Laparoscopic Distal Pancreatectomy

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17.1 Introduction

Minimally invasive approaches to distal (left) pancreatectomy have been shown to produce equivalent short-term and long-term outcomes for the treatment of benign and malignant pancreatic diseases, including equivalent or better operative outcomes such as reduced blood loss, decreased pain medication requirements, and shorter hospital stay in retrospective studies from expert surgeons in high-volume centers [1–4]. Oncologically, lymph node retrieval, histologically negative margins, and recurrence have also been shown to be equivalent to open procedures in well-selected patients [3].

Pancreatic neuroendocrine tumors (PNET) represent a unique entity: they vary in location and can be small and therefore difficult to localize intraoperatively. Furthermore, many patients with PNETs have soft glands, and because these lesions do not typically cause pancreatic ductal dilatation, the risk for post-pancreatectomy pancreatic fistula is high [5]. Some of these characteristics render PNETs ideal for a laparoscopic approach to resection, however. It is important to note that the indications for resection of PNETs should not change based on the availability of minimally invasive technology.

Evaluation of a patient for distal pancreatectomy should include several considerations. As with any pancreatic malignancy, patients with PNETs require local and distant disease staging with high-quality cross-sectional imaging. Patients are first imaged with triple-phase, contrast-enhanced CT using a pancreas protocol technique with thin (2 mm) cuts. Distant disease is not a contraindication to resection, but it may alter the approach if a liver-directed procedure is required at the time of pancreatectomy [6]. Close proximity of the tumor to the takeoff of the splenic artery, retroperitoneal tumor invasion, or extensive lymphadenopathy are relative contraindications to laparoscopic distal pancreatectomy.

From a technical standpoint, some PNETs may be amenable to splenic preservation. Select tumors located in the body or tail of the pancreas without obvious lymphadenopathy may allow for pancreatectomy with preservation of the splenic artery and vein. If the splenic artery and vein must be resected because of tumor location or vascular invasion, the spleen may still be preserved with an intact short gastric arcade (the Warshaw procedure) [7]. Furthermore, based on the location and size of a PNET, an anatomic formal left pancreatectomy may not be required. Other procedures such as enucleation and central pancreatectomy are beyond the scope of this chapter but remain important technical procedures for the pancreatic surgeon treating patients with PNETs.

This chapter describes the technical considerations and approaches to laparoscopic distal pancreatectomy. The focus of the chapter is a total laparoscopic approach, but variations such as a hand-assisted technique and the technical aspects of splenic preservation are also addressed.

17.2 Laparoscopic Distal Pancreatectomy with Splenectomy

17.2.1 Patient Positioning and Port Placement

This operation can be performed in the right lateral decubitus position, supine, or in lithotomy. The choice of position is based primarily upon surgeon preference, ergonomic comfort, the patient's body habitus, and tumor location. We prefer the patient be positioned supine on a beanbag with straps over the legs and chest to allow for table movement, as steep reverse Trendelenburg with right lateral rotation often facilitates this procedure. In patients with a short distance between the xiphoid and the umbilicus, an infraumbilical 12-mm port

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is placed using the Hassan technique to gain safe access to the abdomen. This incision can later be extended downward if necessary for specimen retrieval. The location of the operating surgeon is user-dependent and may change when training surgical house staff. The operating surgeon may also prefer to stand between the legs, positioned in lithotomy. When the operating surgeon is on the patient's right side, a 10- or 12-mm supraumbilical or infraumbilical port is placed to gain access into the peritoneum, and after insufflation, another 10–12-mm port is placed to the patient's left side at the level of or above the umbilicus. This port will be used by the assistant, who will help retract to expose as needed; these two ports of 10–12 mm will be used for the camera and staplers, although a 5-mm camera may also be used so that only one larger port is needed. The operating surgeon will place two additional ports (which can be 5-mm ports) on the patient's right side at or slightly above the level of the umbilicus, to be used for retraction and dissection. One port may be placed in the subxiphoid region for retraction of the liver and stomach, if necessary. The ports should be directed towards the midline and left upper quadrant, where most structures are located (Fig. 17.1).

