Concepts in Surgery of the Pancreas

88

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Surgical Anatomy

The pancreas lies in a relatively protected and inaccessible location in the upper abdomen. The head of the pancreas nestles in the C-loop of the duodenum, and the body and tail drape over the retroperitoneum, extending out toward the hilum of the spleen.

The pancreas has a rich and somewhat variable arterial blood supply. The head and neck are supplied by the anterior and posterior pancreaticoduodenal arches (which form anastomoses between the celiac and superior mesenteric circulations), and the neck, body, and tail are supplied by the greater pancreatic artery, the dorsal and inferior pancreatic arteries, and the artery to the tail of the pancreas.

Regional lymph nodes include the superior and inferior pancreaticoduodenal nodes; the celiac, hepatic, and superior mesenteric nodes; the superior pancreatic nodes (which drain the body and tail); and the splenic nodes.

The pancreas develops embryologically as dorsal and ventral anlages which fuse during development. The main pattern duct usually receives contributions from both the dorsal and ventral anlage, but variations abound. In the most common pattern, the ducts of the pancreas converge into the main pancreatic duct (of Wirsung) which drains into the duodenum through the major duodenal papilla (of Vater) in conjunction with the terminal portion of the bile duct. A second, smaller duct, the duct of Santorini, drains into a minor duodenal papilla cephalad to the major papilla. Annular pancreas is a common anomaly in which a complete ring of pancreatic tissue encircles the duodenum, usually causing duodenal obstruction early in life.

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Adequate exposure of the body and tail of pancreas requires wide entry into the lesser sac. This is best accomplished by opening the gastrocolic omentum and reflecting the stomach cephalad. To elevate the body and tail of the pancreas, incise the peritoneum along the inferior aspect of the pancreas. Expose the head and neck of the pancreas by first mobilizing the hepatic flexure of the colon and reflecting the right and transverse colon inferiorly. Perform a generous Kocher maneuver to elevate the duodenum and head of pancreas and palpate the head.

Trauma

Pancreatic injuries are uncommon because of the relatively sheltered position of the gland. Blunt trauma to the upper abdomen may result in pancreatic contusion or complete transection, most commonly at the point where the pancreas drapes over the vertebral column. Penetrating injuries to the pancreas are usually accompanied by injuries to overlying viscera and major vascular structures – stomach, duodenum, spleen colon, or small intestine.

During trauma laparotomy, explore any hematoma in Zone I (upper central) of the retroperitoneum (see Chap. 8). The AAST grading system for pancreatic injuries lists five grades, of which the first two (grade I and grade II) do not involve injury to the main pancreatic duct. These are best treated by drainage. Grade III injuries consist of distal transections and are generally managed by distal pancreatectomy, and this is probably the commonest resection performed for trauma.

Grade IV and V injuries are more complex proximal injuries. There may be accompanying duodenal trauma or injury to the common duct or liver. Bleeding is often a major problem, due to the rich blood supply of the pancreas and numerous arteries in the region. Pancreatoduodenectomy for trauma carries a high mortality and morbidity rate, but may be unavoidable. Consider the principles of damage control

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laparotomy; obtaining temporary hemostasis, control of bile and gastrointestinal leakage, and other temporizing maneuvers may allow resection to be done more safely at a second procedure when the patient is in better condition.

Chronic Pancreatitis

Diagnosis

The diagnosis of chronic pancreatitis depends on a combination of episodic or daily moderate to severe upper abdominal pain radiating to the back associated with structural or functional derangements in the pancreas. Such derangements distinguish this entity from recurring acute pancreatitis or from acute relapsing pancreatitis. The functional derangements are endocrine (diabetes) or exocrine (malabsorption).

Generally spiral CT scan will be performed as the initial diagnostic modality, followed by targeted studies designed to elucidate ductal anatomy. CT- or endoscopic ultrasound (EUS)-directed biopsies help exclude or confirm the presence of a carcinoma.

