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The Use of Computed Tomography in the Diagnosis of Fatty Liver and Abdominal Fat Distribution among a Saudi Population

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Abstract

BACKGROUND: The pandemic of obesity is striking heavily worldwide and particularly among the affluent Gulf States where it is expected to continue to rise along with its complications.

AIM: To examine the link between liver fat infiltration and abdominal fat amount using plain computer-assisted tomography (CT).

METHODS: Fifty patients visiting the obesity clinic of "King Fahd Specialist Hospital" or Dr Suliman Alhabeeb Hospital between January 2015 and April 2016 were included. Liver and splenic attenuation dimensions were undertaken with three hepatic regions of interests (ROIs) and two ROIs from the spleen. The liver attenuation indices (LAIs) that were measured liver parenchymal attenuation (CTLP), liver/splenic attenuation ratio (LS ratio)and the (3) difference between liver and splenic attenuation (LS dif) and based on this LS dif The patients were grouped as LS dif greater or less than 5. Abdominal fat was evaluated utilising a 3 mm chop CT scan starting from the umbilicus; then computed by a workstation. The abdominal fat was classified as total fat (TF) and the sub-compartments of visceral adipose (fat) (VF), and subcutaneous fat (SF).

RESULTS: Twenty-six of the participants were males. The mean (SD) of the age and BMI was 48 (14.9) years and 32.05 (8.3) kg/m^2 respectively.The BMI and body Wt had a moderate negative correlation with the liver attenuation indices CTLP, LS ratio, LS diff (r = -0.417, -0.277, -0.312 and 0.435, -0.297, -0.0297), respectively. A very strong negative correlation between fatty liver, LS ratio and CTLP was found (-0.709, -0.575) respectively.

CONCLUSION: Plain computed tomography can reliably be used as a survey device for fatty liver disease.

Introduction

The pandemic of obesity is striking heavily worldwide and particularly among the affluent countries like the Gulf States where it is expected to continue to rise as projected by the previous reaserch [1, 2]. Consequently, its complications are expected to follow a similar trend one of which is the fatty liver disease. Fatty liver is a disease where surplus adipose, mainly triglycerides, compiles to make more than 5% of the hepatic weight [3]. For patients with no history of indulgent alcohol drinking, this condition is recognised as the non-alcoholic fatty liver disease (NAFLD) and it commonly presents in the context of metabolic syndrome [4]. NAFLD is eminently ubiquitous worldwide and its clinicopathologic spectrum encompasses the grades from uncomplicated fatty change to nonalcoholic steatohepatitis (NASH), which can evolve to cirrhosis [5, 6]. NAFLD is common in the obese and is connected with the metabolic syndrome. Such abnormalities are associated with heightened risk of cardiovascular incidents [6].

Among similar disease entities, central obesity is closely linked to high metabolic risk, independent of whole-body obesity. Early detection of NASH (the most advanced stage of NAFLD that can

progress to cirrhosis) using non-invasive tools helps in identifying those in jeopardy of developing hepatocellular carcinoma. Visceral adiposity (VF) is more strongly connected with increased metabolic risk among the category of central obesity, than subcutaneous fat (SF) [7]. In routine imaging modalities ultrasound scan (US), computer assisted tomography (CT), and magnetic resonance (MR) NAFLD is often detected in patients with normal body mass indices (BMIs). In contrast, it is also often that normal liver parenchyma is found in obese patients. Therefore, it is likely that NAFLD might have a tighter connection with abdominal VF compared to the total fat (TF). Liver biopsy is the best available test to diagnose fatty liver [8]. However, they are invasive, painful and require bed rest for six hours or more; furthermore, they modestly increase the mortality hazard [9]. Given the potential hazards, biopsies are not regularly undertaken in all patients. Imaging techniques have surfaced as a substitute for biopsy, where they include US, CT, and MR, and are now widely used. Of these, we have selected CT as the method for this study [9]. CT attenuation measurements of the liver were tightly linked with histologically proven hepatic steatosis [10]. Finding liver attenuation to be considerably lower than splenic attenuation is a dependable gauge of fatty liver [11]. Therefore, CT scan can be utilised as a non-invasive test to prove the presence of hepatic steatosis. There are few prior studies that investigated the relationship between fatty liver and abdominal adiposity using CT [12]. Therefore the current study was conducted to investigate the possible correlations between hepatic fat infiltrations expressed as CT liver enfeeblement readings (in Hounsfield units (HU) and abdominal adiposity amount, which was quantitated directly from CT.