It is important to note that there is not a uniform way to position or place ports for every patient. We have found in our experience that there is some variability depending on the type and location of the tumor, the patient's body habitus, and the experience of the operative assistant. Also, some maneuvers may be completed by a team approach involving the surgeon and the assistant, often based on the best visual and ergonomic angle. The ultimate goal is to have a comfortable arrangement for both the surgeon and the assistant that facilitates a safe operation.

17.2.2 Dissection of Peripancreatic Structures

A 30° or 45° camera is introduced and the abdomen is explored systematically for the completion of operative staging. Then the patient is rotated to the right and placed in steep reverse Trendelenburg, and the splenic flexure is lowered using an electrothermal dissector (ultrasonic shears or electrothermal bipolar tissue sealing device). As the operation progresses, the lesser sac is entered and the omentum is separated from the greater curvature of the stomach (Fig. 17.2). The stomach is grasped and held up to expose the plane of dissection for the operating surgeon. If the short gastric vessels are to be divided, take care to completely encompass these vessels with the electrothermal device to avoid partial transection, which can result in significant bleeding. When splenectomy is planned, the dissection is carried up to the fundus of the stomach to free the spleen completely from the stomach.

Once the greater curvature is freed, the stomach can be retracted out of the field under the left lateral segment of

Figure 17.1

Port placement for laparoscopic distal pancreatectomy. The initial site of entry, whether by the Hassan or Veress technique, is left to the discretion of the surgeon. A supra- or infra-umbilical port (1) should be carefully placed so it can either join or be far enough away from an upper abdominal hand port (2; if necessary). Secondary working ports are placed on the right for tissue manipulation and electrical dissection devices and for retraction if needed (3, 4). Ports on the left are for the camera and more retraction by the assistant (5). This operation can be performed with as few as four ports, but extra ports should be utilized if the operation requires them

the liver. The use of a fixed hand or liver retractor here can facilitate this retraction, which will free the left hand of the assistant. Now that the pancreas is exposed, the dissection begins with freeing of the inferior and superior borders of the pancreas (Fig. 17.3). The inferior border of the pancreas is carefully dissected out by dividing the overlying peritoneum with an electrothermal dissector. The pancreas is then lifted up bluntly with a grasper to facilitate further dissection and careful identification of vascular structures. Laparoscopic ultrasound can help identify small PNETs if necessary to assist with determining the point of parenchymal division, which should be approximately 2 cm proximal to the tumor [8]. Inferiorly, the transverse mesocolon is lowered either laterally from the splenic flexure or medially at the point of transection, using a combination of careful blunt and bipolar dissection. Take care to dissect behind the pancreas carefully, which will allow visualization of the superior mesenteric vein (SMV), inferior mesenteric vein (IMV), and splenic vein (Fig. 17.4). This maneuver is not necessarily performed to assess resectability, but rather to allow these structures to be identified and protected during further dissection and transection of the pancreas. The SMV can be found anatomically by tracing the right gastroepiploic and/or middle colic veins superiorly.

While freeing the inferior border of the pancreas by lowering the transverse mesocolon, take care to identify the IMV to avoid inadvertent injury. Further dissection posteriorly and superiorly will expose the splenic vein. If the pancreas is going to be divided far left of the SMV *en masse* with the splenic vein, then SMV dissection is not necessary; this decision is dictated by tumor location and pathology. If a formal left pancreatectomy is planned, the dissection is carried medially until the SMV is reached, and then dissection continues under the pancreas while the SMV is freed and protected. At this point in the dissection, the venous structures are fully identified and ready to be divided.

The goal of the dissection at the superior aspect of the pancreas is to identify the splenic and left gastric arteries and to completely free the lesser curvature of the stomach off of the pancreas. Injury to the coronary or left gastric vein during this part of the operation can lead to severe hemorrhage and must be avoided. Identify the splenic artery, which most commonly arises superiorly off of the celiac axis; it is often tortuous and should not be confused with the hepatic artery takeoff (Fig. 17.5). It is important to have the patient's cross-sectional imaging available to help correctly identify vascular structures and the relationship of these structures to the tumor. The splenic artery does not have to be isolated at the takeoff unless there is concern for proximity of the tumor to the celiac axis. Once the splenic artery is confirmed, it can be taken more distally, when coursing superiorly along the pancreatic parenchyma. The vessel is freed in order to facilitate stapler placement, completing the dissection of the pancreas and major vascular structures.

