

LIVER

1) Other Names:

- Reidel's Lobe – normal anatomic variant; projection of the right lobe that can extend as far as the iliac crest (Tempkin, p.54, Anatomy).

2) Definition/Location:

- The liver is the largest internal organ of the body. Its size and shape are variable. Viewed anteriorly it has a basic wedge shape, tapering toward the left side. The right lobe is significantly larger than the left lobe (Tempkin, p.53, Anatomy).
- The liver has 4 lobes: Left Lobe, Right Lobe, Caudate Lobe and Quadrate Lobe (Tempkin, p.54, Anatomy).
- Vascular functions:
 - Storage and filtration of blood.
 - Acts as a blood reservoir in times of excess blood volume and supplies extra blood in times of diminished blood volume.
 - Kupffer cells cleanse the blood of up to all but approximately 1% of bacteria found in portal blood from the intestine (Tempkin, p.58, Physiology).
- Metabolic functions:
 - Synthesizes many substances sent to other areas of the body and performs a vast number of other metabolic functions including protein, fat, and carbohydrate metabolism (Tempkin, p.58, Physiology).
- Secretory and excretory functions:
 - Produces and releases bile through the biliary tract into the small bowel where it is used for the digestion of fat (Tempkin, p.59, Physiology).
- Occupies almost all of the right hypochondrium, the greater part of the epigastrium, and the left hypochondrium as far as the mammillary line. The contour and shape of the liver vary according to the patient's habitus and lie. The liver lies inferior to the diaphragm (Hagan-Ansert, p.143, 1/2).
- The ribs cover the greater part of the right lobe (usually a small part of the right lobe is in contact with the abdominal wall). In the epigastric region, the liver extends several centimeters below the xiphoid process. Most of the left lobe is covered by the rib cage (Hagan-Ansert, p.143, 1/2).
- The fundus of the stomach lies posterior and lateral to the left lobe of the liver. The remainder of the stomach lies inferior to the liver. The duodenum lies adjacent to the right lobe and medial segment of the left lobe of the liver (Hagan-Ansert, p.143, 2/1).

- The body of the pancreas is inferior to the left lobe of the liver. The posterior border of the liver contacts the right kidney, inferior vena cava, and aorta. The diaphragm covers the superior border of the liver (Hagan-Ansert, p.143, 2/1).
- One can live without sections of the liver; however, one can not live without the entire organ.

3) **Ultrasound Appearance**

- Normally appears homogenous, mid-gray (medium-level echoes) lobes (Tempkin, p.59, Sonographic Appearance).
- Normal liver parenchyma may be described as hyperechoic to normal renal parenchyma (Tempkin, p.59, Sonographic Appearance).
- Normal parenchyma may be described as hypoechoic to normal pancreas parenchyma (Tempkin, p.59, Sonographic Appearance).
- Blood vessels and bile ducts have anechoic lumens surrounded by hyperechoic walls (Tempkin, p.59, Sonographic Appearance).
- Portal and hepatic veins are seen as anechoic tubular structures branching throughout the lobes; for differentiation, follow branches toward the porta hepatis or IVC, respectively (Tempkin, p.59, Sonographic Appearance).
- Highly reflective or very echogenic ligaments and fissures (Tempkin, p.59, Sonographic Appearance).

4) **Normal Size Range(s):**

- The normal longitudinal measurement of the right lobe is 13 cm or less; the measurement has also been stated to be 15-17 cm (Curry-Tempkin, p.137, 1/4).
- An accurate ultrasound measurement of liver volume is technically difficult. However, an ultrasound estimate of liver size can be made based on the craniocaudal extent of the right lobe and anteroposterior extent of the left lobe (<http://www.sonoworld.com>, "The Normal Liver").
- When measured in the midclavicular line the right lobe normally measures up to 13 cm and is considered enlarged if more than 15 cm. The left lobe does not normally exceed 6 cm measured anteroposteriorly in the midline. Accurate positioning of the probe is important as the right lobe may measure more than 15 cm in length when measured more laterally (<http://www.sonoworld.com>, "The Normal Liver").

5) **Pertinent Lab Data:** (Curry-Tempkin, p. 151, Lab Value Chart) and (Hagan-Ansert, p. 155, 1/3)

- Albumin - Normal Range: 3.3-4.5 g/d – In patients with hepatocellular damage, a low serum albumin suggests decreased protein synthesis.
- Bilirubin - Normal Range: Adult indirect less than or equal to 1.1 mg/dl and Adult direct: < .5 mg/dl – Adult indirect bilirubin is unconjugated bilirubin. Elevation of this test result is seen with increased red blood cell destruction. Adult direct is a conjugated bilirubin. Elevation of direct is usually related to obstructive jaundice.
- Alkaline Phosphatase (ALP) - Normal range: 1.5-4.5 BU/dl (metastases) or .8-2.9 BLB (obstruction) – In hepatitis and cirrhosis this enzyme is moderately elevated.

