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Computed Tomography grading of fatty liver disease in alcoholic and non-alcoholic patients

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ABSTRACT

Background: Last three decades, the universality of non-alcoholic Steatohepatitis has been continuously on the rise. Fatty liver diagnostic assessment could also do using cross-sectional non–contrast CT imaging. Our study aimed to evaluate the Computed Tomography grading of fatty liver disease in alcoholic and non-alcoholic patients. *Methodology:* A case-control study has conducted on 62 patients divided into two groups, alcoholic and non-alcoholic, with 31 patients in each group. NCCT was performed and HU values were obtained from the right and left lobes of the liver and spleen for comparison. *Results:* The grading has been provided with the help of median liver attenuation values. The four-point grading system is given. Grade I was considered with a range of 35 to 39. The variation was between 30.75 to 35 HU in grade II patients. In grade III patients, the median, ranging from 22.25 to 30.75 HU. In grade IV patients, the median value is 14.37HU. *Conclusion:* NCCT can detect the presence of fatty liver changes in alcoholic and non-alcoholic patients, and grading of the fatty liver could do by assessing the liver attenuation.

Keywords: Alcoholic, Computed Tomography, Fatty liver, and Non-alcoholic

1. INTRODUCTION

In Western countries, it is the most common reason behind abnormal tests and chronic liver disease. It has been forecasted as the most common sign of liver transplantation in the near future (Chartampilas, 2018). Excess alcohol consumption can cause alcoholic liver disease, whereas non-alcoholic fatty liver disease can cause due to insulin resistance and metabolic syndrome. Other conditions that can cause fat accumulation in the liver include viral hepatitis and the overuse of certain drugs (Hamer et al., 2006).

The prevalence of fatty liver in the general population is about 15%. Still, it is higher among those who consume large quantities of alcohol (45%), about 60g per day, those with hyperlipidemia (50%) or obesity (75%), who have a body mass index of 30kg/m2, and those with both (Angulo, 2005; Shen et al.,

2003). Worldwide the estimation of the prevalence of the non-alcoholic fatty liver ranges from 20-46%, which can vary with the study population and use of diagnostic criteria (Chalasani et al., 2012). Multidetector Computed Tomography (MDCT) is an advanced technology that uses a multiple-row detector array which allows scanning four to eight times faster than scanning with spiral CT (Berland and Smith, 1998). With MDCT, the diagnostic accuracy has increased, resulting in detection rates of up to 95% for focal liver lesions (Itoh et al., 2003).

For diagnostic assessment of fatty liver, liver biopsies and histologic analysis has performed. However, it can also be diagnosed with the use of cross-sectional imaging (Hamer et al., 2006). Non-contrast CT is more specific than ultrasound for detecting non-alcoholic fatty liver disease (Alberti et al., 2009). On a non-contrast CT scan, the typical liver attenuation is slightly greater than that of the spleen and blood, and intrahepatic vessels have decreased attenuation. A fatty liver has diagnosed if liver attenuation is less than 40HU or if the liver attenuation is less than 10HU than the spleen (Hamer et al., 2005; Joy et al., 2003).

The CT parameters for detecting fatty liver includes, the Hounsfield unit, the discrepancy in HU values between the liver and the spleen, and liver-to-spleen ratio attenuation values (Li et al., 2018). For the diagnosis of moderate to severe fatty liver, an attenuation ratio of liver to spleen <0.8 has a high specificity of 100% (Singh et al., 2013). NCCT can detect the presence of fatty liver changes in alcoholic and non-alcoholic patients, and grading of the fatty liver, which could do by assessing the liver attenuation

2. MATERIALS AND METHODS

Patient Selection

This Case-control study was carried out from October 2022 to March 2023. The study included a total of 62 patients, which consisted of two groups, 31 patients in each group. Patients referred for plain CT Abdomen were included in the study. The Inclusion Criteria were all patients undergoing plain CT abdomen within the age group of 30-70 years. Patients with a clinical history of other pathology related to the liver had excluded from the study.

Statistical Analysis

The Independent sample "t" test has used to compare the age of alcoholic and non-alcoholic subjects. An Independent sample "t" test has used to compare fatty liver changes between alcoholic and non-alcoholic subjects. The four-point grading system used for describing the degree of fatty liver changes in alcoholics and non-alcoholics on the bases of the median liver attenuation value.

