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ESTIMATION OF FACTORS EFFECTING VOLUME OF LIVER USING LIVER ANALYSIS SOFTWARE IN COMPUTED TOMOGRAPHY

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ABSTRACT

The aim of the study was to estimate the factors effecting volume of liver. This study included 124 men and 124 women between the ages of 20 and 80 years who came for CT scan of abdomen for various clinical reasons were included in the study. Abdomen Helical protocol was used and raw data was acquired with 5mm slab thickness, incrementation 5mm and it was further reconstructed into 1.5mm. Volume of liver was measured on extended brilliance workspace workstation using liver analysis software. Mann Whitney U test was performed to determine average difference in liver volume between two age groups; 20-50 and 51-80. Result indicated that there was no statistically significant difference between two age groups (p=0.390). Independent sample t test was performed to determine average difference in liver volume between males and females. Result indicated that there was statistically significant difference between gender with respect to liver volume (p<0.001).

KEYWORDS: Computed Tomography, Liver volume, Extended Brilliance Workspace (EBW) workstation, Age, gender

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INTRODUCTION

It is a roughly triangular organ that extends across the entire abdominal cavity just inferior to the diaphragm. Liver is made of very soft, pinkish-brown tissues encapsulated by a connective tissue capsule and this capsule is further covered and reinforced by the peritoneum of the abdominal cavity, which protects the liver and holds it in within the abdomen. The liver performs many essential functions such as digestion, metabolism, immunity, and the storage of nutrients within the body. Liver has an incredible capacity for regeneration of dead or damaged tissues and it is capable of growing as quickly as a cancerous tumour to restore its normal size and function[1].Couinaud classification divides the liver into 8 functional segments depending on vascular inflow, outflow and biliary drainage[2].Liver size increases with the age, averaging 5 cm span at 5 years and attaining adult size by age 15. The size depends on various factors such as age, sex, body size and shape, as well as the particular examination technique utilized (e.g., palpation versus percussion versus radiographic). By percussion, the mean size of the liver is7 cm for women and 10.5 cm for men .A liver span 2 to 3 cm larger or smaller than these values is considered to be abnormal. The liver weighs about 1200 to 1400 g in the adult woman and 1400 to 1500 g in the adult man. In metastatic or primary liver cancer, the liver becomes infiltrated with deposits of cancer cells which can grow rapidly. Similarly, liver enlargement can occur in lymphoma. In cirrhosis, the liver may be enlarged or small, the latter usually occurring in end-stage cirrhosis or fulminant hepatic failure following hepatocyte necrosis and collapse. Alcoholic hepatitis and other causes of fatty liver lead to liver enlargement by hepatocyte fatty infiltration and hepatocyte enlargement. Hepatic distension and smooth enlargement are typical of significant right sided heart failure, which occurs because of hepatic venous congestion secondary to impaired myocardial functio[3].According to double helix-spiral CT, the average liver volume in control group was 1070.68cc +- 227.52cc and in portal hypertensive patients the average liver volume was 797.02cc +- 135.11cc[4].Computed tomography provides an efficient and accurate way of measuring liver volumes and, it would be useful for radiologists in their measurement of liver volumes[5].The liver analysis software in CT provides a robust set of segmentation tools to facilitate quantities assessment of the entire liver, hepatic vasculature of individual vascular territories and physician identified lesions. Thus proposed study was performed on CT to demonstrate the factors affecting the liver volume using liver analysis software in computed tomography.

LITREATURE SURVEY

Kenji Suzuki et al found that CT liver volumetric determined by computerized scheme agreed excellently with gold-standard manual volumetric, and they required substantially less completion time. Our computerized scheme provides an efficient and accurate way of measuring liver volumes in CT; thus, it would be useful for radiologists in their measurement of liver volumes[5].M. Hori et al conclude that the liver volume calculated based on CT volumetry significantly increases as the slice thickness decreases. With current technologies, this has potential implications for radiologists/surgeons work effort to accomplish. If a maximum error of 5% in the calculated graft volume is within the range of having an insignificant clinical impact, 5mm thick images are acceptable for CT liver volumetry. However, if an error of 5% is unacceptable, 3D data could be essential for CT volumetry[6]. W kratzer et al concluded that a sonographic finding of a liver diameter of 16 cm or greater in the right MCL should be considered consistent with enlargement of the liver. Influence parameters, particularly BMI and height, must be considered individually in borderline cases. The influence of special factors such as alcohol consumption on liver size must be addressed specifically by further studies in representative collectives[7]. Helena et al concluded that Phantom calibration in CT scans produced more accurate results than autopsy or CT alone. The liver measurements can be utilized as a guideline to detect abnormalities in volume, mass, and density of the liver, which can be the first signs of alcohol related disease such as cirrhosis and fatty liver[8].Chandramohan A et al conclude that age has a small negative correlation with total liver volume and does not influence the standard liver volume(SLV) calculation and

