3 Specimen Dissection and Sampling

Macroscopic examination is a key step in the process of reporting on pancreatic resection specimens. The complexity of the local anatomy, the large number of inflammatory and neoplastic diseases that can occur in the pancreas, and the existence of anatomical variation and developmental anomalies require an accurate and 'fail-proof' approach to the dissection and sampling of pancreatic specimens. This chapter provides detailed practical guidance on the various aspects of specimen handling and macroscopic examination. Where appropriate, alternative techniques will be discussed.

3.1 Handling of Fresh Specimens

While dissection of surgical pancreatic resection specimens is best and easiest performed after fixation of the tissue, it is desirable to receive specimens fresh within a controlled, short time interval following surgical removal. The prime motivation is obviously the procurement of fresh tissue samples for biobanking or dedicated research purposes. In addition, reception of the fresh specimen allows preliminary preparation of the tissues to ensure optimal fixation. On occasion, it may be desirable to take photographs of particular lesions prior to fixation.

Most pathology departments will have established a standardized operating protocol describing the locally agreed procedures for fresh tissue sampling and subsequent (cryo-)preservation, storage, and registration. Sampling should be accomplished in the shortest possible time, and recording of the time from specimen reception to tissue sampling is recommended. Which tissues are to be sampled depends on local agreement, but usually, tissue fragments from the tumor and the tumor-free pancreas are collected.

As an important general rule, fresh tissue sampling for biobanking or other purposes should never jeopardize correct and detailed diagnostic reporting. It is therefore of key importance to limit incisions and sampling volumes to a minimum and to refrain from sampling in case the tumor is small or cannot be identified with certainty. The latter is not an uncommon problem, as the tumor is often invisible on external specimen inspection and may not be identifiable on palpation due to concomitant fibrosis of the surrounding pancreatic tissue. The following findings may be helpful in locating the tumor:

- Irregularity of the specimen surface: bulging of the pancreatic surface, retraction of the groove of the superior mesenteric vein (SMV groove), adherence to the pancreas of a segment of SMV or other structures or organs.
- Ulceration or irregularity of the duodenal mucosa or papilla of Vater.
- A palpable mass.
- Dilatation of the main pancreatic duct or common bile duct: if absent, the tumor is likely to

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be located in the uncinate process or in the caudal half of the pancreatic head, inferior to the level of the ampulla.

The incision(s) to be made for fresh tissue sampling should be in line with the dissection technique that is used. As explained below, serial specimen slicing in the axial plane offers several advantages and is therefore the recommended technique. If this technique is used, incision of the fresh specimen should be in the axial plane, at the level where the tumor has been located, and, if possible, avoiding transection of an overlying segment of resected vein.

When sampling the tumor, care should be taken to avoid areas of involvement of anatomical structures that are important for correct reporting and staging, that is, for the assessment of the TNM descriptors, in particular T, N, and R. In practice, this means that samples are best taken from central tumor areas to avoid interference with the tumor periphery, which is relevant for tumor measurement (pT-stage) and assessment of the surfaces and margins of the specimen (R-status) (Fig. 3.1). For small tumors, it may be impossible to avoid sampling of these critical areas, which on occasion may preclude fresh tissue procurement.

The use of disposable biopsy corers is recommended, because they allow sampling of tissue pieces that are uniform in size and shape. As the corers are available in different sizes, they facilitate precise sampling. Tumor-free pancreatic tissue may be easily sampled at the transection margin of the pancreatic neck, provided this is well away from the tumor. Alternatively, tumor-free tissue can be taken from the incision that has been made for sampling of the tumor, if the latter is sharply delineated from the surrounding pancreatic parenchyma. Using a separate knife, scalpel, and forceps for sampling of tumor and tumor-free tissue may be helpful in avoiding cross-contamination.

To allow optimal formalin-fixation, it is important that all hollow organs are opened and rinsed. This can be done after fresh tissue sampling to minimize bacterial contamination, unless the tumor is present at the duodenal mucosal surface and opening of the duodenum is required to allow sampling. In the case of a Whipple's specimen (see Chap. 2, Sect. 2.1), the distal part of the stomach is opened along the greater curvature. At the pylorus, the longitudinal incision is continued along the duodenal wall opposite to the papilla of Vater. To avoid inadvertent cutting through lesions in the duodenum, the latter should be carefully probed with the finger to identify possible lesions prior to longitudinal incision. If included in the specimen, the gallbladder should also be opened longitudinally. Subsequently, all opened structures are rinsed with cold water.

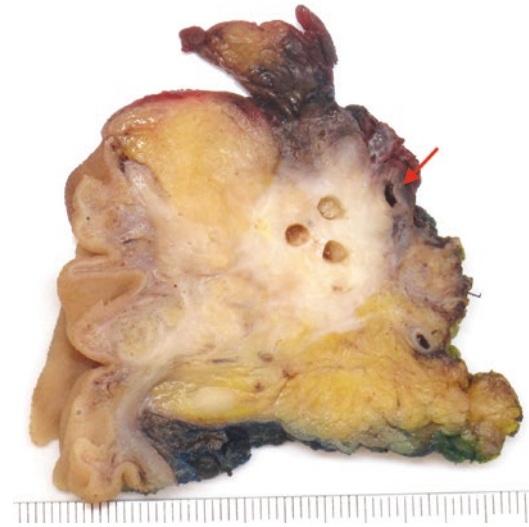

Fig. 3.1 Biobanking of tumor tissue from a pancreatoduodenectomy specimen: using a tissue corer, fresh tumor tissue can be sampled easily from an axial incision through the pancreatic head. Samples are taken from the center of the tumor, leaving untouched the tumor periphery and its relationship to the adjacent venous resection (*arrow*) and specimen surface. On microscopic examination, the punched-out holes allow unequivocal identification of the site of biobanking

In the case of large cystic tumors, if these are not already opened for the purpose of biobanking, it may be advisable to make a controlled linear incision of the wall (where the latter exhibits no specific features, that is, no adherence to other structures or palpable solid mass) to allow drainage of content and filling of the cyst cavity with formalin. A similar approach may be considered for bulky solid tumors, should these not have been incised for fresh tissue sampling.

Color-coded inking of the various specimen surfaces is usually done after formalin fixation, as the ink tends to adhere better to fixed tissue (see Sect. 3.3.2). Alternatively, inking can be performed on the fresh specimen, and if staining is required prior to fresh tissue sampling, the use of dry ground pigment rather than the usual liquid specimen stains may be considered. Immediately before application, the ground pigment is dissolved in acetone, which allows almost instantaneous drying of the ink. This avoids smearing of the various colors, which is not uncommonly a problem with liquid inks.

3.2 Specimen Fixation

Pancreatic specimens should be fixed in a large volume of 10% buffered formalin. The specimen can float freely in the fixative, as the risk of fixation-induced tissue shrinkage is low in this solid organ. However, in some pathology departments, the specimen is pinned onto a corkboard to limit fixation-induced distortion of the area that was incised for fresh tissue sampling. Fixation for 48 hours is usually adequate, but shorter fixation times may be appropriate for smaller specimens such as those resulting from central pancreatectomy or surgical enucleation (see Chap. 2, Sects. 2.6 and 2.7). On occasion, additional fixation of the cassetted tissue samples may be required prior to tissue processing.

3.3 Macroscopic Examination of Pancreatoduodenectomy Specimens

Because pancreatoduodenectomy specimens differ from other surgical pancreatic resection specimens in the anatomy of their constituting tissues, they require a different dissection technique, which is the focus of this section. The approach to other parts of the macroscopic examination process, for example, tissue sampling, macroscopic description, and photodocumentation, is not particular to pancreatic head resection specimens and can be applied to any surgical resection specimen of the pancreas. A summary of the various steps to be undertaken during specimen dissection and sampling is provided in Table 3.1.

Table 3.1 Summary of handling of pancreatoduodenectomy specimens

Before fixation
• Open longitudinally and rinse the stomach, duodenum, gallbladder
• Make one or two axial incisions for biobanking, if required
Fixation (approximately 48 hrs)
After fixation
• Take measurements: stomach, duodenum, head of pancreas (in 3 dimensions), gallbladder, cystic duct, extrapancreatic common bile duct, and any other structures or organs included in specimen (e.g., venous resection)
• Carefully remove surgical sutures and clips
• Sample the transection margins: proximal (gastric or duodenal), distal (duodenal), pancreatic neck, common bile duct
• Inspect and sample the gallbladder and cystic duct
• Ink the pancreatic surfaces according to an agreed color code: anterior, SMV groove, surface facing SMA, posterior, around extrapancreatic common bile duct. Ink in different colors any other important structures (e.g., venous resection)
• Remove the distal duodenal 'tail' and clip the duodenal 'wings' (if normal)
• Serially slice the specimen in the axial plane, slice thickness 3 mm
• Lay out the specimen slices in sequential order
• Take photographs: overview and close-ups
• Describe the tumor: shape, texture, solid/cystic, color, size and localization (in 3 dimensions), relationship to key anatomical structures (ampulla, duodenum, common bile duct, peripancreatic soft tissue, vein), and distance to the nearest margins
• Describe any other lesions, including their size and localization
• Take tissue samples following the sequential order of the specimen slices; record in the block key the number of the slice from which the samples stem
• Take at least one whole mount sample, if possible, from the slice where the tumor is at its largest
• Take standard-size samples from other specimen slices by dividing them in a geometrical way and including anatomical 'landmarks'
• Ensure that all lymph nodes are sampled 'en bloc' with the inked specimen surface and/or other anatomical 'landmarks'

Abbreviations: *SMA* superior mesenteric artery, *SMV* superior mesenteric vein

3.3.1 Dissection Techniques

Worldwide, a variety of dissection techniques for pancreatoduodenectomy specimens are currently being used. The three main approaches differ in the plane of dissection, and whether or not the pancreatic and bile duct are opened longitudinally.

3.3.1.1 Bivalving or Multivalving Technique

According to this technique, the main pancreatic duct and common bile duct are probed, and the specimen is sliced once (bivalving) or several times (multivalving) along the plane defined by both probes (Fig. 3.2). In this way, both ducts are exposed longitudinally in only two specimen slices facing the same dissection plane. This technique is challenging, not only when it comes to the insertion of the probes into the narrow ducts that are often distorted or obstructed by tumor. Equally difficult is the subsequent slicing of the specimen along the probes. The resulting slices are large and require further dissection, which is usually done by slicing in an additional, perpendicular plane. The use of different planes, one of which varies between specimens depending on the configuration of the pancreatic and bile duct, hinders the pathologist's mental 3-dimensional reconstruction of the tumor and its exact localization within the pancreatic head.

3.3.1.2 Bread Loaf Slicing Technique

Following this technique, the main pancreatic duct and common bile duct are left untouched. Instead, the pancreatic head is serially sliced along a plane perpendicular to the longitudinal axis of the pancreatic neck (Fig. 3.3). The main disadvantage of this technique is of a practical nature. The rubbery texture of the duodenum renders it difficult to slice the latter and the flanking pancreas in a longitudinal fashion, with the result that the specmen slices through the ampulla and the junction with the pancreatic and common bile duct may be suboptimal, for example incomplete, fragmented, or thicker than desired.

Serial slicing perpendicular to an axis that follows the curvature of the pancreatic head is advocated by the Japan Pancreas Society (JPS) [1]. It solves the above-mentioned practical problem but has the disadvantage that sectioning is

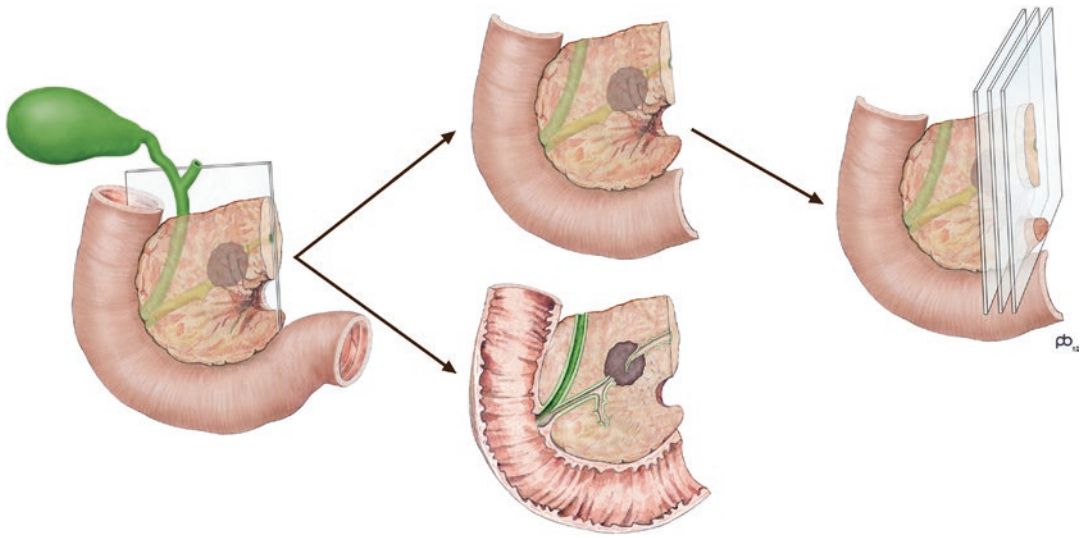

Fig. 3.2 Bivalving or multivalving dissection technique: the pancreatoduodenectomy specimen is sliced in a plane defined by probes in the main pancreatic duct and common bile duct. As the resulting slices are large, further dissection is usually performed in a plane perpendicular to the pancreatic neck (Image courtesy and copyright of Paul Brown, The Leeds Teaching Hospitals NHS Trust, Leeds, UK)

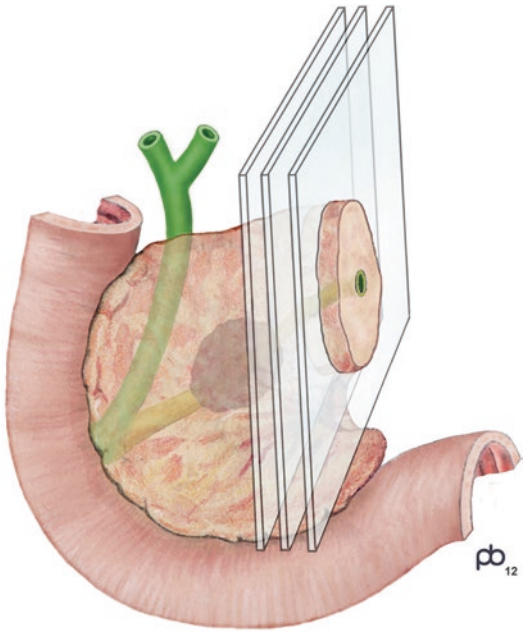

Fig. 3.3 Bread loaf slicing technique: the pancreatoduodenectomy specimen is serially sliced in a plane perpendicular to the pancreatic neck (Image courtesy and copyright of Paul Brown, The Leeds Teaching Hospitals NHS Trust, Leeds, UK)

not parallel but fan-like and the resulting specimen slices are wedge-shaped rather than square.

