The role of MRI in Detection and Characterization of Benign Hepatic Focal Lesions

Thesis

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By

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Introduction

The majority of HFL arising in no cirrhotic liver are benign, even in patients with known extra-hepatic malignancy. Cysts, hemangiomas, focal nodular hyperplasia (FNH), and hepatocellular adenomas (HCA) are the most commonly encountered benign lesions ***(Nault., 2013).***

A tremendous development of new imaging techniques has taken place during these last years Maximizing accuracy of imaging , and avoiding unnecessary biopsies, which may result in post-procedural complications up to 6.4%, and mortality up to 0.1% ***(Strassburg and Manns, 2006)***.

Definitive characterization by magnetic resonance (MR) imaging may alleviate patient anxiety, drastically alter management in someone, and help avoid unnecessary biopsy or costly follow-up imaging.

MR imaging offers important advantages over computed tomography (CT), such as the lack of ionizing radiation and improved soft tissue contrast ***(Cogley and Miller, 2014)*** **and** plays a key role in management of liver lesions, using a radiation-free technique and a safe contrast agent profile ***(Bartolozzi, 2012)*.**

The heightened soft-tissue resolution and sensitivity to intravenous contrast agents provided by magnetic resonance imaging (MRI) makes it an invaluable problem-solving tool for fully characterizing HFL ***(Acay et al., 2014)***.

Previous studies estimated the sensitivity and specificity of MRI for the diagnosis of HFL of 94% and 82%-89%, respectively ***(Xie et al., 2011)***.

MRI can be used as the primary imaging examination for patients who cannot receive iodinated IV contrast material and patients in whom the liver is the only organ of concern. MRI is useful as a problem solving technique when other imaging studies show equivocal findings ***(Lee, 2006)***.

The American College of Radiology Appropriateness Criteria assigns the highest rating to MR imaging without and with contrast for characterization of indeterminate liver lesions, regardless of whether the patient is otherwise healthy, has liver disease, or has a known extra hepatic malignancy ***(Nelson et al., 2013)*****.**

The state of the art MRI protocols rely on pre contrast T1,T2 and a fat-suppressed and, in- and opposed-phase (IP/OP) T1-WI and post contrast images and diffusion study ***(Fowler, 2011).***

Recently, diffusion-weighted imaging (DWI) sequences have been shown to be an emerging contributor for liver MRI and are being incorporated in most abdominal MR protocols ***(Galea, 2013).***

Aim of the Work

This study aims to describe the role of MRI in early detection and characterization Of benign Hepatic focal lesions. Using unenhancement, contrast enhancement and diffusion weighted MR images. For better patient management plan.

Chapter (1)

Anatomy of the Liver

I-Gross Anatomy:

Functional and Morphological Anatomy, Hepatic Surfaces and Relations, Liver Support, Vascular Anatomy, Biliary System.

II- MR Anatomy of the Liver:

- Axial, Coronal, Sagittal Image.
- T1 & T2WIs.

I-Gross Anatomy

The liver is the largest solid organ in the body. It fills the right hypochondrium just beneath the diaphragm and extends across the epigastrium into the left hypochondrium and mostly under cover of the ribs **(*Standring et al., 2005*).**

The normal liver is wedge shaped with its base against the right abdominal wall, and its tip pointing to the spleen and extends from the fifth left intercostal space right midclavicular line down to the right costal margin. It measures 12 to 15 cm coronal and 15 to 20 cm transversely.

The median liver weight is 1800 gm in men and 1400 gm in women ***(Schiff et al., 2007).***

A- Functional and Morphological Anatomy:

Liver anatomy can be described using two different aspects: morphological anatomy and functional anatomy. The classical morphological description of the liver anatomy is based on the external appearance. On the diaphragmatic surface, the falciform ligament divides the liver into the right and left anatomical lobes **(Fig.1)** which are very different from the functional right and left lobes. In this morphological description, the quadrate lobe is part of the right lobe of the liver, but functionally it is part of left lobe***(Rubin, 2006).***

