

Multi-detector Computerized Tomography in pre-operative evaluation of living donors for liver transplantation

THESIS

**Submitted in partial fulfillment of the degree of
Medical doctorate (M.D) in Radiodignosis**

Yousef Ahmed Yousef Sliem

**MBBCh. Msc
Ain Shams University**

Supervised By:

Prof. Dr. / Ferdous Abdel Raof Abdeen

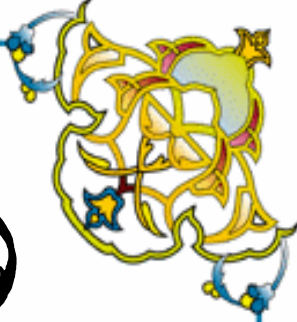
**Professor of Radiodiagnosis
Radiology department – Ain Shams University**

Dr. /Ahmed Mostafa Mohammad

**Assist .Professor of Radiodiagnosis
Radiology department – Ain Shams University**

Ain Shams University

٢٠١٠

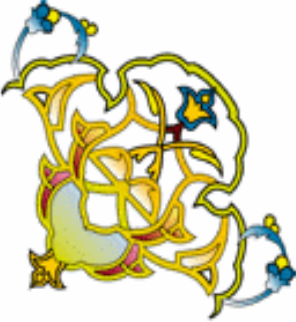


سُبْحَانَكَ اللَّهُمَّ

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا
إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ
الْعَلِيمُ الْحَكِيمُ

صدق الله العظيم

سورة البقرة آية (٣٢)



Acknowledgment

Uncountable thanks to God who creates this work by guiding me to the frank clear way and by offering assistance of honest professors and lecturers.

I would like to express my deep gratitude and sincere thanks to Prof. Dr. Ferdous Abdel Raof Abdeen , Professor of Diagnostic Radiology, Ain Shams, Faculty of Medicine, for her guidance, encouragement and valuable advice throughout the whole work, without her continuous support ,this study could have never been completed. It is really a great honor for me to conduct this under her supervision.

I appreciate too much the guidance offered by Dr. Ahmed Mostafa Mohamed, Assitanat professor of Diagnostic Radiology, Ain Shams, Faculty of Medicine, for his moral support, continuous help and great aid.

Yousef Ahmed Yousef

A cartoon illustration of a yellow scroll with a black outline. The scroll is partially unrolled, showing a greenish-brown inner layer. A hand with a blue sleeve is writing on the scroll with a yellow pen. The text is written in a black, serif font.

Dedication

To
My Beloved Father,
Mother, Brother, sisters
And My Wife

List of Contents:

Title	Page
• List of figures	
• List of tables	
• List of abbreviations	
• Introduction and Aim of the Work	١
• Review of the Literature:	
• Radiological anatomy of the liver	
a) Hepatic Segmental Anatomy	٣
b) Normal Anatomy of the Hepatic Vasculature..	١١
c) Anatomic Variants	١٤
• Multislice CT findings	١٧
• Principals of Living donor liver transplanatation ...	٣٢
• Patients and Methods	٥٤
• Illustrative cases	٦٢
• Results	٨٢
• Dissuction	٨٩
• Summary and Conclusion.....	١٠٤
• References.....	١٠٦
• Arabic Summary	--

List of Figures:

Fig. No	Subjects	Page
١. (a)	The superior, anterior and right lateral surface of the liver	٥
١. (b)	The inferior surface of the liver	٥
٢.	The liver and gall bladder (a) anterior (b) inferior views ..	٧
٣.	Segments of the liver	١٠
٤.	The segmental anatomy of the liver	١٠
٥.	Normal hepatic arterial anatomy	١١
٦.	Normal portal venous anatomy	١٢
٧.	The segmental anatomy of the liver	١٢
٨.	Hepatic venous confluence	١٣
٩.	The types of Right portal vein branching	١٦
١٠.	٣D (VR) image of the normal hepatic arterial anatomy ...	١٨
١١.	MIP image of replace RHA from The SMA	١٨
١٢.	(VR) image of replaced LHA from The left gastric A.....	١٩
١٣.	MIP image of an accessory LHA from the left gastric A...	١٩
١٤.	MIP image shows Two LHAs	٢٠
١٥.	Coronal VR show Segment IV from RHA	٢٠
١٦.	MIP image show triple supply to segment IV	٢١
١٧.	(VR) image shows normal portal venous anatomy	٢٢
١٨.	MIP image shows trifurcation of the main portal vein	٢٣

