Ultrasound, Doppler and multidetector CT evaluation of vascular complications of liver transplants

An Essay

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1. <u>Introduction</u>

Liver transplantation has become the treatment of choice for patients with end-stage acute or chronic hepatic disease. Over the past several decades, advances in surgical techniques, organ preservation, immunosuppressive therapy, and early detection of postoperative complications have increased survival rates after liver transplantation. ***(Caiado et al., 2007)***

Nevertheless, there are still significant complications, particularly those of vascular origin, which can lead to graft failure and require retransplantation unless prompt treatment is instituted. Since the clinical presentation of post transplantation complications is frequently nonspecific and varies widely, imaging studies are critical for early diagnosis. ***(Quiroga et al., 2001).***

Ultrasound (US) and Color Doppler ultrasound (CDUS) are the most important tools in the follow-up of LT patients because they show high sensitivity and specificity in detecting vascular complications, During transplantation, CDUS is usually performed to detect the intraparenchymal flows (arterial, portal and venous), and to evaluate the velocity of flow and waveform to detect very early complications such as hyper acute hepatic artery or Portal vein thrombosis. ***(Choi JV et al., 2007)***

The development of spiral computed tomography and subsequently multidetector CT has provided unparalleled opportunities for advancement of CT technology and clinical applications. **(Kim et al., 2006)**

Although it requires careful use of iodinated contrast material, particularly in patients with impaired renal function, CT is now widely available and is faster than other methods, such as magnetic resonance imaging for detection of vascular complications, thus, multidetector CT is a valuable technique for evaluation of liver transplant patients. When vascular complications are suspected and US results are indeterminate, it can avoid the need for diagnostic angiography. **(Quiroga et al., 2001)**

Multidetector computerized tomography (MDCT) angiography is the best option for confirming the ultrasonographic suspicion of early and late vascular complications (Hepatic artery thrombosis (HAT), main portal vein or inferior vena cava (IVC) stenosis or thrombosis) In addition, it permits a good assessment of liver parenchyma and other abdominal organs, and the evaluation of bilomas, bleeding, abdominal or hepatic abscesses, adrenal infarction, and intestinal perforation or obstruction. MDCT can identify biliary duct dilatation, even if the anastomosis is not easy to depict. MDCT also plays a key role in detecting late complications, such as recurrence of the primary disease, post-transplant lymphoproliferative disease (PTLD), Kaposi’s sarcoma or other malignancies related to long-term Immunosuppression. **(*Kayahan et al.*, 2007)**

Aim of work

The goal of this study is to discuss the role of ultrasound, Doppler and multidetector CT in the evaluation of vascular complications of liver transplantation.

2. References

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تقييم مضاعفات الأوعية الدموية بعد زراعة الكبد بإستخدام الأشعة المقطعية متعددة المقاطع و الموجات فوق الصوتية و الدوبلر

رسالة

توطئة للحصول على درجة الماجستير في الأشعة التشخيصية

مقدمة من

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Anatomy of Liver

Gross Anatomy

Lobation and segmentation of the liver:-

The liver has four lobes or eight segments, depending on whether it is defined by its gross anatomical appearance or by its internal architecture. Classification of the liver by internal architecture divides it into lobes, segments or sectors. The biliary, hepatic arterial and portal venous supply of the liver tends to follow very similar distributions used to define the hepatic segments. The hepatic venous anatomy follows a markedly different pattern.

The value of the segmental classification, according to vascular and biliary supply, is that surgical resection of a segment, multiple segments or a whole lobe, may be planned and performed to encounter the fewest possible major vascular structures ***(Standring, 2008)***

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Gross anatomical lobes *(Fig.1)*:

The gross anatomical appearance of the liver has been divided into right, left, caudate and quadrate lobes by the surface peritoneal and ligamentous attachments. The falciform ligament superiorly and the ligamentum venosum inferiorly, mark the division between right and left lobes. On the inferior surface, to the right of the groove formed by the ligamentum venosum, there are two prominences separated by the porta hepatis. The quadrate lobe lies anteriorly, the caudate lobe posteriorly. The gallbladder usually lies in a shallow fossa to the right of the quadrate lobe ***(Standring, 2008)***.

