Surgery of the Pancreas

By

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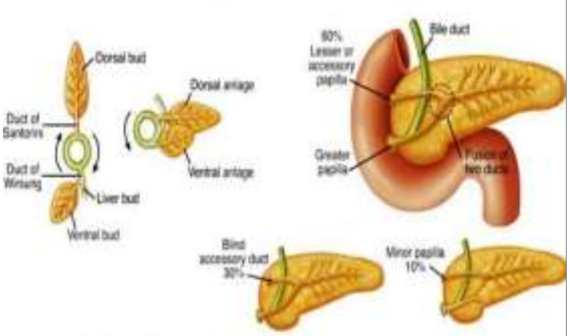
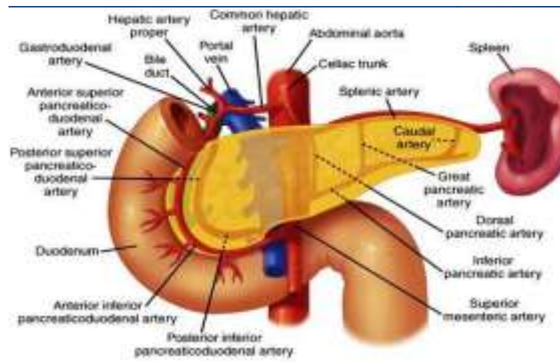
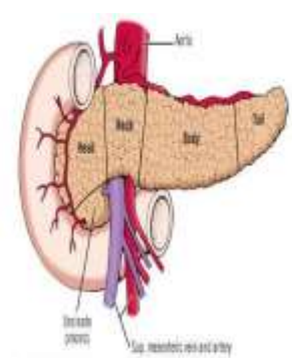


Embryology of pancreas and duct variations. The duct of Wirsung from the ventral bud connects to the bile duct, while the duct of Santorini from the larger dorsal bud connects to the duodenum. With gut rotation, the two ducts fuse in most cases such that the majority of the pancreas drains through the duct of Wirsung to the major papilla. The duct of Santorini can persist as a blind accessory duct or drain through the lesser papilla. In a minority of patients, the ducts remain separate, and the majority of the pancreas drains through the duct of Santorini, a condition referred to as pancreas divisum.



Arterial supply to the pancreas. Multiple arcades in the head and body of the pancreas provide a rich blood supply. The head of the pancreas cannot be resected without devascularizing the duodenum unless a rim of pancreas containing the pancreaticoduodenal arcade is preserved.



Five parts of pancreas. Line dividing body and tail is entirely arbitrary. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr. Anatomical Complications in General Surgery. New York: McGraw-Hill, 1983; with permission.)

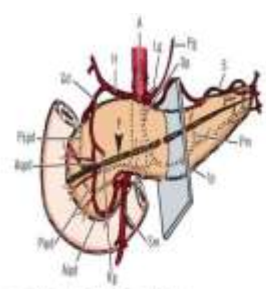
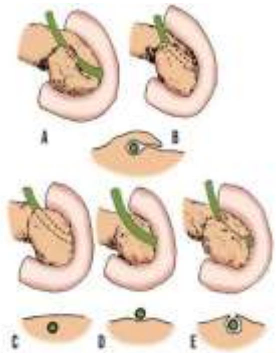
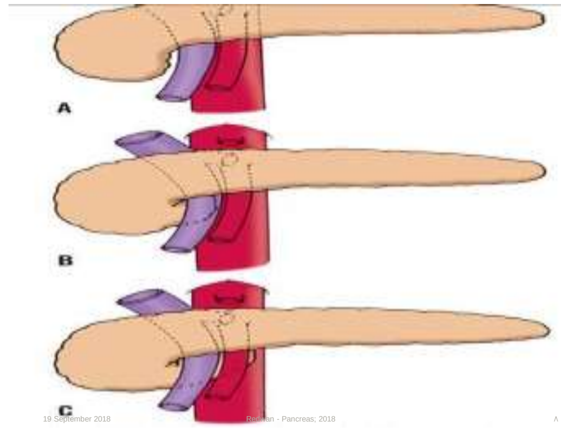
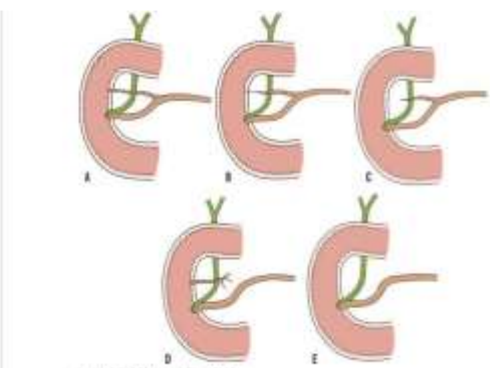