Material and Methods

Patient selection

A cross-sectional study was conducted at the outpatient clinic of King Fahd Specialist Hospital and Dr Suliman Alhabeeb Hospital, Qassim, Kingdom Saudi Arabia for self-perception during the period of January 2015 through April 2016. The sample size was calculated as per the following equation

$$\text{Total sample size} = N = [(Z\alpha+Z\beta)/C]^2 + 3 = 47$$

The standard normal deviate for $\alpha = Z\alpha = 1.960$, the standard normal deviate for $\beta = Z\beta = 0.842$, type 1 error was regarded as 0.05, type 2 error was regarded as 0.2, the expected r was regarded as 0.4

After signing an informed consent, the following information was collected for each patient on a well-structured questionnaire including sex, age, height; body weight (WT), BMI, history of alcohol consumption, the blood pressure was measured. Fasting serum cholesterol, Triglyceride level (TG), and low-density lipoprotein (LDL) were measured. Those who had a history of alcohol consumption, bile duct dilatation, hepatic mass, viral hepatitis, liver cirrhosis, and hepatic surgery were excluded.

A fat protocol CT was conducted on each patient. According to World Health Organization, a BMI over 25 kg/m^2 is labelled as overweight and a BMI of over 30 kg /m2 as obese [13]. This study was approved by the Qassim University Review Board on bases complying with the principles of the Declaration of Helsinki.

CT liver enfeeblement quantitation

The liver and the splenic attenuation were assessed using plain CT scans. The evaluation was carried with the voltage of the tube being 120 kVp, a tube current of 50 mAs, and a tube circumrotation time of 750 ms. with the patient in the supine position, five consequent axial slices 3 mm in density were captured at approximately the mid-part of the liver shadow on tomogram. Among the five consecutive chops, we randomly selected one image for quantitation of the hepatic and splenic enfeeblement for each patient. Five regions of interests (ROIs) were determined in the liver, escaping vessels, bile ducts, calcifications, and artefacts; similarly, four ROIs were determined in the spleen. The higher most and lowermost measurements were excluded on gauging the mean enfeeblement of the hepatic and splenic dimensions. As such, three liver measurements and two splenic dimensions were utilised to gauge the mean dimensions. We extracted the liver attenuation indices (LAIs) from the calculated mean enfeeblement measurements of the liver and spleen. The LAIs included: (1) liver parenchymal attenuation (CTLP; mean liver attenuation); (2) liver / spleen attenuation ratio (LS ratio; mean liver attenuation /mean splenic attenuation); and (3) difference between liver and spleen attenuations (LS dif; mean hepatic attenuation - mean splenic attenuation) 5. The patients were grouped into two groups based their LS dif. LS dif is one of the popular reference measurements for grading fatty liver with CT [11]. Subjects with an LS dif greater than 5 were labelled as normal. Patients with an LS dif less than 5 were labelled as having fatty liver.

Analysis of the abdominal adipose dispersal

All the patients were subjected to abdominal adipose dispersal analysis. With the iliac crest as the starting point, 5 slices 3 mm in density were scanned in a superior direction to measure the VF and TF regions. The iliac crest coincides with the L4/5 level as well the umbilical level. The cross-sectional surface

regions (cm^2) of variant abdominal fat regions were automatically analyzed in three dimensions using commercially accessible CT software (Philips EBW2 version 3.0). The fat tissue width was driven electronically by setting the attenuation measurements for an area of interest within a range of -175 to -25 HU. The center of the aperture was adjusted at 100 and the girth was set at 150. The VF area was estimated by determination of the intra-abdominal cavity size at the internal facet of the abdominal wall encompassing the cavity. Gaseous and other intestinal contents were excluded. Abdominal adiposity consists of TF, VF, and SF. The SF width was calculated by subtracting the VF width from the TF width. The ratio of VF to SF (VS ratio) was also calculated.

Statistical analysis

SPSS statistical software (version 20.0 for Windows; SPSS Inc., Chicago, IL, USA) was utilised for statistical evaluation. The significance value (α) level was set at a P-value of 0.05 for all tests. We used the bivariate spearman correlation analysis to assess the correlation between LAIs and TF, VF, and SF after checking for the normality of the data distribution using Shapiro-Wilk normality test. Kendall's tau-b correlation was used to assess the relationships between the LAIs and BMI, WT, TG, and LDL and between BMI and TF, VF, and SF as well as the TF, VF, SF, CTLP, LSRatio and Fatty liver (See Table 3).

Results

A total number of 50 patients participated in the study, 26 of them were males, with a mean age of 48 ± 14.9 years, while the mean BMI was 32.05 ± 8.3 kg/m^2, see Table 1.