Methodology

The study has performed on 16 SLICE MDCT- GE Bright Speed Elite scanners. For the study, all subjects were informed, and written consent was taken. The procedure had explained to the subjects. The plain CT abdomen scan had performed for patients referred to the Radio-diagnosis department

3. RESULTS

This study comprised 62 patients and divided them into two groups, alcoholic and non-alcoholic, with 31 patients in each group. The analysis of fatty liver had performed on patients where images of both the liver lobes and spleen have acquired on the CT scans to compare attenuation values between them. The lower mean HU or attenuation of the liver on CT indicates that the lower the tissue density of the liver, the more fat content will be. Therefore, the tissue density of the liver is inversely related to liver fat. The liver attenuation with <40HU and the liver-to-spleen ratio of <1.0 was used as an indicator of fatty liver hepatitis.

In terms of gender-wise distribution of subjects, we found the difference by combining the groups of 62 patients. There were 20 females and 42 males, with the percentage being 32% and 68%, respectively. Among 62 cases of alcoholic and non-alcoholic, the maximum distribution of fatty liver cases had seen between the age group of 50-59 years with a percentage of 33.9% in which 11 subjects were alcoholic and ten subjects were non-alcoholic. About 25.8% of cases have been found between the ages of 40 and 49 years, with eight subjects equally distributed in alcoholic and non-alcoholic. In the 30-39 age range, there were 22.6% of cases in which nine subjects were alcoholic, and five subjects were non-alcoholic, and 12.7% of cases seen in the 60-69 age group, in which three subjects were alcoholic and eight subjects were non-alcoholic (Table 1).

Table 1 Age wise distribution of fatty liver in alcoholic and non-alcoholic patients

	Alcoholic		Non-alcoholic	
	N	%	n	%
30 - 39	9	29.03	5	16.13
40 - 49	8	25.81	8	25.81
50 -59	11	35.48	10	32.26
60 -69	3	9.68	8	25.81

By combining both the groups of alcoholic and non-alcoholic subjects, the mean age of the patients with fatty liver was found to be 48.77 (SD=10.15) with a minimum age of 30 and maximum age of 67 years. Among the 62 subjects, the mean HU with fatty liver was 28.38 (SD=8.13), with a minimum mean HU of 6.5 and a maximum mean HU of 39. The median value was 30.75HU, with the first quartile value being 22.25 and the quartile three as 35HU. The overall prevalence of fatty liver in alcoholic subjects was 45.2%, with a median attenuation value of the liver being <30.75HU in 14 patients and 54.8% in 17 patients, with a median attenuation value of the liver >30.75HU. In a non-alcoholic group of subjects, the overall prevalence of fatty liver in 17 patients was found to be 54.8% with a median attenuation value of <30.75HU, and 14 patients showed a prevalence of 45.2% with a median attenuation value of liver >30.75HU (Figure 1).

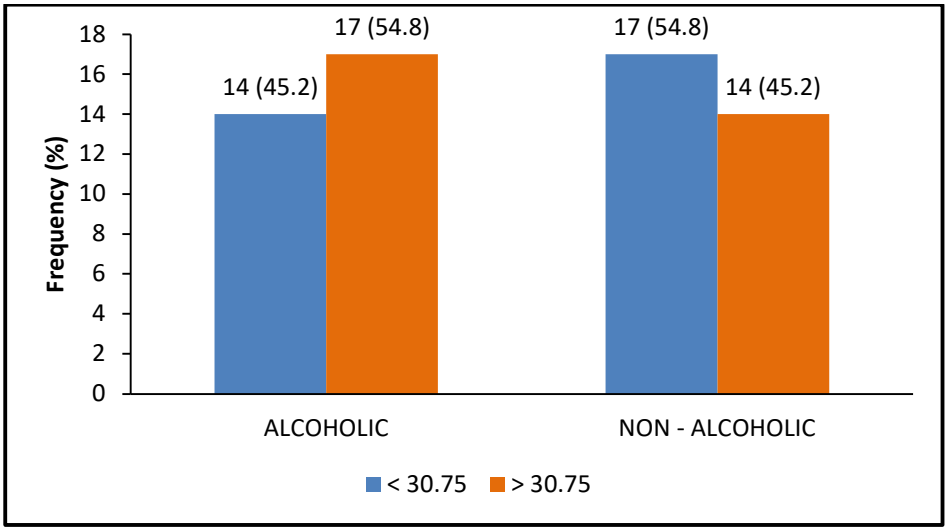

Figure 1 Bar chart showing mean HU value changes in fatty live.

