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Gut

Leading article

Pancreatic sphincterotomy and sphincteroplasty

History and definitions

In 1681 Glisson described a sphincter at the end of the common bile duct, which allowed bile to flow intermittently into the duodenum.[1] Exactly 200 years later, Oddi portrayed the sphincteric mechanism in greater detail,[2] but it was not until 1957 that Boyden unravelled the complexity of the anatomical sphincter surrounding the terminus of the common bile duct and pancreatic duct.[3] Although the surrounding duodenal musculature can compress the distal end of both ducts, there is a more important sphincter that acts independently. Boyden showed a submucosal muscular sheath which surrounds the intramural portion of both ducts, and the two ducts are separated by a thin veil of tissue, the septum.

Clinical application of this knowledge began in 1956 when Doubilet and Mulholland published the results of biliary sphincterotomy for recurrent pancreatitis, which they thought resulted from reflux of bile into the pancreatic duct.[4] Believing that outflow obstruction was more important than reflux, Bartlett and Nardi[5] extended the operation by dividing the common septum between the terminal bile duct and pancreatic duct, thereby achieving a pancreatic sphincterotomy in addition. Subsequently, Moody and colleagues actually excised this common septum (transampullary septectomy or extended papilloplasty) in 92 patients with disabling post cholecystectomy pain, 85 of whom were found to have stenosis of the origin of the duct of Wirsung.[6,7] We have recently undertaken a modified pancreatic sphincteroplasty in a small series of patients with pancreatic or papillary disease.[8] The first endoscopic cannulation of the papillar of Vater by McCune in 1968 opened a new era in the diagnostic approach to pancreatobiliary disorders.[9] Six years later this purely diagnostic technique was adapted to become a therapeutic modality by the introduction of endoscopic biliary sphincterotomy,[10] followed by other treatment modalities including pancreatic sphincterotomy.[11]

The term 'sphincterotomy' means division of the mucosa and underlying sphincter mechanism, a procedure that can now be achieved either endoscopically or by transduodenal surgery. 'Sphincteroplasty' indicates mucosa-to-mucosa suture, either duodenum to bile duct alone (biliary sphincteroplasty) or bile duct to pancreatic duct in addition (pancreatic sphincteroplasty). Both procedures produce permanent destruction of the sphincter mechanism. Sphincteroplasty offers the theoretical advantage of preventing restenosis, but at present it can only be achieved by an open operation of some technical complexity. This paper reviews the indications for division of the pancreatic sphincter, both at the major and minor papilla, and the endoscopic and surgical means by which this can be accomplished.

Indications

POSTCHOLECYSTECTOMY PAIN

Persistence or recurrence of symptoms after cholecystectomy is common but sometimes difficult to evaluate and treat. Extrapapillary disease must be excluded by thorough investigation of the alimentary, hepatopancreatobiliary and urinary tracts. The contributions of emotional overlay and of alcohol and analgesic abuse may need to be disentangled. Thus selection of the small number of patients who will benefit from pancreatic sphincteroplasty is not straightforward, and the operation should probably be reserved for those with papillary stenosis involving the pancreatic ductal orifice. Even then, lasting benefit cannot be guaranteed.[7-12] Three tests can help to confirm organic papillary disease, though their precise role remains to be established.

Endoscopic retrograde cholangiopancreatography and manometry

Endoscopic retrograde cholangiopancreatography (ERCP) is an important part of the investigation of patients with upper abdominal pain of biliary or pancreatic distribution. Repeated failure by an experienced endoscopist to cannulate either the bile duct or the pancreatic duct may be a clue to anatomical abnormality. Likewise, delayed clearance of contrast from either ductal system or reproduction of typical pain during ERCP may also indicate outflow obstruction. Although ERCP alone is not accurate in predicting the results of pancreatic sphincteroplasty,[12,13] coincident manometry can provide additional information. Manometric pressure measurements are recorded within the sphincter of Oddi, common bile duct, pancreatic duct and duodenum. The examination requires a cooperative patient and a skilful endoscopist, who can pass a soft manometry catheter through the papilla into the common bile duct and pancreatic duct, manipulate the catheter parallel with the axis of the appropriate duct and maintain a stable position during the recording period. As experience increases, a few centres are now reporting success rates of 70–100% in measuring pancreatic sphincter pressure.[14-16] The predictive value of ERCP manometry remains unproved, but accurate pressure recordings across the sphincter should provide logical criteria on which to base the decision to operate.

