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Role of US Elastography in evaluation of Non Alcoholic Fatty Liver Disease

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Abstract*: Fatty liver is a widely prevalent hepatic disease worldwide. Moderate fatty liver can lead to significant necrosis and inflammation in hepatocytes. Severe fatty liver can lead to fibrosis. If untreated, the condition can progress to liver cirrhosis.*

In recent years, ultrasonic imaging technique has transformed to functional imaging from anatomical imaging. Ultrasonic elastography technique is one of the new functional ultrasonic imaging techniques, which developed in the past few years and can be used in quantitative and semi-quantitative assessment of diffuse lesions in liver, such aspost-hepatitis cirrhosis, alcoholic cirrhosis, hepatic dysfunction after surgery etc. Although many researchers have employed ultrasonic elastography in study of chronic hepatic diseases, few studies are available on the diagnosis of fatty liver. This cross sectional study was done to evaluate the role of ultrasonic shearwaveelastography in assessment of fatty liver grading.

Materials & Methods*: Prospective, observational study comprising of 150 adults with no gender bias between the age of 20 and 70 yearsreferred for routine abdominal sonography. All patient underwent gray scale sonography and shear wave elastography and results were analysed. History of hepatitis, alcoholism, diabetes mellitus, hypertension and obesity was taken into consideration.*

Results: A significant positive correlation was found between various grades of Non alcoholic fatty liver disease (NAFLD) as assessed subjectively on grey scale sonography and the liver stiffness in kilopascal (Kpa) using shear wave elastography.

Conclusions: *Shear wave elastography being an objective imaging tool is a reliable modality compared to grey scale sonography in diagnosis of NAFLD and has the capacity to carry out quantitative evaluation of liver parenchyma in vivo.*

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I. Introduction

The non-alcoholic fatty liver disease (NAFLD) is on a global rise with prevalence rates of 15-30% in the western population and 9-32% in Indian population.

Spectrum of disorders ranging from simple steatosis to lobular inflammation with variable degrees of fibrosis, non-alcoholic steatohepatitis (NASH), NAFLD can be a forerunner of cirrhosis and hepatocellular carcinoma, conditions associated with grave clinical outcome.

The prognosis of NAFLD depends on histological stage. Simple steatosis with benign slow progression has a better prognosis while NASH has poor prognosis because of its early progression into end stage liver disease.

Hence, the pivotal issue in the management of patients with NAFLD is the diagnosis of steatohepatitis and fibrosis at an early stage.

Although, liver biopsy is indisputably the gold standard for diagnosing NAFLD, being an invasive technique biopsy carries its own limitations.

The preferred first line of investigation among clinicians for making the diagnosis of a fatty liver disease, therefore continues to be noninvasive methods such as serum markers and imaging modalities like gray scale ultrasonography.

The newer elastographic technique allows for objective assessment of tissue parenchyma based on a physical parameter that measures tissue elasticity or stiffness in kilopascal (kPa). It gives indirect information about pathological alterations like inflammation and fibrosis.

The elastography technique has also been evolving over time. Commencing with conventional transient elastography (TE), it has now transited to shear wave elastography. The latter has advantage of being quantitative with advantage that it does not require separate equipment and can be combined with a conventional US, thus saving time and cost. It is operator independent, reproducible, carries high spatial resolution, and has the ability to perform a quantitative evaluation of elasticity in kPa without manual compression artefacts.

The present study was carried out to assess the liver stiffness in fatty liver disease with shear wave elastography and further to correlate these liver stiffness values with gray scale sonographic grades of fatty liver, to determine if elastography can act as a reliable noninvasive tool to grade NAFLD.

II. Materials And Methods

A cross sectional observational study was carried out in the Department of Radiodiagnosis, V.S Hopistal, NHL MMC, Ahmedabad over a period of 12 months (September 2017 to September 2018).

Inclusion criteria for the study group:- 150 subjects between 20 and 70 years of age were included in this study group, referred for routine abdominal ultrasonography among which 80 were males and 60 were females.

History of alcoholism, hypertension, diabetes and hepatitis was taken.

Instrument:-

Exclusion criteria:- Paitents with SOL of liver, alcoholic fatty liver disease and ascites were excluded.

Routine transabdominal hepatic sonography using SAMSUNG scanner were performed in all the subjects and were graded as grade 0, 1, 2 and 3 (Figure 1) based on the echotexture of liver.

