Section: Miscellaneous

Original Research Article

# CORRELATIVE STUDY BETWEEN SERUM FERRITIN LEVELS AND SHEAR WAVE ELASTOGRAPHY FINDINGS AMONG PATIENTS WITH NON-ALCOHOLIC FATTY LIVER DISEASE

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**ABSTRACT**

**Background: Aim:** The aim of the present study was to assess the correlation between ultrasound transient elastography (TE) and serum ferritin (SF) in patients of NAFLD.

**Materials and Methods:** All the patients of NAFLD (newly diagnosed or old patients) were included in the current study after applying inclusion and exclusion criteria after taking written and informed consent. A detailed history was obtained and thorough clinical examination was done. These patients were clinically evaluated for NAFLD by doing detailed general examination, systemic examination and then subjected to lab investigations as per protocol.

**Results:** Majority of the patients (26.8%) belonged to 40-49 years of age (26.8%) followed by 30-39 years of age (24.1%). Mean age was 42.86±12.67 years. Out of 112 patients, 55.4% were females and 44.6% were males. 66 patients had hypertension and 38 patients had diabetes mellitus. Mean BMI of the study population was 25.86±3.27. Majority of the patients (42.9%) had BMI 25-29.9 followed by 23-24.9 (25.9%). Out of total study population, 48.2% patients had HbA1c <5.7, followed by >6.4 (31.3%) and 5.7-6.4 (20.5%). Mean ferritin levels in females were 116.66+59.74 ng/mL and Mean ferritin levels in males were 204.14+ 111.90 ng/mL. The difference was statistically significant. Mean ferritin levels in patients with fibrosis grade F0 was 68.53+38.03 ng/mL, F1 was 114.28+29.19 ng/mL, F2 was 153.83+33.88 ng/mL, F3 was 253.21+68.95 ng/mL, and F4 was 389.00+100.72 ng/mL. The difference between grades of fibrosis and mean values of ferritin was also found statistically significant.

**Conclusion:** In this study, a significant relationship was seen between the serum ferritin level and liver stiffness as measured by shear wave elastography in patients with NAFLD, and it can be used as a non-invasive economic option in comparison with liver biopsy and elastography for predicting the severity of liver fibrosis among NAFLD patients in a resource limited setting.

**Keywords:** Ferritin, nonalcoholic fatty liver disease, transient elastography.

## INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) represents a spectrum of hepatic pathology with fat excessively accumulating in the hepatic parenchyma in individuals who consume little or no alcohol.[1,2] It has become the most common liver disorder across the world, with a global prevalence estimated to be 25.24%,[3] and still on the rise,[4] heavy in both clinical and economic burdens. Noticeably, sex differences in NAFLD exist – NAFLD is more prevalent and more severe in men than in women

during the reproductive age; the differences usually get smaller after menopause.[5]

Generally, NAFLD consists of two subtypes: the first is simple steatosis (also termed as NAFL), which is nonprogressive; the second is non-alcoholic steatohepatitis (NASH), which has not only steatosis but also hepatocyte damage.[6] NASH is progressive and may lead to end-stage liver diseases such as fibrosis, cirrhosis, and hepatocellular carcinoma, possibly resulting in liver-related mortality.[7,8] In the United States, one of the major causes of adult cirrhosis is NASH, with NASH-related cirrhosis recognized as the second indication for liver transplantation.[3]

Hence, clinical evaluation of the disease progression in NAFLD patients is important for physicians to choose appropriate interventions and assess prognosis. NAFLD is an important cause of chronic liver injury with a prevalence of 20-50% worldwide.[6] As it affects approximately 30% of the population, accounting for almost 100 million people,[9] it is important to estimate the degree of liver steatosis and fibrosis in order to determine the optimal treatment, as well as prognosis and surveillance of the disease.

