Portal Vein Resection: How I Do It

15

Alexis Ulrich, Pietro Contin, and Thilo Hackert

Venous tumor infiltration of the portal vein (PV) or superior mesenteric vein (SMV) by pancreatic ductal adenocarcinomas (PDAC)—although classified as a borderline resectable finding—is not a contraindication for curative resection. This practice is widely accepted, looking at the guidelines of the International Study Group on Pancreatic Surgery (ISGPS) [1], which is mainly influenced by the recommendations of the National Comprehensive Cancer Network (NCCN) [2] However, venous infiltration can cause irresectability when the remaining diameter of the vein—mostly at the site of the superior mesenteric vein (SMV)—is too small to ensure adequate drainage of the blood from the small bowel to the liver. A good impression of the resectability can be achieved by preoperative contrast-enhanced computed tomography (CE-CT). Characteristic findings of venous infiltration are a reduced diameter or occlusion of the PV or SMV lumen as well as the extension of contact between the tumor and the vein circumference of >180°. In the majority of cases, the necessity for venous resection can be expected and planned preoperatively by evaluation of the CE-CT.

A. Ulrich (✉) · P. Contin · T. Hackert
Department of General, Visceral and Transplantation Surgery, University of Heidelberg, Heidelberg, Germany
e-mail: Alexis.Ulrich@med.uni-heidelberg.de

Several factors have to be considered before attempting a venous resection.

1. Are the diameters of the remaining cut ends of the vein—after resection—appropriate for anastomosis, allowing blood flow from the small bowel to the liver?
2. Can the splenic vein (SV) be preserved?
3. Is there a need for interposition of an allograft/patch, or can an end-to-end anastomosis without interposition be performed?
4. Which allograft/patch—if required—is the most appropriate one in the individual situation?

The most common limitation for SMV/PV resection occurs in cases where the tumor invades the mesentery of the small bowel which may lead to technical irresectability, as the remaining SMV or its branches would be too small for a technically and functionally safe anastomosis.

During the operation, it is of paramount importance to be prepared for resection as the time of vein clamping should be as short as possible. During the clamping time, venous congestion of the small bowel can occur, impairing the healing of the latter anastomoses (pancreaticojejunostomy, hepatico-jejunostomy, and gastrojejunostomy). In doubt, simultaneous clamping of the superior mesenteric artery (SMA) might be an option to avoid excessive congestion and subsequent bowel edema after reperfusion.

M. Tewari (ed.), *Surgery for Pancreatic and Periampullary Cancer*,
https://doi.org/10.1007/978-981-10-7464-6_15

The SV is involved in the tumorigenic infiltration on the level of the venous confluence in many cases, requiring its partial resection. Due to collaterals, the SV not necessarily has to be reinserted into the PV in most patients. However, in case of venous congestion of the spleen, a splenectomy or reinsertion of the SV into the PV is of benefit. The reinsertion, however, should not create too much lateral tension on the PV/SMV anastomosis as this could lead to a narrowing of the vessel lumen with a higher risk of postoperative thrombosis. Attention should also be given to the gastric coronary vein (CV), which might be the only venous drainage of the stomach, if the SV has to be resected, most commonly in patients who undergo total pancreatoduodenectomy combined with splenectomy. Anatomically, the CV can drain into the SV or the PV which should be clarified intraoperatively to evaluate the possibility of CV preservation or of reinsertion, if necessary.

For restoration of continuity of the PV/SMV axis, in the majority of cases, no interposition is required to bridge the defect after PV/SMV resection, and an end-to-end-anastomosis is feasible. However, tension should be avoided as it increases the risk of thrombosis. Therefore, the right hemicolon and the mesenteric root of the small bowel should be completely dissected from the retroperitoneum, the lateral side wall, and the major vessels (aorta, vena cava, Cattell-Braasch maneuver). This creates the necessary flexibility to lift the small bowel together with the mesentery root toward the upper abdomen.

If the distance remains to be too long for a direct anastomosis, a graft interposition has to be used. Various options are available and are discussed later. If possible, autologous material should be chosen, as the risk of thrombosis and infection is reduced compared to synthetic materials.