Diagram of the arteries surrounding the human pancreas. The intersegmental plane has been drawn on the left of the superior mesenteric artery. ... (Modified from Bertelli E, Di Gregorio F, et al. Anatomicosurgical segments of the human pancreas. Surg Radiol Anat ...; with permission.)

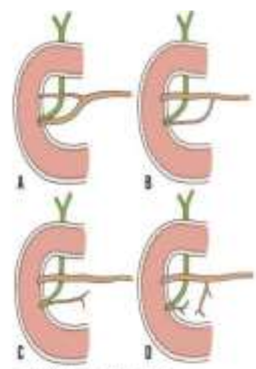


Five variations of relation of third part of common bile duct to head of pancreas. (Data from Beales T. Varying relations of the common bile duct with the posterior face of the pancreas in negroes and white persons. J Int Coll Surg 13:150, 1954; drawing modified from Skandalakis JE, Gray SW. Embryology for Surgeons (2nd ed). Baltimore: Williams & Wilkins, 1994; with permission.)

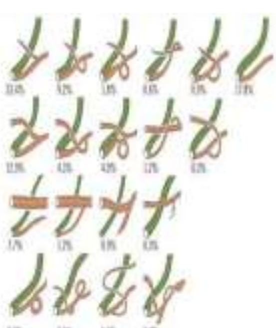




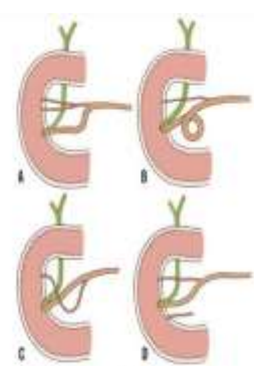
Variations of pancreatic ducts. Degrees of suppression of accessory duct. A, Both ducts open into duodenum (XX percent). B, Accessory duct ends blindly in duodenal wall. C, Accessory duct ends blindly before reaching duodenum (XX percent). D, Accessory duct has no connection with main duct. E, Accessory duct absent. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979; 15:17-50; with permission.)



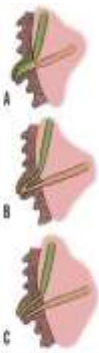
Degrees of suppression of main duct. A, Both ducts open into duodenum. B, Main duct smaller than accessory duct. C, Main duct with no connection to larger accessory duct (XX percent). D, Main duct short or absent (XX percent). (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-50; with permission.)



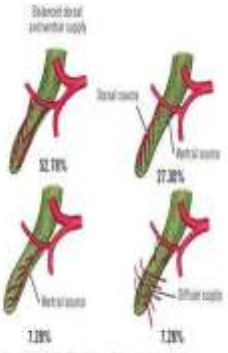
Relations of common bile duct, duct of Wirsung, and duct of Santorini to each other and duodenum. Upper thickest duct is common bile duct; smaller duct is duct of Wirsung; smallest duct is duct of Santorini. The white circular area indicates where the duct enters the duodenum. In rows 2 and 3, duct of Santorini is a major pancreatic duct. Injection studies of M. Stolte. (Modified from Cubilla AL, Fitzgerald PJ. Tumors of the Exocrine Pancreas. Washington: Armed Forces Institute of Pathology; 1984; with permission.)



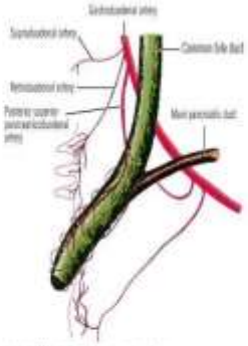
Rare variations of pancreatic ducts. A, Duplication of accessory duct. B, Loop in main duct. C, Anomalous course of accessory duct. D, Triple pancreatic ducts. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-50; with permission.)



