Liver

10

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10.1 Anatomy

The liver, the largest gland in the body, is concerned with the production and secretion of bile and many metabolic functions crucial to normal homeostasis. The majority of it is surrounded by a peritonealized fibrous capsule and it is situated in the right upper quadrant of the abdomen for the most part under the cover of the ribs. It is divided into a large right and smaller left lobe by the attachment of the falciform ligament. The right lobe is further subdivided into the quadrate and caudate lobes by the gallbladder and the ligamentum teres (Fig. 10.1). However, this is a purely anatomical subdivison as it has been found that the quadrate and caudate lobes are actually a functional part of the left lobe, i.e., they are supplied by the left hepatic artery and left hepatic duct. This has led to a different division of the liver into surgical lobes and segments (see below).

The hilum of the liver, or *porta hepatis*, is found on the infero-posterior surface with the lesser omentum attached to its margin. Emerging from and entering the porta hepatis (from posterior to anterior) are the portal vein, right and left branches of the hepatic artery, the right and left hepatic ducts, and autonomic nerves.

Histologically the liver is composed of lobules (Fig. 10.1). Each lobule comprises a central vein (a tributary of the hepatic veins) with the portal tracts situated at the periphery. The portal tracts contain a branch of the hepatic artery, portal vein, and bile duct. Each lobule is divided into triangular-shaped *acini* with terminal branches of the hepatic artery and portal vein at their bases and the central vein at the apex. The acinus is divided into three zones (zone 3 being the most remote from the blood supply). The liver cells (hepatocytes) are arranged in anastomosing cords, with those adjacent to the portal tract forming the limiting plate.

Between the cords of liver cells are vascular channels (sinusoids) lined by a discontinuous layer of endothelial cells. These sinusoids carry blood (both arterial and portal) from the portal tract to the central vein. Channels (canaliculi) formed between adjacent hepatocytes conduct bile to the ducts in the portal tracts and then to the extrahepatic bile ducts and gallbladder.

Lymphovascular drainage:

The liver receives 30% of its blood from the hepatic artery (oxygenated blood), the remaining 70% being supplied by the portal vein (venous

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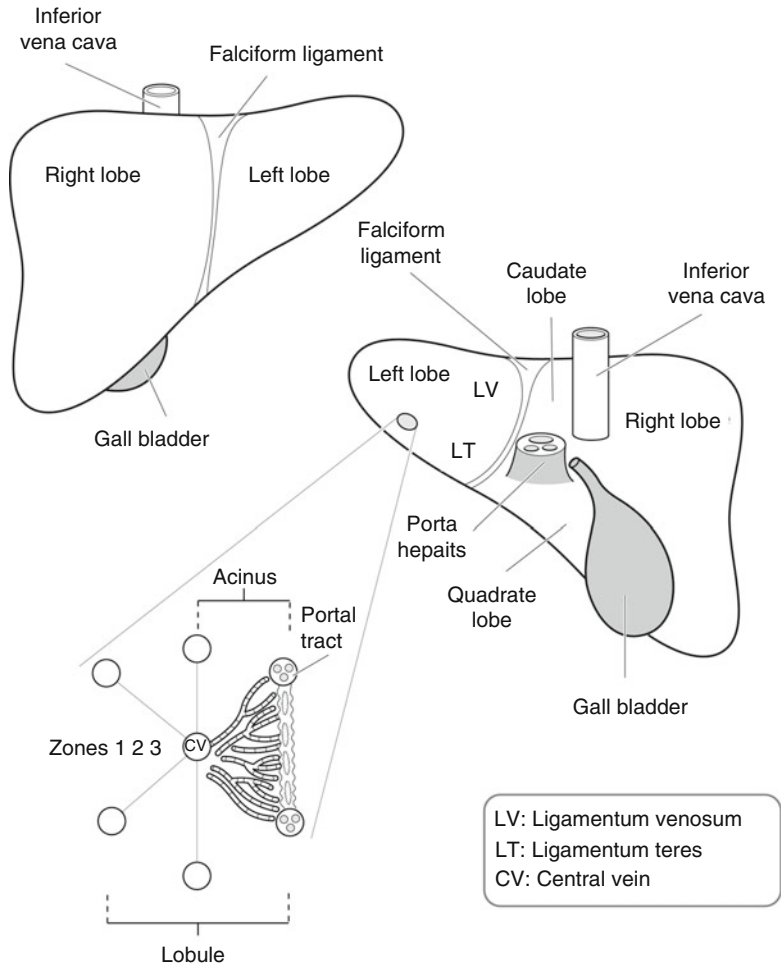

Fig. 10.1 Liver anatomy and histology (Reproduced, with permission, from Allen and Cameron (2004))

blood rich in nutrients absorbed from the gut). The blood is conducted through the sinusoids from the portal tracts to the central veins, which in turn drain into the hepatic veins and ultimately the inferior vena cava. Most of the lymphatics drain to nodes in the porta hepatis (hepatoduodenal ligament) and then pass to the celiac nodes. A small number pass through the diaphragm into the posterior mediastinum.