According to the ISGPS guidelines, four types of resection and reconstruction are used [1].

In case of only short segmental attachment of the tumor to the vein, a tangential resection might be oncologically sufficient. The vein can be clamped with a Satinsky (or any other vascular) clamp and the tumor be resected. Afterwards, the vein integrity is reconstructed by running a suture with, e.g., 5-0 polypropylene threads (type 1 reconstruction) (Figs. 15.1 and 15.2). Attention has to be put on the

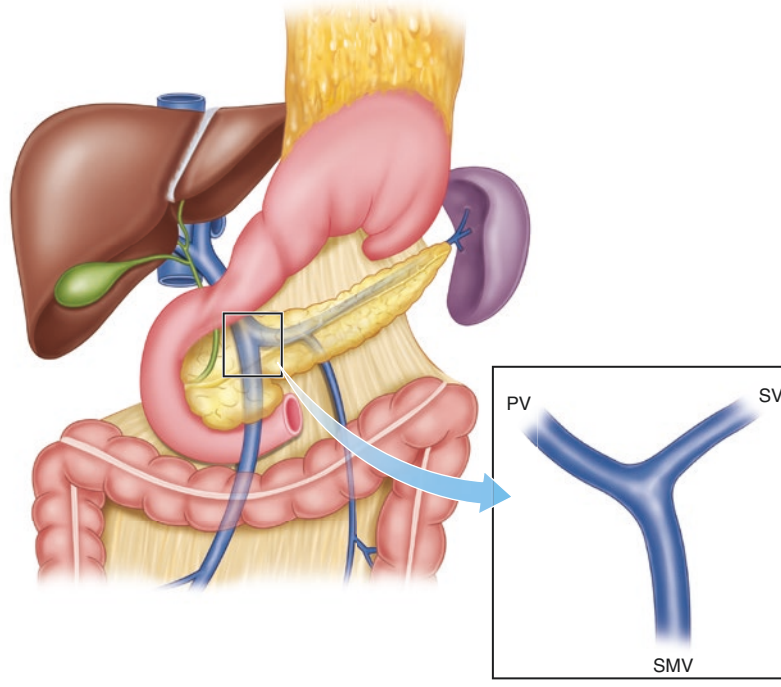

Fig. 15.1 Anatomy of the right upper abdominal quadrant with accentuation of portal (PV), splenic (SV), and superior mesenteric vein (SMV)

diameter of the vein, as this type of reconstruction could lead to a stenosis of the vein, impairing the drainage of the venous blood from the small bowel. To avoid this narrowing, the longitudinal venous defect may be closed transversally (Fig. 15.3), according to the technique known for pyloroplasty. This closure is appropriate for defects up to 2 cm in length and preservation of at least half of the circumference. The possibility for this type of closure, however, may be limited by the possibility of venous kinking that can occur. An alternative in this situation would be the closure of the defect with a patch (type 2) (Fig. 15.4). Besides bovine or artificial patches, autologous material is suitable for patch creation. Autologous venous patches can be taken from the left renal vein (close to the vena cava under preservation of the respective ovarian/testicular vein to ensure preservation of venous renal drainage), from the cava itself, or from the jugular vein. A recent publication suggested the creation of the patch from the parietal peritoneum [3]. A part of the peritoneum is harvested from the lateral abdominal wall together with the dorsal fascia of the rectus muscle. The patch is placed onto the PV/SMV defect with the peritoneal side positioned toward the lumen and fixed by running sutures (i.e., polypropylene 5-0).