Morphine-prostigmine (Nardi) evocative test

This test consists of an intramuscular injection of 10 mg morphine plus 1 mg prostigmine (neostigmine). Serum amylase (and lipase) are measured both before and (hourly) for four hours after the injection. The test is considered positive if the injection reproduces pain and causes a four-fold increase in serum enzyme concentrations. In our limited experience the test has been helpful in predicting a satisfactory outcome from pancreatic sphincteroplasty in patients with postcholecystectomy pain, and the operation certainly abolishes the enzyme response to morphine-prostigmine.[8] The test can be positive in patients without pancreatobiliary disease, however, and Moody found it a poor predictor of outcome after ablation of the sphincter.[12]

Secretin stimulation during pancreatic ultrasonography

Another product of the Massachusetts General Hospital is the secretin stimulation test, which can be used for patients with suspected papillary stenosis. According to Warshaw and colleagues, the test is positive if there is prolonged dilatation of the pancreatic duct for 15–30 minutes after intravenous administration of secretin (1 mg/kg).[17] The pancreatic duct dilated up in 10 of 12 symptomatic patients who were later found to have a stenotic sphincter but in none of 10 patients without operative evidence of stenosis. A positive test predicted a good result from surgical sphincteroplasty (in 90% of patients) and, like the Nardi test, the operation subsequently rendered the test negative.[17] It can be difficult to identify a normal size pancreatic duct by ultrasound, but modern computed tomography scanners could offer an alternative means of conducting the test.

RECURRENT ACUTE PANCREATITIS

In younger patients who do not abuse alcohol, recurrent attacks of acute pancreatitis require active investigation to seek underlying causes such as occult gall stones and metabolic disorders (hyperlipidaemia, hypercalcaemia). Stenosis may be encountered at either the major or the minor papilla, especially in patients with anatomical variants of the pancreatic ductal tree. Classical pancreas divisum with separate dorsal and ventral ducts is the most common variant. It occurs in approximately 5% of population,[18,19] but the incidence increases to 10–25% among patients with unexplained recurrent pancreatitis.[19,20] Less common anomalies include incomplete pancreas divisum, in which the communication between dorsal and ventral ducts is tiny and functionally inadequate, and a variation in which only the dorsal duct system is found, the ventral duct having probably regressed. Major papillary stenosis can cause recurrent acute pancreatitis, whether the ductal pattern is normal[5,8] or there is pancreas divisum.[21] Sphincteroplasty of the main pancreatic duct prevented recurrent attacks of acute pancreatitis in five of our patients with a normal disposition of ducts but probable papillitis at a median follow up of 18 months.[8]

To develop pancreatitis, patients with pancreas divisum must probably also have minor papillary stenosis, so that the bulk of exocrine secretion is forced to flow through a site of partial obstruction. Under these circumstances accessory pancreatic sphincteroplasty can prevent further attacks of acute pancreatitis, and we have successfully treated five such patients. Warshaw's 100 patients with 'dominant dorsal duct syndrome' includes 71 with classical pancreas divisum, 23 with only a dorsal duct and six with a filamentous connection between the two ducts. Forty nine had recurrent acute pancreatitis, while 51 had chronic pain alone. Among 88 patients undergoing accessory pancreatic sphincteroplasty, the operation was 85% successful, as assessed by the absence of further attacks of pancreatitis or pain and freedom from narcotic usage, if the accessory papilla was stenotic; in the absence of stenosis the operation was only 27% successful.[22]

There was a close correlation between the result of an ultrasound secretin test and a successful postoperative result in Warshaw's patients with recurrent pancreatitis:[17,22] 90% of those with a positive test were improved, whereas 60–70% of those with a negative test had a poor result. ERCP manometry may also be useful in identifying a subgroup of patients with clear cut sphincter dysfunction, affecting either the major part of the sphincter of Oddi (ampullary sphincter) or the pancreatic sphincter or both. Most patients with raised basal pressures will benefit from endoscopic or surgical ablation of the sphincter.[16] An endoscopic stent was placed recently across the major papilla in 15 patients with recurrent pancreatitis with or without raised basal pressures. There was one technical failure, but only eight of the other 14 patients (57%) were improved.[23] Better results were obtained among 31 patients with pancreatitis and pancreas divisum who received an endoprosthesis into the dorsal pancreatic duct:[24] 92% were improved, though 26 patients subsequently required pancreatic surgery (either accessory sphincteroplasty or resection) for recurrent symptoms. Those who improved with endoscopic drainage had better postoperative results than those who did not.