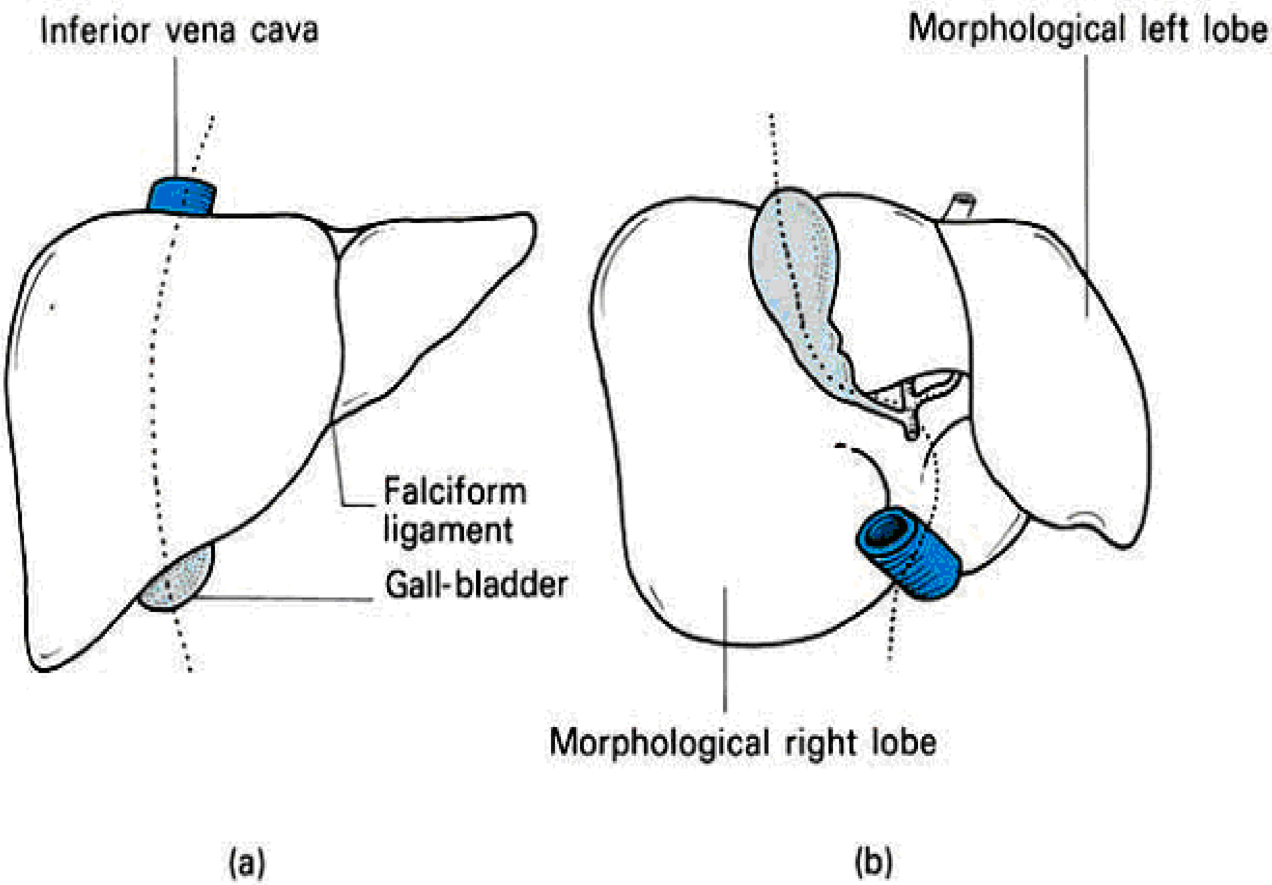

Figure (1): The morphological right and left lobes of the liver shown separated by the dotted line: (a) anterior and (b) ventral aspect. Note that the quadrate lobe is morphologically a part of the left lobe while the caudate lobe belongs to both right and left lobes ***(Ellis, 2006)***

Hepatic segmentation:
Couinaud's segments (Fig. 2, 3):