NAFLD encompasses a spectrum of disease, including steatosis in which there is non-inflammatory isolated fat accretion in hepatocytes; non-alcoholic steatohepatitis (NASH), a more aggressive form of the disease, which is characterized by steatosis, inflammatory changes, and hepatocyte cell ballooning associated with varying degrees of liver fibrosis; and cirrhosis with its characteristic collagen bands surrounding liver nodules. Hepatocellular carcinoma can arise from both pre-cirrhotic NASH and cirrhosis. The different stages of disease can regress or progress accordingly.[10] NAFLD, diabetes, and cardiovascular disease all share a common origin. On ultrasound (US), hepatic steatosis appears as diffusely increased hepatic echogenicity and is often called “bright liver”. This is due to increased reflection of the US waves from the bed of the liver parenchyma, caused due to fat vacuole accumulation in the intracellular space. The evaluation process of hepatic steatosis by US depends on the qualitative visual assessment of echogenicity of liver parenchyma that is then used to determine differences in measurements between the echo-amplitude of the liver and kidneys.[11]

Traditionally, liver biopsy is regarded as the gold standard in the diagnosis of NAFLD. However, due to its invasiveness, expense, and the possibility of complications, its use is now limited.[12] Recently, significant progressions have been made in introducing simple and non-invasive methods for estimating the degree of liver fibrosis among NAFLD.[13] One of this non-invasive methods is transient elastography (Fibroscan) which uses ultrasound for determining liver stiffness and estimating the degree of liver fibrosis.[13,14]

The aim of the present study was to assess the correlation between ultrasound transient elastography (TE), serum ferritin (SF) in patients.

## MATERIALS AND METHODS

All the patients of NAFLD (newly diagnosed or old patients) were included in the current study after applying inclusion and exclusion criteria after taking written and informed consent. A detailed history was obtained and thorough clinical examination was done. These patients were clinically evaluated for NAFLD by doing detailed general examination, systemic examination and then subjected to lab investigations as per protocol. A blood samples for serum Ferritin was collected and sent to laboratory for measurement of serum ferritin levels and Shear wave Elastography of the patient was done. Then correlation between Serum ferritin levels & Shear wave Elastography findings in NAFLD patients was done.

**DIAGNOSTIC CRITERIA OF NAFLD**: According to American Association for the Study of Liver Diseases (AASLD)

1. Evidence of hepatic steatosis (HS) by imaging or histology.
2. No significant alcohol consumption (less than 20 g/day in female and 30g/day in male).
3. No competing causes of HS.
4. No coexisting causes of chronic liver disease.

**INCLUSION CRITERIA:**

Patients between age of 18 to 65 years with fatty or coarse liver commented on USG and/or deranged LFTs with no obvious other cause of Liver disease were included.

**Exclusion Criteria**

- Age <18 years.
- Pregnant female.
- Severely Anaemic patients.
- Patients of viral hepatitis (Hepatitis B & C).
- Patients with history suggestive of Autoimmune Hepatitis.
- Patients with history suggestive of Acute Viral Hepatitis.
- Patients with history suggestive of Decompensated Cirrhosis.
- Alcohol consumption more than 20 g/d in female and 30g/d in male,
- Patients with history of gastrointestinal (GI) tract surgery.
- Patients with history of total parenteral nutrition during last 6 months.
- Patients with history of consumption of hepatotoxic drugs during the last 6 months (tamoxifen, glucocorticoids, isoniazid, amiodarone, methotrexate, anti- retroviral drugs, estrogen, sodium valproate and tetracyclines).
- Patients with history suggestive of congestive heart failure.
- Patients with any hepatic mass lesion
- Patients with history of chronic kidney disease

- Patients on iron therapy.
- Patients having sepsis.

**Methodology**

A detailed history was taken to obtain information regarding demography, personal history, medical history, alcohol consumption and medications.

Standardized methods were used for measurement of all parameters.

- Weight was done after removing heavy clothing by instructing the patients to stand still in the platform, with the body weight evenly distributed between both the feet. Weight was measured to the nearest of 0.1 kg.
- Height was measured using stadiometer with head held in Frankfort plane to the nearest of 0.1 cm. Body mass index (BMI) was calculated by the following formula; weight (kg)/height ($m^2$).
- Waist circumference (WC) was measured mid-way between iliac crest and lowermost margin of the ribs, in quiet breathing using non-stretchable measuring tape.
- Hip circumference (HC) was measured at the maximum protruding part of buttocks at the level of the greater trochanter with the patient wearing minimal clothing and with feet together using same non stretchable measuring tape.
- Pulse rate was recorded after 5 minutes of rest.
- Blood pressure was also recorded after at least 5 minutes of rest.

