Chapter 3

Liver Anatomy

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Liver Anatomy

Background

Assessment of vascular and biliary anatomy and presence of anatomic variants may be important for interventional or surgical planning.

Evaluation of hepatic volume can be helpful in estimating functional liver reserve, selecting an appropriate treatment, and determining the prognosis.

- Liver volumes vary between patients and are related to patient body surface area and weight.
- Average liver volume in healthy patients is 1,225 cm\(^3\) (±217).
- As cirrhosis progresses, segmental atrophy leads to decrease in liver volume. Mean liver volumes are 1,100 cm\(^3\) (±337) in Child-Pugh class A, 1,040 cm\(^3\) (±365) in Child-Pugh class B, and 800 cm\(^3\) (±205) in Child-Pugh class C.

Sector and segmental anatomy: overview

Use of standardized, segmental anatomy facilitates communication of observation location and treatment planning.

Historically, the convention for liver anatomy has been controversial and there are several systems that propose slightly different terminology to identify liver anatomy:

- Couinaud’s system: Divided anatomic units into segments 1-8, based on portal scissura
- Bismuth, Healey & Schroy, and Goldsmith & Woodburne: Further revised Couinaud’s system with 1) division of liver in two lobes and further into left lateral and medial sectors and right anterior and posterior sectors, and the caudate lobe, and 2) division of segments using hepatic veins and fissures
- Federative committee on anatomical terminology (FCAT): Combines the concepts of both above systems and proposed international standard
- International Hepatopancreatobiliary Association (IHPBA): Proposed terminology for surgical resection based on anatomical/functional sections: left hemiliver-lateral and medial section, right hemiliver-anterior and posterior section

Both FCAT and IHPBA systems are used commonly in America, recognize the smallest functional units of liver as segments (named according to Couinaud system), and use the nearly interchangeable terms sector or section.
Sector and segmental anatomy: overview

The liver is divided into right and left lobes or hemilivers by the plane of middle hepatic vein. This plane runs from the left of the IVC to the left of the gallbladder fossa (Cantlie’s line).

The right lobe is divided into anterior and posterior sectors or sections by the plane of the right hepatic vein.

The left lobe is divided into a medial and lateral sectors or sections by an oblique plane connecting the left hepatic vein and the falciform ligament.

The liver is divided into upper and lower segments at the level of main portal vein (MPV) bifurcation.

- Segment I: Caudate
- Segment II: Superior left lateral sector/section
- Segment III: Inferior left lateral sector/section
- Segment IVa: Superior left medial sector/section
- Segment IVb: Inferior left medial sector/section
- Segment V: Inferior right anterior sector/section
- Segment VI: Inferior right posterior sector/section
- Segment VII: Superior right posterior sector/section
- Segment VIII: Superior right anterior sector/section
Segment I: Caudate lobe
Bounded anteriorly and medially by the fissure for ligamentum venosum

Segment II: Superior segment of the left lateral sector/section
Bounded medially by falciform ligament and inferiorly by plane of MPV, also known as the posterior lateral sector (Bismuth, FCAT)
Sector and Segmental Anatomy

**Segment III: Inferior segment of left lateral sector/section**
Bounded medially by the falciform ligament and superiorly by the plane of the MPV bifurcation, also referred to as lateral anterior sector (Bismuth, FCAT)

**Segment IV: Left medial sector/section**
Bounded laterally by falciform ligament and medially by Cantlie’s line
- IVa: Superior to the MPV bifurcation
- IVb: Inferior to the MPV bifurcation
**Sector and Segmental Anatomy**

**Segment V:** Inferior segment of the right anterior sector/section

Bounded anteriorly by the gallbladder fossa and posteriorly by the plane of the right hepatic vein, superiorly bounded by the plane of MPV bifurcation

**Segment VI:** Inferior segment of the right posterior sector/section

Bounded anteriorly by plane of the right hepatic vein and superiorly by the plane of the MPV bifurcation
Sector and Segmental Anatomy

Segment VII: Superior segment of the right posterior sector/section
Bounded anteriorly by the plane of the right hepatic vein and inferiorly by the plane of the MPV bifurcation

Segment VIII: Superior segment of the right anterior sector/section
Bounded anteriorly by the plane of the gallbladder fossa and middle hepatic vein, posteriorly bounded by the plane of the right hepatic vein and inferiorly by the plane of the MPV bifurcation
Arterial, Portal, and Biliary Anatomy

Radiologists should be aware of anatomic variants in arterial supply, portal venous supply, and biliary drainage as these may affect treatment planning.

The next few pages illustrate the most common variants.

It is not necessary for radiologists to memorize the names of the variants, as they can be reported descriptively.
**Arterial Anatomy**

**Michel Classification**

**Type I**
- 55-80%
- RHA and LHA arise from CHA

**Type II**
- 3-10%
- RHA arises from CHA; replaced LHA from LGA

**Type III**
- 4-11%
- LHA arises from CHA; replaced RHA from SMA

**Type IV**
- ~1%
- Replaced RHA and LHA

**Type V**
- 3-8%
- RHA and LHA arise from CHA; accessory LHA from LGA

**Type VI**
- 2-7%
- RHA and LHA arise from CHA; accessory RHA from SMA

**Type VII**
- <1%
- RHA and LHA arise from CHA; accessory RHA and LHA

**Type VII**
- 0.4-2%
- Replaced RHA or LHA with other hepatic artery being an accessory one

**Type IX**
- 1-4%
- The hepatic trunk arises as a branch of the SMA

**Type X**
- <1%
- The hepatic trunk arises from the left gastric artery

- RHA: right hepatic artery
- LHA: left hepatic artery
- LGA: left gastric artery
- SMA: superior mesenteric artery
- aRHA: accessory RHA
- aLHA: accessory LHA
Portal Venous Anatomy

The standard portal venous anatomy consists of the main portal trunk branching into the right and left portal veins, with the right portal vein subsequently dividing into anterior and posterior branches.

- **Standard anatomy (65-80%)**
  - Main portal vein trifurcation into right anterior, right posterior and left portal vein (7-9%)
  - Right posterior portal vein as first branch of main portal vein (5-13%)
  - Segment VII branch as separate branch of right portal vein (1-3%)

- **Segment VI branch as separate branch of right portal vein (1-6%)**

**Abbreviations:**
- RAPV: right anterior portal vein
- RPPV: right posterior portal vein
- RPV: right portal vein
- LPV: left portal vein

Liver Anatomy
Biliary Anatomy

The standard biliary anatomy consists of the right hepatic duct and left hepatic duct joining together to form common hepatic duct.

**Standard anatomy (63%)**

**Triple confluence (10%)**

**Right posterior segmental duct drains anomalously into LHD (11%), CHD (6%) or cystic duct (2%)**

**RHD drains into cystic duct (<1%)**

**Accessory duct arises either from CHD (3%) or RHD (3%)**

**Ducts of segments II and III drain individually into CHD (1%)**

**Abbreviations**

- CHD: Common hepatic duct
- RHD: Right hepatic duct
- LHD: Left hepatic duct
- RAD: Right anterior duct
- RPD: Right posterior duct
- SII: Duct to segment II
- SIII: Duct to segment III
- CD: Cystic duct
- Acc: Accessory duct
References

Botero AC, Strasberg SM. Division of the left hemiliver in man--segments, sectors, or sections. Liver Transpl Surg. 1998 May;4(3):226-31