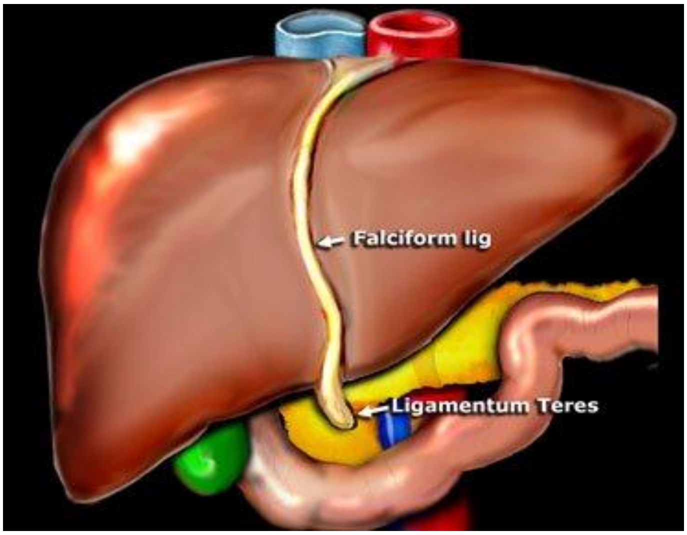

Figure (1): Gross right and left anatomical lobes of the liver based on falciform ligament***(Quoted from Rubin, 2006)***

1-Morphological Anatomy:

Historically the gross anatomical appearance of the liver has been divided into **right, left, caudate and quadrate lobes** by surface peritoneal and ligamentous attachments (Fig. 2) ***(Standring et al., 2005).***

a-The Right Lobe

It is much larger than the left. It occupies the right hypochondrium and it is separated from the left lobe on its upper surface by the falciform ligament. Its inferior and posterior surfaces being marked by three fosse: the porta hepatis and the fosse for the gall-bladder and inferior vena cava which separate its left part into two smaller lobes; the quadrate and caudate lobes ***(Standring et al., 2005).***

b-The Quadrate Lobe

It is placed on the inferior surface of the right lobe, bounded in front by the anterior margin of the liver; behind by the porta hepatis; on the right by the gall-bladder; and on the left by the ligamentum teres ***(Standring et al., 2005).***

c-The Caudate Lobe

It is situated on the posterior surface of the right hepatic lobe. It is seen behind the porta hepatis and separates the fossa for the gall-bladder from the commencement of the fossa for the inferior vena cava ***(Standring et al., 2005).***

d-The Left Lobe

It is smaller and more flattened than the right lobe. It is situated in the epigastric and left hypochondrial regions ***(Standring et al., 2005).***

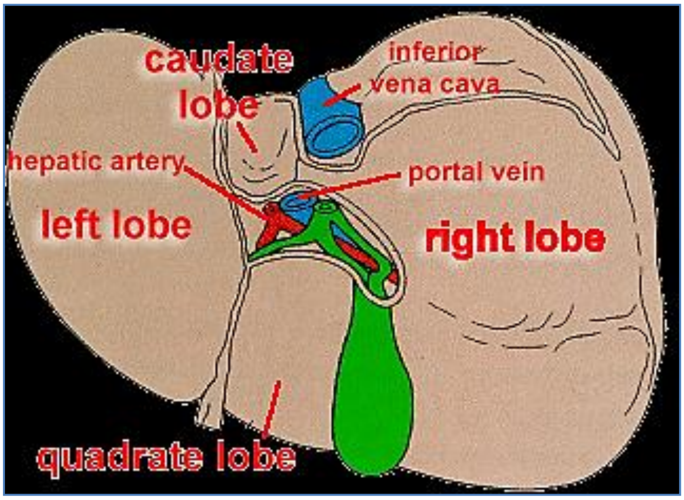

Figure (2): Gross anatomical lobes of the liver***(Quoted from Rubin, 2006).***

2-Functional (Segmental) Anatomy:

The functional division of the liver is first described by the French surgeon ***Couinaud (1957)*** (Fig 3).This classification was based on the divisions of the portal veins that divide the liver into eight functionally independent segments (Table1) ***(Schiff et al., 2007).***

Each segment has its own vascular inflow, outflow and biliary drainage. In the center 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. Couinaud divided the liver into a functional left and right liver by Cantlie's line which runs from the middle of the gallbladder fossa anteriorly to the inferior vena cava posteriorly. **Right hepatic vein** divides the right lobe into anterior and posterior segments. **Middle hepatic vein** divides the liver into right and left lobes. **Left hepatic vein** divides the left lobe into a medial and lateral segments. **Portal vein** divides the liver into upper and lower segments, the left and right portal veins branch superiorly and inferiorly to project into the center of each segment ***(Rubin, 2006).***

Table (1): Segments numbering of the liver

- Segment I: Caudate lobe.
- Segments II and III: Left superior and inferior lateral segments.
- Segment IVa and IVb: Medial segments of the left lobe.
- Segments V and VI: Caudal to the transverse plane.
- Segments VII and VIII: Right superior anterior and posterior segments.

