Role of Multi Slice CT in Imaging Portal Venous System

Essay

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In Radiodiagnosis

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Introduction

Precise and reliable assessment of the portal venous system in patients with hepatic cirrhosis and portal hypertension is essential before liver transplantation, nonsurgical transjugular shunting, or surgical portosystemic shunting. In patients with portal hypertension and a history of gastroesophageal bleeding, it is mandatory to determine whether the portal venous system is patent or the portal vein or its main branches has thrombosis **(Agarwal et al., 2006).**

Noninvasive evaluation can be achieved with color Doppler ultra sound (US), which depicts the portal vein and provides additional information about the velocity and the flow direction. However, Doppler US is observer dependent and is sometimes hampered by inadequate delineation of the whole portal venous system. In patients who are potential candidates for surgery, that is, for portosystemic shunt procedures, a more exact diagnostic method that covers the whole portal venous system is required **(Wachberg et al., 2002).**

Diagnostic angiographic procedures have conventionally included both direct and indirect portography. Indirect portography involves arterial injections into the superior mesenteric artery or splenic artery and requires prolonged arterial infusion of contrast material followed by delayed imaging. These techniques are invasive, may be limited by flow dynamics, and require the use of potentially nephrotoxic iodinated contrast material and ionizing radiation **(Sehgal et al., 2000).**

Magnetic resonance (MR) imaging is probably as accurate as computed tomography (CT) but is more expensive and less accessible; in addition, some of the rarest pathways (eg, pleuropericardial or thoracic wall varices) may be missed at MR imaging **(Nakayama et al., 2001).**

CT imaging optimally depict extravascular anatomy. Nonhelical contrast-enhanced CT is hampered by respiratory and motion artifacts and has largely been superseded by helical CT. CT angiography provides superior temporal and contrast resolution for evaluation of the portomesenteric circulation. Thrombosis involving the larger splanchnic veins is readily identified. However, owing to limits in spatial resolution, evaluation of the smaller, distal mesenteric branch vessels was a challenge for all cross-sectional imaging methods **(Fishman et al., 2001)**.

The development of spiral computed tomography (CT), soon followed by that of multidetector CT, and has provided the radiologist with unparalleled capabilities to acquire high-quality image data. Whether it be the capability to acquire thin-section images (1-1.25mm), reconstruct data at narrow interscan intervals (1.0mm), or acquire these data in the arterial and portal venous phases, the newest scanners provide capabilities that were never thought possible a few short years ago **(Foley et al., 2000)**.

Multidetector CT angiography has become powerful tool for investigation of the liver. The addition of a portal-phase acquisition with 3 dimenional vascular reconstruction can augment the surgeon's perception of potentially problematic varices by detailing the course of these tortuous vessels. This knowledge is important not only for major operations such as liver transplantation but for more common procedures in which an unexpected varix can result in significant bleeding. With this tool, the radiologist can significantly affect patient care and alert a colleague to potential disaster **(Kirn et al., 2007)**.

Aim of Work

This study aim to discuss the role of multidetector CT angiography in the evaluation of the portal veinus system

Anatomy

Hepatic Portal System :

A portal system is a pattern of circulation in which the vessels that drain one group of capillaries deliver blood to a second group of capillaries, which in turn are drained by more usual systemic veins that carry blood to the vena cava and the right atrium of the heart **(Graaff, 2001).**

Hepatic portal circulation is a subdivision of systemic circulation in which blood from the abdominal digestive organs and spleen circulates through the liver before returning to the heart **(Scanlon and Sanders, 2007)**.

The portal venous system receives blood from the length of gut from the lower third of the oesophagus to the upper half of the anal canal as well as the spleen, pancreas and gall-bladder **(Faiz and Moffat, 2002).**

From these viscera the blood is conveyed to the liver by the portal vein. In the liver this vein ramifies like an artery and ends in capillary-like vessels termed sinusoids, from which the blood is conveyed to the inferior vena cava by the hepatic veins **(Gray, 2000).**

Portal vein :

Is about 8cm. in length, and is formed at the level of the second lumbar vertebra in the retroperitoneum by the junction of the superior mesenteric and splenic veins, the union of these veins taking place in front of the inferior vena cava and behind the neck of the pancreas (Fig. 1 explain the formation of portal vein behind neck of pancreas) **(Gray, 2000).**