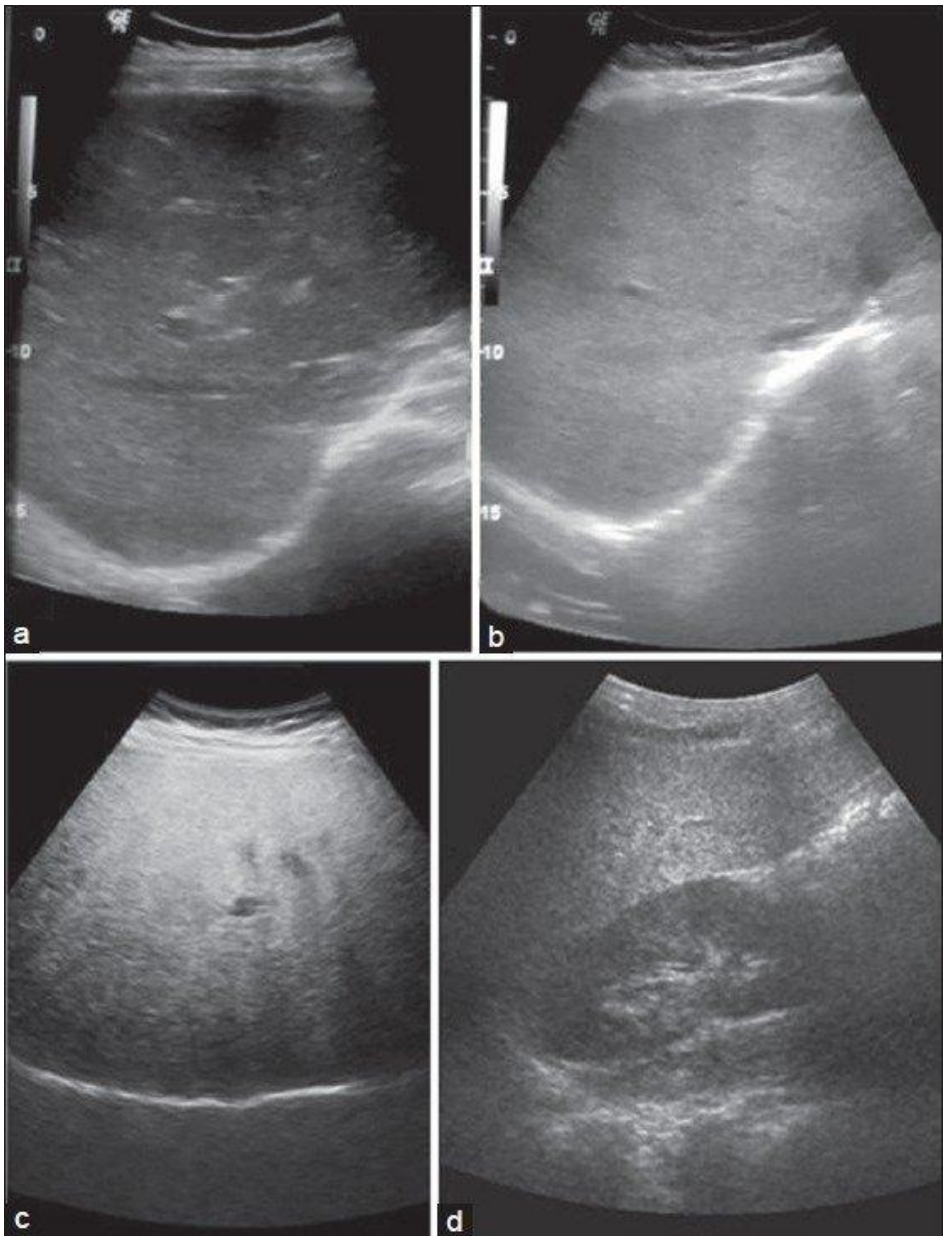


Figure 1: Grey scale sonographic image of normal liver and various grades of fatty liver. A) Grade 0/normal, B) Grade I, C) Grade II, D) Grade III.