3.3.1.3 Axial Slicing Technique

According to this technique, the specimen is sliced in an axial plane, that is, perpendicular to the longitudinal axis of the descending duodenum (Fig. 3.4). Slicing is easy to perform, as the duodenum is sliced in a cross-sectional fashion, and it results in a large number of thin slices (on average 12 or more), which allow good views and from which it is easy to take tissue samples for microscopic examination. As the axial dissection plane is identical to that of CT- or MRI-imaging, correlation between pathology and imaging is straightforward and usually much appreciated by the radiologists and surgeons. The dissection plane is fixed, that is, independent of duct configuration as is the case for the bivalving or multivalving technique, with the result that key anatomical structures such as the ampulla, common bile duct, and main pancreatic duct, always occur at the same position in the specimen slices and are therefore easily identified.

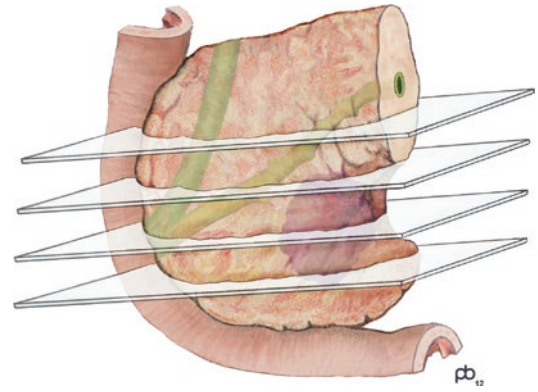

Fig. 3.4 Axial slicing technique: the pancreatoduodenectomy specimen is serially sliced in a plane perpendicular to the longitudinal axis of the descending duodenum (Image courtesy and copyright of Paul Brown, The Leeds Teaching Hospitals NHS Trust, Leeds, UK)

Consequently, any deviation from normal, either as an anatomical variant or a pathological lesion, is easy to identify and to locate in relationship with the surrounding anatomical structures. The latter is particularly important for the correct identification of the origin of the cancer, that is, whether adenocarcinoma in the pancreatic head is derived from the pancreas, ampulla, or distal common bile duct. Regarding the assessment of the margin status, it is important to note that the entire surface of the pancreatic head can be inspected in every specimen slice (Fig. 3.5).

The combination of these advantages allows not only exact identification of the 3-dimensional localization and extent of the tumor in the specimen, it also facilitates accurate margin assessment [2–5]. The proximity of the tumor to the various resection margins can be examined in detail in every specimen slice (see also Fig. 3.29). In some countries and pancreatic cancer centers, the axial specimen slicing technique has been accepted as an integral part of the national recommendations for the handling of pancreatoduodenectomy specimens [6, 7].

3.3.2 Inking of Surfaces

Inking of resection margins and specimen surfaces can be done before or after fixation. Prior

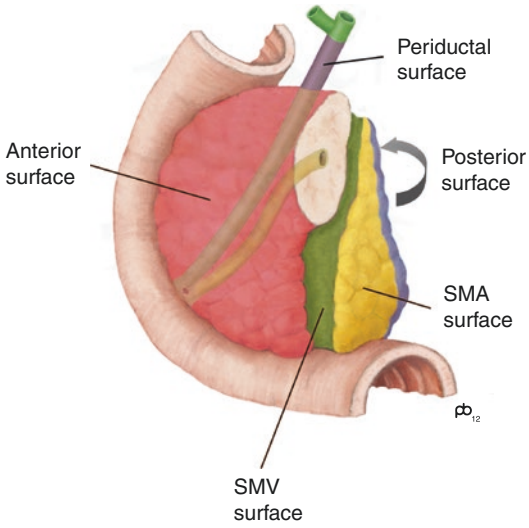

Fig. 3.5 Circumferential resection margins in a pancreatoduodenectomy specimen: color-coded inking facilitates identification of the circumferential margins: anterior (*red*), facing the SMV (*green*), facing the SMA (*yellow*), posterior (*blue*), and periductal (*purple*) (Image courtesy and copyright of Paul Brown, The Leeds Teaching Hospitals NHS Trust, Leeds, UK)

Fig. 3.6 Fixation of inks on the specimen surface: acetic acid is sprayed onto the inked surfaces through a thin paper towel to avoid running of colors due to the jet of the spray

to application of the ink, all surgical sutures and metal clips should be carefully removed to allow unhampered specimen slicing. Removal of the clips and sutures should be done without tissue disruption, as the tissue at the specimen surface represents the circumferential resection margin. If conventional liquid inks are used, it is important to pad dry the specimen surface before applying the ink and to spray with acetic acid (10%) to improve adhesion of the ink to the specimen surface. The acid is best sprayed through a paper towel that is wrapped around the specimen, such that the jet of the spray does not make the ink run over the tissue surface (Fig. 3.6). The use of different colors of ink for the various parts of the specimen surface according to an agreed color-code allows unequivocal identification of these surfaces both during macroscopic and microscopic examination. The following section lists the structures that require color-coded inking and describes how these can be identified (Fig. 3.5).

The *transection margin of the pancreatic neck* is readily identifiable, and it is therefore a good starting point when identifying the various pancreatic surfaces. The transection margin shows bare pancreatic parenchyma and contains the main pancreatic duct, which in many cases is dilated. The length of the neck can vary slightly, but in most cases it is less than 1 cm long and protrudes somewhat from the superior left-lateral aspect of the pancreatic head (Fig. 3.7). Inking of this margin is best done after en face sampling of the transection margin (see Sect. 3.3.8), because this allows assessment of completeness of excision at this margin. If unequivocal identification of the main pancreatic duct may be of particular importance (e.g., in case of intraductal papillary mucinous neoplasia), introducing a small amount of ink into the main duct at the transection margin may be helpful.

The surface of the groove of the superior mesenteric and portal vein ('*SMV margin*' or '*SMV groove*') is located immediately posterior to the pancreatic transection margin (see Chap. 1, Sect. 1.3.1.2). It runs in a slightly curved fashion along the left-lateral aspect of the pancreatic head. Its surface is normally smooth and slightly shiny, and it may sometimes be flanked on either side by multiple clips or sutures on small veins that drain from the pancreatic head into the superior mesenteric vein (Fig. 3.7). If a venous resection was undertaken, the segment of vein

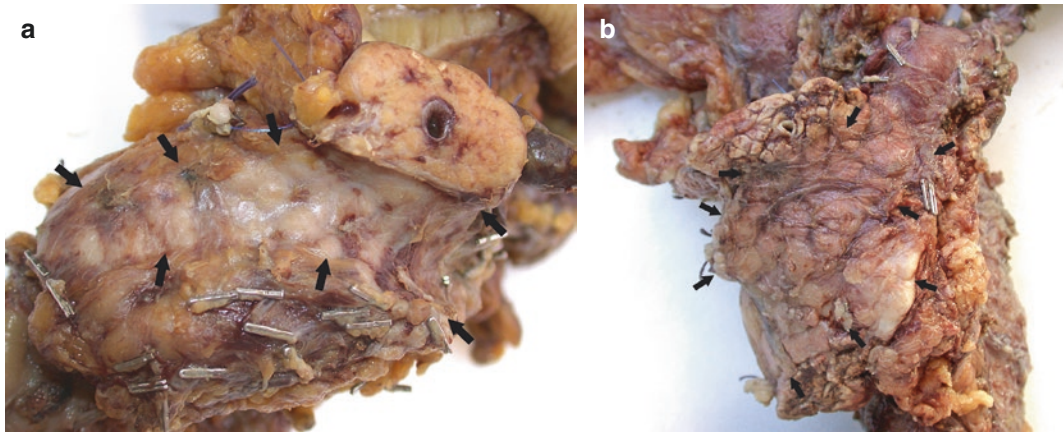

Fig. 3.7 SMV groove and pancreatic neck: the transection margin of the pancreatic neck is easily identified by the presence of lobulated parenchyma and the cross-sectioned main pancreatic duct. The SMV groove (*arrows*) runs posterior to the pancreatic neck, is slightly curved, and can be fairly narrow and deep (**a**) or wide and shallow (**b**). Note the rows of metal clips on small veins draining into the SMV

will be found adherent to the SMV groove. It is recommended to ink the resected piece of vein with a different color to facilitate identification following specimen slicing and during microscopic examination (Fig. 3.8).

The resection margin facing the superior mesenteric artery ('*SMA margin*') lies posterior and to the left of the SMV groove. In contrast to the latter, the surface of the SMA margin is rough, fibrous, and often irregular. It is usually wedge-shaped, that is, narrower towards the cranial aspect of the pancreatic head and broader towards the inferior pole (Fig. 3.5).

The *posterior margin* is the fibrous but relatively smooth, flat surface at the back of the pancreatic head. It extends from the left-lateral side of the SMA margin to the posterior duodenal wall. The angle between the SMA and posterior margin is usually acute and well-defined.

The *anterior surface* of the pancreas is not a true margin, but rather a free anatomical surface, which faces the lesser sac. It extends from the SMV groove to the anterior duodenal wall. It is usually smooth but can on occasion be overlaid with adipose tissue. As breaching of this surface by a cancer bears the risk of local tumor spread or recurrence, the anterior surface should be part of the macroscopic and microscopic assessment (see Chap. 9, Sect. 9.11.4, Fig. 9.44).

Finally, the surface of the soft tissue sheath surrounding the extrapancreatic common bile duct stump also represents a circumferential resection margin, which is sometimes referred to as the '*periductal margin*' or '*radial bile duct margin*'. The extrapancreatic stump of the common bile duct can be easily found by following the SMV groove in a cranial direction, as the bile duct stump lies immediately adjacent to the cranial end of the SMV groove.

3.3.3 Stents, Coils, and Glues

Because obstructive jaundice is the most common presenting symptom of pancreatic head tumors, many pancreatoduodenectomy specimens contain a stent. The latter lies within the common bile duct and protrudes over a short distance from the papilla of Vater. The presence and material (plastic or metal) of a stent should be recorded in the macroscopic description. Plastic stents are usually inserted with a view to short-term jaundice relief, whereas metal stents are indicated if biliary drainage should be ensured for a longer period of time. For this reason, pancreatic resection specimens following neoadjuvant treatment often contain a metal stent to allow biliary drainage during the entire preoperative treatment period.