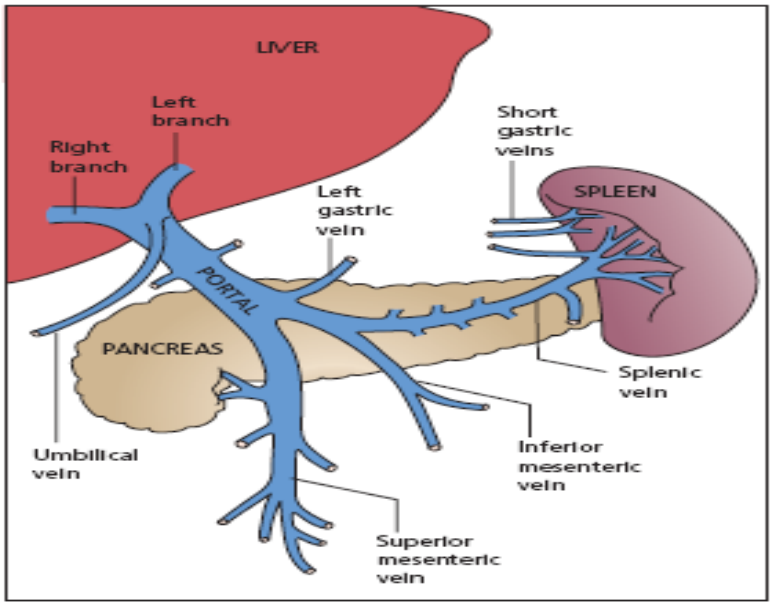

Fig. (1) The anatomy of the portal venous system: portal vein is posterior to pancreas **(Quoted from: Sherlock and Dooley, 2001)**

It passes upward behind the superior part of the duodenum and then ascends in the right border of the lesser omentum to the right extremity of the porta hepatis, where it divides into a right and a left branch, which accompany the corresponding branches of the hepatic artery into the substance of the liver. In the lesser omentum it is placed behind and between the common bile duct and the hepatic artery, the former lying to the right of the latter **(Gray, 2000).**

The **right branch** of the portal vein enters the right lobe of the liver, but before doing so generally receives the cystic vein. The **left branch,** longer but of smaller caliber than the right, crosses the left sagittal fossa, gives branches to the caudate lobe, and then enters the left lobe of the liver. As it crosses the left sagittal fossa it is joined in front by a fibrous cord, the **ligamentum teres** (obliterated umbilical vein), and is united to the inferior vena cava by a second fibrous cord, the **ligamentum venosum** (obliterated ductus venosus) **(Gray, 2000).**

The portal bifurcation may be extrahepatic (48% of cases), intrahepatic (26%), or located right at the entrance of the liver (26%) **(Anne, 2004).**

Segmental anatomy :

Couinaud classification:

Couinaud divided the liver into a functional left and right liver by a main portal scissurae containing the middle hepatic vein. This is known as Cantlie's line. Cantlie's line runs from the middle of the gallbladder fossa anteriorly to the inferior vena cava posteriorly (**Saxen, 2003).**

The Couinaud classification of liver anatomy divides the liver into eight functionally indepedent 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 (**Saxena, 2003).**

Right hepatic vein divides the right lobe into anterior and posterior segments.

Middle hepatic vein divides the liver into right and left lobes (or right and left hemiliver). This plane runs from the inferior vena cava to the gallbladder fossa.

Left hepatic vein divides the left lobe into a medial and lateral part.

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 (Figs. 2 & 3 explain segmental anatomy) (**Meyers, 2001)**.

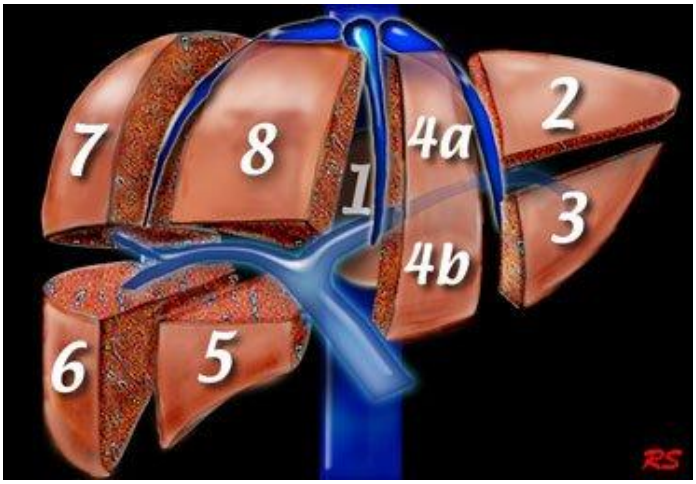

Fig. (2): Segmental anatomy according to Couinaud **(Quoted from: John, 2004)**.

