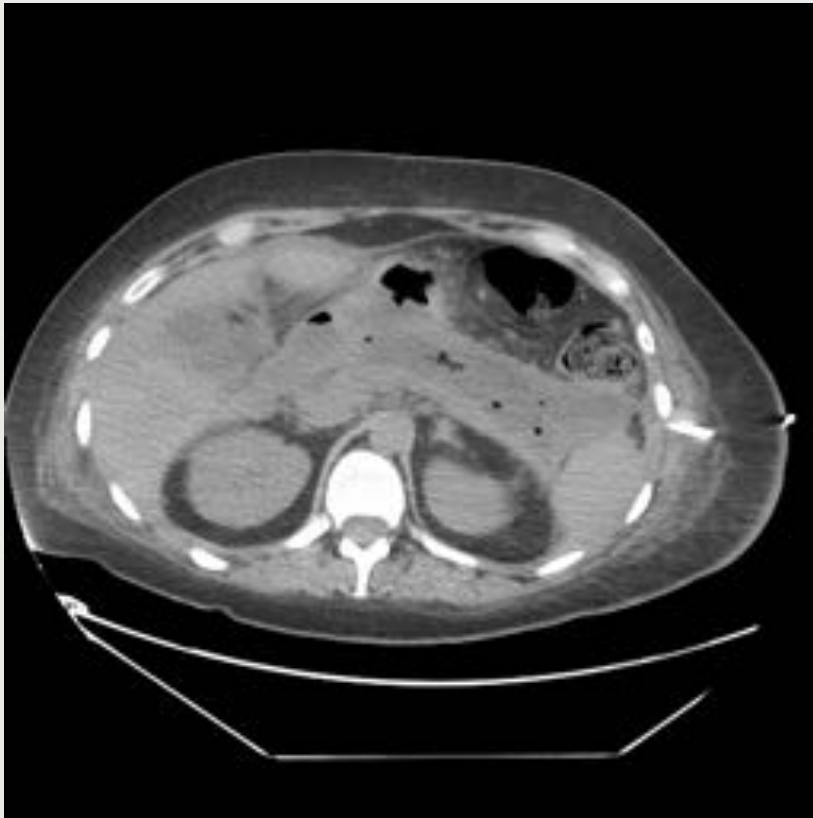
Symptomatic Walled-Off Necrosis



Symptomatic Walled-Off Necrosis



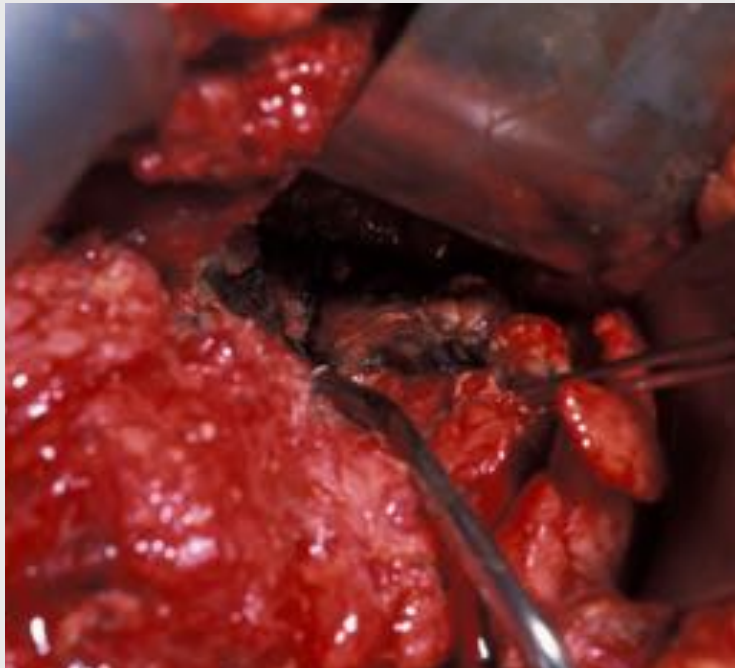
Debridement



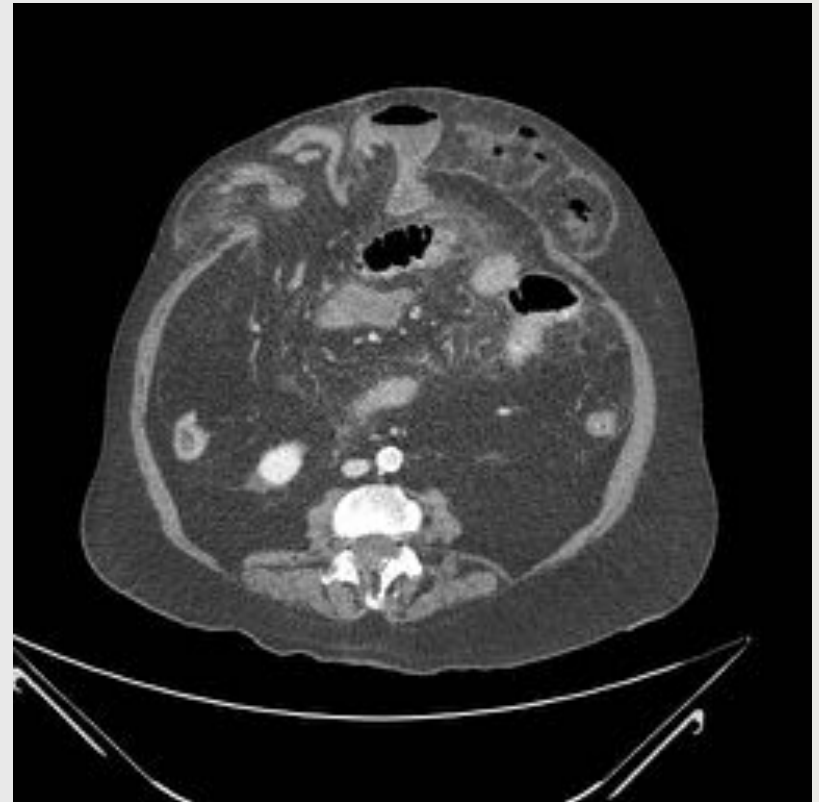
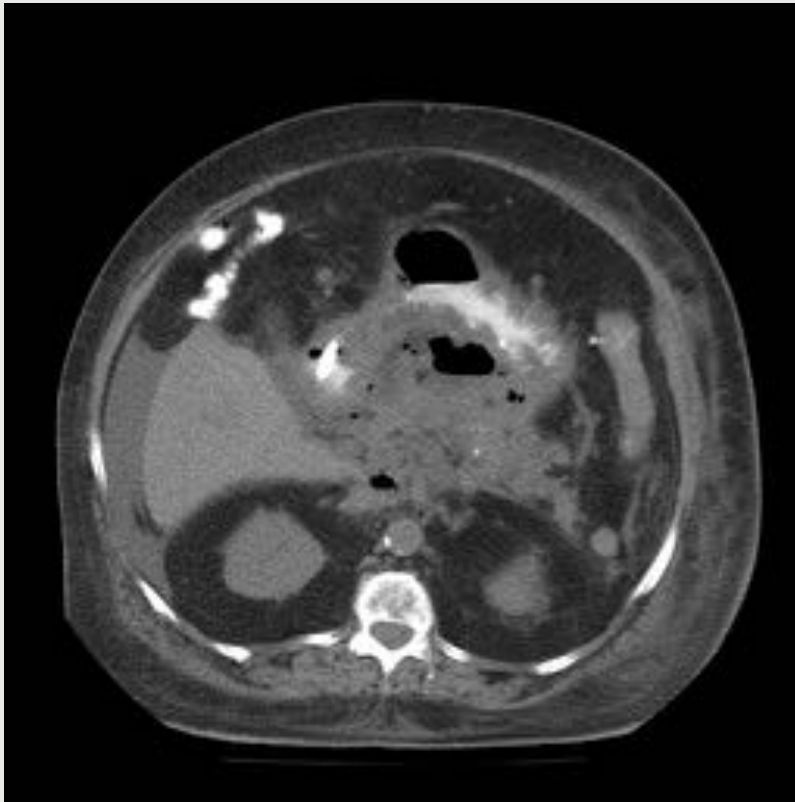
Open Debridement