If preoperative stenting of the pancreatic duct can help select patients with recurrent pancreatitis for operation, the Nardi test is less reliable in this group[20] and may even be dangerous. A single experience of necrotising pancreatitis in a patient with a slight rise in basal serum amylase had led us to avoid stimulating the pancreas in such circumstances and to terminate the test with atropine if severe pain develops.[25] Our present policy is to recommend exploratory laparotomy in nearly all patients with repeated attacks of 'idiopathic' acute pancreatitis. Tiny gall stones and/or cholesterosis of the gall bladder may be missed by any other technique. If the gall bladder is healthy we usually proceed to double sphincteroplasty (biliary and pancreatic) when the pancreatic ductal system is normally disposed or to accessory pancreatic sphincteroplasty if there is pancreas divisum. The full disposition of the pancreatic ductal tree should be delineated by on-table pancreatography[26] if ERCP was incomplete.

CHRONIC PANCREATITIS

Chronic pancreatitis is an uncommon indication for pancreatic sphincteroplasty. Indeed in severe disease it has little or no role. In a few patients with mild disease and an apparent stenosis of the pancreatic duct adjacent to the papilla, pancreatic sphincteroplasty may be beneficial.[8,27] Some patients with unequivocal chronic pancreatitis have symptoms dominated by recurrent pain and raised serum amylase, and in these a timely sphincteroplasty might relieve pain and prevent progressive fibrosis. In those with alcohol related disease, however, abstinence is likely to be much better as prophylaxis than surgery. There is increasing interest in managing selected patients with endoscopic techniques, including pancreatic sphincterotomy, stenting of the duct and calculus extraction.[28–31] Although good results are claimed, these manoeuvres seem unlikely to achieve anything other than temporary success in patients with established chronic pancreatitis.

Techniques and results

MAJOR PAPILLARY SPHINCTER

Interruption of the pancreatic sphincter mechanism can be achieved by either an endoscopic or a surgical approach. Endoscopic sphincterotomy of the pancreatic duct (endoscopic septotomy) is usually performed together with biliary

sphincterotomy by dividing the common septum, using a short sphincterotome, a pre-cut papillotome or a needle knife papillotome.[28 29] The orifice of the pancreatic duct is cut at 2 o'clock for a length of about 5 mm. Alternatively, the pancreatic orifice may be enlarged by dilatation, using dilating catheters and/or balloons.[32] In experienced hands, the success rate of endoscopic pancreatic sphincterotomy approaches 90%, but good long term results only ensue in half the patients,[29] presumably because of restenosis. A surgical approach may therefore be preferred, although a delicate technique is required. The operation begins with transduodenal biliary sphincteroplasty. The common septum between the terminal portions of the bile duct and pancreatic duct is then incised for 10–15 mm and the mucosae are approximated by using fine absorbable sutures. We generally perform retrograde on-table pancreatography to evaluate the pancreatic ductal system,[26] and cover the procedure with an intravenous injection of aprotinin (Trasylol®, 10^6 units) to minimise postoperative pancreatitis. Long term good results can be anticipated in 75–85% of patients in terms of pain relief and prevention of further pancreatitis.[7 8]