Secondary ductula**r** ectasia, changes seen only in the side branches of the main pancreatic duct, is the first sign of chronic pancreatitis. This is best demonstrated on ERCP. As the disease progresses, areas of stricture and dilatation are seen in the main pancreatic duct. Here MRCP and ERCP both demonstrate changes well. The degree of dilatation varies, in some cases resembling a cystic mass and in others being minimal. A mass effect is common and may reach the extreme of a mass in the head of the pancreas measuring 10 cm in diameter. The term dominant mass in the head of the pancreas is generally reserved for patients with a mass >5 cm in diameter. Parenchymal calcification occurs in approximately 60 % of patients with chronic pancreatitis.

Secondary narrowing of the terminal common bile duct may be found in 30–50 % of patients, accompanied by significant proximal ductal dilatation. Typically the alkaline phosphatase is markedly elevated but the bilirubin is normal. True obstructive jaundice is rare.

There is significant geographic variation in incidence and manifestations, and this must be kept in mind when reports from other parts of the world are evaluated. For example, a dominant mass associated with chronic pancreatitis appears to be far more common in middle Europe than in the United States, and hence, resectional therapy is more routine there. In another example, the variant of chronic pancreatitis with non-dilated ducts, the so-called small duct variant of chronic pancreatitis, appears to be more common in Great Britain, and resectional therapy predominates there. Dilated ducts with a variably significant mass and head of the pancreas appear to be more common in the United States. Thus, US reports tend to include more of a mix of drainage procedures and resectional therapy.

Pseudocysts are often associated with chronic pancreatitis. Adequate relief of pain generally requires that both the pseudocyst and the underlying chronic pancreatitis be addressed.

Treatment of Chronic Pancreatitis

The typical patient with chronic pancreatitis generally requires a period of intensive medical therapy before any consideration for surgery. Narcotic dependence is common and may be complicated by alcohol dependence or abuse which often causes the disease. Nutritional depletion is common owing to exocrine or endocrine failure or to severe postprandial pain. Supplementing with insulin or pancreatic enzymes is a significant first step.

Two kinds of abdominal pain are commonly seen with this disease. Unrelenting abdominal pain may occur daily, requiring chronic narcotic use. Episodes of exacerbation of pain unassociated with enzyme elevations or other signs may nonetheless be mistaken for an episode of acute pancreatitis. Some patients have daily pain without exacerbations, many have both, and certain patients have intermittent attacks only.

Octreotide (the somatostatin analog), anticholinergic medications, and oral enzyme supplementation have all been used for pain relief in the past. Results have been mixed at best. Endoscopic stenting is being investigated; it appears to provide temporary relief in some patients and may be predictive of results after operative decompression.

The indications for surgery are severe, unrelenting abdominal pain, in most cases resulting in narcotic dependence. The need for intermittent hospitalization is another important indicator supporting the use of invasive, potentially lethal treatments. It is generally advised that patients be weaned from narcotics before surgery.

Choice of Operation

In general terms the operative procedures for chronic pancreatitis include resection, drainage or decompression, and nerve ablation. The primary goal of each of these operative procedures is pain relief. Pancreaticoduodenectomy, typically performed as pylorus-preserving resection of the pancreatic head, is the classic resection. Indications for pancreaticoduodenectomy are the symptoms previously described combined with a dominant mass in the head of the pancreas. Resection is further indicated in any patient in whom there remains the suspicion of malignancy based on imaging studies or the relatively inaccurate CA 19-9 tumor marker. Resection is also considered reasonable after failure of a previous drainage procedure and is advocated in patients with a so-called small duct variance of chronic pancreatitis. A variation of the classic Whipple resection known as the duodenum-preserving pancreatic head resection has been devised. The specific advantages suggested for duodenum

preservation include enhanced nutritional status and better gastric emptying. The body of the pancreas is divided in a manner similar to that for the Whipple resection, and pancreatic tissue is excavated from the C-loop of the duodenum, preserving the floor of this dissection plane and leaving a small remnant of pancreas along the edges of the duodenum. Reconstruction is performed by placing a Roux limb of jejunum over the excavated head of the pancreas and similarly into the remnant of the body and tail of the pancreas after it has been divided.

