Positive Predictive Value of Ultrasound in Predicting Non-Alcoholic Fatty Liver Disease taking Magnetic Resonance Imaging as Gold Standard

Anek Ammar,[1] Syed Farrukh Nadeem,[2] Khadija Tul Kubra,[3] Mazhar Shafiq,[4] Tariq Mehmood Mirza,[5] Muhammad Arshad[6]

Abstract

Objective: To determine the positive predictive value of ultrasound in predicting non-alcoholic fatty liver disease taking magnetic resonance imaging as gold standard.

Method: 84 patients of both sex groups with ages in the range of 18-60 years suspected to have NAFLD underwent ultrasound examination of the liver and kidney and the ratio of mean gray-scale intensity of the liver / renal cortex calculated. The NAFLD on ultrasound was labelled as per operational definition. The MRI was performed and areas under the water peak and fat peak were recorded. Liver fat content was calculated. The NAFLD on MRI was labelled as per operational definition. All the data was noted along with demographic details of the patient.

Results: The age of the patients ranged from 18 years to 60 years with a mean of 41.4years. Male to female ratio of 1:5 was found. The BMI of the patients ranged from 22.6 Kg/m2 to 34.8 Kg/m2 with a mean of 30.8 Kg/m2 and 71.4% patients were obese. 34.5% patients were diabetic. The diagnosis of NAFLD was confirmed in 96.4% cases on MRI. Taking MRI diagnosis of NAFLD as gold standard, it yielded a positive predictive value of 96.4% for ultrasound in predicting NAFLD.

Conclusion: Ultrasound showed a high positive predictive value in the diagnosis of non-alcoholic fatty liver disease irrespective of patient's age, gender, BMI and history of diabetes which advocate its preferred use in future medical practice.

Keywords: NAFLD, MRI, ultrasound, predictive value, diabetic

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Introduction

Non-alcoholic fatty liver disease (NAFLD) is fat accumulation in liver which is not caused by excessive alcohol intake. NAFLD is the most common liver condition in the world with a prevalence of up to 30% and 10% in developed and developing countries respectively. NAFLD is found predominantly in obese and diabetic patients due to its pathogenesis being associated with insulin resistance. NAFLD has genetic and lifestyle risk factors, and it is recognized as a major indicator in deaths and diseases related to liver. With the growing obesity and metabolic syndrome epidemidcs, non-alcoholic fatty liver disease (NAFLD) has become the most common cause of chronic liver disease worldwide and will become one of the leading causes of cirrhosis.[1-3] The non-invasive modalities to diagnose and evaluate NAFLD are ultrasound, elastography, CT scanning, MRI which employs various techniques including chemical shift and spectroscopy.[4] The sensitivity and specificity of MRI in detecting NAFLD is reported to be 100%.[5-7] Zhang, et al. in 2014 conducted a study and calculated the positive predictive value (PPV) of ultrasound in predicting NAFLD and found it to be

1-5. CMH Lahore
6. Avicenna Medical College

Correspondence:
Dr Anek Ammar, Registrar, CMH Lahore, ammaranek@gmail.com

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94.2%.[8] The positive predictive value varies with the prevalence of the disease. In our community, a related study has not been published yet and thus there is a dire exigency to perform it so that ultrasound's PPV in predicting NAFLD, taking MRI as gold standard, in local population could be determined which up till now has been proven to be a silent disease; and this silent disease's incidence is progressively increasing. This study will help us to determine the PPV of ultrasound (which is readily available and is a cheap modality) in detecting NAFLD, which can help us in using this modality as screening tool among the local population, helping in early detection of NAFLD and reducing the mortality and morbidity associated with NAFLD caused by its progression to hepatic cirrhosis, hepatocellular carcinoma, and hepatic failure in very short period of time.