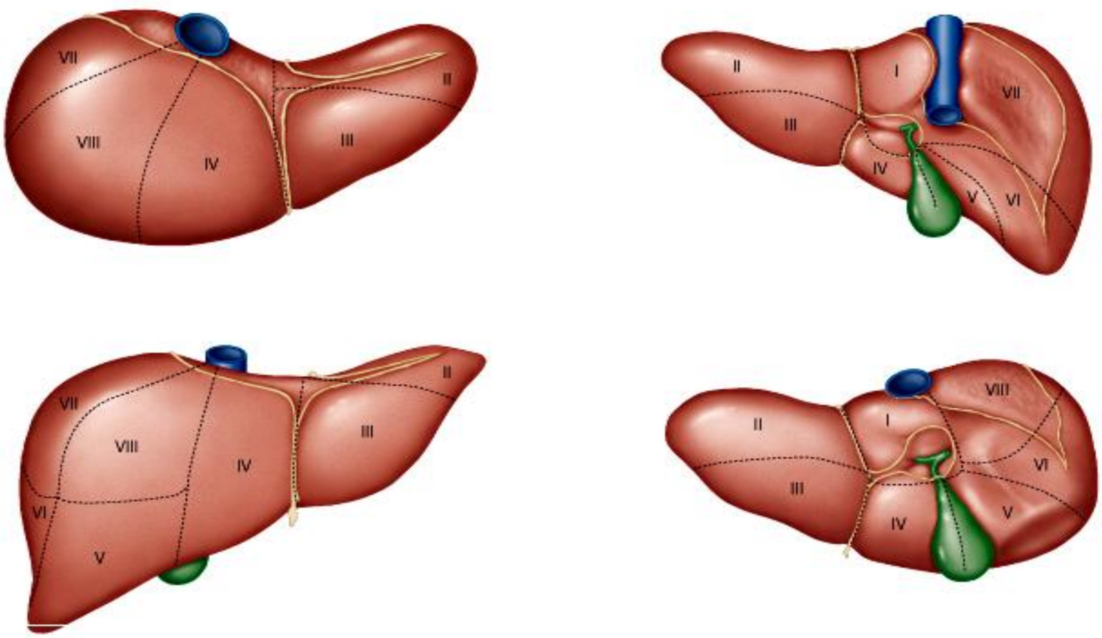

Figure (2): **Segmentation of the liver - Couinaud. Top left, superior view; top right, posterior view; bottom left, anterior view; bottom right, inferior view. The segments are sometimes referred to by name - I, caudate (sometimes subdivided into left and right parts); II, lateral superior; III, lateral inferior; IV, medial (sometimes subdivided into superior and inferior parts); V, anterior inferior; VI, posterior inferior; VII, posterior superior; VIII, anterior superior *(Standring, 2008)*.**

There are eight distinct liver segments; each of these segments has its own portal venous supply and separate hepatic venous and biliary ductal drainage. Therefore, each segment theoretically could be individually resected or survive on its own. This system uses the three major hepatic veins as boundary lines to divide the liver into four major sections. The right hepatic vein divides the right lobe into anterior and posterior segments, the middle hepatic vein divides the liver into right and left liver lobes, the left hepatic vein divides the left lobe into medial and lateral segments. Three of these major segments are further subdivided into superior and inferior divisions by imaginary transverse line passing through the respective right and left portal veins. The liver is partitioned into eight segments which are numbered in a counterclockwise fashion beginning with caudate lobe (segment I). The left liver lobe is divided into two sectors by the left hepatic vein, segments III and IV (anterior sector) are anterior to the vein, whereas, segment II (posterior sector) is posterior to it. Within anterior sector, segment III is separated from segment IV by the umbilical fissure and falciform ligament.