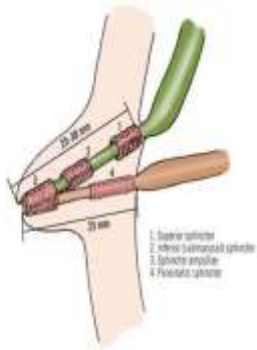
Variations in relation of common bile duct and main pancreatic duct at duodenal papilla. **A**, Minimal absorption of ducts into duodenal wall during embryonic development. Ampulla present. **B**, Partial absorption of common channel. No true ampulla present. **C**, Maximum absorption of ducts into duodenum. Separate orifices on papilla; no ampulla. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15(5):97-108; with permission.)



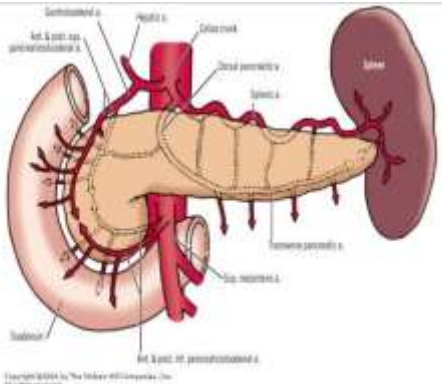
Frequency distribution of vascular supply of ampulla of Vater. (Modified from Stolla M, Wiesemer V, Schaffner D, Koch H. [Vascularization of the papilla vater and bleeding risk of papillotomy]. Leber Magen Darm 1980;10:293-302; with permission.)



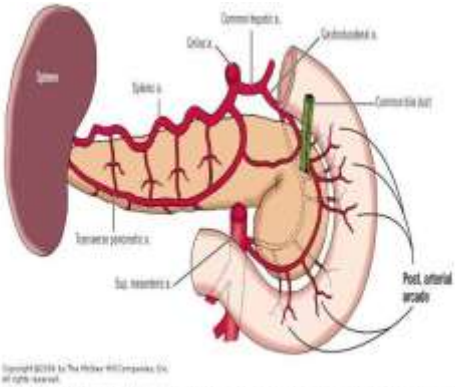
Schematic of papillary vascular blood supply. Posterior superior pancreaticoduodenal artery crosses bile duct and gives rise to dorsal and ventral branches. These join to form arterial plexus of papillae. (Modified from Stolla M, Wiesemer V, Schaffner D, Koch H. [Vascularization of the papilla vater and bleeding risk of papillotomy]. Leber Magen Darm 1980;10:293-302; with permission.)



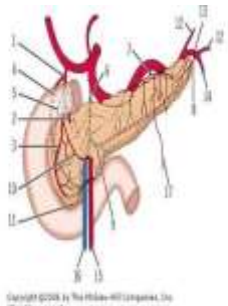
Four entities composing sphincter of Boyden. (Measurements from: White TT. Surgical anatomy of the pancreas. In: Carey LC (ed). The Pancreas. St. Louis: CV Mosby Co, 1972; drawing modified from Skandalakis JE, Gray SW, Rowe JE Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15(1):97-108; with permission.)



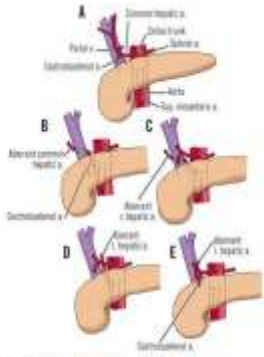
Major arterial supply to pancreas (anterior view). Left and right gastric arteries not shown. (Modified from Skandalakis JE, Gray SW, Rowe JE Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:97-108; with permission.)



Major arterial supply to pancreas (posterior view). Left and right gastric arteries not shown. (Modified from Skandalakis JE, Gray SW, Rowe JE Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:97-108; with permission.)



Arteries of the pancreas. 1, Gastroduodenal artery; 2, Right gastroepiploic artery; 3, Anterior pancreaticoduodenal arcade; 4, Posterior pancreaticoduodenal arcade; 5, Intermedian pancreaticoduodenal arcade; 6, artery for the neck; 7, Artery for the body; 8, arteries for the tail; 9, Transverse pancreatic artery; 10, Preparenchymatic arcades; 11, Branch for the uncinate process; 12, Superior and inferior splenic branch; 13, Splenic gastroepiploic trunk; 14, Left gastroepiploic artery; 15, Superior mesenteric artery; 16, Superior mesenteric vein; 17, Epiploic branch. (Modified from Van Damme JP, Van der Schueren G, Bonte J. Vascularisation du pancréas: Proposition de nomenclature PNA et angioarchitecture des îlots. C R Assoc Anat 1968; 139:1184-1192; with permission.)