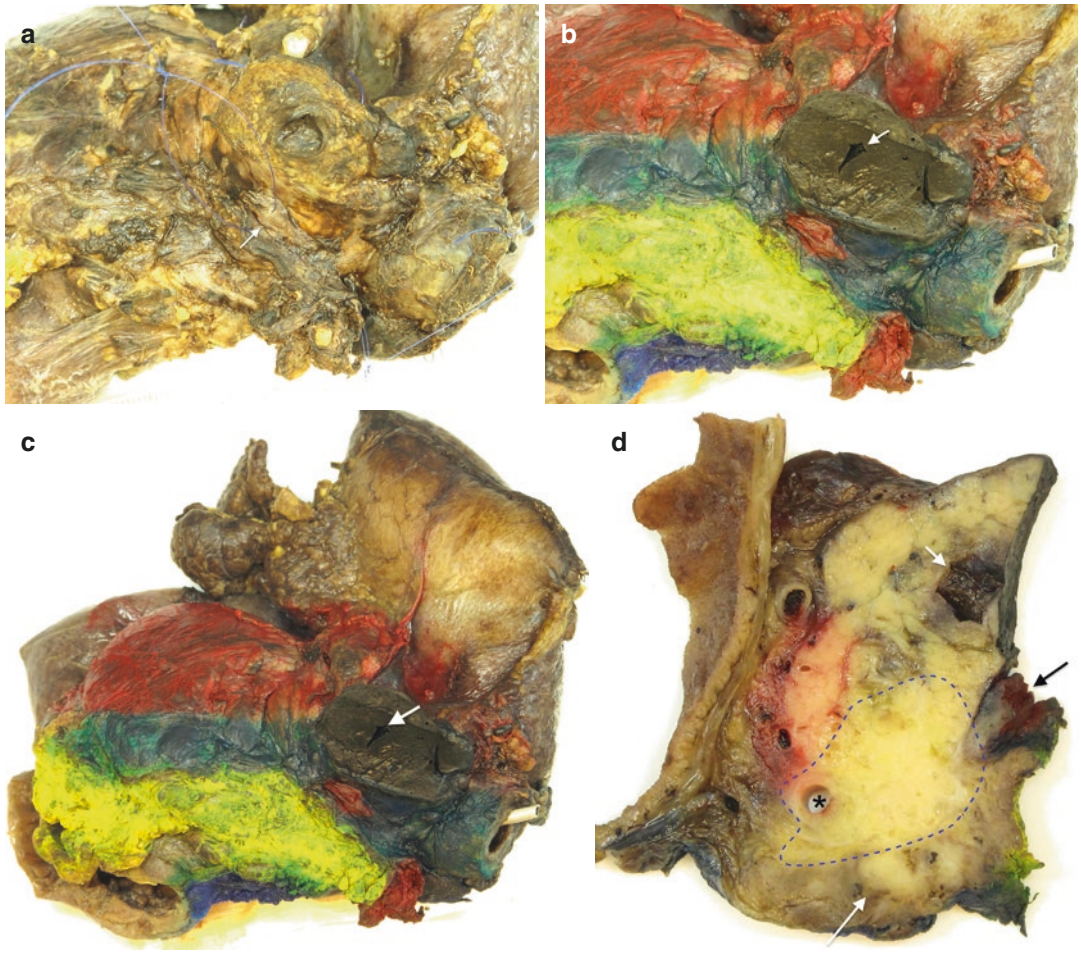

Fig. 3.8 Inking of a Whipple's specimen with venous resection: a small venous resection (*arrow*) consisting of a sleeve of the superior mesenteric vein (SMV) is attached to the SMV groove at the level of the pancreatic head. Note the surgical marker suture (**a**). The vascular sleeve is labeled with red ink, while the other surfaces are inked according to an agreed color code (pancreatic transection margin: *black*, SMV groove: *green*, SMA margin: *yellow*, anterior surface: *red*). Note the dilated main pancreatic duct (*arrow*) and a plastic stent in the common bile duct (**b**, **c**). An axial specimen slice through the venous resection (*black arrow*) shows it close relationship to the poorly circumscribed tumor (*dotted line*). Note the punched-out lumen of the tumor-obstructed common bile duct (*asterisk*), a lymph node metastasis in the posterior peripancreatic fat (*long white arrow*), and the dilated main pancreatic duct (*short white arrow*) (**d**)

Plastic stents are difficult to remove as they are barbed, but since they can be sliced easily, they are best left in place and removed from the slices prior to tissue sampling (Fig. 3.9).

Metal stents obviously require removal before slicing. Because tumor tissue may have grown into the meshwork of the stent, removal of it by simple pulling bears the risk of marked tissue disruption. A more gentle removal is achieved by extracting the metal wires one by one with forceps, which may be facilitated by cutting as many as possible of the wires that protrude from the papilla of Vater, such that the metal mesh is partially broken up. After removal of the stent, the common bile duct will typically be widely open, often with a visible imprint of the metal mesh onto the bile duct mucosa (Fig. 3.10). A plastic stent of a smaller caliber than a plastic

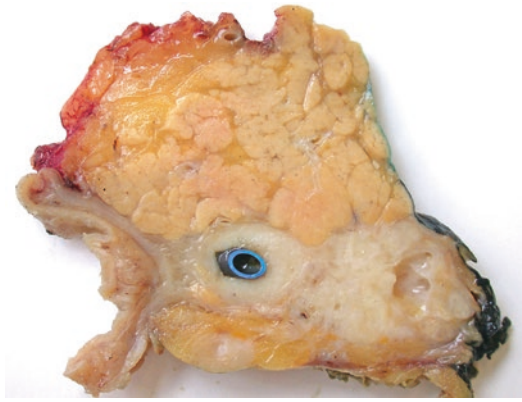

Fig. 3.9 Plastic biliary stent: a blue plastic tube secures biliary drainage through the common bile duct, which is infiltrated and narrowed by carcinoma

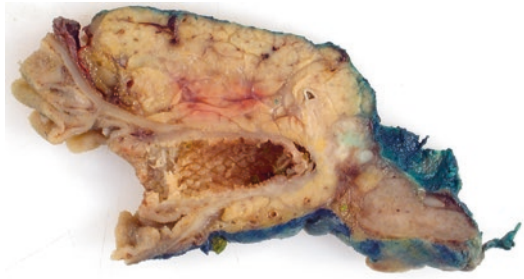

Fig. 3.10 Biliary dilatation due to metal stent insertion: after removal of a metal stent, the common bile duct remains widely open and a reticular imprint of the metal mesh can be seen on the bile duct mucosa

biliary stent may be found in the main pancreatic duct in patients with chronic obstruction (Fig. 3.11).

Fibrin glue or sealant is a surgical formulation used to create a fibrin clot for hemostasis or wound healing and may be used, for example, following enucleation of a small lesion (Fig. 3.12). Duct occlusion in the remnant pancreas by injection of a non-biodegradable "glue" of varying chemical composition, is a procedure that mainly belongs to the past (Fig. 3.13). It was used to prevent postoperative anastomotic leakage following pancreatoduodenectomy and induced atrophy of the pancreatic remnant with ensuing exocrine and endocrine insufficiency.

On rare occasion, coil embolization for massive hemorrhage may have preceded resection of

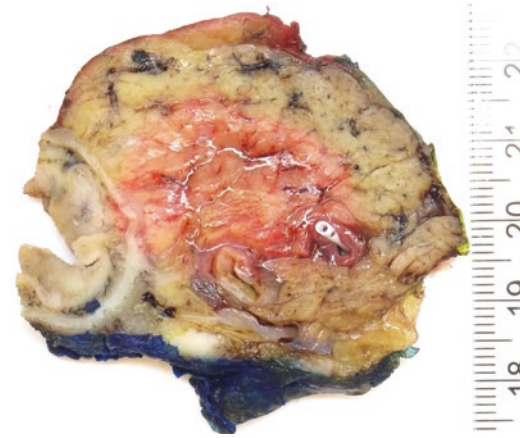

Fig. 3.11 Pancreatic duct stent: a plastic stent with a small caliber is inserted in the main pancreatic duct because of chronic duct obstruction

usually large pancreatic cancers, and the small metal coil may be identified during specimen dissection (Fig. 3.14). Other, non-metallic embolization particles may be seen only microscopically in blood vessels adjacent to areas of tumor necrosis (Fig. 3.15).

3.3.4 Axial Specimen Slicing

As outlined above, according to the axial dissection technique, pancreatoduodenectomy specimens are sliced along the axial plane, that is, perpendicular to the descending part of the duodenum. The specimen slices should be thin—approximately 3 mm in thickness—which is important in view of the small dimensions of the native anatomical structures in the pancreatic head. For example, if slices are considerably thicker than 3 mm, then the main pancreatic duct, which is normally no more than 3 mm wide, may be concealed from macroscopic inspection.

Axial slicing of the specimen may be easier if the 'tail' of distal duodenum that is not adherent to the pancreatic head is removed. Similarly, clipping of the 'wings' of the opened duodenal wall that extend on either side of the pancreatic head may facilitate slicing. Wiping the blade of the dissection knife blade during serial slicing may help to prevent smearing of ink. The use of a long

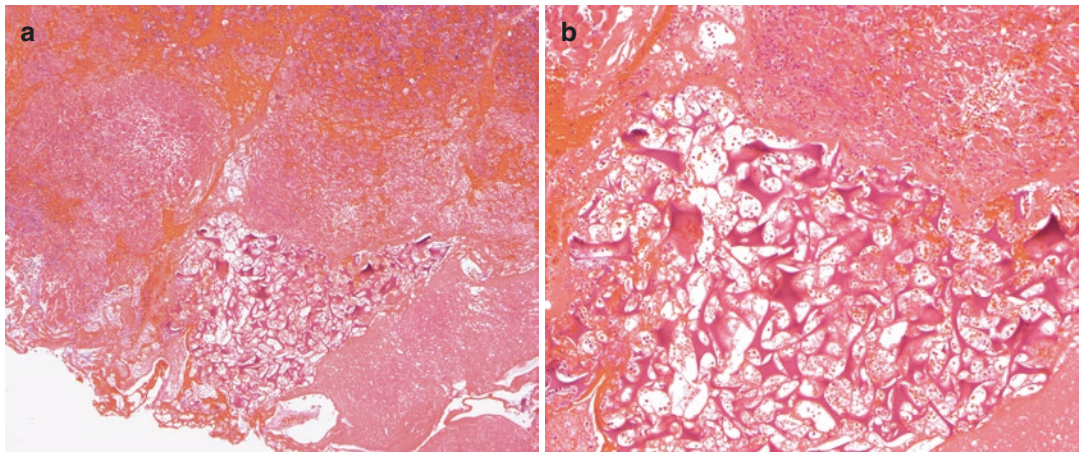

Fig. 3.12 Fibrin sealant: fibrin glue is applied to the pancreatic surface of the surgical bed following enucleation of a small neuroendocrine tumor (**a**). The fibrin glue forms a biodegradable hemostatic mesh (**b**)

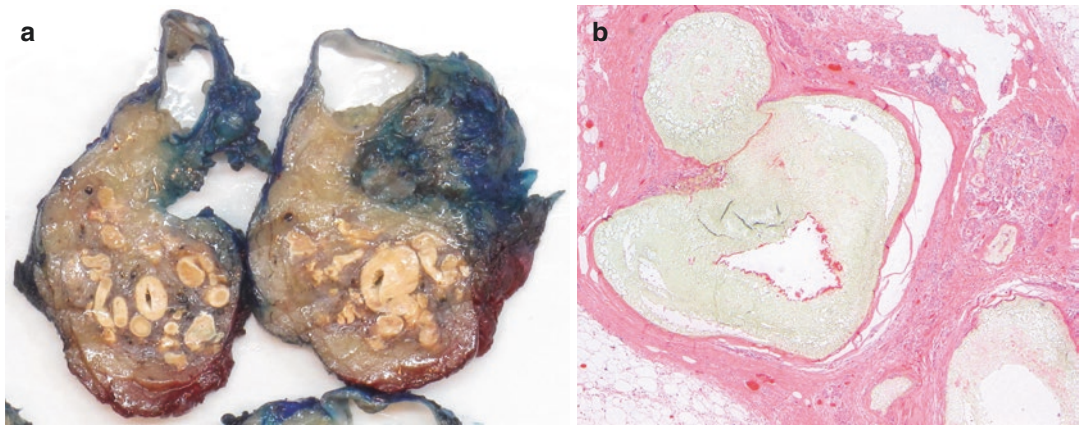

Fig. 3.13 Duct occlusion with non-biodegradable glue: the duct system of the pancreatic body and tail is occluded with a glue-like chemical substance (Neoprene ®) as a measure to prevent anastomotic leakage following pancreatoduodenectomy (**a**). The opaque material occludes pancreatic ducts, including small intralobular ducts. Note the complete atrophy of the acinar parenchyma with clustering of islets (**b**)

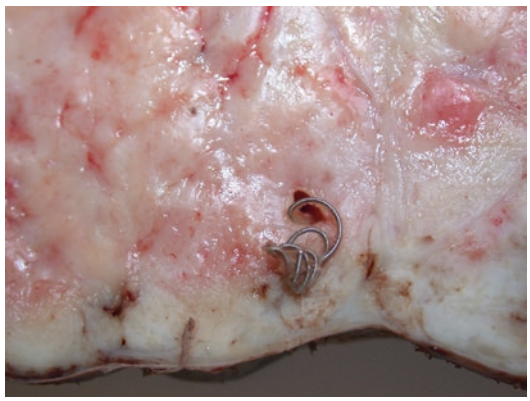

Fig. 3.14 Embolization coil: a metal coil protrudes from a blood vessel in a large, locally advanced pancreatic endocrine tumor. Emergency embolization for fulminant bleeding had been performed prior to distal pancreatectomy

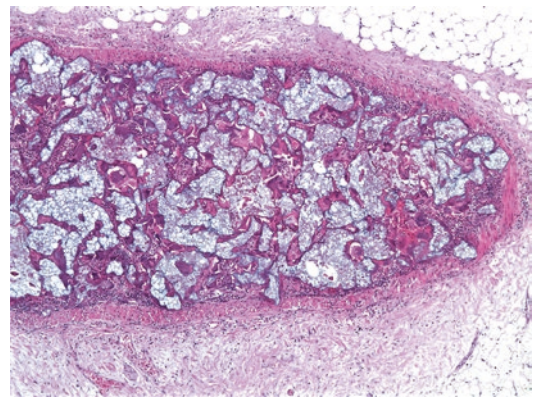

Fig. 3.15 Embolization material: histology reveals occlusion of the arterial lumen by injected embolization material