Open Debridement



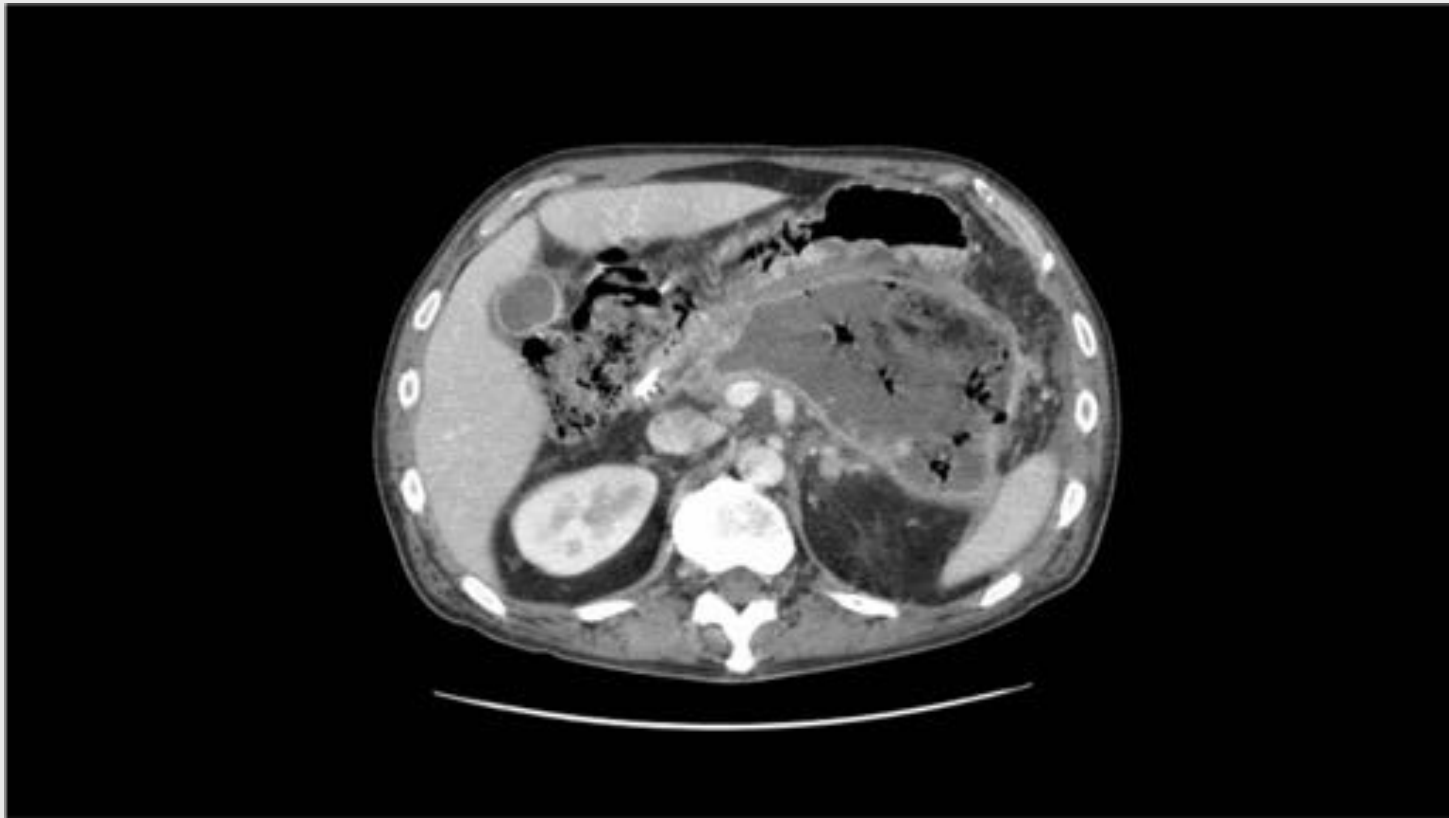
Open Debridement



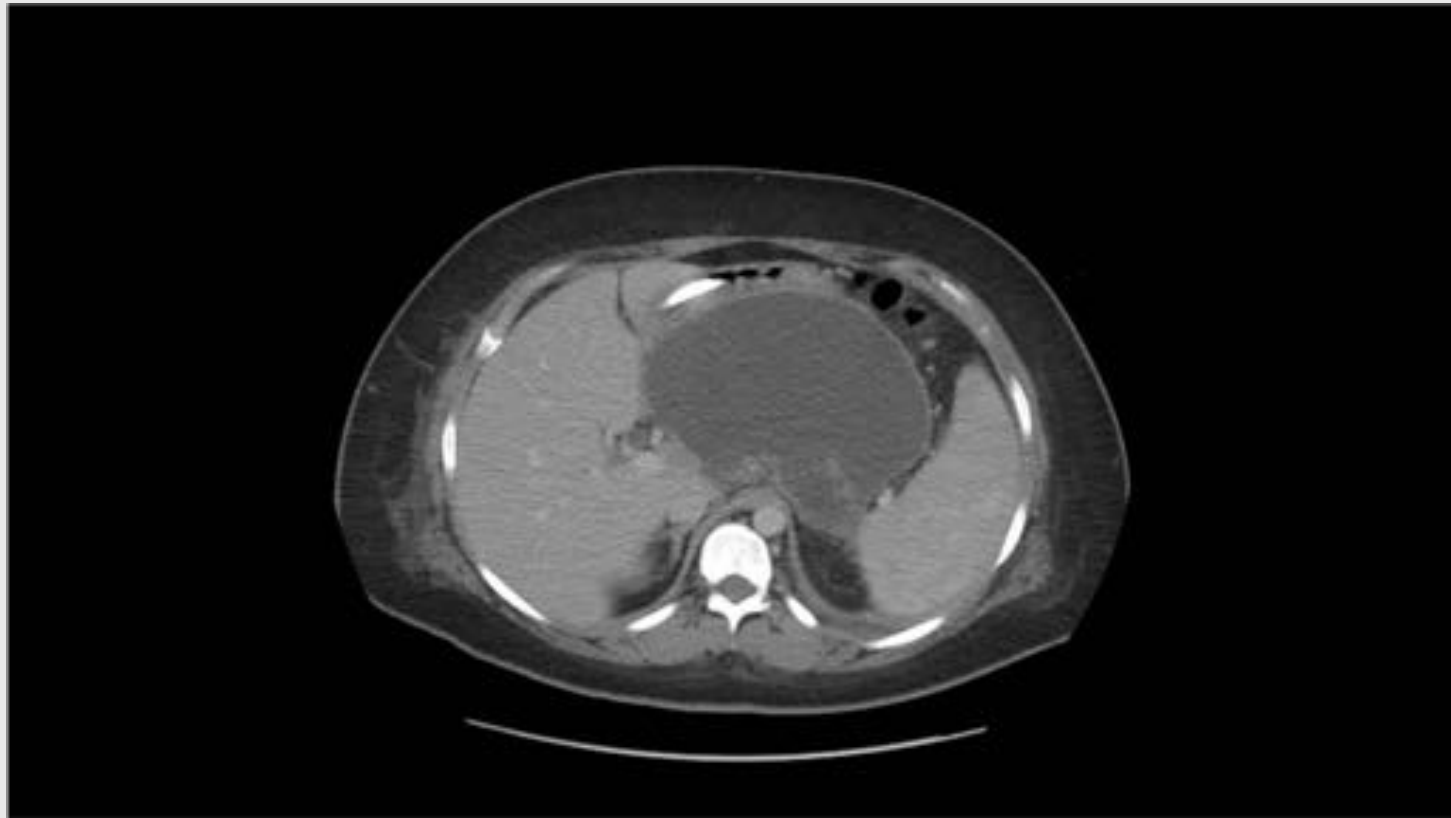
Step Up Approach