Figure 17.1

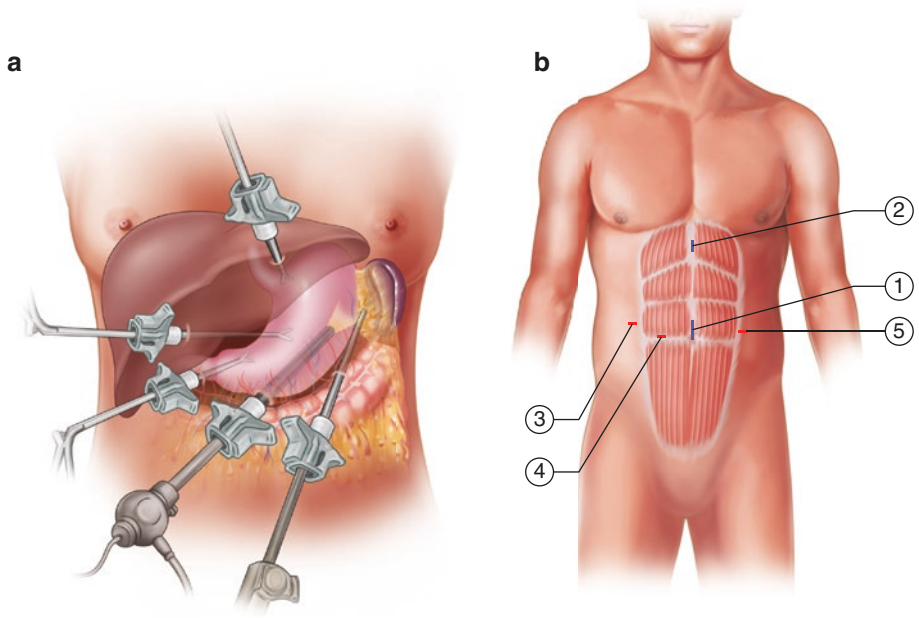


Figure 17.2

Exposure of the pancreas. With the stomach held up to the right and the omentum held inferiorly, the lesser sac is entered. With the patient in reverse Trendelenberg, the omentum and transverse colon will fall as will the greater omentum. The omentum is taken up to the level of the fundus if a splenectomy is planned, allowing the stomach to be pushed out of the field under the left lateral segment. If splenic preservation is planned, stop at the level of the short gastric arcade and retract the stomach for exposure

Figure 17.3

The peritoneum along the inferior edge of the pancreas is dissected out using an electrothermal device. It is safer to begin laterally and move medially, being careful not to go too deep and injure the inferior mesenteric vein (*IMV*). Dissect carefully over the region of the middle colic vein (*MCV*), as the superior mesenteric vein (*SMV*) will be right below the MCV