This innovation forms the basis for a number of modifications that appear to be intermediary between drainage procedures and resections. They include the so-called Frey procedure, in which more limited excavation of the head of the pancreas is combined with longitudinal drainage of the main pancreatic duct. No division of the body of the pancreas is performed during this procedure. After Frey's original description many have explored the effectiveness of the procedure, and the results have been favorable. The indications for this modification include a dilated main pancreatic duct throughout the gland associated with the mass and the head of the pancreas. A more recent innovation by Izbicki focuses on small duct disease treated with a V-shaped excavation along the body of the pancreas down to the main pancreatic duct. The concept behind this procedure is to extract the inflammatory tissue surrounding the duct and create an operative equivalent of a Puestow-type drainage procedure. Unfortunately, the only data available regarding this procedure are those developed by Izbicki, who reported a high level of persistent pain relief after this procedure with apparent preservation of function. One important precept of surgery for chronic pancreatitis is that preservation of the pancreatic parenchyma is a goal, and all efforts to preserve function while providing adequate pain relief are desirable. Near-total or 95 % pancreatectomy is almost never utilized, and we have no enthusiasm for this procedure.

Drainage Procedures

When the main pancreatic duct is dilated, a drainage procedure should be considered. The classic drainage procedure is the Puestow procedure. It was developed as a modification of the Duval procedure: resection of the tail of the pancreas and Roux-en-Y jejunal drainage of the distal duct. Puestow modified the Duval procedure by combining resection of the tail of the pancreas with a longitudinal incision along the main pancreatic duct. This procedure has been evaluated extensively in clinical series and achieves 85–95 % clearance of pain.

The Puestow procedure provides persistent relief of pain while preserving parenchyma. The mortality and morbidity associated with this procedure are considerably lower than that associated with major pancreatic resections. The underlying disease will, however, continue to progress (although progression may be slowed by ductal decompression).

Successful outcomes after a Puestow procedure appear to be limited to ducts >6 mm in diameter. The diameter of a normal pancreatic duct is 2–3 mm. Ducts that have been less dilated have been associated with less success in pain relief. It is conceivable that the rate improves when the modification previously described by Izbicki is used.

Biliary Decompression

Biliary stenosis and dilatation occur in 30–50 % of patients with chronic pancreatitis. The problems vary from an obvious narrowing seen by an imaging study with normal blood chemistries to a massively dilated common bile duct associated with significant elevations in the serum alkaline phosphatase levels (often above 1,000 U/dl). Because the narrow area of the common bile duct is elongated, extending well beyond the wall of the duodenum, neither sphincterotomy nor long-term stenting is generally useful. There is some concern that prolonged obstruction of the bile duct results in ongoing fibrosis of the liver and finally leads to biliary cirrhosis. We generally reserve consideration of a simultaneous biliary drainage procedure for patients with significant dilatation of the common bile duct (>10 mm in diameter) associated with a chronically elevated alkaline phosphatase level (>400 U/dl). Although the purported advantage of biliary bypass is protecting the patient from biliary cirrhosis, the risk of developing biliary cirrhosis in this setting is not known. It is possible that some additional pain relief may result from adequate biliary decompression.

Nerve Ablation

Nerve ablation, most commonly performed percutaneously under CT or ultrasound guidance, may be successful in some patients.

Adenocarcinoma of the Pancreas

Diagnosis

The standard description of a patient above the age of 55 with a complaint of "painless jaundice" belies the significant pain that develops as carcinoma of the pancreas progresses. The presence or absence of pain should never be used to eliminate this diagnosis. Early symptoms consist of dyspepsia and weight loss, often without jaundice. Recognition of jaundice frequently triggers an imaging workup with ultrasound or CT.

Imaging

Spiral CT scanners can now clearly define the boundaries of a carcinoma in the midst of the otherwise enlarged head of the pancreas. This single development has greatly enhanced

our ability to define exact sizes of tumors preoperatively and greatly facilitates CT-directed fine-needle and core biopsies of a pancreatic cancer, which may be necessary prior to operation. Thus, even though a patient may have had a conventional CT scan before coming to the surgeon, it is advised that a multidetector spiral CT scan be obtained to provide additional and more precise information regarding the tumor. A specific protocol with thin slices taken through the pancreas at specific times after injection of contrast (pancreatic arterial and portal venous phases) should be ordered.