10.2 Clinical Presentation

Patients with liver disease may be asymptomatic. The most common clinical sign is jaundice, although other stigmata of chronic liver disease such as spider nevi, finger-clubbing, gynecomastia, etc. may also be present. If the jaundice is obstructive, then the patient will have dark urine and pale feces. Weight loss, anorexia, anemia, and ascites may suggest cirrhosis and/or an underlying malignancy. Fever and rigors may be seen if an abscess is present. Hepatomegaly may be encountered in numerous conditions including cirrhosis and malignancy.

A careful clinical history including medication (prescription and otherwise), alcohol intake, foreign travel, and sexual practice is diagnostically invaluable to the pathologist.

10.3 Clinical Investigations

- U&E – electrolyte imbalance may occur and hyponatremia (low sodium) is a poor prognostic sign in liver failure.

- Liver function tests (LFTs) – these should include tests for liver secretory capacity (bilirubin, alkaline phosphatase, and gamma glutamyl transferase (αGT)); synthetic capacity (albumin) and inflammation (aspartate aminotransferase (AST) and alanine aminotransferase (ALT)).
- Coagulation screen – measures clotting potential and as such is a test of hepatic function (synthesis of clotting factors).
- Serology – viral titres of hepatitis A–E.
- Autoimmune screen – including anti-mitochondrial, anti-smooth muscle, and antinuclear antibodies.
- Serum immunoglobulins.
- Specific tests – serum iron, ferritin, total iron-binding capacity (TIBC), and HFE gene analysis (genetic hemochromatosis); serum and urinary copper (Wilson's disease); serum alpha-1 antitrypsin (alpha-1 antitrypsin deficiency).
- Tumor markers – alpha fetoprotein (AFP: hepatocellular carcinoma); CEA (metastatic colorectal carcinoma).
- CXR – may detect primary lung tumor (which has metastasized to the liver).
- AXR – may show calcification around a hydatid cyst.
- USS – shows dimensions of intra- and extrahepatic bile ducts; useful in demonstrating both primary and metastatic tumors (colorectal metastases have a characteristic echogenic picture).
- CT scan – used to further define the nature and anatomical relationships of a lesion diagnosed by USS. CT PET can distinguish metabolically active metastatic tumor from benign or necrotic lesions.
- Radioisotope scanning – this provides information on the liver texture and is useful in diagnosing cirrhosis or multiple tumors (if >2 cm). Tumors will have decreased uptake.
- Angiography – hepatic artery angiography can be used to delineate the vascular anatomy of a tumor prior to resection. It is the most sensitive method of diagnosing hepatocellular carcinoma and is useful in ensuring that a metastasis, which is considered for resection, is indeed a single deposit. It will also allow the extent of a vascular tumor to be mapped and, if indicated, embolized. An inferior venogram will establish if the inferior vena cava is involved by tumor prior to any resection.
- Peritoneal aspiration – may detect malignant cells in ascitic fluid.
- FNAC – percutaneous under USS/CT guidance.
- Needle core biopsy – Tru-cut needle biopsy under USS/CT guidance can be carried out on focal lesions which have given a poor yield on FNAC. A biopsy of "normal" parenchyma adjacent to the lesion will show the state of background liver disease which may provide a clue to diagnosis (e.g., association of cirrhosis and hepatocellular carcinoma) and may rule out any attempt at resection. Diagnosis of hepatocellular carcinoma is often based on a combination of serum AFP and appropriate radiological features avoiding the need for biopsy. A needle core biopsy may also be performed on a suspicious lesion during laparotomy. Alternatively diffuse medical liver conditions can be sampled percutaneously and blind by a needle (16–18 G).
- Staging laparoscopy with biopsy.

10.4 Pathological Conditions

Patients with liver disease may present with signs of liver failure or complications of it, e.g., esophageal varices or because of biochemically detected abnormal LFTs. The latter can indicate whether the pattern of damage is hepatic (parenchymal), extrahepatic (obstructive) or mixed in nature. Hepatic assault is typified by viral hepatitis, alcohol or drug damage, and extrahepatic disease by duct obstruction due to stones or tumor, e.g., head of pancreas. Mixed biochemical profiles are not infrequently seen in these various disorders. Needle core biopsy is interpreted in close correlation with full clinical information that includes a detailed history and wide range of investigations (see above). Its aims are to distinguish between a surgical and medical cause for the damage, and, in non-neoplastic

conditions, to assess the degree of necroinflammatory activity that is present and the reparative response of the liver to it. It also establishes a baseline against which subsequent treatment can be assessed or indicated, e.g., interferon therapy in chronic viral hepatitis.