In alcoholic and non-alcoholic subjects, the fatty liver changes were analyzed, and the grading was provided with the help of median liver attenuation values. The four-point grading system has been given to describe fatty liver changes in alcoholics and non-alcoholics based on median liver attenuation values. Grade I was considered with a range of 35 to 39HU, with the median value being 37HU, the first quartile value being 35HU, and quartile 3 being 39HU. This value had seen in 8 alcoholic subjects with an overall fatty liver was 25.81%.

In grade II the range was 30.75 to 35HU with a median value of 32.87HU with the first quartile value as 30.75HU and the quartile three values as 35HU. These have been noticed among six alcoholic subjects, with % overall fatty liver being 19.35%. In grade III patients, the median value was 26.5HU with a range of 22.25 to 30.75HU, and quartile one and quartile 3 were 22.25 and 30.75HU, respectively. These values have found in 14 alcoholic subjects, with the overall fatty liver in these subjects being 45.16%. In grade IV patients, the median value was 14.37HU, the first quartile value was 6.5HU, and the value in quartile three was 22.25HU. The range of grade IV was 6.5 to 22.25HU in 3 patients having overall fatty liver of 9.68% (Figure 2, 3, 4) (Table 2).

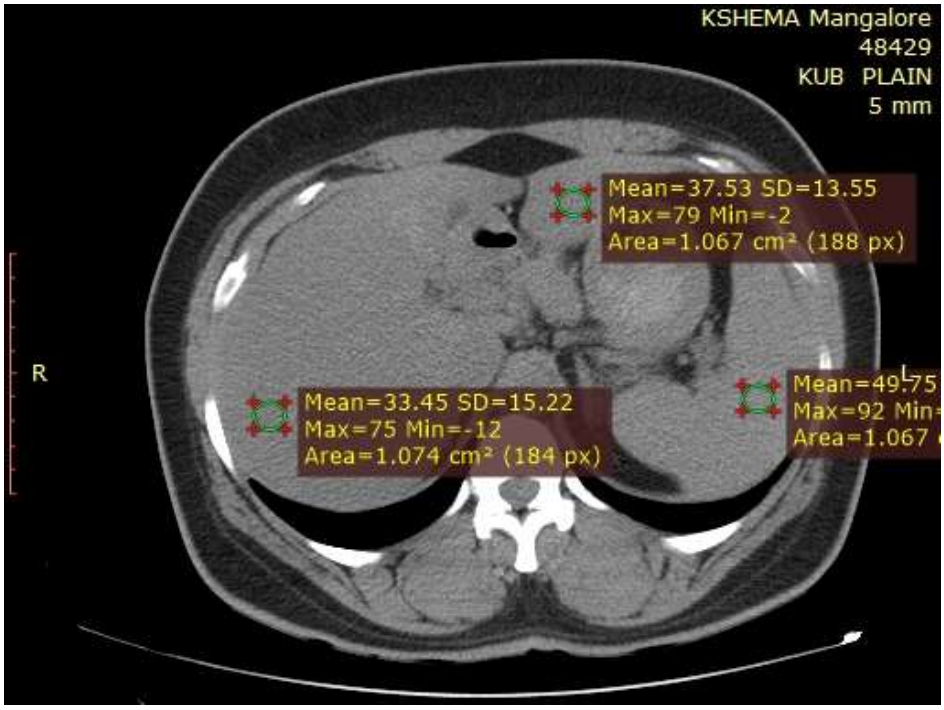

Figure 2 Unenhanced CT scan shows fatty liver with an attenuation value of right and left lobe of liver 33HU and 37HU respectively and attenuation of spleen as 49HU indicating grade I fatty liver