Endoscopic ultrasonography (EUS) allows identification and biopsy of lymph nodes and pancreatic masses in sufficient proximity to the probe. Identification of vascular structures, particularly the superior mesenteric artery and the splenic vein, portal vein, and superior mesenteric vein, is excellent with EUS. Clear planes between structures can normally be identified; hence, invasion into the walls of any of these structures is clearly delineated. All layers of the intestinal wall can be demarcated, and any invasion into one of these layers identified. The one limitation worth mentioning with EUS is failure to evaluate the liver fully. The decision regarding resectability of the carcinoma of the pancreas depends on a number of issues, but clearly hepatic metastasis is an important one. Thus, in the absence of another form of imaging, the EUS is unlikely to give a full evaluation of resectability.

Mesenteric arteriography, routinely used in the past to evaluate vascular involvement, has been abandoned by most experienced pancreatic surgeons in favor of less invasive methods. The spiral CT scan shows the vascular anatomy clearly and is now established as the more appropriate imaging technique for evaluating the resectability of carcinoma of the pancreas.

Magnetic resonance imaging (MRI) and *magnetic resonance cholangiopancreatography* (MRCP) are related technologies. Clear anatomic features of the main pancreatic duct (MPD) and the common bile duct (CBD) allow stones and tumors to be easily defined with MRCP. Vascular anatomy can be delineated with *MR angiography* (MRA). If the signal weighting is altered, an adequate view of the liver and of peripancreatic lymph nodes can be obtained. These studies can be obtained quickly and noninvasively. Although no data have yet been developed to establish its superiority, one might argue that this procedure is capable of defining all of the necessary features to establish both diagnosis and resectability. If one flaw exists regarding this modality, it is that the fine anatomy of the MPD and the CBD may be less clear than that obtainable with EUS or endoscopic retrograde cholangiopancreatography (ERCP). Finally, specialized MR studies are not yet universally available.

Endoscopic retrograde cholangiopancreatography is currently used selectively in these patients. Because the lesion originates in the ducts, it should not be surprising that 94–96 % of patients with this diagnosis have an abnormal pancreatogram. If preoperative biliary drainage is desired, ERCP can help accomplish it. Unfortunately, there are no data to suggest the therapeutic value of this strategy. In some regards, stent placement may be unavoidable if ERCP is performed. During ERCP the instrument traverses the (contaminated) intestinal tract before injecting contrast into an obstructed bile duct, placing the patient immediately at risk for cholangitis. Once this entity is recognized, the endoscopist has no choice but to place a stent to prevent the development of cholangitis. We believe that ERCP, if used at all, should be implemented within 24 h of operation, so any information that helps with the diagnosis is obtained when the risk of sepsis is extremely low. The procedure is of potential value in patients in whom the diagnosis is equivocal or if choledocholithiasis is suspected, as choledocholithiasis can be diagnosed and treated by ERCP by simply adding endoscopic sphincterotomy and stone extraction.

Percutaneous transhepatic cholangiography (PTC) may establish a diagnosis and an access point for biliary decompression but is rarely used in current practice. When obstructive jaundice is diagnosed by PTC, a transhepatic stent must be placed to avoid bile leak and bile peritonitis.

Finally, it should be stressed that for an experienced pancreatic surgeon, *tissue documentation of the diagnosis of pancreatic carcinoma is not considered mandatory*. In major centers as many as half of the resections in these patients are performed without the benefit of tissue confirmation. This should not convey the message that pancreaticoduodenectomy is an operation undertaken lightly. A mass in the head of the pancreas, obstructive jaundice, weight loss, and nonspecific dyspeptic symptoms in a patient over the age of 55 form a constellation of signs and symptoms highly suspicious for the diagnosis of carcinoma of the pancreas.

Preoperative biopsies are required in patients who are enlisted for *neoadjuvant chemoradiation* in an attempt to increase resectability. Patients undergo 8–12 weeks of therapy before operation. The diagnosis must be confirmed by fine-needle aspiration or core biopsy under CT or EUS guidance before initiating therapy. Because of the delay prior to operative therapy, patients enlisted in this program also routinely undergo biliary decompression. Thus, patients enlisted in neoadjuvant chemoradiation require two treatment modalities not routinely used when operation is performed first.