**Laboratory Investigations**

The blood samples were drawn from all patients after minimum 8 hours of fasting. The venepuncture was done in cubital fossa. About 10 ml of blood was drawn using perfectly dry and sterile syringes and blood was transferred to dried glass vials. Routine investigations were done. Serum ferritin levels was determined for all samples using the VITROS ECi/ECiQ Immunodiagnostic systems, the VITROS 3600 Immunodiagnostic system and the VITROS 5600 Integrated System. The VITROS Ferritin test was performed using the VITROS Ferritin Reagent pack & the VITROS Ferritin Calibrators on the VITROS ECi/ECiQ Immunodiagnostic systems, the VITROS 3600 Immunodiagnostic system and the VITROS 5600 Integrated System using Intellicheck Technology**.**

**Radiological Investigation**

Ultrasound whole abdomen of the patients was done after at least 8 hours of fasting Shear wave Elastography was done after at least 8 hours of fasting.

1. Abdominal ultrasonography to detect and grade the fatty liver infiltration was performed by the radiologist.
2. Shear wave Elastography was performed by the radiologist by using sufficient ultrasonic coupling agent. The examinations were performed by using a 3-12 Mhz linear-array transducer (Logic P9). The subjects were in supine position. The position of all participants was standardized to avoid any discrepancy. The stiffness in kPa of the region of interest (ROI) was automatically generated based on the integrated shear wave elastography software.

**Statistical Analysis**

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 22 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages, means and standard deviations were calculated. Statistical test applied for the analysis were Pearson chi-square test, student t-test, One-way ANOVA and Pearson correlation coefficient. The level of confidence interval and p-value were set at 95% and 5%.

## RESULTS

**Table 1: Demographic data**

| Age (In Years) | Frequency | Percent |
|---|---|---|
| 20-29 | 23 | 20.5 |
| 30-39 | 27 | 24.1 |
| 40-49 | 30 | 26.8 |
| 50-59 | 19 | 17.0 |
| ≥60 | 13 | 11.6 |
| Mean±SD | 42.86±12.67 | |
| **Gender** | | |
| Female | 62 | 55.4 |
| Male | 50 | 44.6 |
| **Co-morbidities** | | |
| Hypertension | 66 | 58.92 |
| Diabetes Mellitus | 38 | 33.9 |
| **BMI** | | |
| <18.5 | 0 | 0.0 |
| 18.5-22.9 | 22 | 19.6 |
| 23-24.9 | 29 | 25.9 |
| 25-29.9 | 48 | 42.9 |
| ≥ 30 | 13 | 11.6 |
| Mean±SD | 25.86±3.27 | |
| **HbA1c** | | |

| | | |
|---|---|---|
| <5.7 | 54 | 48.2 |
| 5.7-6.4 | 23 | 20.5 |
| >6.4 | 35 | 31.3 |
| Mean±SD | 6.53±2.00 | |

Majority of the patients (26.8%) belonged to 40-49 years of age (26.8%) followed by 30-39 years of age (24.1%). Mean age was 42.86±12.67 years. Out of 112 patients, 55.4% were females and 44.6% were males. 66 patients had hypertension and 38 patients had diabetes mellitus. Mean BMI of the study population was 25.86±3.27. Majority of the patients (42.9%) had BMI 25-29.9 followed by 23-24.9 (25.9%). Out of total study population, 48.2% patients had HbA1c <5.7, followed by >6.4 (31.3%) and 5.7-6.4 (20.5%).

**Table 2: Distribution of LFT among study population**

| Parameters | Cut off value | Frequency (n) | Percent |
|---|---|---|---|
| SGOT | <59 | 89 | 79.5 |
| | >59 | 23 | 20.5 |
| SGPT | <50 | 76 | 67.9 |
| | >50 | 36 | 32.1 |
| ALP | <126 | 76 | 67.9 |
| | >126 | 36 | 32.1 |
| Total | | 112 | 100 |

79.5% had SGOT <59 U/L, whereas 20.5% had SGOT >59 U/L. 67.9% had SGPT <50 U/L, whereas 32.1% had SGPT >50 U/L. 67.9% had ALP <126 U/L, whereas 32.1% had ALP >126 U/L.