Figure 17.2

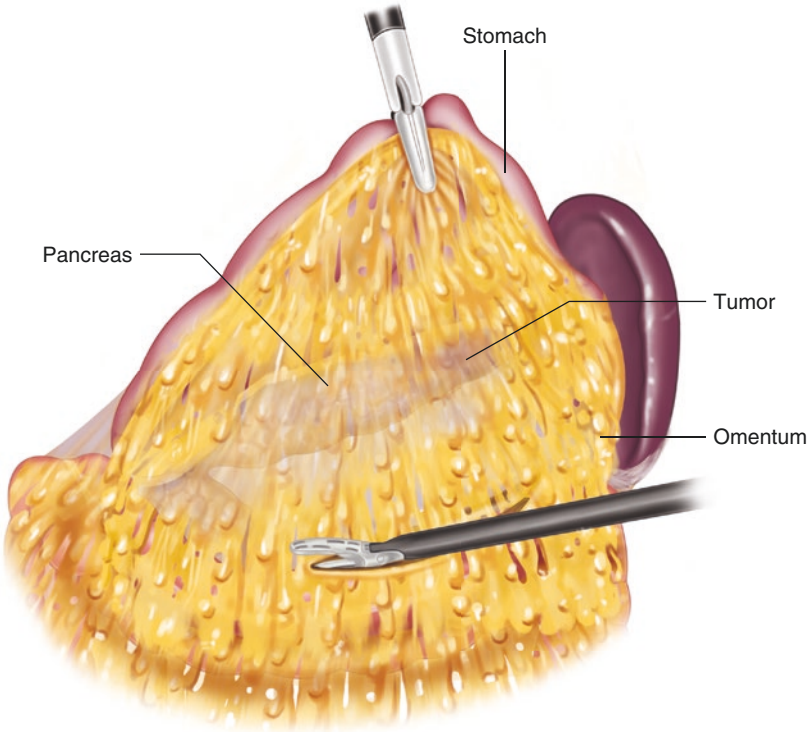


Figure 17.3

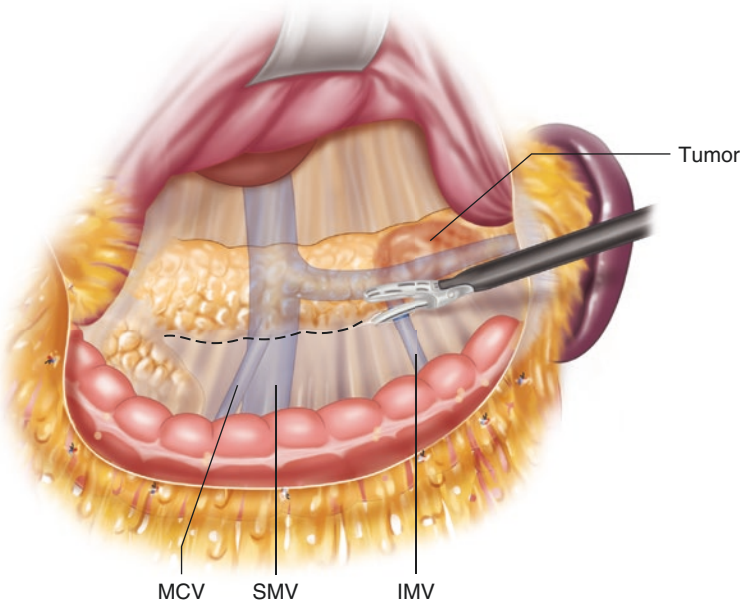


Figure 17.4

As the pancreas is exposed and freed from all attachments, critical vascular structures are identified. Dissection started inferiorly will expose the SMV by following the MCV and the right gastroepiploic vein. This maneuver also allows for exposure of the splenic vein, and it is important to confirm the anatomy before dividing any major vessels. The IMV can also be exposed as the inferior border of the pancreas is freed and transverse mesocolon is lowered. The IMV can be stapled or doubly clipped to facilitate dissection. Small branches from the splenic vein can be divided carefully with the bipolar device under direct vision. As the pancreas is freed inferiorly, dissection can continue behind the pancreas to free it from retroperitoneal attachments. Care must be taken to avoid injury to the renal vein and adrenal gland during this portion of the procedure. Moving laterally, the splenic flexure can then be freed from the spleen, and the entire pancreas is in view. This is a good time to perform intraoperative ultrasound if necessary

Figure 17.5

The top of the pancreas is freed from its attachments, taking great care to locate the splenic artery. Referring to the prior CT can confirm the artery's location, or intraoperative ultrasound can be used. It is critical to confirm celiac axis anatomy and its branches before any vessels are divided