Transperitoneal Pancreatic Debridement



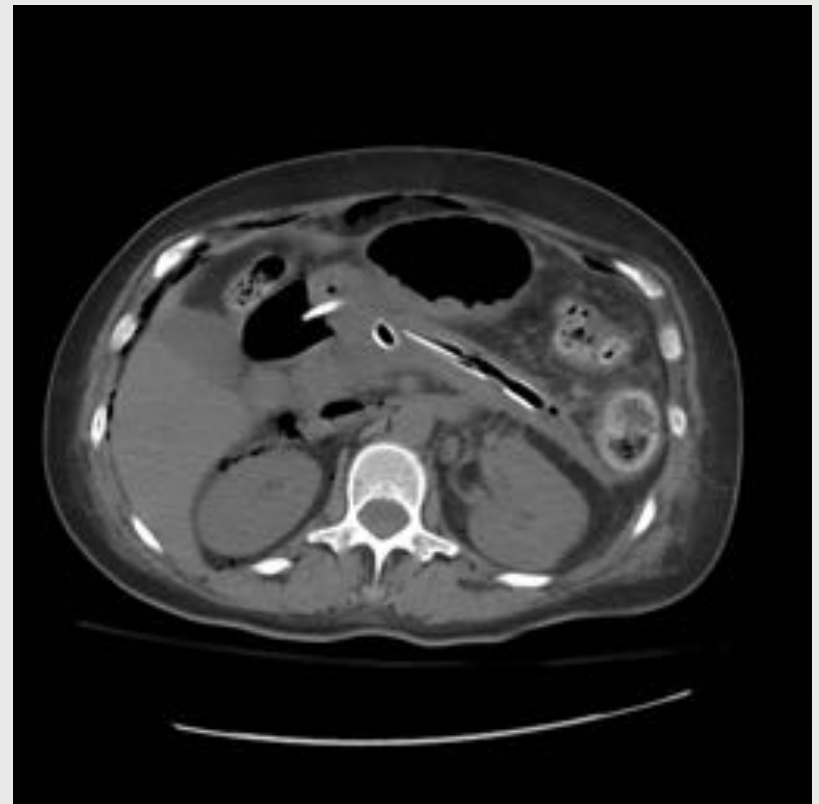
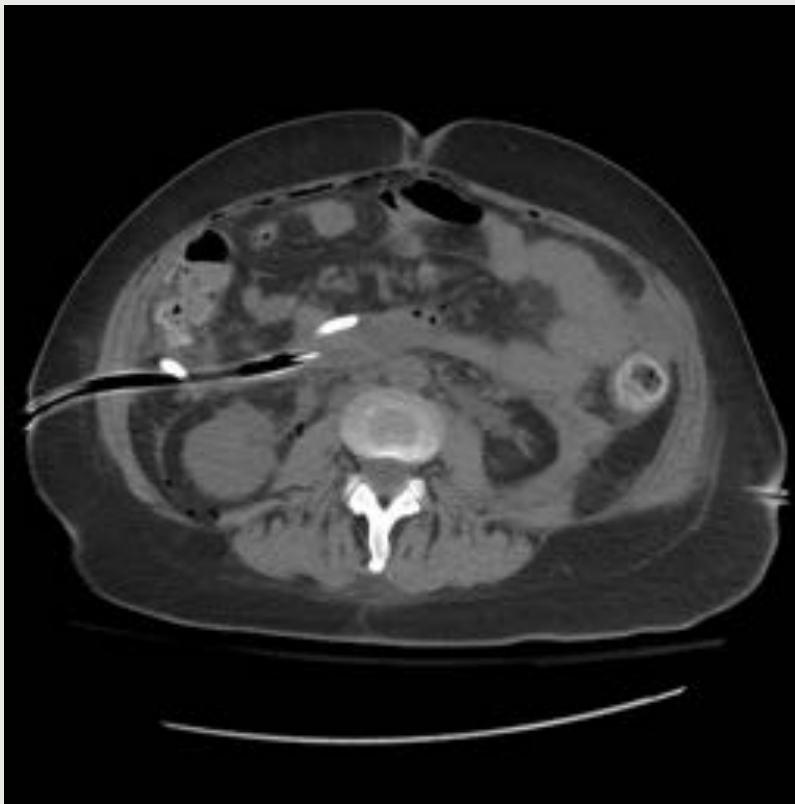
Laparoendoscopic Transgastric Debridement



