Review of Couinaud's Hepatic Segmental Anatomy:

Ultrasound & CT point of view

Harshavardhan Balaganesan Suresh Varupula

Introduction:

Lesions in the liver are very common & locating it, is primary for diagnosis, treatment & follow up. There were so many classifications previously, but now the most commonly used one is Couinaud's classification.

Couinaud's nomenclature is surgically relevant system of hepatic segmental anatomy which defines the liver segments by their relationship to vascular structures, hepatic ligaments & gallbladder. Accurately locating the hepatic mass allows us to plan about the patients treatment. We discuss how to accurately localize hepatic masses using sonography & Computed tomography.

Couinaud’s Segmental Anatomy of Liver:

The Couinaud classification of liver anatomy divides the liver into eight functionally independent segments. Each segment has its own vascular inflow, outflow and biliary drainage. In the centre of each segment there is a branch of the portal vein, hepatic artery and bile duct. In the periphery of each segment there is vascular outflow through the hepatic veins.
There are eight liver segments. The numbering of the segments is in a clockwise manner. Segment 1 (caudate lobe) is located posteriorly.

Because of this division into self-contained units, each segment can be resected without damaging those remaining. For the liver to remain viable, resections must proceed along the vessels that define the peripheries of these segments. This means, that resection-lines parallel the hepatic veins, the centrally located portal veins, bile ducts, and hepatic arteries are preserved.

**Ultrasound:**
How to distinguish between right & left lobe?

Placing the probe in a transverse right subcostal view in deep inspiration through the superior portion of the liver will reveal the main fissure separating the right & the left lobes. In the inferior portion of the liver, a plane connecting the long axis of the gallbladder to the left side of IVC separates the right & the left lobes.
**Fig. 2a**
The sagittal plane defined by the MHV & the IVC separates the right & left lobes.

**Fig. 2b**
Plane connecting the long axis of the gallbladder to the left side of IVC separates the right & left lobes.

How to distinguish Right lobe segments: 5/6 or 7/8?

A transverse plane through the horizontal portion of the RPV separates segments 7/8 superiorly from 5/6 inferiorly.
Fig. 3a Transverse subcostal view in deep inspiration through the right lobe at the level of RPV branch.

Fig. 3b Turning the transducer 90 degrees will obtain a sagittal intercostal view of the left posterior oblique portion. The transverse portion of the RPV is shown in cross section. Dashed line separated segments 7/8 superiorly from segments 5/6 inferiorly.

How to distinguish Right lobe segments 5/8 or 6/7?

A longitudinal plane defined by RHV and the IVC separates segments 5/8 medially from segments 6/7 laterally. Turning the transducer 90 degrees will obtain a transverse intercostal view of the right lobe in the posterior oblique position.
How to distinguish Left lobe segments 4 or 2/3?

A longitudinal plane connecting the ligamentum teres, the ascending portion of LPV, and the fissure for Ligamentum venosum separates segments 2/3 laterally from segments 4a / 4b medially. Turning the transducer 90 degrees will obtain a transverse scan through the left lobe. Solid line separates segments 2/3 laterally from segments 4a/4b medially.
How to Distinguish Left lobe 2 or 3?

A longitudinal plane containing the LHV and the IVC separates segment 2 posteromedially from segment 3 anteromedially. Turning the transducer 90 degrees will obtain a transverse image through the lateral portion of the left lobe. Confusion exists in the literature regarding the separation of segments 2 and 3. According to Couinaud, the LHV is the dividing landmark between these two segments. However other authors have stated these segments are separated by an imaginary plane containing the transverse portion of the LPV. This results in the non anatomic segments, placing segment 2 superior to segment 3 rather than posteromedial to it.
Fig. 6: Recumbent view of the left portal vein bifurcation. On a subcostal US scan, the left portal vein (p), the accessory left portal vein (a), and the branches to three segments of the left lobe of the liver (2, 3, and 4) suggest a recumbent H view.

How to distinguish Left lobe 4a or 4b?
An oblique transverse plane through the transverse portion of the LPV separates segment 4a superiorly from segment 4b inferiorly. Turning the transducer 90 degrees will obtain a sagittal view through the medial portion of the left lobe. This image shows the transverse portion of the LPV; dashed line separates segment 4b.

How to identify Caudate lobe?
The caudate lobe (segment 1) is bordered by the fissure for ligamentum venosum anteriorly, the IVC posteriorly and a line connecting the MHV and the GB laterally. The lobe extends cephalad to the junction of the MHV and the IVC.
Review of Couinaud's Hepatic Segmental Anatomy

Computed Tomography:

CT scans illustrate the Couinaud classification of numbering of liver segments. The longitudinal plane of the right hepatic vein divides VIII from VII in the superior portion of the liver and V from VI in the inferior portion of the liver. The longitudinal plane of the middle hepatic vein through the gallbladder fossa separates IVa from VIII in the superior liver and IVb from V in the inferior liver. The longitudinal plane of the left hepatic vein and fissure of the ligamentum teres separates IVa from II in the superior liver and IVb from III in the inferior liver. The axial plane of the left portal vein separates IVa superiorly from IVb inferiorly and II superiorly from III inferiorly in the left lobe. The axial plane of the right portal vein separates VIII and VII superiorly from V and VI inferiorly in the right lobe. The caudate lobe (segment I) extends between the fissure of the ligamentum venosum anteriorly and the inferior vena cava posteriorly.

Fig. 7

Caudate lobe (CL) is seen anterior to Inferior vena cava (VC) & posterior to the Ligamentum venosum (arrow).

Conclusion:

This classification of segmental anatomy of the liver, which uses the distribution of the portal venous branches as a guide to the center of each segment, is relatively easy to learn. It greatly facilitates the teaching of liver anatomy, as well as the clinical investigation of the patient. We hope that it will provide a common language for radiologists and their referring colleagues.

References:

2. Role of US in the Detection, Characterization, and Staging of Cholangiocarcinoma
4. Vu The Huynh, Couinaud Liver Segments in CT Scanner, Vietnamese Radiology Network, February 6, 2011
5. Yoshihisa Kodama, Chaan S. Ng, Tsung T. Wu, Gregory D. Ayers, Steven A. Curley, Eddie K. Abdalla, Jean Nicolas Vauthey and Chusilp Charnsangavej, Comparison of CT Methods for Determining the Fat Content of the Liver, doi: 10.2214/AJR.06.0992, AJR May 2007 vol. 188 no. 5 1307-1312
6. M Lafortune, F Madore, H Patriquin and G Breton, Department of Radiology, Saint-Luc Hospital, Montreal, Quebec, Canada, Segmental anatomy of the liver: a sonographic approach to the Couinaud nomenclature, November 1991 Radiology, 181, 443-448.
8. Robin Smithuis, Radiology Department of the Rijnland Hospital, Leiderdorp, the Netherlands, Liver: Segmental Anatomy, the radiology assistant, Publication date: 7-5-2006