Determination of Resectability

Many of the same modalities used for diagnosis can also be employed to determine resectability. Three categories of factors determine resectability: local invasion of the tumor into contiguous structures that should be preserved (e.g., vascular structures), tumor spread in the abdomen to sites remote

from the primary tumor, and hepatic metastasis. Each is discussed separately.

Vascular Invasion

Invasion, encasement, or obliteration of the superior mesenteric artery or the celiac trunk precludes resection. Invasion into the portal vein or the superior mesenteric vein/splenic vein confluence may or may not represent an unresectable lesion because resection and reconstruction of the portal vein is an established modality. A segmental resection of part of the circumference of the vein with a patch graft or complete vein resection can be performed. These operative procedures are longer in duration than conventional pancreaticoduodenectomy, and blood loss is higher. Survival appears to be considerably better with segmental resection and the patch graft than with complete resection of the vein, possibly reflecting the extent of invasion required to proceed to complete vein resection versus a simple patch graft. As previously mentioned, vascular invasion may be judged by spiral CT, MRA, or EUS.

Tumor Extension Remote from the Primary Tumor

Local extension may be paraaortic disease, extension into the colon or stomach, or carcinomatosis. Spiral CT, EUS, MRI, or laparoscopy may define this entity, but often it is established only at laparotomy.

Hepatic Metastasis

Spiral CT scan and MRI may be helpful for detecting hepatic metastases; ERCP and PTC are not. *Transabdominal ultrasonography* sometimes demonstrates hepatic metastases more clearly than routine spiral CT. Portal-enhanced CT scans may more clearly delineate hepatic metastases, but do not provide additional information about the pancreas.

Resectability may be further evaluated intraoperatively. Preliminary minilaparotomy or laparoscopy, with washings for cytology and/or the use of ultrasound, may identify spread beyond the projected operative field. In these cases, nonoperative palliative methods may be applied.

Treatment

Neoadjuvant Chemoradiation

Neoadjuvant chemoradiation protocols may be employed in an attempt to downstage tumors and improve resection rates and, ultimately, long-term outcomes.

Operative Management

Surgical resection provides the only hope for cure of this disease. Most patients are treated with a *pylorus-preserving pancreaticoduodenectomy*. A number of important margins are considered in this resection. As a routine, the bile duct is divided above the cystic duct entry, and the common hepatic duct is a margin, which is sent for frozen section analysis. The body of the pancreas is typically divided at or slightly to the left of the area that overlies the portal vein and the superior mesentery vein/splenic vein confluence. The duodenum is divided just past the pylorus. Each of these margins should be sent for frozen section pathologic analysis during the operative procedure; a report of positive margins is an indication for further resection. Perhaps the most problematic margin is that at the uncinate process as it abuts the superior mesenteric artery. This and the radial margin of the uncinate process extending down into the retroperitoneum are commonly found to be unexpectedly involved in tumor at final pathology. In some regards, these margins are not correctable because we would not consider resecting the superior mesenteric artery, and a deeper dissection into the retroperitoneum is not considered reasonable because of the proximity of the vena cava and the aorta.

Total pancreatectomy has been proposed to treat cancer of the pancreas. It appears to be a rare patient whose lesion is considered resectable yet requires total pancreatectomy. In most cases resection of the body and tail with a distal pancreatectomy or resection of the head and body with a pancreaticoduodenectomy is sufficient to achieve cure. There are no data to suggest that total pancreatectomy enhances survival. Multicentricity of carcinoma of the pancreas is rarely described.

Essentially all pancreatic surgeons agree that a *truncal vagotomy is not necessary* after pancreaticoduodenectomy. As many as 65 % of patients complain of delayed gastric emptying early after Whipple resection, a concern that dictates omitting vagotomy, which might potentiate the problem. It was hoped that this complication would be less common when the pylorus is preserved. Unfortunately, pylorus-preserving pancreatic head resection is still associated with a reasonable rate of delayed gastric emptying. Some surgeons routinely employ a prokinetic agent during the immediate postoperative period after this procedure. Fortunately, long-term delayed gastric emptying is reported far less frequently. Pharmacologic acid suppression may be necessary.