Figure 17.4

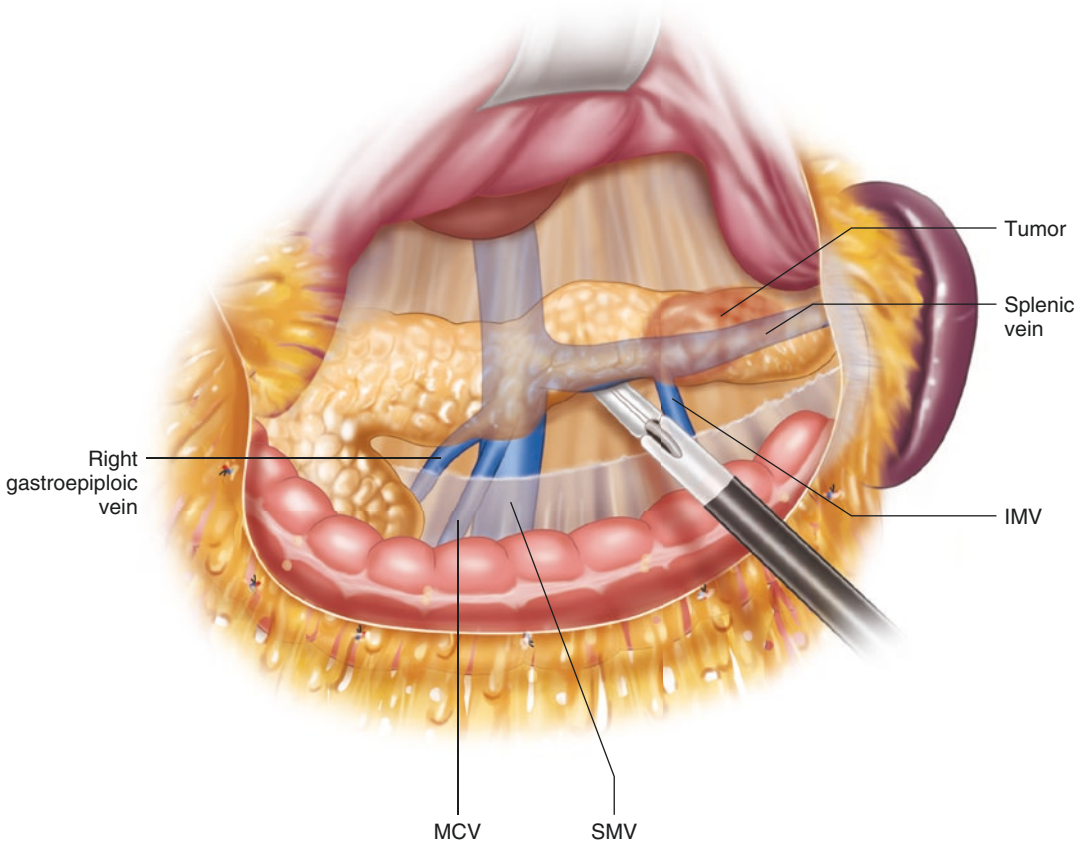
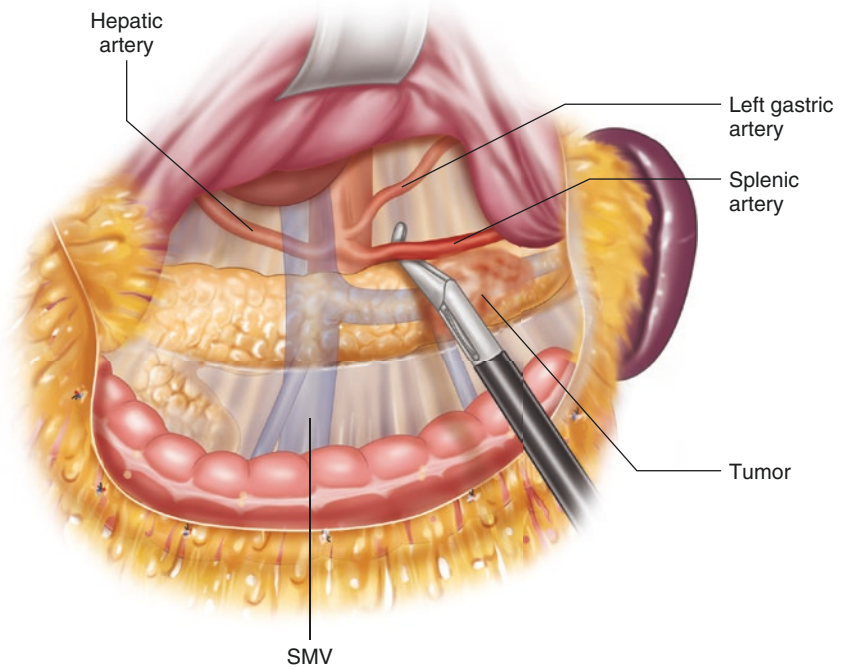


Figure 17.5



17.2.3 Division of the Pancreas and Vascular Structures

Now that the pancreas is completely mobilized, with the stomach, transverse colon, and mesocolon out of the field and the major vascular structures exposed and identified, the next step is to divide the vascular structures. The operation is technically easier to perform from a medial to lateral approach, which allows for protection of the major vascular structures and prevents bleeding from splenic traction. This approach also facilitates splenic preservation (see below). Once the desired point of transection is determined, divide the splenic artery first with an Endo GIA™ (Medtronic; Minneapolis, MN, USA) 30-mm or 45-mm stapler using a 2.5-mm load. The splenic vein is identified either within or below the pancreas, which will determine how the pancreas will be divided. When the splenic vein is firmly embedded in the posterior pancreas, *en masse* division to include both the pancreas and splenic vein may be preferred. An endo GIA™ 60-mm stapler using a reinforced purple load (three rows of staples, 3 mm, 3.5 mm, and 4 mm) or a reinforced black load (three rows of 4 mm, 4.5 mm, and 5 mm) is preferred for this division.