Video-Assisted Retroperitoneal Debridement



Video-Assisted Retroperitoneal Debridement



Video-Assisted Retroperitoneal Debridement

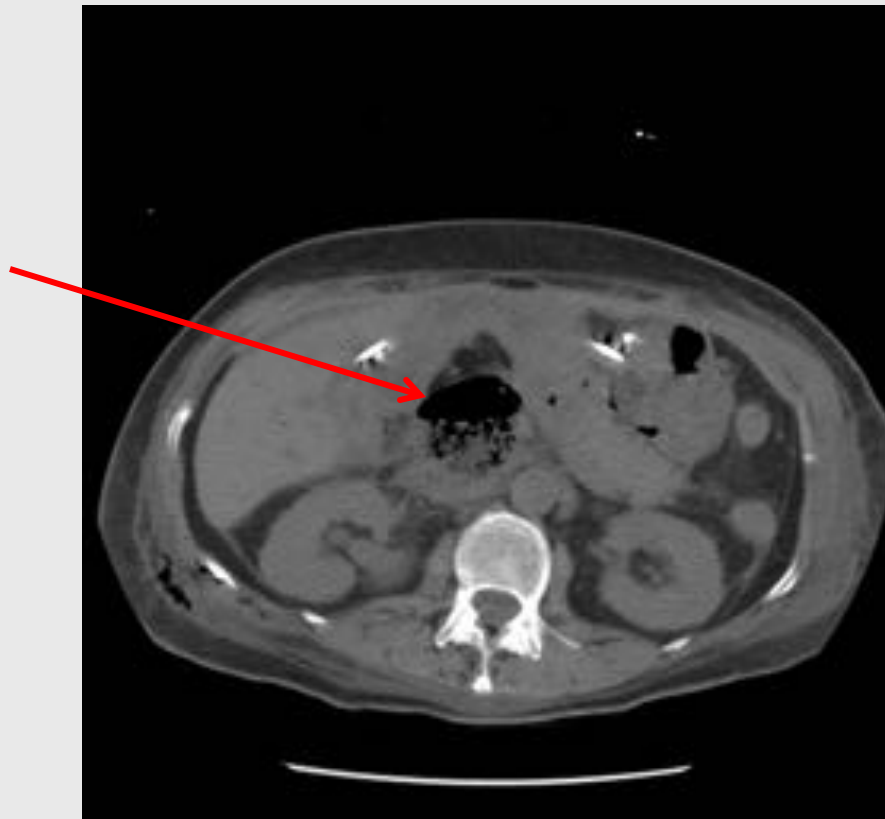


Surgical Complications



- Early
 - Anastomotic complications
 - Leak → fistula, abscess, infection
 - Bleeding
 - Delayed gastric emptying
- Late
 - Anastomotic complications
 - Stricture, bleeding, stasis
 - Nutritional
 - Endocrine and exocrine insufficiency

Pancreatic Abscess/Fistula



Pancreatic Fistula



- International Study Group on Pancreatic Fistula definitions
 - Drain output of any measurable amount on or after POD 3 with amylase $> 3\times$ serum
 - Grade A – well, no treatment, - CT, drainage < 3 weeks, no signs of infection
 - Grade B – often well, +/- treatment, +/- CT, drainage usually > 3 weeks, signs of infection
 - Grade C – ill appearing, + treatment, + CT, drainage > 3 weeks, signs of infection and sepsis, reoperation, possible death

Pancreatic Fistula



- Fistula risk score
 - Gland texture (firm=0, soft =2)
 - Pathology (PDA or pancreatitis=0, others=1)
 - Pancreatic duct diameter (≥ 5 mm=0, 4=1, 3=2, 2=3, ≤ 1 =4)
 - Blood loss (≤ 400 ml=0, 401-700=1, 701-1000=2, >1000 =3)
- Negligible risk (0), low risk (1-2), moderate risk (3-6), high risk (7-10)

Pancreatic Fistula



- Management
 - Drainage and control of infection
 - Percutaneous drainage
 - Pancreatic duct stenting (after distal pancreatectomy)
 - ? Pancreatic rest
 - ? Enteral nutrition
 - ? Parenteral nutrition
 - ? Somatostatin and analogues
 - ? Enzyme therapy

Pancreatic Fistula

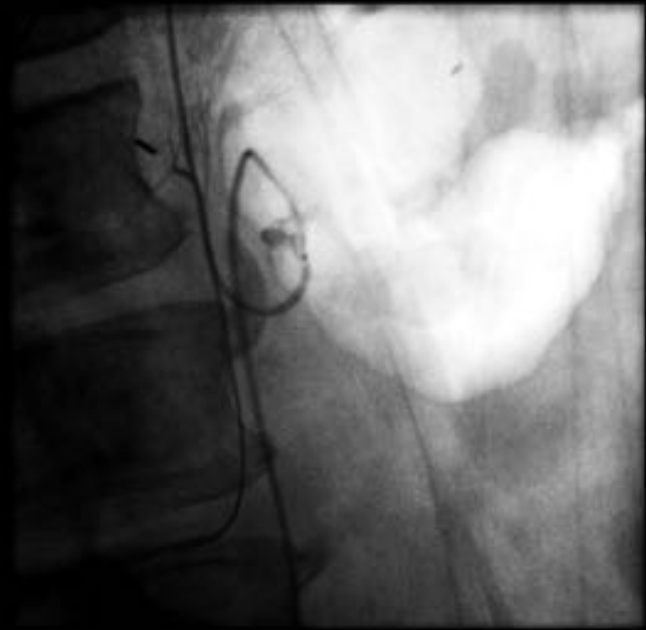
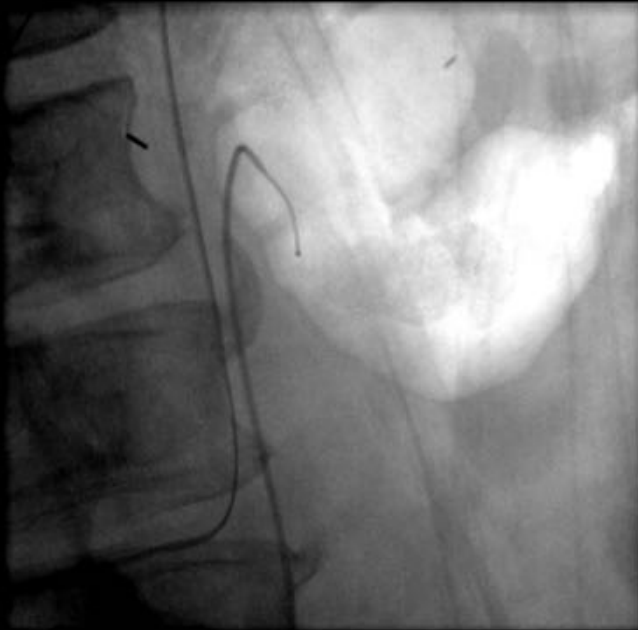


GI Fistula



- Leak from anastomosis of stomach/duodenum → jejunum
 - Sepsis
 - Fluid and electrolyte abnormalities
 - Diversion of nutrient stream
- Management
 - Control of sepsis, drainage, skin care, correction of fluid and electrolyte abnormalities,
 - GI rest
 - Distal feeding
 - Parenteral nutrition

Bleeding from Pseudoaneurysm



Delayed Gastric Emptying



DGE Grade	NG tube Required	Unable to tolerate solids by POD	Vomiting/ gastric distention	Use of Prokinetics
A	4-7 days or reinsertion > POD 3	7	+/-	+/-
B	8-14 days or reinsertion > POD 7	14	+	+
C	> 14 days or resinsertion > POD 14	21	+	+

Delayed Gastric Emptying



- ↑ risk
 - Preoperative diabetes
 - Pancreatic fistula
 - Other post-operative complications
- ↓ risk
 - Antecolic reconstruction
- No effect
 - Standard vs pylorus sparing
 - Pathology (malignant vs benign)