Islet Cell Tumors

Islet cell tumors, which are rare, are well known to be diagnostically elusive. Their clinical presentation may be subtle, and localization of the tumor once the endocrinopathy has been defined is even more challenging. A number of modalities are utilized. Ultrasonography or spiral CT scans comprise a good initial approach. As with other potentially

malignant lesions of the pancreas, ultrasonography is more effective for evaluating the liver for metastatic lesions, and spiral CT scanning is much more effective for evaluating the pancreas. Unfortunately, neither of these modalities is typically associated with significant success. Selective venous sampling (portal and splenic veins and venous tributaries from the pancreas), sometimes combined with the use of secretagogues such as secretin, has been used in the past with varying success.

The innovation of a radioisotope scan using *octreotide* as the marker has had some success for detecting all known islet cell tumors. It has been known for years that immunocytochemistry evaluation of islet cell tumors routinely yields the presence of various other islet cell products in addition to the primary one associated with the endocrinopathy in individual patients. In other words, a patient with an insulinoma is likely to have somatostatin and possibly glucagon or gastrin in the islets present within the insulinoma. In view of the added specificity of octreotide scanning, it is most recommend that it be performed early in the diagnostic workup of patients with suspected islet cell tumors.

The role of EUS and of laparoscopic ultrasonography remains uncertain. These modalities may reveal lesions not found using conventional imaging techniques. An advantage for both procedures is their ability to access the duodenal wall, which is the most common site of extrapancreatic gastrinoma.

Once diagnosed, the problem of intraoperative localization remains. *Intraoperative ultrasonography* plays a major role. The so-called gastrinoma triangle is bounded by a vertical line drawn between the pylorus and the third portion of the duodenum. The apex of the triangle is the hilum of the liver, which is a reasonable starting point for assessing the possible locations of this entity. For all other islet cell tumors, the primary site is almost always within the pancreatic parenchyma. In this regard, we simply advise careful evaluation of the uncinate process and the inferior border of the pancreas as the superior mesenteric vein progresses underneath it. Each of these sites is somewhat remote until adequate dissection has been performed.

Where possible, perform enucleation. If there is any evidence of extension beyond the capsule or if lymph node involvement (and certainly hepatic involvement) is evident, the tumor may be malignant, and thus, a more extensive resection may be required. It is important to realize that gastrinoma metastatic to the liver may be present in a patient for decades. A formal resection may also be required when the lesion is strongly suspected to be in a particular lesion but cannot be easily defined in the operating room. One exception to the operative approach to islet cell tumors is when a gastrinoma is associated with multiple endocrine neoplasia type I. These patients have multiple sites of gastrinoma, and it is the general consensus that complete resection of each of these multiple lesions is unreasonable.

Cystic Lesions of the Pancreas

Pseudocysts of the pancreas occur with both acute and chronic pancreatitis. Pseudocysts seen in association with acute pancreatitis will generally resolve. Those seen with chronic pancreatitis rarely do so and may require drainage.

In general, the choices include operative decompression of a cyst, percutaneous decompression of the cyst by interventional radiologists, and endoscopic transluminal decompression of a pseudocyst or endoscopic endoluminal transpapillary decompression of the cyst by placing a stent in the main pancreatic duct. Long-term success rates for percutaneous endoscopic and endoluminal decompression have been approximately 70 %. These data are comparable to the known operative success rates for external drainage of pseudocysts established decades ago, which typically were about 70 % as well. Although some endoscopic and some interventional studies have reported slightly higher success rates, long-term follow-up has been scant.

Infectious complications have been common after percutaneous or endoscopic drainage procedures. This is not altogether surprising, as many cysts contain solid or semisolid material that is unlikely to be adequately drained through passive drainage with relatively small catheters. It poses a risk for secondary infection after being exposed to microorganisms via drainage tubes.

The options for providing operative drainage include cystogastrostomy and Roux-en-Y cyst jejunostomy. Resection of the pancreatic pseudocyst is also an option and is generally reserved for cysts in the body and tail of the pancreas. Always obtain an intraoperative frozen section biopsy specimen of the wall of the cyst to rule out the presence of a cystic neoplasm.