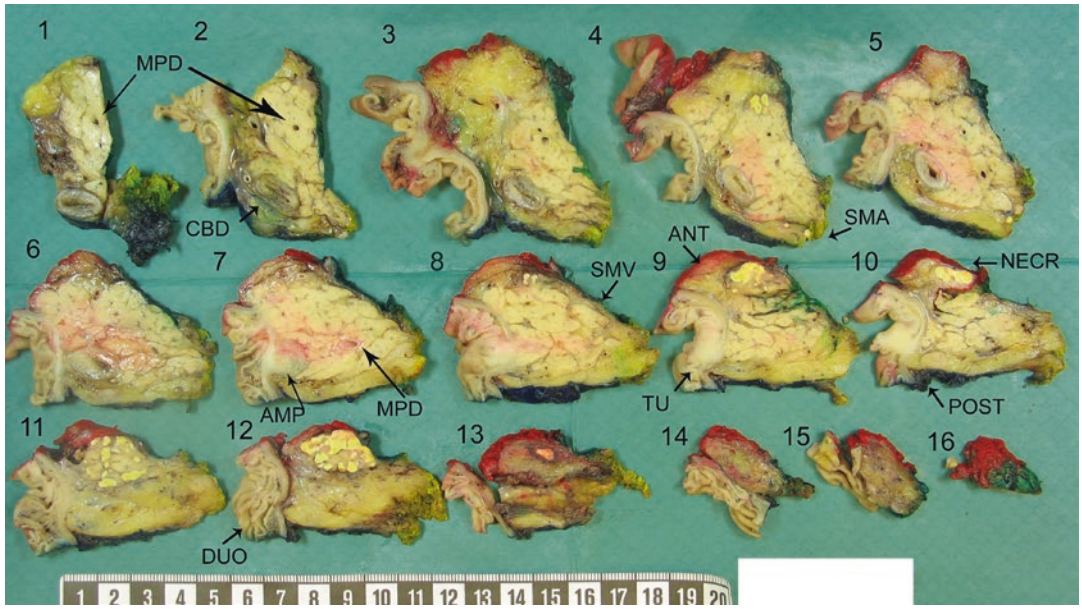

Fig. 3.16 Overview of specimen slices: following axial slicing of a pancreatoduodenectomy specimen, the slices are laid out in sequential order, from cranial to caudal, the inferior cut surface looking upward. The common bile duct (*CBD*) is seen in extrapancreatic position (slice 1–3) and in the posterior part of the pancreatic head (slices 4–6). The main pancreatic duct (*MPD*) can be followed from the pancreatic neck (slice 1) to the ampulla (slice 8). The ampulla (*AMP*) is represented in slices 7–8. In this case, a tumor involves the papilla of Vater (*TU*). Note the presence of multifocal fat necrosis (*NECR*). *ANT*: anterior surface, *DUO*: duodenum, *POST*: posterior surface, *SMA*: SMA-facing surface, *SMV*: SMV groove

knife is recommended, as it allows slicing in one swoop through the full width of the pancreatic head. As the axial specimen slices are produced, they can be laid out in sequential order from cranial to caudal, in a rectangular format that fills the camera viewer (Fig. 3.16) (see Sect. 3.3.6). To allow optimal correlation with preoperative imaging, the slices are best placed with the caudal surface showing up ('looking up to the slices from below').

3.3.5 Identification of Anatomy and Margins in Axial Specimen Slices

An important advantage of the axial dissection technique is that the pancreatoduodenectomy specimens are always sliced in the same (axial) plane and that therefore anatomical structures are present at the same position within the specimen slices. This greatly facilitates identification of anatomical structures, especially if these are altered in appearance or localization due to disease or anatomical variation. This section provides guidance on where in the specimen slices, the key anatomical structures can be found and, if appropriate, which specific macroscopic features allow their correct identification.

3.3.5.1 Pancreatic Duct System, Bile Duct, and Ampullae

The main pancreatic duct can be seen along its oblique descent from the pancreatic transection margin to the ampulla as an up to 3 mm wide, round or slightly collapsed, oval-shaped cross section (Fig. 3.17). Towards its distal end, the main pancreatic duct changes direction and runs in a nearly axial plane towards the ampulla, with the result that this particular part of the main pancreatic duct may be displayed as a more longitudinal section (see Chap. 1, Sect. 1.3.1.3, Figs. 1.2 and 1.6). If the main pancreatic duct is dilated significantly, the distal end of the duct

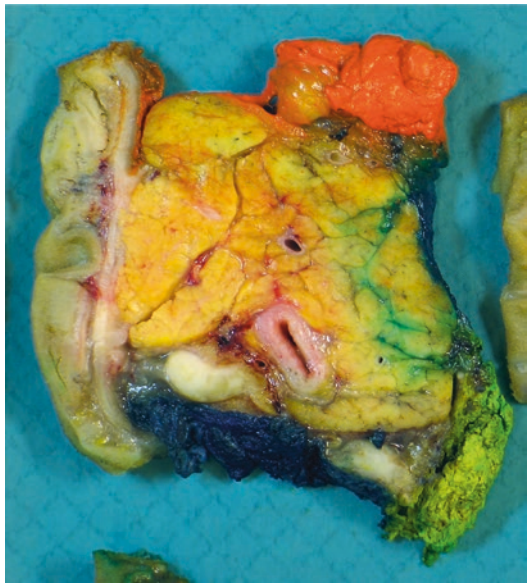

Fig. 3.17 Main pancreatic duct and common bile duct: the main pancreatic duct is small, has a membranous wall, and is located relatively centrally in the pancreatic head. The common bile duct is larger, has a thicker wall, and is located in the posterior aspect of the pancreatic head. Note the presence of two suspicious lymph nodes in the posterior pancreatoduodenal and SMA-facing fat

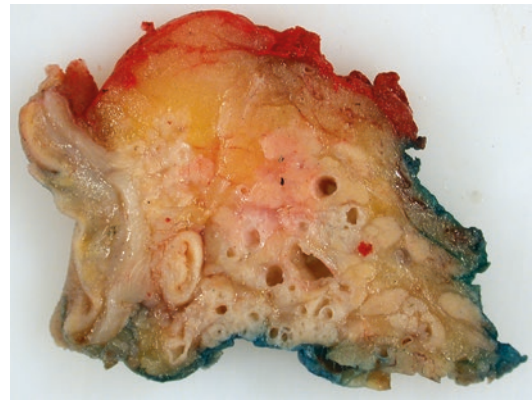

Fig. 3.18 Dilated pancreatic branch ducts: under normal conditions the pancreatic branch ducts are not visible macroscopically. This specimen slice contains multiple dilated branch ducts, whose diameter ranges from pinpoint to 2–3 mm. Cause of the branch duct dilatation in this case was focal chronic pancreatitis with stone formation

may be represented in a longitudinal fashion in more than one specimen slice. However, if the duct is of a normal caliber and the slices are thicker than 3 mm, this part of the pancreatic duct may remain hidden within a single specimen slice. In contrast to the intrapancreatic common bile duct, which runs through the posterior part of the pancreatic head, the main pancreatic duct is located more centrally within the pancreatic parenchyma. Santorini's duct may be visible close to the minor ampulla (see Chap. 1, Sect. 1.3.1.3, Fig. 1.7). Pancreatic branch ducts are not visible on gross inspection, unless they are pathologically dilated (Fig. 3.18), for example, in cases with duct obstruction or involvement by intraductal papillary mucinous neoplasia (see Chaps. 7 and 17).

The ampulla of Vater is usually present midway along the craniocaudal length of the pancreatic head, i.e., in one of the middle axial specimen slices, but there is considerable variation and in some cases, the ampulla of Vater may be found towards the caudal end of the pancreatic head. The full length of the ampulla—from its superficial part in the duodenal submucosa to its deep portion joining the distal common bile duct—is usually represented in two or three consecutive slices (Figs. 3.19 and 3.20) (see Chap. 1, Sect. 1.3.3, Fig. 1.9). Due to the configuration of the pancreatic and bile ducts as they approach the ampulla (see Fig. 1.2), the junction of the latter with the main pancreatic duct is usually represented in the slice caudal to the one containing the junction with the common bile duct.

In most pancreatic specimens the minor ampulla is visible as a nodular structure straddling the duodenal muscle layer. The size of the minor ampulla can vary, and prominence of this structure is often due to the presence of ectopic pancreatic tissue (see Chap. 1, Sect. 1.4.8). The minor ampulla (and associated Santorini's duct) is present in the specimen slice located approximately two levels above the slice containing the junction of the ampulla with the common bile duct.

The common bile duct can be followed over its entire extrapancreatic and intrapancreatic course, from the transection at the junction of the common hepatic duct with the cystic duct down to the junction with the ampulla (Fig. 3.20). The

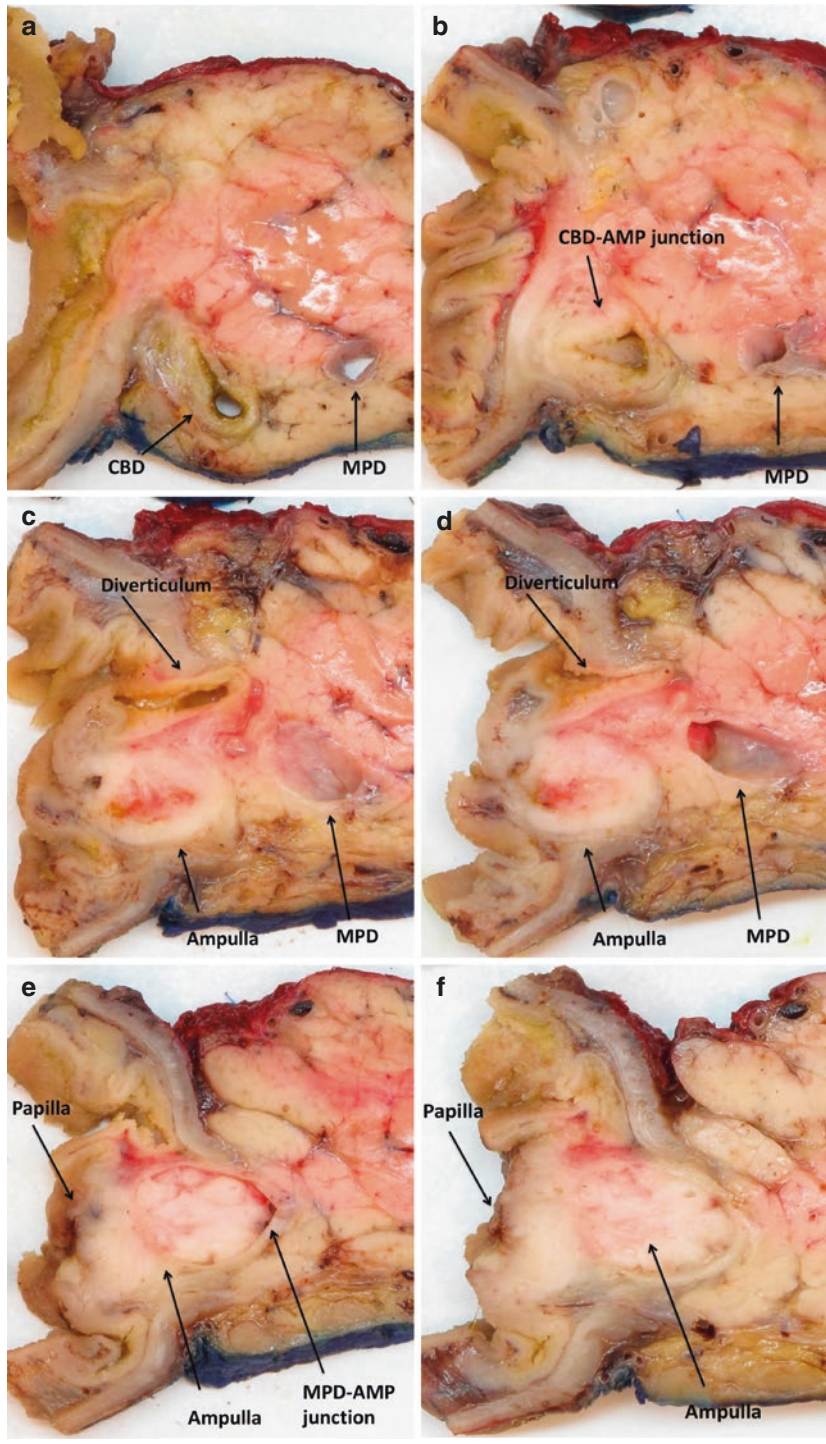

Fig. 3.19 Ampulla of Vater: in consecutive axial slices (in cranial-to-caudal sequence), the distal end of the main pancreatic duct (*MPD*) and common bile duct (*CBD*) can be seen to approach (**a**) and join the ampulla of Vater (*CBD-AMP junction*, **b**; *MPD-AMP junction*; **e**). Both ducts are dilated due to a tumor, which occludes the ampulla (**c**–**f**), protrudes into the distal pancreatic duct (**e**), and infiltrates the papilla of Vater (**f**). Note the presence of a small duodenal diverticulum that is located anterior to the ampulla (**c**, **d**) (Reproduced with permission from Verbeke and Gladhaug [2], Elsevier)

