Original Research Article

Comparison of Computed Tomographic Hounsfield Numbers with Ultrasonographic Categorization of the Fatty Liver Disease

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Abstract

Aims and Objective: The aims of the study were Determination of the range of CTHFN in different categories of FLD by USG and to compare CT Hounsfield Numbers with Ultrasonographic categorization of the FLD. **Methods:** This was a Cross sectional analytical study conducted in the Department of Radiology, Patna Medical College and Hospital, Patna, Bihar, India for 1 year. Total 180 Patients of FLD age between 18-72 years, who underwent both CT and USG scans of abdomen and with Ultrasonographic diagnosis of diffuse FLD was included in this study. **Results:** Total 180 patients of FLD were observed. The mean age of population was 51.25±15.32 years and range was 18-72 years. The mean Values of CTHFN of liver was 37.85 ± 13.52 HU and range was -10.65-54.62 HU with significant p value. The frequency of male population was 110(61.11%) and female was 70 (38.89%). The mild, moderate and severe FLD was found in 135(75%), 30(16.67%) and 15(8.33%)patients respectively. The mean values of Liver CTHFN in mild moderate and sever FLD categories by US Gwere 41.74±4.88HU, 23.77±3.89HUand3.05±6.79 HU respectively. These values along with P values and 95% Confidence Interval (CI) were analysed. In multiple comparisons the Least Significant Difference (LSD) of USG categories of FLD with mean Liver CTHFN, p value was significant when mild FLD was compared with moderate and severe FLD, Moderate FLD was compared with mild and severe FLD and severe FLD was compared with mild and moderate FLD. **Conclusion:** USG is a reliable and sensitive modality for the grading of FLD.

Keywords: Fatty Liver Disease (FLD); Computed Tomography Hounsfield Numbers (CTHFN).

Introduction

Non-alcoholic fatty liver disease (NAFLD) is a common condition characterised by excess deposition of fat in liver which ranges from simple steatosis to steatohepatitis, cirrhosis and hepatocellular carcinoma (HCC) in the absence of excessive alcohol intake. Metabolic syndrome and conditions associated with it like diabetes, obesity and dyslipidaemia are predisposing factors of NAFLD[1]. NAFLD is becoming a major public health problem due to rising incidence of obesity and type II diabetes. The overall prevalence of NAFLD is 15 to 40% in western countries while 9-40% in Asian countries[1].

The data from Asian countries derived from various published series where there was no uniformity in definition of NAFLD and population studied. Prevalence of the disease is estimated to be around 9-32% in the general Indian population, with a higher incidence rate amongst obese and diabetic patients. NAFLD is a common cause of chronic liver disease and liver transplantation in western countries[2]. Increasing incidence of NAFLD has been well documented from Asian countries like Japan, China and the Indian subcontinent[3].CT diagnostic criteria for steatosis are liver attenuation at least 10 Hounsfield Units (HU) less than that of the spleen or absolute liver attenuation of less than 40 HU. Unenhanced CT has a sensitivity for steatosis ranging from 43 to 95% and a specificity of 90–100%[4,5].Sensitivity rises to 93% for detecting steatosis involving greater than 33% of the liver, with positive predictive value of 76%[6]. With contrastenhanced CT, a difference of 18.5 HU between liver and spleen attenuation had a sensitivity of 93%, a specificity of 93%, and a receiving operating curve of 0.98[7].The sensitivity and specificity of unenhanced CT are similar to those of ultrasound (SN 84.8%, SP 93.6%) and Magnetic Resonance Imaging (SN 81%, SP 100%)[4,5].

Computed tomography (CT) scanners measure tissue density in Hounsfield units (HU) on a scale that sets water (H2O) at zero and air at –1,000, independent of the spectral distribution of X-rays[8]. For body tissues HU measurements vary not only with density and composition (fat, lean, mineral content) but also the peak kilovoltage (kVp), X-ray filtration, and how the spectrum is modified by differences in body thickness (beam hardening)[9]. In quantitative CT (QCT) the HU measurements are converted into tissue densities by scanning the subject together with a phantom containing standards representing known densities of bone and soft tissue[10].In these standards bone mineral is often represented by dipotassium hydrogen phosphate (K2HPO4) and proprietary software for analysing QCT scans is primarily designed to measure bone mineral density (BMD).Current imaging methods including USG, CT, and MRI have shown their values to serve as noninvasive imaging methods to evaluate FLD progression, but they are still relatively limited in the detection of inflammation (NASH), which is more important than FLD in terms of its high risk for fibrosis, cirrhosis, and HCC. Detection of NASH by imaging remains the future direction in FLD.