- Aspartate Aminotransferase (AST, formerly SGOT) - Normal Range: 5-30 U/L – Any disease that injures the cells causes an increase in AST levels. Significant elevations are characteristic of acute hepatitis and cirrhosis.
- Alanine Aminotransferase (ALT, formerly SGPT) - Normal Range: 6-37 U/L – This enzyme is slightly elevated in acute cirrhosis, hepatic metastases, and pancreatitis.
- Beta globulin - Normal Range: .7-1.2 g/dl
- Cholesterol - Normal Range: 140-200 mg/dl
- Gamma globulin - Normal Range: .5-1.6 g/dl – Chronic liver disease is commonly shown in an elevation of gamma globulins.
- Lactic dehydrogenase - Normal Range: 100-225 U/L; 180-280 U/L
- Protein - Normal Range: 6.67-7.8 g/dl
- Prothrombin Time - Normal Range: 11-15 seconds

6) Common Pathologies: (Hagen-Ansert, p. 170, Table 6-3)

- Diffuse Disease
 - Fatty Infiltration – Sonographically the liver is increased in echogenicity and attenuation; paired visualization of borders of portal/hepatic structures; hepatomegaly, patchy, inhomogeneous and focal sparing.
 - Hepatitis – General name for inflammatory and infectious disease of the liver. There are 2 types:
 - Acute – Sonographically the liver texture may appear normal; portal vein borders more prominent; liver parenchyma is slightly more echogenic; attenuation may be present.
 - Chronic – Sonographically the liver parenchyma is coarse with decreased brightness of the portal triads; the degree of attenuation is less than in fatty infiltration.
 - Cirrhosis – Sonographically there is coarse liver parenchyma with nodularity, increased echogenicity and attenuation, decreased vascular markings with acute cirrhosis, hepatosplenomegaly with ascites, shrunken liver with chronic cirtosis, regeneration of hepatic nodules and portal hypertension.
- Diffuse Abnormalities of the Liver Parenchyma
 - Biliary Obstruction
 - Proximal – Sonographically the carcinoma of the common duct shows as a tubular branching with dilated intrahepatic ducts in the periphery of the liver.
 - Distal – Sonographically there are dilated intrahepatic ducts in the periphery of the liver. Common duct may show shadowing stones within the dilated duct.
- Hepatic Tumors
 - Cavernous Hemangioma (benign) – Sonographically the hemangioma is hyperechoic with acoustic enhancement.
 - Liver Cell Adenoma – Sonographically the mass looks similar to focal nodular hyperplasia. It is hyperechoic with a central hypoechoic area caused by hemorrhage. The lesion may be solitary or multiple. If lesion ruptures, fluid should be found in the peritoneal cavity.

- Hepatocellular Carcinoma (malignant) – Sonographically there is a variable appearance with discrete lesions, either solitary or multiple, that are usually hypoechoic or hyperechoic. The lesions may be isoechoic, and a halo may surround the lesion. Another pattern presents as diffuse parenchymal involvement with inhomogeneity throughout the liver without distinct masses. The last pattern is a combination of discrete and diffuse echoes. Hepatocellular carcinoma cannot be differentiated from metastases on ultrasound.

7) Patient Prep:

- NPO for 8-12 hours because the gallbladder, biliary tract, and pancreas will be evaluated. This guarantees normal gallbladder and biliary tract dilatation and reduces the stomach and bowel gas anterior to the pancreas (Tempkin, p.59. Patient Prep).
- If the patient has eaten, still perform the liver exam (Tempkin, p.59, Patient Prep).

8) Transducer (Probe) Frequency:

- 3.0 MHz or 3.5 MHz
- 5.0 MHz for very thin patient (Tempkin, p.60, Transducer)

9) Protocol: (Tempkin, p. 64, Required Images 1-12)

- 12 images to document liver anatomy.
- Longitudinal image of the left lobe to include the inferior margin and the aorta.
- Longitudinal image of the left lobe to include the diaphragm and the caudate lobe.
- Longitudinal image of the right lobe to include the IVC where it passes through the liver.
- Longitudinal image of the right lobe to include the main lobar fissure, gallbladder and portal vein.
- Longitudinal image of the right lobe to include part of the right kidney for parenchyma.
- Longitudinal image of the right lobe to include the dome and the adjacent pleural space.
- Transverse image of the left lobe to include the lateral margin.
- Transverse image of the left lobe to include the ligamentum teres.
- Transverse image of the right lobe to include the hepatic veins.
- Transverse image of the right lobe to include the right and left branches of the portal vein.
- Transverse image of the right lateral inferior lobe.
- Transverse image of the right lobe to include the dome and the adjacent pleural space.

10) Image Reference:

- Curry-Tempkin, p.139, fig. 9-11
- Hagan-Ansert, p.143, fig. 6-1
- Hagan-Ansert, p.164, fig. 6-25

- Hagan-Ansert, p.168, fig. 6-27
- Hagan-Ansert, p. 174, fig. 6-34

11) References:

- Curry, R.A. and Tempkin, B.B. (2004). *Sonography: Introduction to normal structures and function* (2nd ed.). St. Louis, MO: Saunders.
- Hagan-Ansert, S.L. (2006). *Textbook of diagnostic ultrasonography* (6th ed.)(Vol.1). St. Louis, MO: Mosby.
- MedImageWorld L.L.C. (2002 – 2005). *The normal liver*. Retrieved June 13, 2006, from <http://www.sonoworld.com/Chapter/ShowBookChapter.aspx?bid=2&cid=4>
- Tempkin, B.B. (1999). *Ultrasound scanning: Principles and protocols* (2nd ed.). Philadelphia, PA: Saunders.