Variations of hepatic arteries. **A**, Normal configuration. Common hepatic artery arises from celiac trunk. **B**, Aberrant common hepatic artery arises from superior mesenteric artery. **C**, Aberrant right hepatic artery arises from superior mesenteric artery. **D**, Aberrant left hepatic artery arises from superior mesenteric artery. **E**, Aberrant left hepatic artery arises from gastroduodenal artery. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-50; with permission.)

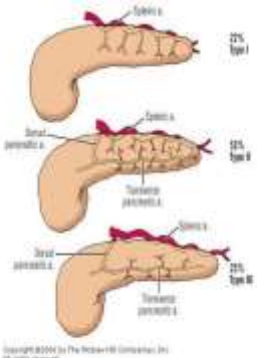
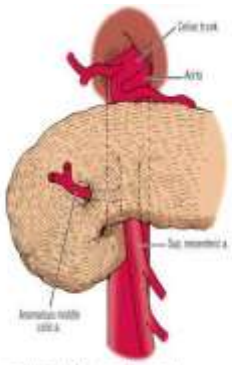
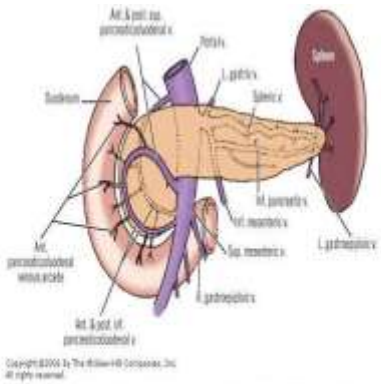


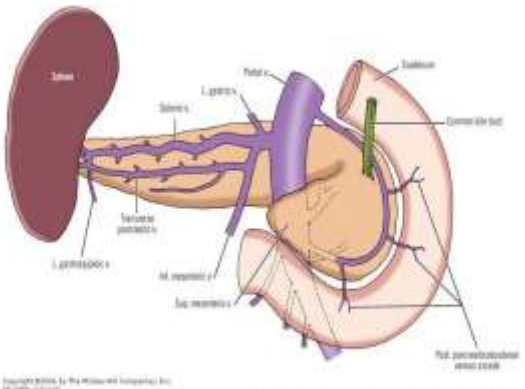
Diagram of possible configurations of blood supply to distal pancreas. Type I, Blood supply from splenic artery only. Type II, Blood supply from splenic and transverse (inferior) pancreatic arteries with anastomosis in tail of pancreas. Type III, Blood supply from splenic and transverse pancreatic arteries without distal anastomosis. This type is susceptible to infarction from emboli in transverse artery. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-50; with permission.)



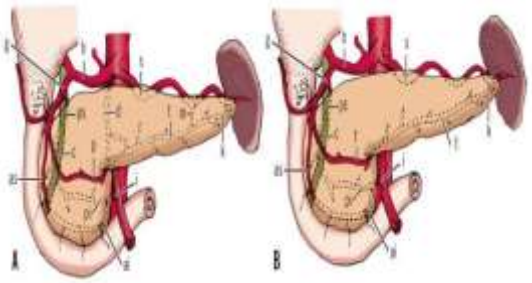
Anomalous middle colic artery passing through head of pancreas. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1978; 15:17-50; with permission.)



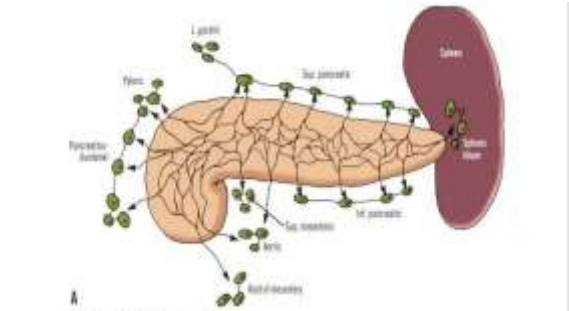
Venous drainage of pancreas (anterior view). (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15: 17-50; with permission.)