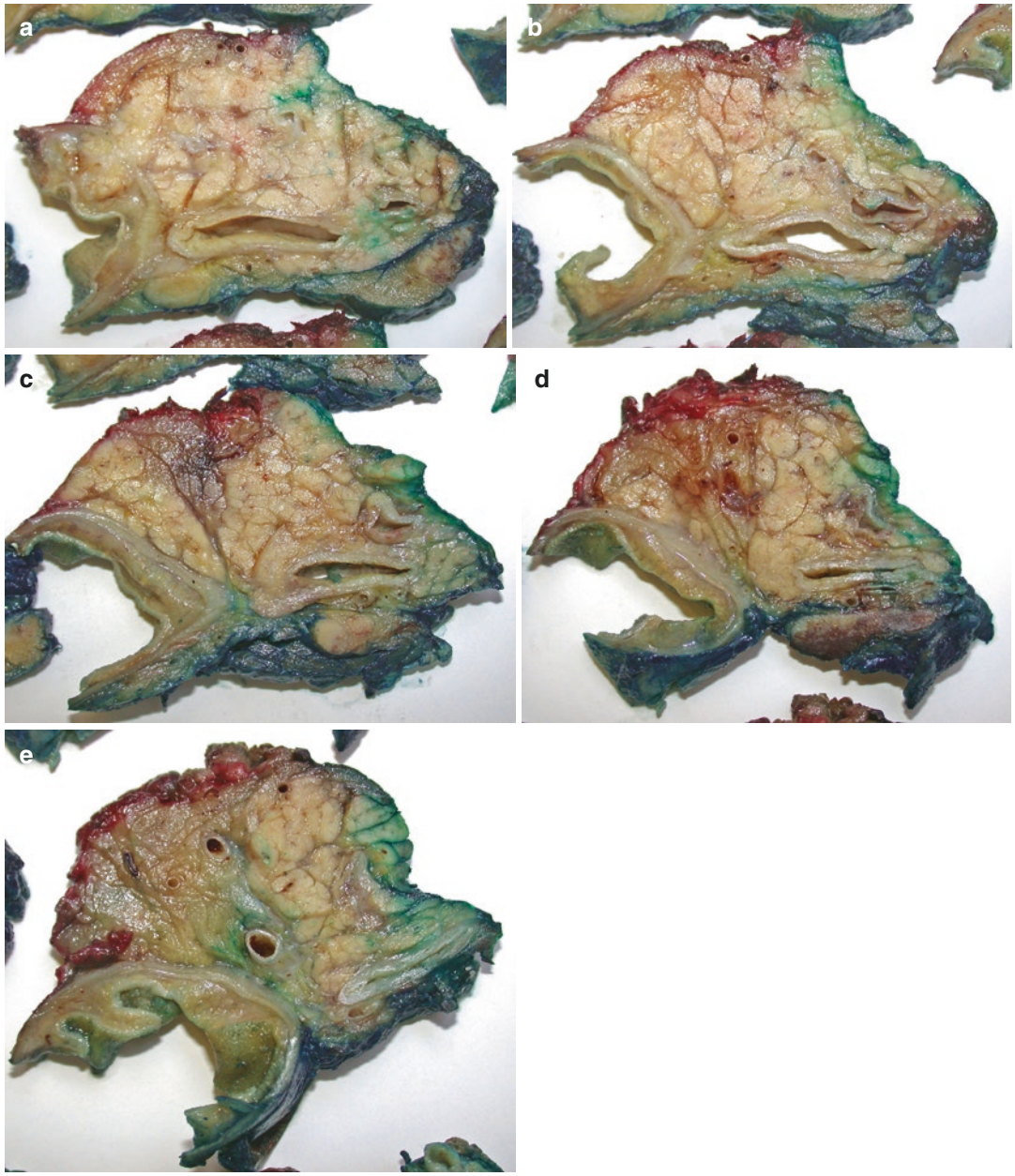

Fig. 3.20 Common bile duct: the course of the common bile duct can be followed in consecutive slices: close to the junction with the ampulla (**a**), in the posterior aspect of the pancreatic head (**b**–**c**), at the point of entry of the bile duct into the pancreas (**d**), and outside the pancreas (**e**). In this case the duct is dilated and only partially surrounded by pancreatic tissue

extrapancreatic part of the bile duct is contained in the most cranial specimen slices (Fig. 3.16), whereas the distal end of the bile duct is represented in the slice located above the one containing the ampulla of Vater and the junction with the main pancreatic duct (Fig. 3.19). The common bile duct runs through the posterior aspect of the pancreatic head and is therefore always located relatively close to the posterior specimen surface (Figs. 3.17 and 3.20). Large lymph nodes are

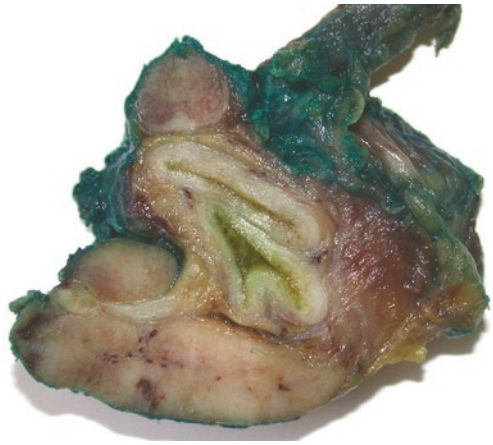

Fig. 3.21 Lymph nodes around the extrapancreatic common bile duct: the extrapancreatic bile duct at the junction with the cystic duct is surrounded by large reactive lymph nodes

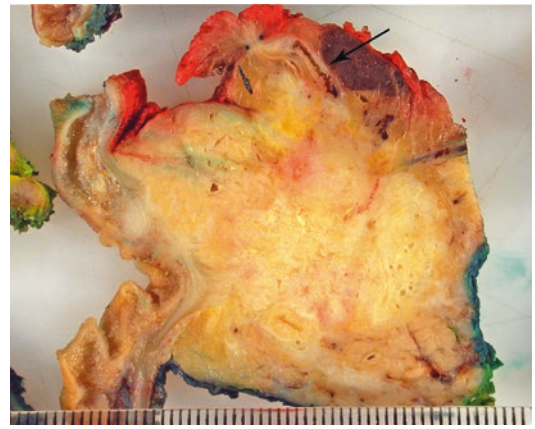

Fig. 3.22 Gastroduodenal artery: this artery is always included in the anterior peripancreatic fat of pancreatoduodenectomy specimens (*arrow*). In this case, pancreatic cancer grows close to the artery

often present in the soft tissue cuff surrounding the extrapancreatic common bile duct (Fig. 3.21).

3.3.5.2 Arteries and Veins

The gastroduodenal artery, which provides the main blood supply to the pancreatic head (see Chap. 1, Sect. 1.3.5), is the only large-caliber artery that is always contained in pancreatoduodenectomy specimens. It can be readily seen in the anterior peripancreatic soft tissue, where it runs over most of the craniocaudal length of the pancreatic head, and is thus represented in many of the axial specimen slices. (Fig. 3.22). Another artery that is contained in pancreatoduodenectomy specimens is the inferior pancreatoduodenal artery. It can be found in the caudal part of the pancreatic head, close to the SMA surface, where it sometimes appears as a small plexus of arterial cross sections (see Figs. 1.11 and 1.12). In selected patients, a segment of the superior mesenteric artery (SMA) may be resected, in isolation or in combination with a part of the superior mesenteric vein (SMV), and is then found adherent to the SMA-margin.

Surgical resection of a part of the superior mesenteric or portal vein during pancreatoduodenectomy (or total pancreatectomy) has become well established. Venous resections are found adherent to the SMV groove. They can vary in size from just a few millimeters across to several centimeters in length, and can be tangential or segmental (Figs. 3.8 and 3.23). Venous resections may be surrounded by irregular, tumor-infiltrated soft tissue (Fig. 3.24).

3.3.5.3 Specimen Surfaces and Margins

The contour of the axial specimen slices has a shape and configuration that is characteristic for each aspect of the pancreatic head (Fig. 3.25).

The anterior surface of the pancreatic head is typically curved in a convex fashion. Particularly in the more cranial slices, it can contain a rather copious amount of adipose tissue, which includes the gastroduodenal artery and some lymph nodes, and often blends with the peripyloric/perigastric fat. The junction of the anterior pancreatic surface with the anterior duodenal wall lies in a natural crevice, caused by the narrowing of the anteroposterior dimension of the pancreatic head as it adheres to the duodenal wall. The ‘anterior pancreatoduodenal crevice’ represents a site of possible margin involvement by tumors infiltrating the duodenal wall and ampullary area (Fig. 3.26) (see Chap. 9, Sect. 9.11.4, Figs. 9.44 and 9.45).

The surface facing the superior mesenteric vein and its junction with the portal vein has a shallow concave contour, the SMV groove.

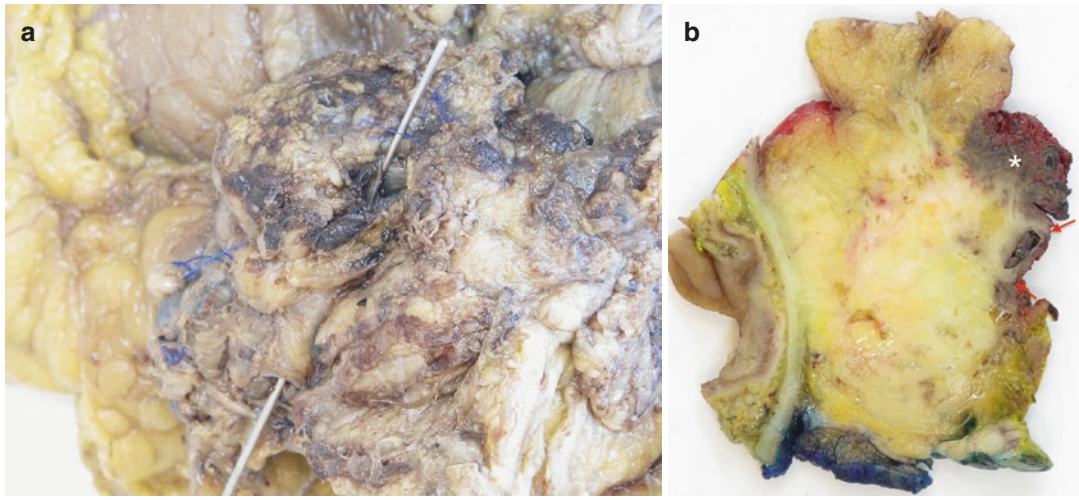

Fig. 3.23 Resection of the SMV: a 3 cm-long segment of the SMV is firmly adherent to the SMV groove just caudal to the transected pancreatic neck (**a**). An axial specimen slice shows that the segment of SMV is occluded with thrombus and its wall semicircumferentially infiltrated with tumor (*arrows*). Note the irregular, tumor-infiltrated soft tissue that flanks the venous resection (*asterisk*) (**b**)

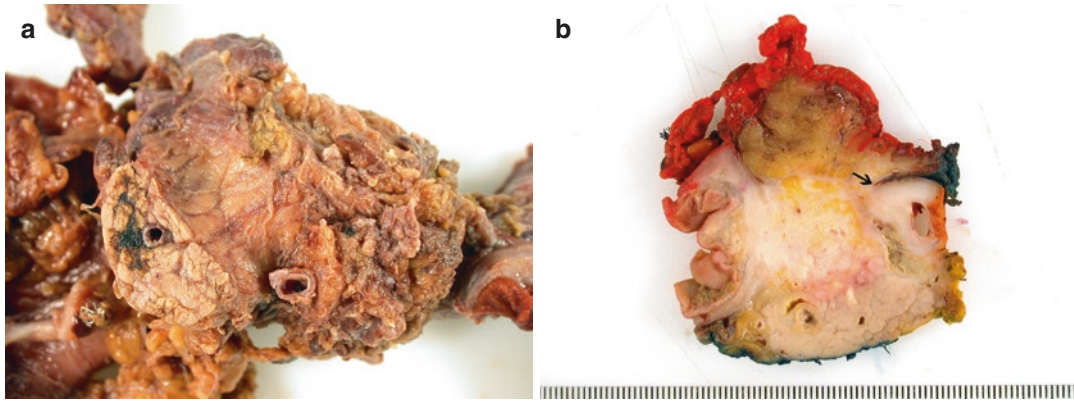

Fig. 3.24 Resection of the SMV: a segment of SMV, located caudal to the level of the pancreatic neck, is adherent to the SMV groove and surrounded by irregular tissue. Note the smooth surface of the SMV groove cranial to the venous resection (**a**). Full thickness of the venous wall is infiltrated by tumor and the segment of vein is drawn into the tumor mass. Note extension of tumor onto the SMV groove (*arrow*; **b**)

Peripancreatic soft tissue is very scanty or almost absent in this area, and consequently, pancreatic parenchyma lies almost immediately at this specimen surface (Fig. 3.25).

The surface facing the superior mesenteric artery (SMA margin) usually has an irregular outline, as this is a true surgical resection margin, where soft tissue is dissected from the artery. The adipose tissue at this specimen surface contains lymph nodes and is particularly rich in peripheral nerves and small lymphovascular channels (see Chap. 1, Sect. 1.4.6, Fig. 1.25).