Frequently, a part of the PV/SMV is completely obstructed by the tumor, and a complete segment has to be resected. In the majority of cases, a direct anastomosis of the both ends of the vein is feasible (type 3). As mentioned above, the root of the small bowel and the right hemicolon should be mobilized for more flexibility. If possible, the SV should be preserved, if necessary, by a diagonal cut of the PV/SMV even if the

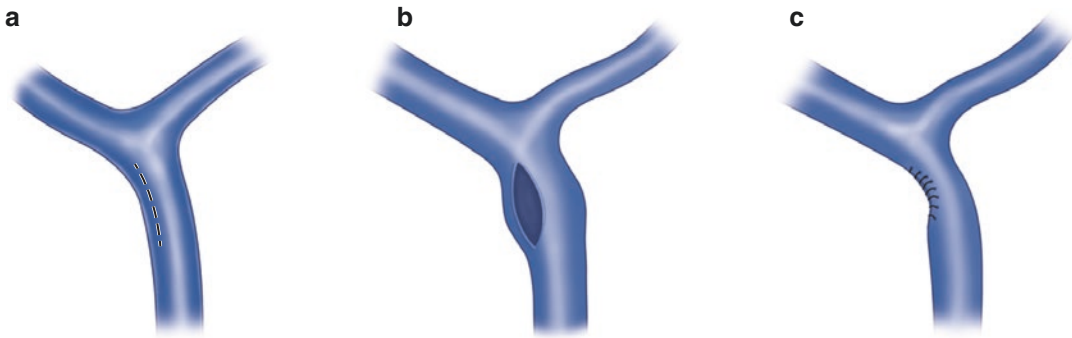

Fig. 15.2 Partial resection of the SMV (**a**), appearance of the defect (**b**), and closure of defect by running suture (**c**) without interposition (type 1 resection according to ISGPS)

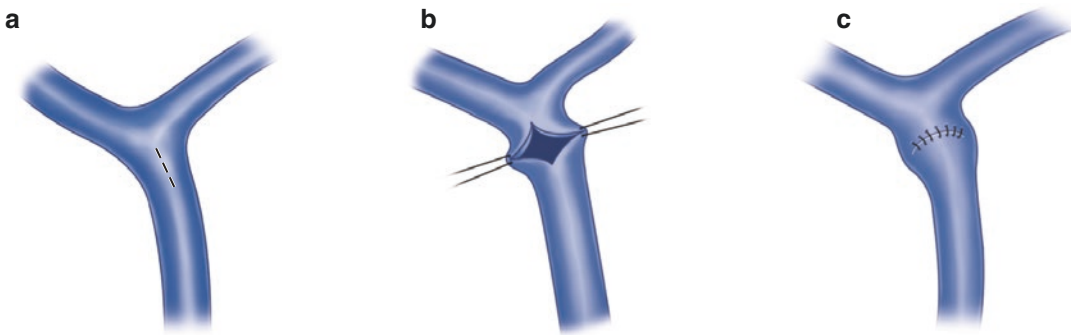

Fig. 15.3 Partial resection of SMV (**a**), lateralization of the side walls of the defect (**b**), and closure of the venous defect transversally (**c**)

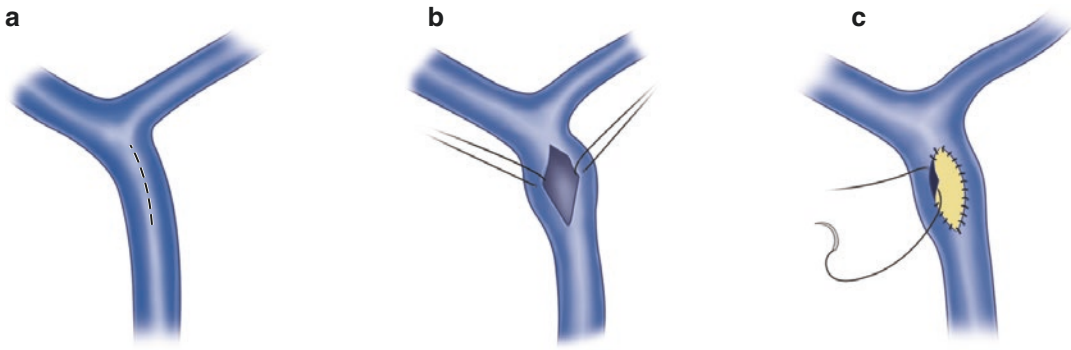

Fig. 15.4 Partial resection of SMV (**a**), appearance of the defect (**b**), and closure of the venous defect by insertion of a patch (**c**) (type 2 resection according to ISGPS))