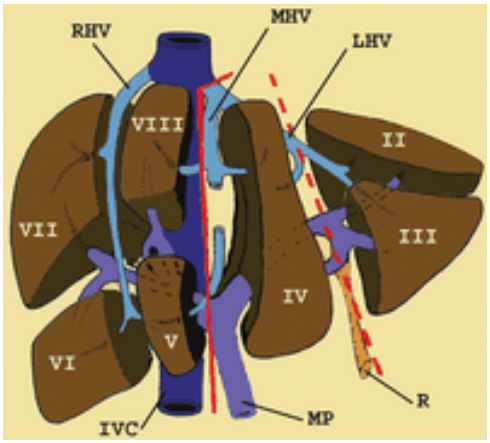

Fig. (3): Drawing illustrates the segmental anatomy of the liver, along with the pattern of hepatic venous drainage, the ramifications of the portal venous system. IVC = inferior vena cava, LHV = left hepatic vein, MHV = middle hepatic vein, MP = main portal vein, R = round ligament, RHV = right hepatic vein (**Quoted from:Ana,2005)**

Segments numbering:

There are eight liver segments.Segment 4 is sometimes divided into segment 4a and 4b according to Bismuth.The numbering of the segments is in a clockwise manner (Figs. 4

& 5 Explain segmental numbering).Segment 1 (caudate lobe) is located posteriorly. It is not visible on a frontal view. (**Saxena, 2003)**

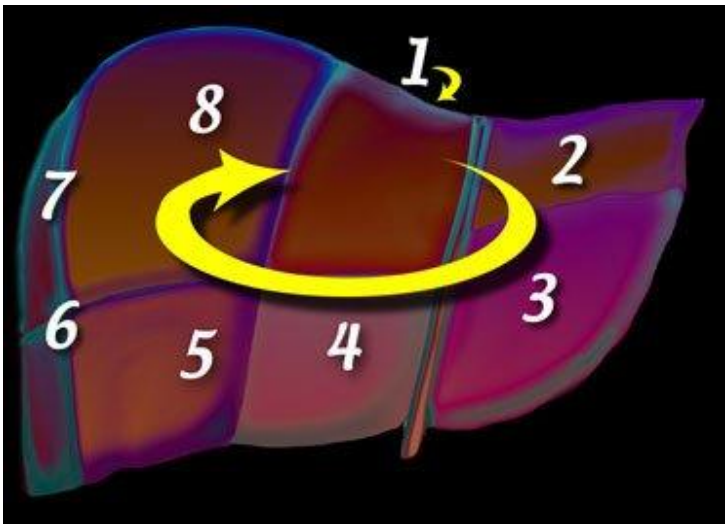

Fig. (4): Clockwise numbering of the segments **(Quoted from:John, 2004)**.

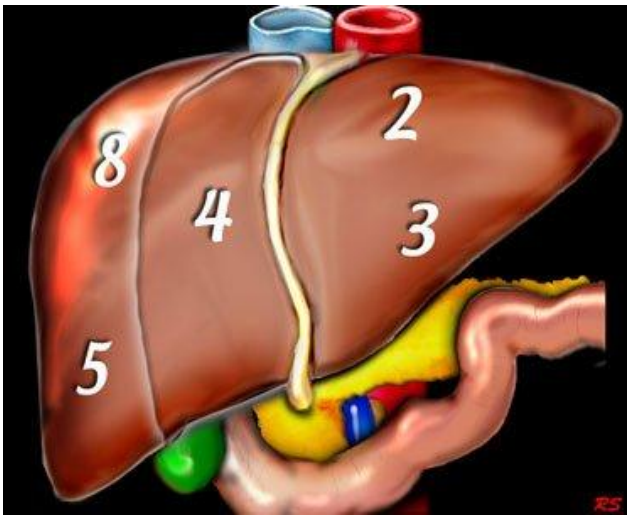

Fig. (5): On a frontal view of the liver the posteriorly located segments 6 and 7 are not visible. **(Quoted from: John, 2004)**.

Transverse anatomy:

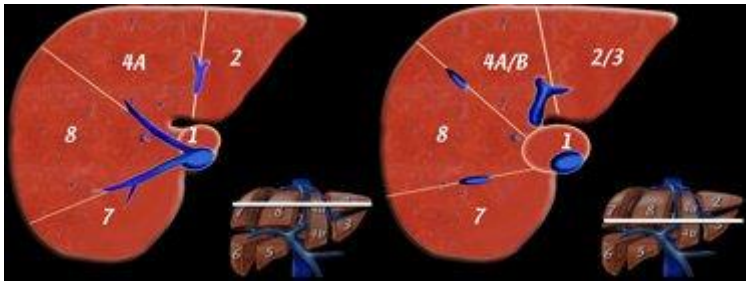

Fig.(6): **Left**: above the level of the left portal vein. **Right**: at the level of the left portal vein **(Quoted from: John, 2004)**.