**Table 3: Mean value of iron, ferritin and TIBC in study population**

| Parameters | N | Mean+ Std. Deviation |
|---|---|---|
| Iron | 112 | 79.46±20.20 |
| Ferritin | 112 | 155.71±96.94 |
| TIBC | 112 | 340.24±56.06 |

Mean ferritin levels in females were 116.66+59.74 ng/mL and Mean ferritin levels in males were 204.14+ 111.90 ng/mL. The difference was statistically significant.

**Table 3: Distribution of fibrosis grades according to USG W/A**

| USG W/A | Fibrosis Grades with Stiffness value (kPa) | | | | | Total | p value |
|---|---|---|---|---|---|---|---|
| | F0 (<4.6) | F1 (4.6-5.6) | F2 (5.7-7) | F3 (7.1-12) | F4 (>12) | | |
| Fatty Liver Grade I | 27 | 30 | 7 | 3 | 0 | 67 | 0.001 (Sig.) |
| | 40.30% | 44.78% | 10.45% | 4.48% | 0.00% | 100.00% | |
| Fatty Liver Grade II/III | 0 | 4 | 12 | 24 | 5 | 45 | |
| | 0.00% | 8.89% | 26.67% | 53.33% | 11.11% | 100.00% | |

Among 67 patients with Fatty Liver Grade 1, 27(40.30%) of patients had F0 fibrosis, 30(44.78%) had F1 fibrosis, 7(10.45%) had F2 fibrosis, 3(4.48%) had F3 fibrosis and 0% hadF4 fibrosis. Among 45 patients with Fatty Liver Grade II/III, 0% had F0 fibrosis, 4 (8.89%) had F1 fibrosis, 12 (26.67%) had F2 fibrosis, 24 (53.33%) had F3 fibrosis and 5 (11.11%) had F4 fibrosis. This difference was found statistically significant.

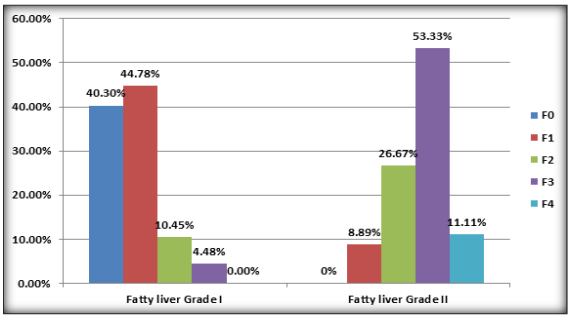


**Figure 1: Distribution of fibrosis grades according to USG W/A**

**Table 4: Distribution of fibrosis grades according to mean value of ferritin**

| Fibrosis Grades | Stiffness value (kPa) | N | Mean Ferritin ± Std. Deviation | p-value |
|---|---|---|---|---|
| F0 | <4.6 | 27 | 68.52±38.03 | 0.001 (Sig.) |
| F1 | 4.6-5.6 | 34 | 114.27±29.19 | |
| F2 | 5.7-7 | 19 | 153.82±33.87 | |
| F3 | 7.1-12 | 27 | 253.21±68.94 | |
| F4 | >12 | 5 | 389.00±100.72 | |
| Total | | 112 | 155.71±96.93 | |

Mean ferritin levels in patients with fibrosis grade F0 was 68.53+38.03 ng/mL, F1 was 114.28+29.19 ng/mL, F2 was 153.83+33.88 ng/mL, F3 was 253.21+68.95 ng/mL, and F4 was 389.00+100.72 ng/mL. The difference between grades of fibrosis and mean values of ferritin was also found statistically significant.

**Table 5: Correlation between Ferritin and stiffness value of SWE (in kPa)**

| | | SWE |
|---|---|---|
| Ferritin | Pearson Correlation | .931** |
| | Sig. (2-tailed) | .000 |
| | N | 112 |

**. Correlation is significant at the 0.01 level (2-tailed).

Pearson Correlation between Ferritin and Stiffness value of SWE was also found statistically significant.

