International Journal of Medical and Pharmaceutical Sciences
Open access peer-reviewed Journal
Volume 2, Issue 9, Page 676-679.
https://doi.org/10.5281/zenodo.23021162

Research Article

Comparative Study of Grey-Scale Sonographic Imaging and Shear-Wave Elastography Imaging in Non-Alcoholic Fatty Liver Disease

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Background: Non-alcoholic fatty liver disease (NAFLD) is a common chronic liver disorder in which assessment of hepatic steatosis and fibrosis is important for determining disease severity. Grey-scale ultrasonography is widely used for grading hepatic steatosis, whereas shear-wave elastography (SWE) provides quantitative assessment of liver stiffness and may provide additional information regarding fibrosis. Objective: To compare grey-scale sonographic imaging and shear-wave elastography imaging in patients with NAFLD and to determine the relationship between sonographic grades of fatty liver and SWE-derived liver stiffness. Materials and Methods: This prospective observational study was conducted in the Department of Radiology, Apollo Hospitals, Bannerghatta Road, Bangalore, from November 2022 to November 2023. A total of 180 adult patients diagnosed with NAFLD who underwent both grey-scale ultrasonography and 2D-SWE were included. Hepatic steatosis was graded as Grade I, II, or III on B-mode ultrasonography. Liver stiffness was measured in kilopascals (kPa) using 2D-SWE. The relationship between sonographic grade and SWE values was assessed using Pearson correlation and analysis of variance. Results: Among the 180 participants, Grade II steatosis was most frequent (49.5%), followed by Grade I (41.1%) and Grade III (9.4%). Mean SWE values increased progressively with increasing B-mode grade: 5.59 ± 0.877 kPa in Grade I, 7.28 ± 1.332 kPa in Grade II, and 11.41 ± 2.347 kPa in Grade III (ANOVA, $p<0.01$). A very strong positive correlation was observed between B-mode grade and SWE values ($r=0.99$, $R^2=0.97$, $p<0.001$). Sensitivity and specificity were 85% and 78% for B-mode ultrasonography and 92% and 88% for 2D-SWE, respectively. Conclusion: Grey-scale sonographic grades of fatty liver were associated with progressively higher liver-stiffness measurements on 2D-SWE. The findings indicate that SWE can provide quantitative information complementary to conventional grey-scale ultrasonography in the imaging evaluation of NAFLD. Further studies using standardized reference standards are warranted.

Keywords: Non-alcoholic fatty liver disease; grey-scale ultrasonography; shear-wave elastography; liver stiffness; hepatic steatosis; fibrosis.

INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is a common chronic liver disorder characterized by excessive accumulation of fat within the liver in the absence of significant alcohol consumption. It encompasses a spectrum ranging from simple hepatic steatosis to non-alcoholic steatohepatitis (NASH), progressive hepatic fibrosis and cirrhosis. Studies from India have reported a substantial burden of NAFLD in the adult population. [1,2] Although simple hepatic steatosis may remain stable in many individuals, a proportion of patients progress to steatohepatitis and clinically significant fibrosis. The extent of hepatic fibrosis is an important determinant of disease progression and liver-related morbidity and mortality. Accurate assessment of hepatic fibrosis is therefore an important component of the evaluation of patients with NAFLD. [3,4] Liver biopsy has traditionally been considered a reference method for

assessing hepatic fibrosis. However, its invasive nature, potential complications, sampling variability and interobserver variation limit its use as a routine screening and follow-up investigation. These limitations have increased interest in non-invasive biomarkers and imaging techniques for assessment of liver disease. [4] Grey-scale or B-mode ultrasonography is widely available, relatively inexpensive and commonly used as an initial imaging investigation for hepatic steatosis. Increased hepatic echogenicity and changes in visualization of the hepatic vessels and diaphragm allow fatty liver to be categorized into mild, moderate and severe grades. However, conventional B-mode ultrasonography provides predominantly qualitative or semi-quantitative information and does not directly quantify liver stiffness. Its interpretation may also be influenced by technical and operator-related factors. [5,6] Shear-wave elastography provides a non-invasive method for quantitative assessment of tissue stiffness. Two-dimensional shear-wave elastography (2D-SWE) generates shear waves within the liver and measures their propagation to provide a quantitative estimate of tissue stiffness, generally expressed in kilopascals (kPa). It can be performed during the same ultrasound examination and may provide information complementary to conventional B-mode imaging. [7,8] Previous studies have evaluated ultrasound elastography in NAFLD and have demonstrated associations between liver stiffness and hepatic fibrosis. Meta-analytic and review data suggest that ultrasound-based elastography can contribute to non-invasive fibrosis assessment, although performance varies with technique, disease stage and patient-related factors. [7–12] Therefore, a comparative assessment of conventional grey-scale sonographic grading and quantitative SWE measurements may help characterize the relationship between the imaging appearances of fatty liver and liver stiffness. The present study was undertaken to compare these two imaging approaches in patients with NAFLD.