Table 1: Means liver attenuation indices, splenic attenuation, BMI, lipids, and weight

Mean(SD) of	
LDL mmol/L	2.88 (0.84)
Cholesterol mmol/L	4.56 (0.94)
$LS_{ratio\ (HFU)}$	1.10 (0.21)
$LS_{diff\ (HFU)}$	4.70 (9.86)
Median (interquartile) of	
BMI (Kg/m^2)	30.4 (26.5-36.7)
Wt (Kg)	80 (70.9−93.6)
Triglycerides mmol/L	1.2 (0.9-1.7)
$CT_{LP\ (HFU)}$	56 (44-60)
VF (cm)	102.5 (98.8-106.5)
TF (cm)	111.8 (108.4-116.3)
SF (cm)	8.5 (3.2-14.8)

Of the participating subjects 6/50 (12%), 18/50 (36%) and 26/50 (52%) were normal weight, overweight and obese respectively. The prevalence of subjects suffering hepatic steatosis followed an increasing trend among the above BMI groups where it increased from 10% among normal subjects to 30% among the overweight group to reach its peak of 60% among the obese patients. While BMI and body weight showed a moderate negative correlation with the liver attenuation indices CTLP, LSratio, LSdiff (r = -0.417, -0.277, -0.312 and 0.435, -0.297, -0.0297) respectively. There was a positive correlation between weight and CTLP (r = 0.435), There was no correlation between lipids and LAIs see Table 2.

Table 2: Correlation between the liver attenuation indices, BMI, weight and lipids

Variables	TF	SF	LS ratio	LS diff	CTLP	Chol	LDL	TG	BMI	Wt
VF	0.163	-0.553	-0.015	-0.034	-0.234	0.158	0.185	-0.155	0.219	0.344
TF		0.624	0.175	0.150	0.120	0.274	0.200	0.89	-0.184	-0.133
SF			0.081	0.074	0.252	-0.043	-0.110	0.142	-0.177	-0.244
LS ratio				0.995	0.791	0.101	0.118	0.140	-0.277	-0.271
LS diff					0.829	0.093	0.117	0.066	-0.312	-0.297
CTLP						0.084	0.142	0.116	-0.417	0.435
Chol							0.852	0.068	-0.172	0.007
LDL								0.259	-0.322	-0.146
TG									0.130	0.130
BMI										0.824

On the contrary, LAIs and BMI have no correlation with the abdominal fat volume. A very strong negative correlation was found between fatty liver, LS ratio and CTLP (-0.709, -0.575) respectively see Table 3.

Table 3: Correlation between hepatic attenuation indices and total fat, visceral fat, and subcutaneous fats

variables	TF	SF	Fatty liver	CTLP	LS ratio
VF	0.117	-0.421	-0.018	-0.150	-0.021
TF		0.474	-0.061	0.072	0.124
SF			0.036	0.170	0.063
Fatty liver				-0.575	-0.709
CTLP					0.637

Discussion

The main finding of the current study is negative correlation between BMI, weight and the liver attenuation indices. Saran et al described similar findings in their study among an Indian population [11]. Moreover, the current study showed that CTLP and LS ratio both show very strong negative correlations with hepato-steatosis, such a correlation has been described by Rockall et al. [14]. Park et al stated that an LS ratio 0.8, an LSdif of -9, and a CTLP 42 granted the highest cut-off values with a yield of 100% specificity for the detection of macrovesicular steatosis of 30% or more (the limit of acceptability for donation) [15]. Another important finding of our study is the increasing prevalence trend of hepatic steatosis among the different BMI groups peaking up to 60% of obese patients. Such a trend has been described by a group of researchers among an American population where the prevalence peaked from 28% among

normal weight subjects to 67% among obese subjects [16]. NAFLD is strictly connected with characteristics of the metabolic syndrome [17]. The amount of intrahepatic fat is closely correlated to the features of the metabolic syndrome [18]. The current study has added to the evidence of the utility of plain computed tomography in the diagnosis of non-alcoholic steatohepatitis where one of its main findings is the moderate negative correlation between the liver attenuation indices and the body mass index. Similar relations has been pointed to by different researchers not only this but further, it has been described that a hepatic attenuation value (CTLP) that is significantly less than the splenic attenuation value is a reliable pointer to the presence of fatty liver [19, 20].

Furthermore, the use of CT in the diagnosis of mild hepato-steatosis is unreliable; such a remark is likely to be observed in the study as an appreciable number of the subjects involved in our study are likely to have mild hepatic steatosis as seen from their BMI.

In conclusion, plain computed tomography can reliably be used as a survey device for fatty liver disease.

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