Liver damage has potential to resolve, but if it is unresponsive to treatment or ongoing, a nonspecific, end-stage or cirrhotic pattern may be reached with few histological clues as to its etiology. It is due to lobular damage and collapse of its framework with fibrous repair expanding and linking portal tracts with each other and the central veins. This micronodular (<0.3 cm diameter) or macronodular pattern disturbs liver function and also its internal vascular relationships. As a consequence, liver failure (jaundice, anemia, generalized edema, and ascites due to hypoalbuminemia, hepatic encephalopathy) and portal venous hypertension with the risk of catastrophic hemorrhage from esophagogastric varices can ensue. In neoplasia or hepatic mass lesions, the biopsy may be for diagnostic purposes to distinguish between hepatocellular carcinoma, metastatic carcinoma, malignant lymphoma and abscess, or, for staging of known primary tumor elsewhere, e.g., colorectal carcinoma. The information accrued is then factored into future management decisions.

10.4.1 Non-neoplastic Conditions

Viral hepatitis: Commonly hepatitis A, B, C, D, or E (hepatotropic viruses). Hepatitis A (feco-oral transmission) is usually of short duration, self-limiting without sequelae, and not biopsied. Hepatitis B and C (transmission by blood, serum, secretions – hepatitis D is often a cofactor) are strongly associated with blood transfusion, sharps injuries, and shared needles in drug abusers. Occasionally there is acute fulminant hepatitis, but a significant minority go on to chronic carriage of viral antigen that can lead to chronic active hepatitis (>6 months clinical duration) with eventually cirrhosis and hepatocellular carcinoma. Diagnosis is by positive serology matched to distinctive histological features (e.g., portal tract lymphoid follicles and bile duct damage in hepatitis C) which are also graded (the degree of necroinflammation) and staged (the absence or presence of fibrosis/cirrhosis) as a gauge of need for treatment, treatment response, and/or evolution of disease. Tissue localization of viral antigens can be demonstrated immunohistochemically or by in situ hybridization. Hepatitis E (feco-oral transmission, epidemic, or sporadic) can cause a mild, cholestatic hepatitis (resembling hepatitis A) or fulminant disease with decompensation, particularly in those with preexisting liver disease.

Alcohol (C_2H_5OH): Chronic excess alcohol intake is a common etiological factor in liver disease and is noted for variable individual susceptibility to it. Its hepatotoxic effect causes a spectrum of change from simple steatosis (fatty change), alcoholic steatohepatitis (lobular necroinflammation with ballooning and Mallory's hyaline – tufts of intracytoplasmic intermediate filaments) to perivenular fibrosis, cirrhosis, and hepatocellular carcinoma. Abstinence short of the stage of cirrhosis leads to potential reversibility of even severe damage. Similar morphological features are seen in NASH (non-alcoholic steatohepatitis) commonly associated with hypertension, diabetes mellitus, and obesity (metabolic syndrome), and also gut bypass procedures and some drugs.

Drugs: The vast majority of drugs are metabolized in the liver and cause damage either due to excess dosage (actual or apparent due to preexisting decreased liver function) or individual idiosyncratic reaction to them. Various effects are seen with different agents: steatosis, cholestasis (commonest), granulomas, necrosis, hepatitis, veno-occlusion, and peliosis (dilated blood channels). Location of damage varies within the acinar zones related to the blood supply and the particular agent involved. Diagnosis is strongly dependent on an appropriate clinical history and chronology of drug usage correlating with the liver dysfunction. Common agents are – tricyclic antidepressants (chlorpromazine), methotrexate, NSAIDs, anesthetic agents (halothane), antibiotics (tetracyclines, erythromycin), and paracetamol.

Autoimmune and cholangiodestructive diseases: Characteristically in late middle-aged females, autoimmune hepatitis is associated with a range of autoantibodies, including antinuclear and anti-smooth muscle antibodies, and is steroid

responsive. In this respect, it is of paramount importance to separate it from an infective hepatitis in which steroids are contraindicated. Primary biliary cirrhosis, some cases of which overlap with autoimmune hepatitis, affects a similar patient demographic and is a non-suppurative, destructive, granulomatous disorder of bile ducts that leads to their disappearance (ductopenia), fibrosis and ultimately cirrhosis. Serum IgM antimitochondrial antibody is typically elevated and progress can be gradual over a long time period, treatment being with ursodeoxycholic acid to reduce bile acid accumulation and symptomatic to relieve related itch. Primary sclerosing cholangitis can affect intra- or extrahepatic bile ducts with a chronic inflammatory infiltrate and surrounding fibrosis, leading to obstructive tapering of the ducts and their eventual disappearance. Diagnosis is often by endoscopic retrograde cholangiopancreatography (ERCP). There is a strong association with ulcerative colitis and predisposition to cholangiocarcinoma.

Systemic diseases: The liver can be involved in many other generalized conditions, e.g., diabetes, celiac disease, Crohn's disease, systemic vasculitis, amyloid (primary or secondary, e.g., due to rheumatoid arthritis) and hereditary disorders such as glycogen storage diseases, alpha-1 antitrypsin deficiency, cystic fibrosis, Wilson's disease (defect of copper metabolism) and hemochromatosis (defect of iron metabolism).