Delayed Gastric Emptying



Enteral Nutrition Prolongs Delayed Gastric Emptying in Patients after Whipple Resection

Marcus E. Martignoni, MD, Helmut Friess, MD, Florian Sell, MD, Lars Ricken, MD, Shailesh Shrikhande, MD, Christoph Kulli, MD, Markus W. Büchler, MD, *Bern, Switzerland*

Enteral Nutrition Reduces Delayed Gastric Emptying After Standard Pancreaticoduodenectomy with Child Reconstruction

Michel Rayar • Laurent Sulpice • Bernard Meunier • Karim Boudjema

Surgical Complications



	Enucleation	Whipple	Distal	Drainage
Pancreatic Fistula	++	++	++	+/-
GI fistula	-	++	-	-
Bleeding	-	++	+	-
Delayed gastric emptying	-	++	-	-
Anastomotic complication	-	++	-	+

Surgical Complications



	Enucleation	Whipple	Distal	Drainage
Decreased pancreatic function	-	++	++	-
Altered pancreatic function	-	++	-	-

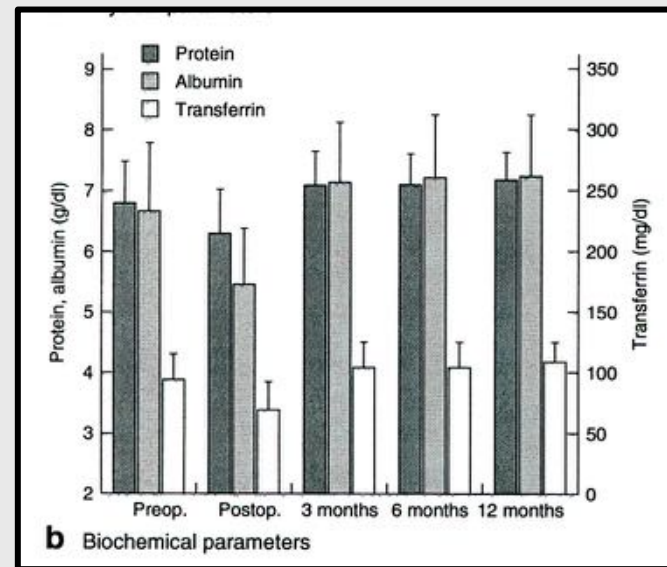
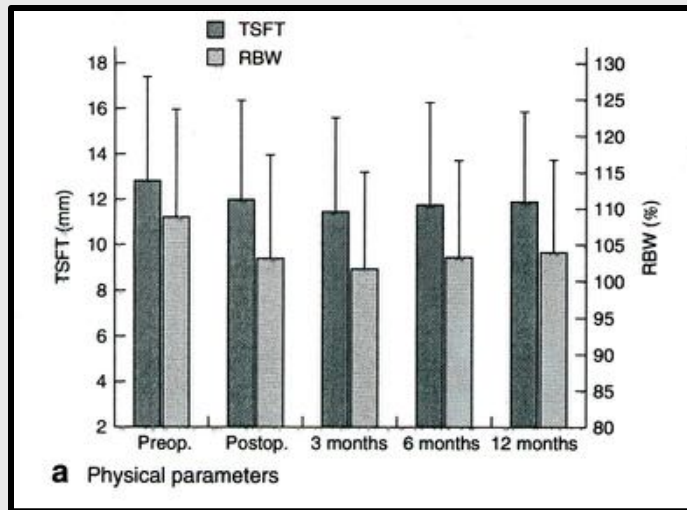
Summary



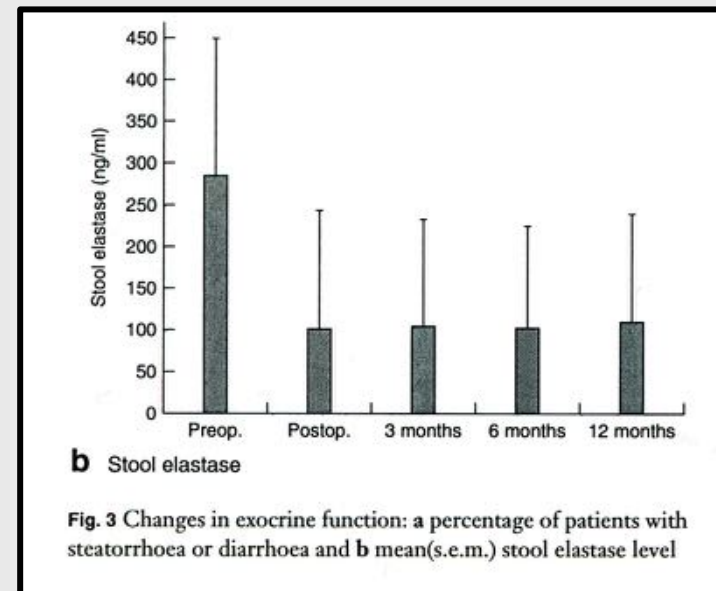
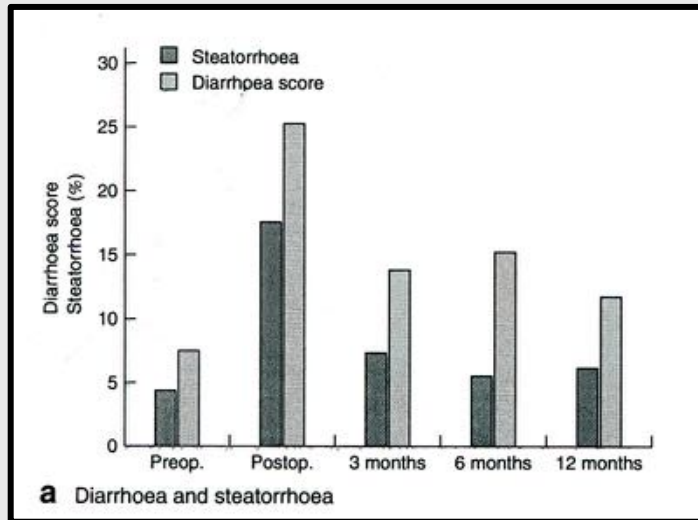
- A variety of operations are performed on the pancreas for treatment of mass lesions and complications of pancreatitis
- These operations may result in postoperative complications as well as loss of pancreatic mass or alterations in pancreatic function resulting in pancreatic insufficiency and nutritional deficiencies
- Strategies should be employed to mitigate, diagnose, and treat these consequences of operations upon the pancreas



Effects of Pancreatectomy



Effects of Pancreatectomy



Exocrine Insufficiency



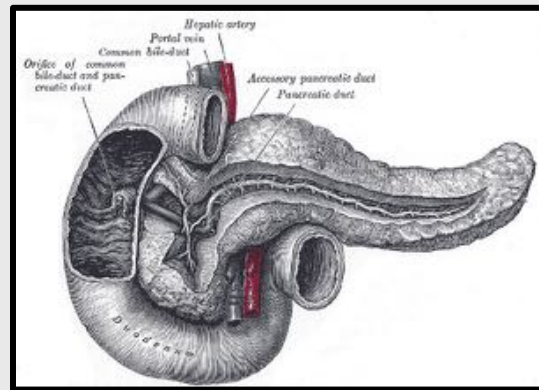
- Loss of pancreatic mass
- Surgical complications
 - Anastomotic stricture
 - Pancreatic fistula
- Changes in pancreatic stimulation/function