**Table 6: Distribution of fibrosis grades according to mean value of triglyceride**

| Grading Of Fibrosis | Stiffness value (kPa) | N | Mean TG ± Std. Deviation | p-value |
|---|---|---|---|---|
| F0 | <4.6 | 27 | 140.18±103.63 | 0.004 (Sig.) |
| F1 | 4.6-5.6 | 34 | 159.14±37.96 | |
| F2 | 5.7-7 | 19 | 174.47±42.10 | |
| F3 | 7.1-12 | 27 | 201.22±73.24 | |
| F4 | >12 | 5 | 236.80±94.71 | |
| Total | | 112 | 169.60±74.52 | |

Mean triglyceride value in patients with fibrosis grade F0 was 140.19+103.63 mg/dL, F1 was 159.15+37.96 mg/dL, F2 was 174.47+42.10 mg/dL, F3 was 201.22+73.24 mg/dL, and F4 was 236.80+94.71 mg/dL. The difference between grades of fibrosis and mean values of triglyceride was also found statistically significant.

**Table 7: Distribution of fibrosis grades according to mean value of HbA1c**

| Grading Of Fibrosis | Stiffness value (kPa) | N | Mean HbA1c ± Std. Deviation | p-value |
|---|---|---|---|---|
| F0 | <4.6 | 27 | 6.07±1.60 | 0.286 (NS) |
| F1 | 4.6-5.6 | 34 | 6.48±2.31 | |
| F2 | 5.7-7 | 19 | 6.49±1.88 | |
| F3 | 7.1-12 | 27 | 6.77±1.77 | |
| F4 | >12 | 5 | 8.14±2.89 | |
| Total | | 112 | 6.53±2.00 | |

Mean HbA1C value in patients with fibrosis grade F0 was 6.08+1.60919, F1 was 6.49+2.32, F2 was 6.49+1.89, F3 was 6.77+1.78, and F4 was 8.14+2.89. The difference between grades of fibrosis and mean values of HbA1C was found statistically non-significant.

**Table 8: Distribution of fibrosis grades according to mean BMI**

| Grading of Fibrosis | Stiffness value (kPa) | N | Mean BMI ± Std. Deviation | p-value |
|---|---|---|---|---|
| F0 | <4.6 | 27 | 25.35±2.59 | 0.151 (NS) |
| F1 | 4.6-5.6 | 34 | 24.99±3.11 | |
| F2 | 5.7-7 | 19 | 26.83±2.78 | |
| F3 | 7.1-12 | 27 | 26.50±3.58 | |
| F4 | >12 | 5 | 27.28±6.11 | |
| Total | | 112 | 25.85±3.27 | |

Mean BMI in patients with fibrosis grade F0 was 25.35+2.60 kg/m2, F1 was 24.99+3.12 kg/m2, F2 was 26.84+2.79 kg/m2, F3 was 26.50+3.58 kg/m2, and F4 was 27.28+6.11 kg/m2. The difference between grades of fibrosis and mean BMI was found statistically non-significant.