Focal mass lesions: These need to be distinguished radiologically and histocytologically from neoplastic conditions (see below) and include simple sporadic cysts (often biliary in origin), multiple simple cysts (polycystic disease of liver and kidneys), infective cysts, abscess, hemangioma, and focal nodular hyperplasia. Abscess may arise from septicemia, acute cholecystitis, or portal pyemia after perforated appendicitis or diverticulitis. Focal nodular hyperplasia is usually solitary in young-to-middle-aged women and has a central stellate fibrous scar containing proliferating bile ducts. It is considered to be a localized vascular abnormality, its main differential diagnosis being hepatocellular adenoma and well-differentiated hepatocellular carcinoma. Bile duct adenoma and hamartoma (von Meyenberg complex) are usually encountered as small, pale, subcapsular nodules at laparotomy, e.g., at staging of gastric carcinoma and submitted as a wedge biopsy for frozen section to exclude metastatic cancer deposits.

10.4.2 Neoplastic Conditions

Adenoma: Rare, causing acute abdominal presentation due to lesional hemorrhage in a middle-aged female with a history of oral contraception. Devoid of portal tracts or central veins within the nodule but lack of cellular atypia and preservation of the pericellular reticulin pattern and liver cell plates – these features help distinguish it from well-differentiated hepatocellular carcinoma.

Macroregenerative or dysplastic nodules: Irregular nodules in background cirrhosis, 1–3 cm diameter with cytoarchitectural atypia and potentially premalignant.

Hepatocellular carcinoma: Often in background cirrhosis, and serum AFP is elevated in 25–40% of cases. Single, diffuse or multifocal, bile stained, and prone to venous invasion with metastases to lung, adrenal gland, and bone. The commonest patterns are trabecular, plate-like, or sinusoidal comprising variably differentiated hepatoid cells.

A minority are encapsulated, pedunculated, or, in a younger patient, fibrolamellar in type, these variants having a better prognosis than usual hepatocellular carcinoma.

Cholangiocarcinoma (*intrahepatic*): Scirrhous, solitary, or multifocal adenocarcinoma with a ductuloacinar pattern and predisposed to by primary sclerosing cholangitis, ulcerative colitis, liver fluke, and biliary tree anomalies.

Metastatic carcinoma: Commonly from gastrointestinal tract, lung, and breast, there are some characteristic clues as to origin.

Colorectum – multiple, large nodules with central necrosis/umbilication, ± mucin ± calcification

Gallbladder – bulk of disease centered on the gallbladder bed

Lung – medium-sized nodules

Stomach, breast – medium-sized nodules or diffuse cirrhotic-like pattern

Note that carcinoma rarely metastasizes to a cirrhotic liver.

Other cancers: Carcinoid (well-differentiated endocrine) tumor metastatic from gastrointestinal tract (particularly ileum), pancreas or lung, malignant lymphoma (portal infiltrates or tumor nodules), leukemia (sinusoidal infiltrate), angiosarcoma, epithelioid hemangioendothelioma.

Prognosis: In hepatocellular carcinoma, this relates to size (>5 cm), differentiation, encapsulation, multifocality, high serum AFP levels, vascular invasion, and the presence of background cirrhosis (adverse). The majority die within several months of presentation and 5-year survival is at most 5–10%. Chemotherapy, chemoembolization, or radiofrequency ablation are used palliatively. Small tumors, encapsulated, pedunculated, and fibrolamellar variants are potentially curable by resection or local ablation. Few patients with cholangiocarcinoma survive longer than 2–3 years due to late presentation and limited resectability. Solitary metastases, e.g., colorectal carcinoma or carcinoid tumor can be resected to good effect. Metastatic carcinoid tumor can show good chemoresponsiveness.

10.5 Surgical Pathology Specimens: Clinical Aspects

10.5.1 Biopsy Specimens

FNAC and needle core biopsy can be carried out percutaneously either blind or preferably under radiological guidance, during laparoscopy, laparotomy, or as a radiologically guided transvascular (vena cava) procedure. Coagulation status is checked prior to core biopsy to avoid risk of hemorrhage.

10.5.2 Resection Specimens

10.5.2.1 Neoplastic Lesions

The key to successful hepatic resection of malignant disease is careful patient selection. In general:

- A primary liver tumor may be considered for resection if it involves a single lobe and there is no invasion of the portal vein or inferior vena cava. There should be no evidence of cirrhosis in the surrounding liver.
- A solitary metastatic deposit (the vast majority of which will be from a primary colorectal carcinoma) localized to a single lobe may be considered for resection. There should be no evidence of metastatic spread elsewhere and the primary tumor should have been adequately excised. More recently, this criterion has been extended to include multiple hepatic metastases provided resection is technically feasible leaving sufficient functioning hepatic remnant. Use of neoadjuvant chemotherapy, intravascular embolization, or radiofrequency ablation facilitates operative resection by downsizing the tumor deposits.