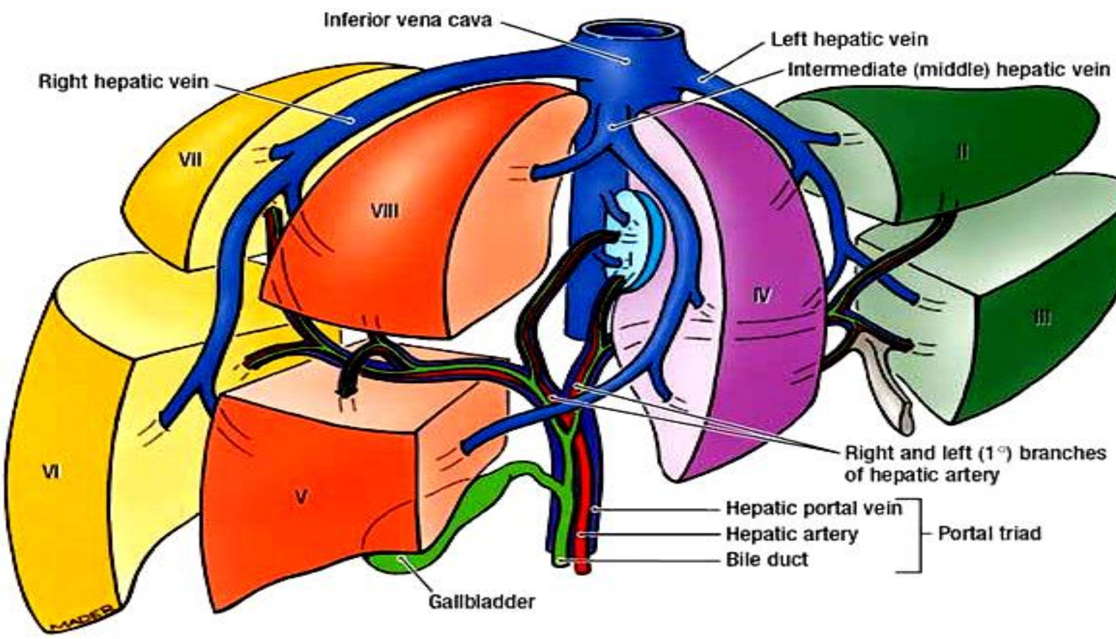

Figure (3): **Hepatic segmentation anterior view**
(Agur and Dalley, 2009).

The right lobe is separated from the left lobe by main portal scissura (Cantlie line) a para sagittal plane that passes through the IVC and the long axis of the gall bladder and contains the middle hepatic vein. The right lobe is divided into the anterior sector (segment V and VIII) and posterior sector (segments VI and VII) by the right portal scissura, an off-coronal plane containing the right hepatic vein and the IVC. Finally, segments V and VI (inferior segments) are separated from segments VII and VIII (superior segments) by an axial plane containing the horizontal portion of the right portal vein *(Gazelle et al., 1994)*.

Liver Vasculature:-

The vessels connected with the liver are the portal vein, hepatic artery and hepatic veins. The portal vein and hepatic artery ascend in the lesser omentum to the porta hepatis, where each bifurcates. The hepatic bile duct and lymphatic vessels descend from the porta hepatis in the same omentum. The hepatic veins leave the liver via the posterior surface and run directly into the inferior vena cava *(Standring, 2008)*.

The porta hepatis *(Fig. 4):*

The porta hepatis is the area of the inferior surface through which all the neurovascular and biliary structures, except the hepatic veins, enter and leave the liver. It is situated between the quadrate lobe in front and the caudate process behind. The porta hepatis is actually a deep fissure into which the portal vein, hepatic artery and hepatic nervous plexus ascend into the parenchyma of the liver. The right and left hepatic bile ducts and some lymph vessels emerge from it. At the porta hepatis, the hepatic ducts lie anterior to the portal vein and its branches, and the hepatic artery with its branches lies between the two. All these structures are enveloped in the perivascular fibrous capsule - hepatobiliary capsule of Glisson - a sheath of loose connective tissue which surrounds the vessels as they course through the portal canals in the liver. It is also continuous with the fibrous hepatic capsule. The dense aggregation of vessels, supporting connective tissue, and liver parenchyma just above the porta hepatis is often referred to as the 'hilar plate' of the liver. It may be dissected surgically to gain access to the intrahepatic branches of the bile ducts and vessels *(Standring, 2008)*.