Loss of Pancreatic Mass



Total Pancreatectomy

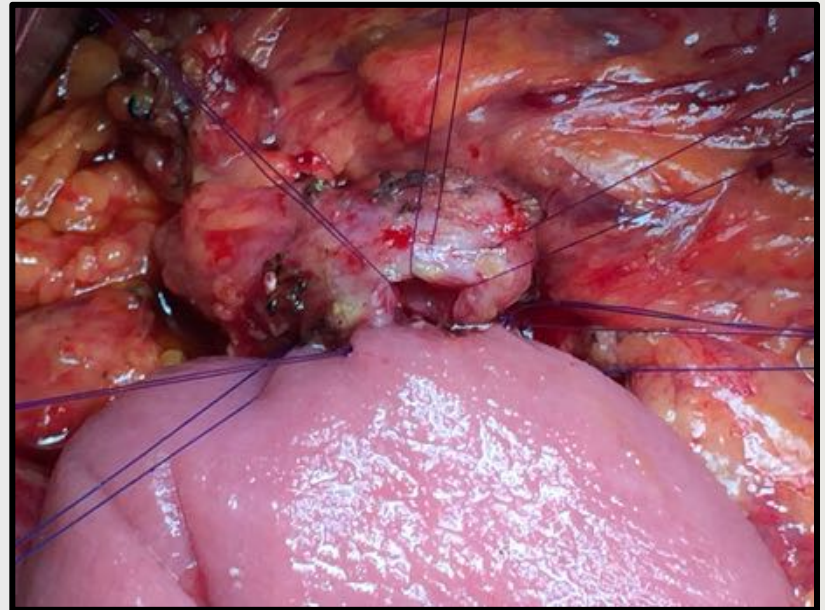
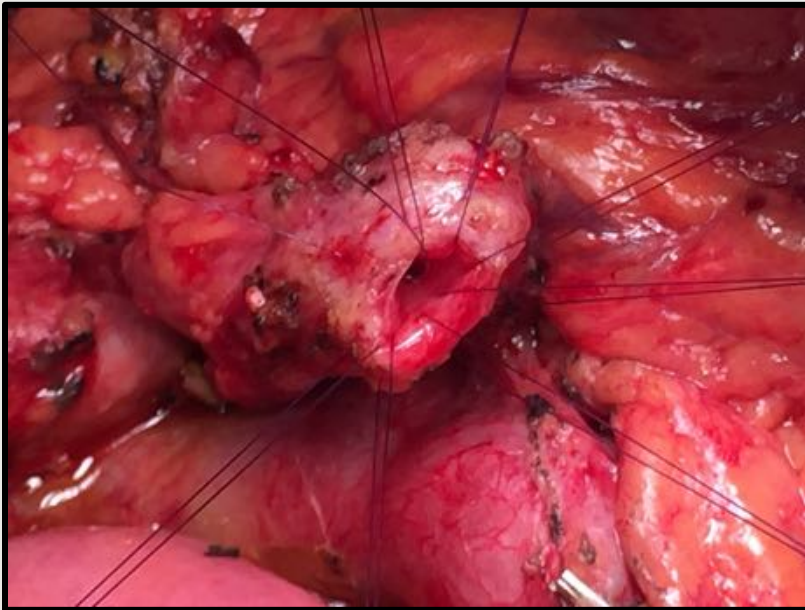
Partial Pancreatectomy



Enucleation

Loss of Mass

Anastomotic Stricture



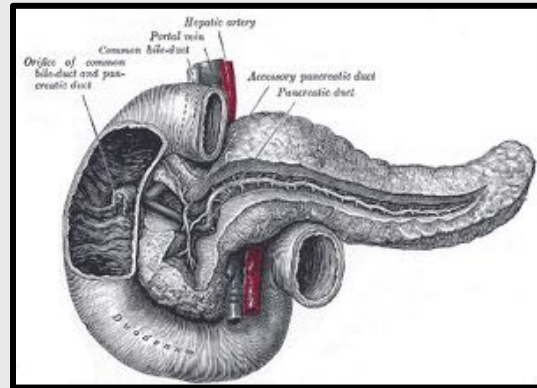
Post-op Alterations in Pancreatic Function