For separate division of pancreas and vascular structures, both the artery and vein must be fully exposed. If the splenic vein can be separated from the pancreas, then the pancreas is

Figure 17.6

Once the splenic artery has been divided with an Endo GIA™ stapler, and the vein location is confirmed, the pancreas is freed inferiorly from the retroperitoneum. Now the stapler is placed across the pancreas, positioned carefully behind the splenic vein if the pancreas and vein are to be taken *en masse*. Alternatively, the pancreas can be dissected out separately and stapled, and then the splenic vein is divided with a stapler

transected using an endo GIA™ 60-mm stapler with a purple or black load. At this point, the splenic artery can be divided with an endo GIA™ 2.5-mm load, and then the splenic vein is taken in similar fashion (Fig. 17.6). Now blunt dissection can be used to roll the pancreas and vessels laterally. The IMV will need to be ligated (stapled or clipped) as it enters into the inferior aspect of the splenic vein (Fig. 17.7). The pancreas is then carefully dissected off until the spleen is reached. Next, the splenic attachments to the lateral peritoneum are divided, as well as all of the short gastric vessels, and the spleen is completely freed. The specimen is placed in a large Endo Catch™ pouch (Covidien) and pulled into the 12-mm port. The incision is enlarged to facilitate removal. Morcellization of the spleen is not advised when the operation is being performed for malignancy.

This approach may vary with larger tumors, or perhaps if a patient has a splenic vein that is invaded and thrombosed on preoperative imaging. In these cases, after medial division of the pancreas, the splenic artery should be carefully dissected out proximally and divided with an endo GIA™ 2.5-mm load. One needs to beware of collateral vessels, as varices will form after splenic vein thrombosis, which can lead to troublesome bleeding. The splenic vein should be likewise divided, either after dissecting it out separately or, in most cases of advanced disease (with splenic vein thrombosis), in conjunction with dividing the pancreas.

Figure 17.6

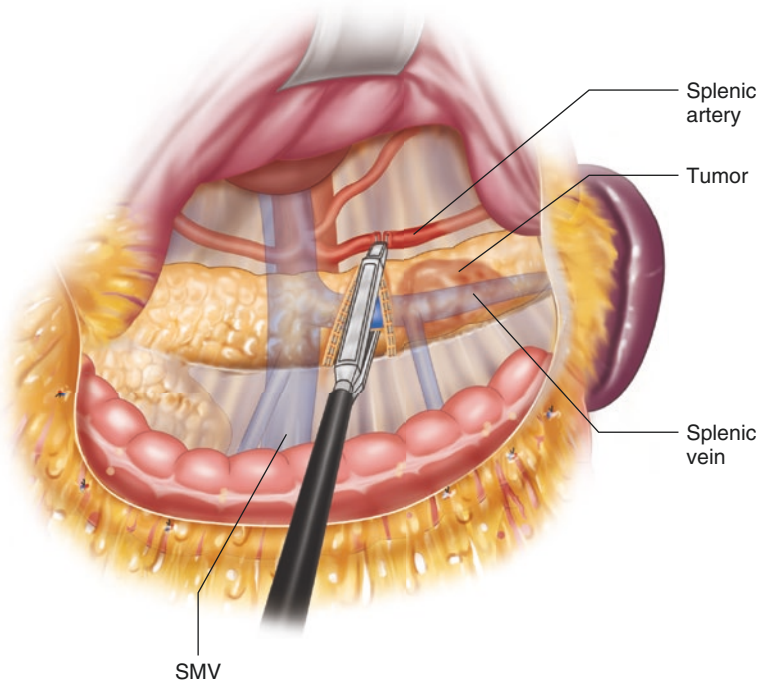
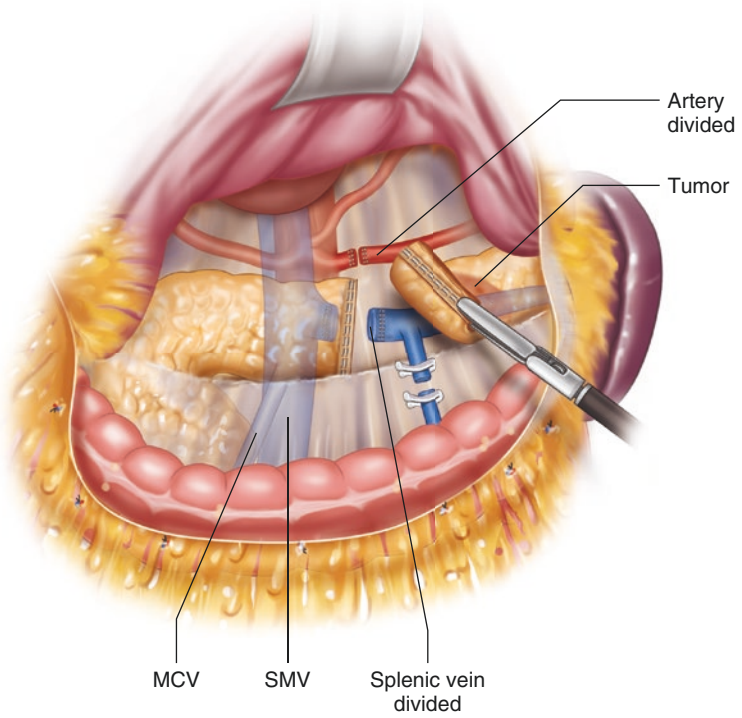