The posterior margin has a flat contour and extends from the roughly textured SMA-margin to the posterior duodenal wall. Similar to the anterior pancreatoduodenal crevice, the posterior

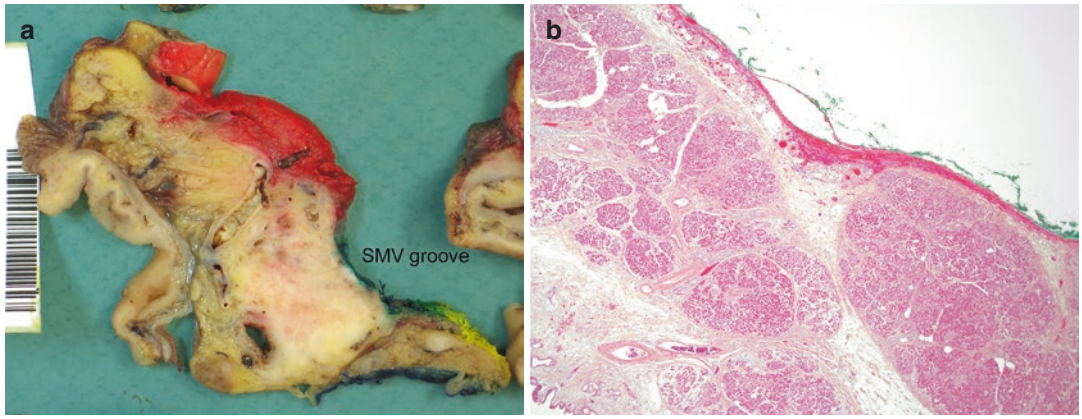

Fig. 3.25 Peripancreatic soft tissue: relatively copious adipose tissue can overlie the anterior (*red*), SMA-facing (*yellow*) and posterior surfaces (*blue*; **a**). In contrast, there is hardly any soft tissue between the pancreas and the SMV groove (**b**). Note the green ink on the SMV-facing surface, which is visible macro- and microscopically

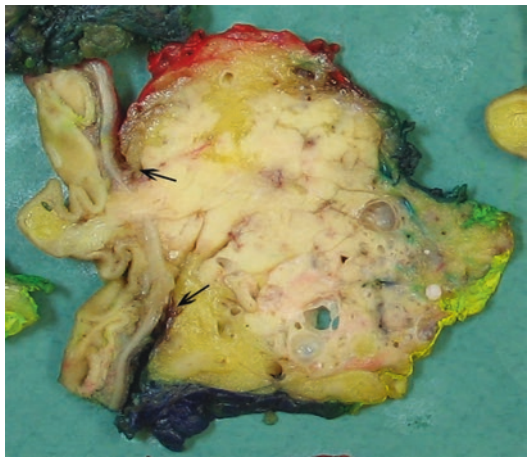

Fig. 3.26 Anterior and posterior pancreatoduodenal crevices: the pancreatic head narrows in the anteroposterior dimension where it meets the duodenum, resulting in a deep crevice anteriorly and posteriorly (*arrows*)

pancreatic margin turns often inward to meet the duodenal wall at the posterior pancreatoduodenal crevice (Fig. 3.26). Although less deep than the anterior crevice, this also represents a site of potential margin involvement, in particular for cancer developing in the ampullary region [8]. Lymph nodes are usually present in the posterior peripancreatic adipose tissue, which contains less numerous peripheral nerves and lymphovascular channels than are found in the neighboring SMA-facing soft tissue.

3.3.5.4 Lymph Nodes

Lymph nodes are present throughout the layer of soft tissue that envelops the pancreatic head and the extrapancreatic common bile duct. In Whipple's resection specimens, lymph nodes may also be contained in the infrapyloric and perigastric adipose tissues. The International Union Against Cancer (UICC) and the Japan Pancreas Society (JPS) have each proposed a system of lymph node allocation to different stations [1, 9, 10]. While (some of) the lymph node stations defined by JPS are often used in pancreatic surgery, pathology staging of lymph nodes is usually performed according to the UICC. Both lymph node systems differ in two aspects. First, the JPS system is more detailed than the UICC and allocates the lymph nodes to a larger number of different stations. A comparison of the stations as defined by both systems, and guidance on where these stations can be found in axial specimen slices, are summarized in Table 3.2 (Figs. 3.16 and 3.27). Second, the JPS uses a system of lymph node groups (group 1–3), which indicates whether certain lymph node stations are regional or distant to the primary tumor in the pancreatic head or body/tail. The UICC includes only lymph nodes that are regarded as regional (for cancer of the pancreatic head, body/tail, or both), but does not provide a grouping system for distant lymph node sites (see Table 9.4).

Table 3.2 Lymph node stations according to Japan Pancreas Society (JPS) [1, 10], their corresponding stations according to UICC [9], and their position in slices from pancreatoduodenectomy or distal pancreatectomy specimens

JPS lymph node stations	Corresponding UICC lymph node stations	Position in specimen slices from PDE	Position in specimen slices from DPE
6 Infrapyloric	Infrapyloric	In slice(s) cranial to top end of pancreatic head	NI
7 Left gastric artery	NM	NI (may be received separately)	
8 Common hepatic artery **a**: anterosuperior **p**: posterior	Common hepatic artery		
9 Celiac trunk	Celiac		
10 Splenic hilum	Splenic hilum	NI	At splenic hilum; in slices at distal end of pancreatic tail
11 Along splenic artery **p**: proximal **d**: distal	Splenic artery	NI	Along cranial border of pancreatic body/tail
12 Hepatoduodenal ligament **a**: along hepatic artery **p**: along portal vein **b**: along bile duct	12a: Common hepatic artery 12p: Portal vein 12b: Common bile duct	12a, 12p: NI (may be received separately) 12b: Around extrapancreatic bile duct in cranial specimen slices	NI
13 On posterior aspect of pancreatic head **a**: superior **b**: inferior	Posterior	Along posterior surface of pancreatic head	NI
14 Along SMA **p**: proximal **d**: distal	14p: Proximal mesenteric 14d: Right lateral wall of SMA	In peripancreatic soft tissue along SMA margin	NI
15 Along middle colic artery	NM	NI (may be received separately)	
16 Para-aortic **a1**: around aortic hiatus of diaphragm **a2**: from celiac trunk to LRV **b1**: from LRV to IMA **b2**: from IMA to aortic bifurcation	NM (Lateral aortic? Retroperitoneal?)		
17 On anterior aspect of pancreatic head **a**: superior **b**: inferior	Anterior	Along anterior surface of pancreatic head	NI
18 Along inferior border of body and tail of pancreas	Inferior	NI	Along caudal border of pancreatic body/tail

Abbreviations: *DPE* distal pancreatectomy, *IMA* inferior mesenteric artery, *JPS* Japan Pancreas Society, *LRV* left renal vein, *NI* not included in specimen, *NM* not mentioned in UICC staging system, *PDE* pancreatoduodenectomy, *SMA* superior mesenteric artery, *UICC* International Union Against Cancer

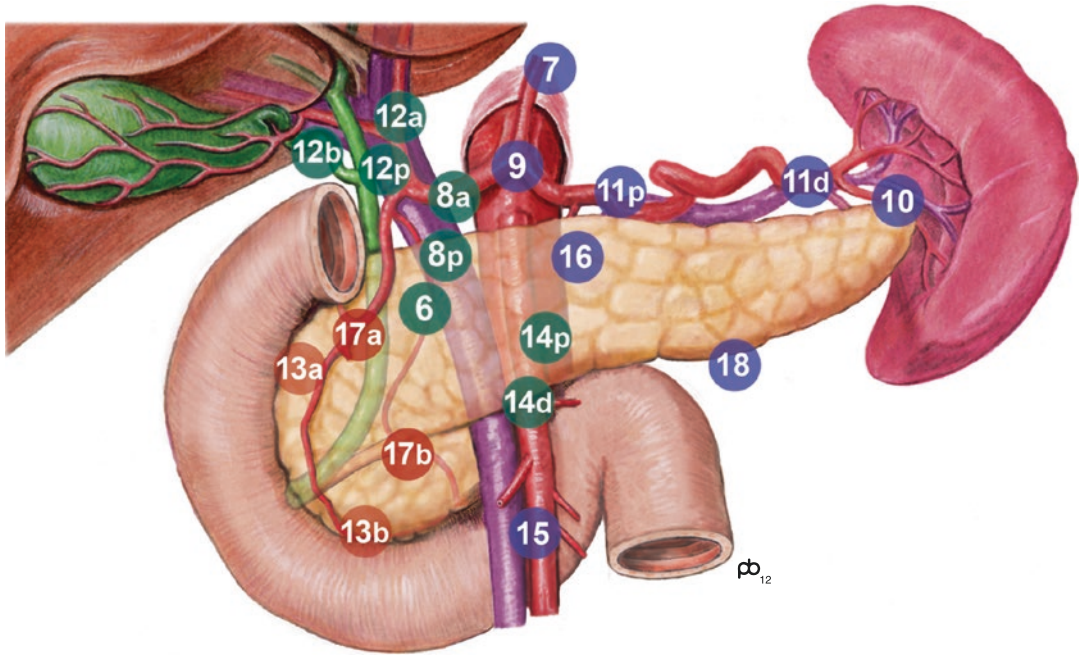

Fig. 3.27 Peripancreatic lymph node stations according to the Japan Pancreas Society (JPS) [1, 10]: lymph nodes are allocated to various stations (Table 3.2). *Red circles* indicate lymph nodes of group 1, i.e., lymph nodes that are removed by conventional pancreatoduodenectomy. Lymph nodes of group 2 (*green*) and 3 (*blue*) are more distant. Involvement of group 3 lymph nodes is regarded as distant metastasis (Image courtesy and copyright of Paul Brown, The Leeds Teaching Hospitals NHS Trust, Leeds, UK)

3.3.6 Photodocumentation

Photographs of the intact pancreatic resection specimen are usually uninformative, unless there are visible lesions on the gastroduodenal mucosa or at the specimen surface. However, overview photographs may be helpful in the case of multivisceral en bloc resections, enucleations, or central pancreatectomies.

Irrespective of the specimen type or the pathology encountered, photodocumentation of the specimen slices is of key importance as a permanent record of the macroscopic findings. As such, it allows retrospective review of the macroscopic part of the diagnostic process, which is equally important as and complements histological slide review for the provision of second opinion on an individual case or for systematic quality assurance. Photographs of specimen slices also provide useful guidance during microscopic assessment and allow re-consideration of macroscopic findings in the light of the histology, which is a powerful self-learning tool. Last but not least, the photographs are ideal for demonstration at clinicopathological conferences, as they allow direct comparison with radiological findings (see Chap. 4).

Photodocumentation should include an overview picture of all specimen slices along with close-up photographs of the slices that contain the main pathology and/or any other findings. Photographs—whether in overview or close-up—should always be taken as close as possible, that is, by filling the entire viewer area of the camera. A ruler and the specimen identification number should be included in all pictures.

3.3.7 Macroscopic Description: How and What to Record

As a general rule, during macroscopic inspection, any abnormality should be recorded with a description of its size, appearance, and exact localization. In addition, basic information should be provided regarding the main constituting specimen parts. A reporting checklist is provided in Table 3.3.

The *measurements* that can or should be recorded prior to specimen dissection include the length of the duodenum and distal stomach (along the greater and lesser curvature), and the length and maximum diameter of the gallbladder, cystic duct, and extrapancreatic common bile duct. The size of the pancreatic head is measured in three dimensions, that is, craniocaudal, mediolateral, and anteroposterior. The size, location, and appearance of any other tissues or organs that are included in the specimen, for example, a segmental resection of the superior mesenteric vein, should be recorded. Any abnormalities identified on external specimen inspection should also be included.

Table 3.3 Checklist for macroscopic reporting

• Specimen type
• Specimen dimensions: – Pancreas: craniocaudal, mediolateral, anteroposterior – Duodenum – Stomach – Extrapancreatic common bile duct: length and diameter – Gallbladder and cystic duct – Omentum – SMV resection (if present) – Other organs
• Stent: plastic/metal/none
• Total number of axial specimen slices
• Tumor: – Appearance: solid/cystic, color, texture, secondary phenomena (e.g., hemorrhage, calcification) – Size: craniocaudal (number of slices involved by tumor x slice thickness) and maximum axial dimensions – Localization: slices that are involved, which part of the pancreas (e.g., lateromedial, anteroposterior) – Relationship to key anatomical structures – Relationship to margins: which margins are close, minimum clearance
• Other findings: in pancreas or other structures and tissues
• Block key

Abbreviation: *SMV* superior mesenteric vein

The lesion that has been revealed by specimen dissection is described in terms of *appearance* (e.g., solid/cystic, color, texture, demarcation), size, and localization. The latter is important for accurate clinicopathological correlation and for identification of the cancer origin (i.e., pancreas, ampulla, or common bile duct) (see Chap. 9, Sect. 9.12.3). Using the axial slicing technique, *localization* in the craniocaudal dimension can be conveniently described by recording the number of the specimen slices that contain the lesion (e.g., slices 3-8). The localization in the anteroposterior and mediolateral dimension can be stated in form of a description of the quadrant that is involved (e.g., posterior-left lateral) or the proximity to anatomical structures (e.g., around the bile duct, flanking the SMV groove).

Similarly, the craniocaudal *size* of the lesion can be calculated from the number of slices that are involved, multiplied by the slice thickness. Both dimensions in the axial plane can be measured on the specimen slice where the lesion has reached its maximum extent. In the case of ductal adenocarcinoma of the pancreas, the characteristically poor delineation of the tumor requires that macroscopic 3-dimensional size assessment is verified and, if required, corrected by microscopic measurement.