they also confirmed that gender does not influence SLV calculation significantly[9].

NEED OF THE STUDY
Since no study has been conducted in past for estimating the factors affecting the volume of liver and this study may be helpful in reflecting possible factors which are associated with liver.

AIM
To estimate the factors effecting volume of liver

OBJECTIVES
To estimate the factors effecting volume of liver

INCLUSION
20 – 80 yrs.

EXCLUSION
<20 yrs., patient who all undergone surgery and with metallic implants.

MATERIALS AND METHODS

STUDY SUBJECT
The abdomen CT examination of patients referred for various clinical reasons were included in the study.

EQUIPMENT
A scan was performed on Philips Brilliance 190-64MDCT scanner using abdomen helical protocol and reconstructions was done on EBW workstation.

CT PARAMETERS
CT machine: Philips Brilliance 190-64 MDCT.
Protocol: Abdomen Helical, Tube current will be adjusted automatically using an automatic dose adjustment technique to achieve an SD of 7.5 HU.

Tube potential, MAs	- 120 kV, 250
Collimation	- 64 x 0.625
Slab thickness	- 5 mm
Increment	- 5 mm
Pitch	- 1.172
Gantry rotation	- 0.4 second
FOV	- 350mm
Filter	- standard B
Window	- 60, 360
Matrix	-512

STUDY DESIGN
Cross sectional study

STUDY CENTRE
Kasturba Medical Hospital and College, Manipal

ETHICAL CONSIDERATION
Ethical clearance was obtained from the Kasturba Medical Hospital and College Institutional Ethical Committee.

PROCEDURE
Patients who all came for CT scan of abdomen for various clinical reasons with in age of 20-80 years were included in the study. Abdomen Helical protocol was used and the raw data was acquired with 5mm slab thickness, incrementation 5mm, and it was further reconstructed in to 1.5mm. Volume of liver was measured on extended brilliance workspace workstation using liver analysis software.