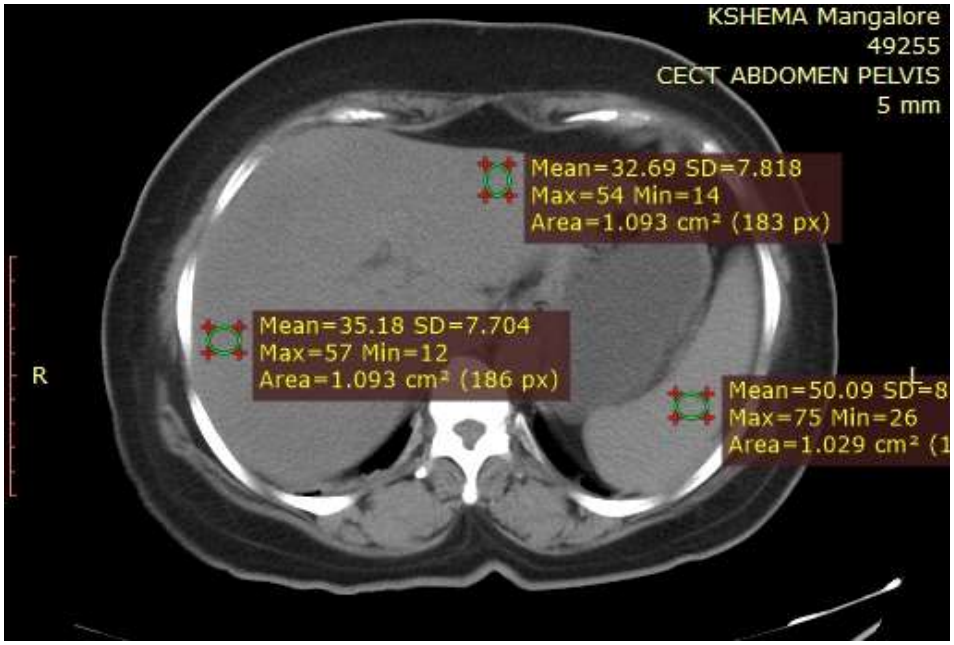

Figure 3 Unenhanced CT scan shows fatty infiltration of liver with an attenuation value of right lobe of liver 35HU and left lobe of liver 32HU and attenuation of spleen as 50HU indicating grade II fatty liver

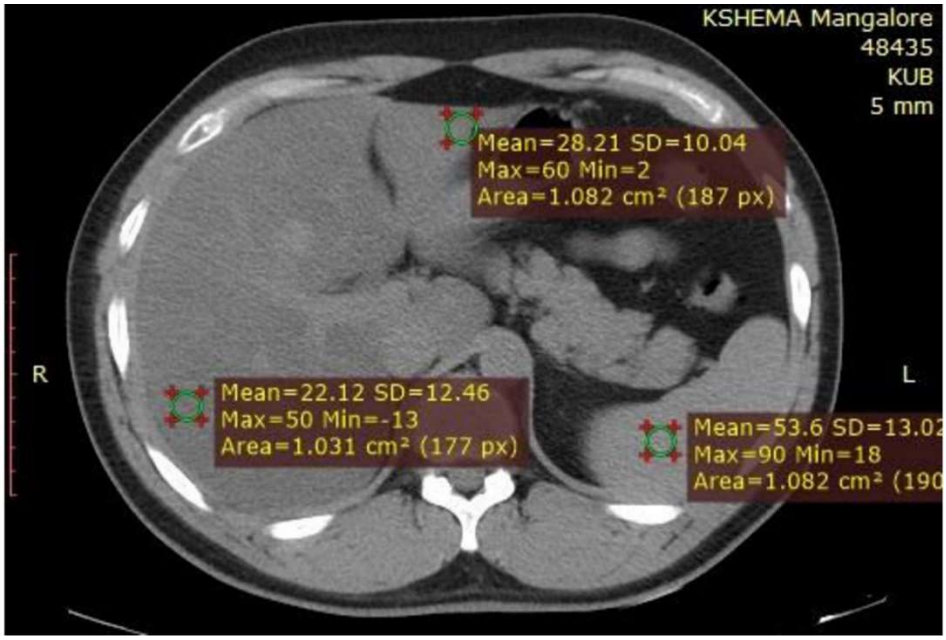

Figure 4 Unenhanced CT scan shows fatty infiltration of liver with an attenuation value of right lobe of liver 22HU and left lobe of liver 28HU and attenuation of spleen as 53HU indicating grade III fatty liver