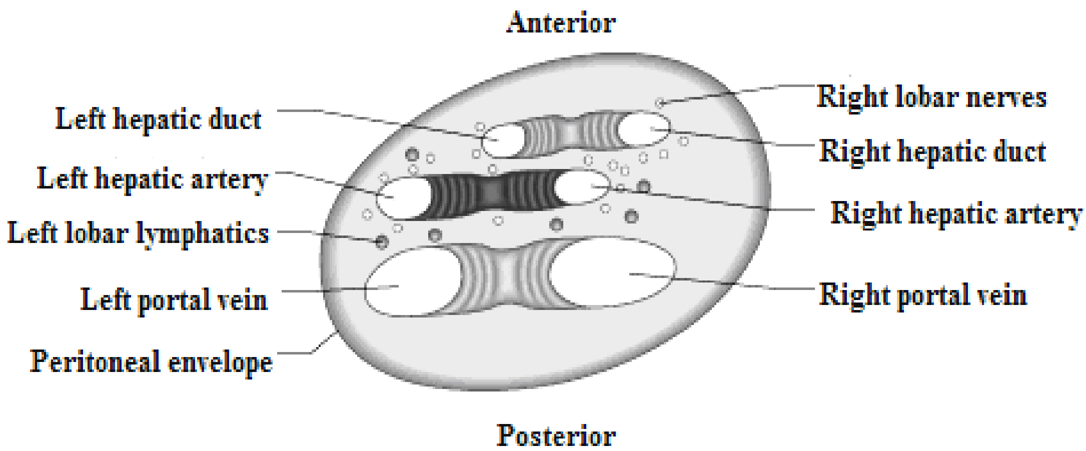

Figure (4): **Cross-section of the structures at the porta hepatis *(Standring, 2008)***

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Common Hepatic Artery (CHA) *(Fig. 5)*

The CHA also shows a highly variable course along the cranial border of the body and the head of the pancreas. The course is variable in direction, but tortuous courses are usually not observed. According to Michels, anatomic variations most often affect the origin of the hepatic artery *(Hindman et al., 2009)*.

Most commonly, the CHA arises from the celiac trunk, gives off the gastroduodenal artery (GDA) and the right gastric and supraduodenal artery, and then becomes the proper hepatic artery, which courses obliquely within the anterior hepatoduodenal ligament. The proper hepatic artery then gives off the cystic artery and bifurcates into the right and left hepatic arteries, with a middle hepatic artery that may arise from either the right or

left hepatic arterial branch (*Hindman et al., 2009)*; this conventional arterial pattern occurs only 55% of the time.

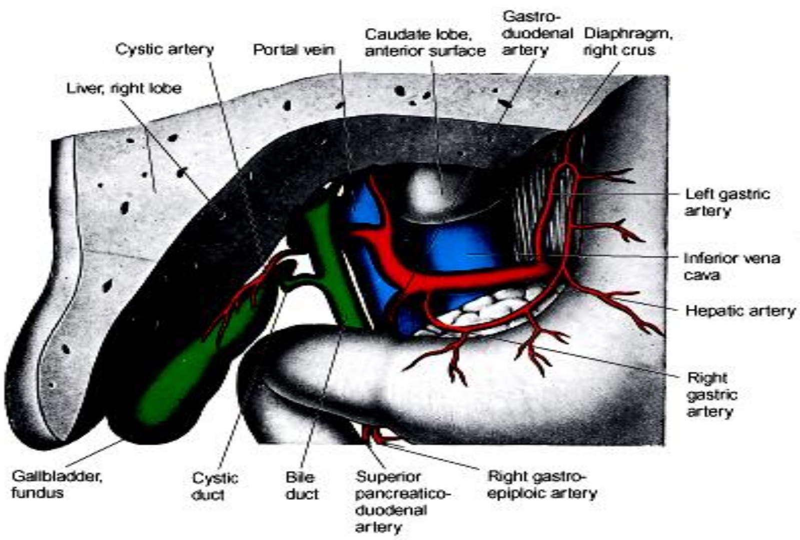

Figure (5): **Dissection to show the relations of the hepatic artery, bile duct and portal vein to each other in the lesser omentum: anterior aspect *(Standring, 2008)*.**

The replaced right hepatic artery is a common variant that traverses the pancreatic head as it passes from the superior mesenteric artery (SMA) to the liver, providing branches to the pancreas. Another common variant is the replaced left hepatic artery, which arises from the left gastric artery (LGA), usually associated with the right and middle hepatic artery arising from the proper hepatic artery. Less frequent variations include an accessory left hepatic artery from the LGA, an accessory right hepatic