Materials and Methods

It was a cross-sectional survey. Research was conducted at Department of Diagnostic Radiology, Combined Military Hospital Lahore. Duration of study was 6 months from 11/09/2020 to 10/03/2021. Sample size of 84 cases was computed with 95% confidence level and 5% margin of error along with expected PPV of ultrasound abdomen predicting NAFLD to be 94.2%. Non-Probability, Consecutive Sampling was employed to select the subjects. Both gendered patients with a range of age between 18 years to 60 years, predicted to have NAFLD on ultrasound as per operational definition. Patients who signed written informed consent to participate in the study. Patients who were taking steroids (>3 doses in past 4 weeks), having hepatitis B or C as per ELISA method, or having any structural abnormality of kidney on ultrasound as per history/investigations and patients who had history of ingestion of alcohol for >7 days in past 8 weeks. After acceptance from institution's ethical review committee, 84 patients suspected to have NAFLD on routine abdominal ultrasound scan presenting in department of radiology as per operational definition and who satisfied the above-mentioned specifications were detailed about the study. Patients gave their coplete histories and written consent was taken. Patients underwent ultrasound examination of the liver and kidney and the gray-scale intensities of both the liver and the kidney were determined two times in a single patient and then the ratio was calculated by dividing mean gray-scale intensity of the liver / mean grayscale intensity of the renal cortex. The NAFLD on ultrasound was labelled as per operational definition. The MRI was performed by measuring the fat content in the right lobe of the liver only while patient was in a supine position. Areas under the water and fat peaks were registered. Liver fat content was determined by [liver fat content (%) = area under the fat peak / (area under the fat peak + area under the water peak) × 100]. The NAFLD on MRI was labelled as per operational definition. The proforma was filled using the patient's data and his/ her demographics. All the ultrasound examinations were performed by the same consultant of the radiology department on the same ultrasound machine and all the MRI fat contents were calculated on the same MRI machine to eliminate bias and confounding variables were controlled by exclusion.

Results

The age of the patients was in the range of 18-60 years with a mean of 41.4±11.7 years. 14 (16.7%) males and 70 (83.3%) females with a male: female totaling 1:5. The BMI of the patients spanned between 22.6 Kg/m^2 to 34.8 Kg/m^2 with a mean of 30.8±3.6 Kg/m^2 and 60 (71.4%) patients were obese. 29 (34.5%) patients were diabetic (Figure:1). The diagnosis of NAFLD was confirmed in 81 (96.4%) cases on MRI. Taking MRI diagnosis of NAFLD as gold standard, there were 81 (96.4%) true positive and 3(3.6%) false positive cases. It yielded a positive predictive value of 96.4% for ultrasound in predicting NAFLD taking MRI as gold standard as shown in Table-1

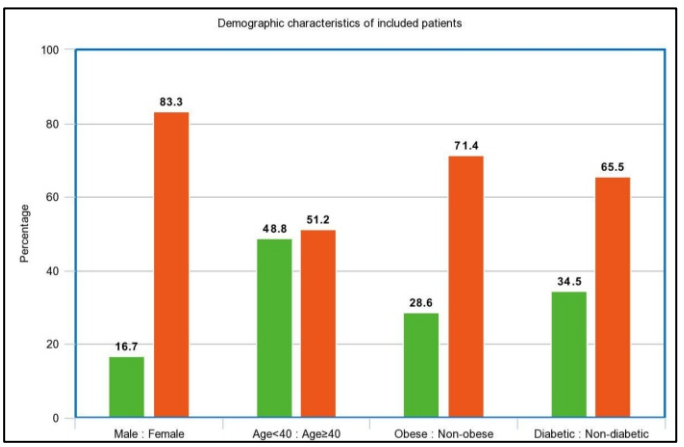

Fig-1: *Demographic Characteristics of study patients*

n=84

NAFLD on MRI	Frequency	Percent (%)
Yes (True Positive)	81	96.4%
No (False Positive)	3	3.6%
Total	84	100.0%