Obviously the background physiological state of the patient has to be taken into account before surgery is considered, i.e., resection is only justified in relatively young and medically fit individuals.

As was stated above, the liver is divided into right and left "surgical lobes," which are different to the anatomical lobes. The surgical lobes are separated along a plane which extends from the gallbladder bed to the inferior vena cava – the main portal plane. The surgical lobes are then subdivided into eight segments – each segment is supplied by its own portal venous and hepatic arterial pedicle (Fig. 10.2).

Major Liver Resection

An S-shaped right subcostal incision is used in all cases and once the abdomen is opened an initial laparotomy examination is done to ensure no other metastatic deposits are present. The definitive type of resection will depend on the site and extent of the tumor.

- *Right hepatectomy* – In this the right surgical lobe is resected by transecting the liver through the main portal plane (main portal scissura). The cut surface of the residual liver is sprayed with thrombin glue to reduce postoperative blood loss and especially bile leakage.

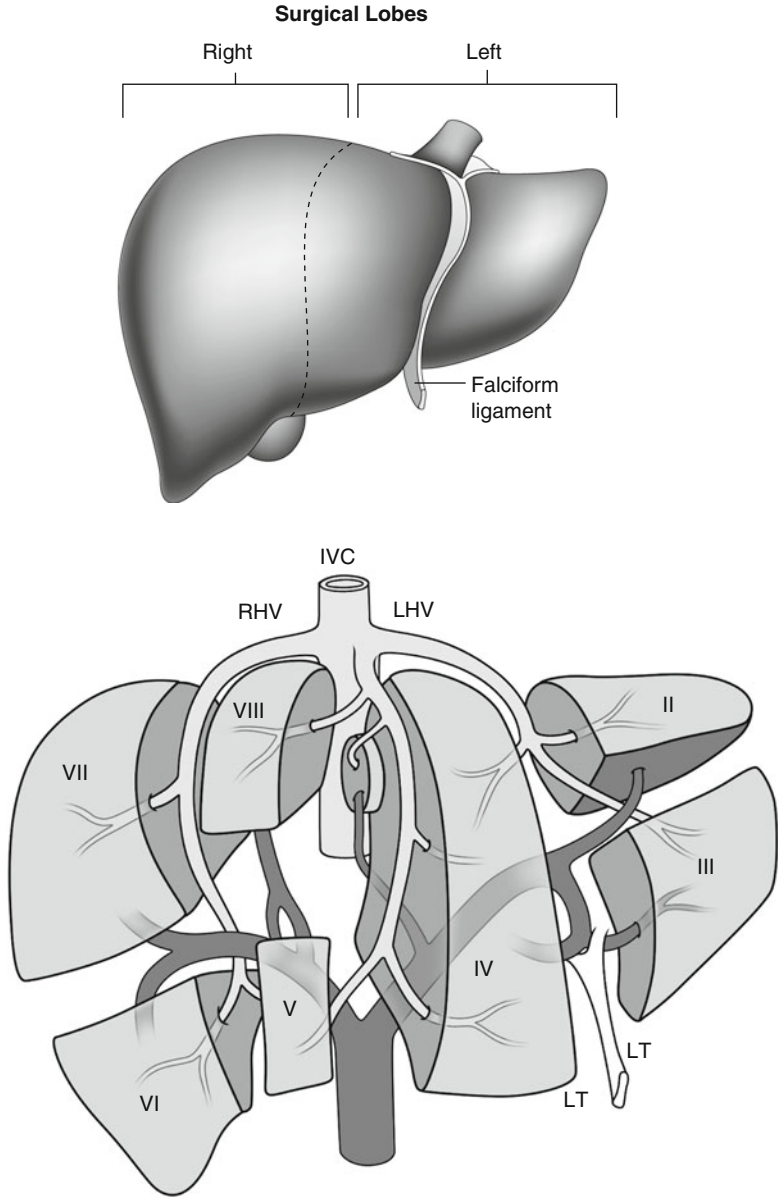

Fig. 10.2 (**a**) Surgical lobes of the liver. The surgical lobes of the liver compared with the usual anatomical division into left and right lobes by the falciform ligament. (**b**) Segments of the liver (after Couinard). *IVC* inferior vena cava, *RHV* right hepatic vein, *LHV* left hepatic vein, *LT* ligamentum teres

- *Left hepatectomy* – This usually involves resection of the anatomical left lobe, the quadrate and caudate lobes (i.e., the left surgical lobe, although the caudate lobe may be left in-situ). Again the line of resection is the main portal plane.
- *Left lobectomy* – In this the anatomical left lobe is resected by dividing the liver just to the left of the falciform ligament.
- *Extended right hepatectomy* – This involves the resection of the anatomical right lobe, i.e., the surgical right lobe plus the caudate and quadrate lobes. Again the line of resection is just to the left of the falciform ligament.
- *Extended left hepatectomy* – This is essentially a left hepatectomy which has been extended to also resect segments I, V, and VIII.