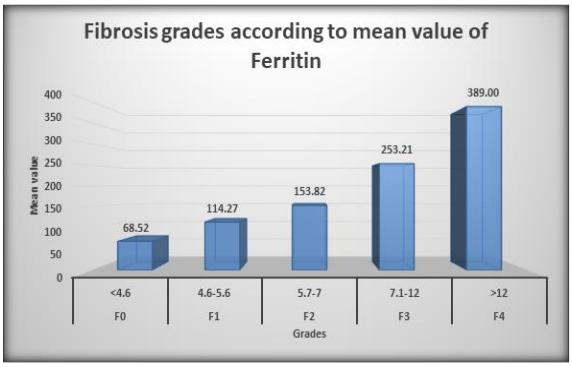

**Figure 2: Distribution of Fibrosis grades according to mean value of Ferritin**

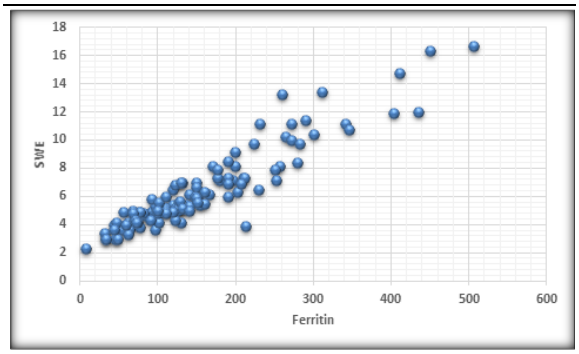


**Figure 3: Correlation between Ferritin and stiffness value of SWE (in kPa)**

## DISCUSSIONS

Hepatic steatosis is defined as the accumulation of fat in hepatocytes, comprising more than 5% of the total weight of the liver.[15] As the global incidence of obesity is increasing, the incidence of liver steatosis has also increased, representing the most common cause of liver disease in Western countries.[16] In addition to obesity, this liver disease is closely linked to a wide range of metabolic comorbidities such as type 2 diabetes, dyslipidemia, high blood pressure. At the same time, hepatic steatosis is also a common etiology for advanced liver diseases such as liver cirrhosis and hepatocellular carcinoma.[17] Depending on the risk factors, hepatic steatosis can be classified as: alcoholic fatty liver disease (AFLD) related to alcohol consumption and non-alcoholic fatty liver disease (NAFLD) related to obesity and metabolic syndrome.[18] NAFLD can be divided according to the histological appearance into 2 simplified subcategories: simple steatosis (presence of excess fat, no inflammation or cell damage) and steatohepatitis (NASH-presence of inflammation and cell damage, with or without fibrosis).[19]

In the present study, majority of the patients (26.8%) belonged to 40-49 years of age followed by 30-39 years of age (24.1%). Mean age was 42.86±12.67 years as compared to study done by Mohammed E et al,[20] and Mousavi SRM et al,[21] where mean age was 49.2±11.5 and 37.93 ± 12.5 years, respectively. 55.4% were females and 44.6% were males in our study which is consistent with study done by Mohammed E et al,[20] where females (67.7%) were more in number as compared to males (32.3%). Mean BMI of the study population was 25.86±3.27kg/m2. Majority of the patients (42.9%) had BMI 25-29.9 kg/m2 followed by 23-24.9 kg/m2 (25.9%) which is almost similar in comparison to studies done by Roy S and Majumder A,[22] and Mousavi SRM et al,[21] where mean BMI was 27.75kg/m2 and 26.45 ± 4.4 kg/m2, respectively. Mean Systolic Blood Pressure was 125.68±14.30 mmHg and mean Diastolic Blood Pressure was 76.43±7.33 mmHg. According to ACC/AHA guidelines, 28.6% had normal blood pressure, 21.4% had elevated blood pressure, 22.3% had Stage I hypertension, and 27.7% had Stage II hypertension. Only 33.9% patients had Type II diabetes. Out of total diabetic patients, 44.7% were having diabetes since less than last 5 years, 26.3% had diabetes since 5-10 years, and 28.9% had diabetes since more than 10 years. In study done by Roy S,[22] and Majumder A,[20] on Diabetic persons, patients had a mean duration of diabetes of six years.

Overall, mean ferritin levels were 155.71+96.94 ng/mL in the current study. The mean ferritin level in males (204.14+ 111.90ng/mL) was more than females (116.66+59.74ng/mL) and the difference was statistically significant($p<0.001$). Similarly, in study done by Seyedian SS et al23, males had an average ferritin level of 173 ± 136ng/mL which was also statistically significant($p<0.001$) as compared to females (98 ± 94ng/mL). Similar statistically significant($p<0.001$) results were found in study done by Mousavi SRM et al,[21] (serum ferritin levels of 280.08 ± 222.92ng/mL in males vs. 97.27 ± 102.77ng/mL in females). On comparison of grades of fatty liver with fibrosis grades on SWE, among 67 patients with Fatty Liver Grade 1, 27(40.30%) of patients had F0 fibrosis, 30(44.78%) had F1 fibrosis, 7(10.45%) had F2 fibrosis, 3(4.48%) had F3 fibrosis and 0% had F4 fibrosis. Among 45 patients with Fatty Liver Grade II/III, 0% had F0 fibrosis, 4(8.89%) had F1 fibrosis, 12(26.67%) had F2 fibrosis, 24(53.33%) had F3 fibrosis and 5(11.11%) had F4 fibrosis. This difference was found statistically significant($p<0.001$).