MINOR PAPILLARY SPHINCTER

Highly experienced endoscopists can now cannulate the duct of Santorini in up to 90% of patients with pancreas divisum,[23 33] and manometry of the accessory sphincter is also technically feasible.[33] As at the major papilla both endoscopic and surgical ablation are valid but difficult techniques. Surgical results are likely to be superior in the long term but at the expense of a greater initial undertaking. Endoscopic techniques include dilatation and/or stenting of the minor papilla.[23 24 33] Stenting Santorini's duct can be achieved in up to 90% of patients, with early symptomatic relief in 80–90% of these.[23 24] Although restenosis of the accessory ductal orifice after endoscopic papillotomy is said to be rare,[34] stent obstruction or dislodgement are common. In Siegel's series,[24] serial pancreatograms at the time of stent exchange revealed progressive deterioration in either the degree of stricturing or ductal dilataton, leading him to conclude that the practical duration of endoscopic treatment is limited to an average of two years. Thus an operative approach should be seriously considered.[8 22] We approach the accessory papilla through a longitudinal duodenotomy, knowing that it may be ectopic in patients with pancreas divisum. An intravenous injection of secretin (1 IU/kg) is invaluable in locating the papilla, and the finest lacrimal probes may be needed before a stenosed duct will accept a cannula. Again retrograde on-table pancreatography can be done if a preoperative dorsal ductogram is not available. The minor papilla is incised for about 10 mm and fine sutures are placed to hold it open.

Postoperative hyperamylasaemia often follows surgical sphincteroplasty, whether major or minor, and especially if pancreatography is also performed; but it rapidly subsides.[8] We have not encountered acute pancreatitis after this operation; if it does occur, it is usually mild to moderate in severity.[7] Other potential complications include duodenal fistula and a collection of infected pancreatic juice.

Evaluating the results of pancreatic sphincteroplasty can be difficult. Some patients with severe postcholecystectomy pain or chronic pancreatitis are already addicted to narcotic analgesics, and these may relapse after initial improvement, even if the ductal orifices remain widely patent.[8] As operation can have a powerful placebo effect, follow up of at least one year is desirable to avoid being misled by short term success. The operation is safe, and in carefully selected cases it can be extremely effective.