As well as neoplastic conditions, major liver resection may also be used for other conditions such as trauma.

Segmental Liver Resection

Although major hepatic resection may be employed for large tumors, when a small tumor (either primary or secondary) occupies one or two segments, a segmental resection can be carried out. This removes a segment(s) of liver, which is supplied by its own vascular pedicle, and is, therefore, an anatomically based procedure. Whatever the segment to be resected, its vascular anatomy is delineated by intraoperative USS before dissection.

Segmental resection has several advantages over major resection; namely as much functioning parenchyma is left as possible and the vascular supply to this is less likely to be compromised, there is reduced blood loss, and the procedure is less likely to leave residual tumor.

If a metastatic deposit is single, small, and superficial, a simple *wedge resection* using diathermy can be employed. This procedure may be performed during resection of the primary tumor, e.g., colorectal carcinoma, and sent for frozen section.

It is known that most metastatic tumors reach the liver by the portal circulation. However, the deposit itself gains its blood supply almost exclusively from hepatic arterial flow. Therefore, in inoperable metastatic disease, numerous techniques have been used to deliver chemotherapy directly into the hepatic arterial circulation:

- Infusion therapy – a catheter is passed percutaneously via the femoral artery.
- Implantable device – this can be placed at laparotomy and allows long-term infusion. An example of this technique is by using a *portacath*, which employs a self-sealing port which is placed subcutaneously and drugs can be injected into this at regular intervals. A catheter runs from the port to the hepatic artery.

10.5.2.2 Non-neoplastic Lesions

Liver Cysts

Liver cysts may be congenital or acquired (e.g., neoplastic, inflammatory/infective, traumatic, etc.). When surgery is to be carried out for a liver cyst, an extensive preoperative clinical and radiological workup is required to ascertain, as closely as possible, its etiology. An initial thorough laparotomy examination is undertaken. For noninfective cysts, the cyst is opened and the contents aspirated and sent for cytological and microbiological examination. The cyst wall can then be excised using cautery if a neoplastic lesion is suspected. However, in non-neoplastic lesions (e.g., simple cyst) complete excision is not necessary and a large opening is made in the cyst to allow free drainage into the peritoneal cavity.

Hydatid cysts (echinococcus tapeworm) may vary in size and situation within the liver. They may be excised without removing adjacent liver parenchyma (*pericystectomy*) or if the cysts are large or multiple, a segmental or major resection may be needed. When a pericystectomy is carried out and the cyst is opened, pads soaked in saline are packed around the cyst to prevent spillage of its contents into the peritoneal cavity.

For pyogenic abscess/cyst there are three main forms of treatment: long-term antibiotics, percutaneous drainage under radiological guidance, and open surgical drainage. Percutaneous drainage is now by far the most popular method. However, if surgical drainage is employed, the abscess is identified and separated from the peritoneal cavity by pads. The abscess contents are then aspirated and the cavity washed out. The cyst wall is then de-roofed to facilitate resolution. Pyogenic abscesses may also be treated by laparoscopic drainage.

Transplantation

The first successful human liver transplant was carried out in 1967 and today over 80% of recipients survive 1 year. Not only can adult livers be transplanted to adult recipients, but the shortage of donor organs has led to adult donor organs being transplanted to children. This is facilitated by resecting and transplanting only part of the donor liver, e.g., left liver (segments I–IV). General indications for transplantation are acute liver failure, end-stage chronic liver disease, and neoplasms. Conditions encountered in the explant specimen can, therefore, be diverse including

viral, autoimmune and alcoholic hepatitis, primary biliary cirrhosis, primary sclerosing cholangitis, end-stage cirrhosis, and primary hepatocellular or cholangiocarcinoma. The liver transplant can be subject to various pathologies including rejection, effects of immunosuppression, and recurrence of the original disease.

10.6 Surgical Pathology: Laboratory Protocols

10.6.1 Biopsy Specimens

For needle core and wedge biopsy specimens see Chap. 1.

Note that viral hepatitis is a category III pathogen – it should be submitted to the laboratory with an attached "hazard of infection" sticker and handled appropriately after 24–48 h of thorough formalin fixation.

Routine histochemical stains that should be provided to help assess the degree of hepatic parenchymal loss, reticulin collapse/elaboration, and fibrous distortion/replacement, respectively, are, PAS (± diastase), silver reticulin, and Masson Trichrome. Elastin stains such as Shikata's orcein or elastic-van Gieson can help distinguish recent collapse (elastin negative) from old fibrosis (elastin positive). Hemochromatosis is diagnosed using biochemical and genetic investigations and the degree of iron deposition on biopsy is graded by Perl's Prussian Blue or the dry weight iron concentration. Other stains are: rhodanine/Shikata's orcein for copper or copper-associated protein deposition in Wilson's disease, primary biliary cirrhosis, or other chronic cholestatic disorders; PAS + diastase (positive globules in alpha-1 antitrypsin deficiency); and Congo Red (amyloid).