(Quoted from Hagen, 2001)

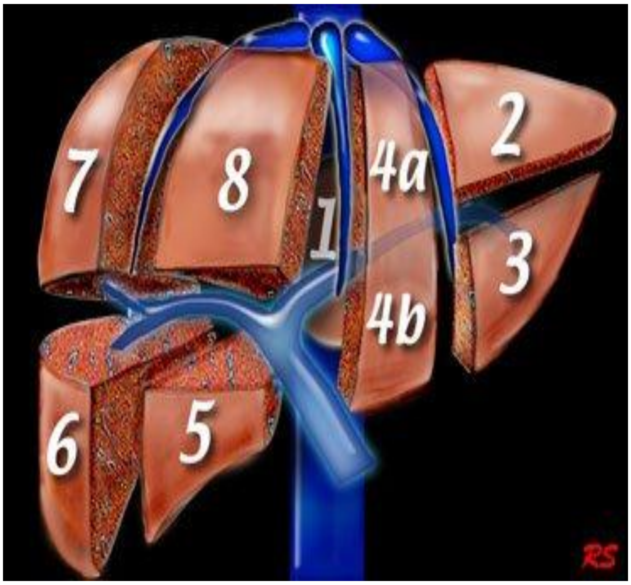

Figure (3): Liver segmental anatomy according to Couinaud classification ***(Quoted from Rubin, 2006).***

B-Hepatic Surfaces and Relations:

- **Superior Surface;** lies immediately below the diaphragm, separated from it by peritoneum except for a small triangular area where the two layers of falciform ligament diverge ***(Hagen, 2001).***

- **Anterior Surface;** It is covered by peritoneum except at the attachment of the falciform ligament. ***On the right***, it is separated from the pleura and six to tenth ribs and cartilages by the diaphragm, and ***on the left*** from the seventh and eighth costal cartilages. The median area of this surface lies behind the xiphoid process and the anterior abdominal wall ***(Standring et al., 2005).***

- **Right Surface;** It is covered by peritoneum and separated from the right lung, pleura and seventh to eleventh ribs by the right diaphragmatic dome. ***(Standring et al., 2005).***
- **Posterior Surface;** It has a deep median concavity corresponds to convexity of the vertebral column. Much of the posterior surface is attached to the diaphragm by loose connective tissue which forms the so-called **` bare area`. The inferior vena cava** lies in a groove in the medial end of the ` *bare area*`. To the left of IVC, the **caudate lobe** is present. To the left of caudate lobe, the fissure for the ligamentum venosum is present. The posterior surface over the left lobe shows a shallow esophageal and gastric impressions ***(Hagen, 2001).***
- **Inferior Surface;** is bounded by the inferior edge of the liver. It is marked near the midline by fissure of ligamentum teres. Posteriorly, it is related to the ligamentum venosum and the gall bladder. Between the fissure for the umbilical vein and the gall bladder lies the quadrate lobe***(Standring et al., 2005).***

N.B.: The Porta Hepatis

The porta hepatis is the area of the inferior surface through which all the neurovascular and biliary structures except the hepatic veins pass through it. It is s between the quadrate lobe in front and the caudate process behind. At the porta hepatis, the hepatic ducts lie anterior to the portal vein and its branches, and the hepatic artery with its branches lies in the middle between them ***(Rubin, 2006).***

C-The liver Support:

The liver is supported in its position in the upper abdomen by: Tone in the anterolateral abdominal muscles and Ligamentous attachments (Fig. 4) ***(Standring et al., 2005).***

- **Falciform Ligament*;*** The two layers of this ligament descend from the posterior surface of the anterior abdominal wall and diaphragm ***(Rubin, 2006).***
- **Ligamentum Teres*;*** represents the obliterated left umbilical vein. It runs in the free border of the falciform ligament ***(Hagen, 2001).***
- **Coronary Ligament;** is formed by the reflection of the peritoneum from the diaphragm onto the posterior surface of the right hepatic lobe ***(Schiff et al., 2007).***

- **Triangular Ligament;** The *left triangular ligament* is a double layer of peritoneum over the superior border of the left hepatic lobe. The *right triangular ligament* is a short structure which is situated at the apex of the 'bare area' ***(Standring et al., 2005).***

- **Lesser Omentum;** is peritoneal fold which extends from the lesser curve of the stomach and proximal duodenum to the inferior surface of the liver. At its lower end, the two layers diverge to surround the porta hepatis ***(Standring et al., 2005).***