The mean serum ferritin levels in our study were found to be 155.71+96.39 ng/mL and the median levels of serum ferritin were found to be 131ng/ml. Our study showed that with increase in serum ferritin levels, higher grades of fibrosis were found on shear wave elastography. The difference between grades of fibrosis and mean values of ferritin was found statistically significant($p<0.001$) in the present study. In study done by Parikh P et al,[24] univariate analysis showed higher Fibroscan values and greater fibrosis in patients with serum ferritin levels ≥48 ng/ml which is slightly lower as compared to mean and median values of serum ferritin found in our study. As shown by present study that increase in serum ferritin levels directly correlates with grading of fibrosis, the study by Kowdley et al,[25] similarly showed an increase of the serum ferritin level more than 1.5 times normal was an independent factor predicting the advanced fibrosis of liver and NASH. Valenti et al,[26] found patients with NAFLD had increased serum ferritin levels without an increase in hepatic iron store. In study done by Seyedian SS et al,[23] the relationship between serum ferritin level and liver stiffness measured by transient elastography was calculated, and among 46 patients with raised serum ferritin level (>225 ng/ml in men and >135 ng/ml in

women), 23 patients (50%) had mild liver stiffness, and among 238 patients with low levels of serum ferritin (<225 ng/ml in men and <135 ng/ml in women), 203 patients (85.3%) had mild liver stiffness and 35 patients (14.7%) suffered advanced liver stiffness, and overall, the relationship between serum ferritin level and liver stiffness was statistically meaningful (P < 0.001).

## CONCLUSION

In this study, a significant relationship was seen between the serum ferritin level and liver stiffness as measured by shear wave elastography in patients with NAFLD, and it can be used as a non-invasive economic option in comparison with liver biopsy and elastography for predicting the severity of liver fibrosis among NAFLD patients in a resource limited setting.