List of Figures (Cont.):

Fig. No	Subjects	Page
١٩.	(VR) image shows extraparenchymal branching of the anterior branch from the left portal vein	٢٣
٢٠.	(VR) image shows a vein arising from the main portal vein and supplying the LLS	٢٤
٢١.	MIP shows the normal hepatic venous anatomy	٢٤
٢٢.	MIP shows the hepatic venous anatomy of the middle and left hepatic veins join to form common trunk	٢٦
٢٣.	(VR) image shows a large accessory Inferior RHV	٢٦
٢٤.	MIP shows early confluence of two branching of the MHV	٢٧
٢٥.	MIP shows late confluence of two branching of the MHV	٢٧
٢٦.	Domninance of the MHV over the RHV	٢٨
٢٧.	MIP shows the branch of segment III draining into the MHV	٢٨
٢٨.	(VR) image shows the calculated volume of the graft (LLS)..	٢٩
٢٩.	Liver regeneration after right lobe donation	٣٠
٣٠.	MR Cholangiogram shows drainage of right posterior duct into left hepatic duct	٣١
٣١.	MR Cholangiogram shows three ducts joinng at hepatic confluence	٤٦
٣٢.	The transaction plane through the liver	٥٠
٣٣.	Surgical division of the liver along the MHV	٥٠

List of Tables:

Tab. No	Subjects	Page
١.	The Michel classification of hepatic arterial variant anatomy	١٥
٢.	Hepatic arterial variants and liver transplantations	٢١
٣.	Portal venous variants and liver transplanatation	٢٥
٤.	Hepatic venous variants and liver transplanatation	٢٩
٥.	Main differences between living donation for a pediatric and adult recieient	٣٤
٦.	Evaluation protocol for potential living liver donors	٤٥
٧.	Protocol for Multidetector CT angiography	٦٠
٨.	The total and lobar liver volumes using CT portal phase.....	٨٣
٩.	Hepatic venous anatomy	٨٤
١٠.	The results obtained by the MDCT	٨٥
١١.	The radiological exclusion criteria of potential liver donors.	٨٦
١٢.	CT findings in ١٢٠ potential donors examined by MDCT ...	٨٧

List of Abbreviations:

AIDS	Acquired Immuno deficiency syndrome
CA	Celiac axis
CBD	Common bile duct
CHA	Common hepatic artery
cm	Centimeter
cm/s	Centimeter per second
CT	Computed tomography
ERCP	Endoscopic retrograde cholangiopancreatography
GB	Gall bladder
GDA	Gastro-duodenal artery
HBV	Hepatitis B virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C virus
HIV	Human immuno deficiency virus
IVC	Inferior vena cava
IJV	Internal jugular vein
Kg	Kilogram
LGA	Left gastric artery
LPV	Left Portal vein
LDLT	Living donor liver transplantation
LHA	Left hepatic artery
MHV	Middle hepatic vein
MIP	Maximum intensity projection

List of Abbreviations (Cont.):

ml	milliliter
mm	millimeter
MPV	Main portal vein
MRA	Magnetic resonance angiography
MRC	Magnetic resonance cholangiography
MRI	Magnetic resonance imaging
MRV	Magnetic resonance venography
PV	Portal vein
RHA	Right hepatic artery
RI	Resistive index
RPV	Right portal vein
SMV	Superior mesenteric vein
SPA	Splenic artery
TE	Echo time
3D	Three dimension
TR	Repetition time
U	Unit
US	Ultrasound
VR	Volume rendering



Introduction

Liver transplantation is a successful therapeutic option for patients with multiple irreversible acute and chronic liver diseases (**Redvanly et al., 1995**).

Living donors liver transplantation has evolved into widely accepted therapeutic option to alleviate the critical shortage of cadaveric liver transplant organs (**Adam et al., 2003**). Living donors liver transplantation provides the advantage of performing an elective operation, having access to a graft in best condition, and lowering the likelihood of recipient death while waiting for a suitable organ (**Broelsch et al., 2002**).