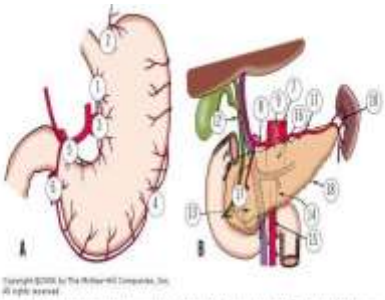
Venous drainage of pancreas (posterior view) and tributaries of hepatic portal vein. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-50; with permission.)



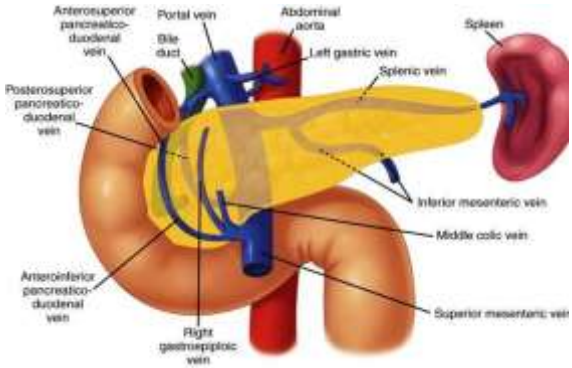
Most common patterns of pancreatic arterial blood supply. h, common hepatic artery; g, gastroduodenal artery; s, splenic artery; as, anterior superior pancreaticoduodenal (ASPD) artery; ps, posterior superior pancreaticoduodenal (PSPD) artery; pi, posterior inferior pancreaticoduodenal (PIPD) artery; ai, anterior inferior pancreaticoduodenal (AIPD) artery; d, dorsal pancreatic (DP) artery; p, prepancreatic arcade; t, transverse pancreatic (TP) artery ("short type" in A, "long type" in B); m, pancreatica magna (PM) artery; k, caudal pancreatic (CP) artery; c, cholecystic; i, inferior pancreaticoduodenal artery. (Courtesy Dr. Eugenio Bertelli.)



A, Highly diagrammatic theoretical presentation of possible lymphatic drainage of pancreas. Drainage to inferior margin of pancreas. B, Distribution of lymph nodes in 21 pancreatectomy resection specimens. Fraction in numerator indicates number of patients with metastases in that lymph node group. Denominator indicates number of patients in which lymph nodes in this group were examined. Stippled line, Whipple resection; SH, superior head; SB, superior body; IH, inferior head; IB, inferior body; APD, anterior pancreaticoduodenal; PPD, posterior pancreaticoduodenal; CBD, common bile duct; Pv, pylorus; LC, lesser curvature; GC, greater curvature; S, splenic; J, jejunum; Col, colon. (A, Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15(6):17-30; with permission. B, From Cubilla AL, Fitzgerald PJ. Cancer of the exocrine pancreas: the pathologic aspects. CA Cancer J Clin 1980;30(2):81; with permission.)

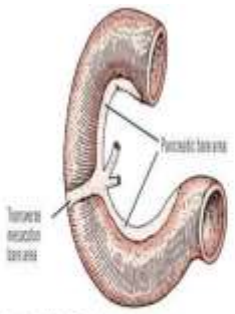


Nomenclature of (A) pericaval lymph nodes in patients with carcinoma of the head of the pancreas and (B) lymph nodes in carcinoma of the head of the pancreas region. 1, right cardiac lymph nodes; 2, left cardiac lymph nodes; 3, lesser curvature lymph nodes; 4, greater curvature lymph nodes; 5, suprapyloric lymph nodes; 6, infrapyloric lymph nodes; 7, lymph nodes around the left gastric artery; 8, lymph nodes around the common hepatic artery; 9, lymph nodes around the celiac trunk; 10, lymph nodes at the hilum of the spleen; 11, lymph nodes along the splenic artery; 12, lymph nodes of the hepatoduodenal ligament; 13, posterior pancreaticoduodenal lymph nodes; 14, lymph nodes around the superior mesenteric artery; 15, lymph nodes along the middle colic artery; 16, para-aortic lymph nodes; 17, anterior pancreaticoduodenal lymph nodes; 18, inferior pancreatic body lymph nodes. (Modified from Nakao A, Harada A, Konomi T, Kaneko T, Murakami H, Inoue S, Takeuchi Y, Takagi H. Lymph node metastases in carcinoma of the head of the pancreas region. Br J Surg 1993;80:399-402; with permission.)