With regard to *cystic neoplasms*, the presence of a cystadenoma in a cyst surrounding the pancreas has been recognized as a possibility for decades. More recently, the important distinction between serous and mucinous adenomas has been established. Serous cystadenomas are rarely malignant, but mucinous cystadenomas are considered to be premalignant or may be frankly malignant. Thus, patients with recognized mucinous cystadenomas are candidates for resection at all times.

Preoperative establishment of this diagnosis depends on a number of features. It is possible to aspirate fluid and measure mucin levels in the fluid. In addition, several investigators have suggested measuring tumor markers including carcinoembryonic antigen (CEA), CA 19-9, and pancreatitis-associated peptide (PAP). The presence of mucin is confirmatory, but the markers are not. Cytology may also be undertaken, and some studies have looked at CA 72-4 in cyst fluid levels. They concluded that pancreatic cysts with high serum CA 19-9 levels, positive cytology, or high CA 72-4 levels in the fluid should be considered for resection.

Intraductal papillary mucinous neoplasm (*IPMN*) *of the pancreas* and the related cystic papillary neoplasms are uncommon. Up to 50 % of resected IPMN specimens may have an associated invasive carcinoma at diagnosis, and both carcinoma in situ and dysplastic changes are common. The head and uncinate process are commonly involved. Diagnosis is suspected when copious mucus is seen exuding from the pancreatic duct at ERCP. Resection is indicated; total pancreatectomy is rarely employed even though the disease may extend along the duct, due to the morbidity inherent in this procedure.

Complications of Pancreatic Surgery

Any pancreatic resection carries an associated risk of *pancreatic fistula*. In the past, this complication was considered to be the cause of the high mortality rate associated with these resections. Pancreaticoduodenectomy adds the risk of bile and gastrointestinal anastomotic leakage. Because of the rich vascular anatomy in the area of the head of the pancreas, *major bleeding* can also occur. Somewhat less recognized are the *vascular accidents* seen with this procedure. The dissection planes include the superior mesenteric vein, portal vein, common hepatic artery, and superior mesenteric artery. In a worst-case scenario, it is possible to interrupt completely the vascular supply to the liver (portal vein and hepatic artery) or the vascular supply or venous drainage to the intestine (superior mesenteric artery and portal vein). Thus, necrosis of the liver and necrosis of intestine are known risks of this procedure.

Most pancreatic surgeons now place closed-suction drainage in the area of the pancreaticojejunostomy and the hepaticojejunostomy. Some believe this practice is responsible for the higher rate of reported pancreatic fistula than was seen in the past. This might be viewed with alarm were it not for the fact that the overall mortality for this procedure has now reached well below 5 % and in capable hands may be 2–3 %. In this regard, there appears to be conflicting data for the high rates of pancreatic fistula and low mortality rates. Most believe that the correlation of pancreatic fistula to mortality in the past was related to the coexistence of abdominal sepsis. Pancreatic fistulas are far more common when the texture of the pancreas is essentially normal and soft (as in resection for trauma); it is consequently poorly prepared to hold a stitch. With chronic pancreatitis or pancreatic carcinoma, the parenchyma is firm and holds sutures quite well. Technical faults may account for some of these fistulas. It should be stressed that a well-drained pancreatic fistula in most series is a relatively harmless complication, and spontaneous closure of such fistulas can be anticipated in more than 98 % of patients.

Bile fistula may be more lethal than pancreatic fistula. Controlled bile fistula should be a fairly benign event when managed with closed-suction drainage. Spontaneous closure again should be anticipated in more than 98 % of patients. An uncontrolled bile fistula, however, can result in bile peritonitis, and sepsis and may represent an extremely morbid complication.

Dehiscence of the gastrointestinal anastomoses represents the least frequent of all complications. Prevent this problem by following the normal precepts of intestinal anastomotic technique.

Prevention of *vascular accidents* depends entirely on recognition of these structures, particularly the hepatic artery and the superior mesenteric artery. Each of these vessels may be unintentionally ligated. For that reason clear dissection of these structures is recommended. Unfortunately, superior mesenteric vein and portal vein injuries may occur simply because of dense adhesion to these structures due to chronic pancreatitis or to invasion of these structures by carcinoma.

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