Accuracy of the CT estimated volume of the right hepatic lobe prior to living related liver transplantation

Thesis Submitted in partial fulfillment for the M.D. degree in Radiodiagnosis

BY

Wael Mohammed Kamal Abdel Haleem

(M.B.,B.Ch. ; M. Sc. Radiodiagnosis)

Supervisors

Prof. Dr. Ahmed kamal El Dorry

Prof. of Radiodiagnosis

Faculty of Medicine

Ain Shams University

Prof. Dr. Ibrahim Kamel Marwan

Prof. of Hepatobiliary Surgery

National liver institute

Menoufiya University

Dr. Mohammed Shaker Ghazy

Ass. Professor of Radiodiagnosis

Faculty of Medicine

Ain Shams University

Ain Shams University

(2010)

Acknowledgment

There is something which makes me proud and I will always mention it to my kids and colleagues that I have prof. Dr. Ahmed El dorry, the leading pioneer of interventional radiology and prof. Dr. Ibrahim Marwan, the leading pioneer in liver transplantation as well as Dr. Mohammed Shaker, the eminent and brilliant interventional radiologist supervising my MD thesis. However this was a challenge that I hope to have succeeded in providing a research work fit like these high medical and scientific summits which I will always appreciate their help, parental advise and wise guidance.

I thank my professors and colleagues in the diagnostic radiology and surgery departments in the National Liver Institute, Menoufiya University for their cooperation.

I also thank my parents and wife for their support.

Finally thanks to God who made all this help, cooperation, and support happen.

بسم الله الرحمن الرحيم

وقل ربى

زدني علما

صدق الله العظيم

LIST OF ABBREVIATIONS

AGRWR	Actual graft- recipient weight ratio
AGV	Actual graft volume
BMI	Body mass index
BSA	Body surface area
CECT	Contrast enhancement computed tomography
CGRWR	Calculated graft- recipient weight ratio
CGV	Calculated graft volume
CPR	Curved planar reconstruction
CT	Computed tomography
CTA	Computed topographic angiography
DDLT	Deceased donor liver transplantation
ERCP	Endoscopic retrograde cholangiopancreatography
gm	Gram
GRWR	Graft- recipient weight ratio
GV	Graft volume
HA	Hepatic artery
HU	Hounsefield unit
HV	Hepatic vein
Hz	Hertz

IN	In phase
INR	International normalized ratio
IVC	Inferior vena cava
LDLT	Living donor liver transplantation
LHA	Left hepatic artery
LLS	Left lateral segment
LPV	Left portal vein
LTx	Liver transplantation
MDCT	Multi detector computed tomography
MHV	Middle hepatic vein
MIP	Maximum intensity projection
mL	Millilitre
mm	Millimeter
MPR	Multi planar reconstruction
MRA	Magnetic resonance angiography
MRCP	Magnetic resonance cholangiopancreatography
MRI	Magnetic resonance imaging
mSv	Millisievert
NAFLD	Nonalcoholic fatty liver disease
NASH	Nonalcoholic steatohepatitis
NCECT	Non-contrast enhancement computed tomography

OP	Opposed phase
PPM	parts per million
PV	Portal vein
RAPV	Right anterior portal vein
RHA	Right hepatic artery
RIHV	Right inferior hepatic vein
RLV	Remaining liver volume
RPPV	Right posterior portal vein
Sec	Second
SLT	Split liver transplantation
SMA	Superior mesenteric artery
SLV	Standard liver volume
T	Tesla
3D	Three dimensional
T1	Longitudinal relaxation time
T2	Transverse relaxation time
TE	Echoe time
TLV	Total liver volume
TR	Repetition time
US	Ultrasound
VR	Volume rendering

Aim of the work

The aim of this study is to determine the accuracy of the CT estimated volume of the right hepatic lobe prior to living related liver transplantation for predicting the inraoperatively measured weight of the graft.

Introduction

During the past years, the number of liver transplantation has increased greatly, but the number of available organs has not increased.

In view of the critical shortage of organs, the indications for living donor liver transplantation (LDLT) have broadened since experience with the procedure has been achieved ***(Chen et al., 2007).***

Increasing the number of living-donor liver transplants would allow us to expedite transplant, avoid death on the waitlist, and possibly save more lives by expanding the criteria for transplant. These benefits must always be weighed against the potential risks and complications to the donor, which can be significant ***(Yeh and Olthoff, 2008).***

Selection and evaluation of a living liver donor for adult recipients is a complex process that involves optimizing graft size in relation to the safety of donors and recipients, technical details of liver procurement, and ethical problems of using nonrelated live donors ***(Li et al., 2007).***

Regardless of the potential benefit that living donor liver transplantation offers to the critically ill patients with end-stage liver disease, donor safety is a prime concern ***(Lo, 2003).***

The preoperative volumetric analysis of the donor liver is an important factor in determining surgical strategy and in predicting postoperative donor and recipient mortality and morbidity. It has been reported that donor hepatectomy exceeding 70% of the total liver volume leads to hepatic insufficiency or death, and that liver remnants should be kept to more than 30% of the total liver volume ***(Akabayashi et al., 2004).***

One of the major concerns with adult-to-adult living donor liver transplantation is the frequent use of potentially small grafts that are unable to meet the immediate functional demands of the recipient and carry the risk of developing so-called “small-for-size” syndrome with subsequent graft failure ***(Dahm et al., 2005).***

Therefore, accurate preoperative estimation of graft volume is of paramount importance to avoid small-for-size syndrome and graft failure following adult-to-adult living donor liver transplantation

(Khalaf et al., 2007).

Volumetry of the hepatic graft and remnant is mandatory for living related liver transplantation and is usually performed with cross-sectional computed tomography (CT) or magnetic resonance (MR) imaging ***(Nakayama et al., 2006).***

Since the first volume calculation of the liver was introduced in the late 1970s by **Heymsfield and colleagues**, several new visualization techniques and refinements in semiautomatic and automatic liver volumetry have been developed which enable individualized computer-generated resection protocols (***Luccichenti et al., 2003).***

Volumetry of the liver on CT images is usually performed by manual tracing of the liver boundary and summation of the liver area on each section. However, manual methods require considerable user involvement in the segmentation of the liver on each section, which is a time-consuming process. The automated method reduced the time required for volumetry of the liver and provided acceptable measurements ***(Nakayama et al., 2006).***

Contents

LIST OF FIGURES