The far left Fig. 6 is a transverse image through the superior liver segments that are divided by the hepatic veins.

The right Fig. shows a transverse image at the level of the left portal vein. At this level the left portal vein divides the left lobe of the liver into the superior segments (2 and 4A) and the inferior segments (3 and 4B). The left portal vein is at a higher level than the right portal vein (**Filipponi, 2000)**

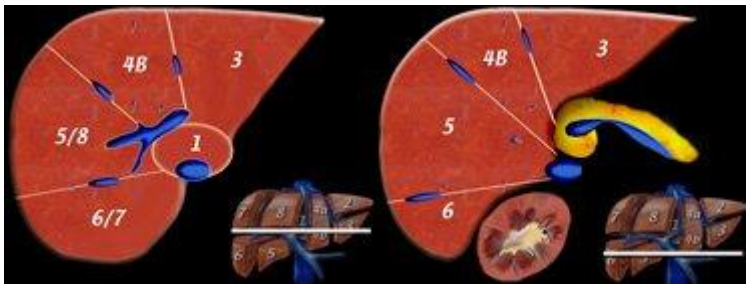

Fig.(7): **Left**: at the level of the right portal vein. **Right**: at the level of the splenic vein. **(Quoted from:John, 2004)**.

The image on the far left is at the level of the right portal vein. At this level the right portal vein divides the right lobe of the liver into superior segments (7 and 8) and the inferior segments (5 and 6).

The level of the right portal vein is inferior to the level of the left portal vein. At the level of the splenic vein, which is below the level of the right portal vein, only the inferior segments are seen (right image) (**Filipponi, 2000).**

Caudate lobe:

The caudate lobe or segment 1 is located posteriorly. The caudate lobe is anatomically different from other lobes in that it often has direct connections to the IVC through hepatic veins that are separate from the main hepatic veins. The caudate lobe may be supplied by both right and left branches of the portal vein (**Abdalla, 2002)**.

Portal vein braching:

In standard portal vein anatomy also called type1 or A anatomy, the main portal vein, which carries as much as 80% of the blood supply to the liver, typically divides at the hilus into the left and larger right portal branches. The left portal vein courses medially to the umbilical fissure and supplies segments II, III, and IV and a caudate branch. The right portal vein divides into the right anterior sector trunk, which in turn divides into segment V and segment VIII branches, and the right posterior sector trunk, which supplies segments VI and VII.Segmental veins then divide into subsegmental branches, which further divide into small veins leading to the portal venule of the liver acinus (Fig. 8: explain standared portal vein anatomy) **(Sabine, 2008).**

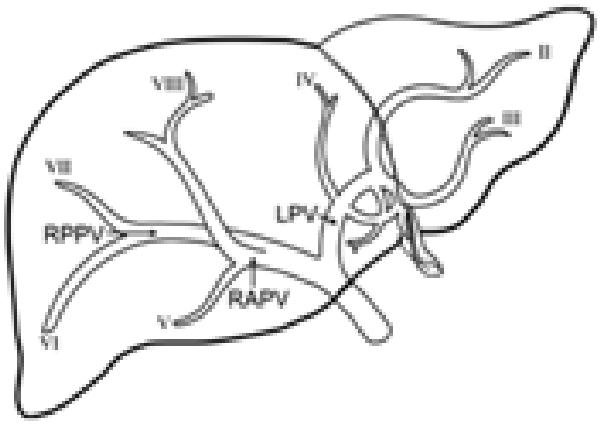

Fig. (8): Drawings depict standard portal vein anatomy also called type (1). LPV = left portal vein, RPPV = right posterior portal vein, RAPV = right anterior portal v**ein. (Quoted from: Enn, 2004)**.

Portal vein variants:

Embryologically, the portal vein is formed in the second month of gestation by selective involution of the vitelline veins, which have multiple bridging anastomoses anterior and posterior to the duodenum. Alterations in the pattern of obliteration of these anastomoses can result in several variants **(Anne, 2004).**

Several dramatic portal vein variants have been described, including duplications, congenital absence, these variants can be quite obvious with modern cross-sectional imaging **(Erbay, 2003)**.