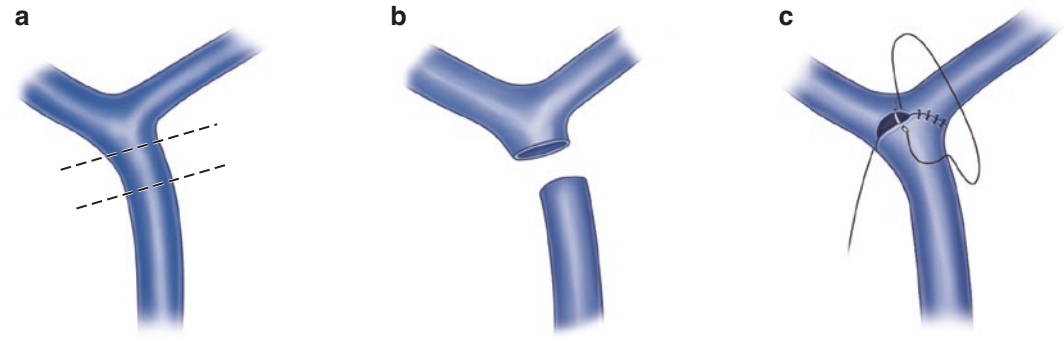

Fig. 15.5 Segmental resection of the SMV (**a**) with a defect that has to be bridged (**b**) and closure by end-to-end anastomosis (**c**) (type 3 resection according to ISGPS)

diameter of the PV end exceeds the diameter of the SMV end by factor of 2 or 3. The vessels can be clamped with vascular clamps of each kind. However, it has to be resected so that both vein ends are not twisted. If large distances have to be bypassed, larger vascular clamps are helpful to pull the SMV together with the mobilized bowel toward the upper abdomen. Afterwards the two cut ends are connected. We normally use a 5-0 polypropylene, double-armed, running suture, starting with the posterior wall from the median to the lateral edge. In case of fragile veins and a large distance to bridge, the first suture line should be created in a parachute technique and approximated, when the thread of the complete posterior wall is set up. The anterior wall is also sutured with a new double-armed thread starting from the lateral border to the middle of the vein. The same is done from the median edge using the remaining end of the first thread. In the middle of the vein, the both ends are tied with a loose knot of up to 1 cm, after the clamps are opened (Fig. 15.5). Thereby, a narrowing of the anastomosis can be prevented as the loose knot allows the elastic vessel wall to adapt to the increasing diameter after reperfusion. Potential minor bleedings at the suture line usually stop without further measures.

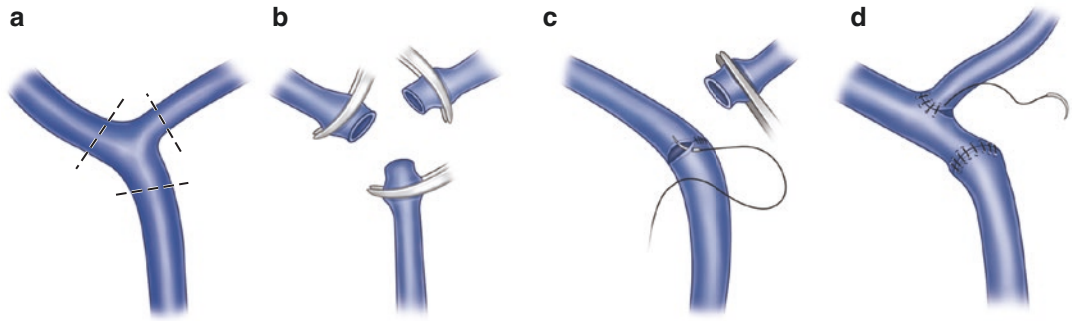

Fig. 15.6 Segmental resection of the SMV and SV (**a**) with a defect that has to be bridged (**b**), closure by end-to-end anastomosis of PV and SMV (**c**), and reinsertion of the SV into the PV (**d**)

As mentioned before, sometimes the SV cannot be preserved. If a reconnection is necessary and feasible (tension), the PV/SMV is clamped again after completion and opening of the first end-to-end anastomosis and a lateral incision of the PV/SMV are made according to the width of the SV. The posterior and anterior walls are sutured with 5-0 polypropylene running stitches (Fig. 15.6).