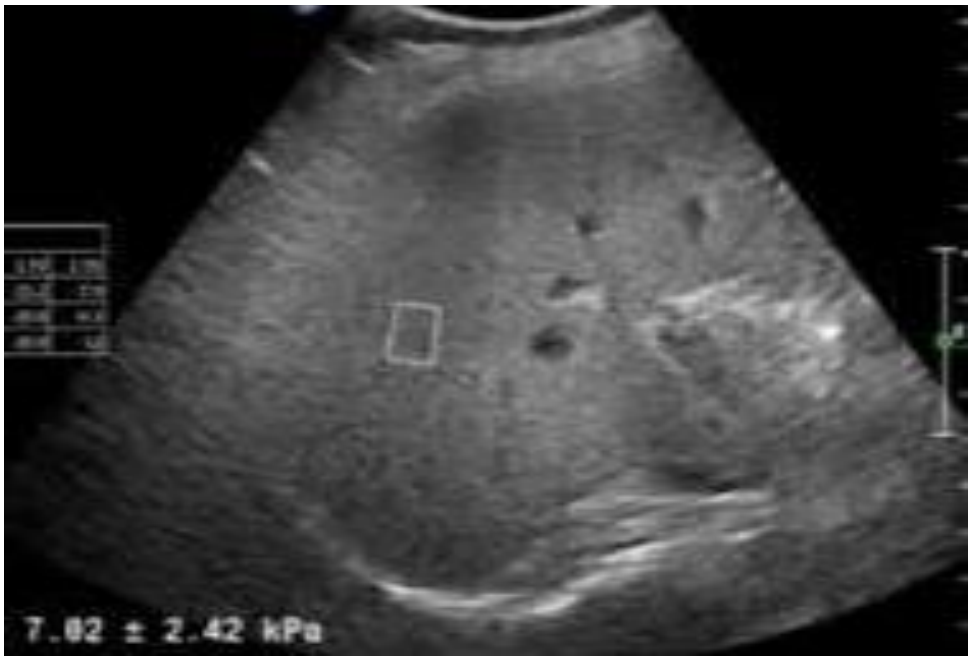
Grade 0: Normal (Figure 1A).
Grade 1: Mild diffuse increase in liver echogenicity with clear visualization of diaphragm and intrahepatic vessels (Figure 1B).
Grade 2: Moderate diffuse increase in liver echogenicity obscuring the intrahepatic vessels and diaphragm (Figure 1C).
Grade 3: Gross increase in liver echogenicity with poor/non-visualization of intrahepatic vessels and diaphragm (Figure 1D).

Shear wave elastography of the different segments of right lobe of liver was performed following grey scale USG using curvilinear array transducer of 3-5MHz frequency on the ??Samsung . The right lobe of the patient was examined in left lateral decubitus with the right arm in maximum abduction.

Scanning was performed with minimal scanning pressure applied by the operator while the patients were asked to stop breathing for a moment in order to minimize breathing motion. All measurements were and reported in kilopascals. Total of ten readings in kPa were taken at various sites to assess stiffness. Mean of quantitative values of liver stiffness was taken.Mean liver stiffness for each grade of fatty liver was obtained.

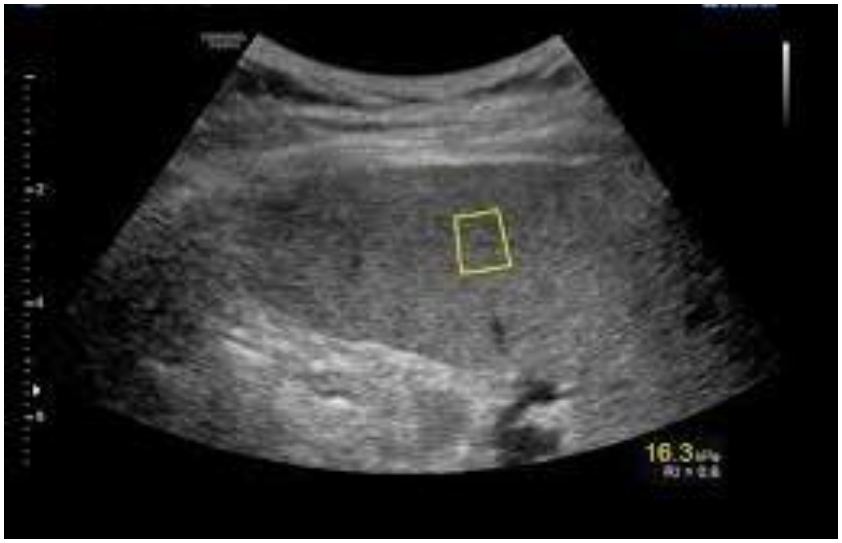
Figure 2 Shear wave elastography of the same patients as in Figure 1 showing mean stiffness values (kPa) for normal liveandvariousgradesof fatty liver.