Physiology Δ

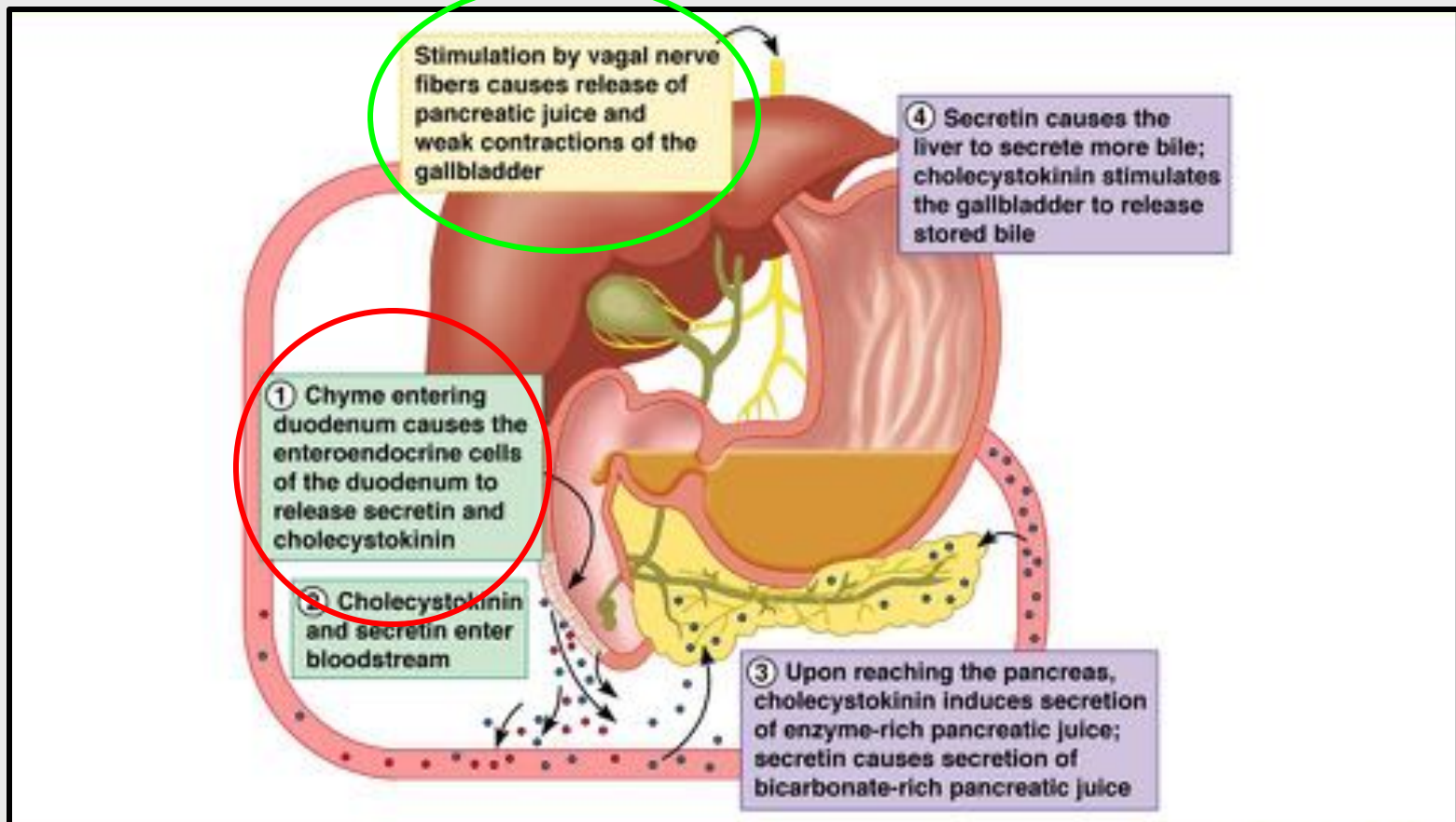
Total Pancreatectomy

Partial Pancreatectomy

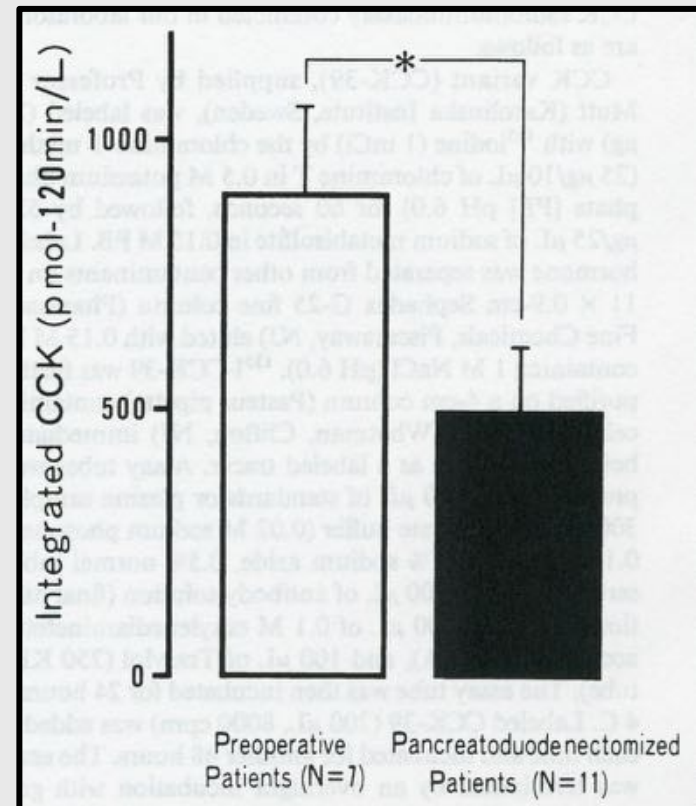
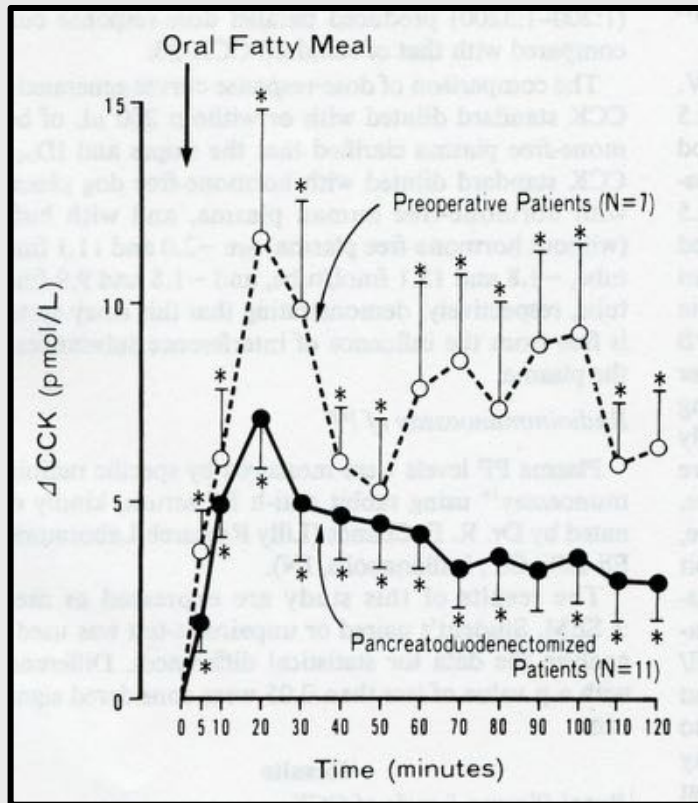