A type IV reconstruction with interposition of the PV/SMV has to be regarded as an absolute exception, as it is just rarely necessary. As material for interposition, the following can serve:

- Saphenous vein
- Internal jugular vein
- Left renal vein (close to the vena cava)
- External iliac vein
- Gonadal vein
- Peritoneal patch
- Bovine patch
- PTFE prosthesis

The advantage of autologous material is the reduced risk of infection; however, it is associated with more surgical efforts and should be harvested before clamping of the PV/SMV to avoid a prolonged ischemia time of small bowel and liver. If no suitable autologous vein segment is available, a tubular interposition graft can also be created from a peritoneal or bovine patch, which is placed around a suction tube or tubular instrument of the required diameter (Fig. 15.7).

The insertion technique is the same as for a direct end-to-end anastomosis with the exception that two anastomoses have to be performed (Fig. 15.8). Loose knots at the end of the anastomosis are recommended, again, if autologous material is used. In PTFE prostheses, this is not required or recommendable as the synthetic material has a fixed diameter and shows no adaptive potential.

To evaluate patency of the reconstructed PV/SMV, routine duplex ultrasound examinations are performed postoperatively, and serum liver enzymes are closely monitored to recognize potential venous flow impairments immediately. In doubtful duplex findings suggesting stenosis or occlusion of the anastomosis, a CE-CT is the diagnostic method of choice to clarify the situation and allow decision-making for the further management.

In general, no further specific anticoagulation is required after venous resection. We use low dose heparin for 6 weeks after the operation that can be stopped thereafter without ongoing anticoagulation.