Common variants:

(Fig. 9 explains most commen variants)

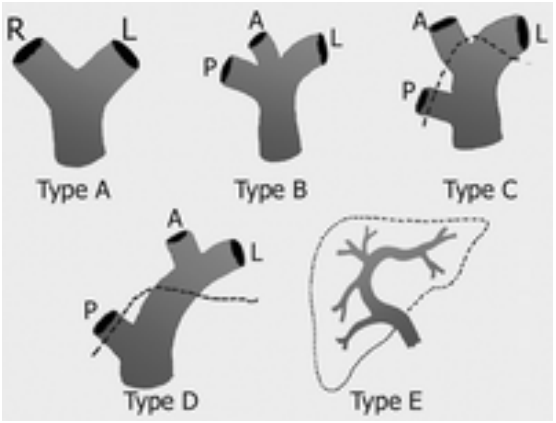

Fig. (9): Drawings illustrate the diffirent typs of portal vein branching: type A, standard anatomy (92.5% of cases); type B, early bifurcation or trifurcation (2.5%); type C, extraparenchymal branching of the anterior branch from the LPV (2.5%); type D, intraparenchymal branching of the anterior branch from the LPV (1.7%); and type E, an undivided main portal trunk (0.8%). **(Quoted from: Ana, 2005).**

Trifurcation also called type 2 or B anatomy of the main portal vein into the right anterior, right posterior, and left portal vein branches.Fig. (10) illustrat trifurcation **(Cetin,2006).**

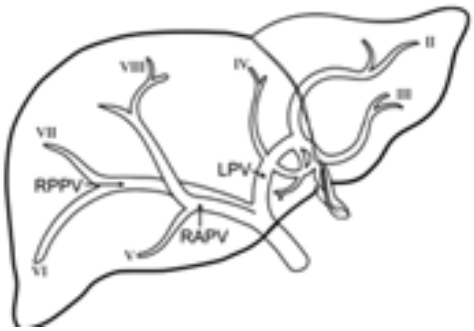

Fig. (10): Drawings depict portal vein trifurcation (also called type2). LPV = left portal vein, RPPV = right posterior portal vein, RAPV = right anterior portal vein. **(Quoted from: Anne, 2004).**

Sometimes the RAPV and the LPV shared a common trunk the length of the common RAPV-LPV trunk ranged from

2.5 to 17.3mm (mean, 7.9mm).When this common trunk branches extraparenchemal (outside the liver) this is what's called type C or type 3. When this common trunk branches intraparenchemal this is what's called type D or type4.Fig. (11) illustrats this type of variation **(Cetin, 2006).**

Trifurcation was the most frequent variation, but in the recent studies a common RAPV-LPV trunk is almost 2.5 times more common than trifurcation. This striking difference may have been the result of use of different methods of imaging the portal venous ramification. On thick axial sections a short RAPV-LPV trunk, which was not infrequent, can easily be misclassified as trifurcation. Reformations in 3D are crucial for accurate visualization of the anatomy in such cases **(Cetin, 2006).**

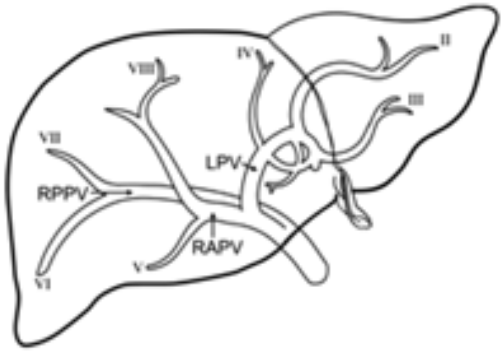

Fig. (11): Drawings depict the common trunk of left portal vein and right anterior portal vein . LPV = left portal vein, RPPV = right posterior portal vein, RAPV = right anterior portal vein. **(Quoted from:Anne, 2004).**

Absence of portal vein branching (in some studies called type E) in which a single portal vein enters the right liver and courses into the left, giving only segmental branches along its course **(Erbay, 2003).**

Other portal vein variants:

- Trifurcation of the right portal vein into the right anterior sectorial portal trunk and into segment VI and segment VII branches.
- Division of the main portal vein into segment VI, segment VII, right anterior portal vein, and left portal vein as a "quadrifurcation".
- Trifurcation of the right portal vein into branches supplying segment V, segment VIII, and the right posterior sectorial trunk.
- Segments IV and VII branches originating from the right anterior portal vein.
- An accessory segment VI branch from the right portal vein.
- Variants of the left portal vein are rare. the segment IV portal vein arise anomalously from the right anterior portal vein **(Zhuanga, 2008).**

Portal vein tributaries are: (Figs 12,13explain tributaries)

I. **Splenic vein.**
II. **Superior Mesenteric vein.**
III. **Coronary vein.**
IV. **Pyloric vein.**
V. **Cystic vein.**
VI. **Parumbilical veins.**

(Gray, 2000)