Enucleation

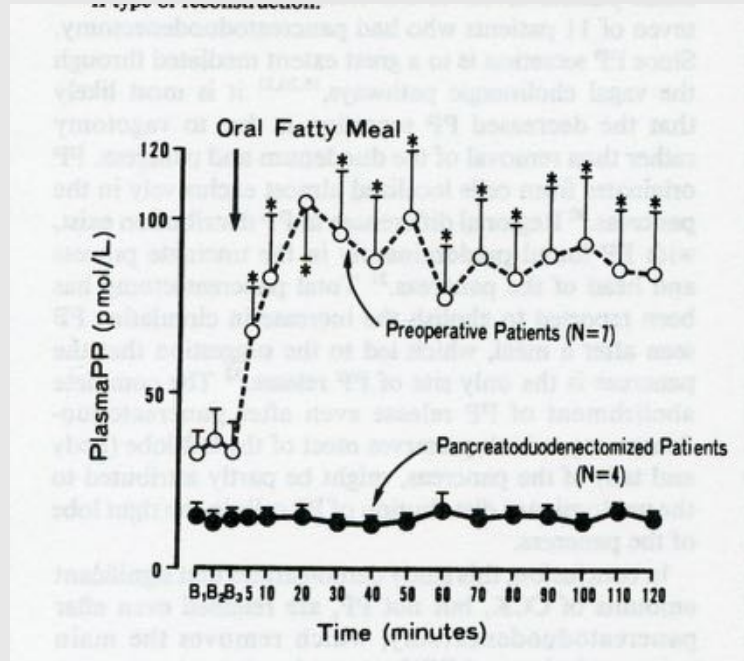
Regulation of Pancreatic Secretion



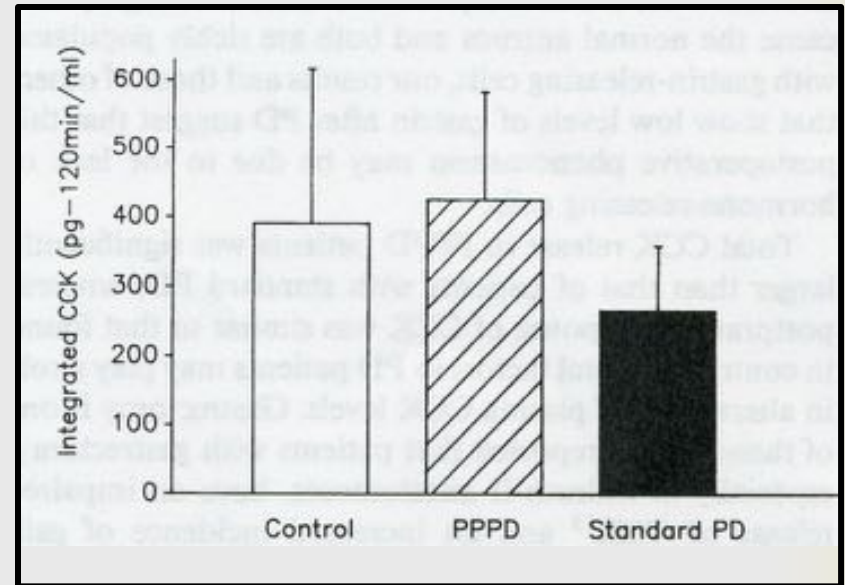
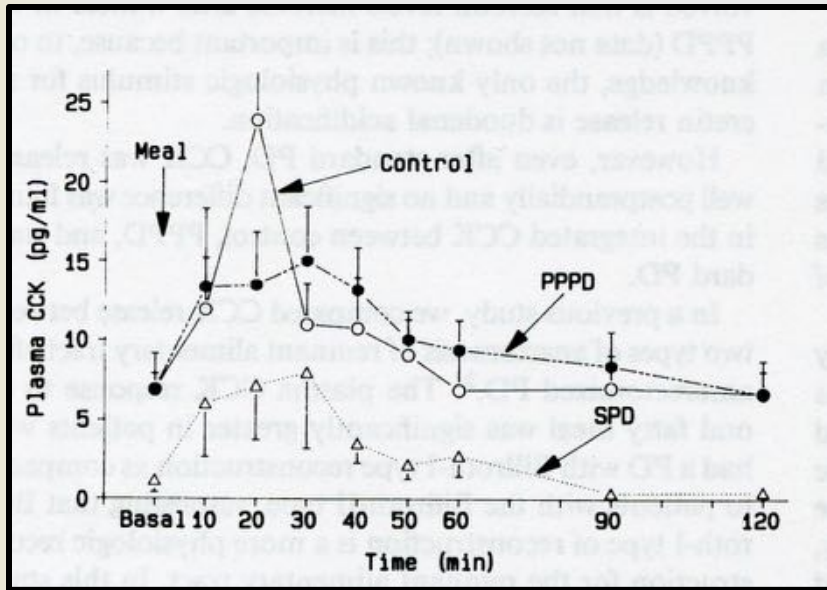
Pancreatic Secretion after Pancreaticoduodenectomy



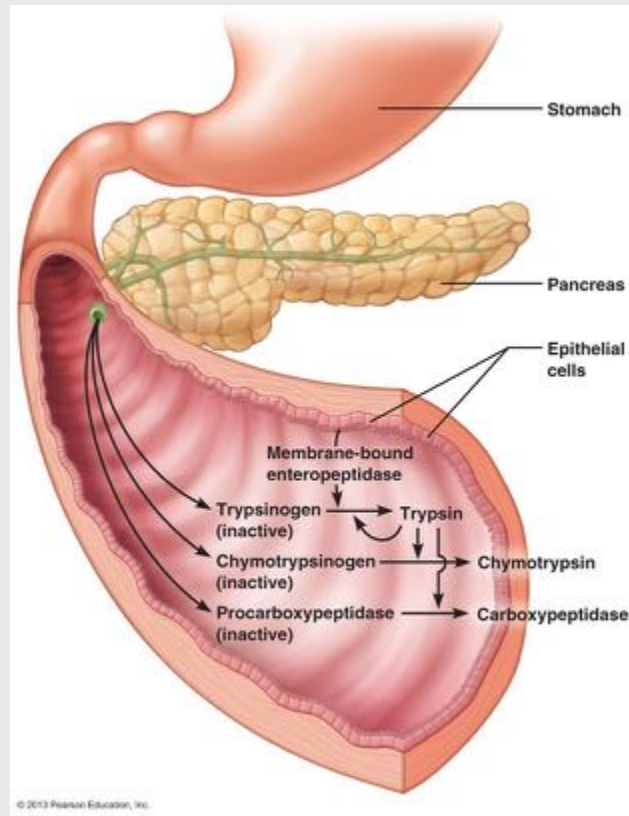
Pancreatic Secretion after Pancreaticoduodenectomy



Pancreatic Secretion after Pancreaticoduodenectomy



Regulation of Pancreatic Secretion



Pancreatic Function



- Normal secretion
 - 1.5 liters of enzyme rich fluid per day
 - HCO_3^- fasting state 80 mmol/liter
 - HCO_3^- post-prandial state 120 mmol/liter

Pancreatic Insufficiency



- Pancreatic exocrine insufficiency → maldigestion of fat and protein →
 - Overt steatorrhea when 90 % of pancreatic exocrine function lost
 - Weight loss, bloating cramping, increased flatulence, diarrhea
 - Fat soluble vitamin (A, D, E, K) deficiencies
 - B12 deficiency may result from decreased intestinal pH that impairs B12 transfer from R protein to intrinsic factor

Evaluation of Pancreatic Function



- Direct pancreatic function tests (stimulation tests)
 - Secretin stimulation test – measures bicarbonate concentration, volume, and total bicarbonate output
 - CCK test – measures enzyme secretory capacity
 - Enzyme secretion may be impaired before bicarbonate secretion

Evaluation of Pancreatic Function



- Indirect pancreatic function tests
 - Measure the consequences of exocrine insufficiency
 - Easier to perform
 - Much less sensitive for milder insufficiency
 - Tests
 - Serum trypsinogen
 - Fecal fat
 - Fecal elastase-1 and chymotrypsin
 - Pancreolauryl test
 - ^{13}C breath tests
 - Secretin-enhanced MRI

Treatment of Pancreatic Insufficiency



- Pancreatic enzyme replacement therapy
 - Pancreas secretes between 700,000 and 1,000,000 USP lipase units with each meal
 - 10 % of normal lipase secretion (70,000-100,000 units) is usually sufficient to control steatorrhea
 - Proteases in stomach and small intestine help to compensate for decreased pancreatic proteases
 - Enzymes should be taken with meal to ensure satisfactory mixing with food
 - Avoid enzyme deactivation by stomach acid

Enzyme Formulations



- Enteric coated
 - Capsule releases coated microspheres in stomach
 - Enteric coating protects enzymes from degradation by gastric acid
 - Coated microspheres pass into intestine and mix with food
- Non-enteric coated
 - Possible use for pain control in CP