Positive Predictive Value = $\frac{81}{81+3} \times 100$

Positive Predictive Value = 96.4%

Table-1: *Frequency of NAFLD on MRI and Positive Predictive Value of Ultrasound*

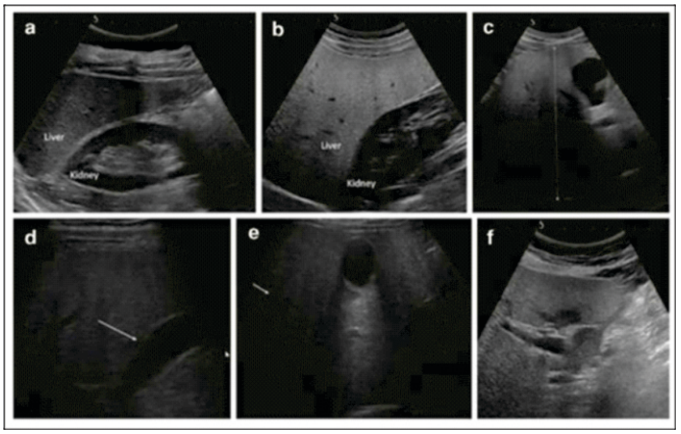

Fig-2: *Appearances of fatty change liver on ultrasonography*

Discussion

One of the foremost causes of liver disease in the world is nonalcoholic fatty liver disease (NAFLD) with increasing prevalence because of the epidemics of obesity and metabolic syndrome and has become the main referral reason to hepatologists.[9] NAFLD is fat buildup in liver more than 5% of the organ's weight, not being explicated by at risk alcohol intake which has a 30 g/ day threshold in males and 20 g/day threshold in females.[10,11] NAFLD carries both a clinical and an economic burden which will increase with population growth.[9] NAFLD is not considered benign as it can advance to hepatocellular carcinoma, liver transplantation, and ultimately death.[1] A subset of patients with NAFLD is usually asymptomatic and is incidentally detected during routine medical workup for some other problem[2]. Delay in the diagnosis adversely affects the prognosis of patient and necessitates accurate screening tests to timely identify patients with early changes at a stage when medical intervention is more effective and is associated with better outcome.[2-4] MRI is the current gold standard for the diagnosis of NAFLD with sensitivity and specificity of 100%.[5-7] However, it is a time consuming test and can't be performed in routine.[5] On ultrasonography fatty change liver appears as increased parenchymal echogenicity in comparison to kidneys. This change is easy to be noticed by ultrasonologist. Few recent studies reported good positive predictive value of ultrasound in the detection of NAFLD which along with its non-invasive nature and bedside availability favoured its use in future practice.[8,12]

However, the available evidence was limited while there was no regional publication which demanded the present study. A comparable mean age of 41.04±12.66 years was observed by Niaz et al. (2011) among patients presenting at PNS Shifa Hospital, Karachi.[13] Iqbal reported similar mean age of 40±12 years in patients presenting with NAFLD at Aga Khan University Hospital, Karachi.[14] A relatively higher mean age of 52.31±5.96 years has been reported by Afzal et al. among patients presenting at Shaikh Zayed Hospital, Lahore[15] while a much lower mean age of 30.26±9.[16] years was observed by Ahsan et al. at Jinnah Postgraduate Medical Centre, Karachi.[16] Kumar et al. observed similar mean age of 40.9±12.[8] years among Indian such patients.[17] We observed that there was a female predominance among patients with non-alcoholic fatty liver disease with male: female of 1:5. A similar female predominance among NAFLD patients has been reported previously by Ahsan et al. (1:6), Alavi et al. (1:2) and Afzal et al. (1:1.7) in local population and Kumar et al. (1:4.3) in Indian population,[15-18] while Taseer et al. reported nearly equal gender distribution among such patients at Nishtar Hospital Multan.[19] Kalra et al. on the other hand observed a male predominance (1.4:1) among such patients in Indian population.[20] We observed that ultrasound had a positive predictive value of 96.4% in predicting NAFLD taking MRI as gold standard. In a previous study, Zhang et al. (2014) reported the positive predictive value of ultrasound in predicting NAFLD to be 94.2% in line with the present study.[18] Our observation is also in line with that of Almeida et al. (2008) who reported the positive predictive value of ultrasound in diagnosing non-alcoholic fatty liver disease to be 98.4%.[12] This study is first of its kind in our native population. In the present study,

ultrasound was found to have a high positive predictive value of 96.4% in the diagnosis of non-alcoholic fatty liver disease irrespective of patient's age, gender, BMI and history of diabetes which along with its low cost, non-invasive and radiation free nature and widespread and bed-side availability advocate the preferred use of ultrasound in the diagnostic evaluation of patients suspected of NAFLD in future medical practice.

Conclusion

In the present study, ultrasound was found to have a high positive predictive value of 96.4% in the diagnosis of non-alcoholic fatty liver disease irrespective of patient's age, gender, BMI and history of diabetes which along with its low cost, non-invasive, radiation free nature, and bed-side availability advocate the preferred use of ultrasound in the diagnostic evaluation of patients suspected of NAFLD in future medical practice.

Conflict of Interest *None*

Funding source *None*

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Authors Contribution

AA, KTK: Conceptualization of Project
KTK: Data Collection
TMM, MA: Literature Search
SFN, MS: Statistical Analysis
TMM, MA: Drafting, Revision
MS: Writing of Manuscript