Needle cores may have an adherent fragment of skin if obtained percutaneously. They can also fragment in diseased liver with cirrhosis or tumor. Fatty liver is pale; hemochromatosis rust-colored. One aspect of a wedge biopsy is covered by peritonealized capsule and its cut margin is often frayed by diathermy. This margin should be painted and the wedge then cut into multiple perpendicular serial slices.

10.6.2 Resection Specimens

Specimen:

- Liver resection is more commonly performed for a focal mass lesion such as a cyst, adenoma, focal nodular hyperplasia, or metastatic colorectal carcinoma and is, therefore, limited in extent, e.g., segmentectomy, lobectomy, or partial hepatectomy. Other indications are major trauma and a small minority of resectable primary liver cancers. Specimen handling and reporting should document the nature of the abnormality, its extent, completeness of excision, vascular invasion, and status of the background parenchyma. Total hepatectomy is encountered in transplantation surgery – aims are to identify the cause of hepatic failure, and for tumor to determine the stage and assess porta hepatis margins.

Initial procedure:

For partial resection

- Weight (g) and measurements (cm) in each dimension.
- Identify the capsular and cut parenchymal surfaces – the latter constitutes the surgical margin. Further orientation can only be given if marked appropriately by the submitting surgeon.
- Paint the surgical margin and any areas of capsular bulging, retraction, or reaction that might be related to an underlying mass lesion.
- Serially section the liver perpendicular to the parenchymal resection margin at 0.5 cm intervals (Fig. 10.3).
- Photograph.
- Fixation by laying flat and immersion in 10% formalin for 36–48 h.

Description:

- Note the number, size, and distances (mm) to the capsule and surgical margin for each lesion.
- Specific points are:

  Abscess
  - Contents (pus: pyogenic/"anchovy sauce": amoebiasis), walled-off, capsular reaction

  Cyst
  - Contents (fibrin, fluid (serous/mucoid)), wall (chitinous-hydatid)

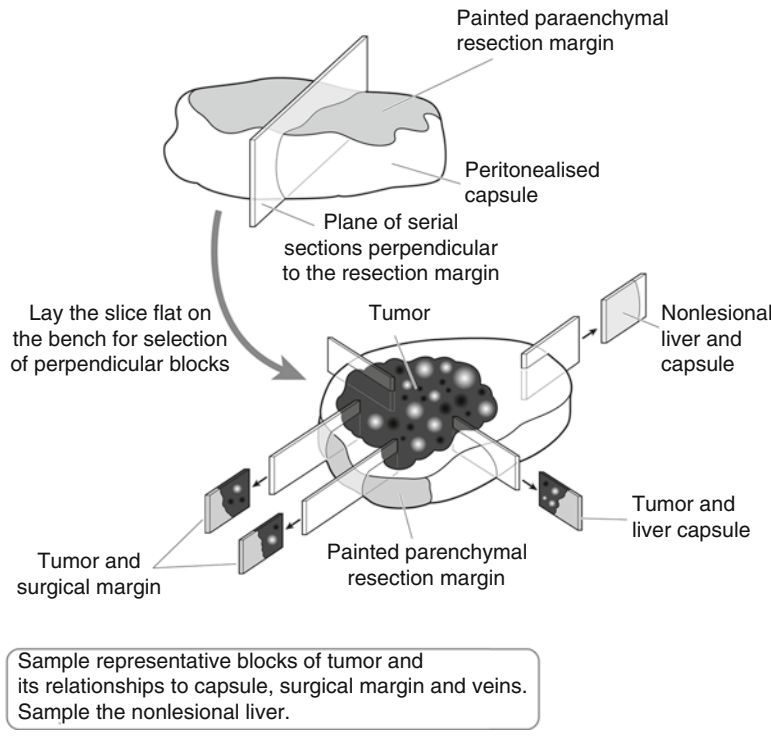

Fig. 10.3 Partial hepatectomy specimen (Reproduced, with permission, from Allen and Cameron (2004))

Trauma
- Capsular tear, subcapsular hemorrhage, parenchymal laceration

Tumor mass
- Edges: circumscribed/irregular/nodular/elevated
- Central scar: focal nodular hyperplasia
- Hemorrhage: hematoma, adenoma
- Bile stained: hepatocellular carcinoma
- Central necrosis/umbilication/mucinous/peripheral calcification: metastatic carcinoma

- Look for vascular invasion, e.g., thrombi in intrahepatic veins and/or any attached length of vena cava.
- Non-lesional liver
  Fatty change/cholestasis/necrosis/cirrhosis/hemochromatosis.