Figure 17.7

The pancreas is rolled laterally, exposing the IMV, which is divided between clips. The tissue superior to the splenic artery is divided with an energy device, keeping the splenic artery nodes with the specimen. The peritoneal attachments of the spleen are taken, freeing up the specimen

Figure 17.7



17.3 Laparoscopic Distal Pancreatectomy with Splenic Preservation

If splenic preservation is planned, then both the splenic artery and vein are left intact, and the pancreas is carefully rolled laterally. Branches coming off both vessels must be carefully identified and clipped or divided with an electrothermal device. Dissection is carried out all the way to where the pancreas ends near the spleen, and the pancreas is removed in an Endo Catch™ bag when it is completely cleared of these vessels. In many cases, the tumor will invade the splenic vein, and the splenic artery and vein therefore need to be divided. The spleen may still be preserved in these patients as long as the short gastric vessels are preserved (Warshaw procedure; Fig. 17.8). This approach has a very low risk for long-term complications and therefore can be considered in select cases [7]. The concept is that if the splenic vessels are to be taken because of the tumor location, then the spleen will receive its blood supply from the short gastric vessels. For this approach, the dissection along the greater curvature stops before reaching the short gastric arcade. It is important not to injure the

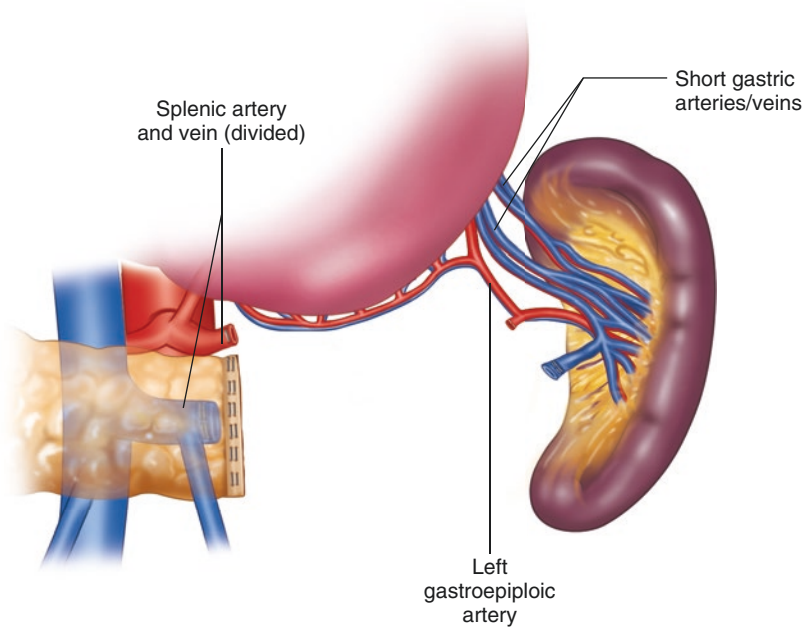
Figure 17.8

Warshaw procedure, with division of the splenic artery, vein, and pancreas proximally. Distally, the splenic artery and vein are taken near the hilum, preserving the short gastric vessels to the stomach for collateral flow