## REFERENCES


1. Clark JM, Brancati FL, Diehl AM. Nonalcoholic fatty liver disease. Gastroenterology. 2002; 122:1649-57.
2. Loomba R, Sanyal AJ. The global NAFLD epidemic. Nat Rev Gastroenterol Hepatol. 2013; 10:686-90.
3. Younossi ZM, Koenig AB, Abdelatif D, Fazel Y, Henry L, Wymer M. Global epidemiology of nonalcoholic fatty liver disease-meta-analytic assessment of prevalence, incidence, and outcomes. Hepatology. 2016; 64:73-84.
4. Zhu JZ, Dai YN, Wang YM, Zhou QY, Yu CH, Li YM. Prevalence of nonalcoholic fatty liver disease and economy. Dig Dis Sci. 2015; 60:3194-202.
5. Lonardo A, Nascimbeni F, Ballestri S, Fairweather D, Win S, Than TA, et al. Sex differences in nonalcoholic fatty liver disease: state of the art and identification of research gaps. Hepatology. 2019; 70:1457-69.
6. Chalasani N, Younossi Z, Lavine JE, Diehl AM, Brunt EM, Cusi K, et al. The diagnosis and management of non-alcoholic fatty liver disease: practice guideline by the American Association for the Study of Liver Diseases, American College of Gastroenterology, and the American Gastroenterological Association. Hepatology. 2012; 55:2005-23
7. Adams LA, Lymp JF, St Sauver J, Sanderson SO, Lindor KD, Feldstein A, et al. The natural history of nonalcoholic fatty liver disease: a population-based cohort study. Gastroenterology. 2005; 129:113-21.
8. Matteoni CA, Younossi ZM, Gramlich T, Boparai N, Liu YC, McCullough AJ. Nonalcoholic fatty liver disease: a spectrum of clinical and pathological severity. Gastroenterology. 1999; 116:1413-9.
9. Rinella ME. Nonalcoholic fatty liver disease: a systematic review. JAMA. 2015;313(22):2263-73. Correction in: JAMA. 2015;314(14):1521.
10. Arab JP, Arrese M, Trauner M. Recent insights into the pathogenesis of nonalcoholic fatty liver disease. Annu Rev Pathol. 2018; 13:321-50. doi: 10.1146/annurev-pathol-020117-043617. PMID: 29414249.
11. Lee SS. Radiologic evaluation of nonalcoholic fatty liver disease. World J Gastroenterol. 2014; 20:7392.
12. Bedossa P. Sampling variability of liver fibrosis in chronic hepatitis C. Hepatology. 2003; 38:1449-57.
13. Feldman M, Friedman LS, Brandt LJ. Sleisenger and Fordtran's gastrointestinal and liver disease: pathophysiology, diagnosis, management, expert consult premium edition enhanced online features. Melbourne, VIC, Australia: Elsevier Health Sciences; 2010.
14. Hajiani E, Hashemi SJ, Masjedizadeh AR, Shayesteh AA, Nejad PA, Kadkhodae A, et al. Comparison of liver biopsy with transient elastography as a non-invasive method for assessment of liver fibrosis. J Gastroenterol Hepatol Res. 2014; 3:1013-6.
15. Brunt EM. Nonalcoholic steatohepatitis: definition and pathology. Semin LiverDis. 2001;21(1):3–16.
16. Ratziu V, Bellentani S, Cortez-Pinto H, Day C, Marchesini G. A position statement on NAFLD/NASH based on the EASL 2009 special conference. J Hepatol. 2010;53(2):372–384.
17. Adams LA, Scott Harmsen JL, Charatcharoenwitthaya P, Enders FB, Therneau T, Angulo P. Nonalcoholic fatty liver disease increases risk of death among patients with diabetes: a community-based cohort study. Am J Gastroenterol. 2010;105(7):1567–1573.
18. Paschos P, Paletas K. Non-alcoholic fatty liver disease and metabolic syndrome. Hippokratia. 2009;13(1):9–19.
19. Chalasani N, Younossi Z, Lavine JE. The diagnosis and management of non-alcoholic fatty liver disease: practice Guideline by the American Association for the Study of Liver Diseases, American College of Gastroenterology, and the American Gastroenterological Association. Hepatology. 2012;55(6):2005–2023.
20. Mohammed E, Hamdy L, Ahmed Y, Ali N. Clinical usefulness of serum ferritin level in patients with fatty liver. MJMR. 2020;31(2):201-5.
21. Modares Mouavi SR, Geramizadeh B, Anushiravani A, Ejtehadi F, Anbardar MH, Moini M. Correlation between serum ferritin level and histopathological disease severity in non-alcoholic fatty liver disease. Middle East J Dig Dis. 2018;10(2):90-5.
22. Roy S, Majumder A. A Retrospective Study to Examine the Correlation of Bioelectrical Impedance Analysis with Shear-wave Elastography in Indian Patients with Non-alcoholic Fatty Liver Disease and Diabetes on Background Sodium-glucose Cotransporter-2 Inhibitor Therapy. Cureus. 2019;11(5).
23. Seyedian SS, Hajiani E, Hashemi SJ, Masjedizadeh A, Shayesteh AA, Alavinejad P, et al. Relationship between serum ferritin level and transient elastography findings among patients with nonalcoholic fatty liver disease. J Family Med Prim Care. 2017;6(4):750-9.
24. Parikh P, Patel J, Ingle M, Sawant P. Serum ferritin levels predict histological severity in patients with nonalcoholic fatty liver disease in India. Indian J Gastroenterol. 2015; 34:200–8.
25. Kowdley KV, Belt P, Wilson LA, Yeh MM, Neuschwander-Tetri BA, Chalasani N, Sanyal AJ, Nelson JE, NASH Clinical Research Network. Serum ferritin is an independent predictor of histologic severity and advanced fibrosis in patients with nonalcoholic fatty liver disease. Hepatology. 2012 Jan;55(1):77-85.
26. Valenti L, Fracanzani AL, Bugianesi E, Dongiovanni P, Galmozzi E, Vanni E, Canavesi E, Lattuada E, Roviaro G, Marchesini G, Fargion S. HFE genotype, parenchymal iron accumulation, and liver fibrosis in patients with nonalcoholic fatty liver disease. Gastroenterology. 2010 Mar 1;138(3):905-12.