Closely related to the localization and size of a lesion is its extension into neighboring tissues and structures. If possible, which structures and the extent to which these are involved, should be included in the description (e.g., the deep part of the ampulla, the anterior half of duodenal wall up to the submucosa, the entire circumference of the common bile duct from slice 2 to 5).

The goal is to provide an assessment of the lesion's localization and extent that mirrors the information in the radiology report, and, together with an accurate size measurement, allows a 3-dimensional reconstruction of the lesion within the pancreatic head [2, 8].

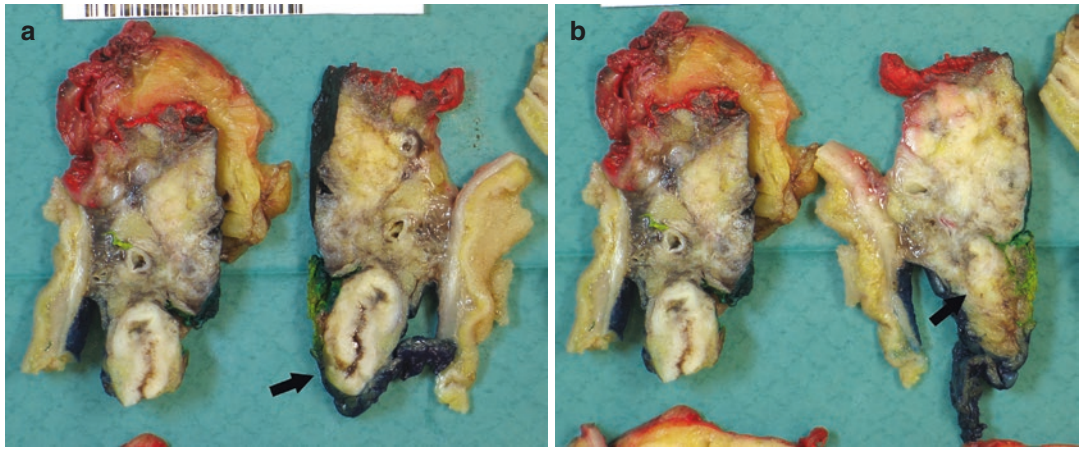

Fig. 3.28 Difference between the front and back of specimen slices: within the width of a single specimen slice of 3 mm thickness, the common bile duct (*arrow*) changes from being clearly identifiable (**a**) to being totally effaced by tumor (**b**)

The minimum distance of the tumor to the nearest specimen margins and surfaces is also part of the macroscopic assessment. However, this always requires microscopic measurement to determine the exact clearance.

Finally, it should be remembered that the most important structures in the pancreatic head—the ampulla, main pancreatic duct, and bile duct—are small, and, therefore specimen slices should be inspected on both sides. There may be significant differences in the appearances on either side, even if slices are thin (Fig. 3.28).

3.3.8 Tissue Sampling

The general rules for tissue sampling apply also to pancreatic resection specimens. The lesion of interest should be sampled adequately, and blocks should also be taken from the background pancreas and from any incidental findings. Specific guidance for the sampling of cystic tumors is discussed elsewhere (see Chap. 14, Sect. 14.2). This section provides a few practical recommendations that may facilitate tissue sampling from pancreatoduodenectomy specimens. Aspects of tissue sampling that are specific for distal pancreatectomy specimens and multivisceral resection specimens are described below (see Sects. 3.4 and 3.6).

Sampling is best performed following the *sequential order* of the specimen slices. The microscopic findings, and in particular the 3-dimensional reconstruction of the tumor location, size, and extent, are easier to capture and report, if the microscopic slides are lined up with the serial specimen slices (and macroscopic pictures). Therefore, sampling according to the tissue type (e.g., tumor first, then lymph nodes, followed by background tissue), as is best practice for many other cancers, is not recommended for pancreatic specimens. Tissue samples are best taken to include the lesion of interest together with neighboring anatomical structures, lymph nodes, or resection margins, such that both the nature of the lesion and its extent can be assessed in the same microscopic section. The structures or margins surrounding the lesion can also be used as anatomical points of reference, which allow unequivocal orientation of the microscopic slide.

Lymph nodes are not to be dissected out from the peripancreatic soft tissue, but left in situ and sampled together with the overlying specimen surface and, if appropriate, with other surrounding tissues. The color of the ink on the specimen surface together with the number of the specimen slice from which the sample was taken, allows unequivocal assignment of the lymph node to the various lymph node stations as defined by the UICC or the Japan Pancreas Society [1, 9], as

described above (see Sect. 3.3.5.4) (Fig. 3.27, Table 3.2). The localization or 'station' from which the lymph node stems does therefore not need to be recorded in the block key. Multiple counting of a lymph node that is represented in several consecutive specimen slices can be avoided by considering the shape, size, and location of the lymph node in both the microscopic section and the close-up photographs of the corresponding specimen slices. All lymph nodes should be sampled, not just the suspicious ones. An average minimum yield of 12 or 15 lymph nodes from pancreatoduodenectomy specimens has been suggested as a quality benchmark (see Chap. 9, Sect. 9.11.2). It is to be noted that perigastric lymph nodes are not represented in the axial specimen slices from the pancreatic head. Hence, they have to be dissected from the perigastric adipose tissue and embedded separately. On occasion, a few lymph nodes may be found in the sparse mesentery attached to the duodenum.

Considering the issues discussed above, it is recommended to divide axial specimen slices by simple rectilinear incisions into 4 or 5 parts, such that they can be accommodated in standard tissue cassettes (Fig. 3.29). Only the number of the specimen slice from which samples are taken needs to be included in the *block key*, while information regarding the site of tissue sampling does not require recording, because this will be obvious from the inked surfaces and the anatomical reference points, as outlined above. Overall, this sampling technique together with the help of close-up photographs from the specimen slices, provides maximum information for tissue orientation and macroscopic-microscopic correlation, thereby facilitating detailed reporting and case review. It also allows accurate microscopic measurement of the distance from the tumor to the various margins.

If possible, it is advisable to take (at least) one *whole mount sample* from the specimen slice that is most representative of the lesion in terms of size and extent. Alternatively, if whole mount block sampling is not available, the entire specimen slice can be embedded by dividing it into four to five parts, as described above.

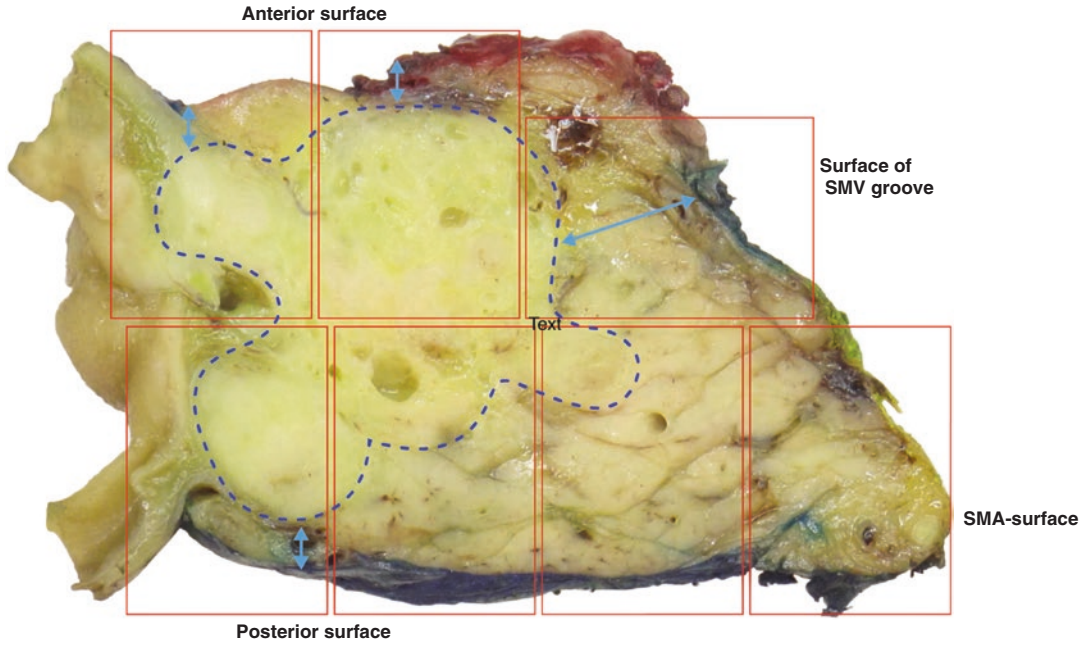

Fig. 3.29 Tissue sampling from a pancreatoduodenectomy specimen: an axial specimen slice is divided by rectilinear incisions into seven pieces that fit in standard tissue cassettes (*boxes*). The tissue samples allow accurate measurement of the tumor dimensions (*dotted line*) and the minimum distance to the various specimen surfaces (*double arrows*). The color of the ink on the specimen surface ensures unequivocal orientation of the tissue samples

In view of the generally poor delineation of pancreatic head cancers and the difficulty this poses for the macroscopic assessment of the tumor size and infiltration of anatomical structures and margins, the *extent of specimen sampling* is an important issue. This is particularly true for specimens from patients who have undergone neoadjuvant treatment, in which the tumor periphery is often even more blurred due to treatment-induced changes, such that subtotal or total embedding of the pancreas together with relevant adjacent tissues is required.

To allow microscopic verification and correction of the craniocaudal dimension of the tumor, samples should be taken from the specimen slices cranial and caudal to those containing the macroscopically apparent top and bottom end of the tumor. Regarding the assessment of the *margin* status, it has been shown that this is directly influenced by the number of samples taken from the tumor and the nearest circumferential margin [3]. The transection margins of pancreatoduodenectomy specimens are sampled en face, and in particular the margin at the pancreatic neck, is best sampled prior to axial specimen slicing.

Further samples may be required if the specimen includes additional tissues or structures. When a segment of superior mesenteric or portal *vein* is part of the surgical specimen, samples should be taken to assess whether and how deep the cancer has infiltrated the venous wall. Equally important is the examination of the margins of the resected vein and the adjacent SMV groove (see Chap. 9, Sect. 9.11.4). The resected vein is best sampled en bloc with the adjacent SMV groove and flanking pancreatic parenchyma, as this allows both accurate examination of the depth of tumor invasion of the venous wall and identification of involvement of the SMV margin and the circumferential margin of the resected venous tissue (Figs. 3.8, 3.23, and 3.24). In case of a long segmental venous resection, which is not adherent to the SMV groove over its entire length, both ends (i.e., transection margins) of the vein may be sampled separately as en face tissue slices.

Finally, tissue samples should also be taken from the background pancreatic parenchyma, ampulla, and bile duct to allow detection of microscopic pathological changes.

3.4 Dissection of Distal Pancreatectomy Specimens

Distal pancreatectomy specimens are best dissected by serial sectioning in 3 mm thick slices along a sagittal plane, that is, perpendicular to the longitudinal axis of the pancreatic body. Orientation of distal pancreatectomy specimens is based on the position of the splenic vessels, which run along the posterior surface of the pancreatic body and tail, the splenic artery cranial to the splenic vein (Fig. 3.30). Margins in this specimen type consist of the pancreatic transection margin, and the anterior and posterior surfaces of the pancreatic body and tail, which should also be

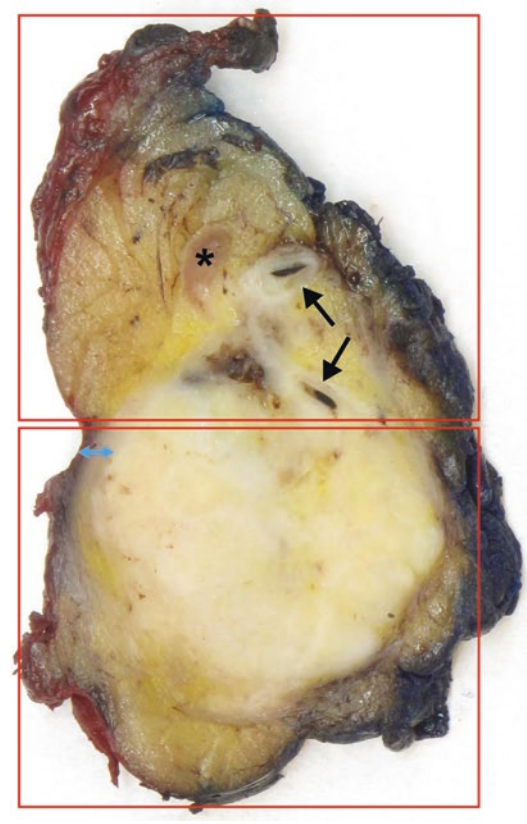

Fig. 3.30 Tissue sampling from a distal pancreatectomy specimen: in most cases, dividing the sagittal specimen slices in two results in tissue samples that fit in standard tissue cassettes. Note the tumor infiltration around the splenic artery and vein (*arrows*), the narrow clearance to the anterior surface (*double arrow*), and the presence of a small lymph node (*asterisk*)

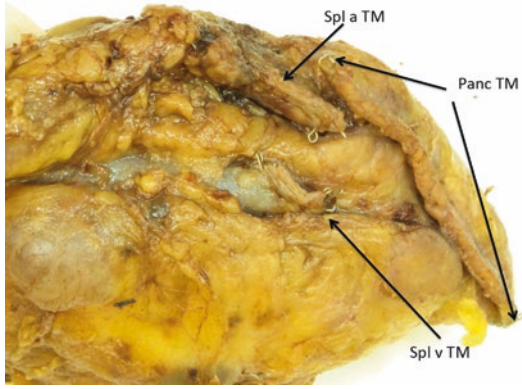

Fig. 3.31 Pancreatic and vascular transection margins: a view onto the posterior aspect of a distal pancreatectomy specimen shows the transection margin of the pancreatic body (*Panc TM*), the splenic artery (*Spl a TM*) and splenic vein (*Spl v TM*). All transection margins are stapled (laparoscopic procedure) (Reproduced with permission from Verbeke [11], Springer)

inked according to an agreed color-code. In addition, the transection margin of the splenic vessels may be of relevance in resection specimens with malignancy, in which case these structures are best inked with a different color and sampled en face (Fig. 3.31). The approach to photodocumentation, macroscopic description, and tissue sampling as described for pancreatoduodenectomy specimens can also be applied to distal pancreatectomy specimens.