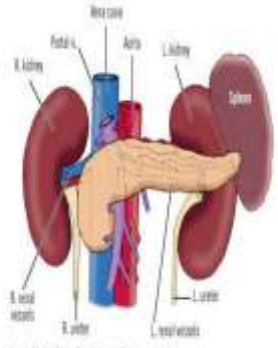


Venous drainage from the pancreas. The venous drainage of the pancreas follows a pattern similar to the arterial supply, with the veins usually superficial to the arteries. Anterior traction on the transverse colon can tear fragile branches along the inferior border of the pancreas, which then retract into the parenchyma of the pancreas. Venous branches draining the pancreatic head and uncinate process enter along the right lateral and posterior sides of the portal vein. There are usually no anterior venous tributaries, and a plane can usually be developed between the neck of the pancreas and the portal and superior mesenteric veins.

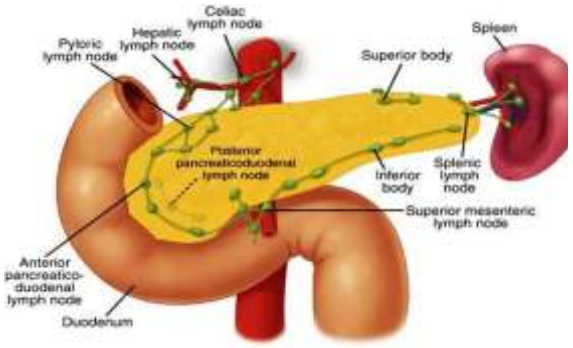
Anterior relationships. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-30; with permission.)



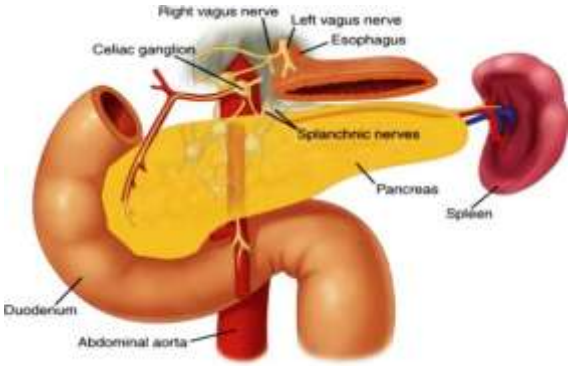
Bare areas of duodenum. Pancreas is in intimate contact with the duodenum along the concave surface. Attachment of transverse mesocolon produces an additional bare area. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-30; with permission.)



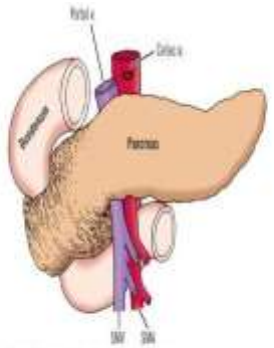
Posterior relationships of the pancreas. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15:17-30; with permission.)



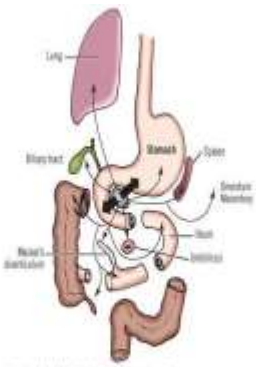
Lymphatic supply to the pancreas. The lymphatic drainage from the pancreas is diffuse and widespread, which explains the high incidence of lymph node metastases and local recurrence of pancreatic cancer. The pancreatic lymphatics also communicate with lymph nodes in the transverse mesocolon and mesentery of the proximal jejunum. Tumors in the body and tail of the pancreas are often unresectable because they metastasize to these lymph nodes.



Innervation of the pancreas. The pancreas has a rich supply of afferent sensory fibers that travel superiorly to the celiac ganglia. Interruption of these somatic fibers with a celiac plexus block can interfere with transmission of pancreatic pain.



Annular pancreas: duodenum under arrows is usually stenosed. SMV, superior mesenteric vein; SMA, superior mesenteric artery. (Modified from Skandalakis JE, Gray SW, Rowe JS Jr, Skandalakis LJ. Anatomical complications of pancreatic surgery. Contemp Surg 1979;15(5):17-30; with permission.)



Chief sites of Helicobacter pylori-related tissue. Fifty percent of these structures occur in the duodenum or pylorus. (Modified from Skandalakis JE, Gray SW. Embryology for Surgeons. 2nd ed. Baltimore: Williams & Wilkins, 1994; with permission.)