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# Cross sectional analytical study to determine the range of comparison of computed tomography Hounsfield number in different categories of fatty liver disease by ultrasonography and its comparison with computed tomographic Hounsfield numbers

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## Abstract

**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.

**Material and Methods:** It was a cross sectional analytical study. By purposive sampling 186 patients of FLD were sampled from Department of Radiology, Maharishi Markandeswar Medical College and Hospital Kumarhatti, Solan, Himachal Pradesh, The data was collected for 9 months. Patients of both gender of age between 20-80 years, who underwent both CT and USG scans of abdomen and with Ultrasonographic diagnosis of diffuse FLD were included. The USG categories of FLD were compared with mean liver CTHFN. Statistical analysis was done by ANOVA; p value of CTHFN was found significant for each Ultrasonographic category of FLD.

**Results:** Total 186 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 113(60.8%) and female was 73 (39.2%). The mild, moderate and severe FLD was found in 138 (74.2%), 32 (17.2%) and 16 (8.6%) patients respectively. The mean values of liver CTHFN in mild moderate and sever FLD categories by USG were 41.74±4.88 HU, 23.77±3.89 HU and 3.05±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

FLD is the most common reason for elevated liver enzymes throughout the world. Although up to 70% of FLD patients are normal on laboratory findings. Most of the patients of FLD are asymptomatic or have nonspecific findings that do not correlate with the severity of disease [1-3]. The most common clinical symptoms of FLD are right upper quadrant pain, feeling of fullness and lethargy or malaise. In addition hepatomegaly can also be found on physical examination [4]. Other findings are related to metabolic syndrome, obesity or overweight [5].
From pathogenic interpretation FLD can be viewed as a single disease with multiple etiologies. Clinically FLD can be divided into Non-Alcoholic Fatty Liver Disease (NAFLD) and Alcoholic Fatty Liver Disease (AFLD) [6].
Several imaging techniques can detect FLD with their own advantages and disadvantages. Ultrasound is still in the first line for determining FLD because of its safety, easy availability, cost effective and radiation-free nature. However, the grading of fatty liver by ultrasound is subjective and there is inter observer variability [7]. The reported sensitivity and specificity of ultrasound for diagnosing mild FLD ranges from 55.3% to 66.6% and 77.6% to 93.1% respectively while for moderate-severe FLD is about 90% and 95% respectively [8].
Computed Tomography (CT) can represent liver fat content quantitatively by measuring liver attenuation/Computed Tomographic Hounsfield numbers (CTHFN) expressed in Hounsfield Units (HU). Liver attenuation of <40 HU represents >30% liver fat content reliably [9]. FLD can also be estimated by comparing attenuation of liver with spleen [10]. It is 100% specific for diagnosis of moderate to severe FLD when liver-to-spleen attenuation ratio is <0.8. From evaluation of transplant donors, it has been concluded that unenhanced CT is excellent for detecting hepatic fat of ≥ 30% with specificity and sensitivity of 100% and 82% respectively. Radiation exposure can be reduced by using low dose protocols [11]. MR spectroscopy is the most accurate and fast method of detecting fat but it is expensive and software is not available on all MR units. MR elastography a new technique to detect liver stiffness has not been demonstrated to detect NAFLD and is still undergoing research for patients of hepatitis and cirrhosis [12]. At present percutaneous biopsy of liver is considered as the gold standard for diagnosis of FLD. However, it is not indicated in healthy individuals because it is an invasive procedure and more importantly it has many serious complications [13].
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 was 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 by USG and to compare CT Hounsfield numbers with ultrasonographic categorization of the FLD.

## Material and methods

It was a cross sectional analytical study. By purposive sampling 186 patients of FLD were sampled from Department of Radiology, Maharishi Markandeswar Medical College and Hospital Kumarhatti, Solan, Himachal Pradesh, The data was collected for 9 months. Patients of both gender of age between 20-80 years, who underwent both CT and USG scans of abdomen and with Ultrasonographic diagnosis of diffuse FLD were included. Approval of the protocol review committee and institutional ethics committee were obtained. The technique,

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risks, benefits, results and associated complications of the procedure were discussed with all patients.

## Methodology

Total 186 Patients of FLD age between 20-80 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. Toshiba Xario with 3.5MHZ probe center 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.
Siemens 64 slice dual source at center was used to scan patients. Patients were scanned in supine position. Unenhanced CT (80-140 kV, 100-300 mAs, 5mm section thickness) was be 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 100 $mm^2$ 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 186 patients of FLD was taken. The mean age of population was 51.25±15.32 years and range was 20-80 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 113 (60.8%) and female was 73 (39.2%) as shown in Table 3. The mild, moderate and severe FLD was found in 138 (74.2%), 32 (17.2%) and 16 (8.6%) patients respectively as shown in table 4. The mean values of liver CTHFN in mild moderate and sever FLD categories by USG were 41.74 ± 4.88 HU, 23.77 ± 3.89 HU and 3.05±6.79 HU respectively. These values along with P values and 95% Confidence Interval (CI) are as presented in Table 5. 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 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 |
|---|---|---|
| 37.85 ± 13.52 | -10.65-54.62 | 52.80 |

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**Table 3:** Gender Frequency and

| Gender | N=186 | Percentage |
|---|---|---|
| Male | 113 | 60.8 |
| Female | 73 | 39.2 |

**Table 4:** Percentage of FLD Grades

| FLD | N=186 | Percentage |
|---|---|---|
| Mild | 138 | 74.2 |
| Moderate | 32 | 17.2 |
| Severe | 16 | 8.6 |

**Table 5:** Mean values of Liver CTHFM in USG categories of FLD

| FLD Category on USG | Liver CTHFN Mean ± SD | p-value |
|---|---|---|
| Mild | 41.74 ± 4.88 | 0.001 |
| Moderate | 23.77 ± 3.89 | |
| Severe | 3.05± 6.79 | |
| Total | 34.85±13.11 | |

**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 Hounsfield numbers. FLD occurs worldwide in obese and excessive alcohol consumers [14]. FLD also occurs in metabolic disorder and several conditions that effect fatty acid metabolism [15]. The diagnosis of FLD is made when lipid content in the liver exceeds 5-10% by weight [16]. If the cause persist, FLD invariably progresses to steatohepatitis, cirrhosis and liver cancer [17]. Wolff L *et al*. Reported severe FLD is associated with excessive pericardial fat and suggested it as a marker for vascular disease [18]. 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 [19].

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 [20]. The prevalence of FLD in routine Sonography is much higher as compared to laboratory findings [21]. Utilizing USG the prevalence of FLD ranges from 20-40% in industrialized countries [22]. 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*. [23] conducted a meta-analysis 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 [24]. 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 [25]. Unenhanced normal liver parenchyma has CTHFN values in the range of 50 to 65HU, typically 8-10HU greater than liver [26]. Unenhanced CT has sensitivity of 43-95% and specificity of 90-100% for detection of Liver Steatosis [27]. 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 [28]. 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 [29]. However this diagnostic criteria excludes mild FLD decreasing overall prevalence as much as 40% as compared to other CT criteria [30]. 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 [30]. 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*. [31] 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 II FLD.

The second study correlating USG grading of FLD with CT was done by Jumana R [25] 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 ± 4.88 HU, 23.77 ± 3.89 HU and 3.05±6.79 respectively.

## Conclusion

The present study concluded that CTHFN decreased with severity of FLD. Hence we can suggest USG is a reliable and sensitive modality for the grading of FLD.

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