Table 2 Level of fatty liver changes among the group

		Alcoholic		Non-alcoholic	
		n	%	n	%
HU (Right lobe)	6 - 22	5	16.13	11	35.48
	22 - 30	10	32.26	8	25.81
	30 - 35	9	29.03	5	16.13
	35 - 39	7	22.58	7	22.58
HU (Left lobe)	7 - 23.75	3	9.68	12	38.71
	23.75 to 31	13	41.94	5	16.13
	31 to 35.25	7	22.58	7	22.58
	35.25 - 41	8	25.81	7	22.58
Mean HU (Liver)	6.5 - 22.25	3	9.68	12	38.71
	22.25 to 30.75	14	45.16	5	16.13
	30.75 to 35	6	19.35	8	25.81
	35 - 39	8	25.81	6	19.35
HU (Spleen)	39 - 45	8	25.81	8	25.81
	45 to 48	6	19.35	11	35.48
	48 to 51	11	35.48	10	32.26
	51 - 55	6	19.35	2	6.45
L/s ratio	0.1 - 0.4	6	19.35	12	38.71
	0.4 to 0.6	15	48.39	9	29.03
	0.6 to 0.7	7	22.58	7	22.58
	0.7 – 0.8	3	9.68	3	9.68

In non-alcoholic, grade I consisted of 6 subjects who had fatty liver with a percentage of 19.35%. We found the number of subjects in grade II with an overall fatty liver in these subjects was 25.81%. Grade III had five subjects with fatty liver, which showed a percentage of 16.13%, and 12 subjects were said to be in grade IV with overall fatty liver in these subjects at 38.71%. There was no difference in age group affected with fatty liver disease in alcoholic and non-alcoholic subjects using the independent t-

test (p-value >0.05). The mean age of patients in the alcoholic group affected with fatty liver disease was 46.55 (standard deviation, SD=9.72), and the non-alcoholic patient's mean age was 51 (SD=10.23).

Among alcoholic patients, the mean attenuation of the right lobe of the liver was 30.26 (SD=6.34), and the mean attenuation of the left lobe was 30.84 (SD=5.49). The mean attenuation of the whole liver was 30.55 (SD=5.56). The mean spleen attenuation was 48.29 (SD=3.73), and the mean L/S ratio was 0.58 (SD=0.13). Among non–alcoholic patients, the mean attenuation of the right and left lobes of the liver was 25.94 (SD=9.55) and 26.48 (SD=10.28), respectively. The whole liver's mean attenuation was 26.21 (SD=9.68) (Figure 5, 6, 7). The average spleen attenuation was 47.58 (SD=3.48), and the mean L/S ratio was 0.58 (SD=0.53) (Table 3).

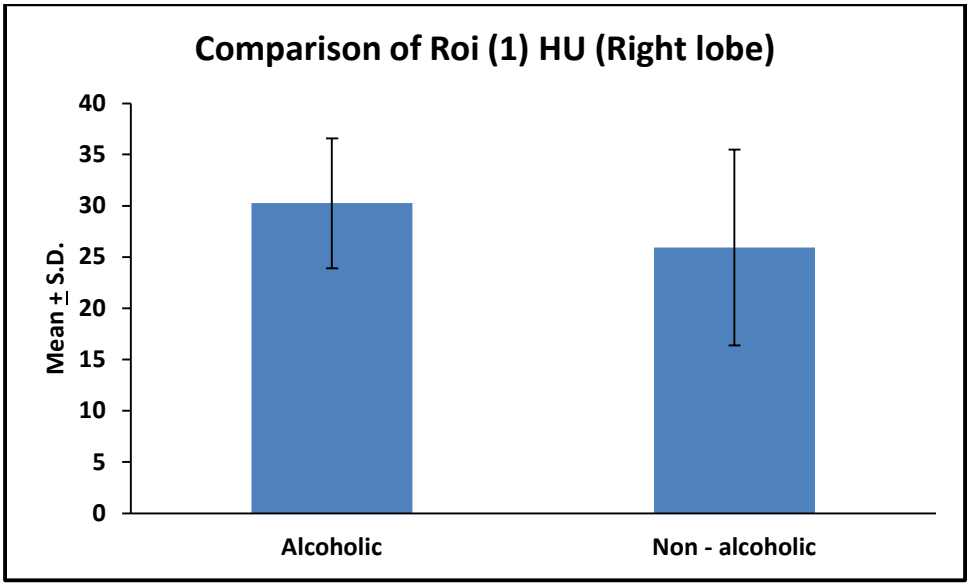

Figure 5 Bar chart showing comparison of mean HU values in right lobe among the alcoholic and non-alcoholic group