Blocks for histology (Fig. 10.3):
- For abscess, cyst, or trauma, four or five representative blocks of the wall, any capsular tear or hemorrhage, and adjacent hepatic parenchyma are usually sufficient.
- For a tumor mass, also sample a minimum of four or five representative blocks to demonstrate the lesion in relation to the capsule, surgical margin, uninvolved liver, and any other relevant structures, e.g., veins. Additional blocks are taken as required, e.g., if in close proximity to the surgical margin. Sections from the periphery of a tumor are often more informative than from the center as there is less necrosis with preservation of tumor tissue, and its interface with the parenchyma can be demonstrated.
- Sample non-lesional liver.

For total hepatectomy specimens (Fig. 10.4):
- Weight (g) and measure (cm) in three dimensions.
- If there is a previous diagnosis of hepatitis, incise deeply at several points to ensure an adequate period (48–72 h) of fixation prior to further handling.
- Identify the porta hepatis and transverse section its surgical margin to include the distal limit of the bile duct, hepatic artery, and portal vein. Further transverse sections at mid-duct and hilar levels can be submitted.
- Count and sample all lymph nodes.
- Dissect off the gallbladder and routinely process if macroscopically normal.
- Section the liver in its long axis either side of the hilum.

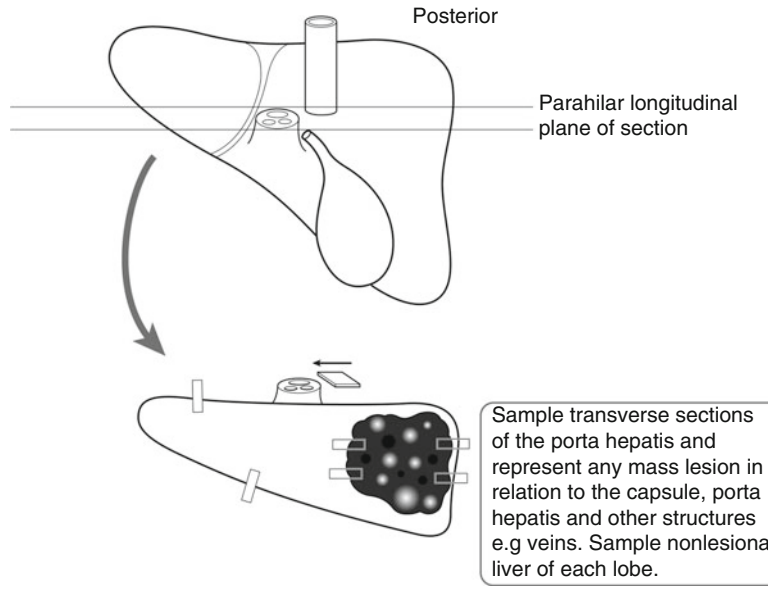

Fig. 10.4 Total hepatectomy specimen (Reproduced, with permission, from Allen and Cameron (2004))

  - Sample representative blocks from the anatomical lobes and additionally as indicated by any mass lesion to demonstrate its relationship to the capsule, vessels, and porta hepatis.
  - Serially slice the rest of the liver to detect any further lesions and sample accordingly.

  Histopathology report:
- Tumor type – hepatocellular carcinoma/cholangiocarcinoma/metastatic carcinoma
- Tumor differentiation – well/moderate/poor
- Extent of local tumor spread (hepatocellular carcinoma)

pT1	Solitary tumor without vascular invasion
pT2	Solitary tumor with vascular invasion or multiple tumors, none more than 5 cm in greatest dimension
pT3	Multiple tumors more than 5 cm (pT3a) or tumor involving a major branch of the portal vein or hepatic vein (pT3b)
pT4	Tumor(s) with direct invasion of adjacent organs other than the gallbladder or with perforation of visceral peritoneum

- Lymphovascular invasion – present/not present. Note the propensity for hepatocellular carcinoma to invade portal tract veins, major branches of portal and hepatic veins, and inferior vena cava. Cholangiocarcinoma typically shows perineural space invasion with spread to lymph nodes, lungs, and peritoneum
- Regional lymph nodes: hilar (hepatoduodenal ligament), hepatic (along the proper hepatic artery), periportal (along the portal vein), and those along the abdominal inferior vena cava above the renal veins (except the inferior phrenic nodes). A regional lymphadenectomy will ordinarily include three or more lymph nodes

pN0	No regional lymph node metastasis
pN1	Metastasis in regional lymph node(s)

- Excision margins
  Distances (mm) to the capsule and limits of excision of the hepatic parenchyma, bile ducts, and major veins
- Other pathology
  Hepatocellular carcinoma – hepatitis, cirrhosis (hepatitis/alcohol/hemochromatosis, etc.), dysplastic nodules, liver cell dysplasia.
  Cholangiocarcinoma – primary sclerosing cholangitis, ulcerative colitis, liver fluke, biliary tree anomaly.

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