Sonographic Demonstration of Couinaud’s Liver Segments

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The segmental localization of liver tumors is critical to planning appropriate resection. Couinaud’s nomenclature is a surgically relevant system of hepatic segmental anatomy, which defines the liver segments by their relationships to vascular structures, hepatic ligaments, and the gallbladder. We demonstrate a way to accurately localize hepatic masses with sonography. KEY WORDS: Liver; Ultrasonography; Couinaud classification.

Couinaud’s system of hepatic nomenclature provides the anatomic basis for modern hepatic surgical resections. In this system, the liver segments are defined by their relationships to vascular structures, hepatic ligaments, and the gallbladder. The multiplanar imaging capability of ultrasonography is well suited to the identification of these structures and to the precise localization of masses to hepatic segments. Accurate preoperative localization is essential to surgical planning.

In this paper we present a systematic method for the segmental localization of liver masses using ultrasonography. With some practice, the technique should be within the capability of most experienced sonographers. We also review the anatomy of the common hepatic resections.

Figure 1 Couinaud’s hepatic segments. Diagrammatic representation of the liver from an anterior perspective (all segments numbered appropriately). The caudate lobe (1) is situated posteriorly.

ABBREVIATIONS
PV, Portal vein; FL, Falciform ligament; RHV, Right hepatic vein; MHV, Middle hepatic vein; LHV, Left hepatic vein; IVC, Inferior vena cava; GB, Gallbladder; RPV, Right portal vein; MPV, Main portal vein; LPV, Left portal vein

Procedure for Localizing a Hepatic Mass to One of Couinaud’s Segments with Sonography

1. Image along the plane that separates any two segments.
2. Rotate the transducer 90 degrees.
3. Keep the separating boundary in the image, and scan through the liver until the mass and the boundary are seen in the same image.

Which Lobe, Right or Left?

Figure 2 The sagittal plane defined by the MHV and the IVC separates the right and left lobes. A, Transverse subcostal view in deep inspiration through the superior portion of the liver reveals the main fissure separating the right and left lobes (dashed line). In the inferior portion of the liver, a plane connecting the long axis of the gallbladder to the left side of the IVC separates the right and left lobes. B, Transverse subcostal view in deep inspiration through the inferior portion of the liver; dashed line divides right and left lobes.

Right Lobe Segments: 5/6 or 7/8?

Figure 3 A transverse plane through the horizontal portion of the RPV separates segments 7/8 superiorly from 5/6 inferiorly. A, Transverse subcostal view in deep inspiration through the right lobe at the level of the RPV branch. B, Turning the transducer 90 degrees will obtain a sagittal intercostal view of the right lobe in the left posterior oblique position. The transverse portion of the RPV is shown in cross section. Dashed line separates segments 7/8 superiorly from segments 5/6 inferiorly.
Right Lobe Segments: 5/8 or 6/7?

Figure 4 A, A longitudinal plane defined by the RHV and the IVC separates segments 5/8 medially from segments 6/7 laterally.
B, Turning the transducer 90 degrees will obtain a transverse intercostal view of the right lobe in the left posterior oblique position. This image shows the descending portion of the RHV and the IVC. Dashed line separates segments 6/7 laterally from segments 5/8 medially.

Left Lobe Segments: 4 or 2/3?

Figure 5 A, A longitudinal plane containing the ligamentum teres (lig. teres), the ascending portion of the LPV, and the fissure for the ligamentum venosum (lig. venosum) separates segments 2/3 laterally from segments 4A/4B medially.
B, Turning the transducer 90 degrees will obtain a transverse scan through the left lobe. Dashed line separates segments 2/3 laterally from segments 4A/4B medially.
Left Lobe: 2 or 3?

Figure 6 A, A longitudinal plane containing the LHV and the IVC separates segment 2 posteromedially from segment 3 anterolaterally. B, Turning the transducer 90 degrees will obtain a transverse image through the lateral portion of the left lobe. This image shows the descending portion of the LHV and the IVC. Dashed line separates segment 2 from segment 3. 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 that these segments are separated by an imaginary plane containing the transverse portion of the LPV. This error results in the creation of nonanatomic segments, placing segment 2 superior to segment 3 rather than posteromedial to it.

Left Lobe: 4A or 4B?

Figure 7 A, An oblique transverse plane through the transverse portion of the LPV separates segment 4A superiorly from segment 4B inferiorly. B, 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 4A from segment 4B.
Caudate Lobe

Figure 8 The caudate lobe (Couinaud’s segment 1) is bordered by the fissure for the ligamentum venosum anteriorly, the IVC posteriorly, and a line connecting the MHV and the GB laterally. The lobe extends cephalad to junction of the MHV and the IVC. A, Schematic representation of lateral view of caudate lobe. B, Longitudinal midline image shows caudate lobe relationships. Lig. venosum, Fissure for the ligamentum venosum. C, Transverse midline image shows caudate lobe relationships.
Hepatic Resections

Patients with primary hepatic neoplasms or fewer than five metastases are potential candidates for resection. The goal of surgery is to remove the entire lesion or all the lesions with tumor-free margins, while preserving a sufficient quantity of residual liver with intact blood supply and biliary drainage to sustain life. This requires the removal or preservation of entire liver segments. Inoperable tumors are those involving the MPV, hepatic artery, or both the right and left hepatic ducts.7

Figure 9 In a left lobectomy, segments 2, 3, 4A, and 4B are removed; the caudate lobe (segment 1) and the entire right lobe are left intact. Black nodule represents tumor; yellow portion, resected area.

Figure 10 A, In a left lateral segmentectomy, segments 2 and 3 are removed. Black nodule, Tumor; yellow portion, resected area. B, Postoperative image, left lateral segmentectomy. No liver is seen lateral to segments 4A/4B (arrow).

Figure 11 Transverse heptectomy is performed most often for GB carcinoma. This resection removes segments 1, 4B, 5, and 6. Black nodule, Tumor; yellow portion, resected area.
Conclusion

Advances in hepatic oncologic surgery require that radiologists specify the location of masses according to the segmental anatomy of the liver. The systematic application of ultrasonography can accurately localize masses to Couinaud’s segments, thereby providing vital information for preoperative planning.

References