gastroepiploic vessels while freeing the stomach, as these will be the source of important collateral flow. The remaining maneuvers of this pancreatic resection remain the same as described, with division of the artery, vein, and pancreas proximally. When the end of the pancreas is reached, dissection and ligation of the splenic artery and vein branches are carefully carried out proximal to the splenic hilum. These vessels are then divided separately or together with an Endo GIA™ vascular 2.5-mm staple load to complete the dissection. The spleen is left behind, and the pancreas is placed into an Endo Catch™ bag and removed through a 12-mm port; the site may need to be enlarged to accommodate a larger specimen.

After removal of the specimen, inspect for hemostasis along the vessels and in the retroperitoneum. Bleeding from the spleen (if preserved) can be dealt with using the argon beam coagulator. Closed suction drainage is optional; many feel that it is important, but others use a selective approach based upon the risk for pancreatic leak. Nasogastric suction is not required routinely. The fascia is closed with a 0 Vicryl suture for all 10–12-mm trocar sites, and then the skin is closed with 4-0 absorbable sutures.

Figure 17.8



17.4 Hand-Assisted Laparoscopic Distal Pancreatectomy

Most cases can be performed with a total laparoscopic approach, but when there is difficulty, a hand port can facilitate the dissection, allow for palpation of vessels and other critical structures, and facilitate specimen removal. The hand port can be placed as an upper midline incision or in the right lower quadrant. The operating surgeon uses the left hand and the right hand holds electrothermal devices and staplers.

17.5 Pearls and Pitfalls

Positioning is a critical aspect of this operation, and reverse Trendelenburg with rotation to the right will facilitate the procedure. During the course of dissection, one of the key elements is to avoid inadvertent vascular injury. This includes tearing or injury to the major veins, including the SMV, IMV, and left gastric vein, or inadvertent division of the hepatic or left gastric artery. Short gastric vessels should be controlled carefully, as injury or partial division can result in significant bleeding. These vessels should be secured with an electrothermal dissector or clips, because they can bleed postoperatively. Securing of the splenic artery before the splenic vein and prior to mobilization of the spleen can help reduce unnecessary bleeding. The use of the hand port is a viable option during a difficult pancreatectomy; it may prevent conversion to an open procedure and will facilitate specimen retrieval. If at any point during the operation there is loss of control, failure to progress, or surgeon discomfort, conversion to an open procedure with an upper midline or left subcostal incision should be performed.

17.6 Results and Conclusions

Mortality from distal pancreatectomy in large series of both open and laparoscopic approaches ranges from 0.3% to 3% [1, 9]. Despite low mortality rates, morbidity remains a significant problem following distal pancreatectomy; common complications include pancreatic fistula, leak, abscess, bleeding, reoperation, delayed gastric emptying, and infection [1, 9]. Prospective recording and grading of complications remains critical for accurate reporting of outcomes in both retrospective and prospective studies. Along these lines, pancreatic fistula rates following distal pancreatectomy range from 12% to 31% in large series; these rates tend to be higher than the rates for pancreaticoduodenectomy [1, 9]. The approach to parenchymal transection has been studied extensively both retrospectively and prospectively, and no particular technique has evolved as superior with regard to fistula prevention. The use of intraperitoneal drains remains controversial, although evidence points to at least a selective approach to drainage with early removal.

Oncologically, laparoscopic and distal pancreatectomy have been compared in retrospective studies and found to be equivalent with regard to nodal harvest, the rate of positive margins, and recurrence [3]. Several retrospective series have evaluated laparoscopy for the treatment of PNETs and found this approach to be safe and feasible in select patients [6, 10]. Overall, it is important that the indication for resection should not change based on having a minimally invasive option for treatment.

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