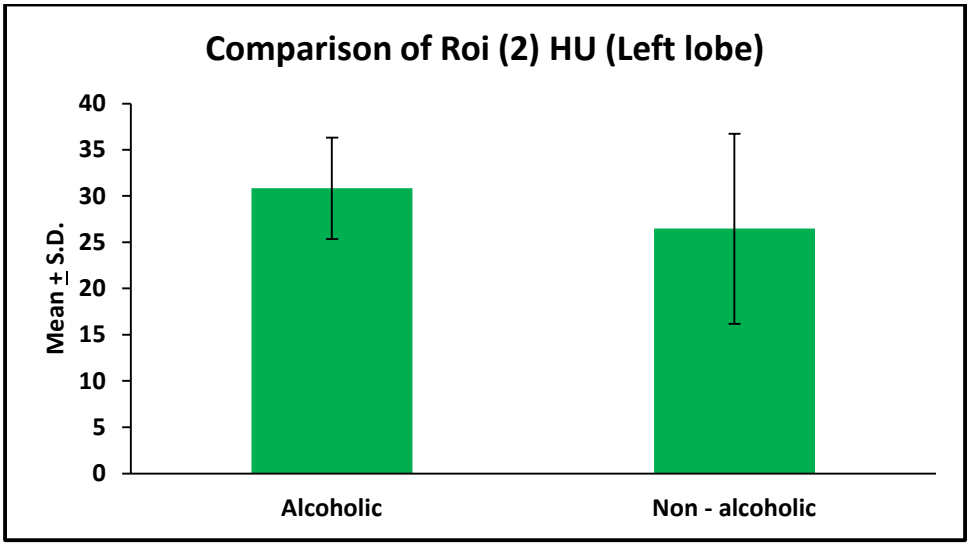

Figure 6 Bar chart showing comparison of mean HU values in left lobe among the alcoholic and non-alcoholic group

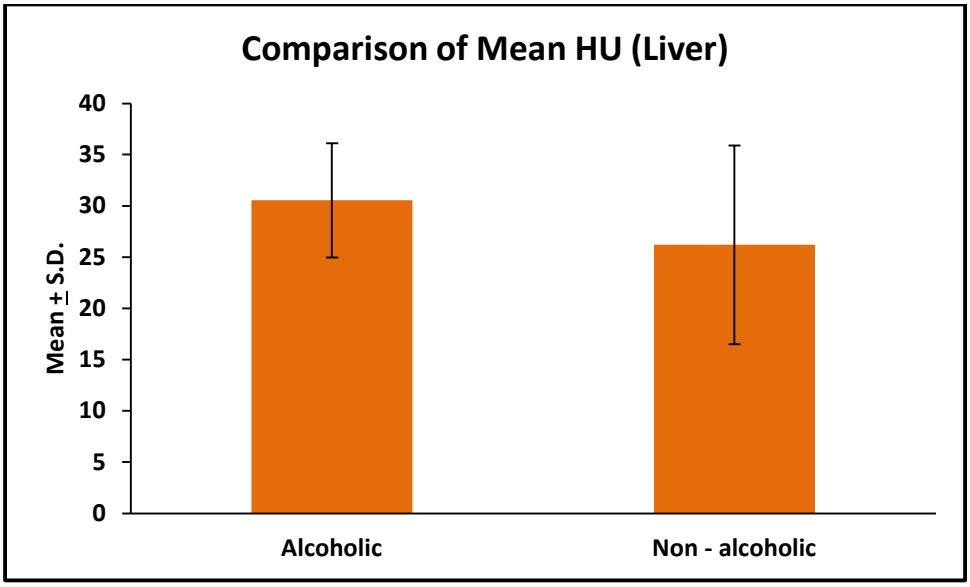

Figure 7 Bar chart showing comparison of mean HU values of the liver alcoholic and non-alcoholic group

Table 3 Comparison of the fatty liver changes in alcoholic with non-alcoholic patients

	Group	Mean	S.D.	"t"	p Value
HU (Right lobe)	Alcoholic	30.26	6.34	2.1	0.040*
	Non-alcoholic	25.94	9.55		
HU (Left lobe)	Alcoholic	30.84	5.49	2.08	0.042*
	Non-alcoholic	26.48	10.28		
Mean HU (Liver)	Alcoholic	30.55	5.56	2.16	0.034*
	Non-alcoholic	26.21	9.68		
HU (Spleen)	Alcoholic	48.29	3.73	0.78	0.441
	Non-alcoholic	47.58	3.48		
L/S ratio	Alcoholic	0.58	0.13	1.77	0.082
	Non-alcoholic	0.51	0.20		

We found a difference between the fatty liver changes among the alcoholic and the non-alcoholic subjects using the independent sample t-test (p-value<0.05). Hence, we found a difference in mean attenuation measurements between alcoholic and non-alcoholic subjects. There was no difference in mean spleen attenuation and L/S ratio between alcoholic and non-alcoholic subjects (p>0.05).