FLD is subjectively categorized into mild, moderate or severe grade depending upon sonographic appearance. But there is no arithmetically defined demarcation for this grading. On the other hand, CT scan has the facility to numerically categorize different tissues on the basis of density. In this study the CT Hounsfield numbers will be compared with the sonographic grading of the fatty liver disease to define it more precisely. A good association will avoid unwanted radiation to the patient. The aims of the study were Determination of the range of CTHFN in different categories of FLD

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by USG and to compare CT Hounsfield Numbers with Ultrasonographic categorization of theFLD.

Material and methods

This was a Cross sectional analytical study conducted in the Department of Radiology, Patna Medical College and Hospital, Patna, Bihar, India for 1 year. after taking the approval of the protocol review committee and institutional ethics committee.

Methodology

Total 180 Patients of FLD age between 18-72 years, who underwent both CT and USG scans of abdomen and with Ultrasonographic diagnosis of diffuse FLD was included in this study. Patients with Liver abnormalities including acute hepatitis and cirrhosis, right renal malformations including agenesis, right nephrectomy, right pelvic kidney and right kidney with cortical abnormalities and with congenital or acquired abnormalities of spleen were excluded.

GE P3 USG machine was used to scan patients in supine and left lateral decubitus position. Images of sagittal view of liver and right kidney were obtained; also scans were performed in multiple planes for better comparison of echogenicity.The severity of FLD was diagnosed in the presence of one of the following standards laid down by the American Gastroenterology Association: Grade 0- normal echogenicity. Liver appears equal to or slightly echogenic than right renal parenchyma. Grade I – Mild diffuse increase in echogenicity. Grade II - Moderate diffuse increase in echogenicity. Grade III - Noticeable increase in echogenicity[6].

GE 16 slice CT machine was used to scan patients. Patients were scanned in supine position. Unenhanced CT (80-140 kV, 100-300 mAs, 5mm section thickness) was being performed. To calculate CTHFN of liver attenuation values were measured using random selection of regions of interest (ROIs) ranging from 50 to 100 mm^2. ROIs of greater than $100mm^2$ were measured where possible while taking care to exclude regions of non- uniform parenchymal attenuation, including hepatic vessels and biliary structures. The ROIs circles were placed when maximum part of both lobes of liver was visible in a slice. The ROIs values were averaged to get mean liver attenuation in Hounsfield Unit (HU)[11].

Result

In the present study 180 patients of FLD was taken. The mean age of population was 51.25±15.32 years and range was 18-72 years as shown in Table 1. The mean Values of CTHFN of liver was 37.85 ± 13.52 HU and range was -10.65-54.62 HU with significant p value as shown in Table 2. The frequency of male population was 110(61.11%) and female was 70 (38.89%) as shownin table 3. The mild, moderate and severe FLD was found in 135(75%), 30(16.67%) and 15(8.33%)patientsrespectively as shown in table 4. The mean values of Liver CTHFN in mild, moderate and sever FLD categories by USG were 41.74±4.88HU, 23.77±3.89HU and 3.05±6.79 HU respectively. These values along with P values and 95% Confidence Interval (CI) are as presented in Table 5.

Table 1: Mean Age of Population

Mean (Std. Deviation)	Min-max	Range
51.25±15.32	18-72	58

Table 2: Liver Mean CTHFN

Mean (Std. Deviation)	Minimum	Maximum	P Value
37.85 ± 13.52	-10.65-54.62	52.80	0.000

Table 3: Mean values of Liver CTHFM in USG categories of FLD

FLD Category on USG	N	Liver CTHFN Mean HU (Std. Deviation)	95% Confidence Interval for Mean		P Values
			Lower Bound	Upper Bound	
Mild	135	41.74±4.88	40.87	43.12	0.000
Moderate	30	23.77±3.89	23.12	26.32	
Severe	15	3.05± 6.79	-.20	6.49	
Total	180	34.85±13.11	32.88	37.28	

Table 4: Gender Frequency and percentage

Gender	N=180	Percentage
Male	110	61.11
Female	70	38.89

Table 5: Percentage of FLD Grades

FLD	N=180	Percentage
Mild	135	75
Moderate	30	16.67
Severe	15	8.33

In multiple comparisons the Least Significant Difference (LSD) of USG categories of FLD with mean Liver CTHFN, p value was significant when mild FLD was compared with moderate and severe FLD, Moderate FLD was compared with mild and severe FLD and severe FLD was compared with mild and moderate FLD as shown in Table 6

Table 6: Least Significant Difference (LSD) of USG categories of FLD with mean Liver CTHFN

Mean Liver CTHFN			
Mild	Moderate	17.87*	0.000
	Severe	39.15*	0.000
Moderate	Mild	-16.87*	0.000
	Severe	20.69*	0.000
Severe	Mild	-39.58*	0.000
	Moderate	-20.88*	0.000