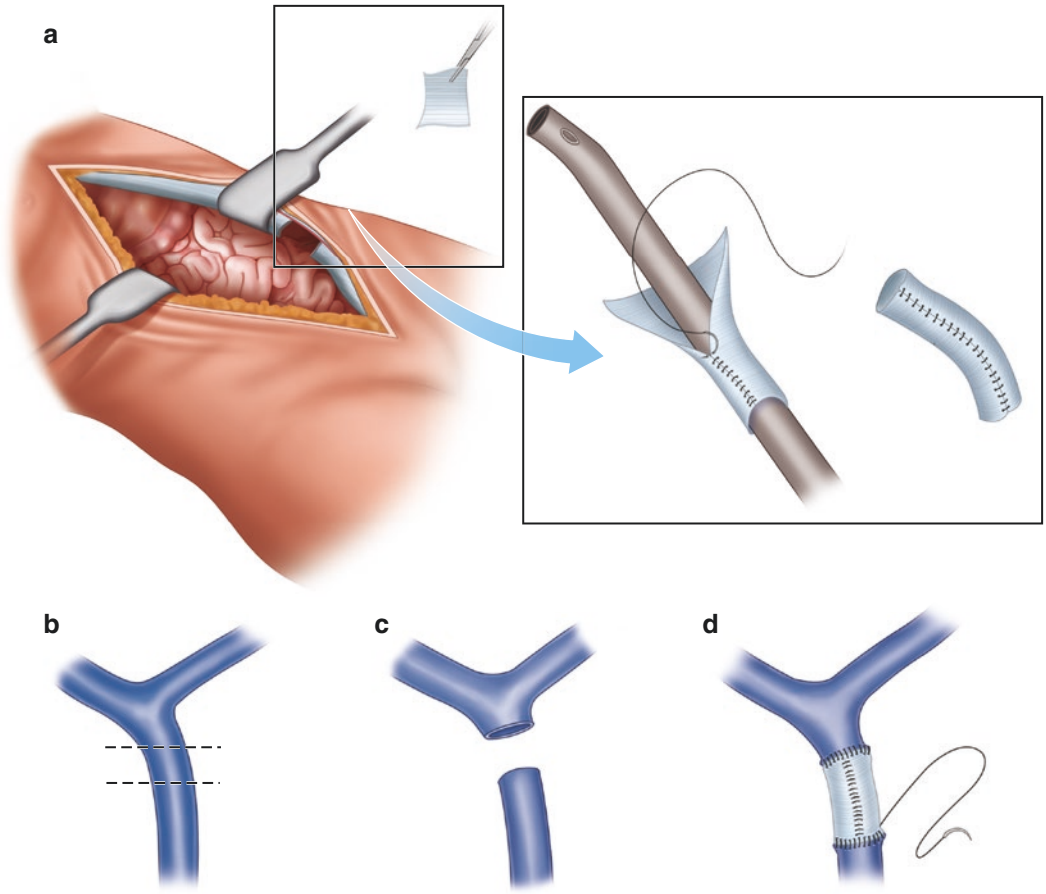

Fig. 15.7 Removal of peritoneal side wall and creation of a tubular interposition graft around a suction tube or tubular instrument (**a**). Segmental resection of the SMV (**b**) with a defect that has to be bridged (**c**) and interposition with the newly created graft (**d**)

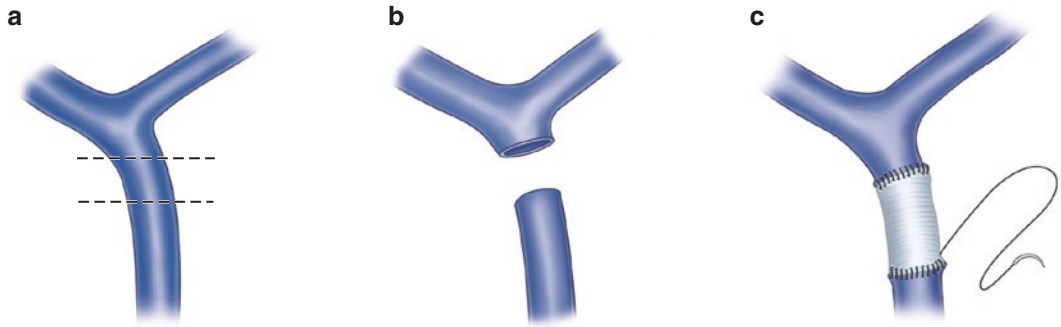

Fig. 15.8 Segmental resection of the SMV (**a**) with a defect that has to be bridged (**b**) and interposition of autologous material or a PTFE prosthesis (**c**). (Type 4 resection according to ISGPS)

References

1. Bockhorn M, Uzunoglu FG, Adham M, Imrie C, Milicevic M, Sandberg AA, Asbun HJ, Bassi C, Büchler M, Charnley RM, Conlon K, Cruz LF, Dervenis C, Fingerhut A, Friess H, Gouma DJ, Hartwig W, Lillemoe KD, Montorsi M, Neoptolemos JP, Shrikhande SV, Takaori K, Traverso W, Vashist YK, Vollmer C, Yeo CJ, Izbicki JR, International Study Group of Pancreatic Surgery. Borderline resectable pancreatic cancer: a consensus statement by the International Study Group of Pancreatic Surgery (ISGPS). Surgery. 2014;155(6):977–88.
2. Tempero MA, Malafa MP, Behrman SW, Benson AB 3rd, Casper ES, Chiorean EG, Chung V, Cohen SJ, Czito B, Engebretson A, Feng M, Hawkins WG, Herman J, Hoffman JP, Ko A, Komanduri S, Koong A, Lowy AM, Ma WW, Merchant NB, Mulvihill SJ, Muscarella P 2nd, Nakakura EK, Obando J, Pitman MB, Reddy S, Sasson AR, Thayer SP, Weekes CD, Wolff RA, Wolpin BM, Burns JL, Freedman-Cass DA. Pancreatic adenocarcinoma, version 2.2014: featured updates to the NCCN guidelines. J Natl Compr Canc Netw. 2014;12(8):1083–93.
3. Dokmak S, Aussilhou B, Sauvanet A, Nagarajan G, Farges O, Belghiti J. Parietal peritoneum as an autologous substitute for venous reconstruction in hepatopancreatobiliary surgery. Ann Surg. 2015;262(2):366–71.