4. DISCUSSION

Alcohol beverages are consumed all over the world. According to the WHO's estimates, the detrimental use of alcohol results in nearly 2.5 million death each year. The adverse effects of alcohol contribute as a significant global factor to death, disease, and injuries such as intoxication, fatty liver, liver cirrhosis, and liver cancer (World Health Organisation, 2011). In Western countries, the most common reason behind abnormal tests and chronic liver disease is NAFLD. It has been forecasted as the most common sign of liver transplantation soon. Most patients undergoing cross-sectional imaging of the abdomen are diagnosed with fatty liver (Chartampilas, 2018; Hamer et al., 2006).

Non–contrast CT is more precise than ultrasound for detecting NAFLD (Alberti et al., 2009). On non–contrast CT scans, the liver attenuates slightly more than the spleen and blood. The fatty liver has confirmed if the liver attenuation is less than 40HU or if the liver attenuation is less than 10HU in the spleen (Hamer et al., 2005; Joy et al., 2003). Our study expounds on the accuracy of diagnosis of fatty liver disease in alcoholic and non-alcoholic by taking the attenuation measurements among the liver and the spleen using non-contrast-enhanced CT.

In the present case-control study, we evaluated 62 cases with fatty liver who were referred for plain CT abdomen to our department by satisfying inclusion and exclusion criteria. The cases are divided into two groups, alcoholic fatty liver and non-alcoholic fatty liver and 31 cases in each group. Liver attenuation was measured by keeping the circular ROI on the right and left

lobes of the liver. Attenuation was calculated and correlated with the attenuation of the spleen for diagnosis of fatty liver. In our study, with 31 cases of alcoholic fatty liver, 30 cases (97%) were seen in males and constituted the majority. In a study by Chang et al., (2019), a similar incidence of males (97.4%) being the majority observed

In our study, 1 case (3%) of alcoholic fatty liver was female. No such similar study had evaluated the female population. The male ratio is higher because the male population consumes more alcohol and is more prone to alcoholic fatty liver, as per Bellentani et al., (1997). In our study, non–alcoholic 12 cases (39%) were male, and 19 (61%) were females. The study conducted by Yu et al., (2018) included 164 males and 290 females. Our study shows the highest number of cases of alcoholic fatty liver between the age group of 50-59 years with 11 patients (35.48%) and the least seen between the ages of 60 and 69 years with 3 cases (9.68%). However, we did not get a similar study in the literature for comparison.

In the non-alcoholic group, most cases belong to the age group of 50-59 years, with ten patients (32.26%), and the least seen in the 30-39 age groups. In a study conducted by Khanal et al., (2019) the highest number of cases had seen in the 50-59 age range (32%) which was similar to our study, but the least number of cases had seen in the 10-19 age group (1%). In our study, the mean age of the patient in alcoholic was 46.55 years (SD=9.72), and in non-alcoholic subjects, the mean age was 51 years (SD=10.23). The study conducted by Long et al., (2020) showed similar findings with a similar mean age of 49.8 ± 10.2 in alcoholic subjects.

In a survey by Ahmed et al., (2016) the result showed a similar mean age of 51.25±18.88 in alcoholic subjects. In the non-alcoholic group of patients, a study conducted by Kan et al., (2014) also had similar findings with a similar mean age of 51.9±14. In this study, we have interpreted the grading of fatty liver hepatitis in alcoholic and non-alcoholic patients using a CT scan. The patients were graded according to the median liver attenuation values and the quartile range and four grades, which are as follows. The patients with grade I had a range of 35-39HU; in grade II, the range was 30.75-35HU. In grade III range was 22.25-30.75HU, and the grade IV range was 6.5-22.25HU.