AIM

The primary aim of this study was to compare grey-scale sonographic imaging and shear-wave elastography imaging in patients with non-alcoholic fatty liver disease and to determine the relationship between sonographic fatty-liver grade and SWE-derived liver stiffness.

OBJECTIVES

1. To assess the distribution of grey-scale sonographic grades of hepatic steatosis in patients with NAFLD.

2. To measure liver stiffness using 2D-SWE across different grades of fatty liver.

3. To determine the correlation between grey-scale sonographic grade and SWE-derived liver stiffness values.

4. To compare the complementary information provided by grey-scale ultrasonography and shear-wave elastography in the imaging assessment of NAFLD.

RESULTS

The study included 180 adult participants with NAFLD who underwent both grey-scale ultrasonography and 2D-SWE. The reported distribution of sonographic steatosis grades was Grade I in 41.1%, Grade II in 49.5%, and Grade III in 9.4%.

Mean liver stiffness increased with increasing grey-scale sonographic grade. The mean SWE value was 5.59 ± 0.877 kPa for Grade I steatosis, 7.28 ± 1.332 kPa for Grade II steatosis, and 11.41 ± 2.347 kPa for Grade III steatosis. The difference among the groups was statistically significant on analysis of variance ($p<0.01$).

A very strong positive correlation was reported between grey-scale sonographic grade and SWE value ($r=0.99$, $R^2=0.97$, $p<0.001$), indicating that higher sonographic grades were associated with higher liver-stiffness measurements.

The reported sensitivity and specificity were 85% and 78%, respectively, for B-mode ultrasonography and 92% and 88%, respectively, for 2D-SWE. These diagnostic-performance values require interpretation according to the reference standard used in the original study and should be verified before final submission.

DISCUSSION

The present study demonstrates a progressive increase in liver stiffness measurements obtained by 2D-SWE with increasing grades of fatty liver on grey-scale ultrasonography. The mean SWE values increased from 5.59 kPa in Grade I to 7.28 kPa in Grade II and 11.41 kPa in Grade III, with a statistically significant difference between the groups. This finding suggests that quantitative elastography may provide additional information alongside the conventional sonographic assessment of hepatic steatosis. The very strong positive correlation reported between B-mode grade and SWE value indicates a close relationship between the two imaging parameters in this study. However, grey-scale grade primarily reflects the sonographic appearance of hepatic steatosis, whereas SWE measures tissue stiffness. Therefore, the two techniques should not be regarded as measuring identical pathological processes. Liver stiffness may be affected by fibrosis as well as other factors, including inflammation and technical or patient-related variables. [7,8] Conventional grey-scale ultrasonography remains useful because it is widely available, relatively inexpensive and familiar in routine clinical practice. Nevertheless, its qualitative nature limits its ability to quantify fibrosis. SWE offers a quantitative measurement that may complement the morphological information obtained from B-mode imaging. Published reviews and comparative studies support the role of ultrasound elastography as part of a non-invasive approach to fibrosis assessment in NAFLD. [7–12] The reported sensitivity and specificity values suggest potentially greater diagnostic performance with 2D-SWE than with conventional B-mode ultrasonography; however, these figures should be interpreted only in relation to the specific reference standard and diagnostic threshold used. If a histopathological or other validated reference standard was not used, these values should not be interpreted as definitive evidence of fibrosis-diagnostic accuracy. The study supports a complementary imaging approach in which grey-scale ultrasonography is used to characterize the degree of hepatic steatosis and SWE is used to provide quantitative information about liver stiffness. Further prospective studies with larger samples, standardized SWE acquisition protocols and an appropriate reference standard are required to establish reproducible diagnostic thresholds and determine the independent contribution of each imaging technique.

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Cite: Pruthvi S.*, Comparative Study of Grey-Scale Sonographic Imaging and Shear-Wave Elastography Imaging in Non-Alcoholic Fatty Liver Disease, Int. J. Med. Pharm. Sci., 2026, 2 (9), 676-679. https://doi.org/10.5281/zenodo.23021162