In living donors liver transplantation, the donor undergoes partial hepatectomy for donation to a recipient, the right lobe of the liver is the lobe usually donated (**Pannu et al., 2001**).

A critical issue of this procedure remains the risk it imposes on the healthy donors which is reflected in a post operative morbidity rate of 21% and a mortality rate of 0.5% (**Russo et al., 2004**). One reason for this drawback is seen in a high number of either unrecognized or during the operation, extemporaneously handled biliary and vascular variants (**Imamura et al., 2000**).

To reduce such risk to a minimum and also to ensure optimal surgical results in the recipient, the donation candidate have to undergo an extensive stepwise – fashioned evaluation of the condition of the transplantation candidate and that of the potential donor (**Schroeder et al., 2006**).

Living donors for liver transplantation (LDLT) is a radiology intensive process that involves the performance of preoperative assessment of potential liver donors to exclude focal lesions, ensure



adequate liver volume, evaluate for fatty infiltration of the liver, and determine hepatic vascular anatomy (**David et al., ۲۰۰۵**).

A primary goal of imaging living potential right lobe liver donors is to determine the suitability of the donor liver for transplantation. The ideal liver graft has a sufficiently large right lobe relative to the body mass of the graft recipient, minimal hepatic steatosis, and favorable vascular anatomy (**Benjamin et al., ۲۰۰۷**).

With the development of the new multidetector computed tomographic (CT) techniques, the radiologist plays a relevant role, providing, with a minimally invasive procedure, valuable information that will be useful in choosing the most suitable candidate. Knowledge of the volumes of the entire liver and of both of its lobes required prior to planning for surgery can be measured by using computed tomographic (CT) volumetric techniques (**Arne , ۲۰۰۶**).

Anatomic variations of the vasculature are common, well recognized, and easily depicted with CT angiography. Since certain anomalies may result in modification of the planned surgical procedure, it is important to document variations in arterial and venous anatomy that may occur in donors, particularly those variations that traverse the anticipated hepatectomy plane (**Ana, ۲۰۰۵**). Inadvertent damage to a major vessel may cause ischemic injury to the graft or to the donor liver (**Guiney et al., ۲۰۰۳**).

Aim of the work:

To evaluate the role of multi-detector CT as a comprehensive minimally invasive tool in the assessment of the hepatic morphology (parenchymal evaluation), volumetry, vascular mapping of the liver in potential living donor for liver transplantation.



Normal Anatomy of the Liver

Gross Morphology:

The liver is the largest gland in the body. It has considerable individual variations in size and shape. It is situated in the cranial and right parts of the abdominal cavity occupying most of the right hypochondrium, epigastrium and not uncommonly extending to the left hypochondrium. It has two surfaces: diaphragmatic and visceral surfaces. The diaphragmatic surface is dome shaped and conforms to the diaphragm. It is divided into superior, anterior, right and posterior portions or surfaces (*Lencioni and Bratolozzi, ٢٠٠٧*).

A- Diaphragmatic surface: (*Blumgartr and Hamm, ٢٠٠٠*).

١-**The superior portion**: It is completely covered by peritoneum except for a small triangular area where the two layers of the falciform ligament diverge. The major landmark of the superior surface is the sagittal groove which is a deep notch providing access for the ligamentum teres that runs in the free edge of the falciform ligament. This portion is related through the diaphragm to the base of the right lung, pericardium and the heart on its extreme left side.

٢-**The anterior portion**: It is completely covered by peritoneum except along the line of attachment of the falciform ligament. It lies against the diaphragm, the costal margin, and the xiphoid process and the abdominal wall.



↯-**The right portion:** It is covered by peritoneum and merges with the other three parts of the diaphragmatic surface and continues down to the right margin that separates it from the visceral surface.

ξ-**The posterior portion:** A large part of this posterior portion of the diaphragmatic surface is not covered by peritoneum and this uncovered area is frequently called the bare area that is bounded by the superior and inferior reflections of the coronary ligament. This surface is broad and rounded on the right but narrow on the left. To the right of vena cava and partially on the visceral is a small triangular depressed area that is named supra-renal impression for the suprarenal gland and to the left of the ductus venosus fossa there is oesophageal groove for antrum cardiacum of the esophagus.