In a study conducted by Rahman et al., (2015) to estimate the range HU on CT for different grades of fatty liver, which had categorized using ultrasound and further graded the fatty liver in a three-point grading system after statistical analysis using the quartile range. The grading is as follows: grade I had a range of 36.22–39.48 HU, grade II range was 22.68-26.68 HU, and grade III had a range of -5.15–7.94. There was a difference in the HU values range of each grade; this can be due to the different grading systems used.

In a study by Lee et al., (2007) they retrospectively compared the visual grading with the liver attenuation index. The grading was done based on liver parenchymal and hepatic vessel attenuation, and they used a five-point grading system (Lee et al., 2007). Our study used a four-point grading system and did not compare liver attenuation with hepatic vessel attenuation. We only considered liver parenchymal attenuation for grading. Furthermore, our study showed that the overall occurrence of fatty liver in alcoholics using a median attenuation value of the liver <30.75 HU was 45.2%, with a median attenuation value of the liver >30.75 HU was 54.8%.

In a study by Boyce at el., (2010) they found that the overall prevalence of the fatty liver ranged from 6.2 % to 45.9%, depicting moderate to severe changes when they used the 40HU value as the threshold and liver-to-spleen ratio of ≤1.1. In our study's other group of non-alcoholic patients, the overall prevalence of the fatty liver using liver median attenuation value <30.75HU was found to be 54.8% and was 45.2% with a median attenuation value of liver >30.75HU (Boyce et al., 2010).

According to Zeb et al., (2012) where they performed a study on non-alcoholic fatty liver patients for diagnosing liver fat, the L/S ratio <1.0 and the liver attenuation of <40 HU were utilized to assess the presence of fat content. They found out that the overall incidence of fatty liver was 17.2%. They also found the prevalence of fatty liver with diabetes to be 24.1%, with hypertension to be 56.8%, in obese was 70.4%, and in dyslipidemia, it was 53% of fatty liver (Zeb et al., 2012). The incidence may vary due to different statistical measurement techniques.

In our study of alcoholic patients, the mean HU attenuation of the right lobe of the liver was 30.26 (SD=6.34), and the mean HU attenuation of the left lobe of the liver was 30.84 (SD=5.49). The whole liver's mean HU attenuation was 30.55 (SD=5.56). The mean spleen HU attenuation was 48.29 (SD=3.73). According to the study by Boyce et al., (2010) the mean liver HU attenuation was 58.8±10.8HU (SD), and the mean splenic attenuation was 54.9HU. However, there are no relevant studies on alcoholic fatty liver showing measurement of mean HU attenuation of the right and left lobes of the liver.

Whereas in non–alcoholic patients in our study, the average attenuation of the right and left lobe of the liver was 25.94HU (SD=9.55) and 26.48HU (SD=10.28), respectively. The average HU attenuation of the whole liver was 26.21HU (SD=9.68). The splenic mean attenuation found to be 47.58HU (SD=3.48). A similar study, conducted by Zeb et al., (2012) in which the mean attenuation of the right liver lobe was 58.7HU (SD=11.5). The left liver lobe was 60.5HU (SD=14.5), with whole liver's mean HU attenuation was

59.3HU (SD=11.3), and mean spleen attenuation was 50.5HU (SD=9.6) (Zeb et al., 2012). The difference is due to the modality used for diagnosis, targeted patients, and the method or criteria used for the diagnosis.

The limitations of this study are the unequal distribution of both males and females in alcoholic and non-alcoholic subjects; the duration of alcohol consumption was not considered, and also did not include possible risk factors of fatty liver disease.

5. CONCLUSION

A total of 62 patients have divided into two groups that are alcoholic and non-alcoholic, with each group having 31 patients in each group. The L/S ratio<1.0 and the HU value of liver <40 was used. To assess the fat of the liver, analysis of fatty liver and grades were assigned accordingly based on the HU value of the liver. A statistically significant difference between both the groups of patients with the help of these HU values was noted, where in alcoholic mean HU value of the liver was 30.55 (SD=5.56) and in the non-alcoholic mean HU value of the liver was 26.21 (SD=9.68). The CT criteria employed in this study are used to assess the existence and prevalence of fatty alterations in the liver.

Acknowledgement

We thank the participants who all contributed samples to the study.

Ethical approval

The study was approved by the institutional ethical committee of KS Hegde medical academy (Nitte deemed to be university) LETTER No: INST.EC/EC/057/2022-23

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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