3.5 Dissection of Total Pancreatectomy Specimens

For total pancreatectomy specimens a combined approach of axial slicing of the pancreatic head and sagittal slicing of the pancreatic body and tail is recommended. The point of transition between axial and sagittal slicing lies in principle at the level of the pancreatic neck but may be extended to either side if the tumor is located at or close to the pancreatic neck.

3.6 Dissection of Multivisceral En Bloc Resection Specimens

Extended surgical resection procedures are usually performed for tumors occurring in the pancreatic body and tail, and may include part of the stomach, the left adrenal, left kidney, or part of the colon (Figs. 3.32 and 3.33) (see Figs. 2.7, 2.8, and 9.3). Less frequently, a pancreatoduodenectomy may be extended by resection of the transverse mesocolon or a segment of small bowel (Fig. 3.34). Dissection is best undertaken following the standard protocol, that is, serial slicing in the sagittal plane for extended distal pancreatectomy specimens and axial slicing for extended pancreatoduodenectomy specimens. Important is prior inking of the various additional structures and organs in a color-coded fashion (Fig. 3.32) as well as meticulous recording of the relationship of the tumor to the various additional structures and their margins. En bloc tissue sampling of the tumor onto the additional structures and surfaces is key to the provision of an accurate record of the extent of the tumor and the margin status (Fig. 3.35). This information is also highly valuable for correlation with preoperative imaging and intraoperative surgical assessment.

3.7 Dissection of Other Pancreatic Specimen Types

Central pancreatectomy specimens (see Chap. 2, Sect. 2.6) are dissected in a similar fashion as distal pancreatectomy specimens, but require sampling and examination of both transection margins of the pancreas.

Resection specimens for chronic pancreatitis (see Chap. 2, Sect. 2.8) following the surgical procedures according to Frey may consist of irregular tissue fragments, which cannot be orientated, but whose entire surface can be

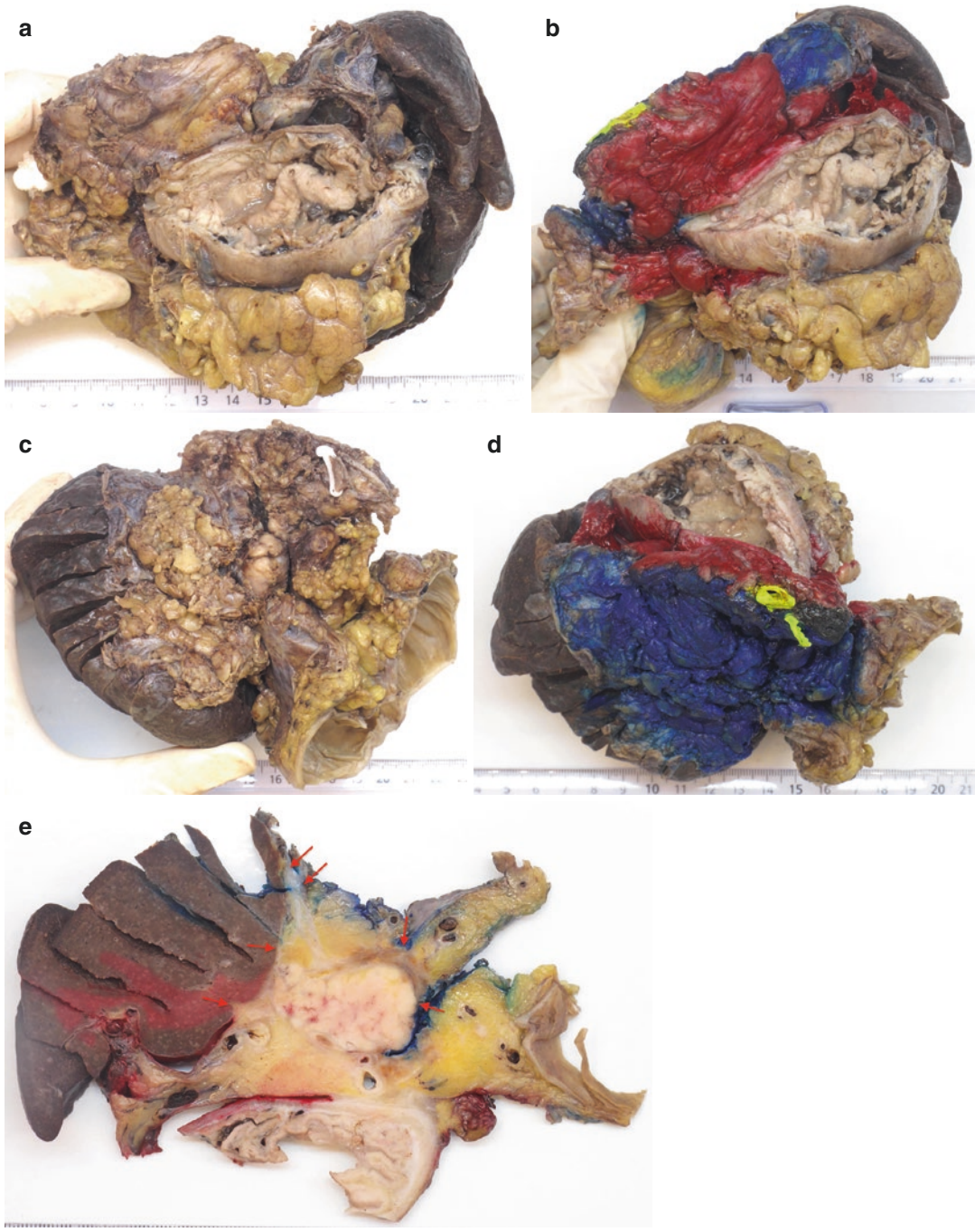

Fig. 3.32 Extended distal pancreatectomy specimen: this multivisceral distal pancreatectomy specimen includes a part of the stomach, which is adherent to the anterior surface of the tumor-bearing pancreatic tail (**a**). The anterior pancreatic surface is inked red (**b**). The posterior aspect of the specimen is irregular, and pale tumor tissue protrudes from it. A segment of colon that is adherent to the tumor is resected. Note the plastic clip and staple lines on the splenic artery and vein (**c**). The posterior surface of the specimen is inked blue, while the transection margins of the pancreatic body and splenic vessels are inked black and yellow, respectively (**d**). A sagittal specimen slice shows the close relationship of the tumor to the posterior margin and spleen (*arrows*), while the stomach and colon are clear (**e**)

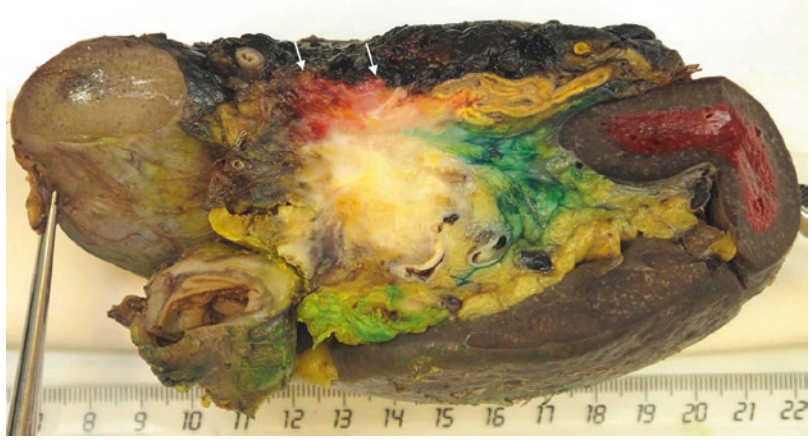

Fig. 3.33 Extended distal pancreatectomy specimen: sagittal slicing of this multivisceral specimen shows the spatial relationship of a tumor that arose in the tip of the pancreatic tail to the spleen, adrenal gland, left colon, and kidney. Note that tumor extends close to the posterior margin, which is inked black (*arrows*). Same specimen as shown in Fig. 2.7

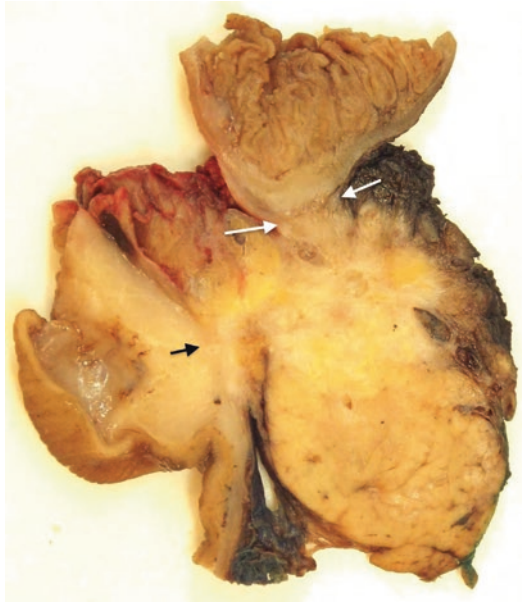

Fig. 3.34 Extended pancreatoduodenectomy specimen: an axial specimen slice reveals a tumor, which occupies nearly the entire mediolateral width of the pancreatic head and infiltrates the wall of the pylorus (*black arrow*) and the soft tissue adhesion to the small bowel (*white arrows*) (Reproduced with permission from Verbeke [2], Elsevier)

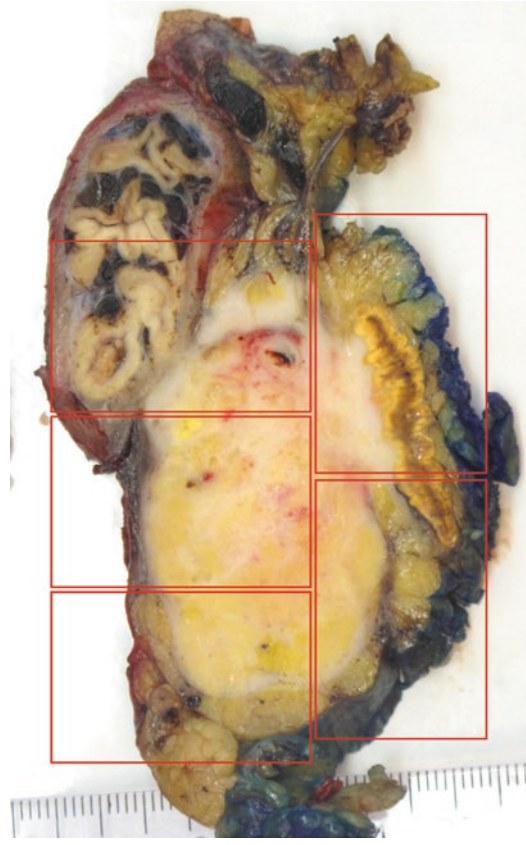

Fig. 3.35 Tissue sampling from an extended resection specimen: to allow meticulous assessment of the size of this pancreatic cancer and the relationship to the stomach, left adrenal gland, and specimen margins, the sagittal specimen slice is divided into rectangular samples (*boxes*) that fit into standard tissue cassettes

inked with a single color. The specimen from a procedure according to Beger results in a segment of pancreatic head and body, which may be received as one single or multiple smaller tissue fragments that, depending on size, should be serially sliced. All specimens from patients with chronic pancreatitis should be extensively sampled or, depending on the specimen size, embedded in their entirety, to exclude the presence of invasive ductal adenocarcinoma.

Enucleation specimens are best serially sliced after inking of the specimen surface. The extent of sampling from these specimens depends on the type of the lesion. However, as these specimens tend to be small, embedding the entire lesion may be considered.

3.8 Handling of Pancreatic Biopsies

The number and length of the trucut biopsies should be recorded. The biopsy sample is embedded in paraffin, sectioned, and stained with hematoxylin and eosin (H&E). In view of the small size of the biopsies and the sometimes limited representation of diagnostic lesions, cutting multiple spare sections at the time of the initial H&E(s) is good practice to safeguard tissue that may be needed for ancillary techniques.

3.9 Reporting Checklist of Macroscopic Findings

A list of data items to be recorded in the macroscopic description of pancreatic specimens is summarized in Table 3.3. The use of reporting proformas, which include the macroscopic findings, may be helpful to allow comprehensive, uniform, and time efficient reporting [6, 7, 12, 13].

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