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1 Glisson F. In: Hendrickson WF. A study of the musculature of the entire extrahepatic biliary system, including that of the duodenal portion of the common bile duct and of the sphincter. *Johns Hopkins Hosp Bull* 1898; **9:** 223.
2 Oddi R. D'une disposition a sphincter speciale de l'ouverture du canal choledoque. *Arch Ital Biol* 1887; **8:** 317–22.
3 Boyden EA. The anatomy of the choledochoduodenal junction in man. *Surg Gynecol Obstet* 1957; **104:** 641–52.
4 Doubilet H, Mulholland JH. Eight-year study of pancreatitis and sphincterotomy. *JAMA* 1956; **160:** 521–8.
5 Bartlett MK, Nardi GL. Treatment of recurrent pancreatitis by transduodenal sphincterotomy and exploration of the pancreatic duct. *N Engl J Med* 1960; **262:** 643–8.
6 Moody FG, Berenson MM, McCloskey D. Transampullary septectomy for post-cholecystectomy pain. *Ann Surg* 1977; **186:** 415–23.
7 Moody FG, Becker JM, Potts JR. Transduodenal sphincteroplasty and transampullary septectomy for postcholecystectomy pain. *Ann Surg* 1983; **197:** 627–36.
8 Williamson RCN. Pancreatic sphincteroplasty: indications and outcome. *Ann R Coll Surg Engl* 1988; **70:** 205–11.
9 McCune WS, Shorb PE, Moscowitz H. Endoscopic cannulation of the ampulla of Vater: a preliminary report. *Ann Surg* 1968; **167:** 752–6.
10 Kawai K, Akasaka Y, Murakami K, Tada M, Koli Y. Endoscopic sphincterotomy of the ampulla of Vater. *Gastrointest Endosc* 1974; **20:** 148–51.
11 Fuji T, Amano H, Harima K, Aibe T, Asagami F, Kinukawa K, *et al.* Pancreatic sphincterotomy and pancreatic endoprosthesis. *Endoscopy* 1985; **17:** 69–72.
12 Moody FG, Calabuig R, Vecchio R, Runkel N. Stenosis of the sphincter of Oddi. *Surg Clin North Am* 1990; **70:** 1341–54.
13 Gregg JA, Taddeo AE, Milano AF, McCartney AJ, Santoro BT, Farger SH, Capobianco AG. Duodenoscopy and endoscopic pancreatography in patients with positive morphine-prostigmine tests. *Am J Surg* 1977; **134:** 318–21.
14 Carr-Locke DL, Gregg JA. Endoscopic manometry of pancreatic and biliary sphincter zones in man; basal results in healthy volunteers. *Dig Dis Sci* 1981; **26:** 7–15.
15 Funch-jensen P, Kruse A. Manometric activity of the pancreatic duct sphincter in patients with total bile duct sphincterotomy for sphincter of Oddi dyskinesia. *Scand J Gastroenterol* 1987; **22:** 1067–70.
16 Lans JL, Parikh NP, Geenen JE. Application of sphincter of Oddi manometry in routine clinical investigations. *Endoscopy* 1991; **23:** 139–43.
17 Warshaw AL, Simeone J, Schapiro RH, Hedberg SE, Mueller PE, Ferrucci JT Jr. Objective evaluation of ampullary stenosis with ultrasonography and pancreatic stimulation. *Am J Surg* 1985; **149:** 65–72.
18 Brenner P, Duncombe V, Ham JM. Pancreatitis and pancreas divisum: aetiological and surgical considerations. *Aust NZ J Surg* 1990; **60:** 899–903.
19 Cotton PB. Congenital anomaly of pancreas divisum as cause of obstructive pain and pancreatitis. *Gut* 1980; **21:** 105–14.
20 Richter JM, Schapiro RH, Mulley AG, Warshaw AL. Association of pancreas divisum and pancreatitis, and its treatment by sphincteroplasty of the accessory ampulla. *Gastroenterology* 1981; **81:** 1104–10.
21 Saltzberg DM, Schreiber JB, Smith K, Cameron JL. Isolated ventral pancreatitis in a patient with pancreas divisum. *Am J Gastroenterol* 1990; **85:** 1407–10.
22 Warshaw AL, Simeone JF, Schapiro RH, Flavin-Warshaw B. Evaluation and treatment of the dominant dorsal duct syndrome (pancreas divisum redefined). *Am J Surg* 1990; **159:** 59–66.
23 McCarthy J, Geenen JE, Hogan WJ. Preliminary experience with endoscopic stent placement in benign pancreatic diseases. *Gastrointest Endosc* 1988; **34:** 16–8.
24 Siegel JH, Ben-Zvi JS, Pullano W, Cooperman A. Effectiveness of endoscopic drainage for pancreas divisum: endoscopic and surgical results in 31 patients. *Endoscopy* 1990; **22:** 129–33.
25 Williamson RCN, Poston GJ. Comment on article 'Pancreatic sphincteroplasty: indications and outcome.' *Ann R Coll Surg Engl* 1988; **70:** 398–9.
26 Desa LA, Williamson RCN. On-table pancreatography: importance in planning operative strategy. *Br J Surg* 1990; **77:** 1145–50.
27 Bagley FH, Braasch JW, Taylor RH, Warren KW. Sphincterotomy or sphincteroplasty in the treatment of pathologically mild chronic pancreatitis. *Am J Surg* 1981; **141:** 418–22.
28 Fuji T, Amano H, Ohmura R, Akiyama T, Aibe T, Takemoto T. Endoscopic pancreatic sphincterotomy-technique and evaluation. *Endoscopy* 1989; **21:** 27–30.
29 Grimm H, Meyer WH, Nam VCh, Soehendra N. New modalities for treating chronic pancreatitis. *Endoscopy* 1989; **21:** 70–4.
30 Huibregtse K, Schneider B, Vrij AA, Tytgat GN. Endoscopic pancreatic drainage in chronic pancreatitis. *Gastrointest Endosc* 1988; **34:** 9–15.
31 Cremer M, Sugai B, Delhaye M, Deviere J. Expandable pancreatic metal stent (Wallstent™) for chronic pancreatitis: first world series. *Gastroenterology* 1990; **98:** A215.
32 Guelrud M, Siegel JH. Hypertensive pancreatic duct sphincter as a cause of pancreatitis. Successful treatment with hydrostatic balloon dilatation. *Dig Dis Sci* 1984; **29:** 225–31.
33 Satterfield ST, McCarthy JH, Geenen JE, Hogan WJ, Venu RP, Dodds WJ, *et al.* Clinical experience in 82 patients with pancreas divisum: preliminary results of manometry and endoscopic therapy. *Pancreas* 1988; **3:** 248–53.
34 Galdermans D, Michielsen P, Pelckmans P, Cremer M, van Maercke Y. Postendoscopic sphincterotomy stenosis. *Endoscopy* 1989; **21:** 237–9.