A)Grade 0 (3.135)



B) Grade I (7.62)

C) Grade II (9.26



D) Grade III (16.3)

III. Results

Distribution of subjects in various grades of fatty liver based on subjective assessment on grey scale sonography was tabulated in Table 1.

Sonographic grades	Frequency	Percentage
Grade 0	30	20%
Grade 1	40	26.6%
Grade 2	40	26.6%
Grade 3	40	26.6%
Total	150	100%

Table 1: Distribution of subjects in various grades of fatty liver showing frequency and percentage distribution of subjects in sonographic grades of fatty liver.

On objective assessment of liver parenchyma using shear wave elastography, the mean liver stiffness (shear modulus) for normal subjects was found to be 5.07±1.73 kPa with increasing mean liver stiffness with increasing grades of fatty liver. Mean liver stiffness on shear wave elastography in various grades of fatty liver is tabulated in Table 2.

Table 2: Mean liver stiffness (kPa) on shear wave elastography with interquartile range (kPa) in various grades of fatty liver.

Grey scale Sonographicgrades	Meanstiffness (kPa)	Interquartilerange (Kpa)
Grade 0	5.07	3.85-5.84

Grade 1	6.84	5.46-7.94
Grade 2	9.43	8.72-10.16
Grade 3	11.96	10.21-13.55

On comparing between subjective and objective assessment on grey scale sonographic grades of fatty liver and liver stiffness on shear wave elastography respectively, it was found that mean stiffness increased with increasing grade of fatty liver on Greg scale sonography.

IV. Discussion

NAFLD, hepatic manifestation of the metabolic syndrome is a commonly encountered condition. It causes early parenchymal damage due to associated inflammation and fibrotic changes resulting in increased liver parenchymal stiffness.

Biopsy, an invasive investigation, continues to be the gold standard to assess degree of liver parenchymal damage and amount of liver fibrosis using a histological score (METAVIR Score) in NAFLD. Previous studies have shown that there is linear correlation between degree of hepatic steatosis as observed by grey scale USG with METAVIR score.

Gray Scale Sonography (USG), a subjective and qualitative assessment has been the most common modality used in then evaluation of fatty liver. It is safe, radiation-free, easily available, inexpensive and costeffective and can determine the fatty infiltration of liver based on increased echogenicity of the liver parenchyma.

However, Gray scale sonographic assessment of changes in echogenicity of liver only allows a semi quantitative estimation of the degree of hepatic steatosis and it cannot make with precision a histopathological quantification of steatosis. It is subjective, operator dependent, high inter and interobserver variation with low sensitivity and specificity.

The elastography technique has been evolving over time. Commencing with conventional transient elastography (TE), it has now transited to shear wave elastography. The latter has advantage of being quantitative with advantage that it does not require separate equipment and can be combined with a conventional US, thus saving time and cost. It is operator independent, reproducible, carries high spatial resolution, and has the ability to perform a quantitative evaluation of elasticity in kPa without manual compression artefacts.

It has been established in previous studies that the liver stiffness is directly proportional to degree of fibrosis. The shear wave elastography helps to diagnose, quantify steatosis as well as indirectly assess degree of fibrosis and inflammation in NAFLD can be used as primary modality for diagnosis and accurate quantitative grading of fatty liver.

In our study, grading of fatty liver was done using grey scale sonography and compared to liver stiffness values obtained in kPa by shear wave elastography.

In our study with increase in severity of fatty infiltration on Frey scale sonography, there is rise in liver stiffness. The mean liver stiffness in grade 1, grade 2 and grade 3 fatty liver was found out to be 6.84kPa, 9.43kPa and 11.96kPa respectively. This can be explained by the fact that degree of fibrosis increases with increasing grade of hepatic steatosis due to increasing level of inflammation with hepatocyte ballooning.

V. Conclusion

Shear wave elastography being an objective imaging tool for diagnosis of NAFLD has the capacity to carry out quantitative evaluation of liver parenchyma in vivo by assessing the liver stiffness in kilopascals (kPa). It appears to be a reliable, non-invasive, easy and quick substitute for biopsy and is a reproducible, quantitative substitute for grey scale ultrasonography.

In patients with NAFLD, change in liver stiffness as measured by shear wave elastographyhas linear relationship with grey scale sonographic grades of fatty liver which is likely due to underlying inflammatory change and fibrosis with increase in fat deposition.

Apart from diagnostic quantification of NAFLD, shear wave elastography can also be used for follow up of patients undergoing treatment to evaluate for reduction in the level of liver stiffness with reduction in steatosis and fibr

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