B- The visceral or inferior surface:

It is facing downward, backward and to the left, and it is covered by visceral peritoneum except at the porta hepatis, fissure for ligamentum teres and fossa for the gall bladder. This surface bears the imprint of the adjacent viscera and this surface is closely related to the pylorus, the duodenum, the gall bladder, the right colon, the hepatic flexure, the right third of the transverse colon, the right kidney and the right supra-renal gland (*Blumgartr and Hamm, ↯ . . .*).

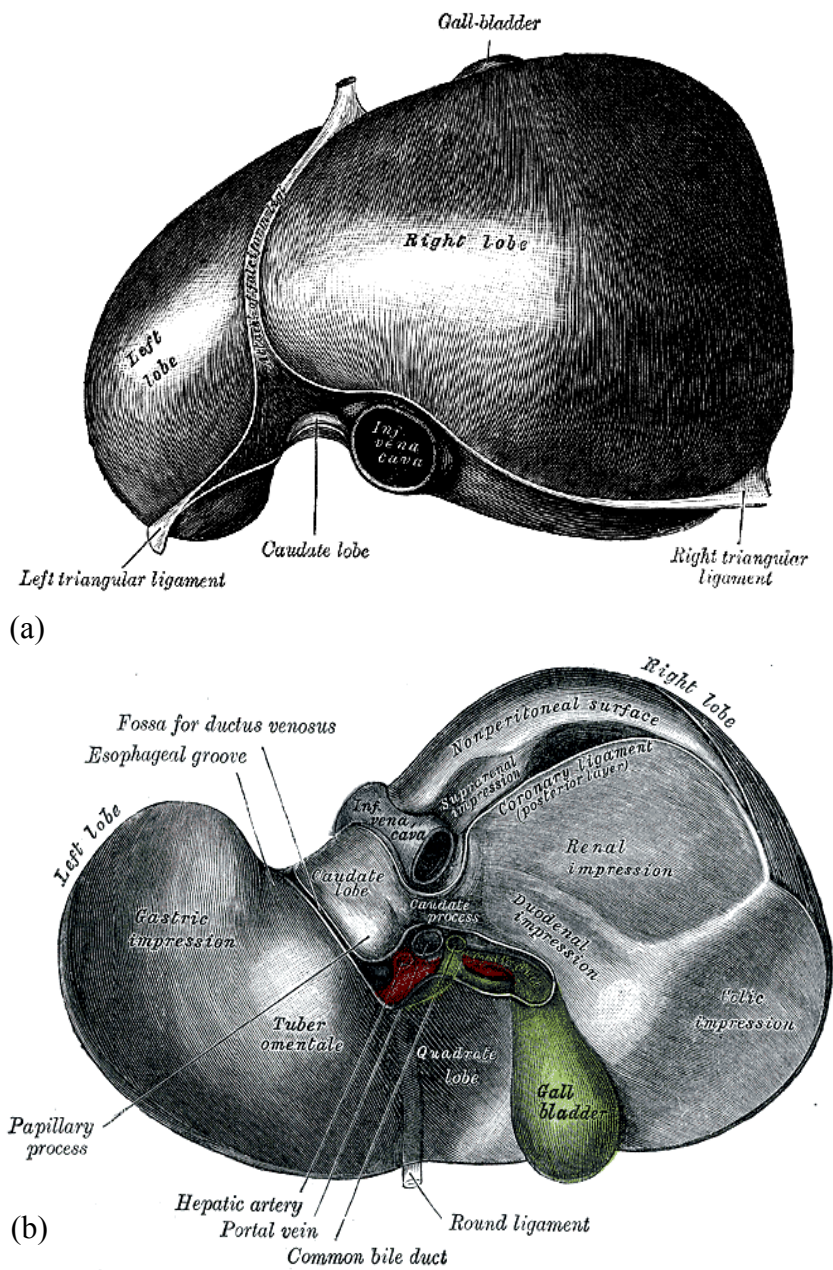


Figure (1): (a): The superior, anterior and right lateral surfaces of the liver **(b):** The inferior surface of the liver (Quoted from Williams, 1999).