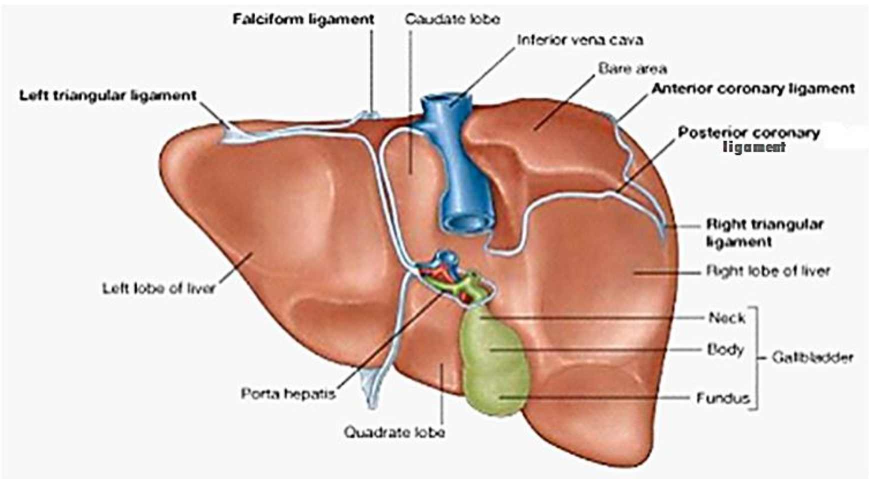

Figure (4): Ligaments of the liver***(Standring et al., 2005).***

D-Vascular Supply of the Liver:

The liver receives blood from two sources: the portal vein (PV) (75-80%) and the hepatic artery (HA) (20-25%). The PV carries poorly oxygenated blood and is the final common pathway for the transport of venous blood from the spleen, pancreas, gallbladder, and the abdominal part of the gastrointestinal tract. It is formed by the union of the splenic vein and the SMV posterior to the neck of the pancreas at the level of L2 vertebra **(Fig. 5).** The HA, a branch of the celiac trunk, carries oxygenated blood from the abdominal aorta. At or close to the porta hepatis, the HA and PV divide into right and left branches, which supply the right and left lobes of liver, respectively. Within each lobe, the primary branches of the PV & HA are consistent enough to form vascular segments. Between the segments are the right, middle and left HVs, which drain parts of adjacent segments. The HVs open into the IVC just inferior to the diaphragm. The attachment of these veins to the IVC helps hold the liver in position ***(Moore & Agur, 2007).***

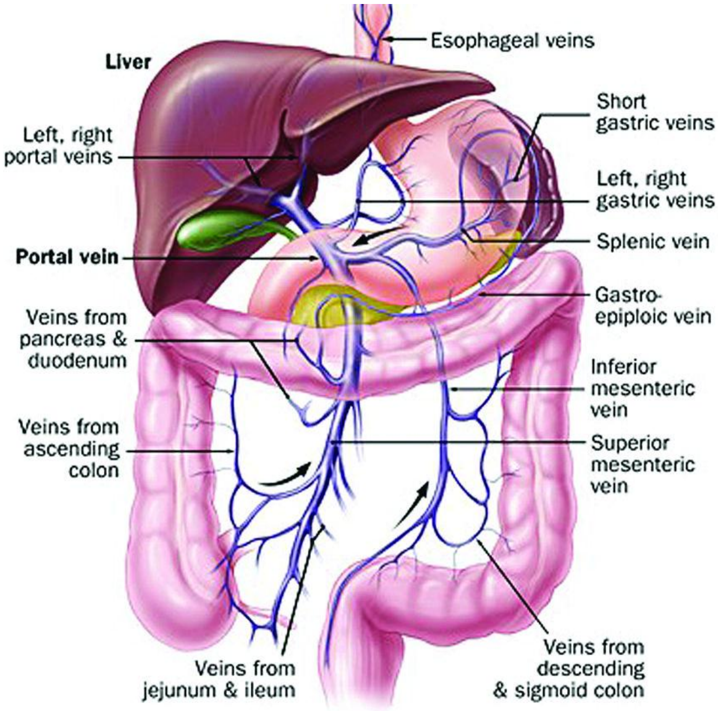

Figure (5): Diagram showing anatomy of portal vein ***(Cichoz-Lach et al., 2008).***

E-Biliary System:

The biliary system includes the bile canaliculi, intra-hepatic and extra-hepatic bile ducts, peri-biliary glands, gallbladder and ampulla of Vater (Fig. 6). The biliary tract (or biliary tree) is the common anatomical term for the path by which bile is secreted by the liver then transported to the small intestine ***(Schiff et al., 2007)*****.**