Discussion

The incidence of FLD is gradually increasing in our country and especially in developed world. The definitive diagnosis of FLD is histological examination but unfortunately this is an invasive technique. Most of the patients are not willing to perform this invasive procedure therefore majority of reversible FLD becomes complicated due to non- availability of definitive diagnostic technique. Ultrasound is the first line modality used for characterization of FLD but sonographic grading of the FLD is more subjective. There is no universal consensus on the USG classification of FLD. But CT Hounsfield numbers are a quantitative measurement of fat. This research was therefore intended to compare the sonographic grading of FLD with CT Hounsfieldnumbers.FLD occurs worldwide in obese and excessive alcohol consumers[12].FLD also occurs in metabolic disorder and several conditions that effect fatty acid metabolism[13].The diagnosis of FLD is made when lipid content in the liver exceeds 5–10% by weight[14].If the cause persist, FLD invariably progresses to steatohepatitis, cirrhosis and liver cancer[15]. Wolff L et.al. Reported severe FLD is associated with excessive pericardial fat and suggested it as a marker for vascular disease[16].FLD is a precursor or it may signal the development of hypertension, cardiovascular diseases and type II diabetes mellitus which is associated with high rates of mortality[17].

Ultrasonography is suggested as a first choice for the diagnosis of FLD, considering its wide availability, low cost and absence of side effects or risks to the patient, furthermore liver enzymes are not a good parameter for detection of FLD[18]. The prevalence of FLD in routine Sonography is much higher as compared to laboratory findings[19].Utilizing USG the prevalence of FLD ranges from 20-40% in industrialized countries[20].The most common criteria for grading of FLD by USG takes into account the echogenicity of liver and its comparison with echogenicity of right kidney. The grading is defined as: G 0- normal echogenicity, Liver appears slightly echogenic or isoechoic to right kidney cortex). G I-mild increase in echogenicity, Liver appears bright than right renal cortex with normal appearance of intrahepatic vessels and diaphragm; G II-Moderate increase in echogenicity with slightly blurred visualization of intrahepatic vessels and diaphragm; G III- Severe increase in echogenicity with poor or no visualization of intrahepatic vessels and diaphragm[6].Hernaez R et.al.[21] conducted a metanalysis on 49 studies and reported sensitivity and specificity of USG

for detection of moderate to severe FLD as compared to histology (gold standard) 84.8% and 93.6% respectively. Latest studies comparing USG with histopathology have confirmed that it is a pertinent non-invasive tool for evaluation of FLD and intends Grade 0 or 1 do not require biopsy[22].Cruz JF et.al found high prevalence of FLD in males as compared to females. They found prevalence of FLD in grade I, II and III in 51.5%, 40.4% and 8.6% patients respectively. In current study we also found high frequency of FLD in males as compared to females. We found frequency of FLD in grade I, II and III in 70.0%, 22.0 and 7.9% patients respectively.

There are many studies which have shown a decrease in CTHFN with increase in severity of FLD[23]. Unenhanced normal Liver parenchyma has CTHFN values in the range of 50 to 65HU, typically 8-10HU greater than liver[24].Unenhanced CT has sensitivity of 43-95% and specificity of 90-100% for detection of Liver Steatosis[25].CT has been proved to be a sensitive modality for quantitative measurement of moderate to severe FLD but its performance for mild FLD is limited[26].The most common diagnostic criteria for diagnosis of FLD on CT is liver CTHFN less than 40 HU or liver CTHFN less than 10HU as compared to Spleen CTHFN which correlates with pathologic fat content of 30% or more[27].However this diagnostic criteria excludes mild FLD decreasing overall prevalence as much as 40% as compared to other CT criteria[28]. CT provides fast, objective and reproducible assessment of liver fat having a good correlation with pathologic findings obviating the need of biopsy in most of the cases.[28] But to date there has been no standard criteria for grading of FLD on CT. The first study correlating USG grading of FLD with CT was published in 1985 by John CS et al.[29] to evaluate accuracy of USG for diagnosis of FLD. They reported the overall accuracy of USG for detection of FLD 85%, with 100% sensitivity and 56% specificity. The USG/CT correlation was found particularly well for the diagnosis of grade I and IIFLD.

The second study correlating USG grading of FLD with CT was done by Jumana R[23] and associates for the estimation of CT HU for different grades of FLD by USG. They reported the significant HU p values between different grades of FLD. The mean age of the patients in their study was 45 years whereas in current study mean age of patients was 51.25±15.32 years. In their study percentage of male patients was 55% and female was 47%, in our study percentage of male patients was 61.11% and 38.89% females. They found mean values of CTHFN in grade I, II and III of FLD 37.74, 24.16 and 0.75 HU respectively. In present study we found mean values of CTHFN in grade I, II and III of FLD 41.74±4.88HU, 23.77±3.89HU and 3.05±6.79 respectively.

Conclusion

We found significant p values of CTHFN for all grades of FLD by USG. CTHFN decreased with severity of FLD. Hence we can conclude that USG is a reliable and sensitive modality for the grading ofFLD

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