Figure 1
24 Years old female with liver volume measuring -1491.0cc

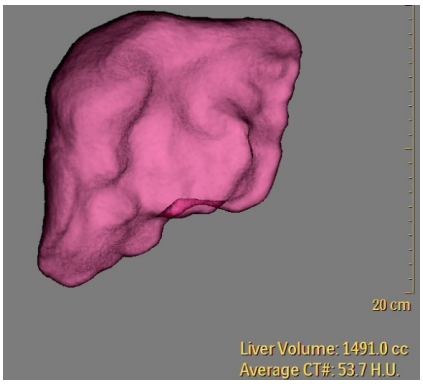


Figure 2
28 years old male with liver volume measuring -1200.2cc

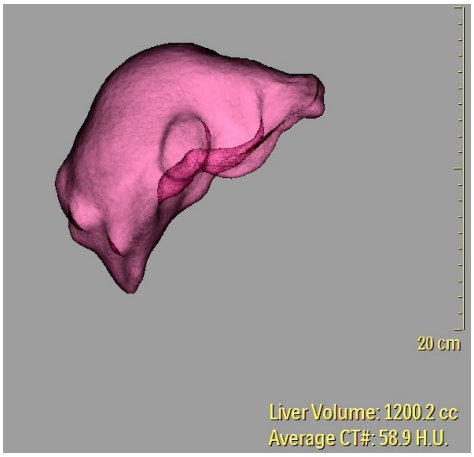


Figure 3
A 68 years old female with liver volume measuring 1246.1cc

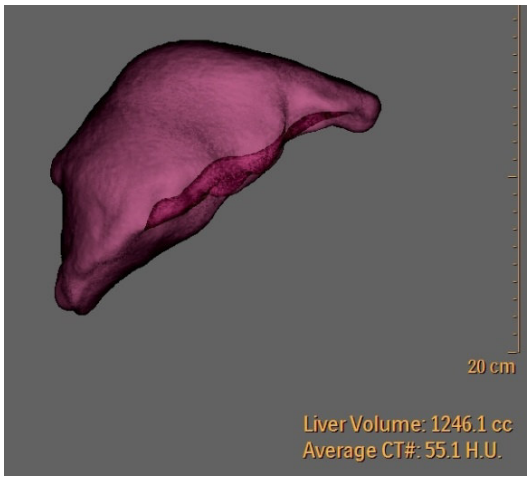
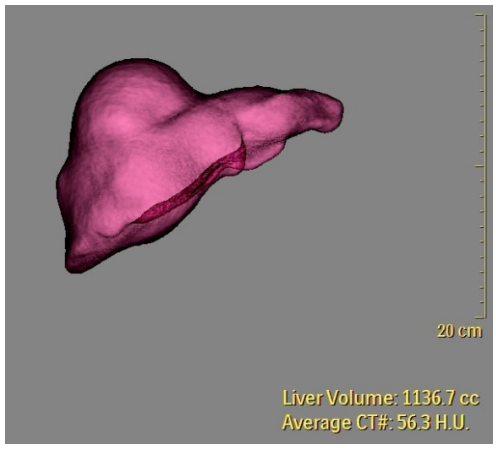


Figure 4
A 58 years old male with liver volume measuring 1136.7cc



STATISTICAL ANALYSIS

Sample size for the proposed study was calculated by independent t test

$$n = \frac{2[Z_{1-\alpha/2} + Z_{1-\beta}]^2 \sigma^2}{d^2}$$

n = minimum sample size

$Z_{1-\alpha/2}$ = 1.96 at α = 0.05

$Z_{1-\beta}$ = 0.84 at 80% power

σ =Standard deviation = 421.51

d = clinically significant difference= 150cc

$$n = \frac{2[1.96 + 0.84]^2 \times (421.51)}{(150)^2} = 124 \text{ per group}$$

The data obtained was statistically analysed using SPSS version 19 software.

RESULTS

Table1
Influence of age on liver volume

Group	N	Median(Q1,Q3)
20-40	124	1287.75(1094.93,1463.30)
51-80	124	1272.50(1117.65,1562.83)

Mann Whitney U test was performed to determine the average difference in the liver volume between two age groups; 20-50 and 51-80. The result indicated that there was no statistically significant difference between the two age groups (p=0.390)

Table2
Influence of gender on liver volume

Group	N	Median ± Standard deviation
Male	124	1433.26 ± 273.68
Female	124	1206.29 ± 226.70

Table 3

Mean difference	T	P	95% confidence Interval of the Difference	
			lower	upper
226.97	7.112	0.000	164.09	289.84

Independent sample t test was performed to determine the average difference in the liver volume between males and females. The result indicated that there was statistically significant difference between males and females with respect to the liver volume ($p<0.001$)

DISCUSSION

This study was aimed at estimating the factors affecting the volume of liver and consisted of 124 men and 124 women between the ages of 20 and 80 years. The influence of age on liver volume was estimated using Mann Whitney U test with a P value of 0.034. Thus, the result indicated that there was no statically significant difference between two age groups; 20-50 and 51-80 with respect to the liver volume. Similar results were found in study performed in 2oo7, confirming that age has a small negative correlation with total liver volume and does not influence the standard liver volume calculation[9].To estimate the effect of gender on liver volume Independent sample t test was performed and we got a p value >0.001. Thus, our result indicated that there was statistically significant difference between males and females with respect to the liver volume. A study done by Chan Sc et al in 2006 concluded that estimated liver volume was positively related to BW, and was also gender-dependent. The liver of the male was slightly heavier than that of the female of the same body weight[10].A study done in 2003 using ultrasonography showed that there was an absolute difference in liver size among female and male subjects (13.5 versus 14.5 cm)[7]. Similarly in our study the liver volume was found to be influenced by gender.

CONCLUSION

This proposed study highlighted the importance of CT and available post processing software in the estimation of factors affecting the volume of liver and concluded that the liver volume was independent of age but there was statically significant difference in liver volume with respect to the gender.

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